



## People, carnivores, biodiversity, and global health around Akagera, Rwanda

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At the Carnivore Coexistence Lab (CCL), we work to understand and preserve large carnivores for future generations while also protecting people and domesticates. We investigate coexistence and ecosystem health, especially in agroecosystems hosting domestic animals. While ecology is our main discipline, we also integrate social sciences and law pertaining to biodiversity, management, and the people living alongside carnivores.<sup>1</sup>

Rwanda's Akagera National Park (ANP) and surrounding landscapes represent a unique study system for ecology and human-carnivore interactions, including an electric fence along ANP's western boundary that restricts human, domestic animal, and wildlife movement into and out of the park. We aim to investigate and compare the occurrence, ecology, and health of spotted hyenas (hereafter, "hyenas") and leopards inside and outside the park.<sup>2,3</sup> We also aim to examine the carnivores' interactions with people and domestic animals in ANP's vicinity.

We see shared goals with the Global Health Institute to study wildlife, domestic animals, humans, and the health and diversity of ecosystems. We will collect non-invasive samples from carnivore scat, kills, or hair to investigate health, populations' genetic connectivity and diversity, diet, and host-pathogen interactions.<sup>4-11</sup> We will focus on ANP's electric fence and the boundary of a vast military zone housing no people, which may be a refuge for carnivores making forays into agroecosystems. We will use mixed social and ecological sciences, including remote sensing and trail cameras to detect suitable habitat and carnivore occupancy, respectively; indirect sign surveys for scat, dens, and kills; and social scientific surveys to interview neighbors of ANP and quantify husbandry defenses of livestock or domestic dog activity.

In 2018, we conducted a pilot study of feasibility outside ANP and interviewed several dozen residents about carnivore-livestock interactions and wildlife-crop damages.<sup>12</sup> We also surveyed indirect signs of hyena dens, kills, and capture sites. These pilot data supplement long-term monitoring by ANP staff from ground and aerial surveys. ANP staff have offered support, including access to wildlife monitoring data, environmental DNA, and geospatial information. Certain data and protocols may be replicable both inside and outside of ANP, enabling direct comparisons of health, behavior, and diversity in and around ANP.

Our starting assumption is that hyenas and leopards living outside ANP differ from those living inside ANP because the fence impedes movement of these carnivores, their competitors (e.g., people, lions), and prey, both wild and domestic.<sup>3,13</sup> Across ANP's fence, we expect differences in genetic diversity<sup>12,14,15</sup> and other health indices, such as endoparasites,<sup>16</sup> diet quality,<sup>17</sup> consumption of human remains from graves,<sup>18</sup> and zoonotic diseases.<sup>19-21</sup> Genetic analyses using fecal samples collected inside and outside ANP will test the assumptions. Also, our trail cameras spaced regularly along the western boundary fence should detect carnivore approaches and crossings, if any. Previously, cameras along 5 km of ANP's southern fence captured no hyena crossings; however, several young leopards were seen traversing the fence, as were a few other mammals.<sup>12</sup> We will also monitor a trench separating the unpeopled military zone from neighboring farms. We will survey wildlife activity stopping at and crossing the trench

and fence to inform our inferences about human-carnivore coexistence around ANP. We propose a comparison of sites that differ in carnivore density, human activity, and wild and domestic prey abundance.<sup>2,3</sup>

We assume the behavior of hyenas and leopards outside ANP differs from that inside ANP, especially in relation to human presence, domestic animal abundance, other hazards and attractants to the carnivores,<sup>17,22</sup> and sympatric carnivore populations.<sup>23</sup> For hyenas, we predict changes in the demographic<sup>17</sup> and social organization outside ANP, as this species is uniquely female-dominant with large, complex clans that use cooperative territoriality and hunting – at least when studied in large protected areas.<sup>22,24</sup> However, recorded den sites, both inside and outside ANP, appear to be more inconspicuous and temporary, indicating these hyenas are transient, possibly due to seasonal weather changes (e.g., flooding) or human persecution outside ANP. Trail cameras outside ANP suggest hyenas travel in smaller parties than inside ANP. We will quantify geographic differences in hyena party size and denning behavior in relation to human pressures. For leopards, we assume no change to social structure (i.e., solitary foragers with male dispersal and maternal residence<sup>25</sup>). Certain findings may prompt adjustment of this assumption, such as detection of a regional shortage of males (e.g., if wide-ranging males face more fatal encounters with humans than do female leopards<sup>26</sup>), or, conversely, genetic evidence of localized inbreeding within ANP.<sup>27</sup>

People and domestic animals are likely to exhibit different behaviors—including how domestic animals are safeguarded, people move by day and night, and children are protected—when there is a higher risk of encountering carnivores.<sup>28,29</sup> We assume people's perceptions and tolerance of carnivores and conservation goals are underpinned by social/cultural norms, past experiences, and governance.<sup>30</sup> We will explore qualitative dimensions of human-carnivore relations outside ANP using a mixed-methods approach (e.g., semi-structured interviews with Rwandans who grew up in the study area, participatory mapping with local community members,<sup>31</sup> household-level questionnaires on perceptions of carnivores) to develop a deeper understanding of coexistence strategies within ANP's social-ecological system.<sup>32</sup> ANP's community liaisons are a valuable asset for connecting us with community leaders and members, and for assisting in translation when conducting surveys. Besides improving our work and the acceptance of our team in rural areas, collaboration with these liaisons will support ANP's ongoing efforts to understand local communities' perceptions of carnivores, ANP itself, and interventions related to long-term coexistence.

Fieldwork would begin summer 2025 with a pilot feasibility study. Lab benchwork would begin autumn 2025. Allison Fisher, BSc, is an MSc student in the Environment and Resources program at the Nelson Institute and a new member of the CCL. She will collect data in the field, process genetic samples, and conduct community interviews for her graduate studies on how anthropogenic activity influences wild carnivore ecology. Meghan Hills, MSc, is a PhD student in Environment and Resources at the Nelson Institute and member of the CCL. She will examine human-carnivore coexistence using a social-ecological approach by collecting and integrating data on wildlife ecology, local communities' perceptions of carnivores, and the socio-cultural contexts of human-carnivore relations. Adrian Treves, PhD, directs CCL and will advise all team members and supervise the preparation of theses and dissertations.

Footnoted references are provided in full at <https://faculty.nelson.wisc.edu/treves/projects.php>