Conservation Leadership Programme: Final Report

1. Project Title: **Status Surveys of Threatened Focal Species in the Magdalena Medio, Colombia** (ID: 02206114)
2. Host country, site location and dates in the field: **Colombia, middle Magdalena River valley, August 2014 – December 2015**
3. NGO's involved in project: **Fundación OIKOS and Cabildo Verde**
4. Overall project aim: **Assess the distribution and habitat use of threatened focal species.**
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7. Final report completion date: **November 5, 2016**

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Project Partners & Collaborators

Our CLP project partners and collaborators included the following individuals, agencies, and NGOs:

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- Juan David Sánchez-Londoño, M.Sc.
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- Corporación Autonoma Regional del Sur de Bolívar, Magangue, Colombia

- Panthera – United States Program, 8 West 40th Street, 18th Floor, New York, NY 10018

Botero-Cañola provided instrumental support with GIS analyses, including mapping land cover and the *M. tridactyla* range expansion.

Sánchez-Londoño contributed records of *M. tridactyla* and *P. onca* at the southwestern part of our study area.

Forero-Medina and Valenzuela at WCS-Colombia assisted with the occupancy analysis and contribution of *P. onca* and *M. tridactyla* data.

BioDiversa and Cabildo Verde provided helpful logistical support throughout project activities (e.g. guides and contact information for private landowners in the study area).

The Corporación Autonoma Regional del Sur de Bolívar in Magangue, Bolívar granted permits and kindly provided access to unpublished research documents for J.J.F.

Panthera-US Program provided J.J.F. with 50 camera-traps.

Section 1:

Summary

We evaluated the distribution and habitat use of four locally and globally threatened large vertebrates across varying levels of habitat modification in Colombia's middle Magdalena River valley. This region has lost > 90% of its native vegetation and continues to experience high deforestation rates, mainly for cattle ranching and oil palm plantation development (Etter et al. 2006; Garcia–Ulloa et al. 2012). Our study area spanned approximately 1,584 km² of oil palm landscape with plantations ranging in size from 4–280 hectares. We aimed to assess variability in focal species habitat use in relation to forest, oil palm, wetlands, and proximity to protected areas. We used single-season occupancy models for analyzing habitat use of jaguars (*Panthera onca*), recorded a 430 km range expansion for giant anteaters (*Myrmecophaga tridactyla*) and, to the best of our knowledge, obtained the first evidence of red brocket (*Mazama americana*) in oil palm plantations. Our camera-trap surveys did not detect the blue-billed curassow (*Crax alberti*), a critically endangered, ground-foraging bird endemic to north-central Colombia. Future research and conservation measures in this high priority ecoregion should target wetland preservation, examine multi-season occupancy dynamics, and investigate finer-scale habitat configurations that may support the persistence of threatened species in landscapes fragmented by cattle ranches and oil palm plantations.

Introduction

Embedded in the northeastern portion of the Tumbes-Choco-Magdalena hotspot (Mittermeier et al. 2011), the middle Magdalena River basin is one of the most degraded and least protected biogeographic regions in Colombia (Etter et al. 2006; Forero-Medina and Joppa 2010). The area is undergoing rapid conversion to cattle pastures and oil palm plantations. Globally, most palm oil is produced in Indonesia and Malaysia where the industry's destructive impacts on biodiversity have been well documented (Maddox et al. 2007; Wilcove and Koh 2010; Sulai et al. 2015). Oil palm cultivation is projected to increase in Latin America (Garcia–Ulloa et al. 2012; Dinerstein et al. 2015), including tropical ecoregions where plantations support low species richness and abundance of birds, invertebrates, and herpetofauna (Nájera and Simonetti 2010; Gilroy et al. 2015). However, data on mammalian ecology in Neotropical oil palm is virtually nonexistent and the potential contribution of plantations to serve as habitat for large vertebrates remained largely unknown until this study.

The plantations of varying age classes in our study area provide different levels of cover and habitat quality for focal species. Young plantations (0-3 years) are planted with low-cropped palms which provide minimal cover for predator and prey alike. In the Puerto Wilches block (mid-central portion of our study area), young plantations represented 61% of all oil palm coverage.

Intermediate plantations (3-6 years) provide more cover because the plantations are left in a semi-fallow state where human disturbance is minimal. We predicted greater detections of focal species in the intermediate plantations located closer to protected areas. In mature plantations (7-12 years), the understory is cleared and palms are harvested by workers. The harvesting stage is accompanied by high levels of human disturbances in the form of tractors, trucks, beasts of burden, and noise.

There are two large forest blocks located at the southeastern and western borders of our study area: The Serranía de los Yariguíes National Park, a 790 km^2 protected area established in 2005 and the Serranía San Lucas, a 15,000 km^2 forested massif that represents the largest block of primary rain forest in the middle Magdalena river valley (Fig. 1). A 3,770 km^2 portion of the Serranía San Lucas was under evaluation for a new national park in 2014 but extensive mining and occupation by armed guerilla groups has complicated the declaration process and the park has not yet been formally established.

We concentrated our survey efforts in the eastern lowlands of the Serranía San Lucas, an Important Bird Area and site of conservation priority (Birdlife International, 2013). Employing a focal species approach, we conducted status surveys on four species of conservation concern: Blue-billed curassow (*C. alberti*), giant anteater (*M. tridactyla*), red brocket (*M. americana*) and jaguar (*P. onca*). The middle Magdalena has long been recognized as a key linkage between jaguar populations east and west of the Andes Mountains (Melquist 1984). It also represents the extreme northwestern range of *M. americana* (Duarte and Vogliotti, 2016) and is one of the largest remaining blocks of habitat for *C. alberti* (Birdlife International, 2013). Perhaps most significant, our CLP-supported surveys confirmed the presence of *M. tridactyla* in the middle Magdalena for the first time since the last indisputable evidence in the late 18^{th} century (Figel et al. 2015).

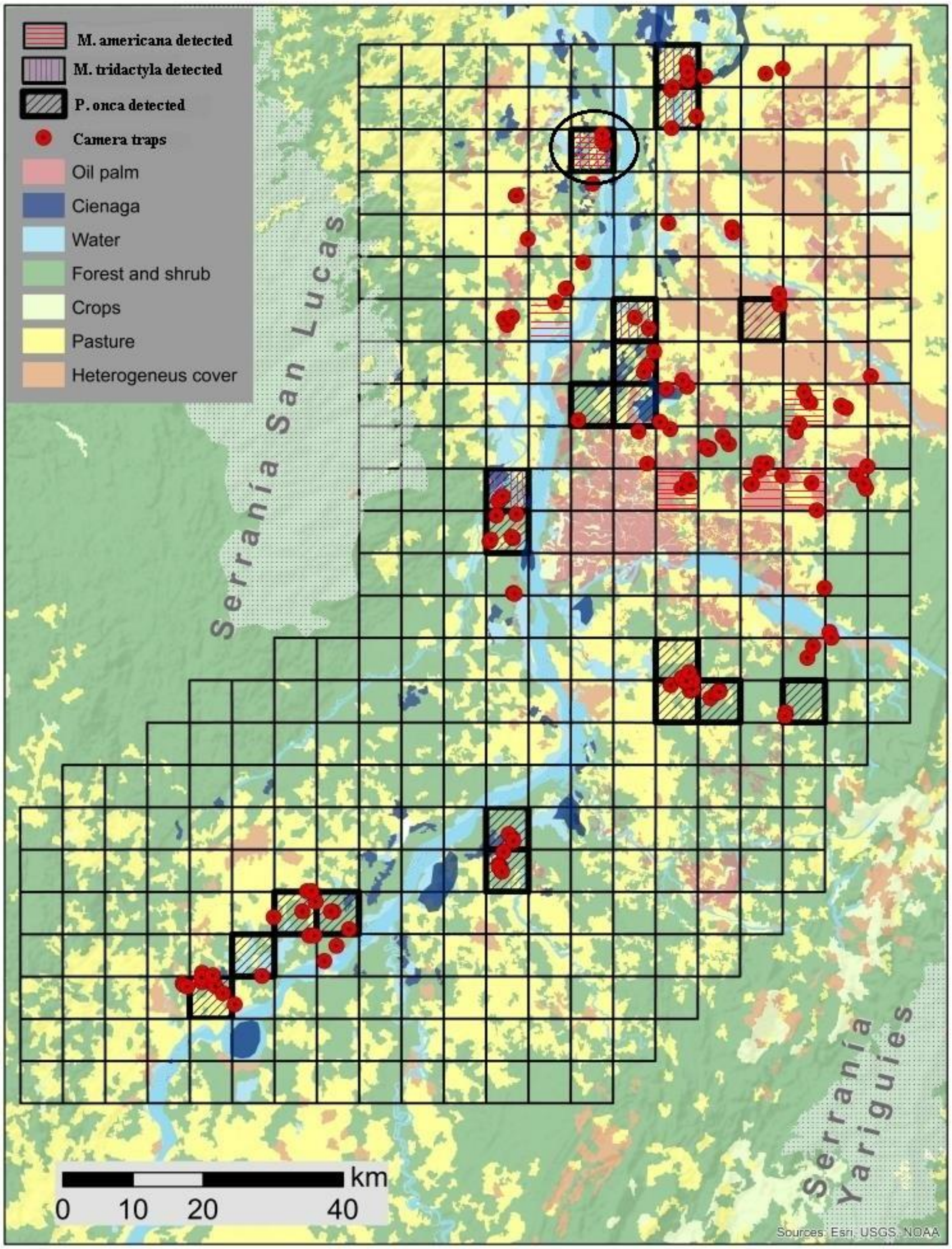

Figure 1. Study area map in the middle Magdalena, Colombia. The circle indicates the only sampling cell where *P. onca*, *M. americana*, and *M. tridactyla* were all detected.

Project Members

Andres Quintero-Ángel (Fundación OIKOS, Cali, Colombia)
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Section 2:

Aim and Objectives

Our primary objective was to examine habitat use and identify the most important stronghold(s) of threatened large vertebrates in the middle Magdalena River valley and work to ensure their survival through environmental education and awareness programs, regulating hunting, and collaborating with private landowners in efforts to preserve key patches of intact forest within pasture and oil palm plantations.

Changes to Original Project Plan

We adapted our project study location to include a wider area due, in part, to logistic and financial difficulties accessing the eastern lowlands of the Serranía San Lucas (gasoline in Colombia is very expensive). We also modified our objectives by increasing emphasis on assessing variability in focal species habitat use in relation to forest, oil palm plantations, wetlands, and proximity to protected areas.

Methodology

We hypothesized that spatial patterns of focal species occurrence would be influenced by variation in human disturbance, habitat type, and proximity to wetlands and protected areas. To test this hypothesis, we conducted presence/absence camera-trap surveys (using 90 cameras total) during the 2014/2015 wet and dry seasons in randomly selected 6x6 km sampling cells. We placed cameras strategically in each cell to maximize detection probabilities of each focal species (e.g. at sites where we observed tracks or local people reported sightings).

Land cover in each cell varied in percentages of forest cover ($\overline{x}$ = 36.4%, range 3.6 – 80.5%), oil palm ($\overline{x}$ 10.3%, range 0 – 77.3%), and ciénaga coverage ($\overline{x}$ = 8.15%, range 0.02 – 32.6%) (Table 1). The average distance between cameras and the nearest wetland was 3.53 km (range 0.01 – 27.75 km). Oil palm plantations, identified by remote sensing and ground-truthed during field surveys, were present in 44 of the grid cells (66.7%).

For estimating the proportion of area (PAO) occupied by the focal species, we used occupancy modeling, which is based on the premise that changes in the PAO occupied may be correlated with changes in population size (MacKenzie et al. 2002).

We used an occupancy approach because it is more feasible than other methods for large study areas, where some population parameters may be impossible to measure. It is also replicable and takes into account that focal species may go undetected in a survey of a sampling unit even when the species is actually present within that unit. MacKenzie et al. (2006) found that detection probability of the species can be estimated through repeated surveying of the sites, which then enables unbiased estimation of PAO. To address this issue of imperfect detection, we conducted multiple surveys of the sampling cells to minimize the possibility of recording false absences (MacKenzie and Royle, 2005), which are one of the greatest sources of biases in occupancy surveys (Moilanan, 2002).

We defined a sampling occasion as each season (wet/dry) a cell was sampled by ≥ 1 camera(s) during our two-year study. Each replicate in the survey was 90 days of one camera, with multiple cameras ($\overline{x}$ = 4.15 ± 3.18 SD) per cell. The number of cameras placed in each grid cell depended on permission from private landowners and accessibility, which was constrained by seasonal flooding in some of the cells flanking the Magdalena River.

To analyze local perceptions and hunting levels of focal species, we completed 107 semi-structured and structured interviews in communities. Through snowball sampling, we identified people who had seen focal species and established a database of interactions. Snowball sampling is particularly well suited when specific segments of a population are involved (e.g., hunters). Targeting fishermen, hunters, and other individuals who spend a lot of time in the forest can generate more information with less effort than random sampling (Figel et al. 2016). Once we identified knowledgeable informants, we recorded the type of interaction (e.g. sighting, depredation, vocalization), date, place, and time. Interviews included questions about perceived abundance of focal species, hunting, traditional cultural beliefs, livestock depredation (for *P. onca*), and crop damage (for *M. americana*).

Table 1. Mean values of covariates in sampling cells (n=65) across the middle Magdalena river valley, Colombia.

Covariate	Average	Range
Forest cover (%)	36.4	3.6 – 80.5
Oil palm (%)	10.3	0 – 77.3
Wetland (%)	8.15	0.02 – 32.6
Distance to SSL (km)	42.5	11.64 – 67.34
Distance to SY (km)	74.99	30.65 – 116.33
Distance to wetland (km)	7.50	0.01 – 29.8

Outputs and Results[1]

Our sampling effort of 8,990 trap nights resulted in 18 detections of *M. americana* (Fig. 3), 109 detections of *P. onca* (Fig. 4), and 21 detections of *M. tridactyla* (Fig. 5). We did not photograph *C. alberti* during our camera surveys. Detections of *M. americana* were correlated with higher elevations and at sites closer to palm plantations and further from the Magdalena river. *M. americana*, a frugivorous ungulate, was the only focal species photographed inside an oil palm plantation. *M. tridactyla* showed less tolerance of oil palm as this species was detected, on average, 8.14 km from the nearest plantation (Table 2). The presence of both jaguars and giant anteaters was strongly associated with riparian habitats.

Our non-randomized snowball sample included 57 interviewees (55%) who reported *M. tridactyla* sightings. Eight-four percent of the sightings were from 2013-2014, 9% since 2004, and 7% were historical sightings reported before 2004. Our camera-trap records from the dry season suggest that *M. tridactyla* may favor seasonally flooded marshlands vegetated with *Heliconia* sp.

Table 2. Mean values of focal species detections at elevation and distances from palm plantations, Magdalena River, and nearest riparian habitat. Standard deviations in parentheses.

	Dist.palm	Elev	Dist. MagRiv	Dist.riparian
Jaguar	2.14 (2.28)	67.39 (19.72)	8.63 (6.21)	0.68 (0.78)
Giant anteater	8.14 (5.02)	55.89 (15.47)	6.3 (3.16)	0.2 (0.22)
Brocket deer	0.57 (0.96)	94 (29.43)	20.64 (14.61)	2.82 (3.87)

**Crax alberti* was not detected.

We were unable to run occupancy models for *M. tridactyla* and *M. americana* due to their low detection probabilities and scarceness of detections. For jaguars, distance to wetlands and percentage of forest cover were the most significant covariates (Table 3). We never detected jaguars in grid cells comprised of > 25% oil palm or <24% forest cover, except for one outlier of a male jaguar photographed in a 93-ha forest patch in a grid cell with > 90% cattle pasture. Jaguar habitat use strongly increased in cells with greater wetland coverage (β = 38.36, 7.77 SE) and was associated with cells containing greater forest cover (β = 0.96, 0.44 SE).

[1] Besides some analysis of *M. tridactyla* sightings, the results of our interviews have not yet been entirely analyzed and, therefore, are not discussed in this report.

The probability of habitat use by jaguars at cameras located less than 1 km from a wetland (ciénaga) was 79.8% (Figure 2). We hypothesize that jaguars may be selecting for capybara (*Hydrochoerus isthmius*) and reptilian prey species present in the ciénagas. Spectacled caiman, for example, can obtain a biomass of 2,000 kg/km^2 (Rueda-Almonacid et al. 2007) in Colombia, where their habitat preferences are very similar to those we observed for jaguars (Moreno-Arias et al. 2013). Caiman, crocodiles, and turtles were undetected by our terrestrial camera-traps and should be surveyed in subsequent studies of jaguars in the Magdalena because they often comprise significant portions of jaguar diet (Emmons 1987; Da Silveira et al. 2010).

Table 3. Top single-season models for jaguars in the middle Magdalena river valley, ranked in ascending order of AICc.

Model*	AICc	deltaAICc	AIC wgt	Model Likelihood	no.Par.	-2*LogLike
psi(D_Cien),p(effort)	221.94	0.00	0.651	1.000	4	213.19
psi(FOR),p(effort)	224.38	2.44	0.192	0.295	4	215.63
psi(D_SSL),p(effort)	225.84	3.90	0.093	0.142	4	217.09
psi(.), p(effort)	227.22	5.28	0.047	0.071	3	220.78
psi(D_Cien),p(.)	230.38	8.44	0.01	0.015	3	223.94
psi(FOR),p(.)	232.59	10.65	0.003	0.005	3	226.15
psi(PALM),p(.)	233.45	11.51	0.002	0.003	3	227.01
psi(.),p(livestock)	234.83	12.89	0.001	0.002	3	228.39
psi(D_SSL),p(.)	235.72	13.78	0.0007	0.001	3	229.28
psi(.),p(.)	236.49	14.55	0.0005	0.0007	2	232.27
psi(.),p(armadillo)	238.69	16.75	0.0002	0.0002	3	232.25
psi(.),p(collared peccary)	238.70	16.76	0.0001	0.0002	3	232.26
psi(D_SY),p(.)	238.71	16.77	0.0001	0.0002	3	232.27

*Site covariates: D_cien=Distance to wetland, D_SSL = Distance to the Serranía San Lucas, D_SY= Serranía de los Yariguíes, Palm = Percentage of oil palm coverage in 6x6 km sampling quadrant, FOR= Percentage of forest cover in 6x6 km sampling quadrant. Survey (sampling) covariates: Effort = Total camera-trap nights at given site, Armadillo=number of armadillo detections at given site, Collared peccary = number of collared peccary at given site, Livestock=number of cattle detections at given site.

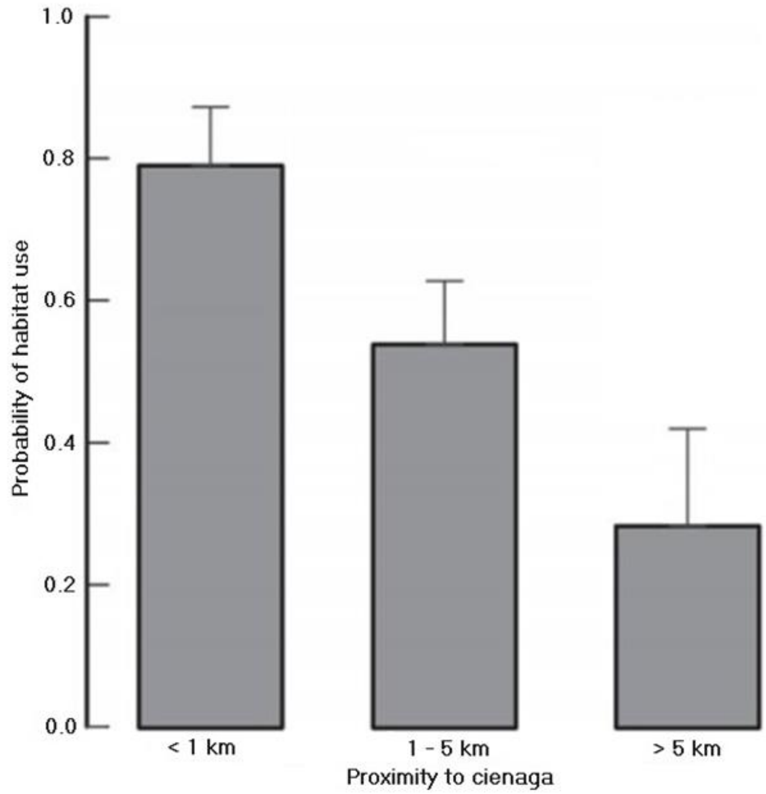

Figure 2. Probability of jaguar habitat use in relation to proximity to wetland (ciénaga) in the Magdalena basin.

Communication & Application of Results

We presented our results at two national conferences attended by hundreds of Colombian students, professors, and biologists: the IV Congreso Colombiano de Zoología in Cartagena (December 2014) and the Segundo Congreso Internacional de Estudiantes de Medicina at the Universidad de Santander in Bucaramanga (November 2015). We also published our giant anteater records in the journal *Mammalia* (Figel et al. 2015; Fig. 6). We are preparing to publish additional papers on mammalian habitat use and human perceptions of focal species in Colombian oil palm landscapes.

Monitoring and Evaluation

We held workshops pre and post project implementation in study area communities, attended by > 100 schoolchildren (Fig. 7). A guide in one of our study communities has become a local champion for species conservation (Fig. 8). We contributed to IUCN assessments for *M. tridactyla* and *C. alberti* (our non-detection of *C. alberti*, although discouraging, is significant for conservation planning) and leveraged additional funding for *M. tridactyla* from the Cleveland Zoo Scott Neotropical Fund (Table 4). A more in-depth analysis of project evaluation is currently underway.

Achievements and Impacts

The most important achievement of our project was detecting the presence of threatened focal species and identifying their basic ecological requirements in an understudied region undergoing extensive habitat destruction (Fig. 9). Our findings have mutual implications for wildlife conservation and planned expansion of oil palm, as our data support new policies of the Colombian National Federation of Oil Palm Growers (Fedepalma). In 2015, Fedepalma began directing palm cultivators to avoid plantation establishment in forests and in areas with poor drainage prone to flooding, where pathogens destructive to the palms occur naturally. *Phytophthora palmivora* is one such pathogen, responsible for the spread of a destructive disease known as bud rot. This disease has decimated 350 km^2 (~27%) of the crop in the middle Magdalena since 2006 (Torres et al. 2016). Likewise, greater enforcement of forest preservation in riparian buffers–already required under Colombian law (Rubiano 2011)–would benefit ecosystem health without sacrificing gains in palm oil production.

Capacity Development and Leadership Capabilities

We learned the importance of communication, which is undervalued in multidisciplinary conservation projects. Although we made significant accomplishments, this project did not realize its full potential due, in part, to poor communication among team members.

Section 3:

Conclusion

Our study evaluated the presence of a suite of threatened focal species in Colombia's middle Magdalena river valley, in an attempt to elucidate the factors contributing to their persistence in this transformed landscape. We recorded a 430 km range extension for *M. tridactyla* (Fig. 10) collected some of the first photographs of *M. americana* in oil palm plantations, and achieved one of the most comprehensive analyses of *P. onca* habitat selection undertaken to date.

Problems Encountered and Lessons Learnt

The camera-trapping went well due to our possession of a sufficient number of cameras (n=90) and effective collaboration with project stakeholders, most of whom willingly granted us permission to investigate wildlife on private lands. We were able to run occupancy models for *P. onca* due to the large number of detections we obtained for that species. Analyses of *M. tridactyla* and *M. americana* habitat use were more limited due to the lack of detections. *C. alberti* was not detected by cameras, resulting in our inability to accurately identify the most critical areas for this species' conservation.

To be forthcoming and entirely honest, unsatisfactory coordination and communication among team members has been the most problematic aspect of our projects' implementation. We are still working to overcome this issue but it is not easy when team members do not fulfil their expectations and fail to answer emails in a timely manner.

At the project's onset, we were encumbered by our affiliation with Esteban Payán of Panthera-Colombia. Payán's uninviting and antagonistic behavior caused us to reconsider our options for collaboration in the middle Magdalena. Fortunately, G. Forero and L. Valenzuela of WCS-Colombia were impressively professional in contributing data and assistance with analysis and our teamwork with Antioquia-based biologists S. Botero-Cañola and J.D. Sánchez-Londoño was outstanding.

Team member J.J.F. recommends that reviewers of future CLP awards consider granting priority to nationals who live at the closest proximity to their proposed field sites. Communication and teamwork can be hindered when the project leader is based hundreds of kilometres from the study area.

Furthermore, the team leader (or team member attending the 2-week international training course in Canada) needs to take greater initiative in reporting to CLP and preparing the reports. CLP projects are team efforts but they should ideally require primary leadership from the national biologists on the project. It is usually the national biologists who hold the greatest potential to make lasting conservation impacts.

In the Future

Colombia targets a six-fold increase in palm oil production by 2020, a goal that would require a total of 7,300 km² countrywide, double the amount of land that was cultivated when we began our study in 2013 (Garcia-Ulloa et al. 2012). One of the primary zones targeted for palm expansion is our study area in the middle Magdalena river valley. Beyond the middle Magdalena, however, oil palm plantations are also projected to expand in the tropical savannahs of the Orinoco region (Garcia-Ulloa et al. 2012), where 55% of Colombia's wetlands are located (IDEAM 2001). The persistence of threatened vertebrates in these transformed landscapes may depend on the extent to which dynamic landscape configurations preserve key features essential for the species. We recommend that more research be directed to the Orinoco region, which is a stronghold for *M. tridactyla* and *P. onca* populations.

In the Tumbes-Choco-Magdalena hotspot, future research should target wetland preservation, examine multi-season occupancy dynamics, and investigate finer-scale habitat configurations that may support species persistence in one of the most important yet vulnerable ecoregions of Colombia. With increasing rates of habitat loss and fragmentation in the middle Magdalena, there is greater urgency to better understand the response of these species to human induced disturbances in transformed landscapes.

Section 4:

Appendices

Figure 3. *M. americana,* a Data-Deficient species. Both photographs of female (above) and male (below) were taken in Bolívar, Colombia.

Figure 4. *P. onca*, a species classified as Near-Threatened by the IUCN. Both photographs, of two different males, from Santander, Colombia.

Figure 5. *M. tridactyla*, a Vulnerable species, photographed during our CLP project in Bolívar, Colombia (above) and with offspring in Santander, Colombia (below).

DE GRUYTER Mammalia 2015; aop

Short Note

Joe J. Figel*, Sebastián Botero-Cañola, Juan David Sánchez-Londoño and Andrés Quintero-Ángel

Unexpected documentation and inter-Andean range expansion of a vulnerable large mammal (Mammalia, Pilosa, *Myrmecophaga tridactyla*) in Colombia

Figure 6. Title page of our *M. tridactyla* range expansion paper published in *Mammalia*.

Figure 7. Workshop organized by A. Quintero and C. Gaitán in study area community in Santander, Colombia. August, 2015.

Figure 8. Dubal, one of our guides in a Santander village where we detected *M. tridactyla* and *P. onca*, holds a portrait he designed on his own initiative. The caption translates as follows: “Protecting the Animals and Caring for Nature.”

Figure 9. Habitat destruction in the middle Magdalena River valley, 2014.

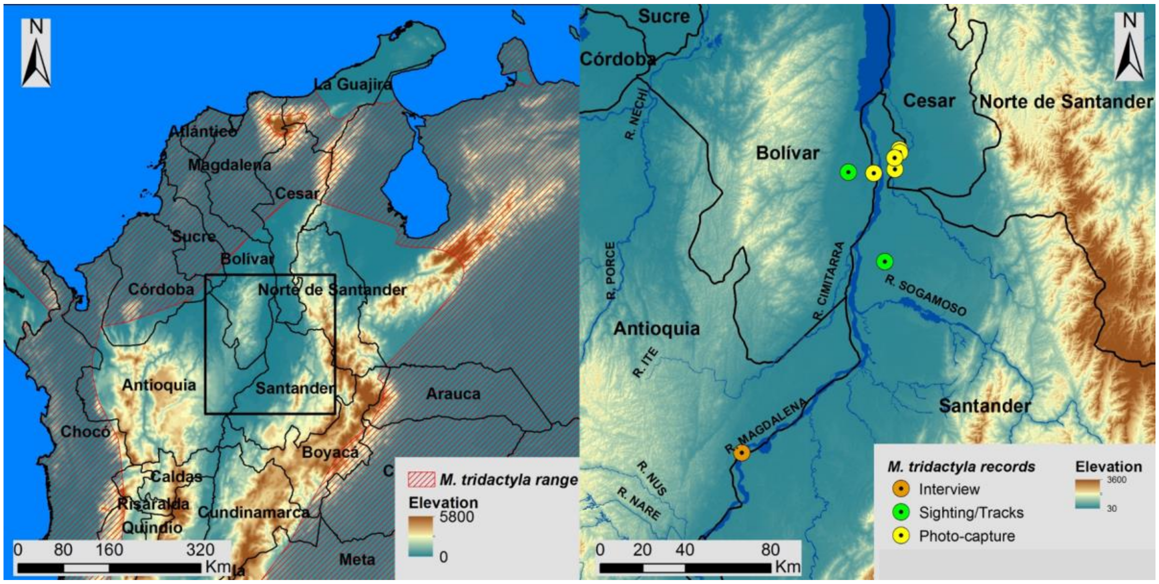

Figure 10. Our *M. tridactyla* records in the middle Magdalena. Map © S. Botero-Cañola.

Table 4. CLP M&E measures.

Output	No.	Additional Information
Number of CLP Partner Staff involved in mentoring the Project	2	G. Forero-Medina and L. Valenzuela from WCS-Colombia provided very helpful assistance with data analysis
Number of species assessments contributed to (E.g. IUCN assessments)	2	*M. tridactyla* and *Crax alberti*
Number of site assessments contributed to (E.g. IBA assessments)	1*	*Figel is currently camera-trapping (2016-2017) the north-western lowlands of the Serranía San Lucas and will inform IBA evaluators of survey results, particularly as they pertain to *C. alberti*.
Number of NGOs established	-	
Amount of extra funding leveraged ($)	$4,709	Cleveland Zoo
Number of species discovered/rediscovered	1*	*We recorded a 430 km range extension for *M. tridactyla*.
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	-	
Number of species/sites legally protected for biodiversity	-	
Number of stakeholders actively engaged in species/site conservation management	-	
Number of species/site management plans/strategies developed	-	
Number of stakeholders reached	100's	100's of villagers in Bolívar and Santander.
Examples of stakeholder behaviour change brought about by the project.	-	
Examples of policy change brought about by the project	-	
Number of jobs created	-	
Number of academic papers published	1	Figel et al. 2015. Mammalia.
Number of conferences where project results have been presented	2	1--II Congreso Internacional de Estudiantes de Medicina, Univ. Santander (J.J. Figel presented). 2-- IV Congreso Colombiano de Zoología (A. Quintero presented on *M. tridactyla* and J.J. Figel presented on all focal species).

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