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Abstract: Current changes in the environment and increases in threats to wildlife have prompted the need for a better understanding of species' conservation requirements. Strategies for the conservation of large-sized animal species with large home ranges have included the creation of large protected areas, or for migrants, the creation of protected breeding, stop-over and wintering areas. We aim to describe the movement behaviour of Andean condors (*Vultur gryphus*), and to relate this movement to its significance in the conservation of this species and its environment. We examine whether current conservation strategies are sufficient to ensure the daily requirements of the species, and evaluate the degree to which breeding and foraging areas are covered by protected areas. We present as a new challenge the conservation of large-sized species that perform daily long-range movements across a number of political and ecological borders. Andean condors tagged with GPS-satellite transmitters make long daily flights from their breeding areas (mountains in Argentina and Chile) to their feeding areas (the steppe in Argentina) crossing over the Andean Cordillera. These flights demonstrate that current conservation strategies are insufficient to protect species with such daily movement patterns, and that new approaches are needed. Thus, it is necessary to gain a more in-depth knowledge of the movement ecology of these organisms through individual-level approaches integrating intrinsic (reproductive and foraging behaviour) and extrinsic (political and geomorphological boundaries) factors that shape movement patterns. Conservation efforts must include international cooperation aiming to combine the conservation of flagship species, the management of public and private lands, and the maintenance of valuable ecosystem services.

San Carlos de Bariloche, August 12th 2013

Dear Dr. Richard B. Primack
Editor-in-Chief
Biological Conservation,

I hereby submit a letter entitled “**Apex scavenger movements call for transnational conservation policies**” by myself and Drs. Fernando Hiraldo, Pablo Alarcón, José A. Sanchez-Zapata, Guillermo Blanco, and José Antonio Donázar for publication in **Biological Conservation**. The manuscript contains original data showing that not only large mammals and migratory birds require special conservation strategies in relation to their large home ranges. We used satellite telemetry units to monitor the movement patterns and behaviour of a large soaring bird, the Andean condor (*Vultur gryphus*). We showed for the first time that a bird may need to cross every day an international border, and a barrier as large as the Andean mountain range, to feed in one side and breed in the other. In those trips birds must cross diverse environments, land use types, administrative regions and protected areas in very short time periods. We demonstrated that conservation policies for this kind of species must consider differences in the individual behaviors. Moreover, our results impose new challenges for cooperative international conservation efforts and policies. We believe that this study is of relevance to the scientific community, conservationists and managers to be considered in **Biological Conservation**.

This paper is all original research carried out by the authors, and all authors agree with the contents of the manuscript and its submission to the journal. It has not been published elsewhere and is not being considered by any other journal. Any research in the paper not carried out by the authors is fully acknowledged in the manuscript. All sources of funding are acknowledged in the manuscript, and authors have declared any direct financial benefits that could result from publication. All appropriate ethics and other approvals were obtained for the research.

Thank you for your consideration and please do not hesitate to contact me if you have any question.

Sincerely,

Sergio

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1 Apex scavenger movements call for transboundary conservation policies

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16 **RH:** Animal daily movements and conservation

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Abstract

Current changes in the environment and increases in threats to wildlife have prompted the need for a better understanding of species' conservation requirements. Strategies for the conservation of large-sized animal species with large home ranges have included the creation of large protected areas, or for migrants, the creation of protected breeding, stop-over and wintering areas. We aim to describe the movement behaviour of Andean condors (*Vultur gryphus*), and to relate this movement to its significance in the conservation of this species and its environment. We examine whether current conservation strategies are sufficient to ensure the daily requirements of the species, and evaluate the degree to which breeding and foraging areas are covered by protected areas. We present as a new challenge the conservation of large-sized species that perform daily long-range movements across a number of political and ecological borders. Andean condors tagged with GPS-satellite transmitters make long daily flights from their breeding areas (mountains in Argentina and Chile) to their feeding areas (the steppe in Argentina) crossing over the Andean Cordillera. These flights demonstrate that current conservation strategies are insufficient to protect species with such daily movement patterns, and that new approaches are needed. Thus, it is necessary to gain a more in-depth knowledge of the movement ecology of these organisms through individual-level approaches integrating intrinsic (reproductive and foraging behaviour) and extrinsic (political and geomorphological boundaries) factors that shape movement patterns. Conservation efforts must include international cooperation aiming to combine the conservation of flagship species, the management of public and private lands, and the maintenance of valuable ecosystem services.

Keywords

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45 Andean condor, animal movement, daily movement, geographical barrier, home range,
46 transnational conservation, protected area size.

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1. Introduction

Under the current extinction crisis, conservation policies that transcend political boundaries are indispensable in dealing with large-scale conservation issues (Abbitt et al., 2000; Donald et al., 2007; Barnosky et al., 2011). It is indisputable that the size of a protected area is key to ensuring the maintenance of populations, ecosystems and ecological processes (Dudley, 2008). However, the conservation of wide-ranging species that move between countries or even between continents poses challenges that exceed these common approaches (Wilcove and Wikelski, 2008; Block et al., 2011). Conservation of wide-ranging vertebrates, such as large mammals, usually focus on the maintenance of strictly protected areas with a general criterion of ‘bigger is better’ (Wielgus, 2002; Du Toit et al., 2003; Thirgood et al., 2004; but see Press et al., 1996). Although effective in some cases, those strategies may not be appropriate for flying organisms (birds, bats, insects), able to move over huge distances. This is especially true for migratory animals alternatively occupying spatially distant breeding and wintering grounds. In such cases, conventions for coordinated conservation strategies in the two extremes of the distribution areas and, in some cases, also at stop-over points along migration routes, are mandatory (Milner-Gulland et al., 2011). Other species, on the other hand, do not migrate but travel large distances over short time periods and are continuously exposed to changing threats. Their patterns of movement have not been well considered in conservation efforts.

Here, we call attention to the necessity of implementing new models of transnational strategies for the conservation of large vertebrates that perform long-distance movements on a daily basis. This is the case of avian scavengers, the largest flying vertebrates on the planet, whose populations are increasingly endangered potentially triggering the loss of key ecosystem services (Ferguson-Lees and Christie, 2001;

Markandya et al., 2008; Ogada et al., 2012). Our study model was the Andean condor (*Vultur gryphus*), a large body-size top scavenger with astounding flight capacities (Pennycuick and Scholey, 1984; Ferguson-Lees and Christie, 2001; Shepard and Lambertucci, 2013). Conservation programs for these birds have mainly focused on reintroduction strategies (BirdLife International, 2012). However, specific conservation designs considering their pattern of movement and home ranges are lacking. Our aim was to describe the movement behaviour of Andean condors and relate this movement to its significance in the conservation of this species and its environment. We also evaluate the degree to which breeding and foraging areas are covered by protected areas. In particular, we examine whether current conservation strategies, mainly based on the protection of pristine ecosystems, are sufficient to ensure the daily requirements of a population distributed in two countries (Argentina and Chile) along either side of the Andean Cordillera.

2. Methods

2.1 Study species

The Andean condor inhabits the Andean Mountains throughout South America and adjoining hills in central Argentina (Ferguson-Lees and Christie, 2001). It is among the largest flying birds in the world, with a 3 m wingspan and a weight of up to 16 kg. Condors are at the limit of flight capacity due to their size and weight (Pennycuick and Scholey, 1984; Shepard and Lambertucci, 2013). This species, considered as 'Nearly Threatened' worldwide and endangered in several countries, is exposed to several human-related threats (Carrete et al., 2010; BirdLife International, 2012; Lambertucci et al., 2011, 2012). Poisoning, including lead contamination, and persecution are among the main threats to which condors are exposed (Ferguson-Lees and Christie, 2001;

Lambertucci et al., 2011, 2013). It is therefore plausible that they are at higher risk in their foraging areas due to those threats. However, some human disturbances in the breeding areas have also been observed (Lambertucci and Speziale, 2009).

2.2 Study area

We worked in the southern tip of South America (36°-44°S, 69°-73°W, Fig. 1), central Patagonia (Argentina and Chile). This area consists of a gradient that encompasses two major biogeographic units, the austral forest and the steppe (from west to east), including the transition region referred to as the forest-steppe ecotone (León et al., 1998). Ecotone and steppe areas have been used for extensive livestock ranching since the last century and they currently hold large numbers of alien mammal herbivores (Brown et al., 2006; Speziale et al., 2012). Condors use the area to feed mainly on domestic and wild herbivores (Lambertucci et al., 2009). A very low proportion of the steppe biome is protected (about 4%), with <1% being National Park (Brown et al., 2006). The west (both the Argentine and Chilean slopes of the Andes) is dominated by woodlands with a large number of cliffs that may be used for breeding. This latter biome is relatively well-protected in Chile and very well-protected in Argentina (10% and 34% of its total surface area, respectively) (Brown et al., 2006; Lara et al., 1996).

2.3 Bird tagging and data collection

During austral spring 2010 and 2011, twenty adult Andean condors (11 females and 9 males) were trapped with baited cannon net traps around the city of Bariloche. Birds were fitted with GPS tags (10 birds with patagial PTT-100 50 gram Solar Argos/GPS tags, Microwave Telemetry Inc., and 10 with backpack 100 gram Solar GPS-GSM CTT-1070-1100 tags, CellTrack Tech.). GPS tags were duty cycled to transmit every

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125 day from dawn to dusk at the maximum interval allowed by the unit (every 15 min for
126 CTT tags, and every 60 min PTT tags). Those tags collected data points corresponding
127 to the coordinates through which each bird passed every day, throughout the months.

128 Condors were monitored continuously after release. To standardize the monitoring
129 periods, we restricted our analyses to the first six months of monitoring of each bird.
130 Because all the captures were done in spring, this period corresponds to spring-autumn.
131 We obtained 49,022 GPS fixes from the 20 tagged breeding adult condors. All of those
132 fixes were used to determine the land areas covered by the condors regarding their
133 location by country, province, municipality, habitat and protected area size and IUCN
134 category (Categories Ia: Strict nature reserves, Ib: Wilderness area, II: National park,
135 III: Natural monument or feature, IV: Habitat/species management area, and V:
136 Protected landscape/seascape; Dudley, 2008). We also used the fixes to locate breeding
137 and foraging areas, and to estimate distances flown and home ranges.

138 139 2.4 Data analyses

140 Home ranges were calculated as the minimum convex polygons projecting all the
141 fixes into ArcGIS 9.3© and ArcView 3.2© (ESRI Inc., USA). The distance flown each
142 day by a condor was estimated from the sequential straight-line distance between fixes
143 for each day.

144 Some birds visited both Argentina and Chile, and thus the time spent by the birds in
145 each country was estimated using the “selection by location” feature of ArcGis 9.3©, as
146 the number of fixes and days within each country. In order to count the number of times
147 the international border was crossed, we first created a 4-km buffer area on each side of
148 the international boundary. We then considered birds to have crossed this international
149 border if they crossed the buffer zone. This was done to avoid the inclusion of data from
150 birds that were flying close to the limit but without crossing it for more than a few

1 kilometres. We chose this buffer since it corresponds to the area surrounding the nest in
2 which condors may be flying while they are in the breeding area, and because some
3 birds were nesting close to the international border and crossed it frequently. We
4 assumed that when they flew more than this distance, it was because the bird was
5 leaving the area.
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7 Breeding areas were determined by the distribution pattern of fixes (coordinates), as
8 the places with the highest concentration of dots in an area of 2-km radius, and were
9 then corroborated in the field. We calculated the number of breeding areas inside
10 protected areas by counting all the nesting areas that fell within the polygon of all the
11 national protected areas in the region. We estimated the time that a bird was foraging
12 outside protected areas first by projecting all data points of the twenty birds that fell
13 within the polygon corresponding to the steppe area. We then estimated the proportion
14 of data points that fell within the steppe biome, and at the same time outside of
15 protected areas. The steppe was a good surrogate of the foraging area since condors do
16 not eat in woodlands; we have observed dozens of carcasses consumed by condors and
17 all of them were located in the steppe and GPS data showed that condor fixes are
18 dispersed and birds spend time on the ground almost exclusively in the steppe.
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20 **3. Results**

21 Taken together, all tagged condors flew over an area of 90,843 km², and the maximum
22 flight distance for a bird was 349.5 km/day (Fig. 1). The maximum home range
23 registered for an individual was 53,254 km² and the mean daily distance for the bird that
24 flew the most was 152.3 km per day (see online Appendix Table A1). Every day
25 condors crossed different biomes and environments such as woodlands, high Andean
26 vegetation, scrublands and steppes. The studied individuals flew over seven national
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176 parks within two countries, which in total protect an area of more than 1,800,000
177 hectares (Table 1), but they were not sufficiently large to meet the condors' movement
178 requirements; most of the movements in fact were concentrated in private lands on the
179 Argentinean side of the Andes (Fig. 1).

180 Most of the marked condors bred inside protected areas (80% of the tagged birds),
181 but foraged outside of those areas (a mean of 90.5% of the foraging time for all birds,
182 and up to 99.8% of the time for the bird that spent the most time in the steppe). The
183 breeding areas of all the tagged birds were within the Andean range both on the
184 Argentinean and Chilean slopes of the Cordillera, but all the birds foraged exclusively
185 in the eastern piedmont (Argentina; Fig. 1). Nine birds visited Chile, three of them made
186 only some short trips close to the international border (<13% localizations in Chile), but
187 the other six birds with a higher frequency of locations in Chile (>43%) bred there on
188 the western slope of the Cordillera (Fig. 2). Movements of those birds involved the
189 crossing of the Andean range on a daily basis (i.e., each bird breeding in Chile crossed
190 the international border a mean of every 1.3-3.0 days depending on the bird, an
191 approximate mean of one cross every 2 days for all birds) with up to two international
192 crosses per day at altitudes of up to 2,952 m asl (see online Appendix, Fig. A1).

194 **4. Discussion**

195 Long-distance daily movements, not related to dispersal processes and migration, have
196 been scarcely considered when shaping trans-jurisdictional conservation strategies for
197 threatened vertebrate populations, however, there is an increasing interest in this area of
198 research in relation to marine ecosystems (Yorio, 2009; Block et al., 2011). Here, we
199 show that the conservation of an apex avian scavenger urgently calls for new
200 transboundary conservation strategies in view of their outstanding movement ecology.

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201 We found that Andean condors cross the international border between two countries
202 (Argentina and Chile) on a daily basis. Extreme cases are those individuals breeding in
203 a country on the western slope of the Cordillera and using remote areas in another
204 country to obtain food resources. Therefore, for species with such wide home ranges
205 and patterns of daily movements, international and national transboundary policies
206 should take into account the variability in individual spatial ecology strategies, without
207 which the preservation of the entire population would be put at risk.

208 Species that present large daily movements across political borders require different
209 conservation approaches than species that may move over large distances but do so
210 seasonally, such as migratory birds. Many species move large distances when
211 migrating, and therefore seasonal migratory conservation corridors are proposed as a
212 strategy to protect them (Block et al., 2011; Milner-Gulland et al., 2011).
213 Transboundary movements may be common in marine ecosystems because land and
214 nearby water often fall under different political jurisdictions (Yorio, 2009). In some
215 cases, marine bird species tend to cross different political boundaries every day when
216 moving from breeding to foraging areas, which implies that they can be affected by
217 different human-related impacts in a single day. Indeed, marine protected areas have not
218 been sufficient to protect these species and management actions beyond those reserve
219 areas are needed (Yorio, 2009). In terrestrial ecosystems, some species such as large
220 carnivores (e.g., wolves) may also require transboundary conservation programs given
221 their large home ranges (Falcucci et al., 2013). Indeed adults from different terrestrial
222 species move daily from breeding to foraging areas, but the two areas are generally in
223 close proximity. We show that condors breed at great distances from foraging areas,
224 implying a need to move very large distances every day. Moreover, they must cross an

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225 international border on a daily basis in order to feed, which is, to our knowledge, the
226 first report of this behaviour for a terrestrial species.

227 Daily movements expose animals to changing environmental conditions and to
228 threats according to large-scale variability in biomes and regimes of land protection.
229 Condors behave differently in each country, which implies varying conservation
230 problems and the need for different strategies. We found that condors are breeding in
231 both countries and that several nests are located within protected areas. However, they
232 forage mostly outside reserves, in the piedmont steppe where high numbers of livestock
233 are available. Reserves in the study area have been created with a double purpose of
234 woodland conservation (woodlands are associated with both sides of the Cordillera), but
235 also with a geopolitical aim of consolidating the international border (Brown et al.,
236 2006). As a result the high mountains, which represent the international border between
237 Argentina and Chile, and the woodlands, are well protected. However, the transition
238 zone to the steppe, and the steppe itself, has been overlooked. Only less than 1% of the
239 steppes where condors gather to forage is under actual protection, and is dominated by
240 private farms that do not ensure serious control or management practices for wild
241 species (Brown et al., 2006; Lambertucci et al., 2009). As a result, reserves are not
242 successfully protecting the species.

243 In particular large scavengers are threatened worldwide, and some species that were
244 very abundant in the past are now close to extinction (Markandya et al., 2008; Ogada et
245 al., 2012; Baral et al., 2013). Those species provide valuable ecosystem services related
246 to carcass consumption (Ogada et al 2012). For example, condors are providing this
247 service mainly on private lands in this zone, but at the same time they are exposed to
248 several threats in those areas. Direct and indirect poisoning, contamination with lead,
249 persecution, and competition, are among the main threats that condors face (e.g.,

Carrete et al., 2010; Lambertucci et al., 2011, 2012). Although there is little information on the mortality rate of this bird (Lambertucci et al., 2013), there has been some observations of dead animals mostly in our study area, suggesting that most birds die outside of protected areas, on private lands (authors' unpublished data). Some disturbances in breeding areas exist (Lambertucci and Speziale 2009), but their impact is probably lower than those suffered in the foraging areas.

The fact that this species can cross physical and political barriers brings to light that common policies and strategies are clearly needed (Abbitt et al., 2000; Wilcove and Wikelski, 2008; Block et al., 2011; Hawkes et al., 2011). For instance, high mountain ranges are often natural frontiers for human and animal populations. However, we found that condors were passing over the Andes Mountains when crossing between the two countries. Mountains are not necessarily an insurmountable barrier, but they imply higher costs of transport (Rees, 2004; Hawkes et al., 2011). Therefore, detailed information on the movement patterns and the costs at various scales should be obtained to build sound conservation strategies (Wilcove and Wikelski, 2008). This is particularly important for large soaring vultures who have large movement capacities, are facing special conservation concerns and are key in providing ecosystem services (Markandya et al., 2008; Nathan et al., 2012; Ogada et al., 2012). Since new technology allows the collection of more and better movement data, new and unpredicted movements are being discovered (Hawkes et al., 2011; Klaassen et al., 2011), demonstrating that efforts aimed at protecting these species are insufficient or are not appropriately targeted.

5. Conclusion

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274 An increasing knowledge of life-history patterns and, in particular, the ecology of
275 movement of threatened populations adds new challenges to animal conservation
276 strategies (Holyoak et al., 2008). Our study highlights that the preservation of wide-
277 ranging organisms performing large daily movements, in this case, apex scavengers,
278 may require common international strategies under schemes other than those previously
279 considered (Wilcove and Wikelski, 2008; Block et al., 2011). Our results also highlight
280 that strategies should focus on individual-level approaches integrating intrinsic (e.g.,
281 reproductive and foraging behaviour) and extrinsic (e.g., political and geomorphological
282 boundaries) factors able to shape movement ecology (Tibbets and Dowling 1996;
283 Martin et al., 2007; Holyoak et al., 2008; Milner-Gulland et al., 2011).

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284 A combination of approaches is needed for the conservation of these types of wide
285 ranging species such as the creation of large protected areas and the implementation of
286 specific local strategies. A promising strategy is the implementation of international
287 reserves working under common criteria, such as the Andean North-Patagonian
288 Biosphere Reserve between Argentina and Chile, which covers 4,588,167 hectares.
289 Similar examples that include transboundary reserves exist in other countries (e.g.,
290 Parque Internacional La Amistad, between Costa Rica and Panama, with 401,000
291 hectares), and can be very useful in conserving species that move across international
292 borders. Nonetheless, those huge areas are not sufficient to cover the complete daily
293 movements of some species such as condors. Local conservation strategies are also
294 needed such as collaboration with private land-owners. This is particularly important in
295 countries with large proportions of privately owned lands (e.g., >80% in Argentina) and
296 for the species that depend on them. Policies should also acknowledge the particularities
297 of the species to be protected considering different behaviours (i.e., needs differ
298 between breeding and foraging activities) to design efficient conservation strategies.

This approach may be valid not only for apex scavengers but also for other large-sized organisms with extreme movement patterns like carnivorous mammals, birds and fish (Gittleman and Harvey, 1982; Yorio, 2009; Block et al., 2011; Louzao et al., 2012; Falcucci et al., 2013). Therefore, our results impose new challenges for cooperative international, regional and local efforts aimed to combine the conservation of flagship species, management of public and private lands and maintenance of valuable ecosystem services.

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Figures

Figure 1. A: Movement patterns of 20 GPS-tagged Andean condors in north-west Patagonia. Coloured dots represent different individuals. The yellow line represents the international border. Protected areas are in green. Breeding areas are the sites with high concentrations of dots close to the international border, and feeding areas are the zones with diffuse distribution of dots to the east (see Methods). Inset graph B: Detail of the longest one-day trip recorded (349.5 km). The bird departed in the morning from the breeding area close to the international border in Chile (inside a National Protected Area), crossed the Andean range to Argentina and went to the steppe to forage (inside private lands); then returned to the Andean piedmont for night roosting.

Figure 2. Proportion of localizations (%) in Argentina (grey) and Chile (black) of the nine Andean condors fitted with satellite tags (from the 20 tagged birds) that crossed the international border (total data localizations, N=23,987).

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Tables

Table 1. Land areas in Argentina and Chile used by 20 GPS radio-tagged Andean condors.

Lands	Category (IUCN)*	Country	Size (ha)	Provinces (number)	Municipalities	Habitat
Nahuel Huapi	National Park (I and II)	Argentina	712160	Neuquén and Río Negro (2)	Several	Woodland, Ecotone
Lanín	National Park (I and II)	Argentina	412000	Neuquén (1)	Several	Woodland, Ecotone
Arrayanes	National Park (II)	Argentina	1753	Neuquén (1)	One	Woodland
Los Alerces	National Park (I and II)	Argentina	259570	Chubut (1)	Several	Woodland, Ecotone
Limay	Protected Landscape (V)	Argentina	50000	Río Negro (1)	One	Ecotone Steppe
Llao Llao	Municipal reserve (IV)	Argentina	1225	Río Negro (1)	One	Woodland
Puyehue	National Park (I and II)	Chile	107000	Ranco and Osorno (2)	Several	Woodland
Vicente Perez Rosales	National Park (I and II)	Chile	253780	Llanquihue (1)	Several	Woodland
Hornopiren	National Park (II)	Chile	48232	Palena (1)	One	Woodland
Private lands	Non protected area	Argentina/ Chile	>1000000	Neuquén, Río Negro, Llanquihue, Ranco and Osorno (5)	Several (>100)	Woodland, Ecotone, Steppe

*IUCN categories Ia: Strict nature reserves, Ib: Wilderness area, II: National park, III: Natural monument or feature, IV: Habitat/species management area, and V: Protected landscape/seascape (Dudley, 2008).

Figure 1
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Figure 2
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Online Appendix

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Highlights

- A species breeding in a country and feeding in other challenges conservation efforts.
- Every day condors cross several biomes, and political and geographical barriers.
- No standard protected area may include the area used by this species in a day.
- Individual-level approaches integrating factors shaping movement ecology are mandatory.
- Our results impose new challenges for cooperative international, regional and local efforts.

Dear Dr. Mauro Galetti
Americas (Zoological) Editor
Biological Conservation,

Thank you for the comments on our BIOC-D-13-00894 "Apex scavenger movements call for transnational conservation policies" We really appreciate the comments of the reviewers on our work. Here, we are re-submitting our article following your suggestion, after revising the MS and answering the reviewers' comments. We indicate in this rebuttal letter how we have incorporated the comments in our revised version as requested. We have also checked the English style and grammar of the manuscript, and that the format is in accordance with the standard format of Biological Conservation based on the Author's guide. We have also checked and included the pertinent articles that have been published in conservation journals in the past five years.

Yours sincerely,

Sergio (on behalf of the coauthors)

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Answers to the reviewers' comments (A):

Reviewers' comments:

Reviewer #1: 1) Overall, I think that this is an interesting article. I think the topic is an important one and also one that could span many fields, from fundamental biology to politics for example. There is a clear conservation focus that is within the scope of the journal.

Answers (A): We thank the reviewer for the comment on our manuscript.

2) In many ways this manuscript presents a new and original contribution. Other similar studies exist but I am unaware of any involving this species or from this area. This is simultaneously one of my critiques, however. For example, Abbitt et al. 2000 discusses many similar issues, and focuses on birds as well as butterflies, but it not referenced or discussed in the paper. In the discussion, several papers are referenced relating for mammal studies, but are not discussed. I think that the unique aspects of this manuscript as well as the overlap with the conclusions of these other studies needs to be developed more to highlight the contribution of this project. As another example, the authors emphasize how this system is different because it it a matter of daily activity. There is no discussion on why this is pertinent, however.

A: *We have included the work of Abbitt et al. (2000) in the introduction and the discussion sections. Thank you for the suggestion. We have also discussed more in depth the fact that the movement we found corresponds to daily movements. In the previous version part of this information was present, but it might probably not be presented in a clear way. We have discussed the differences between a daily movement and a seasonal movement. We have highlighted the differences in conserving a species in the area where it is breeding and where it is foraging. We have also discussed more in depth the works related to other taxa as the reviewer suggests. Please see the first (for the citation), but mainly the new second and third paragraph of the discussion section for most of this new information.*

3) I feel that the results could very well have a broad impact. This is dependent on the presentation of the results and discussion, however. As noted above, there needs to be a synthesis that shows how this study related to other studies on trans-boundary species studies. Throughout the manuscript, the data is presented as though the problems of crossing a border are simply inherent. Unfortunately, there is no discussion of the actual issues with cross boundary movements. Clearly cross boundary conservation can be difficult, however, this is likely to be dependent on the location. In fact, there are many trans-boundary reserves (e.g. La Amistad) that have been quite successful in many ways. I think serious consideration should be given to why trans-boundary conservation can or cannot be successful based on their results and as related to other studies. This would really highlight the big picture and make the paper of interest to a broader audience as it would help to focus on the global issues and not just on the problems associated with a single species in the Andes. The work of D. Hamilton on three wattled Bell birds in Costa Rica may also be helpful.

A: *As we have said above we have deepened on the discussion of the facts the reviewer asked for in different parts in the discussion section (we added two new paragraphs and modified others; please see from lines 208 to 255). We have modified part of the structure of the results section. We have also included a new figure where we show the daily movements of the birds that breed in Chile (see online Appendix, Fig. A1). We have included a discussion in relation to other transboundary species that have been studied (please see lines 208-226). And we have also discussed the benefits of crossboundary conservation and the importance of the implementation of these strategies for this kind of species (please see lines 276-298). As an example of transboundary reserves we have commented on the case of La Amistad, and highlighted that those large reserves are a first step for conserving species with large home ranges. However, we explained that in cases as the one we presented on condors, those reserves are not enough and need complementation with the collaboration with private owners (see the last paragraph of the article, lines 284-305).*

4) I suspect the conclusions are sound, but they are a bit unsubstantiated in my opinion. The conclusions that conservation has a problem in this scenario seem to be drawn from the fact that the birds migrate across boundaries and outside of parks, but as stated earlier, there is no evidence presented that constitutes a problem with this. Do birds suffer higher mortality rates in one country than the other? Outside reserves? On private lands? I think these facts need to be clarified before one can conclude that there is going to be a conservation dilemma because the animals have a significant daily range. In short, the conclusions are not really justified by the data presented. It seems that the authors have the data to back up their justification, it just needs to be presented in a way that gets to their point. Right now, the manuscript just shows some very interesting things about the migratory patterns of the birds in relation to protected areas and their activities. The conservation question is not clearly addressed.

A: In this new version of the MS we have clarified that condors are behaving in a different way in both countries (in the study area in Argentina there are feeding and breeding areas but in this part of Chile they only breed), and that this implies different conservation problems and the need for different strategies (please see discussion on this fact in lines 229-242). Most threats for this kind of birds (scavengers) are associated to the food source and the area that they use to forage (eg., poisoning, lead contamination, persecution, etc.). We have included information on the threats that condors are exposed to (and the citations regarding those threats) in the methods and discussion sections. Unfortunately there is no information on the mortality rate of this bird, only particular observations mostly from Argentina. Most of the birds tend to die more in the areas where they feed. Most of those threats are outside the protected areas (in foraging areas), in private lands. Now we have included all this information in the methods sections (see lines 97-101) and discussion (see lines 246-255). We have included a sentence regarding the current conservation status of large scavengers (see lines 243-246). We have also shown that condors are flying many kilometers to forage and that the foraging areas are on the steppe of Argentina, an area that is almost entirely outside the national protected areas. We have then discussed the problems associated to this fact (see lines 180-182 and 230-241).

-This leads to the final point which I believe is critical to this paper: There really are no stated questions, hypotheses, or objectives. The final sentence of the introduction is close, but says "we examine if current conservation strategies are enough to insure the daily requirements of the population". No conservation strategies are really tested however. The objectives need to be clearly stated to make better use of the data at hand. Questions like "To what degree are breeding and foraging grounds protected in either country?" are testable and fitting to the claims made in the discussion.

A: Regarding the objective and the conservation issue we have followed the reviewer recommendations and included them in the introduction in the following way: "Our study model was the Andean condor (*Vultur gryphus*), a large body-size top scavenger with astounding flight capacities (Pennycuik and Scholey, 1984; Ferguson-Lees and Christie, 2001; Shepard and Lambertucci, 2013). Conservation programs for these birds have mainly focused on reintroduction strategies (BirdLife International, 2012). However, specific conservation designs considering their pattern of movement and home ranges are lacking. Our aim was to describe the movement behaviour of Andean condors and relate this movement to its significance in the conservation of this species and its environment. We also evaluate the degree to which breeding and foraging areas are covered by protected areas. In particular, we examine whether current conservation strategies, mainly based on the protection of pristine ecosystems, are sufficient to ensure the daily requirements of a population distributed in two countries (Argentina and Chile) along either side of the Andean Cordillera." (see the introduction and the abstract).

-Also, there are no conservation recommendations made. I ask myself, what do you propose? The reserves in your map seem to follow the border really well. This says to me that it's not a border crossing issue. What specifically is the problem with crossing a border, and how can the problem be solved? Also, again, how is a daily migration different from a monthly or annual migration from a conservation perspective. This point is repeatedly stressed but never really justified. There is a note that policies and strategies are weak....but how? Why? You claim they are insufficient but offer no data that they are not working. Instead it could be argued, for example, that the parks are really successful, as the birds are even traveling outside the reserves and expanding their territory into unprotected land. This is why you need to back up the claims.

A: We do not agree at all with the reviewer in the asseveration that there is no conservation recommendations made. You can read our recommendations in different parts of the discussion, but mainly in the conclusion you will see what we are proposing. Please see particularly the last two paragraphs of the article (mainly the end of the first paragraph and the entire second paragraph). Moreover, in this new version we have included more details on our conservation recommendations based on the recommendations.

Reserves in this area have been created with a double purpose of woodland conservation (woodlands are associated to both sides of the cordillera) but mainly with a geopolitical aim in order to consolidate the international limit. As a result the high mountains and woodlands are very well protected but the transition to the steppe, and the steppe itself, has been completely overlooked. That is another of the interesting results that condors' movements are highlighting. They can be crossing in their daily movements all those protected areas but spend most of their time outside them. Then parks are not successfully protecting the species, although this species can be using them for breeding and flying, they are not foraging there. We have presented this fact and its conservation implications mainly in the following lines 233-242.

Finally, as we have explained above we have detailed more in depth different aspects of the daily migration, the border crossing issue and the conservation implication associated to this.

5) The title is effective

A: Thank you. We have changed the word "transnational" by "transboundary" in the title since we realized that this word better reflects the focus of the manuscript. Transnational conservation is only part of the subject.

6) The abstract is fairly well written. There are some minor issues with grammar: A: Line 21, increases (not "an increase"); Line 33, extrinsic factors that (not able to); Line 33, Conservation efforts, (not "The conservation"). It does discuss intrinsic and extrinsic factors, however, which I never really understood or saw any discussion of in the main manuscript.

A: We have corrected the minor issues as suggested. We have also clarified what we refer to when speaking about "intrinsic and extrinsic factors", (see lines 37-41 and 279-283).

7) The statement of the objectives is clearly lacking. This leads to the issues I have with the conclusions that are drawn.

A: As explained above, we have included the objective in this new version in the abstract and the introduction sections.

8) The methods are mostly well written. Lines 84-85 sound more like justification that could fit in the introduction.

A: We have moved this sentence to the introduction. Thank you for the comment.

-The term "eastern hills" in line 76 is vague.

A: We have clarified this term.

-There are some grammatical errors as well.

A: We have justified, explained more in depth and corrected the errors in the places the reviewer suggests. We have also sent this new version to a native English researcher for detailed English review.

-In the study species section, there is a comment on threats, but none are mentioned.

A: As we explained above, we have included the information on the threats this species is suffering (see lines 97-101 in methods and lines 246-255 in the discussion section).

-Also, the comment on taking energy from their environment seems disconnected from the rest of the section.

A: This comment has been eliminated from this new version.

-Also, the organization seems a bit off to me. The section on bird tagging seems ok at first, but then the next section is Data analysis. There is no discussion of what data will be collected prior to this. Are you collecting point data, temporal data, distances, ..etc.??? This needs to be clearly stated before an appropriate decision can be made on analytical techniques.

A: We have clarified the type of data we collected and used, before the Data analysis section. For this we have included new information and reordered the information available in the Data analysis section (please see lines 124--137). We have also slightly changed the subtitle to "Bird tagging and data collection" (line 119)

-What IUCN categories are you referring to in Line 119?

A: We clarified in the main text the categorization from the IUCN we used (see lines 133-136 and Table 1).

-Why was the 4 km size chosen for the buffer. Is this the amount of variation that a bird can show when flying more or less straight? It just seems like a bit of an arbitrary number. Also, even if a bird flies 1km into another country, is it not under their jurisdiction for however long it stays there? This seems just as relevant to the problem you are discussing.

A: We used this buffer to be sure they were crossing the border and not only flying throughout it. We choose a buffer of 4km, since this is the area surrounding the nest that condors might be flying during the time they are in the surrounding of the nest. When they fly more than this, it is highly probable that the bird is leaving the area. This was necessary because some birds were nesting close to the international border and crossed it continuously. Very importantly, we should remind that this buffer was only used to know if the bird was leaving a country to the other, but not flying in the surroundings of the international border (i.e., in order to count the number of times the international border was crossed when they went to forage, as we explained in the data analysis section). We clarified it in the text (see lines 146-155).

9) There was no real statistical analysis in this paper

A: Right.

10) The organization is fairly well done. I think that some additional sections need to be added and expanded, however.

A: *Thank you for the comment; as explained in this letter we have reordered the article based on the suggestions received.*

11) The figures and tables are adequate. The map needs a bit of refining. I think that it could be more focused (zoomed in) to show the area of interest. This would clear up the blurriness in the point data. Also, a narrower line for the bird's daily route would help to clarify the pathway. Both of these steps would really alleviate the need for the "B" subset map. Also, the other subset map could use an "extent rectangle". This option is in the Dataframe properties in ArcGIS. It could use a legend as well.

A: *We have modified the map following the suggestions of both reviewers. Unfortunately much of the points overlap making it difficult to show all of them in a clearer way. However, we consider that the most important facts the map must show are clearly seen in this new version. Please consider that probably the pdf version of the map the reviewer receives may be of a lower quality than the version used for printing. The real map is in high quality.*

Furthermore we have also tried to present a map including a narrower line for the bird's daily route but, as there is a lot of data, the map is less clear. However, we have included a new figure with the daily flight of the six birds that breed in Chile (see the online appendix Fig. A1). On the other hand the inset map is only to show the largest daily flight of a bird, not for showing the typical daily flights. We consider this is an important inset map and we prefer to maintain it unless the editor considers it should be eliminated. Finally, as suggested, we have produced (and included) the extent rectangle for the location of the study area that is now included in the new version.

12) The references are adequate, but several important references were overlooked. Abbitt et al. 2000 is one of the more noteworthy. Also, the authors note that "bigger is better for conservation, but I think Press et al 1996 demonstrate otherwise (at least for certain scenarios). This isn't a major issue, but both sides should be noted I think. Also, consider the work of D. Hamilton on Bellbirds in Costa Rica. Also, the paper in Endangered Species Research by Baral et al. 2013 could be useful for discussing scavenger threats. Simberloff and Cox 1987 could also be quite useful.

A: *We have included the citations suggested by the reviewer that better fitted the new version of the MS (eg. Abbitt et al. 2000, Press et al. 1996, Baral et al. 2013).*

13) The English is satisfactory, however, it could use another revision to clean up the minor grammatical and punctuation errors that were scattered about.

A: *We have sent this new version to a native English speaking biologist for detailed idiomatic revision.*

14) The paper is a good length, but certain sections need to be expanded.

A: *As explained before we have expanded several parts of the manuscript following the reviewer's recommendations.*

Reviewer #2: It is my pleasure to suggest the acceptance of this manuscript as is, long time I did not write that... Perhaps, try to improve graphic quality of figure 1 since there is no legend (colors matching individual birds) and improve the selection of colours used in that figure since I was able to identify dots belonging to only few birds on that figure.

A: *Thank you very much for your comment. As explained before to the reviewer 1 the quality of this figure is probably much higher than the one observed in the pdf you received. On the other hand, the dots of the birds have strong overlaps. Nonetheless we have made a new version of this figure changing some of the colors of the dots representing each bird and other minor details (please see the new Figure 1). We hope it is much better than the previous one. We have also included a new figure with the daily flights of the 6 birds that breed in Chile (see Figure A1).*