ECOLOGICAL AND INSTITUTIONAL LANDSCAPES OF ANDEAN BEAR CONSERVATION IN COLOMBIA

by

RHIANNA RACHELLE HOHBEIN

(Under the Direction of Nathan P. Nibbelink and Robert J. Cooper)

ABSTRACT

Effective environmental governance is often viewed as one of the most important contributing factors to successful conservation. Good alignment between institutions and the geographical extents of ecological issues or systems they are meant to manage contributes to this success (known as "social-ecological fit"). However, issues and systems often extend beyond the control of any one organization or agency and thus require the efforts of multiple actors working together to achieve their common goals. Different governance structures may vary in the degree to which they foster networks for successful collective action. In this dissertation, I analyze the performance of Colombia's environmental governance in conserving the Andean bear (*Tremarctos ornatus*), a flagship species entangled in human-wildlife conflict. My analysis considers the actions and interactions of three groups of conservation actors: 1) environmental authorities known as autonomous regional corporations (*corporaciones autónomas regionales* or CARs)—the primary entities responsible for implementing conservation policy in Colombia; 2) Colombia's National Natural Park Service; and 3) nongovernmental organizations (NGOs). Interinstitutional coordination is crucial as the known range of Andean bears in Colombia crosses the boundaries of 22 CARs and 22 national natural parks. My analysis was based on

qualitative and social network data gathered via 67 semi-structured interviews with conservation practitioners during 2018-2019; these data were later integrated with a landscape connectivity model for Andean bears constructed with circuit theory. My research suggests that the successful coordination of large-scale wildlife conservation may yet require leadership from central institutions. Inconsistent program implementation among the CARs and limited information exchange potentially exacerbate human-bear conflicts, particularly at CAR borders. Only 30% of those CARs that shared habitat critical to Andean bear movement had communicated with one another about Andean bear research and conservation strategies. CARs were more likely to communicate with the National Natural Park Service or NGOs. These other entities were often located within the social network structure as intermediaries between otherwise disconnected CARs. These actors could use such strategic positions to facilitate coordination between CARs that share habitat important for Andean bear connectivity and, in so doing, improve social-ecological fit for the conservation of this species.

INDEX WORDS: *corporaciones autónomas regionales*, decentralization, environmental governance, human-wildlife conflict, institutional analysis, landscape connectivity, network governance, nongovernmental organizations, *oso andino*, *oso de anteojos*, social-ecological fit, social network analysis, spectacled bear, threatened species, *Tremarctos ornatus*, wildlife conservation

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RHIANNA RACHELLE HOHBEIN

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RHIANNA RACHELLE HOHBEIN

Major Professors:	Nathan P. Nibbelink
	Robert J. Cooper
Committee:	Julie Velásquez Runk
	Patricia Dunne
	Daniel Markewitz

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
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DEDICATION

To my mom, for instilling in me a love for all critters which eventually led me to this path.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Effective environmental governance is often viewed as one of the most important contributing factors to successful conservation. Good alignment between institutions and the geographical extents of ecological issues or systems they are meant to manage contributes to this success. However, issues and systems often extend beyond the control of any one organization or agency and thus require the efforts of multiple organizations or actors working together to achieve their common goals. Different governance structures may be more or less conducive to the voluntary formation of networks for collective action; in turn, these networks may be more or less effective in achieving their goals, often depending upon the types and characteristics of the actors involved. In this dissertation, I contribute to current knowledge about effective governance by examining the actions and interactions of organizations and agencies working to conserve the Andean bear in Colombia. Throughout my research, I was guided by one overarching question: *How does the structure of the conservation network in Colombia impact the network's collective ability to conserve the Andean bear?*

STUDY CONTEXT

Andean bears (or spectacled bears) (*Tremarctos ornatus*) are the only bear species in South America. They occur across the Andean mountains in Bolivia, Ecuador, Peru, Venezuela, and Colombia (Velez-Liendo and García-Rangel 2017). Andean bears are considered by the International Union for the Conservation of Nature to be "vulnerable" to extinction (Velez-Liendo and García-Rangel 2017). The primary threats to their persistence are habitat loss and

increasing levels of human-bear conflict (Velez-Liendo and García-Rangel 2017). All five countries with confirmed Andean bear presence have programs and strategies in place to confront these threats and conserve the species (Peyton 1999). Andean bear experts have pointed to challenges of governance when it comes to implementing Andean bear conservation strategies. For example, in the "Spectacled bear conservation action plan," Peyton (1999) described "weak institutions" as one of the primary challenges to Andean bear conservation. However, little research has been conducted on the topic to date.

At the time of writing, one element remained uncertain for the authors of the "Spectacled bear conservation action plan" (Peyton 1999): the effects of Colombia's then-newly implemented model of environmental governance. In 1993, Colombia had dramatically restructured natural resource governance in the country, shifting from a centralized strategy to one of "decentralization[1]" where 33 autonomous regional corporations (*corporaciones autónomas regionales* or simply "CARs") would have the power, responsibility, and resources to implement environmental policy (including for the conservation of threatened species) within their respective jurisdictions across the country. Though environmental policy would be determined by a central (i.e., national) agency, the Ministry of the Environment and Sustainable Development ("MinAmbiente"), these CARs were given a great deal of discretion as to its implementation after giving due consideration to their regional needs and realities. These CARs collectively comprise the majority of the primary actors in the Andean bear conservation network in the country, suggesting that particular attention ought to be paid to Colombia's decentralized model of environmental governance in building a comprehensive understanding of the network's effects on Andean bear conservation. The particularities of this decentralized

[1] Ribot (2002) defines decentralization as when "a central government formally transfers power to actors and institutions at lower levels in a political-administrative and territorial hierarchy."

model might dictate the degree to which these CARs coordinated with one another as well as generally affect the country's overall ability to achieve its conservation objectives, including those for threatened and endangered species like the Andean bear.

Decentralization of environmental and natural resource management became widely institutionalized in the early 1990s; more than 60 countries had implemented some form of decentralized environmental governance by the end of the decade (Ribot 2004). Proponents of this model argue that empowering people closer to the local context will allow for 1) more rapid and informed responses to problems as they develop; 2) more local compliance because rules are developed by those closer to the situation rather than by distant, bureaucratic officials; 3) a greater efficiency in the allocation of resources; and 4) more equitable governance (Caldecott and Lutz 1998; Ribot 2004; Lemos and Agrawal 2006; Larson and Soto 2008; Ribot et al. 2010). Extensive research has since explored the impacts, successes, and failures of these efforts and their ability to grant the purported benefits of the decentralized model. These scholars have found that many countries have only made weak or insincere attempts at decentralization by maintaining the vast majority of decision-making power at the national level or simply granting insufficient resources to lower level institutions to do the job (Larson 2003; Ribot et al. 2006). Interestingly, Colombia seems to be one rare case of "genuine" decentralization: Colombia's CARs generate their own resources and are even considered by some to have almost *too much* decision-making space (Blackman et al. 2004; Canal Albán and Rodríguez Becerra 2008; Rodríguez Becerra 2009). Thus, while my objectives did not originally include a critical analysis of decentralized environmental governance, my research on the Andean bear conservation network in Colombia nevertheless presented an opportunity to make novel contributions to our knowledge about this model.

Specifically, through a country-wide analysis of efforts to conserve a threatened species, the Andean bear, in the context of what appears to be genuine decentralization, this dissertation research provided an opportunity to explore two aspects of decentralization that to date have received insufficient attention.

First, decentralization was originally championed as a solution for successful management of common pool resources—such as timber or fisheries—the sustainable use and conservation of which is implicitly motivated by the promise of economic returns (Pacheco-Vega 2014). However, wildlife, particularly in the context of human-wildlife conflict, often do not qualify as common-pool resources. In fact, the successful conservation of such species often come with far more economic costs than benefits (with the rare exception of lucrative ecotourism enterprises), and these costs and benefits are usually distributed at different scales that are not well-contained within those scales occupied by decentralized institutions (Caldecott and Lutz 1998). Said another way, the costs of conservation—e.g., costs of coexistence with carnivores—are assumed by local actors (constituents served by decentralized entities); the benefits—e.g., ecosystem services, existence values—are typically appreciated by other, more distant actors (*not* constituents). Scenarios like these—where conservation costs are borne locally, but benefits accrue at other scales—are particularly challenging for decentralized governance (Caldecott and Lutz 1998; Gregersen et al. 2004). Given these challenges and incongruities with the original premise of the model, can decentralized environmental governance still benefit the conservation of threatened species, even those which are entangled in human-wildlife conflict? What institutional structures need to be in place to improve the chances of success?

Second, the geographical delineation of the CARs was originally motivated by a desire to encompass a single "ecosystem [or] geopolitical, biogeographical, or hydrogeographic unit"

within individual jurisdictions (Law 99 of 1993, Article 23), an innovative model that simplifies many aspects of natural resource management. However, not all ecosystem components for which the CARs are responsible fall so cleanly within their bounds, creating issues of "social-ecological fit[2]" for this decentralized system. This is true for the range of Andean bears, which crosses the borders of 22 different CARs. These CARs have no mandate to coordinate their efforts with one another, even among those neighbors that share jurisdictional boundaries. This is despite the clear fact that the actions (or inactions) of one CAR affect the successes of others due to the distributed nature of wildlife populations (and therefore the possibility of phenomena like population sinks in metapopulations). However, actors may self-organize into networks and collaborate to address common challenges; such "bottom-up" networks are documented in a variety of different landscapes and have been shown to improve social-ecological fit (Guerrero et al. 2015; Sayles and Baggio 2017). Of course, other actors beyond the CARs, such as nongovernmental organizations (NGOs) and Colombia's National Natural Park Service (*Parques Nacionales Naturales* [PNN]), are also part of this complex network working to conserve Andean bears. Does the structure of decentralized environmental governance provide sufficient incentives to encourage collaboration among these actors so as to meet the challenges of conserving this species? What role do other kinds of actors have in guiding the conservation and management of Andean bears? What might this case study tell us about how to implement change in other systems (decentralized or not) that have similar issues of social-ecological fit?

DISSERTATION STRUCTURE

The core of this dissertation is comprised of three self-contained manuscripts that address different components of this research. Chapters 2 and 3 set the stage by addressing Colombia's

[2] Specifically, the *spatial* dimension of social-ecological fit, or the degree of agreement between institutions and the geographical extents of ecological issues they are trying to manage (Epstein et al. 2015).

model of environmental governance and ecological connectivity, respectively. Chapter 4 then brings together governance and ecological connectivity for an analysis of social-ecological fit.

Chapter 2—Impacts of decentralized environmental governance on Andean bear conservation in Colombia—is a critical analysis of Colombia's National Environmental System as relevant to the conservation of the Andean bear. I considered not only the decentralized entities (the CARs), but also the roles played by nongovernmental organizations in advancing the conservation of this species. For this chapter, I used a literature review combined with a qualitative analysis of 67 semi-structured interviews conducted with conservation practitioners across the CARs, PNN, and NGOs. The research presented in this chapter was guided by three objectives: 1) determine strengths and weaknesses of decentralization as implemented in Colombia according to current literature, 2) identify impacts of decentralized governance on approaches to Andean bear conservation, and 3) identify opportunities to strengthen the conservation network in ways that will better enable organizations to meet their goals.

Chapter 3—Omnidirectional connectivity for the Andean bear (*Tremarctos ornatus*) across the Colombian Andes—is the first landscape connectivity model for the species in Colombia. I used general knowledge about Andean bear habitat associations, indices of ecological integrity, and the application of circuit theory (via Circuitscape; McRae et al. 2008; Anantharaman et al. 2019) to create this model. The objectives for this chapter were to 1) produce the first approximation of country-wide connectivity for Andean bears in Colombia and 2) demonstrate a novel approach for model validation which uses publicly available web and social media records of a flagship species.

Chapter 4—Nongovernmental organizations improve the social-ecological fit of institutions conserving the Andean bear in Colombia—assesses the degree to which the network

of institutions working across the Colombian Andes corresponded to Andean bear connectivity. In this chapter, I constructed a model of the Andean bear conservation network with social network data gathered via the 67 semi-structured interviews with conservation practitioners. This institutional network was then integrated with an ecological network derived from the connectivity model described in Chapter 3. I further contextualized my findings with qualitative data from the interviews. The three objectives guiding the research presented in this chapter were to 1) assess social-ecological fit of the current governance structure in Colombia for the conservation of the Andean bear, 2) determine the impacts non-jurisdictional organizations have on the network and indices of social-ecological fit, and 3) identify opportunities for strategic "network weaving" that could strengthen the conservation network and improve social-ecological fit.

Chapter 5 offers a synthesis of these components, proposals for further research, and reflections on my experiences while pursuing integrative research. Also included within this dissertation are various appendices comprised of manuscripts and other written works that did not directly pertain to the overarching research questions and/or that served as partial fulfillment of the "strategic communication" requirement of the Integrative Conservation PhD program.

To provide more detailed context for this research, the following sections include an overview of key historical background; the history and structure of environmental governance in Colombia; and the focal species, the Andean bear.

KEY HISTORICAL BACKGROUND

The civil conflict in Colombia—which only recently concluded with a peace treaty signed in 2016—was previously among the world's longest ongoing civil wars, having lasted more than 50 years.

Origins of the Colombian Conflict

The start of the civil conflict in Colombia is often dated to 1964, but the roots of the conflict can be traced to the 1948 assassination of liberal party leader and presidential candidate Jorge Eliécer Gaitán and the subsequent 10-year civil war referred to as *La Violencía* (Yaffe 2011; Giraldo Hoyos 2015). This period was characterized by state-sanctioned persecution of Colombia's liberal and communist citizens and anyone else believed to be against either the government or the conservative party (Loaiza Cordero 2012). In response, *La Violencia* saw the birth and growth of the first guerrilla movements in the Colombian countryside as liberal and communist *campesinos* (those of the rural working class) organized to protect their lives and livelihoods (Paredes and Díaz 2007). While many guerrilla organizations were primarily formed for self-defense, those affiliated with the *Partido Comunista* (Colombian Communist Party) were also politically motivated, their primary concern being enduring land and income inequality for the laboring class across rural Colombia (Loaiza Cordero 2012; Olave 2013). Towards the beginning of *La Violencia*, liberal and communist guerrilla groups were united through their shared persecution and the two groups even occupied some of the same territories during this conflict (Olave 2013). However, irreconcilable disagreements between the two groups gradually arose, especially regarding the appropriateness of the use of violence for political gain (ibid.). Liberal guerrillas began to see the communists as a danger to society and worked to discredit their movement (Loaiza Cordero 2012).

In 1953, General Gustavo Rojas Pinilla—a military dictator who had acquired executive power through a peaceful coup d'état supported by leaders of both conservative and liberal parties (Atehortúa Cruz 2010)—called for an end to the violence and offered amnesty to all guerrilla fighters who surrendered their weapons and returned home. While liberal guerrillas

largely disbanded following this proclamation of amnesty, many of those affiliated with the *Partido Comunista* refused to give up arms, fearing future persecution by the government (Pataquiva García 2009; Loaiza Cordero 2012). Further, the amnesty offered by General Rojas failed to address those issues of inequality that were fundamental to communist dissent (Loaiza Cordero 2012). Communist guerrillas which had refused to demobilize moved to more distant regions that were largely beyond state influence. Here they continued to act primarily in self-defense against state suppression (Pizarro Leongómez 1989), grow their ranks, and bring awareness to other rural Colombians about their movement, ultimately consolidating zones of influence that were later designated as illegal *Repúblicas Independientes* (Independent Republics) by conservative leaders (Loaiza Cordero 2012; Olave 2013).

La Violencia concluded in 1958 with a pact between the liberal and conservative parties, referred to as *El Frente Nacional*. This pact created a bipartisan coalition and formalized an agreement to alternate between liberal and conservative presidents every four years (Paredes and Díaz 2007). While *El Frente Nacional* succeeded in easing tensions between the liberal and conservative parties, it did so at the expense of all other minority parties, essentially excluding them from participation in Colombian politics (ibid.). Furthermore, *El Frente Nacional* again failed to resolve critical issues of inequality, thus leaving many *campesinos* sympathetic to the messaging of the *Partido Comunista* (Loaiza Cordero 2012).

In the 1960s, *Repúblicas Independientes* were declared war zones to be subjected to armed military intervention with the intention of expelling the guerrilla forces and re-assimilating these zones under state control. In 1964, the "independent republic" of Marquetalia (in the department of Tolima) was targeted for such an intervention, and there a two-week campaign was waged until the ~48 (accounts differ) communist guerillas were forcibly expelled.

These 48 guerrillas fled and shortly thereafter became the founding members of the *Fuerzas Armadas Revolucionarias de Colombia* or FARC (Revolutionary Armed Forces of Colombia)—an offensive (rather than defensive) guerrilla group which sought to overthrow the Colombian government (Vélez 2001), and which later went on to become the most notorious of the guerrilla groups in Colombia.[3]

Many other insurgent groups also arose during the 1960s, included among them the *Ejército de Liberación Nacional* (ELN) (National Liberation Army; 1964) and the *Ejército Popular de Liberación* (EPL) (Popular Liberation Army; 1967), both of which were heavily influenced by the Cuban revolution. In response to these and other emerging guerrilla groups, military advisors from the United States (concerned with the spread of Communism) urged the Colombian government to implement, as part of their counter-insurgent efforts, a strategy of training and arming civilians to act as paramilitary that could confront the guerrillas and help "restore public order" (Tate 2001). In the 1970s, rapid growth in the illicit crop market led several prominent drug cartels to become major actors in the Colombian conflict as well; several of these cartels created their own private armies to protect their investments (ibid.). Over time many of the paramilitary groups developed ties to these drug cartels. As Tate (2001) describes it:

> This was the beginning of the "dirty war" in Colombia, during which paramilitary groups linked to drug cartels, particularly the Medellín Cartel, worked closely with Colombian military officers to eliminate suspected guerrilla sympathizers, while at the same time they attacked Colombian authorities investigating drug trafficking and paramilitary activity.

[3] Some challenge this origin story, pointing out that FARC wasn't formalized until two years after Marquetalia. These scholars suggest the story of Marquetalia was selected by FARC for purposes of "image and propaganda" (Pataquiva García 2009), a myth presented so as to cast FARC as reticent heroes forced into revolution (Olave 2013).

In their first decade of activity, FARC had support from many *campesino* communities, within which they positioned themselves as leaders who established order and provided many services that these communities had otherwise not received from the Colombian state (Vélez 2001; Sánchez and Chacón 2005). However, FARC and other guerrillas soon expanded their operations beyond those distant *campesino* communities and into regions with greater economic potential (Vélez 2001; Sánchez and Chacón 2005; Pataquiva García 2009). FARC began to adopt terrorist tactics of kidnapping and extorsion (Vélez 2001)—tactics that were also adopted by other insurgent groups including ELN. The 1970s boom in marijuana, opioid, and cocaine markets provided lucrative enterprises through which to further finance guerrilla activities. The economic autonomy acquired through these new methods meant that popular support diminished in its importance for the survival of the guerrilla movements (Echandia Castilla 2001). This evolution has led scholars to distinguish between those motivators that precipitated the civil conflict (addressing inequality, low governability in rural regions, political exclusion) and those that perpetuated it (namely, greed) (Yaffe 2011).

The Conflict Intensifies

In the early 1990s, Colombia adopted neoliberal economic policies[4] which prioritized the attraction of foreign investment, the liberalization of markets, and the protection of private accumulation (Vélez-Torres and Ruiz-Torres 2015). This shift in economic strategy was strongly propelled by the World Bank and other international financial institutions that made structural adjustment programs and other types of aid contingent upon these reforms (ibid.). Scholars have

[4] Neoliberalism is defined by Harvey (2005) as "a theory of political economic practices that proposes that human well-being can best be advanced by liberating individual entrepreneurial freedoms and skills within an institutional framework characterized by strong private property rights, free markets, and free trade. The role of the state is to create and preserve an institutional framework appropriate to such practices."

since pointed to neoliberalism and globalization as factors in the perpetuation (and worsening) of Colombia's civil conflict (e.g., Mantilla Valbuena 2012; Vélez-Torres and Ruiz-Torres 2015).

For example, in its attempt to attract foreign investment, Colombia sought the business of transnational mining corporations that were, in turn, quick to capitalize on new opportunities presented by Colombia's transition to a neoliberal economy (Vélez-Torres and Ruiz-Torres 2015). Mining operations (primarily for oil and gold) proliferated across Colombia, covering close to 2.1 million ha by the end of 2012 (Vargas Valencia 2013). This had several cascading effects. First, the prioritization of these extractive industries by the Colombian state unfortunately came at the cost of many civil rights violations including the dispossession of land from indigenous communities and other vulnerable groups (Negrete Montes 2013; Vargas Valencia 2013). Second, these mining operations quickly became foci for exploitation by guerrillas (e.g., via threatening to destroy pipelines, extortion of contractors), allowing for further economic diversification (Mantilla Valbuena 2012). Finally, counter-efforts by the paramilitary led to even more human-rights violations. For example, Mantilla Valbuena (2012) describes how efforts by the paramilitary to take control of *Sur de Bolivar*, a gold-producing region long-since occupied by ELN, led to "36 thousand people displaced between 1997 and 2009, 700 documented disappearances between 1999 and 2000, and 380 homicides between 1997 and 2007." Municipalities with mining operations, particularly for petroleum, are associated with the highest rates of human rights violations in Colombia (Vargas Valencia 2013).

Greater access to world markets provided new opportunities for the exportation of cocaine and other drugs. Simultaneously, a "coffee crisis" (wherein the price for coffee had dropped precipitously in response to several interacting factors in the global market) was worsening socio-economic conditions across much of rural Colombia (Mantilla Valbuena 2012).

Unemployment and poverty potentially drove some landless laborers to join insurgent or paramilitary organizations (ibid.). Many of those with small farms were driven to convert their coffee crops to cocaine for economic survival (Osorio 2003; Acero 2016). The area of cultivated cocaine crops nearly quadrupled between 1994 and 2000, from ~45,000 ha to 163,000 ha (Mantillla Valbuena 2012), extending to over 65% of the Andean region of Colombia (Vargas Meza 2004). Colombia eventually surpassed other countries to become the world's leading producer of cocaine. Coffee, once 50% of Colombia's exports in 1985, accounted for just 8% by 2000 (Mantilla Valbuena 2012). These transitions were, somewhat obviously, coincident with greater activity of insurgent groups in areas historically associated with coffee production. In 1985, only 2% of those municipalities in *Eje Cafetero* (the coffee-producing region of Colombia) had registered insurgent activity; by 1995, the percentage of affected municipalities had grown to 53% (Vicepresidencia 2001 *cited in* Acero 2016).

Concurrently, in the late 1980s, Colombia began the process of political, administrative, and fiscal decentralization (Sánchez and Chacón 2005) (note that the decentralization of environmental governance—one of the primary subjects of this dissertation—followed shortly thereafter). Many of the most significant reforms arrived with *La Constitución Política de 1991* (the Political Constitution of 1991), including among them the transfer of half of the revenue collected by the central government to local governments, the popular election of mayors and governors, and integration of mechanisms for local democratic participation (ibid.). The transfer of political power and economic resources to regional and local governments was meant to improve the delivery of social services and basic public goods in these areas, as well as provide more opportunities for third party participation in Colombian politics. Indeed, many of these objectives were met. Throughout the 1990s, there were significant improvements to the

provisioning of health, education, electricity, water, sewage, and telephone services (Sánchez Torres and Núñez Méndez 2000). Local popular elections also saw more participation from third parties and new, politically formidable coalitions were formed (Sánchez and Chacón 2005).

However, the influx of resources and political clout to local governments essentially "translated the conflict to a fight for local power" (Sánchez and Chacón 2005). In their report, Sánchez and Chacón (2005) describe how decentralization offered new opportunities for the insurgents and paramilitary alike to expand and finance their operations:

> The reason for this is twofold. On the one hand, the local governments have less repressive capacity than the central government which makes local leaders more susceptible to intimidation, and on the other hand, as more resources are transferred to local governments, the "loot" available for depredation by irregular groups increases.

Thus, decentralization—meant to deescalate the conflict by addressing the original grievances of political exclusion, inequality, and lack of social services in rural Colombia—instead increased the intransigence of the conflict by inadvertently funding the activities of armed groups on the left and the right (Eaton 2006).

2016 Peace Treaty

Several earlier attempts were made by the Colombian government to reach an agreement with the guerrillas, the first of these in the early 1980s. Though some other guerrilla organizations reached settlements and demobilized, negotiations with FARC had remained largely unsuccessful. However, in 2016, following four years of negotiations, Colombian President Juan Manuel Santos and the leaders of FARC were able to reach a peace treaty. The agreement was sent to the people of Colombia for referendum, and in an unexpected turn of events (Álvarez-Vanegas et al. 2016), more than 50% voted the treaty down, in part due to an anti-settlement

campaign waged by the Central Democratic party of Colombia (Rico Revelo and Sottilotta 2020). The Colombian government and FARC thus returned to the negotiating table where they successfully agreed upon a revised peace treaty which was then approved by the Colombian Congress. The revised peace treaty includes 1) comprehensive rural reform; 2) democratic opportunities for political participation; 3) conditions for ceasefire and disarmament; 4) solutions to illicit drugs; 5) reparations for victims including mechanisms for justice; and 6) "implementation and verification mechanisms" to monitor compliance of both parties with the terms (Final Agreement to End the Armed Conflict and Build a Stable and Lasting Peace, 2016). However, in 2018, Iván Duque Márquez of the Central Democratic Party (i.e., the party that opposed the original peace treaty) was elected as the next Colombian president. Since his inauguration, many of the conditions promised by the 2016 treaty have been delayed while he seeks to revise the agreement (Rico Revelo and Sottilotta 2020), particularly in pursuit of heavier sentences for crimes committed by FARC (Binningsbø et al. 2019). These actions, along with continued violence from paramilitary organizations, threaten the tenuous and relative peace achieved in 2016 (Maher and Thomson 2018; Binningsbø et al. 2019).

The Toll

The civil conflict has taken an incalculable toll on Colombia and its citizens—the most recent estimates place the number of people killed throughout the conflict over 260,000; most of the victims were civilians (Centro Nacional de Memoria Histórica 2018). Close to 30,000 people have been reported missing, and over 10,000 have been injured or killed by landmines (Grupo de Memoría Histórica 2016). Between 1980 and 2012, there were close to 2,000 massacres (defined as "the intentional murder of four or more persons in a defenseless state; in the same way, time and place; and meant to be a public display of violence") (ibid.). Close to 5.6 million people are

estimated to have been forcibly displaced due to the armed conflict (ibid.), making Colombia home to the second highest number of internally displaced people in the world (following Syria) (Internal Displacement Monitoring Centre 2019). It's worth noting that the vast majority of the casualties were not perpetrated by the guerrillas, but rather by the paramilitary forces who claimed to be fighting for the Colombian government (Tate 2001; Centro Nacional de Memoria Histórica 2018). In addition to this immense human toll, there were also, of course, irreparable environmental damages wreaked by illegal (and legal) mining operations, deforestation for illicit crop cultivation, and the subsequent aerial fumigation with glyphosate by the Colombian government in its attempts to eradicate the same[5] (Giraldo Hoyos 2015).

Though I do not specifically examine the ramifications of the civil conflict for Andean bear conservation, it is nevertheless critical context to bear in mind while interpreting the research presented in this dissertation. By necessity, I have glossed over what is an incredibly complex and nuanced subject, and I hope interested readers will seek out some of the sources referenced above for additional information.

ENVIRONMENTAL GOVERNANCE IN COLOMBIA

Pre-1993

Colombian environmental governance has experienced many significant changes in the last three decades. Prior to 1993, when most of these changes were introduced, environmental governance was largely handled by two central institutions: Institute for the Development of Renewable Natural Resources and the Department of National Planning (*Instituto Nacional de los Recursos Naturales Renovables* [INDERENA] and *Departamento Nacional de Planeación* [DNP],

[5] Aerial fumigation of cocaine crops was suspended in 2015 due to health concerns raised by the World Health Organization, but President Duque Márquez is resuming this practice with support from the US government (Bureau of International Narcotics and Law Enforcement Affairs 2021).

respectively) (Canal Albán and Rodríguez Becerra 2008). As the national environmental authority, INDERENA was responsible for environmental policy, protected area management, and general oversight of natural resources in ~65% of the Colombian territory. The other 35% was collectively managed by 18 regional environmental authorities, known as regional autonomous corporations (*corporaciones autónomas regionales* [CARs]) (Canal Albán and Rodríguez Becerra 2008). These first 18 CARs were modeled largely after the Tennessee Valley Authority in the United States (Blackman et al. 2006) (which itself had been established in 1933 to improve economic conditions and oversee energy development and environmental stewardship in the Tennessee Valley; Tennessee Valley Authority Act of 1933). These 18 CARs were overseen by the DNP. Most of the CARs served dual roles within their jurisdictions: advancing economic development and protecting the environment—two very conflicting tasks, and the former, more profitable task predictably prevailed (Blackman et al. 2004; Rodríguez Becerra 2009).

This system was prone to many internal conflicts, not just within the CARs, but also between INDERENA—which was focused more on protecting the environment, but which had fewer resources—and the DNP—which was focused on development and production and had more resources (Canal Albán and Rodríguez Becerra 2008). These institutional conflicts of interest and the disparities in their power amounted to general environmental mismanagement (Uribe Botero 1998). While these issues were coming to fruition in Colombia (in the form of mass pollution, destructive natural resource extraction practices, and the like), the environmental movement was reaching new heights on the global stage. The then Colombian President, César Augusto Gaviria Trujillo, attended the United Nations Earth Summit in Rio de Janeiro in 1992. This seminal event led Gaviria to push for broad reform of environmental governance in

Colombia (Canal Albán and Rodríguez Becerra 2008; Rodríguez Becerra 2009; Salinas Mejía 2010).

Law 99 of 1993

Following on the heels of the political, administrative, and fiscal decentralization provided by *La Constitución Política de 1991*, Law 99 of 1993 decentralized Colombia's environmental governance. Law 99 upturned and reshaped Colombian environmental governance structures into *Sistema Nacional Ambiental* (National Environmental System), commonly referred to as SINA. SINA is defined as "a set of orientations, norms, activities, resources, programs, and institutions that allow the implementation of general environmental principles" (Law 99 Art. 4). Law 99 dissolved INDERENA and created in its place the Ministry of the Environment (what is now called the Ministry of the Environment and Sustainable Development or "MinAmbiente"). The primary responsibility of the MinAmbiente would be developing environmental laws and policies (Rodríguez Becerra 2009). To help the MinAmbiente in this task, Law 99 created and endowed to SINA five institutes that would conduct research with the end of producing scientific data to inform policy development (Rodríguez Becerra 2009). Additionally, Law 99, through some elimination, creation, and reformation, brought the total number of CARs across the country to 34 (later reduced to 33) (Sánchez Pérez 2002; Rodríguez Becerra 2009). These CARs, which now covered the entirety of the national territory, were to be the new implementation arm of the MinAmbiente in their respective jurisdictions and the primary mechanisms through which decentralization of natural resource management occurred. Among their responsibilities are the sustainable management of natural resources and the conservation of all threatened and endangered species within their jurisdictions. They were, according to Article 31 of Law 99, "to

act as the chief environmental authorities within their jurisdictions" (*"ejercer la función de máxima autoridad ambiental en el área de su jurisdicción"*).

All of these institutions—the CARs, the research institutions, and the MinAmbiente—comprise SINA. The MinAmbiente was designated as the leader of this new system; from Law 99, Article 5, one of the primary functions of the MinAmbiente is "to direct and coordinate the planning process and harmonious implementation of environmental activities of the entities of the National Environmental System [SINA]." However, and—some would argue—paradoxically, the CARs were granted ultimate environmental authority in their jurisdictions. While the CARs were mandated to implement environmental policy created by the MinAmbiente, they were permitted to do so selectively and with discretion based upon the realities within their regions (Canal Albán and Rodríguez Becerra 2008). The CARs would be permitted to establish their own institutional structures, set their own budgets, and hire personnel largely without intervention from national authorities, including the MinAmbiente (Canal Albán and Rodríguez Becerra 2008). To ensure autonomy, Law 99 mandated that CARs receive resources via property taxes from within their respective departments, thus freeing them from relying upon budget provisions from the central government—a critical step for effective decentralization (Blackman et al. 2004).

To ensure a more democratic form of environmental governance, SINA developed mechanisms that would enhance the participation and influence of civil society. For example, the CARs are each governed, in part, by a board of directors mostly comprised of elected officials from within the jurisdiction and one representative each from the president and MinAmbiente. Law 99 requires the board of directors of each CAR to also include two representatives from local NGOs. This grants these members of civil society influence over the general activities of

the CARs, the appointment of the CAR director, and a means through which to help hold the CARs accountable (Blackman et al. 2004).

Issues with SINA Emerge

Despite its ambitious origins, SINA has shown many signs of poor structure and instability. One of the more notable flaws is that environmental governance in Colombia is especially vulnerable to presidential priorities (Rodríguez Becerra 2009). Law 99 granted the president the ability to elect their own Environmental Ministers but mandated no specific qualifications for the person who held this title. Furthermore, while Law 99 guaranteed fiscal independence for the CARs, no such provision was made for the MinAmbiente that remained (and remains) largely reliant upon funding from the national administration (Mance 2007). Because of a national financial crisis in the late 1990s, the MinAmbiente experienced drastic budget reductions and staff lay-offs (ibid.). Though these cuts were not unique to the environmental sector, the MinAmbiente received more significant cuts than any other entity (ibid.). Furthermore, because it is mandated by the constitution to make some specific, and large, expenditures, the MinAmbiente had very little flexibility with those funds it did receive (ibid.). By 2002, the MinAmbiente was receiving less than half of what it had received in 1995 (Ibánez Londoño and Uribe Botero 2002; Mance 2007).

One of the greatest impacts to the environmental sector came in 2003. Citing a determination to tackle big government spending and issues with inefficiency, President Alvaro Uribe Velez merged the fledgling MinAmbiente with the Ministry for Housing and Territorial Development. The merge replicated and internalized the same conflicts of interest that had plagued INDERENA and the DNP in the 1980s (Blackman et al. 2004; Mance 2007). At the time of the merger, it wasn't yet clear whether this would be the disastrous blow some top environmental officials believed it to be (Blackman et al. 2004). However, hindsight has revealed

that rather than integrating these two objectives into a more holistic, sustainable approach as it was sold, "*Es como si el Ambiente y la Vivienda hubieran sufrido un matrimonio concertado por los padres, y ahora se acuestan uno al lado del otro en la misma cama, en medio de sueños distintos.*" ("It's as if the environment and housing [ministries] have suffered an arranged marriage by their parents, and now lay side by side in the same bed in the midst of different dreams."; Mance 2007).

Predictably, as occurred in the 1980s, development again gained prominence over environmental concerns. During this period of time, technical capacity and budget allocation were both drained from environmental management and shifted towards economic development (Rodríguez Becerra 2009). The personnel working on environmental matters in the Ministry were overburdened and poorly paid; as a result, staff turnover was high (Mance 2007). With the departure of so many professionals, the Ministry lost important institutional memory and any chance at progress continuity (Mance 2007). While this decision was reversed in 2011 by President Juan Manuel Santos (Decree 3570 of 2011), these past actions demonstrate the fragility of Colombia's environmental governance, and effects still linger from this debilitating event having occurred at such a critical moment in the evolution of Colombian environmental governance (Mance 2007).

The CARs were likewise not immune to debilitating actions taken by the national administration, despite their supposed guaranteed autonomy. Just a few years after the reformation of the CARs, many allegations about severe corruption emerged (Canal Albán and Rodríguez Becerra 2008). In response to these allegations (and his campaign promise to tackle big government spending), Uribe attempted to reform the CARs (Mance 2007). While he was not successful in this effort, he did force them to contribute funds towards potable water and basic

sanitation services, leaving less behind for environmental efforts. The first Minister of the Environment, Manuel Rodríguez Becerra, critiqued this mandate, asserting that under Uribe's leadership, CARs had all but lost their ability to act as environmental authorities (Rodríguez Becerra 2009).

Aside from general vulnerability to politics, SINA has shown signs of other fundamental issues. As mentioned earlier, Law 99 granted CARs fiscal independence through regional taxation mechanisms (they can also subsidize their budgets with licensing fees, environmental compensations, etc.). Naturally, not all regions throughout Colombia are equivalently prosperous. Approximately 75% of all revenue accrues to just 8 CARs, covering just ~13% of the territory (Blackman et al. 2004; Gómez Torres 2005). This results in great disparities among the CARs in their capacity to complete their objectives, making it so that "environmental regulations are stringently enforced in some CARs and virtually ignored in others" (Blackman et al. 2004). Attempts to correct these fiscal inequalities have been made and failed (Blackman et al. 2006). A more recent report from the *Departamento Nacional de Planeación* (Tomás Blanco et al. 2015) presents further evidence that the financial disparities among the CARs continue.

Finally, many arguments have been made that the CARs simply have too much autonomy. While Law 99 created control and reprimand mechanisms to help MinAmbiente "direct and coordinate," these appear weaker than they ought to be. For example, the CARs are subject to fiscal review by the Comptroller of Colombia (*Contráloria General de la República*) which is theoretically meant to have the power to discipline CARs for failure to implement plans or for abuse of office. In 2018, the Comptroller detected over 100 billion COP (~27 million

USD) of what were believed to be misspent funds and other "irregularities"[6] across 10 CARs investigated by the Comptroller for fraud (Contráloria General de la República 2018a). Though the findings were turned over to the Office of the Prosecutor and the Secretary General (Contráloria General de la República 2018b) for further investigation and possible criminal charges, the Comptroller still argued that it could not adequately respond to or penalize the CARs for these infractions:

> *Frente a todas estas irregularidades encontradas, la Contraloría considera necesario continuar el debate con respecto a la importancia y alcance de la autonomía de las CAR, frente a las debilidades que de manera reiterada ha señalado en sus informes de auditoría. . . Las CAR tienen una naturaleza jurídica sui generis, por lo que solo se les aplican determinadas disposiciones administrativas y, aunque* [la Contraloría General de la República] *ejerce sus labores de control frente a las mismas, cuentan con alto nivel de discrecionalidad en la toma de sus decisiones.*— Contraloría General de la República. [In light of all these irregularities found, the Comptroller considers it necessary to continue the debate regarding the importance and the scope of the autonomy of the CARs, given the weaknesses that have been repeatedly revealed during audits…The CARs have a sui generis legal nature, so only certain administrative provisions apply to them, and although the Comptroller exercises its control over them, they have a high degree of discretion in their decision-making.]

[6] The Comptroller referred to "*hallazgos fiscales*"—defined as "when damage is caused to the state's assets as a result of the malicious or culpable conduct of those who perform fiscal management" (Govimentum 2016). These *hallazgos* were numerous and varied; e.g., suspiciously large contracts given repeatedly to the same contractors, contracts awarded directly to a contractor without the requisite public contract bidding process, investments in projects or programs unrelated to the CARs' missions, etc.

Further, the freedom to adapt national management plans to "suit regional realities," means that in practice many CARs can flagrantly disregard policy from the MinAmbiente; "*some corporations take advantage of their autonomy to avoid complying with the law*" (pers. comm., ASOCARS). This particular critique of SINA (that the CARs are *too* autonomous) has been attributed to multiple factors. A detailed assessment funded by the World Bank boldly asserts that "the design of Law 99 virtually ensures inadequate national-regional coordination" (Blackman et al. 2004). As early as 1997, obvious issues of coordination between the MinAmbiente and the CARs were apparent (Blackman et al. 2004). The exact level of autonomy guaranteed to the CARs is highly debated and contentious, leading to subjective interpretations by each CAR. Others, including the first Minister of the Environment in Colombia, have cited a severe lack of leadership by the MinAmbiente as the fundamental issue rather than a defect in the design of SINA (Mance 2007; Rodríguez Becerra 2009); the merger between 2003 and 2011 may be to blame as it stunted the leadership potential of the MinAmbiente at a highly critical time in the evolution of SINA (Rodríguez Becerra 2009).

ANDEAN BEARS

The Andean bear or spectacled bear (*Tremarctos ornatus*) (in Spanish, *oso andino* or *oso de anteojos,* less commonly *oso frontino*) is the only bear species in South America and the last surviving lineage of the subfamily *Tremarctinae* (García-Rangel 2012). The Andean bear is a medium-sized ursid, with males generally weighing between 140 and 175 kg (Peyton 1999). Andean bears, as may be surmised from their name, are endemic to the Andean mountains. Specifically, they are found across the northern Andes in Venezuela, Colombia, Peru, Ecuador, and Bolivia (Velez-Liendo and García-Rangel 2017). They may also occur in northern Argentina (Cosse et al. 2014) and southern Panama (Goldstein, Guerrero, and Moreno 2008), but their

presence in these two countries is debated, and evidence is particularly dubious for Panama. These countries are often not included in research or reports about the species. Andean bears occur on all three ranges of the Andes, from elevations as low as 200 m to as high as 4,750 m (Goldstein, Velez-Liendo, Paisley, and Garshelis 2008). In Colombia, as elsewhere, they are most often found in mountainous ecosystems above 1200 m (Peyton 1999; Ríos-Uzeda et al. 2006) including Andean cloud forest and shrub ecosystems known as *páramo* (Peyton 1999).

The Andean bear is one of the most herbivorous of the ursids, with a diet consisting primarily of bromeliad hearts (a family of monocot flowering plants found in the tropics) and only 3.3% meat (Peyton 1980; Peyton 1999). Their diet may include cacti pulp and fruit, various tree fruits, berries, rodents, and insects (Peyton 1980; Peyton 1999). They are known to forage agricultural areas, particularly in corn crops (Peyton 1980; Escobar-Lasso et al. 2020). Andean bears also scavenge, and some individuals will occasionally kill cattle (Parra-Romero 2011).

The Andean bear was first described in 1825 (Cuvier 1825); research on the species has been accumulating since the 1970s (García-Rangel 2012). However, Andean bears remain a relatively under-studied species, especially among charismatic megafauna (Cáceres-Martínez et al. 2020; Falconi et al. 2020). For example, only two empirical estimates of Andean bear density appear in peer-reviewed literature, the first published less than two decades ago (and based on observations of only 3 bears; Ríos-Uzeda et al. 2007) and the second only in 2017 (Molina et al. 2017). Prior to this, studies had used the average density of American black bears as substitute when calculating population estimates (Yerena and Torres 1994; Peyton et al. 1998; Kattan et al. 2004; Goldstein et al. 2008). Despite limited data on their precise distribution and density, evidence has been accumulating that Andean bears have experienced population declines over the last several decades. The International Union for the Conservation of Nature classifies

Andean bears as vulnerable to extinction (Velez-Liendo and García-Rangel 2017). Rough estimates place the current number of Andean bears between 13,000 and 18,000 individuals (Velez-Liendo and García-Rangel 2017); approximately 3,000-6,000 Andean bears are estimated to be in Colombia (Ruiz-García 2003). However, some regard these population estimates with skepticism; there may be far fewer Andean bears than this (Peyton et al. 1998; Garshelis 2011).

Andean bears have experienced extensive habitat loss and fragmentation across their range. Kattan et al. (2004) estimated that remaining habitat for Andean bears comprises approximately 200,000 km^2, 42% of the suspected original extent of the species. Kattan et al. (2004) further found that this habitat was fragmented into 113 distinct patches, with most (56%) intact patches smaller than 500 km^2 ("intact" indicating they were not intersected by roads). The minimum patch size believed to support viable Andean bear populations is between 1200 and 1900 km^2 (Yerena 1998; Peyton 1999). Approximately 12% of total Andean bear habitat is in Colombia, which shows similar patterns of deforestation to those described by Kattan et al. (2004). Rodríguez Eraso et al. (2011) estimated that only 38% of natural systems in the Colombian Andes had remained in 2000. Though Andean ecosystems in Colombia have been inhabited for millennia (van der Hammen 1992 *cited in* Etter et al. 2008), land use conversion was not nearly so prevalent nor detrimental until Spain's colonization of the country in the 1500s and the subsequent introduction and proliferation of cattle ranching (Etter et al. 2008). Deforestation in Andean forests has accelerated over the last half century due to increasing agricultural conversion and upslope development from populous inter-mountain valleys (ibid.). As of 2000, cattle ranching qualified as the "dominant land use and driver of landscape change" in the country (ibid.).

Approximately 20% of Andean bear habitat is under some kind of protection across Venezuela, Colombia, Ecuador, Peru, and Bolivia (Peyton 1999). Yerena (1998) estimates that there are 42 conservation areas (adjacent protected areas are counted as one) that benefit Andean bears, but fewer than 15 of them are large enough to support viable populations. In Colombia, Andean bears are found in 22 different national natural parks and flora and fauna sanctuaries (Orejuela and Jorgenson 1999).

Habitat loss has coincided with increased levels of human-bear conflict across the Andes as Andean bears have increasingly needed to venture into agricultural areas to meet their nutritional requirements (Parra-Romero 2011; Laguna 2013). They can cause significant damage to crops while foraging, sometimes destroying entire crops in a single visit (Peyton 1980; Escobar-Lasso et al. 2020). This—combined with their propensity to scavenge and/or kill cattle—has led many *campesinos* across the Andes to see Andean bears as a threat to their livelihoods and to persecute them (Goldstein et al. 2006; Parra-Romero 2011; Figueroa 2015). Though precise estimates of the number of Andean bears killed due to human-wildlife conflict are difficult to come by, poaching is considered to be one of the greatest contributors to their decline (Velez-Liendo and García-Rangel 2017).

Andean bears are legally protected within all five countries where they occur, and efforts to conserve populations are ongoing (Peyton 1999; Goldstein et al. 2008). In 2001, the Ministry of the Environment in Colombia commissioned a panel of experts to assemble the National Program for the Conservation of the Andean bear (Mayr Maldonado 2001). This document again confirmed the status of the species as “in danger of extinction” within the country and formalized the directive for CARs to begin drafting plans for the species within their territories (Mayr

Maldonado 2001). As with other national environmental policies, the CARs were to take this conservation plan and adapt it to suit regional needs and realities.

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CHAPTER 2

IMPACTS OF DECENTRALIZED ENVIRONMENTAL GOVERNANCE ON ANDEAN BEAR CONSERVATION IN COLOMBIA[7]

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ABSTRACT

Decentralized environmental governance has become increasingly common across much of Latin America and in developing countries more generally, yet the impacts of decentralization on wildlife conservation remain unclear. Decentralized environmental governance is thought to improve efficiency, local compliance, and democratic potential of natural resource management. However, wildlife conservation, especially that of large mammals, poses unique challenges in the context of decentralized governance: wildlife conservation is often expensive, may require large expanses of contiguous habitat, and often offers few economic benefits. We analyzed Colombia's decentralized environmental governance and its performance in conserving a contentious and border-crossing wildlife species, the Andean bear (*Tremarctos ornatus*). We considered both decentralized institutions and nongovernmental organizations (NGOs). This analysis is informed by 67 semi-structured interviews with conservation practitioners in Colombia. We found inconsistent program implementation across the country and little information exchange among institutions. These issues potentially contribute to exacerbated human-bear conflict and thus more Andean bear deaths, suggesting that the successful coordination of large-scale wildlife conservation may yet require the leadership of strong central institutions. A few international NGOs were working to improve Andean bear conservation in Colombia, but we saw little involvement at the national level of Colombian NGOs—some of whom felt they were being unfairly outcompeted by international NGOs. We recommend a greater engagement with Colombian NGOs (by both donors and international NGOs) as a means through which to ensure the integrity of Andean bear conservation into the future.

INTRODUCTION

The importance of effective environmental governance has increasingly been recognized in light of mounting conservation challenges (Wells 1998; Young et al. 2008; Bennett and Satterfield 2018; Beunen and Patterson 2019). Following Lemos and Agrawal (2006), environmental governance is "the set of regulatory processes, mechanisms, and organizations through which political actors influence environmental actions and outcomes." Good environmental governance is viewed by many as one of the most important factors which ultimately enables conservation action (Dietz et al. 2003; Lemos and Agrawal 2006; Armitage et al. 2012; Scarlett and McKinney 2016; Bodin 2017). Many different structures of governance could potentially be effective, depending upon the particular type of conservation challenge faced and the context within which it occurs.

Decentralized governance has been proposed as a solution for when overly-centralized governance systems fail to deliver sustainable conservation outcomes. Decentralization is the devolution of power and responsibility from a central authority to intermediary or local levels of governance which are largely or entirely independent from the higher authorities and accountable to their local constituents (Manor 1999; Ribot et al. 2006). Decentralization is considered one of "the most important emerging trends that are shaping environmental governance" (Lemos and Agrawal 2006). The presumed advantages of decentralization are that empowering people closer to the local context will allow for i) more rapid and informed responses to problems as they develop; ii) more local compliance because rules are developed by those closer to the situation rather than by distant, bureaucratic officials; iii) a greater efficiency in the allocation of resources; and iv) more equitable governance (Caldecott and Lutz 1998; Ribot 2004; Lemos and Agrawal 2006; Larson and Soto 2008; Ribot et al. 2010).

Most studies that have critically assessed these possible impacts of decentralized environmental governance have done so in the context of forest resources and with local governments or communities rather than intermediary institutions on the receiving end of the devolution of power (e.g., community forestry, community-based natural resource management) (Ribot 2002; Andersson and Ostrom 2008; Larson and Soto 2008; Clement 2010), although there are exceptions (e.g., see Sullivan 2019). We still have much to learn about how decentralization towards intermediary institutions of the state could impact other facets of environmental management, such as the conservation of threatened and endangered wildlife. Wildlife conservation often presents distinct challenges in the context of decentralized governance: wildlife conservation is often expensive, may require large expanses of contiguous habitat that cross jurisdictional borders, and often offers few economic benefits. To our knowledge, no one has yet interrogated how decentralized governance systems perform in the context of conserving wildlife when there are no obvious economic incentives to do so. Thus, questions about how decentralized governance systems can best achieve their objectives despite these challenges remain unanswered. Given the vast number of countries with decentralized governance structures, combined with the ever-increasing number of threatened wildlife species, these gaps in our understanding need to be addressed.

This article begins to address these gaps by offering insights gained through the analysis of Colombia's decentralized environmental governance and its performance in conserving a contentious and border-crossing wildlife species, the Andean bear (*Tremarctos ornatus*). We had three specific objectives in conducting this research: i) Determine strengths and weaknesses of decentralization as implemented in Colombia according to current literature, ii) Identify impacts of decentralized governance on approaches to Andean bear conservation, and iii) Identify

opportunities to strengthen the conservation network in ways that will better enable organizations to meet their goals. In assessing performance and structure of their environmental governance system, we consider both decentralized intermediary institutions and nongovernmental organizations (NGOs). This analysis is informed by 67 semi-structured interviews with conservation practitioners in Colombia conducted between August 2018 and September 2019.

Challenges within Decentralized Governance Systems

Despite being embraced as a near-panacea in developing countries, decentralization of environmental governance has resulted in mixed environmental outcomes, at best (Batterbury and Fernando 2006; Andersson and Ostrom 2008; Bartley et al. 2008). The institutions which receive the newly devolved powers and responsibilities usually lack the resources or technical capacity to fulfill their new mandates (Larson 2003; Gregersen et al. 2004; Andersson 2006). For example, state governments in Nigeria charged with managing forest resources lacked the capacity to monitor illegal harvesting or draft adequate forest policies or programs, leading to mismanagement and unsustainable forest use (Gregersen et al. 2004). Furthermore, there seem to be consistent issues with coordinating decentralized governance systems (Blackman et al. 2004). Research on the efficacy of decentralized governance systems suggests that horizontal communication among entities is critical (Gregersen et al. 2004; Andersson 2006; Young et al. 2008; Lockwood et al. 2010). When this communication is missing, decentralized institutions are less effective in achieving their mandates (Andersson 2004). For example, townships in Yunnan, China—recipients of devolved responsibility for natural resource governance—did not coordinate watershed maintenance, leading to negative externalities experienced by downstream villages, inter-township disputes, and increased levels of social conflict (Dupar and Badenoch 2002). For this reason (among others), central authorities do not become obsolete in

decentralized schemes; by facilitating communication, they are linchpins holding the decentralized framework together, preventing environmental governance from becoming uncoordinated and ineffective (Caldecott and Lutz 1998; Gregersen et al. 2004). Central authorities can institutionalize horizontal communication and reduce "transaction costs" through simple means such as providing spaces for meetings, facilitating group workshops, or granting resources to cover travel.

Wildlife conservation adds numerous complexities to the already difficult task of effectively decentralizing environmental management. First, many wildlife, especially large mammals, require large expanses of contiguous habitat that are likely to cross jurisdictions. For example, wolves in Italy have an estimated home range of 197 km^2 (Ciucci et al. 1997). Horizontal communication among entities may thus become particularly critical for success. Otherwise, how might institutions ensure wildlife habitat connectivity across boundaries? Second, unlike forest management which deals with common pool resources that could generate revenue for institutions responsible for overseeing their management (thus incentivizing them to manage these resources sustainably) (Larson 2003), wildlife conservation rarely offers such tangible benefits. Studies that have examined decentralization of wildlife conservation were usually centered around community-based ecotourism operations in Africa, but opportunities to derive economic benefits from wildlife in other areas without established tourism operations are limited (Walpole and Thouless 2005). In these situations, benefits of wildlife conservation, such as the provision of cultural or ecological services, are often intangible and tend to be appreciated only at broader scales. When the wildlife in question are contentious in the landscape or otherwise entangled in human-wildlife conflict (e.g., predators that threaten livestock), costs accumulate at the local scale for those who coexist with the species. Scenarios like these—where

costs are borne locally, but benefits accrue at other scales—are particularly challenging for decentralized governance (Caldecott and Lutz 1998; Gregersen et al. 2004). The conservation of contentious wildlife may come with costs, both economic and political, that intermediary institutions are unwilling to assume. In such cases, central authorities have an additional responsibility to create incentives (whether positive or negative) to ensure compliance and participation by the intermediary authorities (Caldecott and Lutz 1998; Gregersen et al. 2004; Bartley et al. 2008).

Decentralization and Civil Society

The proliferation of decentralized governance systems around the world in the 1990s was, not coincidentally, concurrent with a rapid growth of the civil society sector (Zaidi 1999; Kajimbwa 2006; Bernauer and Betzold 2012). Though civil society is comprised of many important groups of non-state actors, NGOs have become especially prevalent and influential (Werker and Ahmed 2008; Holmes 2011; Nasiritousi 2019). Environmental NGOs can be powerful actors with vast resources, superior technical abilities, and high levels of trust from the public (Clark 1995; Edelman Public Relations Worldwide 2019). These characteristics allow environmental NGOs to assume authority in spheres historically dominated by the state (Clark 1995). NGOs can play a critical role in decentralized systems, particularly through their ability to hold institutions accountable to their local constituents (Caldecott and Lutz 1998; Gregersen et al. 2004). Because of their ability to amplify voices of underrepresented communities, NGO involvement in decentralized governance is thought to improve democratic representation (Batterbury and Fernando 2006). Additionally, environmental NGOs may enhance the performance of decentralized environmental governance if they build the capacity of the intermediary or local institutions.

Gregersen et al. (2004), who conducted a broad review of decentralized forest governance systems across 11 countries, found that in many of these cases international NGOs had even more influence than local ones. However, this ability of international NGOs to wield more influence than their local counterparts may have unpredictable or even adverse effects. For example, because of their reliance on donors usually located elsewhere, their priorities may not always reflect those of local institutions or their constituents (Sachedina 2008; Werker and Ahmed 2008; Smith et al. 2009; Cook et al. 2017). Asymmetrical access to external resources could exacerbate power differentials between the international and national NGOs, giving non-local voices undue influence (Hudock 1995). The presence of a strong and active civil society, of both national and international origins, could fundamentally change the overall performance of decentralized governance (Andersson and Ostrom 2008). Thus, any analysis of decentralized environmental governance is incomplete without due consideration paid to the behavior of environmental NGOs and their connections to and influence over state entities.

RESEARCH CONTEXT

Colombia

Colombia is considered by the United Nations to be one of 17 "megadiverse" countries in the world (United Nations Biodiversity Programme 2014). Colombia has more than 54,000 species registered in the Global Biodiversity Information Facility (GBIF 2020) making it second only to Brazil in terms of species richness. The Colombian Andes account for much of this tremendous biodiversity; many of the species found here are endemic to these high elevation ecosystems (Kattan et al. 2004). Just over a quarter of the surface of the country is occupied by the three ranges of the Colombian Andes, which extend from the southwestern to the northeastern borders of the country. Colombia is also a populous country–the third most populous in South America–

with close to 50 million residents. The majority of this population is located in the inter-mountain valleys of the Colombian Andes. This demographic distribution has important implications for the conservation of these mountainous ecosystems and the endemic species residing there.

Colombia has a presidential representative democracy not unlike the structure of the United States, with power divided among executive, legislative, and judicial branches of government. Administratively, the country is divided into 32 departments and a capital district, each of which have their own departmental assemblies elected by popular vote. The departments themselves are comprised of municipalities; there are 1,122 municipalities across the nation.

Colombia has had a tumultuous history due to civil conflict that consumed the country for more than 50 years and which only just formally ended with a tenuous peace treaty signed in 2016 with the largest insurgent group in Colombia, *Fuerzas Armadas Revolucionarias de Colombia* (Revolutionary Armed Forces of Colombia) or FARC (Brodzinsky 2016; Binningsbø et al. 2019). Because of previous occupation by guerrilla groups, several regions of Colombia have only recently become accessible for institutions of the state; these communities were previously bereft of many social services and other public goods. Dissidents of FARC remain active in some areas despite the peace treaty, as do some paramilitary groups and other guerrilla groups not associated with FARC.

Environmental Governance in Colombia

In keeping with the broad trend across the world, Colombia shifted towards decentralization in the early 1990s. Decentralization of the state was initially motivated by the political, economic, and social challenges of the time period—largely due to the armed conflict—when the central government was struggling to meet demands (Pening Gaviria 2003; Eaton 2006; US Agency for

International Development 2009). The Republic of Colombia officially embraced political decentralization in the Constitution of 1991 while the decentralization of natural resource management came two years later with the enactment of Law 99 in 1993.

Law 99 created Colombia's current system of decentralized environmental governance known as the National Environmental System (*Sistema Nacional Ambiental* [SINA]; see Table 2.1 for a glossary of all acronyms). Officially, SINA is defined as "a set of orientations, norms, activities, resources, programs, and institutions that allow the implementation of general environmental principles" (Law 99 of 1993, Article 4). Law 99 dissolved the previous institution responsible for environmental oversight (the Institute for the Development of Renewable Natural Resources) and created a new Ministry of the Environment (now the Ministry of Environment and Sustainable Development, or *Ministerio de Medio Ambiente y Desarollo Sostenible* ["MinAmbiente"]). The MinAmbiente is responsible for developing environmental laws and policies (Rodríguez Becerra 2009). To help the MinAmbiente in this task, Law 99 created and endowed to SINA five research institutes that would conduct research with the objective of producing scientific data to inform policy development (Rodríguez Becerra 2009). Law 99 further transformed and expanded state entities known as regional autonomous corporations (*Corporaciones Autónomas Regionales* [CARs]) which are largely modelled after the Tennessee Valley Authority in the United States (Uribe 1996; Canal and Rodríguez 2008). Collectively, these 33 CARs became the implementation arm of the MinAmbiente in their respective jurisdictions across Colombia and the primary mechanism through which decentralization of natural resource management occurs (Figure 2.1). Listed among the many responsibilities of the CARs are the conservation and management of threatened and endangered species existing within their territories (including the Andean bear).

Colombia's National Natural Park system was also restructured in the 1990s (Uribe 1996). Historically overseen by the Institute for the Development of Renewable Natural Resources, protected areas are now collectively managed by the National Natural Parks of Colombia (*Parques Nacionales Naturales de Colombia* [PNN]). PNN was designed as a semi-autonomous special administrative unit within the MinAmbiente (Blackman et al. 2004). PNN has a hierarchical administrative structure, tiered at the national, regional, and local (park) levels. Colombia's many national protected areas (n = 58) and the biodiversity conserved within are managed by PNN independently from the CARs.

The MinAmbiente was designated as the leader of SINA: Law 99, Article 5 states that one of the primary functions of the MinAmbiente is "to direct and coordinate the planning process and harmonious implementation of environmental activities of the entities of the National Environmental System [SINA]." However, and—some would argue—paradoxically, the CARs were granted ultimate environmental authority in their jurisdictions (except in the case of coincident national protected areas). While the CARs were mandated to implement environmental policy created by the MinAmbiente, they were permitted to do so selectively and with discretion based upon the realities within their regions (Canal and Rodríguez 2008). The CARs would be permitted to establish their own institutional structures, set their own budgets, and hire personnel largely without intervention from national authorities, including the MinAmbiente (ibid.). To ensure autonomy, Law 99 mandated CARs receive resources via property taxes from within their respective departments, thus freeing them from relying upon budget provisions from the central government (Ibánez Londoño and Uribe Botero 2002; Blackman et al. 2004), a critical step for effective decentralization that is rarely observed

(Caldecott and Lutz 1998; Manor 1999). Approximately 94% of CAR funding is internally generated, with just 6% provided by the national government (Benavides Muñoz 2012).

To ensure more democratic environmental governance, SINA developed mechanisms to enhance the participation and influence of civil society. For example, the CARs are each governed, in part, by a board of directors mostly comprised of democratically elected officials from within their jurisdictions and one representative from both the president and MinAmbiente. Law 99 requires the board of directors of each CAR to also include two representatives from local NGOs. This grants these members of civil society influence over the general activities of the CARs, the appointment of the CAR directors every four years, and a means through which to hold the CARs accountable (Blackman et al. 2004).

Challenges within Colombia's Decentralized Governance

As early as 1997, issues of coordination between the MinAmbiente and the CARs were apparent (Blackman et al. 2004). The freedom to adapt national management plans to "suit regional realities" created the opportunity for many CARs to flagrantly disregard policy from the MinAmbiente (ibid.). This particular critique of SINA (that the CARs are too autonomous) has been attributed to multiple factors. A detailed assessment funded by the World Bank boldly asserts "the design of Law 99 virtually ensures inadequate national-regional coordination" (ibid.). Because the exact level of autonomy guaranteed to the CARs via Law 99 is subject to interpretation (it posits CARs are both autonomous and subordinate to the MinAmbiente), it is a highly debated and contentious issue.

Law 99 created control and reprimand mechanisms to help the MinAmbiente "direct and coordinate" as mandated:

> First, CARs are required to submit 10-year, 3-year, and 1-year action plans that tie in with the national development plans drafted by the executive branch. Second, the National Department of Planning must approve CAR investment projects. Third, CARs boards of directors include a representative of the [MinAmbiente], as well as a representative of the president of Colombia. Fourth, Colombia's control organizations can discipline CARs for failure to implement plans or for abuse of office. Fifth, national authorities have some control over the salaries of CAR staff. Finally, in the past, the [MinAmbiente] and other national institutions have contributed investment funds—or have allocated funds contributed by multilateral institutions—and this power of the purse has given them some sway over CAR investment projects.—Blackman et al. 2004

According to Blackman et al. (2004), these approaches have proven largely ineffective. However, others, including the first Minister of the Environment in Colombia, have cited a severe lack of leadership by the MinAmbiente as the fundamental issue rather than a defect in the design of SINA (Mance 2007; Rodríguez Becerra 2009).

Another concern beyond the lack of coordination between the MinAmbiente and the CARs is the vulnerability of SINA to the vicissitudes of national politics (Rodríguez Becerra 2009). Law 99 granted the president the ability to appoint their own Environmental Ministers but mandated no specific qualifications for the person who held this title. This led to a series of what have been described as unqualified ministers (i.e., lacking experience or training in environmental science) during the early 2000s (Mance 2007). Furthermore, while Law 99 guaranteed fiscal independence for the CARs, no such provision was made for the MinAmbiente that remained (and remains) largely reliant upon funding from the national administration (ibid.). Because of a national financial crisis in the late 1990s, the MinAmbiente experienced drastic

budget reductions and staff lay-offs (ibid.). By 2002, the MinAmbiente was receiving less than half of what it had received in 1995 (Ibánez Londoño and Uribe Botero 2002). Then, between 2003 and 2011, the fledgling MinAmbiente was merged with the Ministry for Economic Development (Blackman et al. 2004; Mance 2007). During this period of time, technical capacity and 80% of the remaining budget of the MinAmbiente were both drained from environmental management and shifted towards economic development (Mance 2007; Rodríguez Becerra 2009). Personnel working on environmental matters in the Ministry were overburdened and poorly paid; as a result, staff turnover was high (Mance 2007). With the departure of so many professionals, the Ministry lost important institutional memory and any chance at progress continuity (ibid.). Rodríguez Becerra (2009) argues that the lack of leadership from the MinAmbiente on environmental matters during this critical stage in the evolution of SINA has had lasting effects on the capacity for the MinAmbiente to effectively lead the CARs and thus environmental governance in Colombia more generally.

Aside from general vulnerability to politics, SINA has shown signs of other fundamental issues. As mentioned earlier, Law 99 granted CARs fiscal independence through regional taxation mechanisms (they can also subsidize their budgets with licensing fees and environmental compensations). Naturally, not all regions throughout Colombia are equally prosperous. Approximately three-quarters of all revenue accrues to only 8 CARs, covering just ~13% of the territory (Blackman et al. 2004; Gómez Torres 2005). This results in great disparities among the CARs in their capacity to complete their objectives, making it so "environmental regulations are stringently enforced in some CARs and virtually ignored in others" (Blackman et al. 2004). Attempts to correct these fiscal inequalities have occurred and failed (Blackman et al. 2006).

Andean bears

As a signatory to the Convention on Biological Diversity, Colombia is expected to protect threatened and endangered species. Andean bears, also known as spectacled bears, are one such species. They are the only extant ursid in South America, occurring in Venezuela, Colombia, Peru, Ecuador, Bolivia, and possibly Argentina (Cosse et al. 2014; Velez-Liendo and García-Rangel 2017). As their name implies, they are endemic to the Andean mountains. They occur primarily in high elevation cloud forest and *páramo* ecosystems, though their presence has been confirmed from elevations as low as 200 m (Velez-Liendo and García-Rangel 2017).

The Andean bear is a medium-sized bear; males generally weigh between 140 and 175 kg (Peyton 1999). Andean bears are not aggressive towards humans; only one known report exists of an Andean bear attacking a person (the person had quietly approached a bear in an attempt to kill it and was bitten) (Peyton 1980). Andean bears are largely herbivorous, but they will occasionally scavenge, and some reports exist of "problem" Andean bears attacking cattle (Peyton 1980; Goldstein et al. 2006; Castellanos et al. 2011; Zukowski and Ormsby 2016; Parra-Romero et al. 2019). They are also known to forage in agriculture fields, sometimes destroying entire crops in a single visit (Peyton 1980). For these reasons, *campesinos* (people living in rural areas) often see Andean bears as a threat to their livelihoods. Retaliatory (and preventative) poaching is an issue across much of Colombia as well as their broader range (Torres et al. 1995; Jorgenson and Sandoval-A 2005; Goldstein et al. 2006).

Andean bears are currently classified as "vulnerable" by the International Union for the Conservation of Nature, but continuous habitat loss and increasing levels of human-bear conflict threaten the likelihood of their persistence (Velez-Liendo and Garcia-Rangel 2017). They are predicted to be endangered by 2030 (Goldstein et al. 2008). The most recent estimates of Andean

bear populations suggest that between 13,000 and 18,000 bears exist in the wild (Velez-Liendo and García-Rangel 2017). Between 3,000 and 6,000 Andean bears are believed to be in Colombia (Ruiz-García 2003). They are found across all three ranges of the Colombian Andes, including the jurisdictions of 22 different CARs and 22 different national parks (Figure 1).

In 2001, the MinAmbiente created the National Program for the Conservation of the Andean bear. This document again confirmed the status of the species as "in danger of extinction" within the country and formalized the directive for CARs to begin drafting plans for the species within their territories (Mayr Maldonado 2001). As with other national environmental policies, the CARs were to take this conservation plan and adapt it to suit regional needs and realities.

METHODS

Interview Methods

All interviews were conducted between August 2018 and September 2019.[8] I (R. Hohbein) conducted 67 semi-structured interviews (Bernard 2011) with 71 individuals either directly or indirectly involved with Andean bear conservation in Colombia. Those 65 interviews included representatives of 22 CARs and 20 NGOs, as well as 12 PNN employees. Interviews were conducted in-person or via telephone/video chat when in-person interviews were not a viable option. All interviews but one were audio-recorded and only after receiving verbal permission from interviewees. I openly took notes, as recommended by Spradley (1979). Nearly all interviews were conducted in Spanish and with the aid of a local translator. In order to reduce variation in response effects (Bernard 2011), I was always present as the primary interviewer.

[8] The Institutional Review Board at the University of Georgia approved all research conducted for this study (Protocol ID #STUDY00005270).

Through the course of conducting interviews, I was aided by three different translators. Though the use of multiple translators may impact interview responses in some circumstances (e.g., Berreman 1962), none of these translators were associated with conservation or environmental work and had no prior connections to interview participants. I did not ask interviewees to recall distant data or specific numbers, but rather to reflect on their current approaches and beliefs. A complete copy of the semi-structured interview guide can be found in Appendix E.

Sampling

NGOs: Interviews began with Fundacion Wii and the Wildlife Conservation Society - Colombia, the two largest and most well-known NGOs working with Andean bears in the country. I then used chain referral sampling (i.e., snowball sampling) (Bernard 2011) to identify other NGOs/nonprofits involved with Andean bear conservation. While some biases may result from using these two NGOs as my starting points, these two NGOs had done the most expansive work on the topic within Colombia. Thus, this approach captured the most influential components of the conservation network on the national scale. I did not follow-up for interviews with NGOs named during chain referral if the NGOs identified were not actively involved in creating, implementing, or managing projects that directly dealt with Andean bears, unless those NGOs had been named by two or more organizations as relevant to Andean bear conservation work.

CARs: I aimed to interview all CARs that had jurisdictions coincident with Andean bear habitat. Interviews began with CARs named by NGOs in the above sampling strategy; in many cases, NGO interviewees identified specific contacts within these CARs with whom they believed I should speak. For those CARs not mentioned by NGO interviewees, I found phone numbers online, and, with the aid of a local translator, called and asked to be connected with the person who “best knew about their institution’s efforts for Andean bear conservation.”

PNN: I interviewed two employees at the national level and representatives working at the regional level for all six "territorial directorates" (*direcciones territoriales*). Individuals working at the park level were interviewed only opportunistically.

The MinAmbiente was contacted about this research but declined our request for an interview.

Analysis

Interviews were fully transcribed and translated before being imported in MaxQDA 2018 for thematic coding and analysis (VERBI Software 2017). Where applicable, all quotations that appear in this paper have been translated from Spanish to English and edited for clarity.

RESULTS

SINA and Andean bears

The MinAmbiente has the potential to coordinate the CARs in their efforts for Andean bear conservation. However, despite the promising step of initiating a national program for the conservation of the Andean bear in 2001, the MinAmbiente did not seem invested in verifying its implementation or progress among the CARs. This has led many at the CARs to wonder "Where is the Ministry of the Environment?"; e.g., "*We keep waiting for the Ministry to check in with us, but there hasn't been anything.*" This absenteeism of the MinAmbiente has led several of those with whom I spoke to claim the MinAmbiente "*doesn't help with anything*." When asked how they would describe the level of communication between the CARs and the MinAmbiente, I was told, "*There is none. There is no communication,"* or simply, "*It's terrible.*" Others acknowledged the MinAmbiente's involvement as a ". . .*demand [for] annual reports, nothing more.*" A rare few referenced annual or twice-annual meetings held in Bogotá. No other mentions were made of attempts by the MinAmbiente to foster communication among CARs nor to encourage their coordination on this particular matter. Several respondents believed the lack of

involvement by the MinAmbiente in Andean bear conservation could be explicitly linked to the departure of a key champion from the MinAmbiente who had been particularly enthusiastic about working with the species.

Interviews with CAR representatives revealed only a haphazard implementation of the National Program for the Conservation of the Andean bear. The most widely implemented component of the national program was environmental education (implemented to some degree by 19 of 22 CARs, 86.4%). Costlier programs were much rarer. For example, the national program also called for solutions to the conflicts created by Andean bears depredating cattle and destroying crops, but only 9 CARs (40.9%) developed programs to either improve cattle management or support alternative, sustainable practices (e.g., ecotourism, switching to produce not consumed by bears). Interviewees often cited limited resources as the cause for inadequate action. However, there was no readily discernible connection between the amount of economic resources available to the CARs and the quality or quantity of Andean bear programs implemented; i.e., access to more economic resources did not necessarily translate to better funded conservation programs within the CARs. Rather, disinterested CAR directors (who are responsible for creating the annual budget and determining the four-year action plans for the corporation) were often implicated (e.g., "*There are directors that have no affection for wildlife, so they do very little. Meanwhile, it could be the contrary.*"). I received numerous accounts of Andean bear conservation programs being initiated by one CAR director, only to be prematurely terminated by the next, resulting in disjointed or incomplete program implementation. The degree to which Andean bears are embroiled in conflict may be partly to blame. One CAR director was quoted as having said in reference to an injured Andean bear, "*Take this son of a b**** animal from here. That is a hot potato for me!"*

Many CARs felt compelled to act only after bears were killed within their jurisdictions. The death of a bear was cited time and again in instances where interviewees were explaining the origins of Andean bear programs:

> *The idea is to be able to unite forces, to be able to work on the implementation of mitigation methods for the Andean bear. . . Where? We still don't know. We believe it will be where they killed that bear. . .*
>
> *It was a male and it was killed in a prairie called _____. This made the news and it turned into the whole world knowing. [Through] all the social networks, through emails, they were sharing the news. And it became a very famous case. . . This [alerted] the official entities that they should try to work with communities.*

At least in regard to Andean bear conservation efforts, CARs continue to be relatively isolated entities, each working (if at all) from within their own jurisdictions without much regard to what's happening next door (with a handful of exceptions). Only 36.4% of CARs (n = 8) mentioned other CARs as collaborators or even as sources of information regarding Andean bear conservation strategies. Insufficient coordination among the CARs was a noted problem for Andean bear conservation, leading to unnecessary duplication of effort, inefficient use of precious conservation funding, and a general stagnation of efforts. Furthermore, limited communication and coordination among CARs can actively hamper efforts by local NGOs. According to one researcher from a national NGO,

> *The [lack of] communication between agencies is one of the most difficult things you find in your way of researching Andean bears. Because one agency thinks one thing and the other agency thinks another thing. They are neighbors. . . but they won't do the same*

thing. So for me, it's wasting money and time and logistics and effort because one person thinks differently than the other.

This lack of communication can also lead to negative outcomes for Andean bears. Consider the following story:

The other problem is the borders between CARs, no? If an event is occurring with a bear between [X CAR] and [Y CAR], then it's, "No, you attend it," "No, you." . . . Some months ago, we had a complaint about a bear at the border between PNN and [CARS X and Y]. Officials of a corporation came. And they were there already, very close to the site, right? But they didn't go because in that moment they realized it was the neighboring corporation. So they left.

Though it may seem inconsequential, these kinds of incidents can greatly exacerbate an already difficult situation. According to many of my interviewees, after 50 years of civil conflict, rural Colombians already feel abandoned by the state: "*The real problem is that the people feel alone. That the institutions of the government are not helping them, so they feel like the problem they're facing—with the presence of the bears or other predators—is theirs and nothing more."* During interviews, conservation practitioners explicitly linked this feeling of being abandoned with an increased likelihood of rural Colombians to kill Andean bears:

In 2011. . . there was a registered bear attack on domestic animals. A bear attacked a horse on a farm, and then they scared the bear away to another farm. . . where he attacked some calves. So, unfortunately, this was *reported to the environmental authority. It was [Z CAR]. Well, they told [Z CAR], they sent a message about the presence of the bear and about the attacks. But that week was* Semana Santa [Holy Week]. . . *So they*

> *couldn't attend the case. So. . . people–hunters–armed a group. I don't know how many. And they looked for the animal. And that was how a bear died.*

Now, consider this other anecdote heard from an NGO representative:

> *A month ago, four bears were killed in [X Municipality] because a bear killed the cows. The community [had] called the CAR, and what the CAR told them is that the bear is a vegetarian. That it doesn't kill cows and that everything is a lie. . . When the farmer had seen the bear killing the cow!*

This anecdote was supported when three biologists at three different CARs denied or expressed doubt that Andean bears would kill cows despite substantial evidence to the contrary (e.g., Goldstein et al. 2006, Castellanos et al. 2011) and the explicit mention of depredation events in the National Program for the Conservation of the Andean Bear in Colombia (Mayr Maldonado 2001). Improved communication among CARs might have remedied this misinformation over a decade ago. Instead, ranchers in these three departments have had their grievances met with skepticism, and one CAR was channeling limited funding towards their own independent research to determine whether Andean bears really do depredate cattle.

Adaptations to Decentralization

There have been multiple efforts to improve communication among these various governmental institutions. For example, the Global Environmental Facility-National System of Protected Areas (*Sistema Nacional de Áreas Protegidas* [GEF-SINAP]) program executed by the World Wide Fund for Nature regularly unites entities at various spatial scales (departmental, regional, and national) to discuss protected area management strategies. While these meetings had not yet led to new communication ties regarding Andean bear conservation specifically, they were building familiarity among institutions–a key ingredient for future collaborative work. Another

noteworthy NGO is ASOCARS (*Asociación de Corporaciones Autónomas Regionales y de Desarrollo Sostenible* [Association of Regional Autonomous and Sustainable Development Corporations]), formed in 1996 with the objective of uniting the CARs so together they might ward off threats to their constitutional autonomy (ASOCARS 2018). Originally formed by 18 CARs, the organization now counts members from all 33 CARs in the country. The BanC02 program—a payments for ecosystem services scheme founded in 2013 by the CAR, Cornare (*Corporación Autónoma Regional de las Cuencas de los Ríos Negro y Nare*), and executed by a local NGO, MasBosques—was successfully promulgated through ASOCARS and has now been adopted and implemented by 23 other CARs, demonstrating the potential efficacy of information dissemination through this forum. However, the full potential of these forums for increasing communication channels between institutions had not yet been realized. For example, ASOCARs is mostly for the directors of CARs, though some technicians may occasionally be included. Despite assurances from an ASOCARS representative that Andean bears had been discussed many times in their meetings, only one biologist interviewed mentioned ASOCARS as a place where they had discussed or learned about Andean bear conservation efforts. GEF-SINAP enabled dialogue about protected area management among CARs, but other topics of discussion had not yet followed these interactions.

While collaborations among CARs were uncommon, five CARs of the eastern range of the Colombian Andes and the Orinoquia Territorial Direction of PNN voluntarily signed a five-year inter-institutional agreement in 2017 to coordinate their efforts for the conservation of the Andean bear. Participants cited several instigating factors: the deaths of two bears, the desire for a standardized protocol for responding to bear sightings, increasing conflicts between bears and ranchers, and evidence that individual bears were passing between neighboring CAR

jurisdictions. They agreed to adopt the same monitoring strategy (that which is promoted by the Wildlife Conservation Society - Colombia and PNN, see below); they produced the desired protocol for institutional responses to bear sightings; and (at the time of this research) they continued to meet at least four times per year and communicated informally via the cell phone messaging service WhatsApp® far more frequently. Members of the agreement cited many benefits, including more rapid responses to bear conflicts in border zones; a more heterogeneous learning environment (*"We are so many professionals from different careers and [with] different experiences in different territories. We have the ability to complement one another, share experiences, and learn from all that is happening in each of the places."*); more efficient resource allocation; and more confidence in applying approaches already tested by their colleagues. Some participants also seemed to view the inter-institutional agreement as a shield against accusations of poor bear-conflict management. The inter-institutional agreement for Andean bears eventually led to an additional, more encompassing agreement for the conservation of all biodiversity across their shared ecosystems.

Civil Society and Andean bears

There are several environmental NGOs doing important work for Andean bear conservation in Colombia. However, our analysis revealed that the Wildlife Conservation Society - Colombia (WCS) was the most prominent and influential NGO working on this topic in the country. During interviews, WCS was cited more often than any other entity as partners, collaborators, or sources of information on Andean bears. For this reason, we focus on their impacts in more detail than the others.

WCS began their Andean bear conservation efforts in coordination with Colombia's National Park Service (*Parques Nacionales Naturales* [PNN]) in 2007 with a $13,000 fund from

the US Fish and Wildlife Service (US Fish and Wildlife Service 2007). The partnership began with the request of PNN for WCS to help PNN develop and implement a high-quality monitoring program for Andean bears. Prior to this partnership, there was no consistency in monitoring efforts for Andean bears across SINA institutions. Instead there was a decades-long history of sporadic, one-off endeavors using independent methodologies that usually produced incompatible data sets. In 1999, Peyton had claimed "there [was] no population level management being implemented for spectacled bears in the Andes that [had] an empirical foundation." Certainly, this is no longer the case today, in large part due to the diligent efforts of WCS both to develop a monitoring program with broad applicability and to train PNN employees across Colombia in its implementation (and the determination of PNN to implement it).

As an institution, PNN spans the entire country. Therefore, the alliance between these two entities allowed the monitoring strategy developed by WCS to propagate to many other institutions, notably the CARs, several of whom (n = 8) had implemented the effort within their own regional protected areas. It's worth noting that without the invitation and endorsement by PNN, these institutions would have been far less likely to adopt the WCS methodology; the rapid uptake of the protocol suggests a sort of bandwagon effect. This is important because the MinAmbiente cannot mandate the CARs to use the same methodology, yet standardization improves the network's collective ability to accurately assess the status of Andean bear populations, identify ongoing threats to their persistence, and address those threats.

PNN's selection of this international NGO as a strategic partner in Andean bear conservation has had many other benefits. WCS has garnered attention from large donors who now may have a vested interest in conserving the species. For example, the Grupo Argos

Foundation—the nonprofit arm of a Colombian conglomerate, Grupo Argos S.A.—agreed to invest 5 billion Colombian pesos (~1.5 million USD) over a five-year window in the *Conservamos la Vida* project (another Andean bear conservation effort between PNN and WCS) (Foundation Grupo Argos 2019). When I asked the director of the Grupo Argos Foundation why they decided to work with WCS and PNN on this project, I was told they were drawn by its long-term vision ("*that was very important for us*").

WCS endeavors to play a supporting role in the conservation network by building the capacity of their partner institution (PNN) rather than maintaining all technical capacity in-house. The absence created by a hypothetical departure of WCS from the Andean bear conservation network is intended to be seamlessly filled by PNN. WCS has a demonstrated commitment to sharing their methodology with other governmental institutions beyond PNN as well, having hosted numerous monitoring and human-wildlife conflict workshops with CAR employees and associated community volunteers. By sharing these strategies with local partners, WCS strengthens the resilience of the Andean bear conservation network to the inevitable conclusion of this particular conservation program. Various personnel within PNN expressed their appreciation for this approach taken by WCS.

Not all perspectives of WCS were positive, however. Interviews with Colombian NGOs in particular revealed some criticisms and negative perspectives. A few felt as though WCS pushed them out of the picture (unintentionally or otherwise):

> *In Colombia, there is an entity that works with Andean bears: WCS. But what has happened is they have hoarded all the attention and the donors for the bear. . . They have been developing a methodology. . . but they are a bit closed when it comes to other institutions being a part of these investigative projects.*

> *Occupancy models—that is what they are selling to the whole country, saying 'that works,' that the work other organizations are doing doesn't work, that the only one that works is theirs because they have doctorates.* (*Note that advanced degrees are still relatively rare in Colombia.)

Interviews with practitioners at larger, international NGOs revealed they believe they must simply have more competitive proposals than smaller NGOs. Whatever the case, the inability to acquire program funding leaves many Colombian NGOs in a difficult position. To make ends meet, these NGOs are increasingly accepting contracts from institutions of the state, mostly CARs. Contract work comes with many restrictions, and prevents NGOs from developing innovative work (e.g., "*[Local NGOs] lost the capacity to create their own projects or to keep their own proposals because they became contractors instead"*). Understandably, these disparities make the situation feel unfair:

> *They have international funds, money that comes from outside [Colombia]. The national ones, no. We do not have any international support. We depend upon doing something with them [the CARs].*
>
> *If we want a grant, since we are national. . . we have to be connected with an international NGO.*

Furthermore, to prevent conflicts of interest, NGOs who accept contract work are disallowed from participating on the board of directors of the CAR by whom they are contracted. Local NGOs can either choose to influence policy and ensure accountability of the CARs, or they can forgo this opportunity, but make ends meet. However, a few Colombian NGO directors indicated they had no desire to become involved in CAR "politics," indicating barriers other than contract work to their involvement.

DISCUSSION

Gregersen et al. (2004) concluded that within decentralized governance, "the lack of a strong central government is certain to…lead to administrative disorder leading to further loss of national policy coherence." This conclusion appears to be upheld by the state of Andean bear conservation in Colombia. Thus far, the MinAmbiente has fallen short of its mandate to "direct and coordinate the planning process and harmonious implementation of environmental activities." Weak leadership and/or inadequate accountability mechanisms have resulted in the delayed implementation of the National Program for the Conservation of the Andean Bear and, as predicted by Gregersen et al. (2004), a general lack of coordination and coherence. In a coarse analysis of institutional planning documents, Rodríguez-Castro et al. (2015) found most CARs (61.5%) had neither developed nor proposed activities specific to the conservation of the Andean bear (but rather were passing off general environmental conservation efforts as programs for Andean bear conservation). They found most projects for Andean bears that had begun were initiated only after 2009—an eight-year delay in implementation that did not elicit any apparent reprisal from the MinAmbiente. Interviews conducted for this research confirmed, 18 years on, a few CARs still had not initiated programs for Andean bear conservation. The lack of a cogent national program (because it is inconsistently implemented across CARs) has led to negative outcomes for Andean bears.

The conservation of contentious wildlife is both politically and economically expensive; many CARs appeared unwilling to shoulder such costs. The MinAmbiente has at its disposal several methods to encourage greater compliance. For example, Blackman et al. (2004) recommended the MinAmbiente use the "power of the purse" to encourage specific, desirable programs (i.e., they subsidize them). I found no evidence the MinAmbiente was contributing

funds to Andean bear conservation. Nor did any interviewees cite reprisals from the MinAmbiente regarding the weaknesses of their Andean bear programs (or lack thereof). The MinAmbiente thus provided neither incentives nor penalties to encourage greater compliance. Rather, the strongest incentives to comply with the national program came from the media following the deaths of local Andean bears. Even then, programs were developed and implemented only in those specific municipalities where the bears were killed. This is problematic as not all Andean bear deaths are discovered (Peyton 1999). Additionally, fear of reprisal from the media often triggered only short-term, band-aid responses to deep-rooted problems. The need for stronger incentives to encourage compliance of decentralized institutions is a finding echoed in other analyses (e.g., Larson 2003; Bartley et al. 2008).

Horizontal communication can greatly improve decentralized governance. Gregersen et al. (2004) argued connections among decentralized structures were necessary to handle environmental externalities and "functions that spill over administrative boundaries." Andean bear movement across the landscape certainly qualifies as a function that crosses boundaries. Our research suggests coordination is also necessary in situations where rapid responses are required in areas of jurisdictional ambiguity. Anderssen (2006) examined decentralized forest governance in Bolivia and also concluded horizontal communication was critical to successful governance. However, he focused more on the benefits of social learning rather than coordination, per se, which is also something found to be lacking within SINA's approach to Andean bear conservation. All but eight CARs operated their Andean bear programs in communicative isolation from one another; only five CARs actively coordinated their efforts. Participants involved in this inter-institutional agreement cited many benefits, which we can only assume are not occurring for the rest of the CARs across Colombia. The lack of communication among

CARs has, in some cases, allowed inaccurate information–that may ultimately endanger Andean bears–to perpetuate (Castellanos et al. 2011).

While most reviews have found decentralization often occurs with insufficient devolution of decision-making power or "discretionary space" (Ribot 2002; Larson 2003; Ribot et al. 2006; Kiwango et al. 2015), the CARs are routinely considered to be too autonomous (Blackman et al. 2004, 2006). Indeed, the haphazard implementation of the national Andean bear conservation plan appears to support this. Considering the subsidiarity principle, which forms the basis upon which decentralization is argued (i.e., that decisions should be made at the lowest possible political level that still fosters efficiency), one might conclude the conservation of wildlife would actually best be managed by a competent central authority rather than intermediary ones (Føllesdal 1998; Shaw et al. 2000; Ribot 2002). However, that any degree of autonomy could be wrested from the CARs without an ugly and divisive political battle seems unlikely. Whether or not the MinAmbiente as currently managed qualifies as a "competent authority" also warrants some interrogation. Finally, unraveling decades of effort to decentralize—which *has* produced many benefits—would quite likely produce more problems than it would solve. A better solution might be to improve those mechanisms already created by Law 99 through which the MinAmbiente could coerce the CARs into compliance with national environmental policy. Similar mechanisms implemented within China's decentralized governance system resulted in improved performance, though some variation remained due to differences in the economic capacities of local authorities (Kostka and Nahm 2017), something that would need to be addressed in Colombia's system as well. Tensions between different hierarchical levels of decentralized systems are common, and calibrations to their respective authorities can result in enhanced performance (Gregersen et al. 2004).

Several authors have concluded the civil society sector in Colombia is weak (Blackman et al. 2004, 2006; Mance 2007). While Colombian NGOs have grown more numerous since the 1990s, most remain small and have little influence possibly due to their inability to access international donors. Some of those with whom I spoke felt they were being unfairly outcompeted by international elites who they viewed as holding a privileged status due to their advanced degrees and connections to wealthy donors. As noted in the results, a few members of international NGOs denied culpability: their proposals were simply superior. However, this may not necessarily be the case. Several factors are likely at play that have nothing to do with the merit of proposals submitted. Sriskandarajah (2015) reported five reasons as to why donors choose not to fund local NGOs directly: i) smaller CSOs [civil society organizations] do not have the capacity to spend money effectively; ii) [donors] do not have the administrative capacity to give smaller amounts of money; iii) [donors] need to channel money through a few, trusted partners to manage risk and comply with their own rules; iv) strict anti-terror and anti-money laundering rules make giving directly difficult; and v) they are under domestic political pressure to fund through CSOs based in their home country. One common practice to overcome these barriers is for donors to provide international NGOs with grants with the express purpose of having these NGOs "re-grant" to local partners (Ismael 2019). In practice, much of this funding is siphoned off as institutional overhead, resulting in relatively little money ultimately reaching intended beneficiaries (Chapin 2004). Building capacity and gaining donor trust can be an uphill battle. In their review of funding patterns of NGOs in Uganda, Burger and Owens (2012) found efficacy was less a determining factor in grant acquisition than was a history of having already received grants; i.e., money begets more money. These kinds of funding practices systematically disenfranchise smaller NGOs.

The exclusion of local and national NGOs leaves Andean bear conservation in Colombia vulnerable. The Wildlife Conservation Society - Colombia is currently the most influential actor in the country. While they have arguably greatly advanced the state of Andean bear conservation, we have to ask what unseen costs are associated with having an international NGO play this role rather than the MinAmbiente or a Colombian NGO. International NGOs are routinely acknowledged to be vulnerable to shifting donor priorities and changing conservation "fads" (Zaidi 1999; Rodríguez et al. 2007). Because of their superior abilities to access grants and donors, they are outcompeting grassroots organizations whether they mean to do so or not. While local NGOs are stuck contracting, they are not learning the skills necessary to conduct their own large-scale projects. Conservation programs are not eternal, and well-designed exit strategies for conservation programs are essential to ensuring sustainable conservation outcomes that extend beyond the life of the project itself (World Wide Fund for Nature 2017). Insufficient engagement with local institutions has been documented to lead to the collapse of programs meant to be semi-permanent (Pensulo 2015). Though WCS has spent laudable time and effort building the capacity of SINA institutions, the CARs are prone to high rates of institutional turnover, politicization, elite capture, and corruption, and PNN struggles in the face of debilitating budget cuts each year (Blackman et al. 2006). We also have yet to see how decentralization continues now that Colombia has reached a post-conflict period.

We suggest Andean bear conservation would benefit greatly if local and national NGOs were included more meaningfully as partners rather than contractors. This recommendation echoes that of many others for powerful NGOs to shift their focus from implementing their own projects to building the capacity of their counterparts in developing countries (e.g., Kajimbwa 2006; Rodríguez et al. 2007; Pensulo 2015; Brown et al. 2019). In the context of decentralized

environmental governance, we see other benefits to supporting the national civil society. Namely, a more capable civil society with its own resources and programming would be better able to oversee SINA institutions as intended by Law 99. Instead, there has been a phenomenon of "sham" NGOs taking their place on the CAR boards of directors (i.e., NGOs established solely for the purpose of occupying the seats reserved for civil society) (Blackman et al. 2006). Meanwhile, more research is needed to assess and remedy the observed hesitance of Colombian NGOs to more actively engage with the CARs.

CONCLUSION

Andean bears are large, wide-ranging mammals contentious within their landscape and not contained within the arbitrary boundaries drawn by governments—or, as so many of my interviewees were keen to point out, "they know no borders." Therefore, the successful conservation of this species requires the participation, coordination, and collaboration of institutions across many jurisdictional levels and spatial scales. Unfortunately, this is not inherent in the structure of SINA, despite all its original promise. This research demonstrates that decentralization without effective leadership, strong incentives, nor sufficient horizontal communication can hinder the successful implementation of conservation programs for threatened species. Furthermore, inconsistent programming may exacerbate issues of human-wildlife conflict when calls for institutional intervention by vulnerable communities are left unanswered. We recommend for more support to be channeled towards efforts to facilitate communication among the CARs, such as ASOCARS and the GEF-SINAP program. Furthermore, the inter-institutional agreement among the CARs and PNN Orinoquia is ripe for replication and should be examined in more detail to better understand how these entities overcame the many barriers to collaboration. A basic understanding of Andean bear habitat

connectivity across the three Andean ranges could be helpful in guiding and motivating the development of new partnerships among other CARs that share border-crossing Andean bears. Meanwhile, more support should be given to local NGOs, who are less prone to the many issues associated with Colombia's agencies and who can help ensure stability of Andean bear programs into the future.

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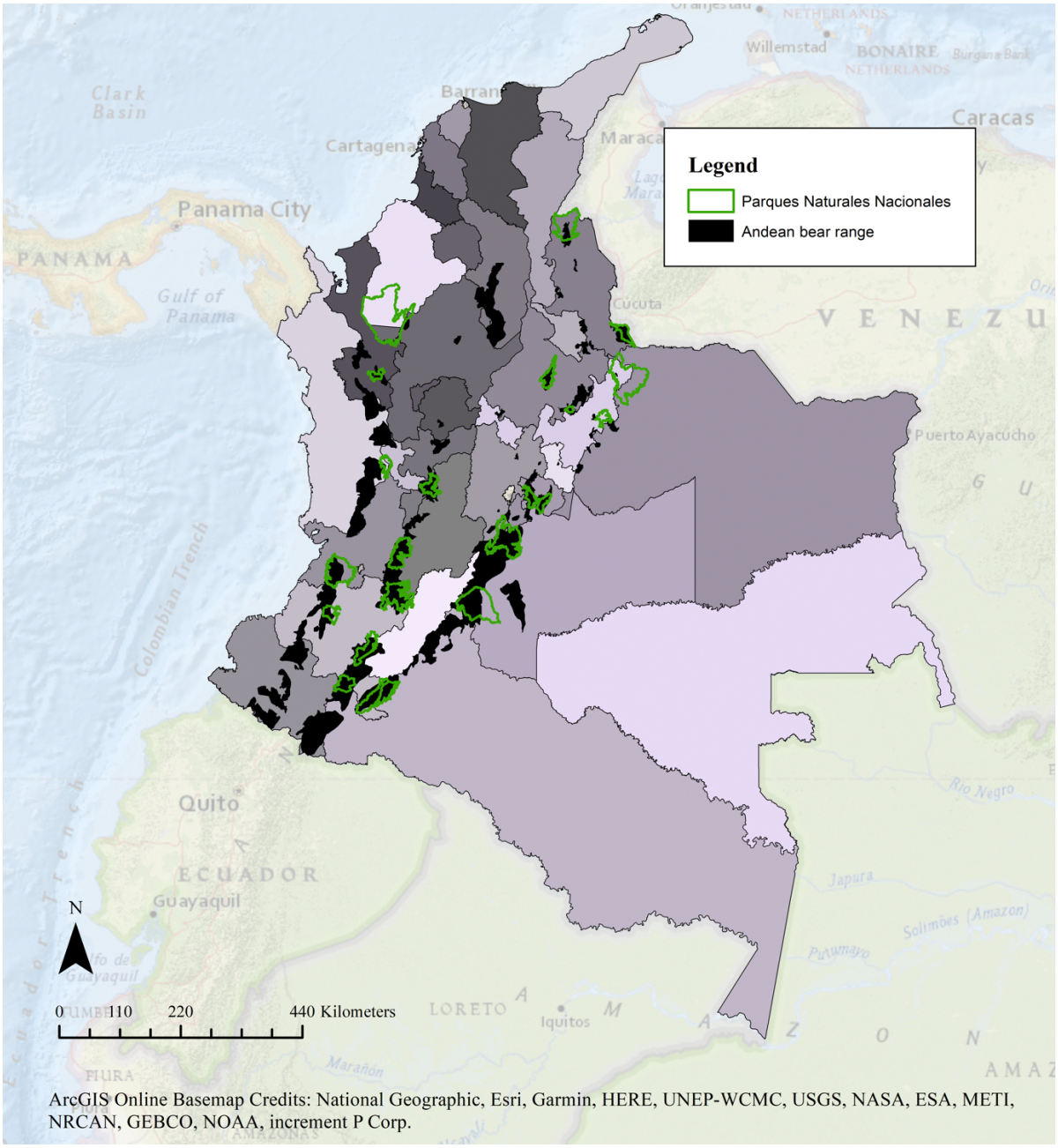

Figure 2.1 The range of the Andean bear (*Tremarctos ornatus*) in Colombia (black) (International Union for the Conservation of Nature 2017) crosses the jurisdictional boundaries of 22 different regional autonomous corporations (grey) (Piragauta Vargas 2020) and 22 different national natural parks (those with Andean bears shown in green) (Parques Nacionales Naturales de Colombia 2017)

Table 2.1 Glossary of acronyms

Acronym	**Meaning**
NGO	Nongovernmental organization
SINA	*Sistema Nacional Ambiental*, National Environmental System of Colombia
MinAmbiente	*Ministerio de Medio Ambiente y Desarrollo Sostenible*, Ministry of the Environment and Sustainable Development
CAR	*Corporacion Autonoma Regional*, Regional Autonomous Corporation
PNN	*Parques Naturales Nacionales*, National Natural Parks
SINAP	*Sistema Nacional de Áreas Protegidas,* National System of Protected Areas

CHAPTER 3

OMNIDIRECTIONAL CONNECTIVITY FOR THE ANDEAN BEAR (TREMARCTOS ORNATUS) ACROSS THE COLOMBIAN ANDES[9]

[9] Hohbein, R. R., and N. P. Nibbelink. Submitted to *Landscape Ecology,* 15 December 2020

ABSTRACT

Conserving or restoring connectivity is a common objective of landscape-scale conservation initiatives. However, precise species occurrence or movement data to inform or validate spatial models are often lacking. Our objectives were to 1) produce the first approximation of country-wide connectivity for Andean bears (*Tremarctos ornatus*) in Colombia and 2) demonstrate a novel approach for model validation which uses publicly available web and social media records of a flagship species. We used general knowledge about Andean bear habitat associations and indices of ecological integrity to construct a resistance surface across the Colombian Andes. We used this resistance surface to model omnidirectional connectivity using circuit theory. We validated our model with coarse location data acquired from local news stories and social media posts. Our model was most sensitive to changes in the resistance values of agricultural landcover and the mid-elevational zone, but uncertainty analysis demonstrated these changes had little impact on our conclusions regarding the municipalities most conducive to Andean bear movement. Just over one-third of those areas most conducive to Andean bear movement were within protected areas, while 8% coincided with agricultural landcover. We constructed a model of connectivity that did not rely on independent, empirically derived location data. Our model is coarse (1 km resolution) but can still provide useful information to practitioners in Colombia who are working with scarce ecological data. More information about how Andean bears move through agricultural landscapes would help improve our understanding of connectivity for this species in Colombia.

INTRODUCTION

Conservation practitioners have frequently identified the improvement or maintenance of landscape connectivity as an overarching objective in landscape-scale conservation initiatives

(Koen et al. 2019; e.g., IUCN 2020). These initiatives rely on a variety of spatial modeling approaches to determine where conservation efforts would be most effective or advantageous. The most popular models for prioritizing landscape elements for connectivity conservation are premised on cost-based analyses. These approaches require the analyst to identify specific landscape characteristics (e.g., landcover, elevation, road density) that enable or prohibit movement to differing degrees. These relative differences in movement conduciveness are parameterized into connectivity models as resistance values or "costs" to movement; landcovers considered permeable to movement have low resistance, while impermeable ones have high resistance. Most early connectivity models were least-cost path analyses (LCPs) which identified linear elements in the landscape which were most conducive to movement and provided the literal "path of least resistance" between two focal habitat patches.

More recently, ecologists have turned to connectivity models guided by electrical circuit theory (McRae et al. 2008). These models, usually operationalized within the open-source program, Circuitscape (McRae et al. 2013; Dickson et al. 2019), take advantage of parallels between electrical current and animal movement (or gene flow) across a landscape (McRae et al. 2008). Contrary to LCPs, circuit-based models acknowledge and account for multiple dispersal pathways that contribute to functional connectivity across a given landscape in the same way that multiple wires in an electrical network simultaneously contribute to lessen the effective resistance between nodes (McRae et al. 2008). While LCPs assume that individual animals have perfect knowledge of the landscape, circuit-based models draw on correlated random walk theory and thus assume no prior knowledge (McRae et al. 2013). Instead, each movement is determined by what the theoretical organism is confronted with in its immediate vicinity, though a general directionality is maintained. Areas identified by circuit-based models as having the

highest current are those which have the highest probability of use by "random walkers" (McRae et al. 2008). Dickson et al. (2019) reviewed publications citing Circuitscape and found that the method has been used for connectivity analyses on every continent. Circuit-based models have successfully predicted locations of Canada lynx (*Lynx canadensis;* Walpole et al. 2012), ovenbirds (*Seiurus aurocapilla;* St-Louis et al. 2014), African wild dogs (*Lycaon pictus*), and cheetahs (*Acinonyx jubatus*; Jackson et al. 2016) and have been validated by numerous genetic studies (e.g., Blair and Melnick 2012, Devitt et al. 2013). Circuit-based models have outperformed LCPs in predicting functional connectivity for moose (*Alces alces*; Laliberté and St-Laurent 2020), dispersal by wolverines (*Gulo gulo*; McClure et al. 2016), and road-crossing by black bears (*Ursus americanus*; Zeller et al. 2020).

Circuit-based models generally begin with the delineation of source and target patches or "nodes" (e.g., two national parks between which conservation practitioners would like to improve functional connectivity), but in 2014, Koen et al. introduced an approach that does not require focal source and target patches. Instead their approach incorporates many randomized nodes located beyond the perimeter of the study area. This approach creates a model of omnidirectional connectivity within a landscape (some researchers refer to this as "wall-to-wall" connectivity). This method is ideal for scenarios in which there are no a priori justifications for source and target patches (e.g., if a practitioner wishes to assess connectivity across the entire state of California) and minimizes the need for potentially complicated site-selection processes (see Beier et al. 2011) that have a disproportionately high impact on the final model. Finally, this approach of placing nodes in a buffer beyond the perimeter of the study area resolves issues of node-placement bias (i.e., the propensity for current values to be artificially inflated near source and target nodes) (Koen et al. 2014).

Practitioners working towards the conservation or restoration of landscape connectivity are often challenged by the need for empirical data required to both develop and then validate models of connectivity. For example, setting resistance values is considered to be "probably the most important bottle-neck for applying [cost-based analyses]" (Adriaenson et al. 2003). Movement data (sometimes referred to as pathway data) (e.g., from GPS collars) is generally considered to be the gold-standard for focal-species based connectivity models. However, studies that seek movement data are notoriously expensive and even high-quality occurrence data are limited for most species. Andean bears (*Tremarctos ornatus*)—the only extant ursid in South America—are one such example of a data-poor species (Cáceres-Martínez et al. 2020; Falconi et al. 2020). This is particularly true within the country of Colombia where many regional environmental authorities have neither the time nor the financial resources to carry out research on Andean bears yet are responsible for implementing conservation programs for the species within their jurisdictions (Velásquez Durán 2018). However, Koen et al. (2014) demonstrated that even a generic resistance surface for species that preferred "natural" landcover types resulted in a Circuitscape model adept at predicting fisher (*Pekania pennanti*) habitat use and amphibian and reptile road mortality in eastern Ontario. This type of "naturalness" model is sometimes referred to as a connectivity model of ecological integrity (e.g., Beier et al. 2011). Connectivity models of ecological integrity have been shown to be particularly suited to modeling landscape connectivity for large-bodied, vagile species (Krosby et al. 2015). Thus, we saw the Koen et al. (2014) approach to modeling omnidirectional connectivity with ecological integrity as a potentially useful approach for creating a country-wide connectivity model for Andean bears in Colombia despite data limitations.

Model validation remains the final obstacle to creating reliable models of connectivity for focal species and ecological integrity alike. Indeed, Laliberte and St-Laurent (2020) very recently wrote of the proliferation of connectivity models that were not empirically validated, calling model validation the "Achilles' heel of landscape connectivity mapping." However, we argue that broad-scale connectivity models do not necessarily need fine-scale data for validation. The model only needs to be accurate to the level at which management actions or decisions would be applied. Thus, we searched for unconventional forms of data that could be used to validate our model at the level of the municipality in Colombia. These data were found in the form of publicly available records on the web, from news media, and from various social media platforms.

We created a coarse (1 km resolution), broad-scale connectivity model for Andean bears based on general knowledge about their habitat preferences and known avoidance of human-dominated landscapes. We had two main objectives guiding this research: 1) produce the first approximation of country-wide connectivity for Andean bears in Colombia and 2) demonstrate a novel approach for model validation which relies on publicly available web records and social media data of a flagship species. In addition to these two objectives, we also sought to identify any challenges or disparate outcomes when applying the Koen et al. (2014) approach to a much broader spatial extent (our study area encompassed over 400,000 square km). Though their methodology had been cited over 100 times at time of writing, very few researchers conducted their own independent analyses of requisite buffer widths and number of nodes in addressing node-placement bias. Thus, we do not yet know if their recommendations are consistent for mapping omnidirectional connectivity in study areas covering larger spatial extents. Though our model was developed for Andean bears, it also serves as an approximation of the connectivity of

ecological integrity across the Colombian Andes. This model could serve as a valuable decision-support tool for practitioners working with scarce ecological data in the country. Moreover, the approach demonstrated herein is extremely cost-effective and can serve as a first step towards identifying priority conservation areas in other data-scarce regions and with other charismatic species.

METHODS

Colombian Andes

The Colombian Andes have three distinct mountain ranges (or *cordilleras*) that run from the southwest to the northeastern borders of the country. The Colombian Andes collectively account for approximately one-fourth of the country's total surface area and are acknowledged to be a biodiversity hotspot and thus a high priority for conservation action (Mittermeier et al. 1999; Armenteras et al. 2003). The Colombian Andes contain a diverse array of tropical ecosystems including cloud forest, wetlands, and high-altitude shrub ecosystems known as *páramo.*

Andean ecosystems have experienced extensive land cover change since Colombia's colonization by Spain in the early 1500s, the majority of which was initially driven by the introduction and rapid expansion of cattle ranching (Etter et al. 2008). The expansion of illicit drug cultivation in the 1980s and the introduction of neoliberal economic policies (that prioritized natural resource extraction) in the 1990s have also had enormous and detrimental impacts in the Andes (Osorio 2003; Vélez-Torres and Ruiz-Torres 2015; Gutiérrez-Gómez 2017). Exponential population growth in the latter half of the 20th century and rural-to-urban migration are also important factors in explaining recent land cover change (Etter et al. 2008). Over 60% of Colombia's 50 million residents currently reside in the Andes and the intermountain valleys. Andean cloud forests are estimated to cover less than 50% of their historic

extent while 15% of Colombian *páramo* has been converted to agricultural uses (Llambí et al. 2019). The cordilleras vary in their degree of land cover conversion, with the eastern cordillera being the most developed of the three. Climate change further threatens these high-altitude ecosystems (Urrutia and Vuille 2009; Buytaert et al. 2011).

The Andean bear

Andean bears (in Spanish, *osos andinos* or *osos de anteojos*) are found across the northern Andes in Venezuela, Colombia, Peru, Ecuador, Bolivia, and possibly Argentina (Cosse et al. 2014; Velez-Liendo and García-Rangel 2017). In Colombia the species primarily occupies Andean cloud forest and *páramo* (Peyton 1999). However, research conducted in other countries documented this species in several other ecosystems such as tropical dry forest (Peru; Kleiner et al. 2018), steppe grasslands (Peru; Peyton 1987), and elfin forest (Bolivia; Ríos-Uzeda et al. 2006). The lowest elevation at which Andean bears have been recorded was 200 m (Velez-Liendo and García-Rangel 2017), but in Colombia as elsewhere they are most often found in mountainous ecosystems above 1200 m (Peyton 1999, Ríos-Uzeda 2006).

Andean bears are classified as a species vulnerable to extinction (Velez-Liendo and Garcia-Rangel 2017). The primary threats to their persistence are habitat loss and increased mortality due to human-wildlife conflict (Velez-Liendo and Garcia-Rangel 2017). Though Andean bears are largely herbivorous, they do scavenge, and some individuals will occasionally kill cattle (Parra-Romero et al. 2019). They can also cause significant damage to crops (Peyton 1980, Escobar-Lasso et al. 2020). Thus, many *campesinos* (people living in rural areas) across the Andes see Andean bears as a threat to their livelihoods and persecute them as such (Goldstein et al. 2006; Parra-Romero 2011; Figueroa 2015). They are considered to be an endangered species within Colombia where approximately 3,000-6,000 individuals are estimated to remain

(Ruiz-García 2003). In 2001, the Ministry of the Environment in Colombia commissioned a panel of experts to assemble the National Program for the Conservation of the Andean bear (Mayr Maldonado 2001). Various state and private entities alike have worked towards the objectives outlined within this program over the last two decades. However, many practitioners have spoken of the challenges of implementing conservation efforts for a species for which they have such scarce ecological data (*pers. observ.*).

Delineating the Study Area

We acquired broad-scale data on the range of Andean bears in Colombia from the International Union for the Conservation of Nature (IUCN). This dataset consisted of polygons delineating known or suspected Andean bear presence across all three cordilleras of the Colombian Andes. We cross-validated this data with interviews conducted with conservation practitioners in Colombia during 2018-2019 (Hohbein et al. 2020, *in review*). We subsequently added to this dataset polygons representing Serrania del Perija Regional Natural Park and Paramillo National Natural Park which were known by local practitioners to have Andean bears, but which were absent from the IUCN dataset (presence in Serrania del Perija was also described in Rodríguez et al. 2019). We used the ArcMap tool "Minimum Bounding Geometry" (convex hull) to incorporate all range polygons into a single feature. The resulting polygon was then clipped to the extent of Colombia to function as our study area. Our final study area encompassed 417,895 km^2.

Calculating the Resistance Surface

Variables Included

We use land cover and transportation corridors as our two indicators of anthropogenic impact. We also included elevation as a consideration for connectivity as Andean bears are known to primarily occur in high-elevation ecosystems.

Choosing Resistance Values

True resistances to movement for organisms are rarely (if ever) known. Methods for interpreting suspected resistances to movement vary substantially and require numerous—and often subjective—decisions by the analyst (Beier et al. 2008). For example, should the costs to movement range from 0 to 1 or from 1 to 1000? Is agricultural land twice as hard to move through as natural forest or five times harder? Fortunately, Bowman et al. (2020) found that so long as the relative ranks of various landscape variables are accurate, circuit-based models are relatively resilient to changes in cost assignments. We chose to follow Koen et al. (2014) in their assignments of resistance values, with the lowest possible resistance assignment set to 10, moderate resistance set to 100, and barriers to movement set to 1000. However, we felt we needed one more degree of flexibility for resistance assignments and added an option for a resistance value of 500 to represent moderately high resistance but not a barrier.

Land Cover

We derived our land cover resistance surface from the most recent classified land cover dataset available from Colombia's Institute of Hydrology, Meteorology, and Environmental Studies (*Instituto de Hidrología Meteorología y Estudios Ambientales* [IDEAM] 2014). This dataset consisted of 53 landcover classes at a resolution of 1:100,000 from 2010-2012. We grouped these original classes into 7 broad categories and assigned these as having one of the four

possible resistance values: forest (10), other natural (10), agriculture (100), inland water (500), rural (500), urban areas (1000), and other "unnatural" (1000) (see Appendix F for full list of classifications). We then converted this feature class to a raster layer with 1000 m resolution; cells were assigned to the landcover class that had the largest area within the cell. We created a distinct river raster layer prior to conversion to better maintain feature continuity and address issues of diagonal discontinuities known to be problematic for eight-neighbor algorithms (Adriaensen et al. 2003). This river raster was then combined with the other comprehensive land cover raster layer.

Elevation

Our elevation data was comprised of a 30 arc-second digital elevation model of South America from the U.S. Geological Survey's Center for Earth Resources and Observation and Science (EROS 1996). Because the lowest known Andean bear sighting was at 200 meters, we classified anything below this value as having high resistance (1000). Elevations between 200 and 1200 meters were assigned medium resistance (100), while elevations above 1200 meters (where Andean bears are most commonly observed) were assigned a low resistance value (10).

Transportation Corridors

We acquired primary Colombian transportation routes from the Colombian National Institute of Roads (*Instituto Nacional de Vias* [INVIAS] 2019) which we converted to a raster layer with a 1000 m resolution. As with rivers, we addressed issues of diagonal discontinuities to ensure there were no "holes" in these barriers (Adriaensen et al. 2003). This dataset included only those major roads that connected larger Colombian cities; thus, we assumed at least a moderate volume of traffic. We assigned all roads included in this data set as having a resistance of 500.

We added the landcover, elevation, and transportation corridor resistance rasters together to create a cumulative resistance surface layer for Andean bears within Colombia.

Resistance Values Beyond Colombia

Arbitrary jurisdictional and study area boundaries can create artificial effects in Circuitscape models (Koen et al. 2010, 2014). We needed both an ocean resistance layer beyond Colombia's shoreline and a suitable substitute for resistances beyond the terrestrial borders of Colombia for which we did not have data.

To create the ocean resistance layer, we assigned oceans within a 100-km buffer around Colombia a resistance value of 2501 (to exceed the highest cumulative resistance of 2500) (see Table 3.1 for full list of variables and corresponding resistance values).

Koen et al. (2010) determined that random resistance layers placed beyond the limits of the study area were as effective as resistance surfaces derived from real data in eliminating artificial boundary effects on resultant connectivity models. Thus, we followed their methodology in creating a random resistance layer that would substitute for unknown resistance values in the neighboring countries of Panama, Venezuela, and Ecuador. To do this, we used the random.raster function from the spatialEco package (v. 1.3-1, Evans 2020) in R (v. 1.1.383, R Core Team 2019) to create a raster layer that extended 100 km beyond Colombia's terrestrial borders. Resistance values for this new random raster were sampled from the cumulative resistance surface within our delineated study area. The resultant random raster and ocean raster were joined to the cumulative resistance layer for Colombia to create our final resistance surface (Fig. 3.1).

Comparing Circuitscape Software and Julia Update

In 2019, the Circuitscape connectivity program was upgraded to operate with the Julia programming language (Anantharaman et al. 2019). To ensure model agreement as well as to eliminate the possibility for user error in Julia script input, we performed a test on a portion of our study area (84,912 km^2) before initiating the buffer width and node analysis. For this test, we calculated the cumulative current map for the smaller area using the original Circuitscape software and compared this against the cumulative current map produced by the Julia upgrade (Anantharaman et al. 2019).

Determining Appropriate Buffer Width and Number of Nodes

Following Koen et al. (2014), we sought to remove the effects of node-placement bias by randomly assigning node locations beyond the extent of the study area and eliminating the buffer which contained these effects before assessing landscape connectivity.

We used a 3-step approach to determine the appropriate buffer size and number of nodes: 1) determine a suitably large buffer width using an arbitrary number of nodes (n = 50); 2) determine the optimal number of nodes at the identified buffer width; and then 3) repeat the buffer analysis with the corrected number of nodes.

Buffer Width

Following the recommendation of Koen et al. (2014), we chose to start our buffer analysis with 50 nodes (Koen et al. considered 50 nodes to be their "full pairwise map"). We tested buffer widths between 10 km and 100 km at 10 km intervals. For each buffer width tested, we randomly generated 50 nodes along the outer perimeter of the buffer; we maintained a minimum of 10 km between neighboring nodes. We used Circuitscape in Julia to connect all possible node pairs using the eight-neighbor rule, imported the resultant cumulative current map into ArcGIS, and

removed the buffers. This allowed us to compare landscape connectivity only within our delineated study area and with a reduced bias from node placement following buffer removal (Koen et al. 2014). The cumulative current map produced using each buffer width was compared against the cumulative current map produced using the largest buffer size tested (100 km) with Pearson's correlation coefficient (*r*). To determine whether the 100-km buffer was sufficiently wide to have removed biases from node placement, we looked for evidence of negligible or no improvement in Pearson's *r* following an increase in buffer width. To do this, we first calculated the rate of change (*m*) in Pearson's *r* between all consecutive pairs of current maps produced at all buffer widths tested. For example, the rate of change between Pearson's *r* for the 70-km buffer and the 60-km buffer was calculated as follows:

$$m_{(70-60)} = \frac{r_{70} - r_{60}}{\Delta Buffer\ Width} = \frac{0.95648 - 0.87489}{10} = 0.00816$$

We then calculated one-sided 3-point moving window averages (MWA) for the slope values. For example, to calculate the one-sided 3-point MWA for the 70-km buffer:

$$3\ Point\ MWA_{70} = \frac{m_{(70-60)} + m_{(60-50)} + m_{(50-40)}}{3}$$

When the 3-point MWA fell below 0.001 for two values in a row, we considered this to be sufficient evidence that further increasing the buffer width would result in negligible improvement to Pearson's *r*. Had this not occurred during our tests, we would have needed to repeat the process with an even larger maximum buffer (e.g., 200 km). However, this procedure

demonstrated that the 100-km buffer was sufficiently wide (the 3-point MWA fell below 0.001 a second time at 70 km).

Number of Nodes

Similar to the procedure above, we tested the effects of increasing numbers of nodes on Pearson's *r*. To do this, we first created 100 random nodes around the outer perimeter of a 100-km buffer. We then randomly selected increasingly larger subsets of nodes from this pool of candidates for each consecutive model. We initially began our testing with 30 nodes, and we increased the number of nodes by 10 until we reached the full set of 100 nodes. We compared all cumulative current maps produced with differing numbers of nodes against the cumulative current map produced with the full set of 100 nodes. We detected a leveling off in the Pearson's correlation coefficients between 70-80 nodes. Following this result, we then tested between 60 and 90 nodes by increments of 2. We followed a similar procedure as used above in the buffer analysis (one-sided 3-point MWA of slope values) for identifying the optimal number of nodes (n = 78; 3003 unique pairs) (Fig. 3.2).

Confirming Buffer Width Selection

Following the identification of a suitable number of nodes for this analysis, we reran the buffer analysis to determine whether the appropriate buffer size would change given the revised number of nodes used. We reran Circuitscape in Julia with 78 nodes at 5-km buffer width intervals that ranged between 10 and 100 km; for each buffer width tested, we generated 78 new nodes along the perimeter of the buffer that were at least 10 km apart from neighbors. We again calculated Pearson's *r* for the current maps produced for the study area using all buffer widths compared against the current map produced with the largest buffer tested: 100 km. We calculated one-sided 3-point MWAs for all consecutive rates of change in Pearson's *r*. We determined the buffer was

sufficiently wide to have removed node-placement bias at 45-km, the point at which two consecutive MWAs fell below 0.001 (Fig. 3.3). Thus, the final current map was produced using 78 nodes and a 45-km buffer.

Validating Model

Andean bears are theoretically more likely to traverse through those areas in our model with higher current densities than they would those areas with lower current densities. Therefore, we would expect Andean bear presence and movement data to be associated with locales with higher mean current. However, data regarding precise Andean bear movements or even presences and absences are extremely limited. Not having access to such data throughout the study area, we validated our connectivity model with a novel approach that allowed us to gain coarse location information using publicly available web records. We searched the web for various mentions of Andean bear sightings, poaching reports, or publicly accessible location data. In November 2019, we searched Google®, Twitter®, Instagram®, and Facebook® for the terms "*AVISTAMIENTO"* (sighting) AND *"OSO ANDINO" OR "OSO ANTEOJOS"* AND *"COLOMBIA*" AND "*VEREDA"* (neighborhood) OR "*MUNICIPIO"* (municipality). We also searched for the terms *"NOTICIAS COLOMBIA OSO"* (news Colombia bear), "*OSO ANDINO MUERTO COLOMBIA*" (dead Andean bear Colombia), and "*OSO ANDINO CORPORACION AUTONOMA VEREDA*" (Andean bear autonomous corporation neighborhood). We examined all web results, video results, and tweets for mentions of specific municipalities or neighborhoods (*veredas*) where Andean bears had either been seen or recently poached. Additionally, we searched Colombia's Biodiversity Information System (*Sistema de Información sobre Biodiversidad de Colombia* [SiB]) and the Global Biodiversity Information Facility (GBIF) for publicly available location data for Andean bears. We included all referenced locations

irrespective of the publication or observation date. Through these combined processes, we identified 421 references to places with Andean bears within 110 different records (numerous place references often occurred within a single document, webpage, tweet, etc.). Of these 421 references, 235 were coordinates from across SiB and GBIF. The remainder of these records were from numerous different sources, including agency reports and websites, local news outlets, and social media (see Appendix G for citations). We further subsidized these 421 references with an additional 106 references made by conservation practitioners during interviews conducted in 2018 and 2019 (Hohbein et al. 2020, *in review*). Cumulatively, these 527 references represented 155 different municipalities in Colombia.

We calculated the mean current value from our final connectivity map across the 155 municipalities with records of Andean bear presence and the mean current of all other municipalities within our delineated study area for which we found no records (n = 775). An F-test on the variances of each group of municipalities showed support for equal variance within each group. Following confirmation of equal variance, we performed a one-sided T-test to assess whether mean current was higher within those municipalities with Andean bear sightings than those without such records. We repeated this process for those SiB and GBIF records which included geographic coordinates by calculating mean current within a 1-km buffer of each record (n = 235) and comparing this against the mean current within a 1-km buffer of randomly generated points (n = 1175) distributed throughout the study area.

Identifying Priority Areas

We calculated the mean current across all municipalities within our study area to identify those municipalities which contributed most to Andean bear connectivity across Colombia.

Sensitivity Analysis

We conducted a sensitivity analysis to determine which variables had the greatest effect on our resultant connectivity model. We adjusted resistance values assigned to 8 major variables included in our model: 1) forest and other natural land cover, 2) agricultural land cover, 3) rural land cover, 4) roads, 5) inland water, 6) elevation <200 m, 7) elevation between 200 and 1200 m, and 8) elevation >1200 m. We adjusted each resistance value assignment by both +/- 20% and +/-50% in turn, while holding all other resistance values constant. We then reran the final connectivity model with the same buffer width and nodes. We compared these 32 resultant current maps against the baseline current map with Pearson's *r* to determine which variables, once adjusted, resulted in the greatest deviation from our baseline current map.

Uncertainty Analysis

We conducted an uncertainty analysis to assess the degree to which changes in resistance values could potentially impact conservation decisions based upon our model. We quantified this impact by calculating an "agreement score" between scenarios—defined here as the degree to which a model identified the same 25 municipalities as having the highest mean current as other competing models. We calculated this agreement score for each scenario of adjusted resistance with the following methodology. We calculated mean current values across all municipalities included within our study area under each of the 32 scenarios tested in the sensitivity analysis; we treated the 20% and 50% sensitivity models as separate groups. We identified those 25 municipalities with the highest mean current under each scenario. Then, for each top-ranked municipality within each scenario, we calculated the percent of other scenarios in the group (including the original model) which also identified this municipality as having one of the highest 25 mean currents. We then averaged the score for each municipality within each scenario

for the agreement score. Thus, if one sensitivity scenario has an agreement score of 80%, this indicates that, on average, the top 25 municipalities identified by this scenario were included in 80% of the other scenarios' top municipalities.

Characterizing Andean bear connectivity in Colombia

We performed several post-hoc analyses to characterize and better understand those areas of Colombia which were particularly conducive to connectivity across the Colombian Andes. First, we reclassified the cumulative current map into 5 classes using Jenks natural breaks (Jenks 1967). We categorized anything in the highest two classes as "highly connective habitat" and eliminated fragments that were less than 100 km^2. We analyzed the proportion of this intact habitat that fell within different categories of protected areas according to a shapefile available from Colombia's National Natural Park Service (*Parques Nacionales Nautrales de Colombia* 2018). We also calculated the percentage of this habitat that either contained or was adjacent to agriculture as per the IDEAM 2014 land cover dataset.

RESULTS

Our final connectivity model for Andean bears in Colombia was calculated with 78 nodes (3003 unique node pairs) randomly distributed along the perimeter of a 45-km buffer (Fig. 3.4). Mean current values within municipalities that had reported Andean bear sightings (M = 6.47, SD = 0.35) were significantly higher than the mean current values in those municipalities without such reports (M= 4.62, SD = 1.99) ($t(208.4) = 9.7498$, $p < .001$) (Fig. 3.5). Additionally, mean current around coordinates of Andean bear locations from SiB and GBIF (M = 9.43, SD = 2.40) was significantly higher than mean current around random locations (M = 4.81, SD = 3.37) ($t(444.14) = 25.055$, $p < .001$) (Fig. 3.6).

Our sensitivity analysis revealed only slight changes to the final connectivity model following adjustments to resistance values. For example, a 50% increase in the resistance value for agricultural landcover (from 100 to 150) resulted in a connectivity model that was 99.521% correlated with the original model. Changes of +/-20% and +/-50% to resistance values for agricultural landcovers and the mid-elevational zone (between 200 and 1200 m) resulted in the greatest discrepancies with our final connectivity model (Figs. 3.7 and 3.8). In all scenarios, lower resistance values for each variable resulted in larger differences in final connectivity models than higher resistance values.

Models with the 50% adjustments to resistance values had, on average, 92.1% agreement among the 25 municipalities with the highest mean currents. The model with agricultural resistance reduced by 50% resulted in the least agreement; municipalities ranked by this model as having the 25 highest mean currents had only an 81.5% chance of appearing in another model's top 25 (Fig. 3.9). The scenario with mid-elevation resistance reduced by 50% had more agreement with the others (88.25% agreement regarding top 25 municipalities). Uncertainty analyses with the 20% adjustments demonstrated an even higher degree of agreement (96.2% overall) (Fig. 3.10).

We identified 41,487 km^2 as "highly connective habitat" (HCH). Just over one-third of this HCH was contained within protected areas (38.5%). National natural parks represented the majority of this protected habitat (62.4%), but much of this area also fell within regional natural parks (17.3%), flora and fauna sanctuaries (10.6%), and integrated management districts (9.7%). Less than 1% of this protected HCH was contained with civil society reserves. Agricultural areas intersected 7.6% of the HCH. We identified the fifteen municipalities that contained the most km^2 of agriculture intersecting HCH (Table 3.2). The intersection of agriculture with HCH

occurred most frequently in the department of Norte de Santander, but Boyacá also had several municipalities listed among those 15 municipalities with the highest amount of HCH in agriculture.

DISCUSSION

We had no difficulties in applying the approach demonstrated by Koen et al. (2014) at our larger spatial extent (our study area was 417,895 km^2; their study area was 11,225 km^2). The updated Circuitscape in Julia (Anantharaman et al. 2019) allowed for fast computing across this large landscape in relatively short time (approximately 1 h for a model with 3003 unique node pairs). We found interesting discrepancies in the width and number of nodes required to address node-placement bias compared to the Koen et al. (2014) study. They suggested a buffer of at least 20% of the width of the study area would be required to remove node-placement bias. Our study area was approximately 500,000 km at its widest point; 20% would have been a buffer of at least 100 km. However, we found that a 45-km buffer was sufficient to mitigate node-placement bias. Additionally, we found more nodes were required in our study than they found were necessary for theirs (78 versus 18 nodes). This suggests there is more to this relationship yet to be understood, and we echo their suggestion for researchers to conduct their own sensitivity analyses with regards to requisite buffer width and number of nodes. There may be a mathematical relationship between the requisite number of nodes, buffer width, and measures of study area shape and size.

We used publicly available web records to demonstrate that Andean bear sightings occurred in municipalities identified as having higher current by our Circuitscape model. Precise location data from SiB and GBIF provided further support for our connectivity model. Overall, the validation technique appeared to work well: we found enough records to demonstrate model

validity with statistical significance. The Andean bear is considered a charismatic species in Colombia (e.g., its image can be observed in many murals throughout Bogotá and rural Colombia), and perhaps because of this charisma, sightings of this elusive species often make local news. We chose not to use these data to inform model construction at the outset because there are some obvious, problematic biases. For example, news of Andean bears observed in national parks (where they are expected to occur) are usually not reported in media outlets, but Andean bears likely spend a large percentage of their time in these areas. Our objective was to create a country-wide connectivity model for a focal species, the Andean bear. Though the literature on landscape ecology has started to deemphasize single species approaches, many practitioners still focus their efforts on umbrella or flagship species for which there is strong public support and often more sponsors. However, the approach demonstrated here could easily be adapted to construct regional connectivity models of ecological integrity that could then be similarly validated with publicly available data and web records of charismatic fauna occupying these regions, even if these species were not the original focus of the study.

Data scarcity has long been recognized as an issue for landscape ecologists; necessity has led researchers to identify creative solutions for filling these gaps. For example, Newbold (2010) discussed the possibilities and limitations of using historical museum records for species distribution modeling. Calls for researchers to take advantage of citizen science data have become increasingly common (e.g., Devictor et al. 2010, Theobald et al. 2015, Kobori et al. 2016, Brown et al. 2019). We add to these options the possibility for using local news and social media to gather coarse location information on charismatic fauna for the purposes of validating ecological models. These data are likely more abundant than we realize (as demonstrated by our success finding 186 place references through such means), and largely remain an untapped

resource even in regions characterized by scarce ecological data and limited financial support for research. Indeed, this method may work even for species not typically considered "charismatic"; for example, Balestrieri et al (2019) found over 200 publicly accessible records of marten (genus: *Martes*) locations in Italy and were able to use these data to guide the development of niche models.

Our model is the first approximation of landscape connectivity for Andean bears in Colombia, as well as the first connectivity model of the ecological integrity of the Colombian Andes. Our model suggests that close to 8% of the area contributing most to connectivity across the Colombian Andes coincides with agriculture such as pastures for cattle grazing or various possible crops. These agricultural areas may represent significant risk to Andean bears as long as rural Colombians view Andean bears as threats to their livelihoods. Our model allows us to identify those municipalities where such human-bear conflicts are likely to occur, and thus where strategies to mitigate the conflict are most urgently needed.

Though our model is coarse (1 km resolution), the outcomes from our model are at a scale that is relevant to Colombian conservation practitioners; many practitioners work at the scale of the municipality for project implementation. For example, environmental education and awareness raising is one of the four overarching objectives described in the National Program for the Conservation of the Andean bear in Colombia (Mayr Maldonado 2001). Many practitioners are pursuing this objective by hosting Andean bear festivals which draw in citizens from the entire municipality in which they are hosted (*pers. observ.*). Furthermore, as part Colombia's transition to decentralized environmental governance, the regional environmental authorities were mandated by the Colombian constitution to coordinate and advise on environmental decisions made by municipalities within their jurisdictions (Blackman et al. 2004). However,

most of these authorities operate with extremely limited financial resources and personnel, meaning they must prioritize the extent to which they engage with different municipalities. Our model can help guide the selection of priority municipalities with which to build or improve these institutional relationships as part of their efforts to ensure adequate protection of key Andean bear habitat. Our model could also be used to determine where limited resources for fine-scale studies might best be invested. Uncertainty analyses demonstrated a relatively high degree of fidelity in the identification of those municipalities which contributed most to landscape connectivity. However, both the sensitivity and uncertainty analyses suggest that more information about how Andean bears move through agricultural landscapes would be helpful in improving our understanding of connectivity for this species in Colombia.

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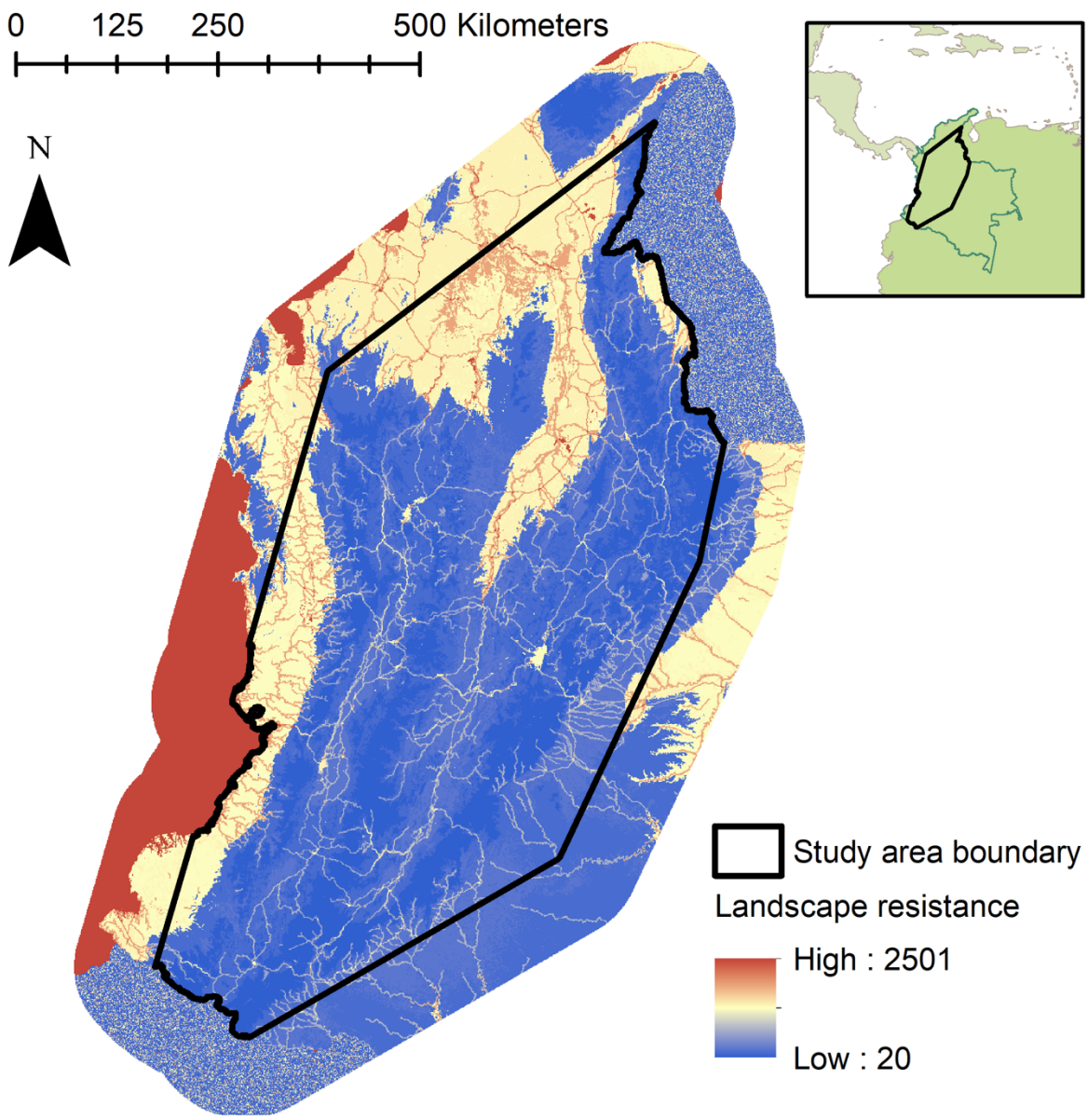

Figure 3.1 Cumulative resistance surface for Andean bears in Colombia clipped to 100 km beyond the border of our study area.

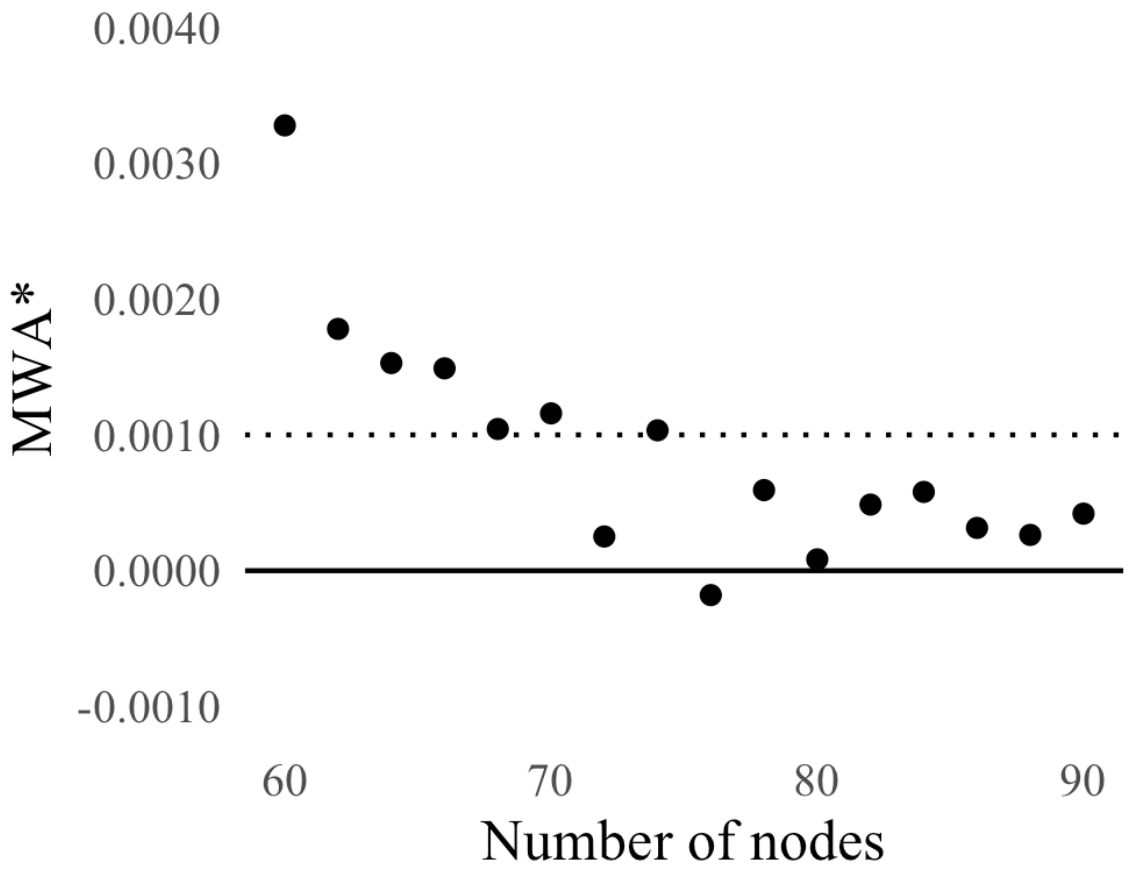

Figure 3.2 Results of node selection analysis. *MWA is the one-sided, 3-point moving window average of improvement in Pearson's correlation coefficient (*r*) for each node added; we determined there was a sufficient number of nodes when the MWA fell below 0.001 (dotted line) for two consecutive values (78 nodes)

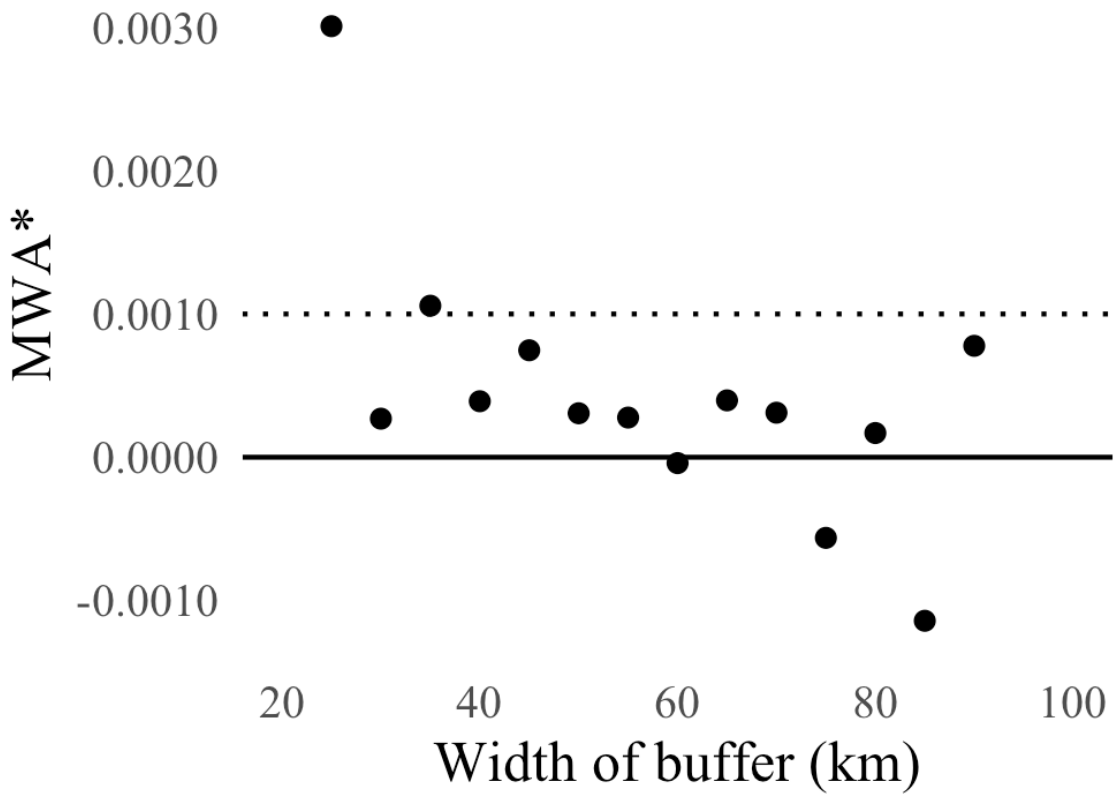

Figure 3.3 Results of buffer width analysis. *MWA is the one-sided, 3-point moving window average of improvement in Pearson's correlation coefficient (*r*) for each additional 1-km increase in buffer width; we determined the buffer was sufficiently wide when the MWA fell below 0.001 (dotted line) for two consecutive values (45 km)

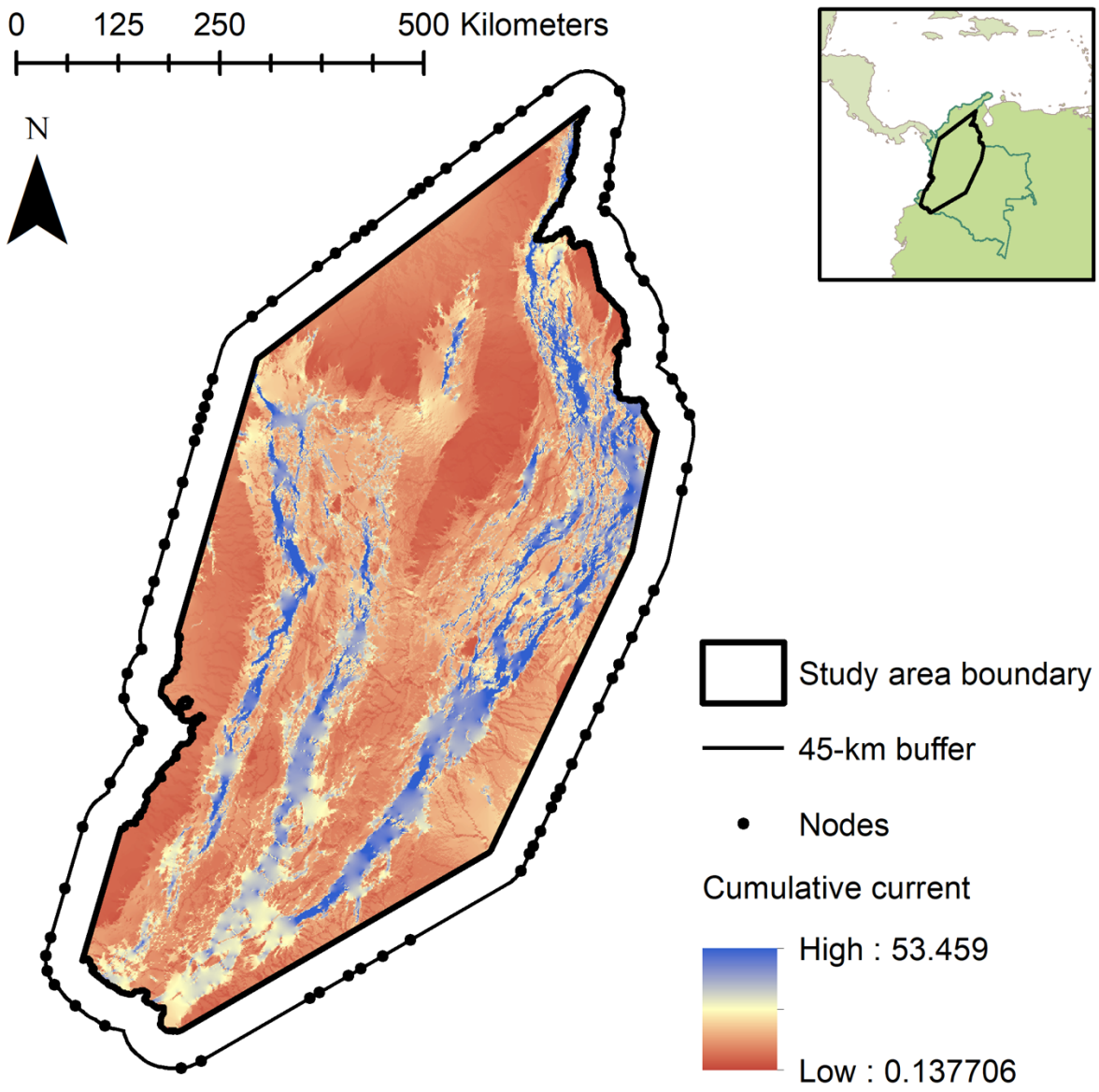

Figure 3.4 Cumulative current density map for Andean bears in Colombia derived from Circuitscape software and calculated with 78 nodes (3003 unique node pairs) randomly located at the perimeter of a 45-km buffer

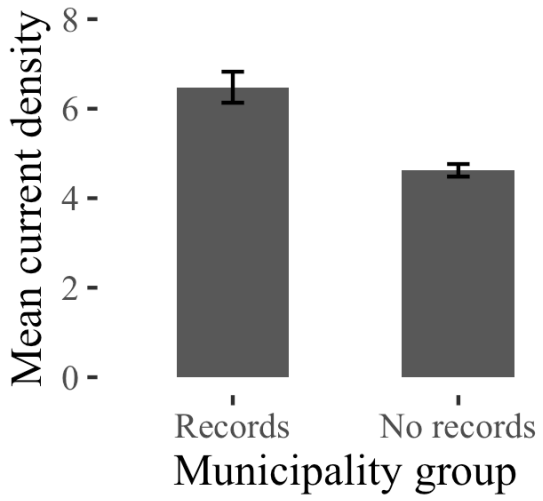

Figure 3.5 Mean cumulative current was significantly higher within those municipalities with records of Andean bear (*Tremarctos ornatus*) sightings (n = 155) than all other municipalities within the study area for which we found no records (n = 775); error bars represent 95% confidence intervals

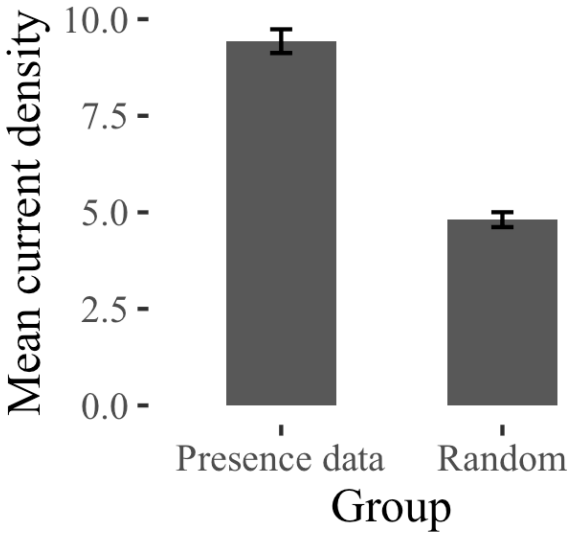

Figure 3.6 Mean current density was significantly higher within 1 km of geographic coordinates of Andean bear (*Tremarctos ornatus*) locations (n=235) than mean current density around random locations (n = 1175); error bars represent 95% confidence intervals

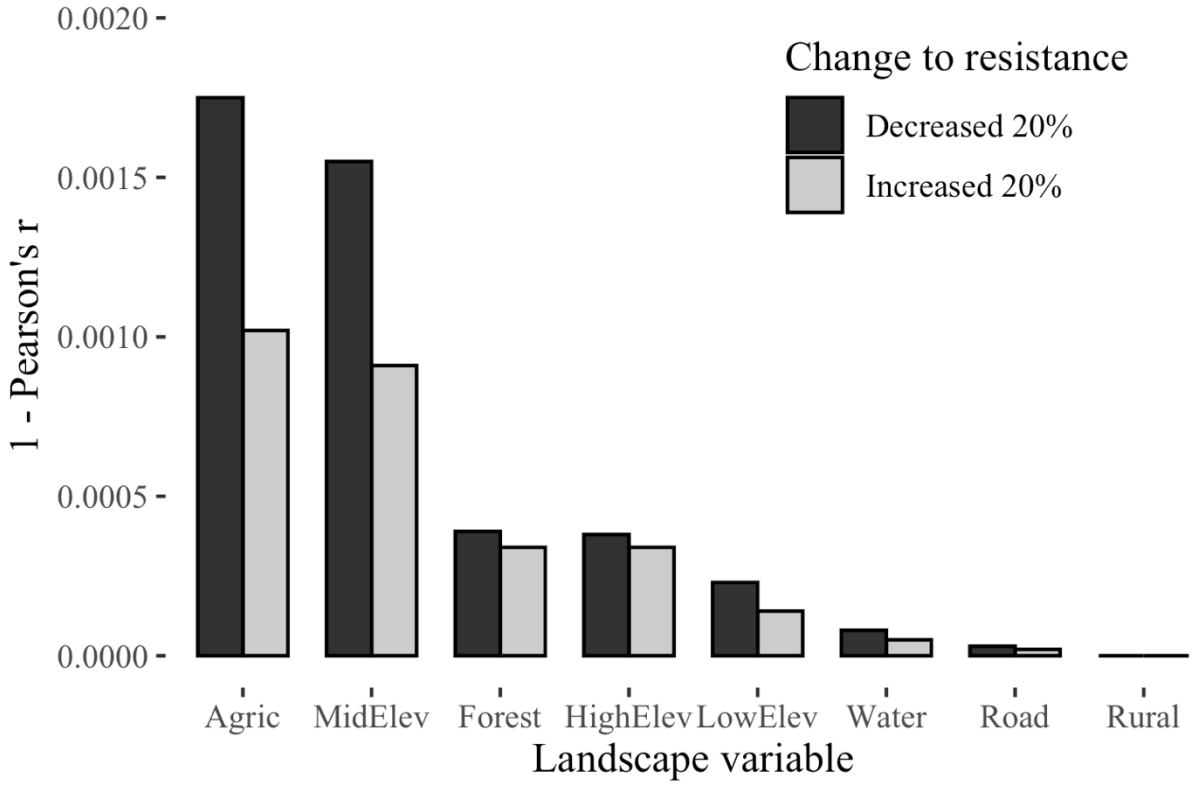

Figure 3.7 We adjusted the resistance values of 8 different landscape variables by 20% to assess model sensitivity; a Pearson's *r* of 1 indicates perfect correlation to our baseline model. Thus, 1-Pearson's *r* is the degree to which each of these various models differed from our baseline. (LowElev: <200 m; MidElev: 200 – 1200 m; HighElev: > 1200 m)

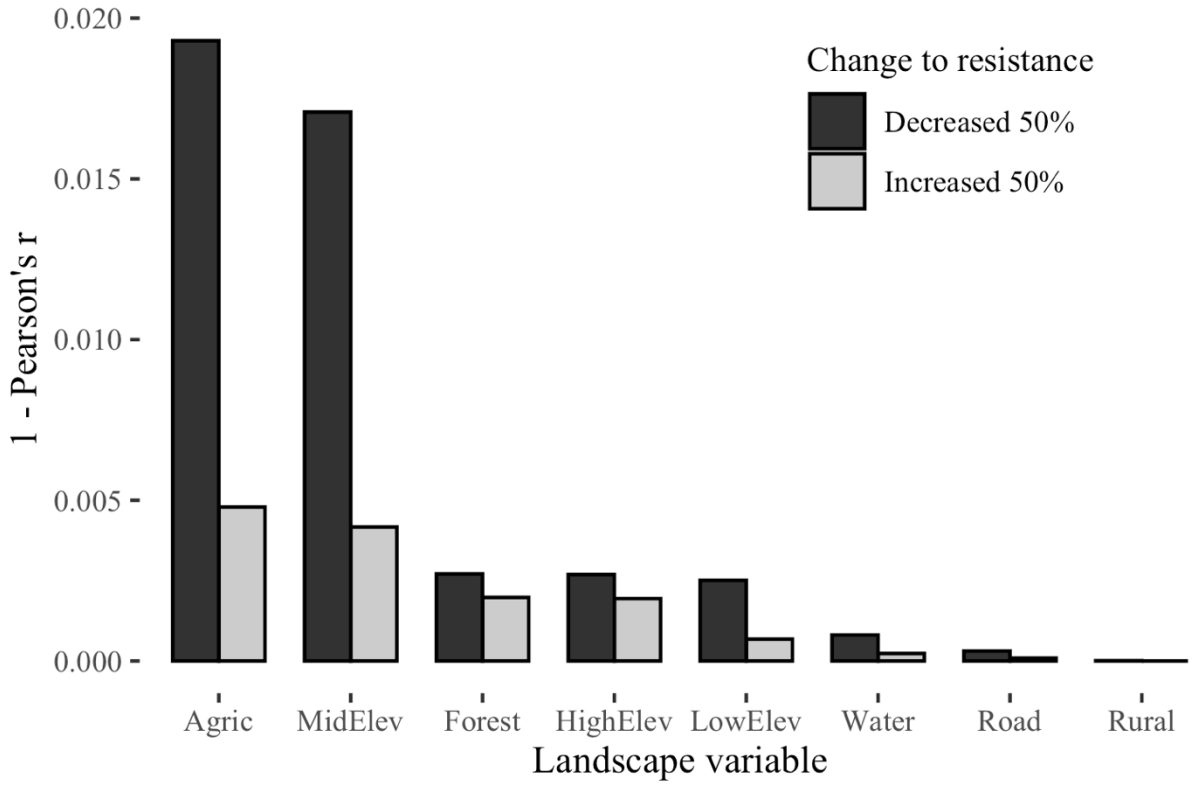

Figure 3.8 We adjusted the resistance values of 8 different landscape variables by 50% to assess model sensitivity; a Pearson's *r* of 1 indicates perfect correlation to our baseline model. Thus, 1-Pearson's *r* is the degree to which each of these various models differed from our baseline. (LowElev: <200 m; MidElev: 200 – 1200 m; HighElev: > 1200 m)

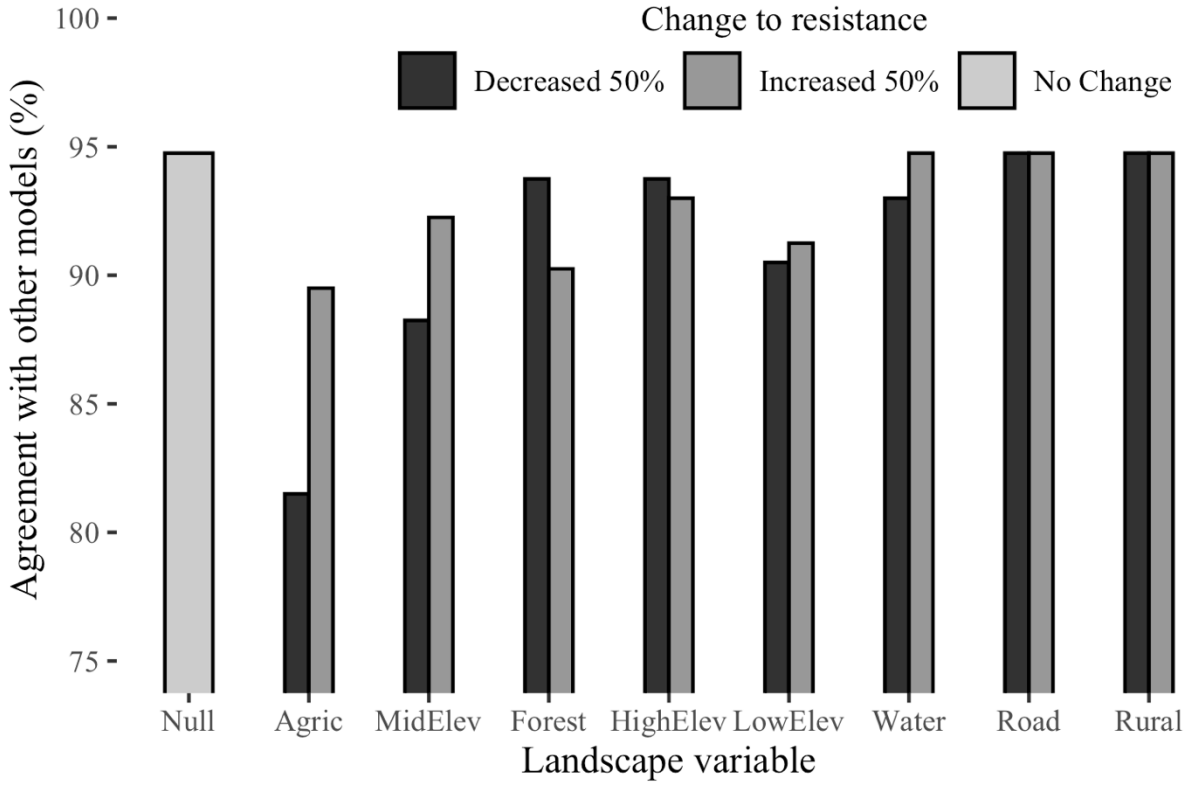

Figure 3.9 Degree of agreement among scenarios regarding the 25 municipalities with the highest mean current density; a score of 95% indicates that, on average, the municipalities ranked in that scenario as having one of the 25 highest mean current densities appeared in 95% of the other models' top 25.

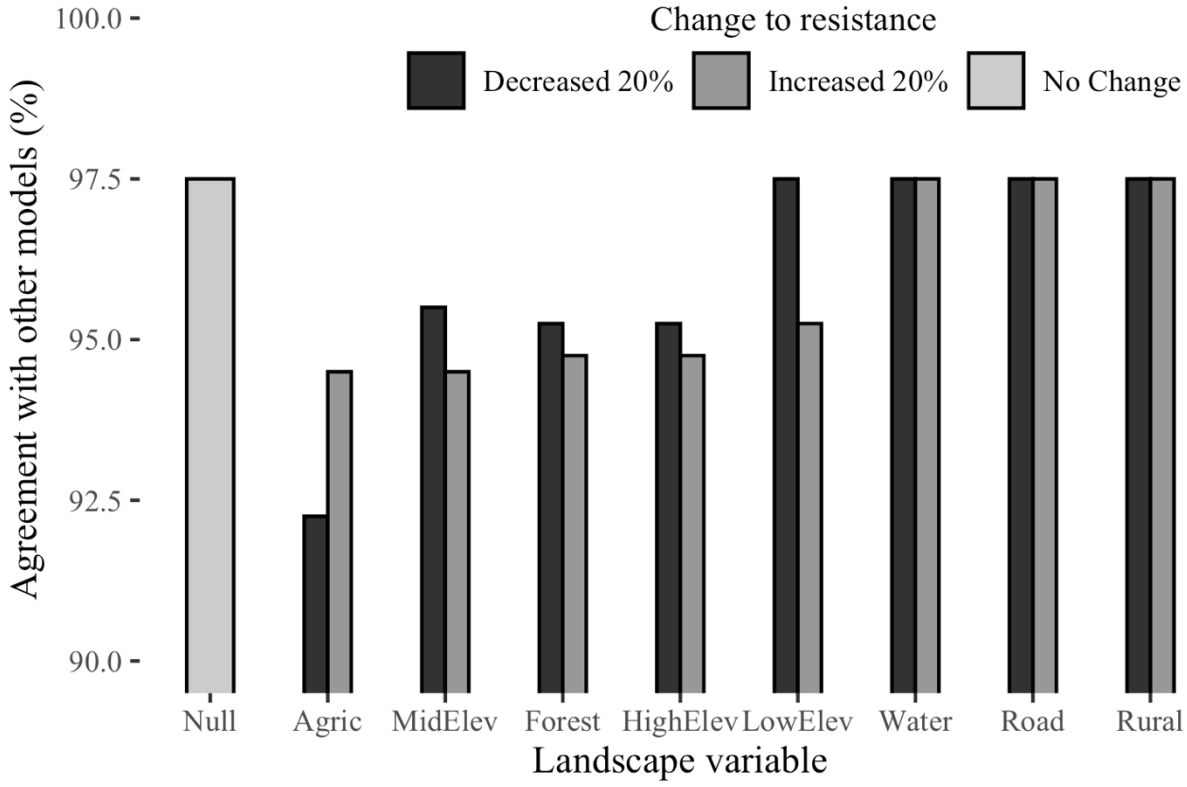

Figure 3.10 Degree of agreement among scenarios regarding the 25 municipalities with the highest mean current density; a score of 97.5% indicates that, on average, the municipalities ranked in that scenario as having one of the 25 highest mean current densities appeared in 97.5% of the other models' top 25.

Table 3.1 Resistance values assigned to three categories of landscape variables for an Andean bear connectivity model in Colombia

Category	Variable	Resistance
Landcover	Forest	10
	Other Natural	10
	Agriculture	100
	Water	500
	Rural	500
	Urban Areas	1000
	Unnatural	1000
	Ocean	2501
Elevation	<200 m	1000
	200–1200 m	100
	>1200 m	10
Transportation	Highway	500

Table 3.2 Eight percent of the habitat considered most conducive to Andean bear movement in Colombia coincided with agricultural landcover. These are the 15 municipalities where this overlap occurred most frequently and thus where conflict mitigation strategies might be most urgently needed.

Municipality	Department
El Carmen	Norte de Santander
Abrego	Norte de Santander
Urrao	Antioquia
Aquitania	Boyacá
Villa Caro	Norte de Santander
Cáchira	Norte de Santander
Chitagá	Norte de Santander
El Carmen	Choco
Toledo	Norte de Santander
Bogotá	Bogotá, D.C.
Mongua	Boyacá
Chita	Boyacá
Socotá	Boyacá
Becerrill	Cesar
Macanal	Boyacá

CHAPTER 4

NONGOVERNMENTAL ORGANIZATIONS IMPROVE THE SOCIAL-ECOLOGICAL FIT OF INSTITUTIONS CONSERVING THE ANDEAN BEAR IN COLOMBIA[10]

[10] Hohbein, R. R., N. P. Nibbelink, and R. J. Cooper. Submitted to *Ecology and Society*, 25 February 2021.

ABSTRACT

Research has increasingly emphasized the importance of spatial alignment between ecosystems and the institutions which govern them, known as social-ecological fit. Social network analysis (SNA) has been recognized as a valuable tool capable of integrating social and ecological network data for empirical assessments of social-ecological fit. Few studies have integrated SNA with more complex spatial models, and assessments of social-ecological fit have rarely been conducted from the perspective of "fit" for wildlife conservation. We examined the spatial fit of the institutional network of heterogenous conservation actors (both governmental and nongovernmental) working to conserve the Andean bear (*Tremarctos ornatus*) across the Colombian Andes. Our analysis was based upon social network and qualitative data derived from 67 semi-structured interviews with Colombian conservation practitioners along with a model of Andean bear connectivity. In Colombia, the known range of the Andean bear crosses the jurisdictional boundaries of 22 different "autonomous regional corporations" (*corporaciones autónomas regionales* or CARs)—the primary entities responsible for implementing conservation policy in the country. We found that 53 pairs of CARs shared habitat along their jurisdictional borders that was identified as important to Andean bear connectivity, but only 16 pairs of CARs (30% of pairwise matches) communicated with one another about Andean bear research and conservation strategies. CARs were more likely to communicate with entities of Colombia's National Natural Park Service or with nongovernmental organizations (NGOs). These other entities were often located within the social network structure as intermediaries between otherwise disconnected CARs. These actors could use such strategic positions to facilitate coordination between CARs that share habitat important for Andean bear connectivity and, in so doing, improve social-ecological fit for the conservation of this species. During

interviews, Colombian NGOs often expressed concern over the lack of coordination among the CARs and several were working to amend the situation.

INTRODUCTION

Research has increasingly emphasized the importance of alignment between ecosystems and the institutions which govern them. This "social-ecological fit" is proposed to be a critical facet of resilient social-ecological systems (Cumming et al. 2006, Folke et al. 2007). Without such fit, institutions may struggle to grasp the true magnitude of ecological problems they face, coordinate their actions enough to manage large-scale issues requiring collective action (Cumming et al. 2006), or address environmental externalities (Dupar and Badenoch 2002). There is a large body of literature that discusses the theoretical foundations of social-ecological fit, and empirical evidence of its importance for resilient systems is accumulating. For example, Bodin et al. (2014) compared common-pool resource governance regimes in Kenya and Madagascar and found that the social-ecological system with better fit (i.e., more communication among individuals who were sharing a resource) was more sustainable and had better conservation outcomes than the system with less fit. Deteriorating ocean health has been attributed to issues with fit, specifically governance arrangements that have failed to account for links between and among managed ecosystem components (Ekstrom and Young 2009). Over time, three dimensions of social-ecological fit have been distinguished: 1) temporal fit is the degree to which institutions can implement responses to ecological changes within the appropriate timeframe; 2) functional fit is concerned with how well links between ecosystem components are accounted for with institutional design; and 3) spatial fit refers to the agreement between institutions and the geographical extents of ecological issues they are trying to manage (Epstein et al. 2015).

Efforts to diagnose issues of social-ecological fit abound, but the simultaneous consideration or integration of both social and ecological systems into analyses has rarely been accomplished (Pelosi et al. 2015), likely due to the incongruous nature of the two datasets. Social network analysis (SNA) is one analytical tool that has drawn increasingly more attention from scholars working to create a holistic framework for assessing social-ecological fit (Sayles et al. 2019). Originally developed by sociologists in the early 20th century, SNA maps the relational or communicative ties between actors (be they individuals, agencies, or organizations) and explores how the patterns of these connections determine characteristics of the network as a whole (Scott 1988). One of the reasons that SNA as a unifying methodology is so attractive is because networks are an analytical tool commonly found across the ecological sciences (Janssen et al. 2006; Cumming et al. 2010). Thus, SNA can be combined with various forms of ecological network data to create a powerful analysis capable of integrating and/or comparing two (or more) datasets derived from different disciplinary perspectives.

Several scholars have used SNA to diagnose social-ecological fit. For example, Pittman and Armitage (2017) used SNA and the theory of social-ecological fit to examine the ability of network governance to address ecological issues that cross terrestrial and oceanic systems in the Lesser Antilles. Guerrero et al. (2015) used SNA to assess the degree to which a self-organized governance network was identifying and addressing interconnected ecological resources in Australia. Bergsten et al. (2014) used SNA to diagnose social-ecological fit of a loose governance network responsible for managing a series of interconnected wetlands in Sweden. These case studies have all led to important insights about the relationships between different governance structures and their ability to address pressing environmental problems. However, only a few studies thus far have integrated SNA with more complex spatial models, and we

know of no study which has done so to assess the social-ecological fit of networks involved with wildlife conservation (but see Dressel et al. 2018, 2020) nor incorporated multiple kinds of actors into such an analysis. Thus, we make novel contributions to this growing collection of informative case studies by examining the spatial fit of the institutional network of heterogenous actors (both governmental and nongovernmental) working to conserve a flagship species, the Andean bear (*Tremarctos ornatus*), across the Colombian Andes.

The conservation of megafauna invariably requires the actions of numerous organizations and agencies. This is no less true in Colombia where the range of the Andean bear crosses the jurisdictional boundaries of at least 22 different autonomous regional environmental authorities (known as *corporaciones autónomas regionales* or CARs) and 22 different national natural parks. Similar to other large mammals, Andean bears are thought to require relatively large tracts of contiguous habitat (between 1200 and 1900 km^2 is the most often used estimate; Yerena 1998, Peyton 1999). However, not only are most national parks in Colombia too small to support stable populations of Andean bears (Yerena 1998), many of the largest remnants of Andean cloud forest (the primary habitat of Andean bears) straddle the jurisdictional boundaries of the CARs. Given the extensive degradation to ecosystems that support Andean bears in the last half century (Kattan et al. 2004), the maintenance of landscape connectivity has become increasingly important for the species. If practitioners are only focused on the habitat within their jurisdictions, they may not readily see whether or how their seemingly smaller parcels fit within a broader context such as regional/national wildlife corridors that are critical to this species' long-term survival. The CARs have no mandate to coordinate their efforts with one another, not even among those neighbors that share jurisdictional boundaries. However, self-organized networks of actors that collaborate to address common challenges are documented in a variety of

different landscapes and have been shown to improve social-ecological fit (Guerrero et al. 2015, Sayles and Baggio 2017). Indeed, in previous work, we documented that knowledge of border-crossing Andean bears had spurred some voluntary inter-institutional coordination among CARs (Hohbein et al. 2020, *in review*) though the extent to which these collaborations correspond to Andean bear connectivity has not yet been explored.

The vast majority of preceding research on the spatial fit of institutions has concentrated on conterminous, spatially-bound organizations operating within distinct and clearly demarcated jurisdictions (though some have also examined cross-scale networks; e.g., local to regional to national). We wish to expand upon our knowledge of social-ecological fit by integrating "non-jurisdictional" actors into our analysis. In our study system, these non-jurisdictional actors are nongovernmental organizations (NGOs) that work to conserve Andean bears in collaboration with or independently from the efforts of the CARs and the Colombian National Natural Park Service (*Parques Nacionales Naturales* [PNN]). These actors may serve particularly important roles in environmental governance *because* they are not bound to distinct jurisdictions and thus may serve as intermediaries among those that are spatially bound. If NGOs are serving in this capacity, they would improve the potential for knowledge diffusion and collective action in the governance network (Bodin and Crona 2009) as well as increase the likelihood that disconnected organizations would communicate in time (due to their mutual correspondent(s) and the principle of triadic closure—simply put, the propensity for two "friends" of a third friend to eventually become friends themselves) (Pittman and Armitage 2017). Indeed, Orejuela and Jorgenson (1999) even anticipated that NGOs would play an important role in coordinating Andean bear management efforts in the then-newly decentralized environmental system of Colombia (the new system included legislation which provisioned for greater NGO involvement in environmental

governance). By including these actors in our analysis, a more complete and nuanced understanding of social-ecological fit in this system can be gained.

We draw on the theories of social-ecological fit, landscape connectivity, and social network analysis to examine the following research question: How does the structure of the institutional network across the Andean mountains impact its collective ability to conserve a flagship species, the Andean bear? We had three overarching objectives guiding this research: 1) To assess social-ecological fit of the current governance structure in Colombia for the conservation of the Andean bear; 2) to determine the impacts non-jurisdictional organizations have on the network and indices of social-ecological fit; and 3) to identify opportunities for strategic "network weaving" that could strengthen the conservation network and improve social-ecological fit. This research is informed by qualitative and social network data derived from 67 interviews with 71 different conservation practitioners in Colombia, as well as a model of landscape connectivity across the Colombian Andes constructed with circuit theory (Hohbein and Nibbelink 2020, *in review*).

METHODS

Study System

Environmental Governance in Colombia

In Colombia, the shift from centralized power and decision-making authority to that which is decentralized and vested in these CARs is a relatively recent one. One of the purported advantages of this shift towards decentralized governance was—though not explicitly put in these terms—to improve social-ecological fit of environmental governance in the country. The previous national environmental authority, INDERENA, had been unable to adequately respond to and address regional issues of environmental degradation. They lacked the ability to be

present in regions far-flung from the capitol, they did not have the necessary local-scale knowledge, and, in short, the feedback loops between local problems and national level decision-making were broken (Rodríguez Becerra 2009). Partly in response to international pressure and partly in response to social and political turmoil within the country, Colombia adopted political decentralization in 1991 (Pening Gaviria 2003). Two years later, natural resource management was also decentralized with Law 99 of 1993 and the creation of 33 CARs whose jurisdictions now covered the entirety of the country. INDERENA was restructured into what is today the Ministry of the Environment and Sustainable Development (*Ministerio de Ambiente y Desarrollo Sostenible* [MinAmbiente]).

The MinAmbiente creates national environmental policy, and the CARs are the entities responsible for implementing it within their jurisdictions—albeit with substantial room for discretion (Blackman et al. 2004). In addition to their primary responsibilities of managing natural resources, the CARs are also expected to work for the conservation of threatened and endangered species such as the Andean bear. National natural parks and the biodiversity within are managed separately from the CARs by Colombia's National Natural Park Service (*Parques Nacionales Naturales* [PNN]). PNN has an administrative hierarchy tiered at the national, regional, and local (park) level. Though the MinAmbiente was originally intended to lead the collective environmental governance system in Colombia and facilitate coordination among the CARs, previous research has documented that they have not fully fulfilled this responsibility (Blackman et al. 2004, Hohbein et al. 2020 *in review*).

In addition to the CARs, PNN, and the MinAmbiente, there are of course many environmental NGOs working at various scales across Colombia. When Colombia restructured its environmental governance, NGOs were clearly expected to become key actors in natural

resource management. NGOs were formally integrated into the National Environmental System (Law 99 of 1993, Article 4); it was envisioned that they would help the State perform some of its functions in environmental governance (Law 99 of 1993, Article 1). Law 99 further laid out that the board of directors of each CAR would be required to include two representatives from the civil society sector, and research institutes were encouraged to partner with environmental NGOs to accomplish their objectives. Today, many Colombian NGOs are contractors, conducting research or implementing projects that staff at CARs either do not have the time, expertise, or manpower to do themselves. NGOs also often partner with PNN; PNN entities are unable to accept economic resources directly and so require third-party executors to manage funds meant to benefit PNN projects or programs. International NGOs, meanwhile, often have superior access to financial resources compared to their Colombian counterparts and are able to build long-term programs for conservation or initiate partnerships with CARs and PNN, occasionally subcontracting components of this work to Colombian NGOs.

Andean bears

Andean bears (also known as spectacled bears, in Spanish *osos de anteojos* or *osos andinos*) are the only bear species in South America and the last surviving lineage of the subfamily *Tremarctinae* (García-Rangel 2012). Andean bears are a relatively under-studied species (Falconi et al. 2020), especially among charismatic megafauna. However, evidence has been accumulating that the species has experienced population declines over the last several decades; the International Union for the Conservation of Nature classifies Andean bears as vulnerable to extinction (Velez-Liendo and García-Rangel 2017). Rough estimates place the current number of Andean bears between 13,000 and 18,000 individuals across the 5 countries where they occur—Bolivia, Peru, Ecuador, Venezuela, and Colombia (Velez-Liendo and García-Rangel 2017).

However, some regard these estimates with skepticism, suggesting there may be far fewer Andean bears (Peyton et al. 1998, Garshelis 2011). Andean bears primarily occupy high elevational zones (above 1200 m) in cloud forests and shrub ecosystems known as *páramo*.

Andean bears have experienced substantial habitat loss across their range, much of this loss occurring in only the last half century due to increasing agricultural conversion and upslope development from populous inter-mountain valleys (Etter et al. 2008). Previously, governments had relied on the simple inaccessibility of cloud forest as a de facto approach to Andean bear habitat protection (Peyton 1999). However, increased transportation infrastructure across the Andes has severely lessened the efficacy of this approach (Peyton 1999) and compromised the integrity of these previously intact forests. In addition, neoliberal economic policies implemented by Colombia in the 1990s meant to attract international investment have resulted in the intensification of mining by transnational organizations in the Andes and many detrimental effects to these fragile environments (Negrete Montes 2013, Gutiérrez-Gómez 2017).

Andean ecosystems are recognized to be extremely fragmented which has important implications for the persistence of this large-bodied species. Fragmentation in the Andes implies the loss of landscape connectivity for Andean bears as well as other species occupying these habitats; landscape connectivity is important for the maintenance of metapopulations, natal dispersal, mating opportunities, and nutritional requirements (Taylor et al. 1993). Furthermore, landscape connectivity may be essential for climate change adaptation by allowing montane species to adjust their home ranges in response to shifting climate envelopes (Davis and Shaw 2001, Littlefield et al. 2019). Though many CARs have established regional protected areas to prevent further degradation of core Andean bear habitat, the explicit consideration of cross-

jurisdictional connectivity in the selection of these areas would improve the net benefits achieved for Andean bear persistence in the landscape.

The second most important threat to Andean bears is poaching. While poaching in other countries has been motivated at least in part by the illegal trade in wildlife parts, poaching in Colombia is more often tied to issues of human-bear conflict (Peyton 1999). Andean bears are largely herbivorous and can cause tremendous damage to crops (Peyton 1980). They also scavenge—a behavior that has implicated them in livestock losses across the Andes (Goldstein et al. 2006). Further, there has been increasing evidence that some "problem" Andean bears will attack and kill livestock (Zukowski and Ormsby 2016, Parra-Romero et al. 2019), something that Andean ranchers have suspected and/or witnessed but whose perspectives, until recently, have been broadly met with skepticism from many conservation practitioners (Hohbein et al. 2020, *in review*). Issues with human-bear conflict are further exacerbated at the jurisdictional boundaries between CARs, as ambiguous responsibilities occasionally lead to calls from locals for institutional intervention in Andean bear depredation events to go unanswered; frustrated ranchers may then take matters into their own hands (Hohbein et al. 2020, *in review*).

Network Analysis Framework

Social networks are comprised of nodes (sometimes called vertices) connected by ties (sometimes called edges). Nodes represent actors in the network while the ties that connect them represent some form of relationship, be it friendship, communication, or formal agreements. In our network analysis, the nodes represent conservation actors across the Colombian Andes, specifically the CARs, PNN, and NGOs (Fig. 4.1). We distinguish two types of possible ties: ecological ties (defined by probable Andean bear movement between the jurisdictions of the CARs, elaborated below) or institutional ties (representing communication, collaboration,

contracts, or other forms of institutional exchanges). Ties involving PNN or NGOs are institutional, while ties between CARs could be either institutional or ecological.

Mapping the Ecological Network

A model of omnidirectional connectivity for Andean bears (Hohbein and Nibbelink 2020, *in review*) was used as the basis for the ecological network across the Colombian Andes. Connectivity models help delineate those areas in the landscape that are most conducive to movement of the focal species for which they are developed. This circuit-based model was produced largely following the methodology of Koen et al. (2014). Briefly, circuit-based models of landscape connectivity draw parallels between electrical current and animal movement (McRae et al. 2014). These models assume organisms have no prior knowledge of the landscape and thus move as predicted by correlated random-walk theory (McRae et al. 2014). Areas shown to have higher levels of "current" in the circuit-based models are predicted to have higher use by animals engaged in correlated random walks. These models are guided by resistance values set by the spatial analyst which correspond to the degree to which different landscape features are understood to prohibit or enable movement (e.g., high-volume highways usually have high resistance values because they are thought to be quite difficult for organisms to cross).

We used this connectivity model to quantify the degree to which neighboring CARs were ecologically connected via the probable movement of Andean bears given the distribution of habitat considered to be important for Andean bear connectivity (i.e., those areas in the model with high current). Several steps were required to turn this current map into an ecological network. First, we categorized into 5 classes the distribution of current values across the Colombian Andes according to Jenks natural breaks (Jenks 1967). Those areas that had current values which fell into the highest 2 classes were categorized as highly connective habitat (HCH)

(Fig. 4.2). We then calculated the total amount of HCH (in terms of 1-km^2 pixels) which was intersected by pairwise jurisdictional boundaries between CARs. Those which had 0 km^2 of shared HCH were considered ecologically disconnected in our analysis (i.e., they did not share ecological ties). We then calculated the quartile values of counts of shared cells of HCH (excluding 0 values). These quartiles guided the strength of ecological ties assigned to pairwise CARs. Neighbors which shared HCH cell quantities in the highest quartile were assigned an ecological tie with a strength of 3; those in the middle two quartiles were assigned moderately strong ecological ties (2); while those in the lowest quartile were assigned ecological ties with a strength of 1.

Mapping the Institutional Network

Semi-structured Interviews

R. Hohbein (RH) traveled to Colombia between August 2018 and September 2019 to conduct 67 semi-structured interviews (Bernard 2011) with 71 different conservation practitioners. These individuals represented 22 CARs, 20 nongovernmental organizations, and 12 PNN employees. Interviews were conducted in person whenever possible; interviews were conducted over telephone/video chat when in-person interviews were not possible. All interviews but one were audio-recorded and only after receiving verbal consent from interview participants. The majority of the interviews were conducted in Spanish with the assistance of one of three local translators. RH was always present as the primary interviewer. The Institutional Review Board at the University of Georgia approved all research conducted for this study (Protocol ID #STUDY00005270). No Colombian permits were required for this research. Interview participants were asked 1) to free list all entities with whom they either collaborated, contracted, or otherwise discussed Andean bear conservation or research and 2) to describe the frequency of

their communication with those identified. These relationships formed the basis of the institutional ties in our network analysis. Participants were also asked 3) to elaborate on challenges in these relationships, benefits to these communication ties, and overall observed barriers to collaborative efforts in the country.

Interview Sampling Strategy

We contacted all 26 CARs across the Colombian Andes. At least one representative from all CARs with coincident Andean bear habitat and confirmed or suspected Andean bear presence (*N* = 22) was interviewed for this research. RH interviewed representatives from all six territorial directorates (the regional tiers) of PNN and two representatives working at the national level. Park-level employees were interviewed only opportunistically. We began NGO interviews with the Wildlife Conservation Society – Colombia (WCS) and Fundacion Wii. We then used chain referral sampling (i.e., snowball sampling) to identify other NGOs or nonprofits who were involved with Andean bear conservation. See Hohbein et al. 2020 (*in review*) for a full description of the interview sampling strategy.

Strength of Ties

We assigned all institutional ties strengths of either 1, 2, or 3 according to various qualifications (see Table 4.1). If respondents indicated different strengths for a mutual tie, we used the higher value. Representatives from 4 CARs in the Andes communicated that they had no evidence of Andean bear presence in their territories and thus were not engaged in any conservation activities specific to the species; we assumed they had no communication ties with other entities specific to Andean bears.

PNN Specificities

For ease of analysis, we collapsed ties to individual national natural parks to the territorial directorate within which the parks belonged. For example, if a CAR or NGO described an information exchange or collaboration with Chingaza National Natural Park, we considered this to be a tie to the PNN territorial directorate of Orinoquía. We assumed all territorial directorates had a moderate tie to the PNN National Administration unless respondents from the territorial directorates indicated otherwise (as per Table 4.1). Communication among territorial directorates was only included if it was mentioned by interview respondents. However, we did not explicitly ask about communication between territorial directorates and thus these inter-territorial ties may be underrepresented.

Workflow for Analyzing the Social-Ecological Fit among CARs

We first compared the ecological network and institutional network among the CARs exclusive of the other two sectors (i.e., PNN and NGOs). This step in our analysis guided our perspectives on the "ideal" fit among the CARs, which assumes the strength of communication between neighbors would correspond to the degree to which they were ecologically connected via Andean bear movements. Our analysis thus reveals the extent to which this ideal scenario was realized at the time of our research and highlights the degree of disparity between these two metrics among neighboring CARs. We assessed fit only among neighboring CARs unless non-neighboring CARs indicated shared institutional ties, in which case these data were included.

We then integrated into our social network analysis the entities of PNN and relevant NGOs. We trimmed NGOs from this network who held only one tie to other actors in our network, but all CARs and PNN entities were included regardless of the number of ties held. For this complex network, we calculated standard SNA metrics including degree centrality,

betweenness centrality, and eigenvector centrality (see Table 4.2 for definitions of these metrics). Additionally, we assessed the number of connected components and examined the shortest paths between all neighboring CARs which did not share direct institutional ties. These analyses give us insights into the impacts these different sectors had on the conservation network across the Colombian Andes.

Finally, we calculated an index of connectedness among neighboring CARs which theoretically corresponds to the degree to which information from one CAR would likely reach another. This weighted connectedness index (WCI) is derived from the number of unique pathways connecting the two CARs divided by 1) the length of the shortest pathway between the two CARs (i.e., the number of intervening nodes) and then by 2) the cumulative weight of the shortest pathway between the two CARs. The weight is the reversed rank order of the strengths of the intervening ties (i.e., strength of 1 = weight of 3; 2 = 2; 3 = 1) and indicates increasing difficulty for information passage. We compared the relative contributions of PNN entities and NGOs on WCIs between CARs that were not directly communicating with one another with an analysis of variance (ANOVA) in Program R. We followed this with a post-hoc Tukey's HSD to determine which sectors resulted in significant differences to WCIs.

We conducted most SNA analyses in Gephi Graph Visualization and Manipulation software (v. 0.9.2). We used Program R to identify the shortest paths between the CARs. All statistics were performed in Program R.

Qualitative Analysis

While SNA can reveal many important insights about social-ecological fit, the analysis is more meaningful when qualitative data is considered as well. For example, Bodin (2017) describes the important insights possible through a deeper understanding of the actors in the network such as

their motivations, objectives, and even personal characteristics. These insights can reveal whether central actors are playing positive roles (leading, connecting), neutral, or negative roles (withholding information). All interview transcripts were translated into English and then imported in MaxQDA for thematic coding. Following the more traditional format of the social sciences, we incorporate our qualitative data into our discussion to contextualize results.

RESULTS

Ecological Network among CARs

Sixty-seven pairs of CARs shared jurisdictional boundaries in the Colombian Andes. Of these pairs, 53 shared habitat important to Andean bear connectivity. Thus, if CARs were neighbors, there was 79.1% chance that they shared at least some amount of habitat critical to Andean bear connectivity (HCH) (range: 2 – 378 km^2; M = 85.4 km^2). Each CAR shared HCH with an average of 4.08 neighbors (range: 1 – 8). Modularity analysis detected four interconnected "ecoregions" across the Colombian Andes (Fig. 4.3). We refer to these ecoregions later in our analysis to characterize conclusions about the relative fit of institutions in different parts of the Andes.

Institutional Network among CARs

Very few CARs listed other CARs among those with whom they collaborated, coordinated, or shared data with respect to Andean bear conservation or research (also reported in Hohbein et al. 2020). Overall, 23 pairs of CARs (consisting of 14 unique CARs) shared social ties regarding Andean bear conservation and research efforts, providing a network density score 0.071; i.e., of all possible pairwise connections between CARs (n = 325), 7.1% were realized (Fig. 4.4). Most of these connections (*n* = 15, 65.2%) came from a regional collaborative agreement among CARs in the central portion of the eastern cordillera of the Andes. Seven of the remaining 8

connections among CARs were weak ties that represented isolated conversations. Each CAR had communicated to an average of 1.77 other CARs about Andean bear conservation or research efforts.

Social-ecological Fit of the CARs

Of the 53 pairs of CARs which shared HCH, only 16 communicated with one another; the other 37 did not communicate on the subject of Andean bears. Of the 13 pairs of CARs we classified as sharing the highest level of ecological connectivity (104 – 378 km^2 of HCH), only 3 communicated (23.1%). Two pairs had strong social ties (strength of 3), while the third had a weak social tie (strength of 1). This indicates that 10 pairs of CARs were missing critical social ties—i.e., had the highest degree of social-ecological mismatch. Of the 26 pairs of CARs we classified as sharing a moderate amount of ecological connectivity (28 – 104 km^2 of HCH), 9 communicated (34.6%). Five of these pairs had strong social ties, 3 had moderate social ties, while 1 had a weak social tie. Fig. 4.5 is a representation of the degree of social-ecological fit among the CARs across the Colombian Andes given the degree of agreement between the ranking of the ecological tie and the weight of the social tie; those with the strongest ecological connection but which did not communicate resulted in the greatest social-ecological mismatch. The central portion of the eastern cordillera had the best fit of the four ecoregions.

Complex Social Network among CARs, PNN, and NGOs

Many CARs identified PNN as an organization with whom they collaborated on Andean bear conservation or exchanged information on the topic (n = 18 CARs; 0.881 ties to PNN per CAR); collaborations and information exchanges with NGOs were even more common (n = 19 CARs; 1.651 ties to NGOs per CAR) (Fig. 4.6). The inclusion of these other sectors increased the average degree centrality of CARs to 4.31 ties. NGOs had an average degree centrality of 6.33

ties relevant to Andean bear conservation and research, while PNN entities had an average degree centrality of 7 ties. Of the three sectors, PNN entities had, on average, the highest betweenness centrality scores (48.01), followed closely by NGOs (40.16), while CARs had the lowest average betweenness centrality scores (9.52). The two entities with the highest betweenness centralities in the complete network were both NGOs (WCS and Fundacion Wii); notably, these two NGOs did not communicate with one another. WCS had the highest eigenvector centrality score in the network, followed by members of the inter-institutional agreement of the eastern cordillera, including participating PNN territorial directorate Orinoquía and closely aligned territorial directorate Nororientales.

The inclusion of these other sectors of natural resource governance into the social network analysis improved many metrics of network cohesion. Because of the higher number of ties held by PNN entities and NGOs, the graph density increased from 0.071 (with only the CARs) to 0.113 (i.e., 11.3% of all possible ties were realized). Another metric that relates to cohesion is the number of connected components. In the previous analysis which considered only the CARs, most appeared disconnected from any network (i.e., they were "isolates"). The inclusion of ties to other sectors greatly changed the number of CARs that were within connected components. The inclusion of ties to PNN resulted in 2 groups of connected CARs—one group contained 19 CARs that were at least weakly connected to one another through mutual correspondents; the other contained 2 connected CARs. The remaining 5 CARs remained isolated. The inclusion of ties to NGOs resulted in similar changes to the network: there were 20 CARs that were at least weakly connected through mutual correspondents, while 6 CARs again remained isolated. When all 3 sectors were included (CARs + PNN + NGOs), 21 CARs were within a single connected component, while 5 remained isolates.

The integration of these other two sectors into the SNA revealed that 25 pairs of CARs which shared HCH, and had appeared disconnected from one another, were connected via mutual correspondent(s); the paths among these CARs had an average cumulative weight of 5.4 (Fig. 4.7). PNN entities were on the shortest paths between 19 pairs of previously disconnected CARs that shared HCH, while NGOs were between 9 pairs. To better understand the differential effects these two sectors had on the social network, we assessed their unique contributions in isolation from the other on our index of connectedness (WCI); i.e., we assessed the connectedness index on a network with only CARs and PNN and then again with CARs and NGOs. We found that the removal of NGOs from the network resulted in a significant decrease to the WCI between disconnected CARs (61.8%, $p < 0.01$), while the removal of PNN resulted in a less dramatic reduction to the WCI among those CARs (42.8%, not significant, $p > 0.05$). This difference between the average WCIs was not due to NGOs significantly shortening the paths between disconnected CARs, but rather because their inclusion in the network introduced more unique pathways for information to travel between the CARs.

DISCUSSION

We found very low levels of communication and coordination among CARs in the Colombian Andes with respect to the conservation and research of Andean bears. Our analysis of spatial fit indicated that close to 70% of the ecological ties created by probable Andean bear movement between CARs were not matched with inter-institutional communication or coordination, suggesting little immediate capacity for collective action across these boundaries (Bodin and Crona 2009). Among general issues caused by the lack of communication and coordination (e.g., redundant efforts, lack of social learning), qualitative interview data also suggested several issues that were symptomatic of social-ecological mismatches such as incompatible datasets between

neighboring CARs, the apparent lack of consideration of protected areas in neighboring CARs in reserve design and land acquisition, and the lack of institutional response to suspected Andean bear depredation events in jurisdictional border zones mentioned previously. The incompatibility of datasets prevents CARs from pooling their data to draw conclusions about the broader status of Andean bear populations in the Colombian Andes, while the latter two issues have consequences for the probability of successful Andean bear movement across jurisdictional boundaries. Conversely, members of the eastern cordillera inter-institutional agreement (which aligned perfectly with the central cordillera oriental ecoregion and contained the most social-ecological "matches" in the Andes) had the same methodology for assessing Andean bear occupancy, a shared protocol for responding to depredation events, and established communication channels for addressing issues at border zones (Hohbein et al. 2020, *in review*), suggesting that this voluntary collaborative agreement has allowed them to address many issues of social-ecological fit in the central region of the eastern cordillera.

While direct institutional ties between neighboring CARs were rare, entities of PNN as well as NGOs often served as intermediaries between otherwise disconnected CARs, bringing nearly all CARs working to conserve Andean bears across the Colombian Andes into a single connected component. This is significant as it demonstrates the existence of potential pathways through which information could travel to and from neighboring CARs. Stronger and more numerous pathways interlinking these CARs increase the likelihood that these entities will eventually communicate or even come to collaborate on conservation initiatives for the species. PNN entities had the highest average betweenness centrality scores of the three sectors considered in this analysis (meaning that they most often appeared between otherwise disconnected actors), suggesting that they have great potential for distributing information to

their correspondents and encouraging the development of institutional ties that would improve social-ecological fit in the country (Bodin and Crona 2009). The degree to which they are leveraging this advantageous position in the network for such ends is currently unknown. Though PNN correspondents often spoke of the importance of coordinating their own efforts with the CARs (e.g., for the designation and management of buffer zones surroundings national natural parks), only one PNN correspondent we interviewed spoke of the importance or need for the CARs to coordinate their efforts with one another. Conversely, the lack of coordination among CARs was a common theme during interviews with Colombian NGO representatives; several NGOs were actively working to facilitate communication between the CARs to remedy this. The degree to which the removal of NGOs from the conservation network impacted the extent to which CARs were interconnected (as observed with the change in WCIs) suggests that they too are strategically positioned for these efforts.

NGOs varied in their structural impacts on the institutional network (visible in Fig. 4.6). These different patterns in network structure that radiate from these NGOs dictate how information is likely to travel in the network and the bonds that could be created through mutual correspondents. For example, the two NGOs with the highest betweenness centrality scores, WCS and Fundación Wii, had drastically different network structures. WCS had "stronger" ties to other actors (indicative of more enduring communication channels), while Fundación Wii's immediate network was characterized by more weak ties (indicating more infrequent communications). WCS had a large-scale Andean bear conservation program characterized by longer-term partnerships with local allies, notably including the national office of PNN, and a concerted effort to share monitoring and human-bear conflict mitigation strategies with interested CARs. Conversely, Fundación Wii operated primarily through comparatively short-

term contracts with the CARs to do various forms of community engagement and research and monitoring programs. Upon contract termination, little on-going communication remained. However, Fundación Wii continued to receive occasional phone calls from previous contacts at the CARs whenever further questions about the species arose. WCS, having stronger institutional ties, is better positioned to transfer complex knowledge to their correspondents, important for building a consistent monitoring strategy across the Andes. They are also more likely to be a catalyst for triadic closure (Granovetter 1973). Conversely, Fundación Wii, through their weak ties, may be acting as a critical "bridge" across the network, allowing for greater dissemination of information between and among heterogeneous sub-groups (Granovetter 1973, Bodin and Crona 2009).

Overall, our results are largely consistent with those found by others who investigated the social-ecological fit achieved by self-organized networks. Specifically, collaborative ties were relatively sparse, and the network was characterized by more social-ecological mismatches than matches (Bergsten et al. 2014). We reach a similar conclusion as Guerrero et al. (2015) that while conservation actors can be successful in self-organizing and overcoming issues of fragmented management, the Andean bear conservation network would generally benefit from guidance in the targeting and formation of these inter-institutional ties. However, our approach of including non-jurisdictional entities into our analysis was critical in allowing us to identify which organizations might be best positioned for and most interested in providing such guidance.

CONCLUSION

We examined the social-ecological fit of actors across the Colombian Andes working to conserve the Andean bear. We found that CARs—the primary entities responsible for implementing conservation policy in Colombia—rarely communicated directly with one another

about their Andean bear conservation and research strategies, leading to many social-ecological mismatches. The CARs were more likely to communicate with entities of PNN and with NGOs about their Andean bear efforts. PNN entities had the highest average betweenness centrality scores in the network, but our qualitative interview data suggest they may not be using this advantageous position to foster inter-institutional coordination among CARs with whom they correspond. Conversely, NGOs (several of whom were in an almost equal if not more advantageous position in the conservation network) seem to be more troubled by the lack of inter-institutional coordination among CARs for Andean bear conservation and were actively working to amend this situation. Two NGOs, WCS – Colombia and Fundación Wii, had the highest betweenness centrality scores of all 48 conservation actors in the network, suggesting that they, in particular, could help to coordinate the network in such a way as to improve social-ecological fit for the conservation of the Andean bear in Colombia.

To our knowledge, this is the first empirical assessment of the impacts of non-jurisdictional actors on social-ecological fit. Our data suggest that NGOs may be particularly helpful in stimulating cross-jurisdictional efforts due to the non-jurisdictional nature of their work and their propensity to be common allies among otherwise disconnected actors. Intentional and strategic leadership from conservation actors that find themselves at the nexus of many disconnected actors could be key to improving social-ecological fit.

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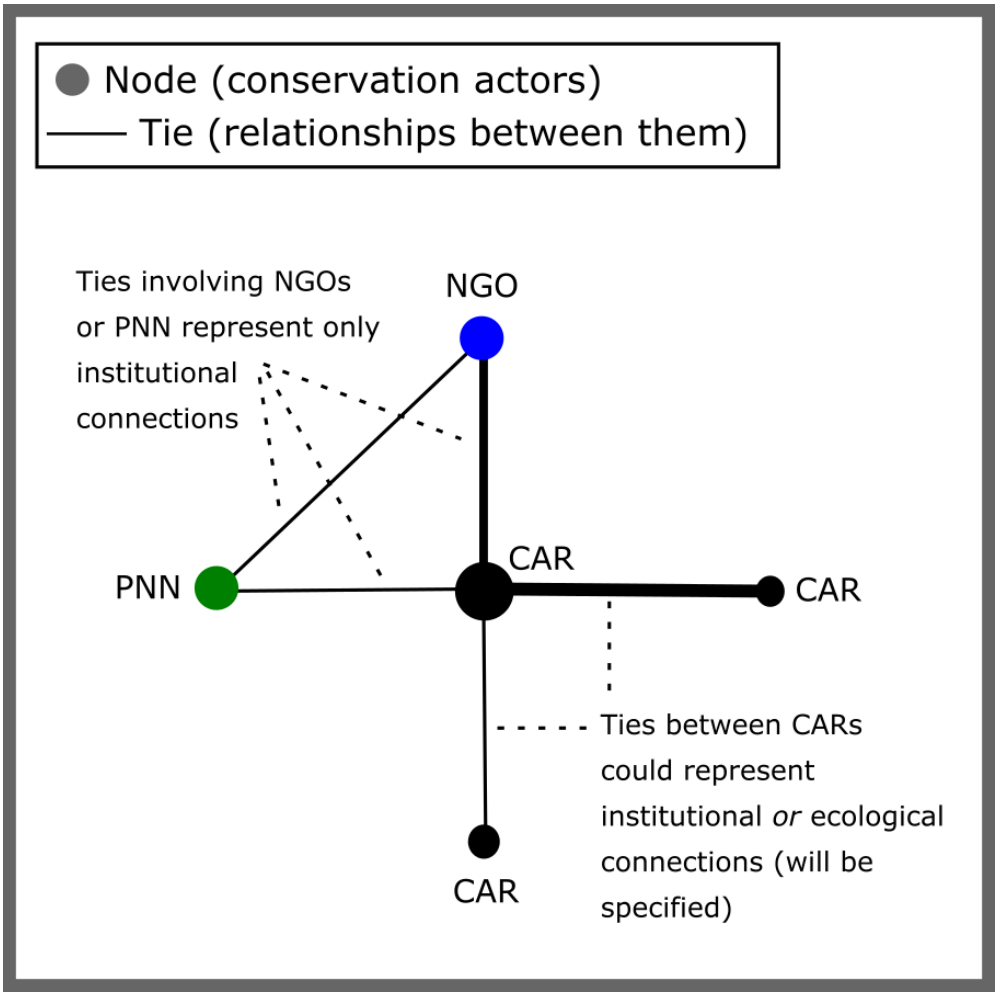

Figure 4.1 An example of a social network. Note the vast amount of information that can be portrayed; e.g., in the example above, the ties between actors are of varying widths, indicating differing strengths of connections. The nodes themselves are sized according to the number of connections held by each; the middle CAR has four connections, the most in the network, and so is depicted with the largest circle (but sizes can also be indicative of other social network metrics). Nodes can also be color-coded to indicate different kinds of actors, as above, where green represents entities of *Parques Nacionales Naturales* (PNN), blue represents nongovernmental organizations (NGOs), and black represents the *corporaciones autónomas regionales* (CARs).

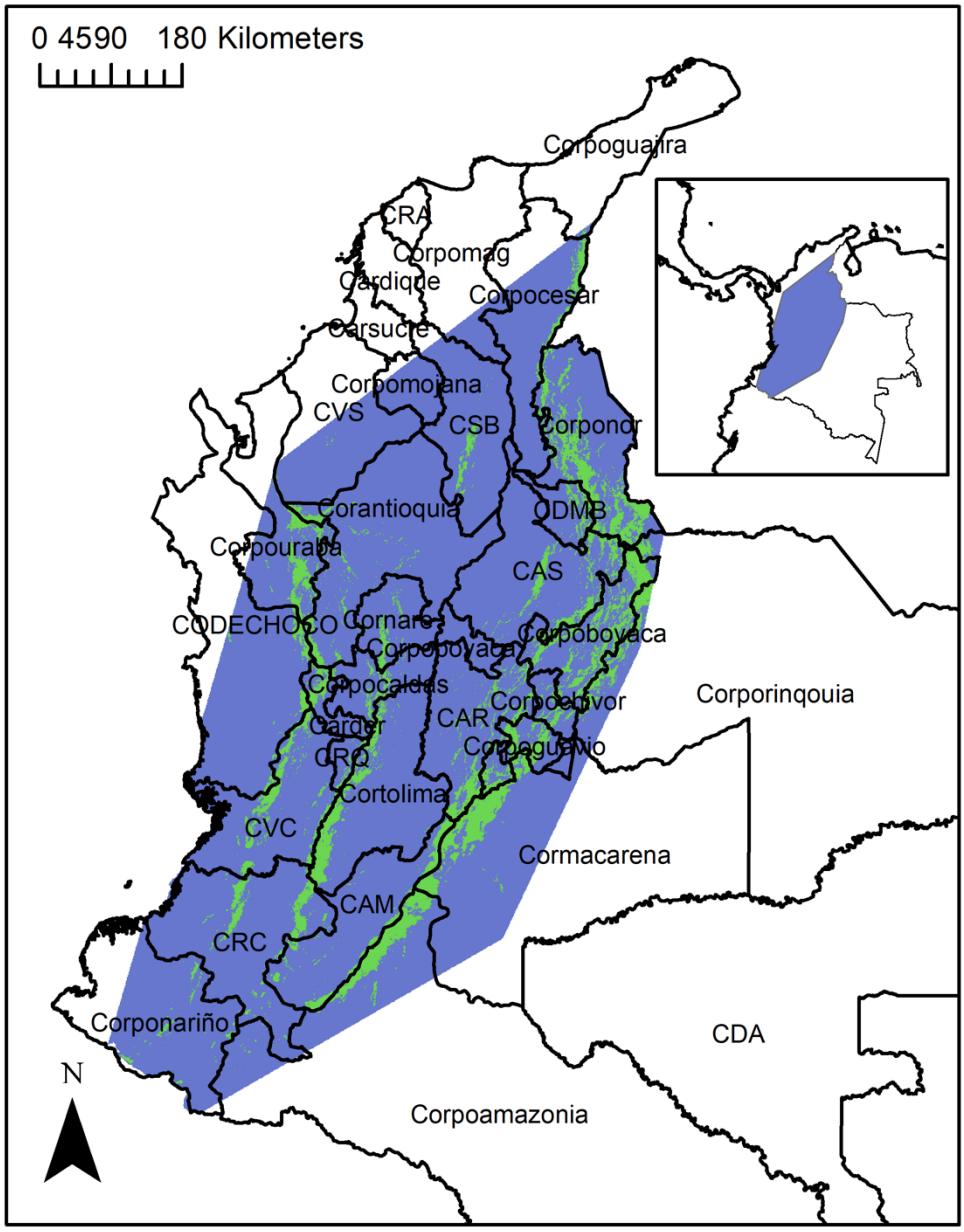

Figure 4.2 This connectivity model for Andean bears in Colombia was constructed with circuit theory and was the basis for the ecological network in this analysis. Areas in green are those which were predicted by the model to be most important for Andean bear connectivity within the delineated study area (blue). Jurisdictions of the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) are depicted.

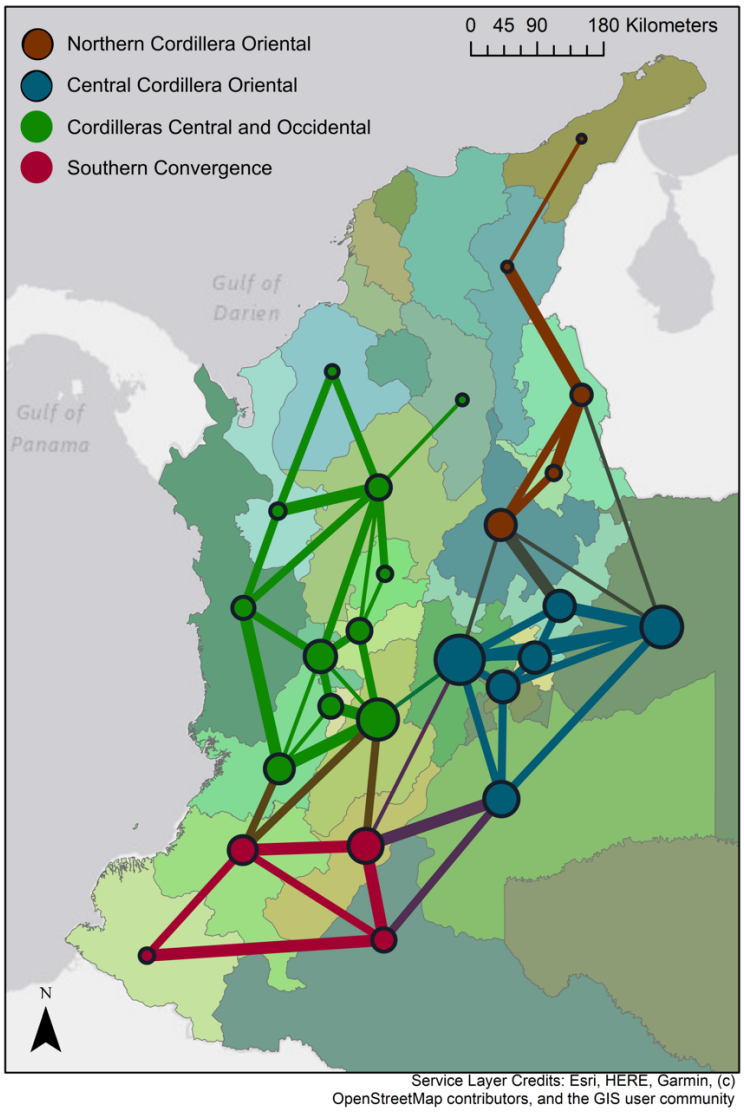

Figure 4.3 Ecological network across the Colombian Andes based upon probable Andean bear movement given the distribution of habitat critical to Andean bear connectivity across jurisdictional boundaries. Jurisdictions of each of the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) are delineated; each CAR is represented by a node. CARs which shared habitat critical to Andean bear connectivity are connected by lines; increasing line width is associated with more shared habitat and thus a stronger ecological connection in the network. Node sizes are indicative of relative ecological degree centrality of each CAR. Colors are indicative of 4 "ecoregions" detected with modularity analysis.

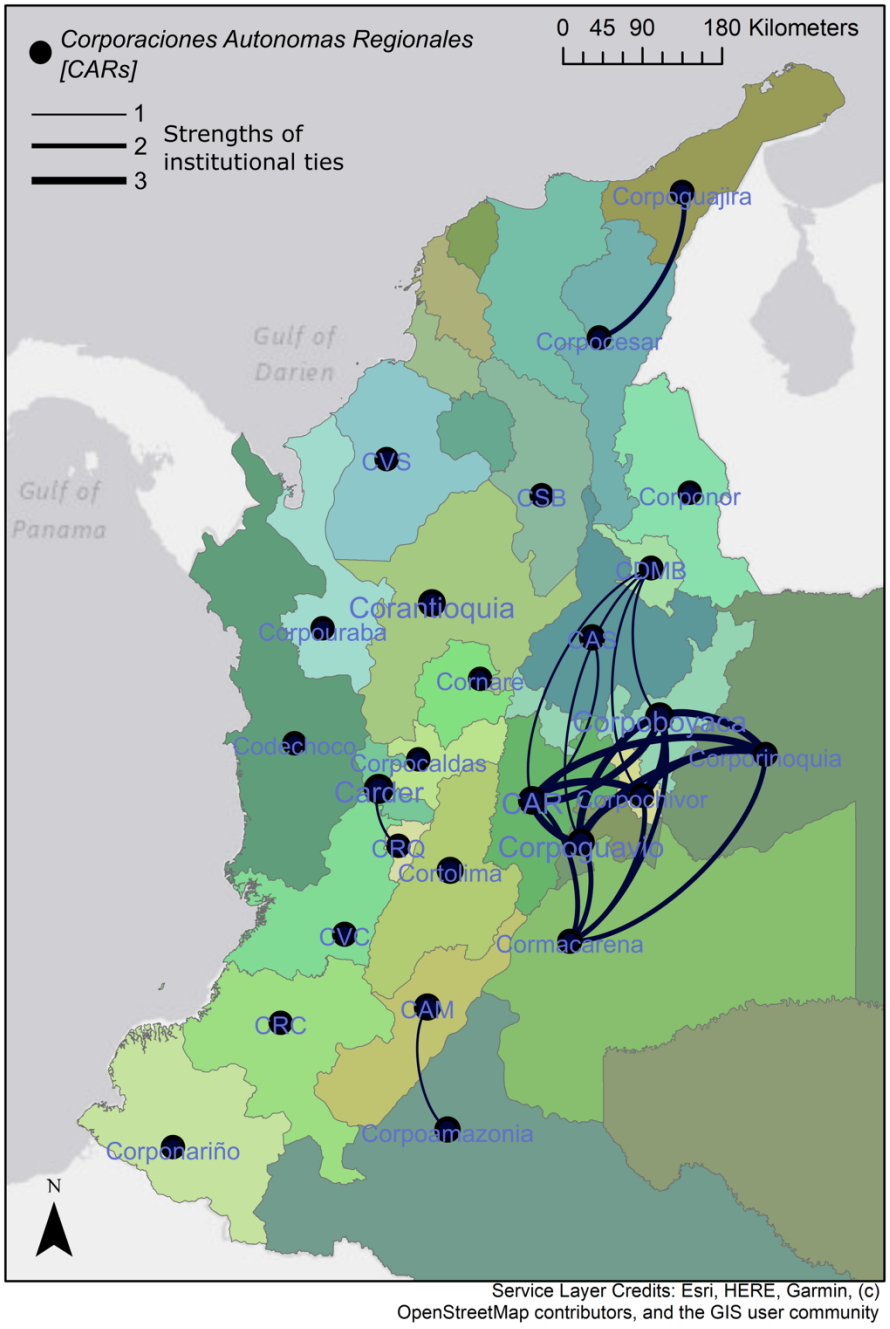

Figure 4.4 Institutional network among the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) regarding Andean bear conservation and research. CARs which are connected by lines had shared some level of communication, coordination, or collaboration; thicker lines are indicative of "stronger" ties between the CARs.

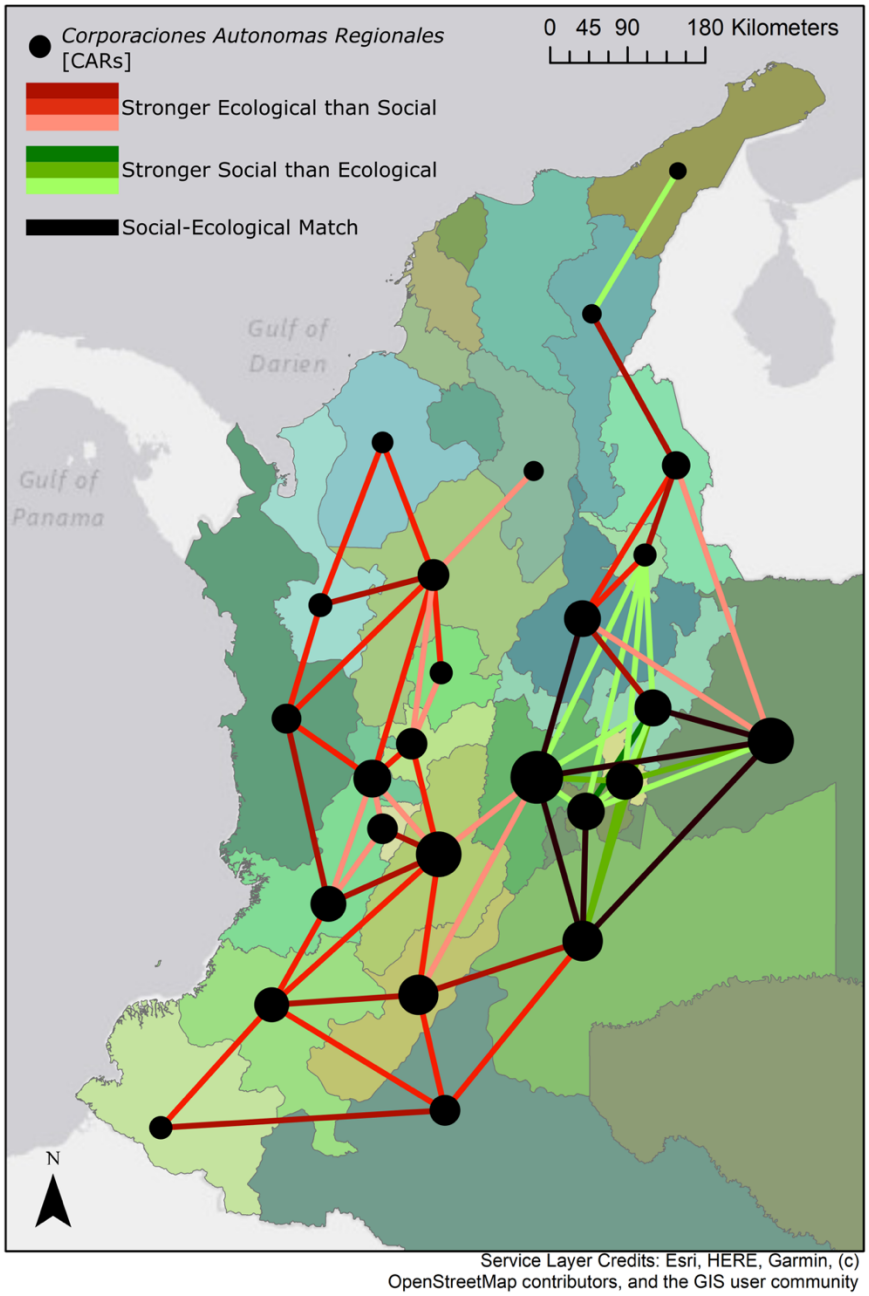

Figure 4.5 Social-ecological fit of the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) with respect to Andean bear conservation and research across the Colombian Andes. Social-ecological matches and mismatches are premised on the degree of alignment between the strengths of institutional and ecological ties between the CARs. Nodes are sized by ecological degree centrality.

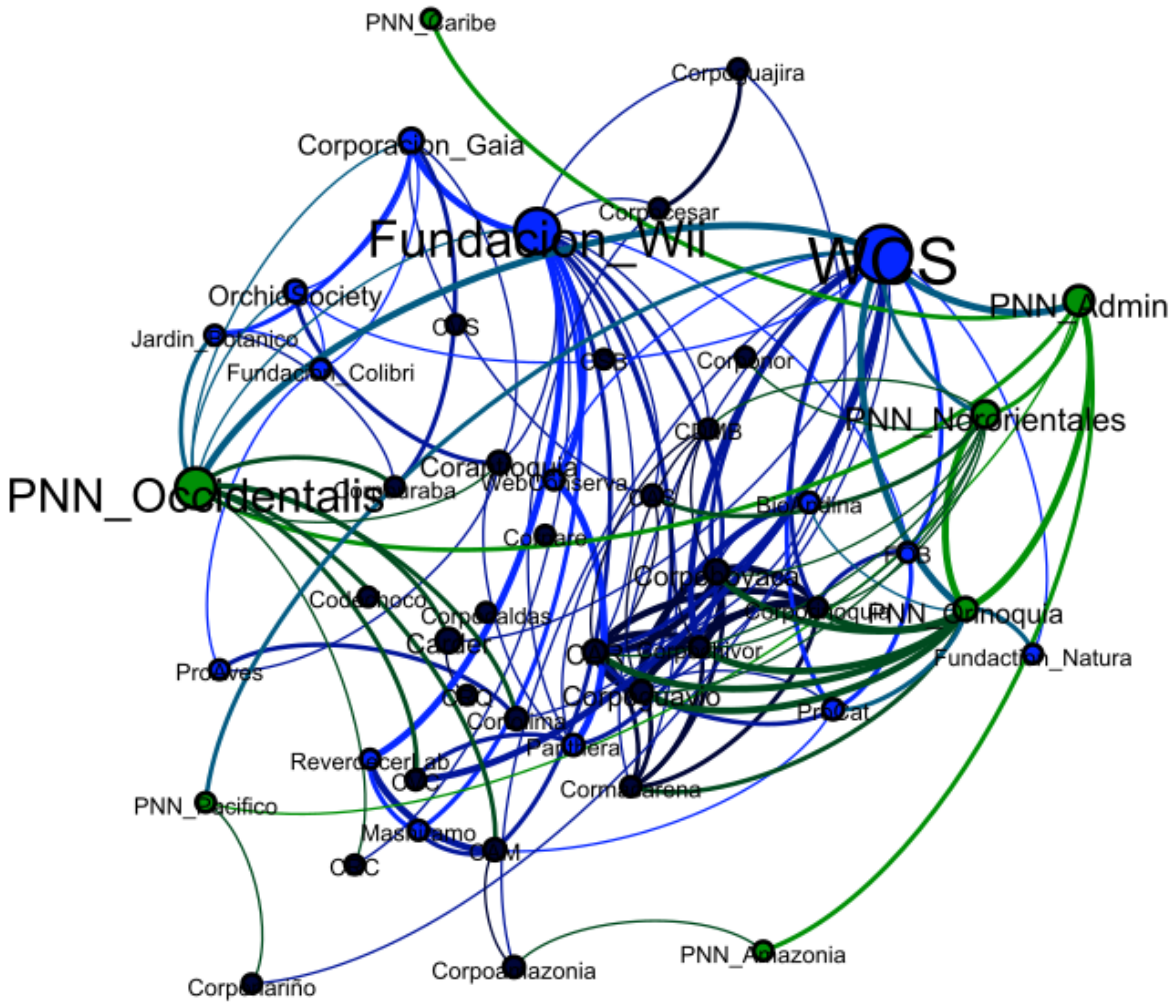

Figure 4.6 Complex social network among the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) (black nodes), entities of Colombia's National Natural Park Service (green), and nongovernmental organizations (blue). Thicker lines are indicative of stronger institutional ties regarding Andean bear conservation and research. Node size is indicative of relative degree centrality of each organization in the network.

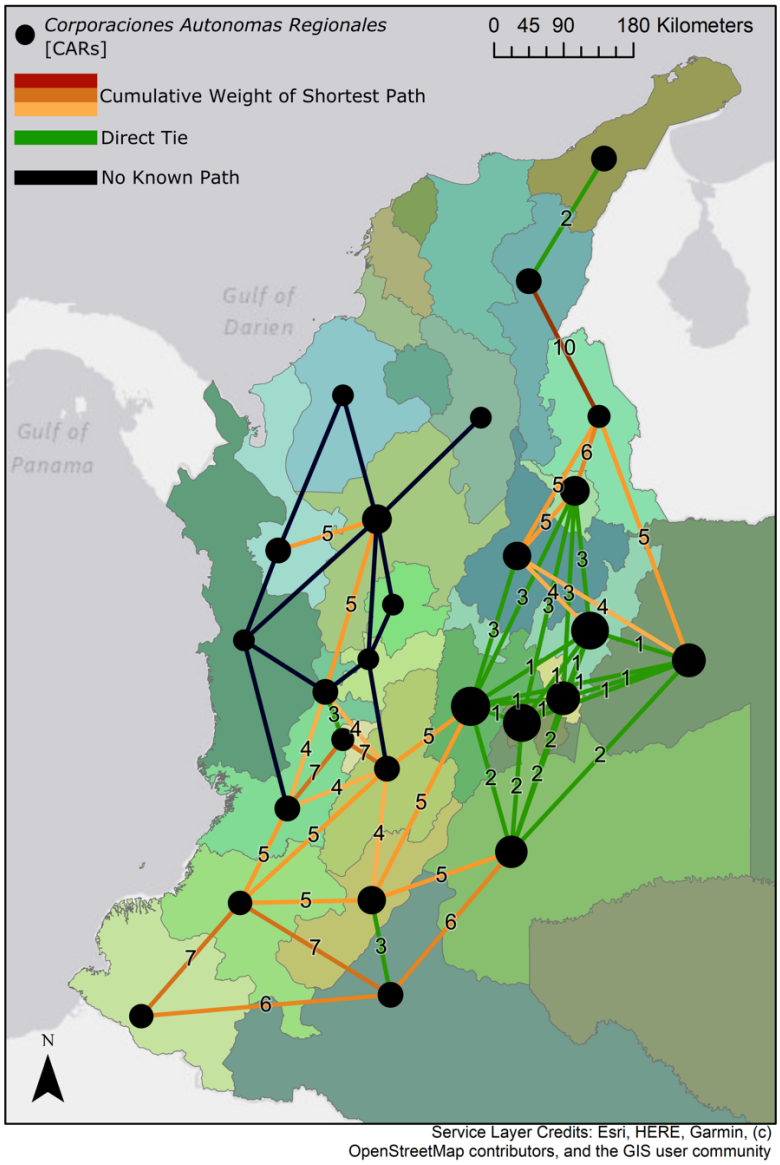

Figure 4.7 The inclusion of nongovernmental organizations and Colombia's National Natural Park Service brought most (n = 21; 81%) of the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) into a single connected component. Cumulative weights of the intervening paths between CARs that did not directly communicate with one another (but did share correspondents) are provided; a higher weight suggests that information is *less likely* to travel from one CAR to the other. CARs connected by lines of any color are considered ecologically connected via probable movement of Andean bears.

Table 4.1. Characteristics of the different strengths assigned to institutional ties between actors

Strength	Qualifications
1 - Weak	• communication explicitly described as "weak" or very infrequent • other indicators of weak communication (e.g., participation in multi-party agreement described as "non-active") • previous collaboration or contract between parties, but no indication provided of ongoing communication • relationships described by one or both parties as "tenuous" or "challenging," but that still included some component of information exchange
2 - Moderate	• grants or funds provided, but no collaborative effort apparent • contracts provided (similar to above); not considered "partners" • all other relationships not scored as 1 or 3
3 - Strong	• communication explicitly described as "strong" or "constant" • partners that shared or were active members of a signed, formal agreement for collaborative work

Table 4.2. Definitions of common social network analysis metrics

Social Network Metric or Analysis	**Definition and relevance to practice**
Degree Centrality	The number of ties held by an actor; a measure of social influence
Betweenness Centrality	The number of times a node lies on the shortest path between otherwise disconnected nodes; indicative of an actor's potential for distributing information or facilitating coordination among disconnected actors
Eigenvector Centrality	A relative metric which corresponds to the degree to which a node is connected to other well-connected nodes; a measure of the extent to which an actor is affiliated with other influential actors (aka "friends in high places")
Modularity Analysis	An assessment of the degree to which the social network is divided into subgroups characterized by more "in-ties" than "out-ties"; helpful for identifying "cliques" in social networks
Connected Components	A simple metric which counts the number of nodes which are inter-connected by mutual ties; identifies which actors are "reachable"
Density	Network-level metric which indicates the number of ties in the network relative to the number of ties possible, indicative of the collective network's relative affinity for collaboration

CHAPTER 5

CONCLUSION

My dissertation research suggests that the decentralization of environmental governance may create issues of social-ecological fit for those components of the environment that are not readily contained within the jurisdictional boundaries of the decentralized entities. Voluntary coordination among decentralized entities can help to at least partially overcome issues of misalignment (or social-ecological "mismatches"). However, external guidance in the targeting and formation of strategic interinstitutional ties would be beneficial, as would institutional structures that incentivize such coordination. Nongovernmental organizations (NGOs) may be particularly helpful in stimulating cross-jurisdictional efforts due to the non-jurisdictional nature of their work and their propensity to be common allies among otherwise disconnected actors. Intentional and strategic leadership from conservation actors that find themselves at the nexus of many disconnected actors could be key to improving social-ecological fit of decentralized systems.

SUMMARY OF FINDINGS

Three specific attributes may be particularly important for successful decentralized environmental governance (DEG) in the context of the conservation of threatened wildlife (particularly large-bodied wildlife entangled in human-wildlife conflict): effective (likely centralized) leadership, strong incentives, and horizontal communication among the decentralized entities. These were not characteristics of Colombia's DEG system, and their

absence appears to have had negative impacts on the system's collective ability to conserve the Andean bear.

There were great disparities in the implementation of the National Program for the Conservation of the Andean bear by the regional autonomous corporations (*corporaciones autónomas regionales* [CARs]). These disparities may be explained, at least in part, by economic disparities among the CARs. However, I gathered additional evidence that unwilling or disinterested CAR directors were also a contributing factor. According to several interview respondents, many CARs felt compelled to act only after bears were killed within their jurisdictions, fearing repercussions of the subsequent media coverage of such incidents. Retroactive and relatively short-term responses to Andean bear deaths is obviously not a sustainable approach to conserving this species. Elsewhere, Andean bear conservation and research programs were driven by enthusiastic and dedicated individuals. While the contributions of these individuals should not be undervalued, these programs are potentially quite vulnerable to the departure of these "key champions." Given the extent to which interview respondents spoke of issues with institutional turnover, this is not an unsubstantiated concern. Andean bear conservation in Colombia would benefit from stronger incentives (whether positive or negative) to encourage compliance of the CARs with national conservation policy; such incentive structures would encourage the development of Andean bear programs more enduring than media outrage, the whims of CAR directors, and the employment of passionate individuals.

Very few of the CARs coordinated their Andean bear conservation and research efforts with one another, creating issues of social-ecological fit across the range of the species in Colombia. The landscape connectivity model presented in Chapter 3 allowed me to identify which CARs' jurisdictional boundaries intersected habitat critical to Andean bear movement. I

found that 53 pairs of CARs shared such habitat, but only 16 of these pairs (or 30% of pairwise matches) communicated with one another about their efforts for the species. Qualitative data suggest that these social-ecological "mismatches"—created by the lack of horizontal communication among the CARs—potentially exacerbated issues of human-bear conflict that arose at jurisdictional border zones. Further, these CARs frequently had different monitoring strategies (if they had any at all), which complicated data sharing and their ability to draw conclusions about the broader status of Andean bear populations across the Colombian Andes. Representatives from those CARs that *did* collaborate with one another spoke of many benefits—more rapid responses to bear conflicts in border zones, a more heterogeneous learning environment, more efficient resource allocation, and more confidence in applying approaches already tested by their colleagues—which one could only assume were not accruing to CARs working in isolation. The presence of a "*mega-convenio*" (large agreement) for the conservation of the Andean bear among the CARs and entities of *Parques Nacionales Naturales* (PNN) in the eastern cordillera demonstrates that "bottom-up" cross-jurisdictional efforts are indeed possible, but it appears that few other CARs were motivated to seek out such arrangements.

An international NGO, the Wildlife Conservation Society – Colombia (WCS), occupied a central position in the conservation network, arguably fulfilling some of the roles and responsibilities that ought to have been fulfilled by the Ministry of the Environment and Sustainable Development—the national entity meant to coordinate the implementation of environmental policy in Colombia (but which was conspicuously absent from the conservation network). WCS made significant contributions to Andean bear research and conservation efforts in the country as well as concerted efforts to build the capacity of local actors including the autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) and especially

Colombia's National Natural Park Service (*Parques Naturales Nacionales* [PNN]). Though these are laudable efforts, rather unfortunately many of the CARs are fragile entities prone to high rates of institutional turnover, politicization, elite capture, and corruption, and PNN struggles in the face of debilitating budget cuts each year (Blackman et al. 2006; this was also mentioned by several interview respondents). Further, several Colombian NGOs felt they had been unfairly outcompeted by this conservation giant. A greater engagement with Colombian NGOs (by both donors and international NGOs) would help ensure the long-term integrity of Andean bear conservation.

My research suggests that the lack of involvement and guidance from the MinAmbiente in the implementation of the National Conservation Program for the Conservation of the Andean bear (Mayr Maldonado 2001) has contributed to inconsistent strategies across the Colombian Andes and insufficient communication among the CARs. This lack of involvement by the MinAmbiente might be attributed to historical debilitating actions taken by previous Colombian Presidents (particularly Uribe) in the decades that followed its creation (Mance 2007; Rodríguez Becerra 2009). However, the MinAmbiente still maintains the constitutional power and responsibility to "direct and coordinate the planning process and harmonious implementation of environmental activities of the National Environmental System." In addition to incentivizing compliance with national conservation policy (including for the conservation of the Andean bear), the MinAmbiente could use their power and influence to institutionalize horizontal communication and reduce "transaction costs" among CARs. This could be accomplished fairly easily; e.g., by providing spaces for meetings, facilitating group workshops, or granting resources to cover travel. This would improve the ability of the CARs to address not just Andean

bear conservation, but also other ecosystem functions that extend beyond the boundaries of individual CARs.

Strategic leadership from NGOs has the potential to greatly improve the social-ecological fit of the Andean bear conservation network in Colombia. WCS and Fundación Wii had the highest "betweenness centrality" scores in the entire conservation network (indicating that they, more than any other organizations or agencies, were common correspondents of entities that otherwise would not share connections). High betweenness centrality indicates a strategic position for passing information between disconnected entities, and in so doing, encouraging the two entities to communicate directly with one another. The propensity for collaborators of collaborators to eventually also become collaborators is known as "triadic closure" and has been well-documented in social network studies. NGOs and also entities of PNN had far more interinstitutional connections relevant to Andean bear conservation and research than did the CARs—this likely stems from the nature of their work that stretches across many jurisdictions.

REFLECTIONS ON DOING INTEGRATIVE RESEARCH

I'll start out by saying that I loved my time in the Integrative Conservation PhD program. There is *so much* value in encouraging this new generation of conservation biologists and anthropologists to consider the perspectives, contributions, and even limitations of other disciplines and ways of knowing our world. But, that doesn't change the fact that doing integrative conservation research is a challenge. I often found myself feeling like a "*jack of all trades, master of none*." I feel I am neither a bear biologist nor a governance scholar nor an expert in spatial analysis, but rather some strange chimera. I drew from many different literatures and disciplines—I know it's unreasonable to expect to know them all completely. Yet in academic settings, I feel that it's often expected, particularly from people that don't know me,

but rather hear me present at some conference. The writing of each new chapter confronted me again with the realization of how much I didn't yet know. My PhD experience was one of constantly feeling out of my element, stretching always into some new, uncomfortable dimension where I felt out of touch and frankly, unworthy. Who am I to be writing about decentralization having never taken a class on governance? (I took one after the fact, to help assuage some of this imposter syndrome.) When I shared these feelings of inadequacy with my advisor, he reframed what I saw as my "problem" as an advantage. By telling the story of Colombia's environmental governance in a way that made sense to *me*, my writing would be better positioned to reach others perhaps not typically reached by environmental governance scholars. *This* was one of the advantages of training integrative scholars. This idea, perhaps more than anything else, has helped me maintain confidence in my work. Beyond that, adaptation and humility have gone a long way, and I think will be some of the more enduring takeaways from my time in the Integrative Conservation PhD program.

Further, my "non-traditional" exposure to some of these other literatures led to what I think were some of the more interesting aspects of my dissertation. My original intent for my dissertation research was to study the actions and interactions of *only* the NGOs, and it wasn't until I was in Colombia that I realized how important it would be to understand the CARs and Colombia's system of environmental governance more generally. It wasn't until I was back from my first field season that I first started reading about "decentralization." Having no background in the subject, and thus not knowing what questions were generally asked and dealt with in the literature, I was asking what came to *my* mind, and these questions looked very different. When I started looking for literature that could inform what to be expected of the "decentralization of wildlife conservation," very little seemed relevant. The papers I found on decentralization of

natural resource management were almost entirely about forestry; if they were about wildlife, it was about community-run ecotourism enterprises in Africa. I reached out to Dr. Laura German to help me understand why I wasn't able to find what I needed, and it was she who finally made me realize I was on to something novel.

Though the framing of social-ecological fit isn't new and inherently calls upon the researcher to do something resembling integrative work, I think my determination to at least *try* to do justice to other disciplinary lenses allowed me to develop a more rigorous, nuanced, and complex assessment of social-ecological fit than many others in the literature. For example, most case studies that used social network analysis to inform their assessment of fit focused entirely on quantitative aspects of SNA and left out important ethnographic detail. Likewise, in studies on species conservation in the ecological literature, often too little attention is paid to issues of governance that ultimately determine whether the "management recommendations" (often made near the end of each article) are even reasonable to consider.

STRATEGIC COMMUNICATION

There are three main audiences with whom I aim to share my research: 1) those who participated in my research; 2) the wider community of conservation practitioners; and 3) general audiences. To reach that first audience, I am pursuing the publication of some of my results in Spanish (Appendix B), as well as creating an executive summary of my primary findings (again, in Spanish) to distribute to all interview participants (Appendix C). I additionally aspire to work with ASOCARS to develop a strategy for sharing my work with the CARs. As they are an organization explicitly dedicated to increasing coordination among the CARs, they are the most obvious entity for whom my work is pertinent. As for the wider community of conservation practitioners, Dr. Patti Dunne has graciously invited me to give a "brown-bag" talk to her

colleagues at Conservation International. This talk will center on the potential for NGOs to facilitate information exchange and coordination in conservation networks. Following this talk, I may try to repeat the process with the Wildlife Conservation Society. My last piece of strategic communication will be a research brief, meant to serve as an "accessible" overview of my research that will be posted on the Integrative Conservation website (Appendix D).

ADDITIONAL REFLECTIONS ON COLLABORATION FOR CONSERVATION

Flagship species obviously draw a lot of attention in the world of conservation (that is, in fact, why they are selected in the first place). However, one thing I had never considered was how researchers, practitioners, or organizations might wield their superiority over the conservation of that one species to gain prominence. When I asked interview respondents to explain what they saw as the barriers to collaborative efforts for the conservation of the Andean bear, a not-insignificant number took the opportunity to describe intense competition, excessive egos, and attitudes of territoriality and possessiveness over the species.

> *There's a lot of mistrust . . . There is an attitude of trying to impose certain property rights over certain things. . . So, who is the owner of the project to protect the bear in the region? There are those who believe they have those rights, so anyone else getting involved with the bears is sort of invading their territory.*
>
> *We have found that some people expect us to ask permission to work with wild species. Like, they think the species is for them. So that is another big barrier to working collaboratively in Colombia.*
>
> *It's a lot like a professional jealousy. Like, "I am the owner of this subject and no one is going to take it away from me." . . . Here they think that, "If I work with a certain species, I don't want anyone else to work with that species"—they're very territorial.*

A few times—often enough to pique my interest—respondents described these characteristics of Andean bear conservation in contrast to work conducted for other species, like birds, tapirs, and dolphins, seeming to suggest that this atmosphere of competition was somewhat unique to Andean bears (or perhaps carnivores, more generally) (e.g., "*Let me tell you [as an ornithologist], working with bear people was* very *hard for me*."). Now, it's possible that these descriptions were because there just *happen* to be a few key Andean bear biologists with very strong personalities. Nevertheless, I found myself wondering, is the relative "charisma" of a species correlated with the behaviors of their advocates? Are certain personalities more drawn to [certain] charismatic species because of the associated prestige? I vaguely remember hearing jokes in my distant past about the stereotypes of carnivore biologists, which appeared to differ from stereotypes about ornithologists or herpetologists. Obviously, stereotypes are flawed, unrealistic portrayals of deeply complex human beings, but these anecdotes seem to suggest there might be something to this idea. Conversations with my fellow ICON comrades further supported this idea. If there are differences among people who prefer to work with different species, why do these differences exist? And, could these differences ultimately impact the conservation (and, therefore, survival) of the species? If Andean bear biologists actually *are* more competitive (on average) and thus less likely to collaborate, the answer would seem to be…yes. I find this endlessly fascinating. I would have loved to write a paper on this, but I had no idea where to start. Perhaps the subject for a future student pursuing a degree in Integrative Conservation and Environmental Psychology?

FUTURE RESEARCH DIRECTIONS

There are number of different avenues through which future research on this topic could be progressed. Knowledge regarding *how* successful interinstitutional connections can be created

(particularly by third parties) would be especially helpful. Many interinstitutional connections in this study system appeared to have been driven by employee movements among organizations (e.g., someone that started at an NGO moved to a CAR, and thus the CAR gained an interinstitutional tie). This is an interesting finding regarding network formation but is obviously not a technique that could be readily (or ethically) wielded by conservation practitioners for building connections. We also need more information about how to successfully incorporate upward accountability into decentralized management of natural resources without overshadowing the downward accountability components that made decentralization valuable in the first place; surprisingly little guidance exists on this subject, perhaps because authentic decentralization has so rarely been achieved in practice. Further, a central institution may not be the only entity capable of encouraging the compliance of decentralized entities with conservation policy—something pointed out to me by Dr. Jesse Abrams following one of my presentations. In short, there may be a form of "peer pressure" at work in conservation networks, encouraging entities to "keep up" lest they lose legitimacy as environmental authorities. More work would be needed to identify whether and how such "peer pressure" manifests in conservation networks and what kind of changes it could affect.

APPENDIX A

CONSERVATION, HUMAN-WILDLIFE CONFLICT, AND DECENTRALISED ENVIRONMENTAL GOVERNANCE: COMPLEXITIES BEYOND INCOMPLETE DEVOLUTION[11]

ABSTRACT

Decentralisation of environmental governance (DEG) proliferated around the world in the 1990s, inspired in part by theories of common-pool resource governance that argued that local communities could sustainably manage valuable but non-excludable resources given a set of proper institutional design principles. However, many species of wildlife, such as predators that consume livestock or herbivores that destroy crops, are considered undesirable by local communities; this challenges the applicability of common-pool resource inspired governance models and calls into question whether decentralisation will work to conserve wildlife in these contexts. Numerous scholars have proposed methods to generate economic value from locally undesired wildlife species to incentivise their conservation, but the overall success of these approaches has been mixed. We explore the intersection of DEG and the management of wildlife entangled in human-wildlife conflict and challenge the assumption that simple models of devolution and decentralisation will lead to the successful governance of wildlife in such circumstances. We argue that conflict species governance is potentially compatible with DEG but requires a fuller consideration of institutions at multiple scales than is typically included in

[11] Hohbein, R. R., and J. B. Abrams. Submitted to *Conservation & Society,* 29 May 2020.

common-pool resource theory or decentralisation. Multiple mechanisms of accountability may be especially important in securing the conservation of wildlife in conflict scenarios.

INTRODUCTION

Human-wildlife conflict is considered to be one of the most urgent threats to carnivore conservation (Treves and Karanth 2003; Ray et al. 2005), but many other non-carnivore species are also threatened by human-wildlife conflict, such as large herbivores that destroy crops (e.g., elephants, Andean bears) or threaten human lives (e.g., hippos). There is a rich literature that discusses various facets of human-wildlife conflict and implications for conservation initiatives. More recently, there have been increasing calls in the human-wildlife conflict literature to consider social dimensions when prescribing efforts for the conservation of species that are entangled in human-wildlife conflict (hereafter: conflict wildlife or conflict species; please note that the authors acknowledge the various issues with this term[12]) (e.g., Treves et al. 2006; Dickman 2010; Douglas and Veríssimo 2013). Scholars have pointed out that many perceived human-wildlife conflicts are actually "human-human" or "conservation" conflicts (e.g., Dickman 2010; Redpath et al. 2015). For example, some human-predator conflicts appear to be informed as much by the sense of a loss of control as by the objective risk to humans, livestock, and wildlife posed by their presence (Goldman et al. 2013; Olson et al. 2015). Poorly designed and/or inequitable institutions may create the appearance of human-wildlife conflict where before there had been coexistence, as sometimes observed after the establishment of protected areas and other forms of "fortress conservation" (Massé 2016; de Silva and Srinivasan 2019).

[12] Some scholars have criticised this term for it inherently implies agency on behalf of wildlife and ignores the underlying dimensions of what are often actually human-human conflicts (e.g., Redpath et al. 2015). Further, the term frames conflict wildlife as purely antagonistic and may obscure other positive benefits of the same species and renders invisible the possibility for coexistence. Nevertheless, "human-wildlife conflict" continues to dominate the literature, and the term is useful in allowing scholars and practitioners to refer to a broad class of problems that, while diverse, are still easily recognisable and understood by those working in the field.

Despite increasing recognition of the importance of social considerations for managing human-wildlife conflict and conserving species within this context, still relatively little attention has been paid to how different institutional arrangements might impact such efforts. This is a contrast with the abundant literature analysing the management of other resources such as fisheries, water, and livestock forage under common-pool resource (CPR) principles (Ostrom 1990; Ostrom et al. 1994). Wildlife (including "conflict wildlife") have often been included in governance interventions inspired by theories of common-pool resources (CPRs)—such as decentralised environmental governance (DEG) and related community-based natural resource management (CBNRM)—without due consideration of whether the wildlife in these contexts meet some of the core assumptions of the CPR model.

The purpose of this review is to contribute to scholarship on environmental governance by exploring two arguments that, to date, have not received sufficient attention in the literature: 1) in some circumstances, wildlife do not meet the basic criteria of common-pool resources, and thus we should not expect them to be managed appropriately according to CPR theory; and 2) consequent to the first point, simple models of devolution and decentralisation may not lead to the successful governance of wildlife under such circumstances. Note that this second point departs from a theme running throughout much of the environmental governance literature, namely that a lack of true devolution (e.g., due to elite capture or an unwillingness of central powers to devolve) is the root cause of governance failure in many nominal decentralisation or CBNRM experiments (see, e.g., Murphree 2000; Blaikie 2006; Dressler et al. 2010; Bluwstein et al. 2016).

We follow these two arguments with a review of interventions that have been proposed to align conflict wildlife scenarios with the CPR context by converting the species from a burden to

a valued resource. Such approaches typically revolve around the creation of economic incentives for conflict species conservation. We argue that these approaches to conflict species conservation rest on problematic assumptions and that few conflict wildlife species can be conserved through economic solutions alone. This suggests that other strategies and institutional solutions may be required to advance conflict species conservation in DEG (Walpole and Thouless 2005; Suich 2013). These "less than perfect" approaches will necessarily need to align with the "less than complete" devolution typical of actually existing DEG and take into account rationalities beyond the logic of individual economic consequences (Saunders 2014).

DECENTRALISED ENVIRONMENTAL GOVERNANCE

Decentralisation is defined as the devolution of power and responsibility from a central or national authority to intermediary or local levels of governance that are—at least in theory—largely or entirely independent from the higher authorities and primarily accountable to their local constituents. The emphasis on downward accountability and inclusion of participatory mechanisms differentiates democratic decentralisation from mere administrative *deconcentration* (Manor 1999; Ribot 2004). A wide range of practices fall under the broad umbrella of decentralised environmental governance including numerous CBNRM models that vary in terms of the precise distribution of powers and responsibilities among governmental and nongovernmental actors at various scales.

Decentralisation as a broad approach to governing is not new, but its specific application to environmental and natural resource management became widely institutionalised beginning in the early 1990s. Lemos and Agrawal (2006, p. 299), for example, called DEG one of "the most important emerging trends that are shaping environmental governance." Proponents of DEG argue that the empowerment and participation of people closer to the local context can result not

only in more equitable governance, but also improved environmental outcomes as a result of tighter feedback loops between problems and decision-makers, more efficient resource allocation, and improved local compliance with rules and regulations (Caldecott and Lutz 1998; Ribot 2004; Lemos and Agrawal 2006; Larson and Soto 2008; Ribot et al. 2010).

DEG is more than simply a form of political and social praxis. It has long been strongly informed by—and itself informs—a robust academic literature pertaining to environmental governance and institutions (Bartley et al. 2008). DEG programmes have been bolstered by governance scholarship such as that associated with Elinor Ostrom's CPR theory (Nagendra et al. 2014; Pacheco-Vega 2014; Ykhanbai and Vernooy 2014). In response to Hardin (1968) and others who claimed that only privatisation or strong centralised government could address CPR dilemmas, Ostrom's new institutional economics approach convincingly argued that local communities could sustainably manage such resources over the long term given a set of design principles concerned with exclusivity, monitoring, sanctions, and the proper combination of deference and support by higher-level authorities (Ostrom 1990). These theoretical insights have been supported by empirical research on the governance of resources such as fisheries (Defeo and Castilla 2012), water (for irrigation) (Lam 1998), grasslands (for livestock forage) (Quinn et al. 2007), and forests (for various timber and non-timber forest products) (Gibson et al. 2000; Lopez and Moran 2016). This body of scholarship lends support to the subsidiarity principle—upon which arguments for DEG are at least partly premised—that authority should be "vested in the lowest level of social organisation capable of solving pertinent problems" (Young 2002, p. 284).

More than 60 countries have experimented with or implemented some form of DEG (Ribot 2004). In some cases, the devolved power and responsibility were allocated to democratic

local, district, or regional governmental entities. Such is the case in Colombia, where autonomous regional environmental authorities (known as *corporaciones autónomas regionales*) were provided substantial discretionary power over the implementation of environmental policy (including threatened species conservation) within their jurisdictions and which were intended to be downwardly accountable to local constituents (Rodríguez Becerra 2009). Elsewhere, local communities were the recipients of devolved responsibility for natural resources; this community-centric form of DEG is commonly referred to as community-based natural resource management (CBNRM). An example of CBNRM can be found in the community conservancies in Namibia that have control over the management of wildlife on communal lands covering more than 160,000 km^2 (MET/NACSO 2018; Gnych et al. 2020). Although there are important differences between governance models in which authority is vested in local non-state actors and those in which authority is vested in local governmental actors (Murphree 2000), both qualify as varieties of DEG and are relevant to our discussion. Hereafter, when we refer to "decentralised entities," we are referring to the local governmental or non-state actors that are the recipients of devolved rights and responsibilities for conserving conflict species.

Research on the efficacy of DEG in securing presumed benefits and improving environmental outcomes suggests mixed success overall. Scholars have frequently pointed towards incomplete devolution of decision-making power and insufficient resources as explanations for these failures (e.g., Larson 2003; Ribot et al. 2006). Others have suggested that experiments with DEG suffer from poor attention paid to commonly acknowledged good governance principles for natural resource management, such as those explicated by Lockwood et al. (2010): legitimacy, transparency, accountability, inclusiveness, fairness, integration, capability, and adaptability. Most of these reviews have assessed DEG performance in the

context of the sustainable management of CPRs (e.g., Béné et al. 2009; Baynes et al. 2015; McLain et al. 2018). We argue that—in addition to these various issues in the implementation of decentralisation reforms—there exists a separate fundamental issue in the compatibility of such paradigms with the context of conserving or managing species entangled in issues of human-wildlife conflict.

CPR Theory and Conflict Wildlife

There are two fundamental reasons why wildlife in many conflict scenarios do not meet the assumptions of Ostrom's CPR model. First, the wildlife in question may not be "common pool." CPRs are defined as those resources that are subtractable but for which exclusion in access to benefits (e.g., via privatisation) is difficult or impossible. The classic example is a fishery, where each fish caught reduces the overall quantity available to other fishers, yet the privatisation of fish stocks is difficult due to the nature of the resource. Some wildlife species that have been involved in conflict scenarios have been productively conserved through converting them into private property—the classic example being game farms throughout much of Africa. To the extent that wildlife can be readily privatised via enforceable tenure claims to the large landscapes on which they live, to the wildlife themselves, or to rights to hunt them, they are not fitting examples of a "common pool" resource.

Second, and more important to our analysis here, conflict wildlife species may not be perceived to be a "resource" by the relevant local community (Adams and Hulme 2001). Ostrom's CPR model was envisioned to apply to "resources"—those things that are seen as valuable by relevant local resource users (e.g., fish, water for irrigation, forage for livestock). Although many wildlife species are seen as important resources from ecological, aesthetic, and existence perspectives, in the case of conflict species, those values tend to be held by non-local

entities, whereas the local users themselves tend to view the wildlife in question as a nuisance rather than a resource. For example, Karlsson and Sjöström (2007) found that perspectives of wolves were more favorable the further respondents were from the nearest wolf territory. When conflict wildlife lack utilitarian value for local resource users, those users do not have the economic motivation assumed by CPR theory to lead them to craft and enforce local institutions for conservation. This simple, yet underappreciated, factor presents serious challenges for wildlife conservation policies built around the assumptions of CPR theory.

To clarify, we are not arguing that conflict wildlife wholly lack value; rather, those who value these species tend to be conservation advocates at national or international scales, rather than the residents, resource users, and elected officials that live nearest these species. Yet, in the context of DEG, it is these latter groups who are burdened with the costs of either implementing conservation policy or coexisting with the species (or both, as with CBNRM). Given the lack of economic or utilitarian value of these species for local resource users, decentralised entities responsible for conserving conflict species may not have clear incentives to do so, leading to non-compliance with national conservation policy and threatening the success of conservation programmes (e.g., Hohbein et al., *in review*). Costs are higher for decentralised entities when locals resent the conservation of species they view as pestilent; this can lead to eroded relationships between communities and the entities doing the conserving (Knight 2000). For example, due to protectionist policies for conflict species in Laikipia County, Kenya, locals believe the government values wildlife more than human lives (Bond and Mkutu 2018).

These inconvenient realities imply that we must look beyond the now-familiar refrain that DEG experiments have mostly been limited by token or incomplete devolution of power. This raises the question of what kinds of interventions and institutions may be required to assure the

persistence of conflict wildlife populations and achieve the outcomes promoted by proponents of DEG. It also implies the potential for an uncomfortable tension between principles of democratic governance and the conservation of conflict species (see, e.g., Holmes 2007; DeMotts and Hoon 2012; Massé 2016).

ECONOMIC INCENTIVES FOR CONFLICT SPECIES CONSERVATION

A seemingly logical remedy to the issues explicated above might be to introduce economic incentives rendering wildlife economically valuable to local resources users. In this section, we review the benefits, limitations, and institutional considerations of three possible methods for creating economic incentives for conflict species conservation: ecotourism, payments for ecosystem services (PES), and hunting. Our objective in reviewing these perspectives is to highlight that, while potentially useful in many scenarios, economic incentives should not be seen as a panacea for reconciling the conservation of conflict wildlife with DEG.

Ecotourism

Under the right institutional arrangements, ecotourism can incentivise local people to conserve wildlife because their continued presence will attract more tourists. The World Travel and Tourism Council (2019) estimated that wildlife-centric ecotourism contributed a cumulative $120.1 billion to national economies in 2018 alone. Community involvement in ecotourism initiatives has been shown to change local perspectives on conflict species. For example, in Ladakh, India, Vannelli et al. (2019) documented that ecotourism improved villagers' perspectives of the endangered snow leopard. Mossaz et al. (2015) reviewed 66 published case studies and visited 48 sites to determine ecotourism impacts on big cat conservation in Africa and confirmed that, when implemented well, ecotourism can provide meaningful contributions to conservation at the local scale by incentivising increased habitat protection. Additionally, excess

revenue gained from ecotourism further supported conservation of conflict wildlife by providing resources for research, anti-poaching efforts, and livestock compensation programmes (ibid.).

While ecotourism can be successful, there are many drawbacks and limitations to its utility (Krüger 2005). First, not every locality with conflict wildlife is optimal for ecotourism; limitations of access, security, and previously established tourism streams are just a few of the factors that can limit the commercial viability of ecotourism campaigns (Walpole and Thouless 2005). For example, despite the popularity of Namibian conservancies as destinations for ecotourism and their perceived success in advancing wildlife conservation and improving livelihoods, Humavindu and Stage (2015) documented that most of the revenue accrues to conservancies considered most accessible by visiting tourists. Conservancies that are less "convenient" (e.g., further away from main roads) are losing money and their long-term viability is in question (ibid.). Second, ecotourism opportunities could be limited by the ecology of the conflict species: species that are nocturnal, reside in dense or inaccessible habitat, or are generally elusive in nature are not readily marketable for ecotourism campaigns since tourists are unlikely to ever see the species in the wild. Third, ecotourism could habituate wildlife to people and thereby exacerbate wildlife conflict (Saberwal et al. 1994; Madden 2008). Fourth, ecotourism rarely generates enough profit to offset the costs of coexisting with conflict wildlife and usually requires subsidisation by states or NGOs (Songorwa 1999; Walpole and Thouless 2005). Finally, ecotourism campaigns have been documented to lead the erosion of the very nature they intend to conserve (Shannon et al. 2017).

Hunting

The provision of limited trophy hunting opportunities can also create economic incentives for conflict species conservation. For example, in the well-known Communal Areas Management

Programme for Indigenous Resources (CAMPFIRE) in Zimbabwe, communities were provided a pre-determined percentage of revenue gained via trophy hunting permits (though revenue was also drawn from ecotourism, the vast majority of actual revenue gained was from trophy hunting) (Frost and Bond 2008). CAMPFIRE generated over US$20 million in a 20 year-time span for participating communities (ibid.). Communities receiving these funds established wildlife corridors and participated in anti-poaching efforts (Balint and Mashinya 2008). CAMPFIRE was widely considered to be a successful example of economically incentivising communities to conserve wildlife (Child 1993; Taylor 2009), and similar programmes were replicated across several nearby countries (Balint and Mashinya 2008). A survey conducted Lindsey et al. (2006) demonstrated that trophy hunters expressed a willingness to visit African countries and locales not typically popular for ecotourism, suggesting that hunting could provide economic incentives for conflict wildlife conservation in a greater diversity of places than could ecotourism. Opportunities to hunt conflict species can also provide other benefits that could improve conflict species conservation. For example, species that are hunted may develop an aversion to human-dominated landscapes (Oriol-Cotterill et al. 2015), reducing opportunities for negative interactions and damage to human property. However, explicit tests of this assumption are limited (Treves et al. 2009). In some circumstances, communities may be able to identify specific, problematic individuals and have these individuals targeted for hunts (Lindsey et al. 2006). In many countries, problem animals would be killed regardless, either legally by wildlife authorities or illegally when affected communities work with poachers to handle problem animals (ibid.). Allowing trophy hunts could actually reduce the total number of animals killed while providing economic benefits to local communities (Child 2005 *cited in* Lindsey et al. 2006). Finally, limited hunting quotas could help reduce conflict wildlife populations to levels

considered tolerable by communities and the overall amount of damage incurred (Decker and Purdy 1988; Conover 2001).

The hunting of protected species is perhaps the single most controversial approach to conflict species conservation. One of the primary reasons many oppose hunting as a solution is because appropriate hunting quotas are so often difficult to determine, leading to unsustainable mortality and population declines of these already threatened species. For example, the countries in Africa with the greatest number of trophy hunts were correlated with the steepest declines in African lion populations (Packer et al. 2009). Complex population dynamics and behaviours exacerbate the issue; e.g., the killing of male lions can result in the deaths of their cubs since males that replace them in the pride kill any previous offspring to increase their own mating opportunities (Bertram 1975). Alternatively, some density-dependent species can actually increase in number after being targeted for hunting due to "demographic compensation" (e.g., via larger litter sizes), thereby increasing issues of human-wildlife conflict. For example, in South Africa, communities that killed more caracals experienced more livestock losses the subsequent year compared to those that killed fewer because of this demographic compensation (Bailey and Conradie 2013). A similar pattern was observed in the United States where increasing wolf harvests in Idaho, Montana, and Wyoming were correlated with more sheep depredated in subsequent years (Wielgus and Peebles 2014). When it comes to correctly identifying the specific problem individuals, communities have poor track records; thus, the hunting of specific problem animals rarely resolves the issue of damage (Treves 2007). The ability of trophy hunting revenue to offset what are often substantial costs incurred by locals from wildlife damage is also in question. For example, Drake et al. (2020) found that economic damages caused by elephants

in one community conservancy in Namibia far outweighed revenue gained via trophy hunting permits.

Payments for Ecosystem Services

Payments for ecosystem services (PES) is another method proposed for creating economic incentives for conflict wildlife conservation (Nelson 2009; Dickman et al. 2011). Conflict species often provide multiple ecological services such as the control of pestilent prey species and disease mitigation; the loss of conflict species has been tied to ecologically damaging trophic cascades (Ripple et al. 2011; Suraci et al. 2016). There are also other more intangible services provided by conflict species; because so many of these species are considered charismatic, they provide "existence value"—"the utility that people derive from knowing of the existence of…biodiversity, and from knowing that others and future generations also might be able to enjoy it" (Turpie 2003, p. 200). By provisioning payments to locals who coexist with and conserve conflict wildlife, PES schemes seek to directly fix the scalar misalignment of costs and benefits without relying on the intermediation of a tourism economy.

In PES, usually an external organisation or entity facilitates the provisioning of such payments to locals in exchange for their meeting some pre-determined performance criteria in maintaining the ecosystem service (i.e., conflict wildlife populations). The payments could be derived any number of ways, but two common origins of the payments are taxes or nongovernmental organisations (and their donors) (Kelsey Jack et al. 2008). PES schemes for conflict species are still rare (Nelson 2009), but some case studies have yielded remarkable success. For example, Persson et al. (2015) reported that payments to indigenous reindeer herders for verified wolverine reproduction within their districts resulted in a marked increase in wolverine populations compared to years prior to programme initiation (the population doubled

within a decade) despite the fact that wolverines primarily preyed on reindeer in that system. There appear to be fewer limitations and caveats associated specifically with PES schemes than there are with ecotourism or trophy hunting solutions. However, there are general limitations and issues when relying on any kind of economic incentive (including PES) to encourage conflict species conservation; these limitations are discussed below.

The Limitations of Economic Incentives

These approaches all rest on the assumption that market failures are the cause of environmental degradation—in this case, the decline in wildlife populations. The decidedly neoliberal argument is that monetising the value these wildlife provide in ecosystem services (e.g., control of prey populations) or via ecotourism or hunting demand will incentivise local resource users, residents, and landowners to conserve the species (Büscher et al. 2012; Frank 2016). So long as the value thereby generated is greater than the cost associated with coexisting with undesirable species, conservation is presumed to prevail. Such approaches, along with other "conservation and development" efforts that attempt to explicitly link conservation with economic gains, are optimistically referred to as "win-win" because both wildlife and locals benefit (Muradian et al. 2013).

Despite the advocacy and adoption of conservation programmes predicated on economic incentives by influential NGOs and development agencies over the last few decades, these approaches have increasingly come under fire for both "expanding the hegemony of global capitalism" (Fletcher and Neves 2012, p. 63) and failing to meet expectations (McShane et al. 2011). Money is not always a fair trade for the damages caused by protected conflict wildlife. For example, human-wildlife conflict can lead to long-term psychological trauma or loss of human life (Bond and Mkutu 2018). Furthermore, there is a certain irony in attempting to solve

environmental problems by further integrating capitalism—so often recognised as the direct cause of global environmental degradation (Büscher et al. 2012)—into less developed areas. A detailed ethnographic account by West (2006) documents how promises of economic development in exchange for conservation at the Crater Mountain Wildlife Management Area of Papua New Guinea led to a series of unmet expectations, increased levels of social conflict within and among communities, and perverse ecological outcomes, such as the destruction of a harpy nest by one local who thought it unfair that a neighbour be paid for its protection when the nest was on contested land. As Saunders (2014, p. 643) documents, the rational individualism that lies at the heart of CPR theory often conflicts with the reality of local resource users in many commons scenarios that are typically "embedded and situated in numerous relations of interests and reciprocal commitments at different scales" that go well beyond the rational calculation of individual costs and benefits.

Indeed, a rich literature covers the various problems that can arise when relying on economic incentives to encourage conservation, perhaps one of the most salient of which is succinctly captured by Hackel (2001, p. 726): "If rural people accept [a conservation and development programme] because of its economic benefits, they may reject it at some point in the future if a better economic alternative is presented." By focusing on the economic values of conflict wildlife alone, other more enduring intrinsic values could be overshadowed or "crowded out" (Muradian et al. 2013), leaving the conservation of species vulnerable to shifting markets. Several articles have detailed how the COVID 19 pandemic evaporated revenue streams for parks and communities reliant on ecotourism, raising fears about the future of these parks and the wildlife they conserve (e.g., Hockings et al. 2020; Lindsey et al. 2020). While arguments against neoliberal approaches to conservation are numerous, the thorough revisiting of each is beyond

the scope of this paper. Suffice it to say that creating economic incentives cannot be the sole solution to conflict species conservation. However, these approaches may be both effective and equitable in certain cases, particularly where those bearing the costs of conflict wildlife species are both empowered to participate in governance and able to benefit materially from economic and other opportunities.

Institutional Considerations for Implementing Economic Incentives in DEG

The complexity of conflict species conservation suggests that adherence to good governance principles is of particular importance in the implementation of these strategies lest the economic incentives exacerbate the conflict. For example, the equitable distribution of revenue is vital. Should these payments or benefits (whether from ecotourism, trophy hunting, or PES) be concentrated in the hands of a few wealthy or influential individuals (i.e., elite capture), the rest of the community will have little incentive to maintain conflict wildlife populations. The conflict wildlife, which were already problematic for locals, may become resented as symbols of the elite few who benefit from their presence and subsequently persecuted as such (Dickman and Hazzah 2016). While the risk of elite capture is widespread in conservation projects that entail some form of economic gain (and decentralisation more generally) (Persha and Andersson 2014), the likelihood of protected wildlife becoming a symbol of this underlying socio-economic conflict is greater when the species was already contentious in the landscape (Douglas and Veríssimo 2013). Thus, risks of perverse ecological outcomes due to elite capture in decentralised conflict wildlife conservation may be greater than in decentralised governance of other environmental resources.

Particularly in the early stages of these programmes, communities or local government entities could benefit greatly from externally supported training and capacity building so as to be

able to more effectively capitalise on these opportunities and not be taken advantage of by more competitive private entities. Good governance principles that help prevent elite capture include inclusiveness (when stakeholders can all equally engage with governance processes) and fairness (Lockwood et al. 2010). Additionally, an extensive review of DEG conducted by Persha and Andersson (2014) concluded that the presence of an external agency or organisation serving as a "watchdog" over the decentralisation process reduced the likelihood of elite capture. Indeed, the CAMPFIRE programme benefited from just such organisations. Balint and Mashinya (2008) documented that after USAID funding ended in 2000 (which had paid for external support by NGOs), two communities in CAMPFIRE previously considered quite successful were captured by elites and opportunities for broader community participation and benefit sharing decreased significantly.

Though the use of economic incentives is often proposed as a model for encouraging local or community conservation behaviour (usually by an NGO), the approach could also be leveraged by decentralised entities operating at other governance levels (e.g., municipal or provincial governments). The successful connection to markets can lower costs of conservation for the entity responsible and, with the equitable distribution of payments, increase local tolerance for conflict species, thereby decreasing issues associated with the politically damning nature of conflict species conservation. However, given that this approach cannot be implemented universally, we now proceed to alternative institutional solutions for conserving conflict species in the context of DEG.

RECONCILING CONFLICT SPECIES CONSERVATION AND DEG

Scholars working in diverse contexts have identified a lack of authentic decentralisation of authority as a contributor to the failure or poor performance of DEG in practice. Our review

suggests that even full and authentic decentralisation may also face substantial challenges when it comes to the conservation of conflict wildlife or other resources that are valued more at regional or global levels than at the local level. The literature on human-wildlife conflict also makes it clear that human coexistence with conflict species is an achievable goal in many cases, given attention to issues of equity, livelihoods, participation, and incentives. Here we provide synthetic recommendations for reconciling the goals of conflict species conservation with the broad principles of DEG.

Accountability in "Actually Existing" DEG

Despite the emphasis on local governance in much of the literature on decentralisation, "pure" forms of DEG are rarely, if ever, encountered in the field; more typical are complex, entangled governance scenarios in which DEG institutions are introduced and unevenly adopted within settings characterized by a multiplicity of actors, interests, and institutions (Saunders 2014; Schnegg 2018). The literatures on multilevel and polycentric governance (Andersson and Ostrom 2008; Nagendra and Ostrom 2012) recognize the scalar complexity of nominally "local" governance arrangements and emphasise the principles of equitable and efficient distribution of authority and accountability at various levels.

The importance of some upward accountability to higher level authorities is one finding from these alternative frameworks that has received little attention in DEG despite early recognition of its value (e.g., Gregersen et al. 2004). Upward accountability is a potential mechanism for incentivising wildlife conservation within DEG where local or even intermediary actors are not self-motivated to manage for their persistence. Relatively little guidance exists on how best to maintain reasonable levels of upward accountability in scenarios of decentralisation. For example, Ribot (2002) suggests the setting of "minimum environmental standards," but does

not provide guidance on how these standards ought to be enforced. Lockwood et al. (2010) suggest that reporting requirements may be "the minimum necessary to provide…accountability," but again offers no guidance for enforcement should the actions reported fall short of expectations or legal requirements.

Central or other high authorities may use sanctions and incentives as mechanisms for actualising upward accountability. Such mechanisms may be necessary to create equitable institutions for accountability and encourage local-level compliance with national conservation policy for conflict species. For example, in the United States, the Environmental Protection Agency (EPA) uses a combination of financial incentives (via state program grants) and sanctions (via audits, performance reviews, and the conditional delegation of powers) to ensure state environmental programs are meeting national requirements (Blackman et al. 2005). When states are found to be out of compliance, they work directly with the EPA to identify corrective measures (ibid.). While not in reference to the specific challenge of conflict species conservation, several authors have highlighted how the use of incentives and sanctions will be necessary for successful DEG in the context of misaligned costs and benefits, externalities, or actions that have broad national significance (Caldecott and Lutz 1998; Gregersen et al. 2004; Bartley et al. 2008). It is critical that any sanctions, incentives, or other rules associated with upward accountability be considered legitimate in order to be effective and durable (Ostrom and Nagendra 2006), just as it is critical that upward accountability not replace downward accountability and thereby undermine the goals of decentralisation itself (Agrawal 1999).

Indeed, upward accountability may stand in tension with the principles of DEG, and if abused, could potentially facilitate elite capture and loss of local control. Many DEG initiatives have been undermined by processes of elite capture or token devolution, and an overreliance

upon upward accountability mechanisms may provide openings for both of these to occur. Effective decentralisation depends upon the vesting of certain rights in local populations, even if not all possible rights are included (Agrawal and Ostrom 2001). Effective decentralised governance of conflict wildlife species may require the careful apportioning of rights among local and nonlocal entities to help ensure the persistence of these species despite local antipathy toward them. As noted above, it will be especially important to avoid scenarios in which conflict wildlife species come to be seen as symbols of local disempowerment, as this can lead to illegal killing of those species as a form of resistance (Olson et al. 2015).

The literature on polycentric and network governance also emphasize accountability via social relationships with other relevant actors that are not necessarily hierarchically superior (Jedd and Bixler 2015). In "actually existing" DEG, local entities rarely work in isolation but rather are formally or informally embedded within governance networks that include state actors at various scales, community-based organizations, regional- to global-scale NGOs, producer associations, private firms, kinship groups, and myriad other entities. Local entities may experience network accountability from these actors so as to "secure recognition" and acquire or maintain authority or legitimacy (Gordon 2016). In other words, decentralised governance entities may come to see the conservation of conflict wildlife species as necessary to maintain their standing as legitimate members of broader governance networks. This "professional" or "peer accountability" may work by rewarding institutions in compliance with established norms with continued access to the network and associated information streams and resources (Jedd and Bixler 2015). This again points to the need to consider governance actors as socially embedded rather than as the autonomous individuals imagined by neoliberal and new institutional economic models. However, effective network accountability will require powerful network entities (such

as NGOs and domestic and foreign governments) to also hold themselves and other powerful actors accountable and to pay special attention to local empowerment to avoid elite capture and support the authentic devolution of rights while ensuring accountability to minimum standards (Sarmiento Barletti et al. 2020).

Politically, Socially, and Ecologically Appropriate Institutional Design

Our review indicates that different institutional solutions will likely be appropriate according to both the particularities of specific human-wildlife conflict scenarios and according to the cultural, political, and livelihood specificities of individual places. Wide variation in state and NGO capacity implies variation in the feasibility of mechanisms that rely on the administration of payments, incentives, or sanctions. Institutions crafted and administered by colonial or postcolonial authorities may be variably adopted, transformed, or rejected by local populations (de Koning 2014). The principle of legitimacy includes not simply Weberian political legitimacy (i.e., the presumed rightness of state authority and its application via an administrative-bureaucratic apparatus) but also congruence with deeply held cultural understandings of human-wildlife relations, at least some of which may hold opportunities for coexistence with conflict species (Gebresenbet et al. 2018). Rules for conflict species management will also need to take into account various ecological variables such as habitat requirements, reproduction, behavioural response to lethal control, etc.; this will often entail coproduction of knowledge as well as collaborative design of conservation institutions (Clark et al. 2016). Although “silver bullet” solutions are unlikely to be identified, combinations of sanctions and incentives from higher government levels along with both empowerment and accountability may be able to achieve satisfactory outcomes without sacrificing the core principles of DEG. By building upon and in concert with local institutions, NGOs and other higher-scale actors may be successful in

encouraging conflict species conservation while still allowing room for autonomy and discretionary decision making.

Consider Subjectivities, not just Compensation and Compliance

Many conservation interventions are premised on the assumption that local resource users will only coexist with conflict wildlife species if their action is compelled by force or, alternatively, if they are fully compensated for the economic costs of coexistence. Although both enforcement and compensation may be important tools in conflict resolution, they are likely to be inadequate in and of themselves. Further, an emphasis on compensation in the absence of empowerment may cultivate a reductionist and neoliberal subjectivity, thereby eroding nonmaterial motivations for conservation and potentially acting in conflict with a more complex understanding of human-wildlife relations. On the other hand, compensation as a part of a larger programme of empowerment may help to reinforce existing intrinsic and non-monetary values regarding wildlife (Kansky et al. 2020). Rather than a primary focus on coercive and compensatory mechanisms, the blend of multiple mechanisms with local-level empowerment in conflict governance may act to cultivate a subjectivity of stewardship and coexistence (Agrawal 2005; Folke et al. 2016; Akers and Yasué 2019) that is more psychologically fundamental and more enduring than any given conservation intervention (e.g., Ohlson et al. 2008). Despite prevailing rhetoric on empowerment and participation in community-based wildlife management programmes premised on economic incentives, too few of these can actually be described as empowering or participatory (Songorwa 1999). Shifting the overarching objective to fostering a subjectivity oriented around stewardship—rooted in empowerment, local knowledge, and legitimacy—may help to bring back into focus the importance of these principles.

CONCLUSION

Our review problematizes the prominent argument that a lack of true devolution is the ultimate cause of governance failures in DEG experiments involving conflict wildlife species. By bringing into focus the incongruities between the assumptions of the DEG model and the realities of human-wildlife conflict scenarios, we show why simple models of devolution and decentralisation may not necessarily produce the desired ecological outcomes for the management of species entangled in human-wildlife conflict. The creation of economic incentives has been the primary means by which the tensions inherent in DEG of conflict wildlife have been addressed. While economic mechanisms can motivate institutional compliance of decentralised entities with national conservation policy, the emphasis on this approach by governance scholars has obscured the reality that not all wildlife can be conserved through economic solutions alone. Attention must also be paid to empowerment and the distribution of rights among local and nonlocal actors within the specific ecological and sociopolitical settings of particular conflict wildlife scenarios.

The possibility for conflict species to become enduring symbols of social conflict is a risk of particular concern, making conflict species conservation uniquely precarious and prone to perverse outcomes when governance goes awry (Douglas and Veríssimo 2013). A key lesson of this review is that, due to the complex and place-specific histories and sociopolitical settings of wildlife conflict scenarios, no single model is likely to be widely successful. Rather than identifying “silver bullet” practices, this review emphasises attention to embeddedness, institutional complexity, empowerment, accountability, and legitimacy as potentially determinative variables in influencing the success of wildlife governance interventions. A reliance on overly simplified governance models or culturally inappropriate conservation

measures may fail to achieve intended conservation outcomes and further alienate or marginalise local populations in the process.

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APPENDIX B

CONSERVANDO EL OSO ANDINO EN COLOMBIA: ESFUERZOS ACTUALES Y RETOS PARA LA IMPLEMENTACIÓN DEL PROGRAMA NACIONAL[13]

RESUMEN

El oso andino (*Tremarctos ornatus*) es considerada una especie vulnerable a la extinción. En el 2001, el Ministerio de Ambiente lanzó el Programa Nacional para la Conservación en Colombia del Oso Andino (PNOA). Las Corporaciones Autónomas Regionales (CAR) son las entidades responsables de implementar el PNOA en sus jurisdicciones. Por entrevistas semiestructuradas, recopilamos información de profesionales en las CAR sobre el avance en la implementación del programa y sobre los diversos retos que las CAR han enfrentado, para que el desarrollo de la política ambiental este mejor informado en el futuro. Nuestros resultados se compararon con los de un estudio similar realizado en el 2010 por Rodríguez-Castro et al. (2015) para realizar un seguimiento de las mejoras a lo largo del tiempo. La implementación del PNOA ha mejorado sustancialmente desde la evaluación anterior. Los esfuerzos más comunes de las CAR son en educación ambiental (19 CAR) e investigación y monitoreo (n = 14). Los profesionales entrevistados describieron numerosos retos para la implementación de los esfuerzos de conservación del oso andino, incluyendo la falta de recursos disponibles, rotación de personal en las instituciones y la desconfianza de las comunidades en las instituciones, entre otros.

[13] Hohbein, R. R., R. Rodríguez Granados, and N. P. Nibbelink.

ABSTRACT

The Andean bear (*Tremarctos ornatus*) is considered to be a species vulnerable to extinction. In 2001, Colombia's Ministry of the Environment published the national program for the conservation of the Andean bear (*el Programa Nacional para la Conservación en Colombia del Oso Andino* [PNOA]). The autonomous regional corporations (*corporaciones autónomas regionales* [CARs]) of Colombia are the entities responsible for the implementation of the PNOA within their respective jurisdictions. Through semi-structured interviews with practitioners at the CARs, we gathered data about the degree to which they have implemented different aspects of the program as well as the various challenges they confronted implementing the PNOA. We compared our data to those of a similar study conducted in 2010 by Rodríguez-Castro et al. (2015) to chart improvements over time. The implementation of the PNOA had improved dramatically since the previous study. The most common efforts of the CARs were for environmental education (n = 19 CARs) and research and monitoring (n = 14). The practitioners we interviewed described numerous challenges to implementing efforts for conservation of the Andean bear including a lack of financial resources, high employee turnover, and communities' lack of confidence in institutions.

INTRODUCCIÓN

El oso andino (*Tremarctos ornatus*) es la única especie de oso existente en América del Sur. Son endémicos de los Andes y se encuentran principalmente en elevaciones superiores a los 1200 m.s.n.m., en bosques nublados y ecosistemas de páramo (Goldstein *et al.* 2008). La Unión Internacional para la Conservación de la Naturaleza ha considerado al oso andino como una especie vulnerable a la extinción desde 1982 (Velez-Liendo y García-Rangel 2017). Los osos andinos han experimentado extensa pérdida de hábitat (Kattan *et al.* 2004), además, están cada

vez más involucrados en conflictos con humanos a medida que la ganadería y otras formas de agricultura han aumentado en los Andes (Parra-Romero 2011; Laguna 2013; Zukowski and Ormsby 2016). Estos dos factores interactúan con la destrucción progresiva del hábitat, causando que más osos andinos se aventuren en las áreas agrícolas para satisfacer sus necesidades nutricionales. El potencial de daño que un oso andino puede causar a los agricultores rurales es significativo (Peyton 1980; Escobar-Lasso *et al.* 2020). La caza furtiva preventiva y de represalia, se considera junto con la perdida de hábitat, como una de las mayores amenazas para su persistencia (Velez-Liendo y García-Rangel 2017). Estas amenazas y dinámicas se conocen desde hace tiempo en los países donde habita el oso andino.

Varias organizaciones no gubernamentales (ONG) e investigadores (*e.g.,* Yerena y Torres 1994; Peyton *et al*. 1998; Peyton 1999; Rodríguez *et al*. 2003) han generado numerosas recomendaciones para el manejo de la especie y los conflictos. Los cinco países con presencia confirmada del oso andino tienen alguna estrategia de protección legal para la especie y documentos de política para guiar su conservación. En el 2001, Colombia publicó el Programa Nacional para la Conservación del Oso Andino (PNOA) (Mayr Maldonado 2001). El Ministerio de Medio Ambiente (ahora el Ministerio de Ambiente y Desarrollo Sostenible o "MinAmbiente") junto con un grupo de investigadores formularon el PNOA que comprende cuatro aspectos generales para avanzar en la conservación de los osos andinos en todo el país: 1) conservación in situ, 2) conservación ex situ, 3) acción institucional, y 4) educación ambiental. Estos esfuerzos debían sumarse a la gestión de áreas protegidas.

A través de la Ley 99 de 1993 se establece el Sistema Nacional Ambiental adoptando una gobernanza ambiental descentralizada en Colombia. El MinAmbiente es responsable de desarrollar la legislación y la política ambiental nacional que es implementada por 33

corporaciones autónomas regionales (CAR) en todo el país. Sin embargo, por tratarse de instituciones autónomas, las CAR cuentan con una discrecionalidad sustancial en su aplicación de la política nacional. Se buscaba que dicha autonomía permitiera adaptar sus enfoques a las necesidades y realidades regionales. Sin embargo, esta flexibilidad también crea oportunidades para que las CAR ignoren políticas onerosas o desfavorables (Blackman *et al.* 2004). Además, la mayoría de los recursos financieros para las CAR se generan a escala regional a través de impuestos y tasas de licencias ambientales. Debido a las desigualdades económicas regionales en todo Colombia, las CAR operan con presupuestos muy dispares. Por estas razones, no hay certeza sobre su adopción del PNOA. Es importante entender el nivel en que las CAR han implementado realmente el PNOA para evaluar el estado general de la conservación del oso andino en Colombia y determinar las necesidades futuras.

En el 2010 Rodríguez-Castro *et al*. (2015) examinaron los documentos de planificación de las CAR para evaluar sus progresos en la implementación del PNOA, nueve años después de la publicación del programa. Clasificaron los esfuerzos descritos en los documentos de planificación con un sistema de semáforo: rojo para ningún esfuerzo descrito, amarillo para esfuerzos que podrían ayudar indirectamente a los osos (pero no fueron específicamente para ellos), y verde para esfuerzos con la intención explícita de conservar al oso andino. Encontraron que la mayoría de las CAR sólo habían propuesto actividades que ayudarían a la especie de forma indirecta (*e.g.*, el manejo de áreas protegidas). El área que tenía la mayor frecuencia de la "luz verde" era conservación in situ, descrito en el 30.8% documentos de planificación de las CAR. Sin embargo, dichas propuestas no necesariamente llegan a implementarse y el trabajo real frente al PNOA era probablemente menor que lo reportado. Mientras que algunas de estas CAR probablemente enfrentan limitaciones presupuestales, también puede haber otras barreras para la

ejecución del programa. Entender la diversidad de obstáculos para la aplicación del PNOA, permitiría un desarrollo más informado de las políticas para la conservación de especies a futuro.

En el 2018 y 2019, R. Hohbein (RH) fue a Colombia para entrevistar a investigadores y otros profesionales en las CAR acerca del trabajo implementado a la fecha en sus respectivas jurisdicciones. Entrevistó mínimo a un funcionario de las 21 CAR que cuentan con oso andino confirmado dentro de sus jurisdicciones. También entrevistó a profesionales de Parques Nacionales Naturales (PNN) y a representantes de ONG nacionales e internacionales que trabajan en la conservación del oso andino en Colombia. Se obtuvo un total de 71 entrevistas semiestructuradas con 67 profesionales. Comparamos nuestros datos sobre la implementación del programa de las CAR a los obtenidos por Rodríguez-Castro *et al.* (2015) para evaluar mejoras en los últimos nueve años. Nuestros objetivos eran 1) evaluar más explícitamente la implementación del programa hasta la fecha, utilizando el cumplimiento real en lugar de inferido de la política nacional, 2) proporcionar una descripción nacional de los esfuerzos de conservación de los osos andinos en Colombia utilizando un léxico común que permite comparaciones entre países, y 3) documentar los diversos retos en la implementación del PNOA enfrentado por profesionales que trabajan o colaboran con las CAR.

MÉTODOS

Métodos de Entrevistar

RH realizó entrevistas semiestructuradas con 30 profesionales de las 21 CAR con presencia confirmada de osos andinos en sus jurisdicciones. Adicionalmente se entrevistaron otros 41 profesionales pertenecientes a PNN y ONG nacionales e internacionales que trabajan en la conservación del oso andino en Colombia. A todos se les solicitó que describieran los esfuerzos de sus organizaciones o agencias implementados hasta la fecha para la conservación del oso

andino. Así mismo se les solicitó a los tres grupos que describieran los retos a los que se enfrentaban mientras trabajaban para conservar esta especie. Todas las entrevistas fueron realizadas entre agosto del 2018 y septiembre del 2019. RH realizó la mayoría de las entrevistas en persona; sin embargo, cuando no fue posible se realizaron por vía telefónica o por video. Todas las entrevistas, excepto una, fueron grabadas después de recibir la autorización verbal por parte del entrevistado. Casi todas las entrevistas fueron realizadas en español, con el apoyo de un traductor local. RH siempre estuvo presente como entrevistadora principal para reducir los efectos de respuesta (Bernard 2011).

Análisis

Después de las entrevistas, los archivos de audio fueron transcritos y traducidos. Posteriormente las transcripciones de las entrevistas se analizaron con MAXQDA (VERBI Software 2019), un programa para el análisis cualitativo y de métodos mixtos. MAXQDA permite a los investigadores "codificar" el texto según categorías o temas predeterminados o emergentes, permitiendo así al investigador recordar y examinar más tarde todo el texto que hace referencia a los mismos temas de interés.

Análisis de implementación – Codificando y Criterios de Inclusión

Se distinguieron cinco estrategias de conservación: 1) manejo de hábitat, 2) manejo de conflictos oso-humano, 3) educación ambiental, 4) conservación ex situ, y 5) investigación y monitoreo (Tabla B1). Estas cinco estrategias fueron ajustadas con las planteadas por el PNOA y las utilizadas por Rodríguez-Castro *et al.* (2015). Se codificó el texto que describe los esfuerzos de conservación del oso andino de acuerdo con el Léxico de Biodiversidad para acciones de conservación de La Alianza para las Medidas de Conservación (v 2.0) (La Alianza para las Medidas de Conservación [AMC] 2016). Posteriormente se clasificaron estos segmentos según

su clase de conservación de acuerdo con su objetivo final (ver la Tabla B2). Para ser incluidos, los esfuerzos de las CAR debían ser realizados directamente o a través de contratos con ONG. No se incluyeron las investigaciones de grado de estudiantes.

Se incluyeron únicamente acciones de conservación ya concluidas o en ejecución al momento de la entrevista. Los proyectos planificados o futuros, independientemente de su proximidad, fueron excluidos. Adicionalmente, sólo se consideraron acciones relacionadas directamente con la conservación de los osos andinos. Dado lo anterior, este análisis difiere de la evaluación de Rodríguez-Castro *et al.* (2015) que también incluyó acciones anticipadas y aquellas acciones que podrían beneficiar indirectamente a los osos andinos. No se evaluó si las CAR estaban abordando las debilidades institucionales descritas en el PNOA. Aunque la importancia de las mismas para el éxito de la conservación del oso andino no se debe subestimar, evaluar los esfuerzos generales para mejorar el funcionamiento de la institución requería un marco de investigación fundamentalmente diferente.

Para poder comparar esta evaluación con la de Rodríguez-Castro *et al.* (2015), se reconstruyeron algunas categorizaciones, principalmente porque Rodríguez-Castro *et al.* (2015) incluyeron esfuerzos de investigación dentro de las clases generales de acción de conservación "manejo de hábitat" y "manejo del conflicto oso-humano." Para poder comparar los resultados de este estudio, se incluyeron los esfuerzos de investigación dentro de sus respectivas áreas temáticas. Dado que sólo se recopiló información sobre los esfuerzos considerados directamente relevantes para la conservación del oso andino, se utilizaron los esfuerzos del 2009 específicos para la conservación de la especie. Esto es el equivalente a la "luz verde" de Rodríguez-Castro *et al.* (2015).

Análisis de los Retos

El texto sobre los diversos retos afrontados por los profesionales fue codificado en MAXQDA. En lugar de usar códigos predeterminados como arriba, se utilizó un enfoque iterativo para identificar las barreras y los retos que se describen con frecuencia y se clasificaron por temas emergentes.

RESULTADOS

Debido a que el objetivo no fue llamar la atención hacia las CAR y sus acciones (o falta de ellas), sino observar las tendencias nacionales, los datos se presentan de forma resumida solamente.

De las 21 CAR con presencia confirmada de oso andino, todas excepto una habían implementado al menos un componente del PNOA en sus jurisdicciones. Dos CAR sólo habían realizado proyectos básicos de educación ambiental y otra había iniciado recientemente (en el año anterior) un estudio piloto para determinar las fuentes de conflictos osos-humanos. Las otras 18 habían implementado dos o más de las acciones recomendadas en el PNOA. Siete CAR habían implementado sólo dos clases de acciones, seis CAR habían implementado tres clases de acciones y cinco habían implementado cuatro clases de acciones ($\bar{x}$ = 2.6 clases de acción). Ninguna de las CAR había implementado las cinco clases de acciones al momento de esta evaluación.

Resumen de los esfuerzos implementados

Manejo de hábitat—Nueve de las 21 CAR mencionaron alguna forma de manejo de hábitat que consideraban específica para la conservación del oso andino. Cinco CAR declararon que habían designado o establecido servidumbres de conservación o áreas protegidas porque beneficiaban a los osos andinos (AMC 6.1). También se incluyeron en esta clase esfuerzos adicionales e independientes para detener o revertir la deforestación. Estos esfuerzos incluyen

pagos por servicios ambientales (PSA) (n = 5) (AMC 5.4) y proyectos de restauración activa (n = 3) (AMC 1.1). Los planes de PSA establecidos en respuesta al conflicto oso-humano se cuentan más adelante como acciones para el conflicto y no para el manejo de hábitat.

Manejo de conflicto— Exceptuando iniciativas en educación ambiental (que se clasifica en otra parte), sólo nueve CAR (42,9%) estaban o habían trabajado en esfuerzos para abordar el conflicto oso-humano (Fig.B1). Uno de los dos esfuerzos más comunes, implementado por cinco de las CAR, fue aumentar o mejorar el acompañamiento a eventos de depredación presunta de ser por parte de los osos (AMC 4.1).[14] La mayoría de estos esfuerzos incluyeron el entrenamiento de voluntarios comunitarios para diagnosticar eventos de depredación en regiones lejanas y para presentar informes a las CAR, permitiendo respuestas oficiales oportunas. La otra acción más común (n = 5) fue proporcionar capacitación práctica y/o materiales específicos a ganaderos y agricultores para mejorar sus prácticas y reducir su vulnerabilidad a la depredación de osos andinos (AMC 5.2). Estas prácticas incluyen pastar el ganado en parcelas más cercanas a las viviendas y no en lugares lejanos y sin supervisión (ganadería extensiva). Para ser clasificar un esfuerzo como manejo de conflicto en lugar de educación ambiental, las CAR necesitaban indicar una provisión de herramientas y entrenamiento y no sólo esfuerzos para “convencer.” Dos de las CAR estaban apoyando activamente sustentos alternativos con menor riesgo de conflicto (ecoturismo, cultivo de mora; AMC 5.1). Otras prácticas incluyeron la provisión de cultivos de amortiguación para reducir la intrusión de los osos andinos en fincas privadas, el traslado de osos andinos problemáticos (acciones clasificadas como la administración de especies por AMC; AMC 2.1), la instalación de cercado eléctrico para evitar la intrusión del

[14] Esta acción fue la más dificil para clasificar con el indice de AMC. Eventualmente determinamos que entraría en la accion de AMC, detección y detención (AMC 4.1) por el potencial del acompañamiento de disuadir la caza furtiva como represalia.

ganado en áreas protegidas (AMC 6.5), la vinculación de campesinos enfrentando altos niveles de depredación a programas de incentivos de conservación (*i.e.*, pagos por servicios ambientales; AMC 5.4), y el entrenamiento a ganaderos y agricultores para espantar a los osos andinos de su propiedad (AMC 9.2).

Educación ambiental—Todos excepto dos CAR describieron esfuerzos de educación ambiental. Siete centraron sus esfuerzos en la difusión de información destinada a persuadir a los miembros de las comunidades para mejorar las prácticas agrícolas, reduciendo su vulnerabilidad a los ataques por los osos andinos (AMC 3.1). Las otras 12 sólo describieron esfuerzos más generales de aumentar la apreciación por la especie (*i.e.*, describiendo su importancia ecológica, centrarse en los aspectos estéticos; AMC 5.5). Tres CAR describieron programas formales realizados juntamente con las escuelas locales, mientras que el resto de los esfuerzos de educación ambiental se realizaron en espacios informales/públicos (una CAR ha hecho los dos). Seis CAR estaban apoyando o habían apoyado esfuerzos de monitoreo comunitario (ciencia ciudadana) que incluyen componentes de educación ambiental y, por lo tanto, se tabulan de forma cruzada en esta evaluación.

Conservación ex-situ—Sólo una CAR había trabajado directamente en asuntos de conservación ex-situ del oso andino desde la publicación del PNOA. Varios otros nos refirieron a una ONG colombiana, BioAndina, como un aliado al que podrían recurrir cuando se requiere la conservación ex-situ (*e.g.*, oso andino herido o incautado).

Investigación y monitoreo—Catorce CAR han realizado en algún momento investigaciones sobre las poblaciones residentes de osos andinos en sus jurisdicciones. Los temas investigados incluyeron genética (n = 2), con-específicos (n = 2), hábitos alimenticios (n = 2), uso de hábitat (incluyendo estudios de ocupancia y densidad; n = 11), y patrones de movimiento

(n = 1). Como se indicó anteriormente, seis CAR estaban apoyando o habían apoyado esfuerzos de monitoreo comunitario (incluido en este recuento de 15). Seis CAR han realizado estudios para identificar fuentes de conflicto oso-humano. En este recuento de 15, no se incluyeron cuatro CAR que sólo han realizado encuestas simples para verificar la presencia de osos andinos dentro de sus jurisdicciones.

Comparación con Rodríguez-Castro *et al.* (2015)

En 2009, sólo ocho CAR habían trabajado directamente con la conservación del hábitat o realizado investigaciones ecológicas específicamente para los osos andinos (Fig. B2). Encontramos que 16 CAR habían implementado o estaban en proceso de implementar acciones (n = 9) o investigaciones (n = 11) con potencial de contribuir al manejo del hábitat y la preservación de los osos andinos (algunas CAR describieron ambas acciones e investigaciones). Sólo 2 CAR han planeado o implementado actividades o investigaciones relacionadas con la disminución del conflicto oso-humano en el momento de la evaluación de Rodríguez-Castro *et al.* (2015). En nuestra encuesta, encontramos que 14 CAR han implementado o estaban en el proceso de implementar acciones (n = 9) o investigaciones (n = 6) relacionadas con el conflicto. La educación ambiental sobre los osos andinos se había planeado o implementado por solo 4 CAR en 2010, pero 19 CAR describieron esa programación educativa en 2018/2019. Conservación ex-situ, fue planeada o implementada por cinco CAR en 2010, en 2018/2019, sólo fue descrita por una CAR.

Retos Descritos

Los profesionales entrevistados describieron numerosos retos para la implementación de los esfuerzos para la conservación del oso andino. Como era de esperar, el desafío más prevalente, descrito por la mayoría de los representantes de las CAR (n = 15, 71,4%) fue lo inadecuado de

los recursos disponibles, mencionado directa o indirectamente (*e.g.*, funcionarios con demasiadas responsabilidades, dotación de personal). Siete de los otros retos más comunes se enumeran en la Tabla B3. A continuación describimos con más detalle tres de estos retos que se describieron con más frecuencia o que aparentemente tienen el mayor impacto.

Rotación de personal en las instituciones—Al solicitar que describieran los desafíos para lograr la conservación del oso andino, nueve representantes de las CAR se refirieron a cuestiones de rotación de personal en las instituciones. Tal vez lo más problemático de estas era el cambio de los directores de las CAR cada cuatro años. Nuevos directores de las CAR tal vez no deseen continuar con los programas de conservación de los osos andinos iniciados por sus predecesores a pesar de su éxito percibido o la duración prevista. Este asunto también fue mencionado por los representantes de PNN y de las ONG que coordinaban esfuerzos con las CAR.

> *Cada vez que hay un cambio de director en una CAR, viene con nuevas ideas, nuevas políticas, y este no da una continuidad a un… un trabajo que debería ser permanente. Yo creo que este es el asunto más grande. Tiene mucho que ver con el placer de la persona y no de responsabilidad institucional.—Representante de ONG*
>
> *Están en el proceso de cambiar el director de esa CAR. Y, seguramente debido a la perspectiva de ese director general, muchos de los programas o proyectos se cambiarán. Así que cada cuatro años, Parques Nacionales tiene que adaptarse a lo que la gestión de las CAR tiene programado políticamente o a los planes de trabajo que vienen a su mente. Obviamente eso complica el objetivo de nuestra entidad, ya que la nuestra es uno a largo plazo.—Representante de PNN*

En las CAR se mencionó también la alta rotación de personal en el MinAmbiente, que hace que sea un reto comunicarse con el personal relevante en la Dirección de Bosques,

Biodiversidad y Servicios Ecosistémicos o iniciar cualquier tipo de esfuerzo coordinado, "*como se supone que es a través de ellos que coordinamos muchos proyectos*."

> *No hay ninguna permanencia en el Ministerio. No hay una persona fija; se cambian muy a menudo. Así que no se comprometen, los objetivos se pierden.*

Un entrevistado explicó que se sentía personalmente responsable de lograr que la CAR para la que trabaja avanzara en estrategias para conservar la especie; le preocupa que de darse su salida de la CAR, se ponga en peligro todo el programa: "*Si me reemplazan con alguien a quien no le gustan los osos, pero les gustan los delfines, bueno, en realidad es 'Adiós, oso' para el delfín*." Otro biólogo coincidió en que los profesionales individuales y entusiastas impulsan programas de conservación en las CAR cuando dijo que un esfuerzo de colaboración interinstitucional era impulsado "*...más por nosotros como profesionales que los directores. . . un grupo que ama al oso andino se junta aquí."*

Desconfianza en las instituciones—Otro tema común frente a las dificultades en implementar los programas de conservación para el oso andino fue la desconfianza de las comunidades en las instituciones, no sólo las CAR, sino hacia las entidades gubernamentales en general.

> *Traté de hacer algo en _____, pero en esta región, la gente no cree mucho en las organizaciones gubernamentales. Dicen que el gobierno se quiere quitar su territorio y extraer minerales y muchas otras cosas. . . Trato de trabajar con la gente aquí, hablando, intentando a iniciar una relación.—Representante de PNN*
>
> [Frente a la razón por la cual el asesinato de un oso andino no fue procesado] *Cosas funcionan de manera diferente allí… Esta era una zona que fue golpeada con fuerza por los guerrilleros, por la guerra. Así que no puedes acercarte a la zona como un tipo duro*

y decir, "Soy la nueva autoridad y llamare a la policía." Así no es como funciona.—Representante de ONG

Otro participante, cuando describiendo un proyecto de investigación realizado por una universidad en colaboración con una CAR, mencionó que la universidad ocultó su relación con la CAR ante la comunidad para no poner en peligro su bienvenida.

Comunicación "vertical"—Aunque no tan prevalente, algunos entrevistados describieron los efectos negativos generados por la falta de comunicación entre los que trabajaban en las CAR y los que tenían la responsabilidad de redactar la política ambiental nacional, resultando en soluciones inadecuadas o sin sentido.

...Las CAR toman decisiones sobre sus practicas basado en sus experiencias y los problemas en dentro de sus territorios. Mientras que el Ministerio toman decisiones de sus escritorios. Pero no tiene la conexión con la gente en sus territorios que tienen las CAR. . . Así que, las políticas de vez en cuando, como comentamos, se toman desde el escritorio sin nuestro consenso… Pues, ahora cuando necesitamos implementar algo, no vemos cómo. Es muy complejo. Y la gente [en las comunidades] *no ven cómo se diseñan las políticas, por lo que exigen acciones inmediatas de nosotros, pero muchas veces no tenemos los recursos o la política publica no nos permite hacerlo. Cuando fuimos a ver las resoluciones que el Ministerio estaba haciendo, nos preguntamos, "¿¿¿Que es este???" No es aplicable. Es imposible aplicar. No hay recursos… Entonces, es en ejemplo donde todas las CAR hablamos de la misma cosa… pero no sé de donde viene esa idea del Ministerio. —Representante de CAR*

Sin tener en consideración la realidad en el territorio, algunas políticas exacerban la problemática entre los que trabajan en las CAR y los miembros de la comunidad:

Nosotros ONG. . . tratamos de utilizar lo mejor de nuestro conocimiento y nuestros recursos para resolver conflictos [osos-humanos]*, así que para nosotros es un poco más fácil llegar a un acuerdo con los productores en como hacerlo, porque somos flexibles, hasta cierto punto. Mientras que las autoridades ambientales no son flexibles; no pueden ser flexibles… Así, para ellos es un poco mas difícil cuando se trata de la comunidad. . . Tienen que seguir ciertas pautas y protocolos establecidos por la ley… Y el Ministerio de Ambiente desarrolló los directrices sin asistir los conflictos directamente.—Representante de ONG*

DISCUSIÓN

En comparación con lo reportado hace 10 años (Rodríguez-Castro *et al*. 2015), se documenta una mayor adopción de esfuerzos de conservación para el oso andino, enfocados hacia el manejo e investigación del conflicto oso-humano, manejo e investigación del hábitat, y educación ambiental. La única categoría que presenta disminución fue conservación ex-situ. A pesar de estas mejoras, queda mucho trabajo para asegurar el futuro de los osos andinos en Colombia. Por ejemplo, los conflictos entre osos y humanos—ya sea con ganaderos u otros productores—son prácticamente universales en el rango del oso andino, pero menos de la mitad de las CAR con hábitat coincidente de osos andinos trabajaban activamente para mitigar estos problemas. Catorce CAR han adelantado investigaciones sobre los osos andinos, pero ninguna de las 21 CAR entrevistadas describió esfuerzos para investigar la eficacia de diversos enfoques para la conservación de la especie. Por lo tanto, ninguna de las estrategias de manejo ha sido evaluada sistemáticamente. No obstante, la falta de monitoreo y evaluación de los impactos de los proyectos de conservación ha sido bien documentada (Sutherland *et al.* 2004; Brooks *et al.* 2006; Can *et al.* 2014; Redford *et al.* 2018) y no es exclusivo de las CAR de Colombia. La

conservación de los osos andinos podría avanzar más si las CAR documentaran como mínimo los índices básicos frente a la eficacia de sus diversos enfoques y compartieran entre ellas los resultados.

Las estrategias para reducir los conflictos que han sido implementadas por las CAR son diversas. Capacitar y proveer herramientas a los productores para ayudarles a reducir su vulnerabilidad ante la depredación de los osos andinos era uno de los dos enfoques más comunes. Este tipo de estrategias han probado, en ciertos casos, mejorar la tolerancia a la fauna silvestre (Browne-Nuñez *et al.* 2015; Kansky *et al.* 2016), pero hay muchas excepciones. La reducción en los daños causados por la vida silvestre no necesariamente resulta en mayor tolerancia (Treves 2007; Dickman 2010), especialmente cuando la vida silvestre refleja conflictos sociales (*e.g.*, en el oeste de los Estados Unidos, los lobos grises representan extralimitaciones del gobierno) (Knight 2000). Las estrategias para reducir los conflictos serían más robustas con mayor investigación frente a las perspectivas de los actores locales en Colombia: percepciones de riesgo, tolerancia existente, cultura de mayordomos, entre otros. (Knight 2000; Treves *et al.* 2006; St. John *et al.* 2011).

La frecuencia con la que los profesionales de las CAR describieron esfuerzos para mejorar la asistencia y el acompañamiento frente a los conflictos (el segundo de los dos enfoques más comunes) fue sorprendentemente alto. Las representantes de las CAR que mencionaron esa estrategia la describieron como un método importante para que los campesinos “se sientan menos solos” y por lo tanto menos propensos a “resolver” el conflicto por sus propios medios. Rara vez se menciona en la literatura este enfoque para gestionar los conflictos entre humanos y la fauna silvestre, pero podría ser muy beneficioso, mejorando la tolerancia hacia la especie y el aumento de la confianza en las instituciones (Moreto 2019). Esto último es particularmente

importante en Colombia ya que muchas CAR son entidades relativamente nuevas (a partir de 1993) y en algunas regiones, desconocidas por las comunidades rurales (según algunos entrevistados). Adicionalmente, debido al conflicto civil, muchas CAR no habían podido visitar partes de sus jurisdicciones hasta recientemente. Varios profesionales describieron las dificultades de acercarse a las comunidades locales con poca confianza en las instituciones del Estado. La asistencia frente a los conflictos con fauna silvestre y otros métodos para mejorar la confianza en las instituciones deben considerarse más explícitamente como una estrategia que favorece la conservación del oso andino.

Sólo cinco CAR mencionaron el uso de PSA para salvaguardar el hábitat del oso andino, aunque 20 de las CAR con presencia del oso andino participan en BanC02, un esquema nacional de PSA. Los ecosistemas en los que ocurren los osos andinos proveen algunos de los servicios ambientales más críticos del país: aproximadamente el 85% de toda el agua potable en Colombia viene de los ecosistemas de páramo (República de Colombia *et al.* 2002). Por esta razón, hace más de 20 años, Peyton (1999) propuso que la conservación del oso andino en Colombia debía vincularse al mantenimiento de cuencas hidrográficas. Los datos obtenidos indican que 15 de las CAR todavía no han aprovechado las sinergias potenciales de estas estrategias de conservación. Así mismo, el uso de PSA no es común en la búsqueda de la reducción de los conflictos entre humanos y fauna silvestre (Nelson 2009), por lo tanto, es interesante conocer el éxito logrado por las CAR que están utilizando esta estrategia.

La teorización de posibles soluciones políticas está fuera del alcance de este artículo; por ejemplo, como resolver la falta de consideración de las perspectivas de las CAR en el desarrollo de políticas ambientales. Sin embargo, algunos de los retos mencionados por los profesionales se han descrito en la literatura de conservación y existe orientación para mitigar los efectos

negativos. Por ejemplo, algunos entrevistados describieron problemas entre el momento en que los directores quieren ver los resultados de los esfuerzos de conservación y el plazo requerido para ver un impacto positivo en las poblaciones de osos andinos. Incluir "cadenas de resultados" puede ayudar a entender las líneas de tiempo visibilizando los diversos subindicadores de éxito (Margoluis *et al.* 2013). Se conocen los problemas con la representación mediática de la vida silvestre, particularmente de especies que presentan conflictos con los seres humanos y sus modos de vida (*e.g.*, Bhatia *et al.* 2013; Dayer *et al.* 2019). Hathaway *et al.* (2017) mostraron que un enfoque proactivo por parte del Parque Nacional Sanjay Gandhi frente a las relaciones con los medios de comunicación mejoró el encuadre mediático de los leopardos. De esta forma, las CAR que han tenido problemas con la representación de los medios locales de los osos andinos pueden implementar estrategias proactivas similares para mejorar la comprensión y presentación de informes ecológicos.

Burmeister y Deller (2016) revisaron 28 estudios sobre retención de conocimiento en la literatura de ciencia organizacional y sintetizaron estrategias que pueden ser relevantes para abordar algunos de los desafíos asociados con la alta rotación de personal institucional. Muchas de estas estrategias pueden incorporarse fácilmente dentro de las CAR; *e.g.*, proveer programas de entrenamiento; proveer espacios formales e informales para interacciones entre personal; crear programas de mentoría; incorporar recompensas que fomenten los comportamientos de intercambio de conocimientos (Burmeister y Deller 2016). Estos esfuerzos disminuyen el nivel de conocimientos específicos e irremplazables en personas específicas, disminuyendo los impactos negativos de la rotación de personal. Aumentar las interacciones y asociaciones con otras instituciones de la conservación también puede disminuir los problemas relacionados con la rotación de personal. Keeley *et al.* (2019) encontraron que una alta rotación institucional de

personal en el sector gobierno es un problema importante en la implementación de los planes de conservación a largo plazo, particularmente después de la pérdida de "paladines claves." La información cualitativa recopilada durante sus entrevistas reveló que las ONG desempeñaron un papel en mantener el impulso de los procesos a pesar de la pérdida de personal relevante en las instituciones asociadas (Keeley *et al.* 2019). Algunos entrevistados de las ONG en el marco de la investigación indicaron una falta de voluntad para trabajar con las CAR (descrito en Hohbein *et al.* 2020, *datos no publicados*). Si estos profesionales fueran conscientes de la importancia de este rol, podría existir mayor motivación para desarrollar relaciones duraderas con estas entidades.

El asunto de desconfianza en agencias ambientales es un problema notado para agencias ambientales en otras partes del mundo. Por ejemplo, Bond y Mkutu (2018) documentaron que los lugareños en Kenia creían que su gobierno valora más la fauna silvestre que la vida humana, generando altos niveles de resentimiento y desconfianza. Como se mencionó anteriormente, mejorar el acompañamiento institucional a los eventos de depredación por parte del oso andino puede ayudar a mejorar la percepción del público de las CAR. Otra estrategia para el mismo fin es incorporar más programas participativos en las estrategias de conservación de los osos andinos. Estos espacios permitirían a las comunidades compartir sus quejas y preocupaciones, a la vez que pueden ver cómo estas se están considerando e incorporando en las estrategias de conservación. Adicionalmente, los programas participativos son una de las estrategias más efectivas para mejorar la conservación de especies involucradas en conflictos con humanos (Treves *et al.* 2006). Las CAR pueden ser capaces de cultivar en las comunidades sentido de mayordomía sobre la especie por involucrándolas significativamente en decisiones sobre el manejo de la misma.

CONCLUSIÓN

Se evidenció que la implementación del PNOA ha mejorado significativamente desde la evaluación realizada por Rodriguez-Castro *et al.* (2015). Sin embargo, hay gran diversidad en la forma como las diferentes CAR han trabajado hacia la conservación de los osos andinos. La falta de supervisión adecuada por parte del MinAmbiente puede explicar parcialmente porque algunos programas de conservación de los osos andinos no han avanzado aunque el PNOA se publicó hace casi veinte años. Hay numerosos desafíos a la implementación de acciones para la conservación del oso andino. Muchos de los desafíos descritos por los entrevistados no cuentan con soluciones sencillas. Esperamos que al visibilizar las perspectivas de estos profesionales, la comunidad de la conservación pueda considerarlos de manera más directa en el desarrollo de programas y políticas.

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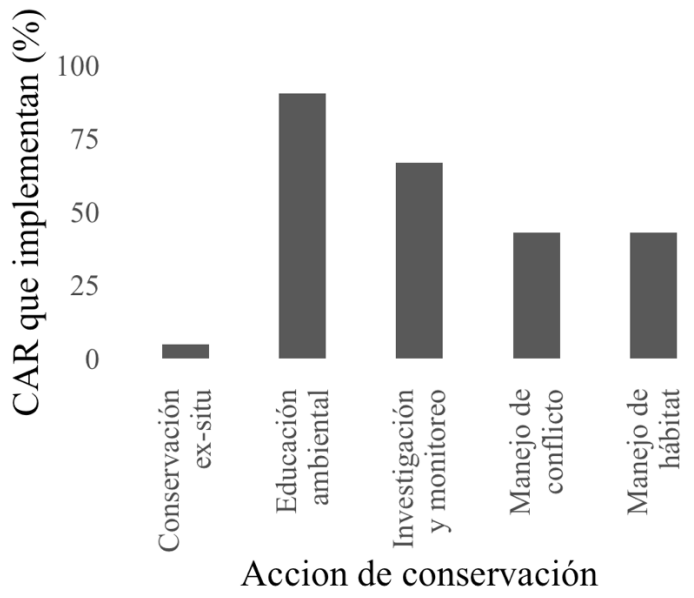

Figura B1. El nivel de compromiso con la conservación del oso andino varía de forma importante entre las diferentes jurisdicciones de las Corporaciones Autónomas Regionales de Colombia. Ninguna de las CAR había implementado las cinco clases de acciones al momento de esta evaluación.

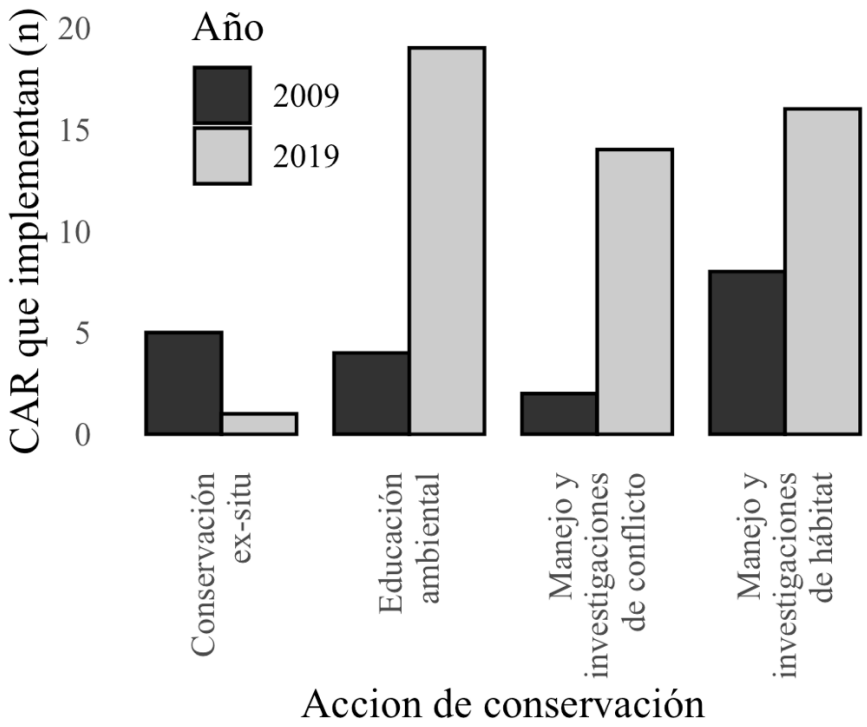

Figura B2. En comparación con lo reportado hace 10 años (Rodríguez-Castro *et al*. 2015), se documenta una mayor adopción de esfuerzos de conservación para el oso andino. La única categoría que presenta disminución fue conservación ex-situ.

Tabla B1. Cinco clases de acción para la conservación del oso andino

Acción	**Descripción**
Manejo de hábitat	Acciones implementados para proteger o restaurar el habitat del oso andino
Manejo de conflicto	Acciones implementados para disminuir o mitigar interacciones negativas entre osos y humanos
Educación ambiental	Esfuerzos para generar conciencia sobre osos andinos o proveer información que podría mejorar la coexistencia
Conservación ex-situ	Esfuerzos para rehabilitar osos andinos en cautiverio con el objetivo final de restaurarlos a la naturaleza
Investigación y monitoreo	Esfuerzos para entender mejor o monitorear los osos andinos en la naturaleza; tambien puede incluir investigaciones sobre el conflicto o percepciones humanas de la especie

Tabla B2. Codificamos descripciones de actividades implementadas por CAR de acuerdo con la clasificación de acciones de conservación (v2.0) de la Alianza para las Medidas de Conservación (AMC 2016). Los números entre paréntesis indican el segundo nivel de especificidad de la clasificación de AMC. Estas acciones se clasificaron en 1 de 5 clases de acción dependiendo de su impacto previsto para la conservación del oso andino.

Clase de acción de conservación	**Acciones de AMC implementados por las CAR**
Manejo de hábitat	• Administración del sitio/área (1.1) • Incentivos económicos directos (5.4) • Designación y adquisición de áreas protegidas (6.1) • Servidumbres y derechos de recursos (6.2)
Manejo de conflicto	• Administración de especies (2.1) • Detección y detención (4.1) • Empresas vinculadas y medios de vida alternativos (5.1) • Mejores productos y practices de gestión (5.2) • Incentivos económicos directos (5.4) • Infraestructura del sitio (6.5) • Capacitación y desarrollo de capacidades individuales (9.2)
Educación ambiental	• Divulgación y comunicaciones (3.1) • Valores no monetarios (5.5)
Conservación ex-situ (2.3)	
Investigación y monitoreo (8.1)	

Tabla B3. Siete de los retos mas comunos para la implementación de programas para la conservación del osos andino según lo descrito por profesionales de la conservación en Colombia

Reto	**Descripción**
Demanda de indemnización por daños	Communities are frustrated by lack of compensation mechanisms following Andean bear damage
Medios sensacionalistas	Representación negativa de los osos andinos exacerba el conflicto oso-humano
Programación impulsada por resultados rápidos	Tiempo insuficiente dado para los resultados; directores de las CAR quieren evitar proyectos que no se pueden terminar rápidamente
Coordinación institucional limitada	La información no llega facilmente a otros CAR; falta de apredizaje social; oportunidades de trabaja colaborativo no reconocidas
Rotación institucional *	Los programas cambian cada 4 años con nuevos directores; es difícil mantener acuerdos de colaboración dada la pérdida de personal relevante
Desconfianza de las instituciones*	Las comunidades no confían en las CAR; pueden tomar sobre sí mismos para abordar cuestiones de los daños causados por los osos andinos, ya sean reales o percibidos
Comunicación “ascendente”*	El MinAmbiente no consultan suficientement con las CAR al diseñar política ambiental; causa políticas ilógicas que no se pueden aplicar fácilmente o políticas que exacerban las relaciones entre las CAR y las comunidades

*Mas detalle se proporcionan en el texto.

APPENDIX C

On the next page is an executive summary of findings to be distributed to interview participants.

Paisajes ecológicos e institucionales de la conservación de osos andinos

Por Rhianna Hohbein, PhD

RESUMEN EJECUTIVO

El área de distribución del oso andino en Colombia cruza las jurisdicciones de 22 corporaciones autónomas regionales (CAR). Este forma de manejo (que esta descentralizada) esta fragmentado desde la perspetiva de la conservación del oso andino porque "*los osos no conocen fronteras.*"

Creé un modelo de conectividad de paisaje para los osos andinos en Colombia. Este modelo muestra cuales eran las CAR que probablemente compartieron osos andinos dado la distribución de hábitat importante para la conectivadad para la especie en Colombia (Fig 1). Luego, lo comparé con un modelo de comunicación entre las CARs (recogida por entrevistas en el 2018-2019) y otras organizaciones de conservación para evaluar dónde asociacones estratégicas entre las CAR serían más beneficiosos.

Muchas representantes de las CAR indicaron en entrevistas que no comunicaron con sus "vecinos" sobre sus esfuerzos de conservación o investigación de la especie. Sin embargo, coordinación para la especie era más comun entre las CAR y Parques Nacionales Naturales y ONGs. Muchas veces, esos identidades estaban "ubicadas" entre CAR que no se comunicaron entre sí. **Esos identidades pueden facilitar mas comunicación entre sus corresponsales comunes en las CAR** y al hacerlo, reducir algunos de los retos del manejo fragmentado.

"Los osos no conocen fronteras."
-Un sentimiento expresado durante muchas entevistas.

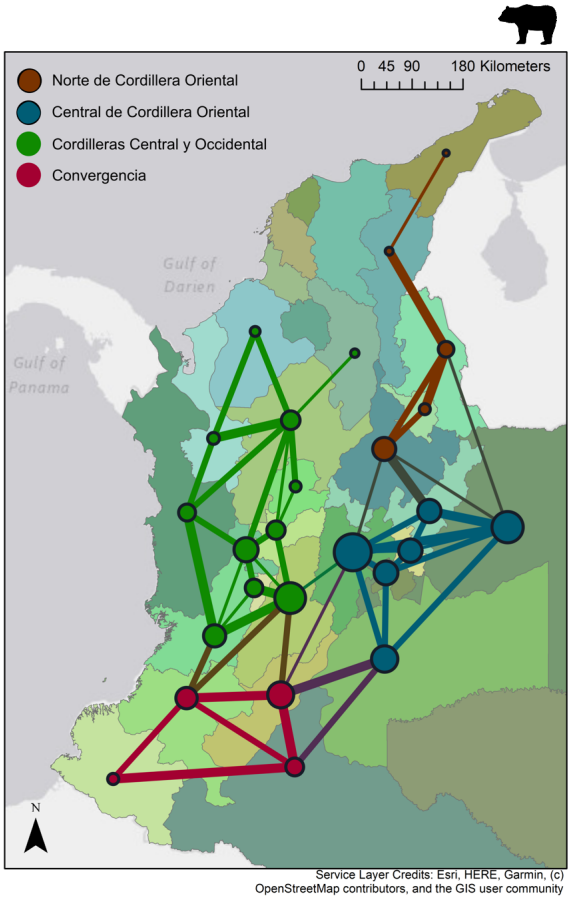

Fig. 1 (derecho) Cada CAR esta representada por un círculo. Las CAR que estan conectadas por líneas pueden compartir osos andinos a través sus fronteras. Líneas más gruesas indican una mayor probabilidad de compartir osos dado la distribución de hábitat importante para la conectividad para la especie.

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ICON
Integrative Conservation Ph.D. Program

APPENDIX D

Following this page is a copy of the research brief prepared for the Integrative Conservation PhD Program in which I describe my research for a general audience.

ICON
2021:2
Integrative Conservation Research Brief

Spectacled bear conservation in Colombia: Collaboration across boundaries

By Rhianna Hohbein

Spectacled bears are South America's only bear species. They are endemic to high elevation zones across the northern Andes (Bolivia, Ecuador, Peru, Colombia, and Venezuela) where they reside in shrub ecosystems known as páramo and Andean cloud forest. Due primarily to habitat loss and increasing levels of human-bear conflict, the spectacled bear is considered by the International Union for the Conservation of Nature to be "vulnerable" to extinction. Undoubtedly, the successful conservation of this species will require the efforts of numerous agencies and organizations. In Colombia, their known range crosses the jurisdictional boundaries of 22 different "autonomous regional corporations"—the primary entities responsible for implementing conservation policy in the country.

These corporations have no mandate to coordinate their efforts with one another despite the extent to which they may share populations of spectacled bears across their jurisdictional boundaries. Fragmented management such as this can have negative effects on the abilities of the organizations to implement actions at the scales required. However, voluntary collaboration could help these organizations overcome the negative effects of fragmented management. My research investigated the degree to which these autonomous entities voluntarily coordinated their spectacled bear conservation efforts with one another, with Colombia's National Park Service (Parques Nacionales Naturales), and with nongovernmental organizations and whether these voluntary interactions accounted for probable spectacled bear movement across jurisdictions in the Colombian Andes.

Research Approach

This research required an interdisciplinary research approach and ultimately drew on methods from social network analysis, ethnography, and spatial analysis.

Social Network Analysis and Ethnography: I interviewed 70+ conservation practitioners across Colombia about their efforts to conserve the spectacled bear and their communication ties to other organizations and agencies. These data allowed me to 1) construct a "social network" which mapped the connections between and among the

Significance

- We constructed the first model of landscape connectivity for the spectacled bear in Colombia. This model can be a valuable decision-support tool for conservation practitioners working with scarce ecological data.
- Building and maintaining inter-institutional collaborations are time-intensive efforts. Our results help inform where cross-boundary coordination would be most beneficial for ensuring connectivity for spectacled bears across the Colombian Andes, allowing practitioners to be strategic with their networking.
- Our research highlights how nongovernmental organizations can play a pivotal role in improving communication among jurisdictional agencies.
- The outcomes of this research contribute to our understanding of which types of governance arrangements are most beneficial for achieving different conservation objectives. Much of the prior research on environmental governance has focused on the sustainable use of economically valuable renewable resources (such as timber and fisheries). Conversely, this case study focused on a threatened species entangled in issues of human-wildlife conflict and is thus a unique contribution to this literature and provides important insights for threatened species conservation.

most important agencies and organizations in Colombia working to conserve the species; and 2) better understand the context within which these organizations were working, including the challenges faced by conservation practitioners and the culture of collaboration in this community.

Spatial Analysis: I used current information about habitat preferences of spectacled bears to construct a model of landscape connectivity across the Colombian Andes. Landscape connectivity models such as this help delineate those areas in the landscape that are most conducive to movement for the species for which they are developed. Thus, I was able to use this model to identify where spectacled bears were most likely crossing the jurisdictional boundaries between the regional autonomous corporations.

Integrative Component: I overlaid the social network analysis with the model of landscape connectivity to identify whether cross-jurisdictional landscape connectivity was matched with inter-institutional communication.

Results

Very few of the autonomous regional corporations communicated or coordinated their efforts with one another, resulting in much of the predicted spectacled bear movement being unmatched by inter-institutional communication (see Figure 1). Interview data suggest that the lack of communication at these boundaries had several negative effects on the conservation of this species. Perhaps most notably, practitioners believed that complaints about spectacled bear depredation events (i.e., the killing of cattle) that occurred in these border zones were less likely to receive attention from either authority; a lack of institutional response was directly tied by interview respondents to an increased probability for spectacled bears to be killed in retaliation by locals. Challenges to collaboration were numerous; many practitioners believed that spectacled bear conservation was characterized by an unusual degree of competition and excessive "egos". Connections between corporations were relatively rare; they were far more likely to coordinate their efforts with nongovernmental organizations or the Colombian National Park Service. These other entities frequently served as intermediaries between otherwise disconnected corporations in the social network, and thus increased the likelihood that information could flow between them. Nongovernmental organizations, in particular, seemed troubled by the lack of coordination between the corporations, and several were intentionally working to generate communication channels between these entities.

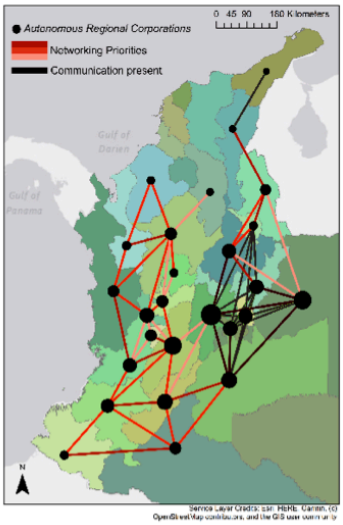

Figure 1. Depiction of the degree to which communication among the autonomous regional corporations matched probable Andean bear movement. Corporations connected by red lines shared habitat critical to Andean bear movement but did not communicate with one another about the species. Deeper shades of red indicate a higher priority for future networking based on shared Andean bear connectivity.

Conclusions

Colombia's autonomous regional corporations infrequently coordinated their efforts for spectacled bear conservation with one another. In other words, the current environmental governance structure has not fostered the development of voluntary coordination among these state entities, leading to inconsistent and disjointed efforts across the spectacled bear range. My research suggests that nongovernmental organizations may be critical in encouraging greater communication and coordination among these agencies. However, the culture of competition within the spectacled bear conservation network (along with other challenges, such as overburdened staff) may likely continue to hinder collaborative efforts. Other incentives may need to be put into place to foster broader coordination. The Ministry of the Environment and Sustainable Development, the centralized agency responsible for developing national environmental policy, is likely the only authority in Colombia that would be capable of providing such incentives.

Acknowledgments
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Rhianna Hohbein *is a PhD Candidate in Integrative Conservation and Forestry and Natural Resources at the University of Georgia. Her interests lie at the intersection of wildlife conservation and environmental governance. She can be reached at rrh32906@uga.edu.*

APPENDIX E

SEMI-STRUCTURED INTERVIEW GUIDE

1. What is your role within [this organization]?

2. How much of a priority is Andean bear conservation for your region?

3. Could you describe your organization's efforts towards Andean bear conservation? What are the specific threats or problems being addressed and how?

4. Are there any particular successes that you would like to highlight? (Change in policy, improved public perceptions, acquisition of funding, e.g.)

5. Where do you see your organization's efforts related to Andean bear conservation going into the future? What are the factors that will determine your organization's ability to achieve this long-term vision?

6. What kinds of obstacles does your organization face when it comes to Andean bear conservation work or conservation work more generally?

7. What do you believe are some of the largest obstacles that organizations face when it comes to Andean bear conservation work in Colombia, overall? What is it that makes Andean bear conservation so difficult?

8. Does your organization have any formal collaborative arrangements with any CARs; NGOs, whether local or international; or any other kind of organization within which Andean bear conservation is advanced?

9. Who all do you talk to about Andean bear conservation?

10. Do you have any challenging relationships with other organizations? What makes these relationships challenging?

11. Do you believe that there is sufficient communication among the various environmental entities operating in your region? What works well and what doesn't? Any ideas for what exactly needs to be improved?

12. How would you describe the communication with PNN? With the Ministry of the Environment?

APPENDIX F

LANDCOVER CLASSIFICATIONS FROM CHAPTER 3

Table A4. Categorical assignments of the 53 land cover classes originally identified in the land cover dataset from Colombia's Institute of Hydrology, Meteorology, and Environmental Studies (IDEAM 2014)

Land Cover Type (English Translation)	Broad Category Assignment	Resistance
Gallery/Riparian Forest	Forest	10
Dense Forest	Forest	10
Fragmented Forest	Forest	10
Open Forest	Forest	10
Low Tide Exposed Sediment	Other Natural	10
Saltpetre	Other	1000
Recreational Installation	Other	1000
Mining Extraction Zone	Other	1000
Hydraulic Work	Other	1000
Port Zones	Other	1000
Waste Disposal Area	Other	1000
Marine Aquaculture Pond	Other	1000
Denuded and Degraded Land	Agriculture	100
Coastal Swamps	Other Natural	10
Swampy Areas	Other Natural	10
Grassland	Other Natural	10
Shrubland	Other Natural	10
Secondary or Transitional Vegetation	Other Natural	10
Sandy Natural Area	Other Natural	10

Burnt Zones	Other Natural	10
Bogs	Other Natural	10
Forest Plantation	Agriculture	100
Mosaic of Crops with Natural Space	Agriculture	100
Other Transitory Crops	Agriculture	100
Permanent Herbaceous Crops	Agriculture	100
Permanent Bushy Crops	Agriculture	100
Permanent Tree Crops	Agriculture	100
Confined Cultivation	Agriculture	100
Agroforestry Crops	Agriculture	100
Clean Pasture	Agriculture	100
Treed Pasture	Agriculture	100
Weedy Pasture	Agriculture	100
Mosaic of Crops	Agriculture	100
Mosaic of Crop and Pasture	Agriculture	100
Mosaic of Crops, Pastures, and Natural Spaces	Agriculture	100
Mosaic of Pasture and Natural Space	Agriculture	100
Vegetable Gardens	Agriculture	100
Oilseeds and Legumes	Agriculture	100
Grains	Agriculture	100
Cloud	Cloud	10
Seas and Oceans	Water	500
Coastal Lagoons	Water	500
Natural Lagoons, Lakes, and Swamps	Water	500
Aquatic Vegetation over Bodies of Water	Water	500
Rivers	Water	500
Artificial Bodies of Water	Water	500
Channels	Water	500
Industrial or Commercial Zones	Urban	1000
Discontinuous Urban Cover	Rural	500
Continuous Urban Cover	Urban	1000

Urban Green Zones	Urban	1000
Airports	Urban	1000
Roads and Rails*	Transportation	10

*Note that a separate transportation file was integrated into the resistance raster; those features had 500 resistance

APPENDIX G

CITATIONS FOR ANDEAN BEAR LOCATIONS FROM CHAPTER 3

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