Combining satellite telemetry and citizen science to design regional and national surveys for Andean Condors (*Vultur gryphus*) in Peru

[Combinando la telemetría satelital con la ciencia ciudadana para el diseño de conteos regionales y censos nacionales del cóndor andino (*Vultur gryphus*) en Perú]

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ABSTRACT

We present 62 localities with the highest number of recorded Andean Condor (*Vultur gryphus*) individuals which should be included as counting stations to estimate population size of the species in Peru. These localities were selected by combining citizen science data available in *ebird*, with daily distances of movement obtained from one adult male condor fitted with a satellite transmitter between October 2015 and September 2016. These localities were separated at least 57 km to reduce biases derived from duplicate counting of individuals during counts or censuses. Despite the fact that the most effective way for estimating population size of Andean condors is by performing direct counts at communal roosting sites, we argue that the known number of roosting sites in Peru is still too low to allow a precise estimation of total number of individuals. For this reason, we recommend that simultaneous counts be conducted from the localities we present here.

KEY WORDS: census, citizen science, communal roosting sites, monitoring, priority areas.

RESUMEN

Presentamos 62 localidades con la mayor cantidad de individuos de cóndor andino (*Vultur gryphus*) en el Perú, que deberían ser consideradas como lugares de conteo para realizar un monitoreo nacional orientado a estimar el número de cóndores andinos en el país. Estas localidades fueron seleccionadas a partir de información proporcionada por ciudadanos que está disponible en la plataforma *ebird*, y combinada con información de las distancias diarias de vuelo recorridas por un cóndor andino adulto entre octubre 2015 y septiembre 2016 y que fue obtenida a partir de telemetría satelital. Todas las localidades identificadas están separadas al menos 57 km para reducir las probabilidades de contar dos o más veces a un mismo individuo durante los conteos o censos. A pesar de que la forma más efectiva de estimar el tamaño poblacional del cóndor andino es a través de conteos directos en dormideros comunales (*o condoreras*), argumentamos que el número conocido de estos dormideros en Perú aun no permite una estimación precisa de número de individuos en el país. Por esa razón, sugerimos que se realicen conteos simultáneos desde los lugares que aquí presentamos.

PALABRAS CLAVE: áreas prioritarias, censos, ciencia ciudadana, dormideros comunales, monitoreo.

INTRODUCTION

Population size is a key demographic parameter to correctly asses the conservation status of wildlife species (IUCN 2001). However, and despite its importance, very few species have robust data to reliably estimate population size and trends in time. This lack of information hinders conservation efforts even for highly charismatic and threatened species that are widespread (Buckland *et al*. 2008, Marsden & Royle 2015). For all species, the assessment and reassessment of their level of threat based on demographic estimates with low bias should inform us on the effectiveness of the conservation measures adopted and should point to other conservation measures in case these are not working (Marsden & Royle 2015).

The Andean Condor (*Vultur gryphus*) is a wide ranging, neotropical vulture with a decreasing population size along its entire distributional range due to human persecution, poisoning and habitat loss (Birdlife International 2021, Wallace *et al*. 2020). The global population size of the Andean Condor is estimated at 6700 mature individuals (BirdLife International 2021) with their population size becoming smaller in countries located in the northern part of its distribution: 2000 individuals in Argentina and Chile, and approximately 280 in Ecuador and Colombia (BirdLife International 2021, Wallace *et al*. 2020).

Despite its large size and extreme weight, the Andean Condor is a highly mobile species, and individuals can effortlessly fly up to 300 km or more in a day (Lambertucci *et al*. 2014, Pávez 2014). This, plus the species' large distributional range represent limiting factors for counting Andean Condors and accurately estimating population sizes at the country and regional levels.

There are many methods to count birds and they depend on some natural history features of each species, such as behavior, morphology, and the habitats where they occur (Bibby *et al*. 1998); as well as research and conservation objectives for the target species. For some species, it may be possible to perform total counts in its entire range, but for most, some sort of sampling that allows to estimate the current population size will be required (Bibby *et al*. 1998).

For the Andean Condor, population estimates are affected by the species high mobility, which might generate the duplicate counting of individuals and inflate population estimates, and that some individuals are not detected in selected locations. Because of this, certain methodological adjustments should be taken into account when censusing this species: i.e., conduct simultaneous counts in selected areas of importance or increase the distance between sampling stations to reduce the chance of counting the same individual at two or more sites (Bibby *et al*. 1998, Escobar 2013). To estimate the population size of Andean condors, three methods are mostly used.

Counts on roosting sites (*condoreras*): Andean Condors are gregarious when feeding and roosting, and several individuals congregate in communal roosting sites or *condoreras* to spend the night and early morning hours, and this is a time when they can be counted (Lambertucci *et al*. 2008, Kusch 2004). The simultaneous count of individuals at known roosting sites can be an adequate method to estimate minimum and total population size in an area/region (Lambertucci 2010, Escobar 2013) or in small countries such as Ecuador (Naveda-Rodriguez *et al*. 2016, Vargas *et al*. 2018).

Point counts from mountain tops: This method has been used to count Andean Condors in vast areas in Ecuador (Koenen *et al*. 2000). Given the large distances that condors can fly in a day (Lambertucci *et al*. 2014), counting points should be widely separated and counted simultaneously, to reduce the probability of counting the same individuals in different points. Special attention should be paid to the individual characteristics of all detected birds to differentiate them (i.e., moulting of wing feathers, etc.) (Koenen *et al*. 2000). Counts should be conducted from elevated areas that grant a 360° angle of view, and between 8.00 AM to 6.00 PM (Wallace & Temple 1987, McGahan 2011).

Counts at feeding stations: When Andean condors aggregate at carrions, they can be counted to estimate population size in a given area (Wallace & Temple 1985, Mendez *et al*. 2019). Specific morphological characteristics of individuals feeding on a carcass can be obtained through photos or by direct observations, helping to reduce duplicate counting of individuals at the same feeding station or at others. However, the number of birds that can be individually identified is low and is usually restricted to adult males (Ríos-Uzeda & Wallace 2007, Mendez *et al*. 2019), and given that some individuals will feed in carcasses that are not monitored, an undetermined portion of the population will not be counted.

For the past decade, citizen science (i.e., the biological information collected by non trained scientist that is generally available to a wider audience), has become a relevant source of information frequently used to asses the occurrence and the distribution of species in time and space globally (Sullivan *et al*. 2010, Devictor *et al*. 2010). Although information generated by citizen scientist is riddled with limitations, its use for the conservation of species has sharply increased recently (Dunn *et al*. 2005). Biases in the collection of this information, which include the incorrect identification of species which can result in the erroneous detection of species outside its known range, should be accounted so the inferences derived from this data can be used for the conservation of species.

In this study, we combined abundance data from *ebird* with flight distance satellite data as a method to estimate population size of Andean Condors in Peru and identify locations and areas counts should be performed. We propose the application of this methodology to implement a long–term population monitoring system with active participation of institutions and citizens interested in bird watching and conservation throughout Peru.

METHODOLOGY

Ebird data

We use information on the presence of Andean Condors (date, latitude, longitude, departments, locality, number of individuals observed and name of the observer) in Peru that was collected by citizens between 1 January 2000 to 30 November 2019 and made available through *ebird* (www.ebird.org) to identify priority (6-35 individuals) and secondary (1-5 individuals) localities for the monitoring of this species in the country. This information was then separated by departments to produce a list of sites within each department where all individuals were detected during this time period. After a visual inspection of all sites within the departments, we excluded from this list all repeated sites (i.e., with same coordinates), selected the list with the highest number of records, and then we plotted these locations as points in a map of Peru with ArcGis 10.3 (ESRI 2016). Subsequently, we identified the points with the highest number of individuals within each department.

Andean Condor satellite data

We calculated the average daily flight distance by one adult male individual (Atahualpa) Andean Condor fitted with a satellite transmitter from June 2015 to October 2016. See Piana and Vargas (2018) for a detailed description of the methods used to release this individual. We selected this individual because six months after it was released its behavior (i.e., flying distances, home range) were similar to those reported from wild individuals released in Chile and Argentina (Lambertuci *et al*. 2014, Pavez 2014). Daily distances were obtained from satellite fixes associated to a flying velocity > 10 km/h, and the distance flown each day was calculated as the sequential straight-line distance between consecutive satellite points obtained for each day (Lambertucci *et al*. 2014). In order to reduce underestimation of daily distances derived from poor satellite coverage, we only included days where number of satellite fixes where ≥10. Daily flying distances were calculated with ArcGis 10.3 (ESRI 2016).

Identification of census locations in Peru

In order to identify the most important areas/locations for Andean Condors in Peru that can be used as counting sites for national monitoring of the species, and given that Andean Condors daily movements are usually centered around a roosting site (Pavéz 2014), we drew a circle (buffer) based on the average daily distance of flight and excluded all other localities inside this circle (see Results).

RESULTS

We measured daily flying distances of one adult Andean Condor during 343 days (4255 satellite points) between June 1 2015 to October 31 2016. However, given that total distances were positively correlated with time after release (rs = 0.58, $p < 0.02$), and average monthly distances increased with days after release (i. e., 22.3 km in October 2015, 36.9 km in April 2016, 60.2 km in September 2016), we selected 12 months (from October 2015 to September 2016) with longer daily distances to minimize the effects that a prolonged captivity period might have had on this individual's flying behavior, namely a poor flying condition derived from a extended period in captivity and a possible association with human settlements when selecting feeding areas (Pávez 2014, Astore *et al*. 2017), that might have prevented this individual to fly at its full potential.

Daily average distance of flight during these months (232 days/3030 points) was 56.3 km (rounded to 57 km), although these varied widely: From 0.1 km to 208.6 km (%CV = 80.5).

Identification of areas for the monitoring of Andean Condors in Peru

We obtained 2206 reports of Andean Condor sightings in Peru from *ebird* in 19 departments (Amazonas, Ancash, Apurimac, Arequipa, Ayacucho Cajamarca, Cusco, Huancavelica, Ica, Junín, La Libertad, Lambayeque, Lima, Moquegua, Piura, Puno, San Martín, Tacna y Tumbes). Reports varied widely between departments with higher numbers for Cusco (638), Lima (561) and Arequipa (425), and fewer reports for Moquegua (6), San Martín (5), Tacna (4) and Tumbes (1).

To identify the most important locations for Andean Condors in Peru to be used as counting sites for national monitoring of the species we drew a circle (buffer) with a 57 km radius centered around locations with the largest number of individuals in each department and excluded all other sites where Andean Condors were detected inside this radius to ensure that all locations were separated at least by 57 km. We then produced a map with locations centered within the 57 km buffered areas and a list containing sites with "priority areas" and "secondary areas" that were separated by 57 km from each other.

We identified 62 areas/locations for population monitoring of Andean Condors: 18 priority areas and 44 secondary areas (Tables 1, 2; Figure 1). Priority areas are those where the number of individuals detected was ≥ 6 in each list and secondary areas where the number was ≤ 5 individuals in each list. Of priority areas, most (eleven) were located from Ica and Huancavelica to the south (Ayacucho, Cusco, Arequipa and Puno), while of all secondary areas, 18 of 44 were located also in the south (departments of Ayacucho, Apurímac, Arequipa, Cusco and Puno). Number of individuals detected in all priority areas was 273 (76%), and number of individuals detected in secondary areas was 87 (Table 1 and 2; Figure 1).

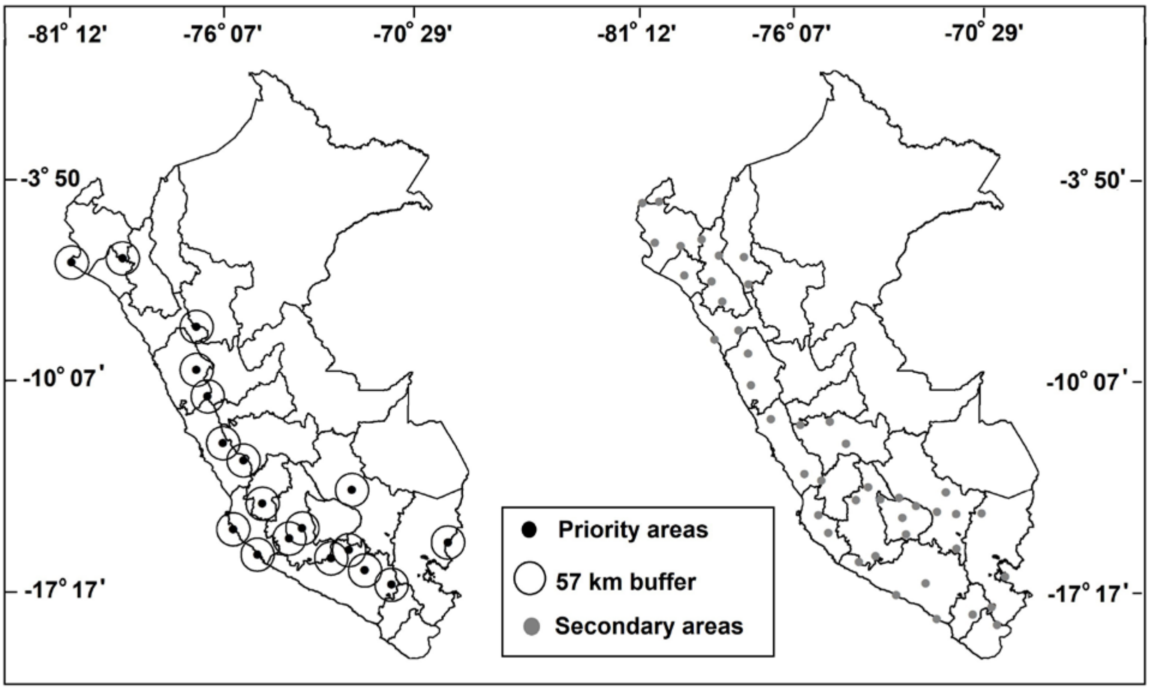

Fig. 1. Map of priority areas with a 57 km buffer (left) and with secondary areas (right) for the potential monitoring of the Andean Condor (*Vultur gryphus*) population in Peru.

Department/Province/Locality	Latitude	Longitude	Maximun No. Individuals	Piana & Angulo 2015
Piura/Sechura/Illescas Reserved Zone	5° 59' 50"	81° 07' 21"	35	1
San Martin/Mariscal Cáceres/ Rio Abiseo National Park/El Horno	8° 01' 56"	77° 15' 19"	9	2
Ancash/Bolognesi/Coordillera de Huayhuash Reserved Zone	10° 12' 01'	76° 55' 26"	8	3
Lima/Yauyos/Nor Yauyos Cochas Landscape Reserve	12° 12' 15"	75° 47' 58"	8	4
Ica/Pisco/Paracas National Reserve	14° 20' 51"	76° 08' 00"	16	5
Ica/Nazca/San Fernando National Reserve	15° 08' 31"	75° 21' 43"	21	6
Arequipa/La Unión/Sub Cuenca Cotahuasi Landscape Reserve	15° 14' 53"	72° 59' 45"	15	8
Arequipa/Arequipa/Salinas y Aguada Blanca National Reserve/Chocoltaña	16° 02' 41"	71° 02' 40"	17	9
Ayacucho/Lucanas/Pampa Galeras National Reserve	14° 38' 21"	74° 20' 24"	25	10
Lima/Huarochirí/Upper Santa Eulalia basin/Japani	11° 39' 47"	76° 26' 34"	10	11
Ayacucho/Lucanas/Sondondo Valley	14° 19' 12"	73° 55' 33"	30	12
Arequipa/Caylloma/Colca canyon/ Mirador Cruz del Condor	15° 36' 42"	71° 54' 25"	30	13
Ancash/Bolognesi/Huascaran National Park/ Rurichinchay valley	9° 22' 24"	77° 15' 48"	13	17
Cusco/La Convención/Abra Malaga	13° 06' 51"	72° 21' 14"	9	NA
Piura/Huancabamba/Abra de Porculla	5° 53' 02"	79° 32' 36"	7	NA
Huancavelica/Huaytará/road to Ayavi	13° 33' 07"	75° 11' 52"	6	NA
Arequipa/La Unión/Puyca district	14° 59' 14"	72° 25' 33"	6	NA
Puno/San Antonio de Putina/ Ananea district/Cojata	14° 41' 26"	69° 16' 15"	8	NA

Table 1. Priority areas determined from this study for monitoring of the Andean Condor (*Vultur gryphus*) population in Peru and maximum number of individuals from ebird (2000-2019).

DISCUSSION

Areas selected from this study can be included in simultaneous national censuses or to use in a subset of the identified locations, with both methods aimed at estimating the population size and temporal trends of the Andean Condor at country and regional levels, respectively. Identified priority areas to census the species were mostly located in the southern Andes, from Ica and Huancavelica departments to the south and east (Ayacucho, Cusco and Arequipa and Puno), while the remaining are distributed almost in a straight line from southeast of Lima department (Nor Yauyos Cochas Landscape Reserve) to the border with Ecuador (Illescas Reserved Zone), following the western flank of the Andes range. Maximum number of individuals reported in priority areas to the south (from Ica to the border with Bolivia) doubled the number of individuals reported to the north (183 vs. 90 individuals). In addition, the Illescas Reserved Zone, in the western lowlands amid the Sechura desert in north Peru, is of high conservation value for the species because a high number of individuals are consistently reported here, and because the first nesting for the species in Peru was also found here (Martínez 2016).

The establishment of a 57 km buffer around all the sites we identified is intended to reduce the probability of duplicate counting individuals between and among sites. Although the buffer we established could be somewhat conservative given that in Argentina, the mean daily distance of flight for one bird was 152 km (Lambertucci *et al*. 2014), in Chile, the average daily distance of flight for one adult male Andean Condor varied from 32 to 96 km depending on the season (Pavéz 2014). The buffer and the location prioritization scheme we propose (and the sites selected) could be adjusted as more wild individuals are fitted with satellite transmitters and more information on the flying behavior and abundance of Andean Condors is obtained.

Department/Province/Locality	Latitude	Longitude	Maximun No. Individuals
Tumbes/Contralmirante Villar/Casitas/Cerros de Amotape National Park/Cerro El Barco	4° 07' 27''	80° 36' 13''	1
Piura/Morropón/La Matanza/Cerro El Virrey	5° 31' 07''	79° 57' 05''	3
Piura/Talara/Los Organos	4° 09' 40''	81° 07' 10''	4
Piura/Piura/Piura/Piura city	5° 24' 06''	80° 44' 35''	1
Lambayeque/Lambayeque/Pacora	6° 25' 34''	79° 50' 38''	2
Cajamarca/San Ignacio/Tabaconas/La Bermeja	5° 18' 59''	79° 17' 30''	5
Cajamarca/Jaén/Jaén/Chamaya	5° 49' 09''	78° 45' 49''	1
Cajamarca/Santa Cruz/Santa Cruz	6° 37' 28''	78° 59' 25''	2
Cajamarca/Cajamarca/Magdalena/Upper Magdalena Valley	7° 14' 55''	78° 40' 02''	1
Amazonas/Chachapoyas/Leimebamba/Abra Barro Negro	6° 43' 21''	77° 50' 42''	4
Amazonas/Bongará/Florida/Reserva Huembo	5° 52' 32''	77° 59' 05''	1
La Libertad/Virú/Virú/Puerto Morín	8° 25' 55''	78° 54' 58''	1
La Libertad/Santiago de Chuco/Santiago de Chuco	8° 08' 49''	78° 10' 19''	1
Ancash/Huaylas/Huaylas/Carretera a Huaylas	8° 52' 36''	77° 52' 22''	2
Ancash/Aija/Coris/San Damián	9° 52' 05''	77° 47' 17''	1
Lima/Oyón/Cochamarca/Arara	10° 55' 35''	77° 10' 09''	3
Lima/Yauyos/Tauripampa/Bosque de Polylepis	12° 38' 27''	76° 07' 37''	2
Lima/Yauyos/Lincha/Carretera Viñak-Tipococha II	12° 50' 57''	75° 35' 09''	2
Junín/Chanchamayo/Chanchamayo/Rio Blanco	11° 00' 42''	75° 18' 59''	1
Junín/Junín/Ondores	11° 06' 39''	76° 14' 32''	5
Junín/Concepción/Andamarca/Valle Andamarca	11° 42' 24''	74° 48' 13''	1
Ica/Ica/San José de Los Molinos/Rio Inca/Carretera 1S	13° 55' 29''	75° 40' 44''	1
Ica/Ica/Santiago	14° 28' 28''	75° 21' 59''	1
Ayacucho/Cangayo/Chuschi/Chaquicocha	13° 27' 14''	74° 28' 50''	3
Ayacucho/Huamanga/Quinua/Bosque Osjowillka	13° 02' 59''	74° 06' 07''	3
Ayacucho/Parinacochas/Pullo/Sacsara	15° 11' 43''	73° 51' 34''	1
Arequipa/Caraveli/Jaqui	15° 23' 08''	74° 22' 58'	2
Arequipa/Castilla/Huancarqui/Zafranal	16° 02' 21''	72° 14' 18''	1
Arequipa/Camaná/Ocoña/Camino de salida de Ocoña	16° 24' 56''	73° 10' 37''	2
Arequipa/Islay/Dean Valdivia/Santuario Nacional Lagunas de Mejía	17° 08' 48''	71° 51' 50''	1
Moquegua/Mariscal Nieto/Torata/Bosque de Queñuales Pampa Cuellar	16° 58' 52''	70° 42' 01''	1
Moquegua/Mariscal Nieto/Carumas/Proyecto Especial Pasto Grande	16° 44' 42''	70° 06' 13''	1
Tacna/Tarata/Ticaco/ACR Vilacota-Maure	17° 16' 59''	69° 54' 24''	1
Cusco/La Convención/Vilcabamba/Yantana Forest	13° 23' 03''	73° 06' 55''	3
Cusco/Espinar/Espinar	14° 56' 49''	71° 15' 58''	1
Cusco/Paruro/Paccaritambo/Microcuenca de Toroy	13° 48' 28''	71° 53' 45''	4
Cusco/Paucartambo/Chayllabamba/Acjanacco/PN Manu	13° 12' 01''	71° 37' 59''	1
Cuzco/Canchis/Pitumarca/Vinincunca	13° 52' 13''	71° 17' 22''	2
Puno/Carabaya/Ollaechea/Chichaccori	13° 49' 50''	70° 29' 15''	3
Puno/Puno/Amantani/Isla Taquile	15° 46' 35''	69° 40' 56''	1
Apurimac/Chincheros/Huaccana	13° 25' 52''	73° 42' 58''	1
Apurímac/Abancay/Cuahuasi/Condor Lodge	13° 37' 44''	72° 34' 26''	3
Apurímac/Antabamba/Juan Espinoza Medrano/Calcauso	14° 30' 39''	72° 52' 49''	1
Apurímac/Abancay/Chacoche/Cachinchigua a Laguna Antay	13° 59' 52''	72° 59' 55''	5

Table 2. Secondary areas determined from this study for Andean Condor (*Vultur gryphus*) monitoring in Peru and maximum number of individuals from ebird (2000-2019).

DISCUSSION

Areas selected from this study can be included in simultaneous national censuses or to use in a subset of the identified locations, with both methods aimed at estimating the population size and temporal trends of the Andean Condor at country and regional levels, respectively. Identified priority areas to census the species were mostly located in the southern Andes, from Ica and Huancavelica departments to the south and east (Ayacucho, Cusco and Arequipa and Puno), while the remaining are distributed almost in a straight line from southeast of Lima department (Nor Yauyos Cochas Landscape Reserve) to the border with Ecuador (Illescas Reserved Zone), following the western flank of the Andes range. Maximum number of individuals reported in priority areas to the south (from Ica to the border with Bolivia) doubled the number of individuals reported to the north (183 vs. 90 individuals). In addition, the Illescas Reserved Zone, in the western lowlands amid the Sechura desert in north Peru, is of high conservation value for the species because a high number of individuals are consistently reported here, and because the first nesting for the species in Peru was also found here (Martínez 2016).

The establishment of a 57 km buffer around all the sites we identified is intended to reduce the probability of duplicate counting individuals between and among sites. Although the buffer we established could be somewhat conservative given that in Argentina, the mean daily distance of flight for one bird was 152 km (Lambertucci *et al.* 2014), in Chile, the average daily distance of flight for one adult male Andean Condor varied from 32 to 96 km depending on the season (Pavéz 2014). The buffer and the location prioritization scheme we propose (and the sites selected) could be adjusted as more wild individuals are fitted with satellite transmitters and more information on the flying behavior and abundance of Andean Condors is obtained.

The maximum number of individuals (360) recorded in all 62 areas identified for the monitoring of the species is very close to the maximum number of individuals (313) reported by Piana and Angulo (2015) in the 21 priority areas they identified. However, our inclusion of a 57 km fixed buffer zone is an attempt to reduce double counting of individuals while increasing sample size and the independence between sampling points, and, we think, is probably more accurate.

Given that Andean Condor numbers diminishes from south to north, and the species low genetic variability that is compatible with a low population size and a high extinction risk (Hendrickson *et al.* 2013), we argue that the Peru population is key for the long-term maintenance of the species in the northern part of its range, as it may be maintaining the genetic connectivity between populations south of the species range in Chile and Bolivia, with those remaining in Ecuador and Colombia. Given their large movements (i.e., one individual released in the Santa Eulalia Upper Basin in central Lima flew 600 km south, reaching the Sub Cuenca de Cotahuasi Landscape Reserve in Arequipa (Piana and Vargas 2015), Andean Condors in south and central Peru, may be maintaining the genetic flow from south to north of the species range within Peru, helping to maintain genetic diversity, and reducing its extinction risk (Lowe and Allendorf 2010, Robertson *et al.* 2019). Monitoring movements of Andean Condors in Illescas Reserved Zone by means of satellite tracking would help to determine if individuals here disperse and breed north and south, contributing to gene flow (Lowe and Anderson 2010).

Recommendations for a nation-wide Andean Condor evaluation in Peru

Given that national and/or regional Andean Condor evaluations have been standardized along the species range and are mostly performed through direct counts at communal roosting sites (Kusch 2004, Lambertucci 2010, Naveda-Rodriguez *et al*. 2016, Vargas *et al*. 2018), this is probably the best method to estimate Andean Condor abundance in Peru. Direct counts during the early morning, before the occurrence of updraft thermal currents, and during late afternoon during and after the arrival to roosting sites to spend the night may allow sufficient time to count condors. These figures can be double checked by performing counts in the morning and afternoon during the following day (Vargas *et al*. 2018).

Population estimations derived from these counts might not be affected by biases related to the duplicate counting of individuals, while the correct identification of the sex and age of perched individuals might render precise information for characterizing the population structure of Andean Condors (Lambertucci 2010). However, in order to be able to estimate the population size of Andean Condors from roosting sites, it is necessary to locate most of the *condoreras* in the area/region where the counts will be performed. This approach might not be immediately possible to carry in Peru given that in all priority and secondary sites we identified, we were only able to document three roosting sites.

Peru's Andean Condor Conservation Plan (SERFOR 2015) prioritizes a national census and the design of a monitoring program to measure changes in the species population size through time. In this study, we attempt to contribute to the implementation of this plan by identifying locations where the monitoring of the Peru population can be conducted. Considering the high financial cost that population monitoring of Andean Condors represent for Peru, in addition to the longevity and generation length of the species (30-80 years and 27.3 years respectively -Bird *et al*. 2020) we recommend annual counts at the 18 priority locations, and a simultaneous national census at all 62 priority and secondary locations identified in this study every five years (Benson and McClure 2019). Although simultaneous counts in 62 sites distributed all along the range of Andean Condors in Peru might prove a somewhat difficult task, this can be achieved by involving students from universities and birdwatchers in the areas/departments where these sites are located and with support from regional and local governments and Peru's protected area system (SERNANP) officials.

A cooperation between professional researchers, Andean Condor conservationists from the public and private sectors and volunteers would make this project feasible. Using this approach, combined with satellite data to identify roosting sites, two national censuses of Andean Condors were successfully conducted in Ecuador in 2015 (Naveda-Rodriguez *et al*. 2016) and 2018 (Vargas *et al*. 2018).

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