Strengthen capacity of ASL governments and communities to analyze wildlife data from camera traps

Final Report and Scaling Plan

Fototrampeo SFPM Orito Ingi Ande, Putumayo

ASL Amazon Sustainable Landscapes Program

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Strengthen capacity of ASL governments and communities to analyze wildlife data from camera traps

Final Report

Prepared by Conservation International, the Wildlife Conservation Society and World Wildlife Fund

This is a knowledge and capacity building initiative commissioned by the World Bank-led and GEF-funded Amazon Sustainable Landscapes Program (ASL) with the purpose of designing and piloting an analytical tool to gather, organize, visualize and analyze information recorded in existing camera traps, demonstrating how camera trap data (in conjunction with other relevant data) collected can facilitate and improve the evaluation of biodiversity outcomes under various conditions, assess impact of management scenarios, and improve planning and development of conservation activities. The pilot sites were chosen through a participatory approach within the ASL areas of intervention in Brazil, Colombia and Peru. Wildlife Insights (WI), an emerging platform built by Conservation International and partners was used to facilitate the processing, management and analysis of camera trap data.

This is the final report of the contract **Strengthening the capacity of ASL governments and communities to analyze wildlife data from camera traps**. The report is divided into the following three sections:

Section 1: Project goals, activities, results, and impact
Section 2: Challenges and Lessons Learned
Section 3: Scaling the use of Wildlife Insights across the ASL network

Section 1 includes a description of the goals and the general conceptual approach to pilot a wildlife monitoring system using camera traps in four ASL sites by using the Wildlife Insights platform. Detailed activities undertaken to choose these sites are described in this section, as well as their opportunities provided by camera trap monitoring, the process to collect, review and analyze camera trap data, the main results of all these activities, and the potential impact on overall management and understanding of wildlife at these sites. The Data Explorer tool built to enable data analysis for this pilot project can be accessed at this link.

Section 2 includes an analysis of the main challenges that arose during the project and summaries of the case studies from each pilot site, identifying what worked, what did not work, remaining challenges, opportunities and lessons learned. The section includes recommendations on how to overcome the remaining barriers to using the tool and take advantage of the opportunities provided by the Wildlife Insights tool.

Finally, Section 3 includes a proposal for scaling the implementation of wildlife monitoring systems and Wildlife Insights within current and future ASL country partners. Major thematic areas where a wildlife monitoring system powered by Wildlife Insights could improve biodiversity outcomes are proposed as well as several models for sustainability of this approach over the mid and long-term.

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Section 1: Project goals, activities, results, and impact

Problem statement

Wildlife is an important component of healthy ecosystems but is often overlooked in ecological assessments due to the lack of quality data on wildlife populations. This can lead to scenarios where forests remain but the wildlife within has been severely depleted. These losses can threaten the health of an ecosystem, decreasing the capacity of forests to store carbon and deliver other key ecosystem services. Ensuring the continued health of wildlife populations is therefore vital to the long-term conservation of ecologically important regions such as the Amazon.

The best way to evaluate changes in wildlife populations is to collect data on the ground (*in situ*) which can be used to estimate wildlife diversity, population trends, and other key indicators of wildlife population health. Camera traps – automated devices that remotely capture photographs of animals in their natural habitats - are one of the most cost-effective methods to do this when compared to traditional wildlife monitoring, which requires human resources to patrol and manually record observations of wildlife[1,2]. Camera trap data can be used to monitor changes in wildlife communities across time and space and ensure protected areas are delivering the biodiversity co-benefits needed to maintain important ecosystem services.

[1] O'Brien, T.G. 2016. Camera traps for conservation: Monitoring protected area investments. In: *Protected areas: are they safeguarding biodiversity?*. Joppa, L., Baillie, J., Robinson, J. (eds). p 228-241. John Wiley and Sons.
[2] Ahumada, J.A. & O'Brien, T.G. 2013. Implementation of camera trap networks at the national level: a cost-benefit analysis for the TEAM Network experiences. Gland. Unpublished to the CBD SBTTA.

Camera traps are used extensively across the Amazon region, in protected areas, indigenous territories, community-managed forests and other areas[3]. However, most of the data collected from camera traps remain underutilized and unavailable for conservation. One of the barriers hindering the use of these data is the large number of images resulting from a camera trap survey. One single camera can often collect hundreds or thousands of images in the span of a few weeks. Sorting through images from a survey deploying tens of cameras consumes enormous amounts of time and resources that could otherwise be spent on carrying out conservation activities. Moreover, the data is difficult to organize and share with others, and non-experts often lack capacity to analyze the collected data with existing tools. These barriers have limited the effective use of camera trap data to measure the impact of conservation interventions at scale and across large landscapes.

Wildlife Insights - a platform to facilitate wildlife monitoring at scale

Over the last three years, Conservation International (CI) in partnership with The Wildlife Conservation Society (WCS), World Wildlife Fund (WWF), Google, and other partners[4], have developed Wildlife Insights (WI), a cloud and Artificial Intelligence (AI) enabled platform that streamlines the processing, management, and analysis of camera trap data for conservation, science and land management. WI was built to address the main barriers to effective use of camera trap data, providing user-friendly tools to accelerate and simplify data management and facilitate data-driven decisions to conserve wildlife (Figure 1). Since launching to the public in 2021, WI has rapidly gained traction in the conservation community. There are currently hundreds of organizations using WI to manage and share their camera trap data. The WI community includes government agencies, NGOs, community-based monitoring initiatives, and companies. More information on WI can be found on [wildlifeinsights.org.](wildlifeinsights.org)

[3] Chen, C., Brodie, J. F., Kays, R., Davies, T. J., Liu, R., Fisher, J. T., Ahumada, J., McShea, W., Sheil, D., Agwanda, B., Andrianarisoa, M. H., Appleton, R. D., Bitariho, R., Espinosa, S., Grigione, M. M., Helgen, K. M., Hubbard, A., Hurtado, C. M., Jansen, P. A., … Burton, A. C. (2022). Global camera trap synthesis highlights the importance of protected areas in maintaining mammal diversity. *Conservation Letters*, 15, e12865. https://doi.org/10.1111/conl.12865

[4] Wildlife Insights core partners include Conservation International, Wildlife Conservation Society, World Wildlife Fund, Smithsonian Institution, North Carolina Museum of Natural Sciences, Yale's Map of Life, Zoological Society of London and Google.

Figure 1. Conceptual framework for Wildlife Insights.

Project Objectives

The main scope of the contract commissioned by the ASL was to design and pilot an analytical tool to visualize and analyze camera trap data in order to demonstrate how camera trap data can facilitate and improve the evaluation of biodiversity outcomes under various conditions, assess impact of management scenarios and improve planning and development of conservation activities. The main objectives were to:

1. Identify ASL pilot sites in Brazil, Colombia, and Peru[5] where conservation management interventions have been implemented, camera trap data has been collected (or is about to be) and a clear need for evaluating biodiversity outcomes is present.
2. Understand the management questions these sites are trying to solve, pain points associated with data management and analysis; design and implement analytical tools to answer these questions and alleviate pain points and integrate with existing data from other systems when feasible.
3. Build case studies for each site showing how WI and associated analytical tools can facilitate the evaluation of outcomes and the impact (or lack thereof) of interventions at these sites.
4. Share these case studies and lessons learned at a regional meeting with additional ASL stakeholders and partners.
5. Overall, enhance the capacity of decision-makers at ASL sites (both technical and non-technical) to evaluate biodiversity outcomes from collected camera trap data under various scenarios (e.g., threats/pressures, intervention/management scenarios), assess impact of management

[5] These are the participant countries of the first phase of the ASL, financing this consultancy.

scenarios, and improve planning and development of conservation interventions, by using analytical tools associated with the WI platform.

Approach and activities

The implementing team consisting of representatives from CI, WCS and WWF designed a three-phase approach to implement the consultancy, which aimed to facilitate maximum participation, ownership and information sharing between stakeholders. The activities carried out during each of the three phases (Planning, Operational and Systematization) are described in detail below.

Phase 1: Planning Phase and Selecting Pilot Sites

Phase 1 of the project focused on selecting pilot sites and designing an approach to engage stakeholders through a series of three workshops and field activities. To determine participants for the pilot, sites in the ASL portfolio were evaluated on 5 criteria: location, camera trap data availability, stakeholder involvement, interventions, and technical expertise. The four pilot sites named below were selected based on these criteria by the implementing team in consultation with ASL country representatives, ASL regional coordination team, implementing partners and site staff.

Selected pilot sites:

- Tabaconas Namballe National Sanctuary (Peru)
- Sustainable Development Reserve Rio Negro (Brazil)
- Medicinal Plants Sanctuary Orito Ingi-Ande (Colombia)
- Jaguar Corridor of San Jose and Retorno municipalities near Chiribiquete National Park (Colombia)

Figure 2. Map showing the locations of the four pilot sites.

Three workshops were jointly designed by the implementing partners and scheduled to ensure sufficient time for stakeholders to carry out field-based activities between the second and third workshops. The goals, agendas and outcomes for each workshop are described in detail in the next section.

Phase 2: Operational Phase - Workshops 1 and 2 and field implementation

The goals for the first two workshops were to familiarize participants with camera trap surveys, as many had not used the devices before, introduce them to Wildlife Insights, introduce them to the goals of the project, engage in open discussions to understand their key questions, barriers and requirements to effectively manage wildlife, and build capacity to carry out camera trap monitoring surveys using the WI platform and associated tools.

Note: A full description of Workshop 1 and 2 can be found in this report.

Workshop 1 (August 3-4, 2021)

Workshop 1 brought together over 30 participants from the four pilot sites with the goal to understand how camera trap data could play a role in answering their key questions on biodiversity management. Participants attending the two-day virtual workshop included representatives from central administration units of country protected area networks, protected area staff, community stakeholders, researchers involved in analytics and monitoring programs in the pilot sites, and ASL project representatives.

The workshop was designed to promote focused conversations within each pilot site group. After beginning the workshop with an introduction to the project activities and an overview of the WI platform, participants were divided into breakout groups based on which site they were associated with.

Staff from WCS and WWF who are closely involved with the pilot sites led breakout group discussions. The goal of the discussions was to unveil the context within which each site operated and understand the decision-making model and key actors at each site. Importantly, the breakout groups also provided time for participants from each site to discuss specific management questions they sought to answer with camera trap data. While the questions varied from site to site, most participants were generally interested in understanding how wildlife populations change over time and space, especially in response to external activities like reforestation and restoration agreements, protected area status, illegal hunting and illegal deforestation. These results from discussions in Workshop 1 provided the implementing team with an understanding of the types of tools and analyses that could be built to help each site answer their biodiversity management questions.

Workshop 2 (September 22-23, 2021)

The main goal for Workshop 2 was to familiarize stakeholders with the full process to design camera trap surveys, collect data, and analyze the data to inform their management questions. The two-day virtual workshop was attended by more than 60 people from the four pilot sites, in addition to stakeholders from other protected areas (like Chiribiquete National Park and Las Hermosas National Natural Park in Colombia) where camera trap data is also being collected.

The workshop was also an opportunity to further discuss the types of analyses required for each site to answer their primary biodiversity questions. Building off the discussions held in Workshop 1, the implementing team identified with each site their analytical needs according to their conservation objectives, explanatory variables, information availability, and target audience. Many pilot sites were interested in the status of a particular species and distribution of the species between different management zones and how they changed over time. These questions could be answered by providing access to analytics such as detection rate, occupancy, activity rates and species richness. Attendees also highlighted the importance of visual interpretations of the results (i.e., graphs and maps) to support decision-making and enhance the communication of the results to a wider audience. This feedback was instrumental in guiding the development of a custom analytics tool that complements the WI platform.

At the conclusion of Workshop 2, participants were asked a series of questions to evaluate their experience during the workshop and with WI tools. Most (8 out of 9 respondents) reported that they were "comfortable" or "very comfortable" teaching others how to use WI. This result is encouraging and suggests that the approach taken during the workshops was effective and could accelerate adoption of the platform through a "train the trainer" strategy. Participants also reported that the WI platform was intuitive, easy to use, and the workshops gave them motivation to start collecting data and using the WI platform. Results from each survey question can be found in Appendix 5 of the Workshop 2 report.

Data collection and processing

Note: A full description of the data collection phase, data analysis and development of the analytical tool can be found in this report.

Three of four pilot sites planned to collect camera trap data as part of the ASL pilot project and worked closely with counterparts at WWF and WCS to design camera surveys, using information presented during Workshop 2 as guidance. The participants from the Tabaconas pilot site did not plan to collect data as they had established plans prior to the pilot to collect data in 2022.

Though survey designs differed between the three pilot sites, all surveys involved setting cameras out for at least one month to collect images in the areas of interest. In the Colombian Jaguar Corridor in San Jose del Guaviare and in Orito-Ingi sites, community members and staff from the protected area were responsible for setting and collecting cameras in the field. A consultant for WCS was responsible for setting and collecting camera trap data in Rio Negro with the help of local community members who aided in navigating through the forest, and staff from the Secretary of the Environment for the state of Pará (SEMA), who monitored field activities. After collecting cameras from the field, these stakeholders

were also responsible for uploading the images to Wildlife Insights and reviewing them to verify the species seen in images.

Design and implementation of an ASL tailored Data Exploration Tool

Note: The Data Exploration Tool can be accessed here.

While the WI analytics functionality continues to be implemented in the platform itself, CI designed and built a Data Explorer tool specifically for the ASL pilot sites. The tool was designed to easily explore data from each site or across all sites, make comparisons between camera trap groups (e.g., inside the protected area vs. buffer zone), obtain basic indicators for species richness, view a full list of species photographed, and quickly calculate analytics including species accumulation curves, activity patterns, detection rates and occupancy. While the Data Explorer tool is not directly accessible via the WI platform, it is built to input the data files received from a download request from WI. The tool is only accessible to those who receive the specific URL and was shared with all pilot site stakeholders during the design phase and their feedback was incorporated into the final design. The goal of this tool —aside from enabling simple data exploration and analysis that are relevant to specific decisions and wildlife outcomes at the sites— is to serve as a bridge between ASL sites that collect camera trap data, as each site can view other areas where data has been connected and can view how their efforts contribute to improving landscape level knowledge on wildlife. In addition, the tool also serves as prototype for validating features that could be available as part of the data analytics package built directly into the Wildlife Insights platform.

Data analysis and case study development

Following the final release of the Data Explorer tool, pilot site participants were able to browse data collected from their site and interpret findings based on their primary management questions. A summary of each site's study, findings and outcomes was shared in the Knowledge Exchange Workshop described below.

Phase 3: Systematization Phase

Note: A full description of Workshop 3 can be found in this report.

Workshop 3

The third workshop was designed to facilitate a knowledge exchange between participants from each pilot site. The goal was to present the results of the work carried out in each project location, share lessons learned in the use of the WI platform, gather feedback on the Data Exploration tool, and discuss the usefulness of camera traps for conservation decision-making. In all cases, the use of the WI platform and the Data Explorer tool was instrumental in enabling pilot sites to quickly process data and explore outcomes even in the absence of specialized experts. The latter is especially important as it removed a barrier that previously existed, where it could take months or even years for researchers to determine results and share findings. Specific findings from each pilot site are described in the following sections.

Case Studies: Summary of Main Results and Impact

Sanctuary of Medicinal Plants Orito Ingi-Ande, Colombia

Background and key questions

The Sanctuary of Medicinal Plants Orito Ingi-Ande (Sanctuary) is a protected area managed within the National Park System in Colombia (Parques Nacionales Naturales de Colombia). The Sanctuary is located in the departments of Putumayo and Nariño, a meeting point between the Amazonian and Andean regions, between the tributaries of the Orito and Guamués rivers (Figure 3). Almost all of the sanctuary is covered by well-preserved forest and there is a great diversity of fauna and flora. More information (in Spanish) here.

The area is part of the Amazonian foothills, a place of traditional use by various indigenous peoples, including the Cofán, Inga, Siona, Kamentsa, and Coreguaje, ethnic groups with their own languages, customs, and traditions, but united by what anthropology has called the "yagé culture," which is one of the strongest shamanic traditions currently existing on the planet. The Sanctuary contains important varieties of medicinal plants associated with the yagé culture and is a space where the indigenous peoples can develop traditions, contributing to the permanence of traditional medicinal systems.

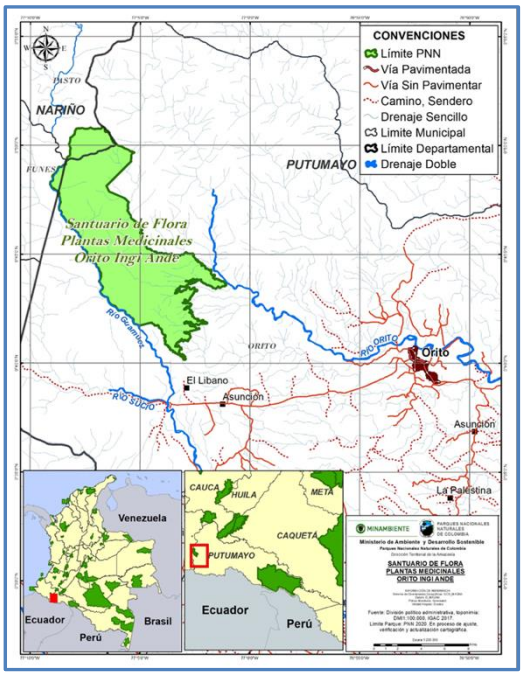

Figure 3. The boundaries of the Orito Ingi-Ande Sanctuary in the department of Putumayo, Colombia.

The Sanctuary of Medicinal Plants Orito Ingi-Ande was declared a protected area in 2008 with the objective of protecting the territory for its biological and cultural values. Despite its biological and cultural importance, the protected area has been threatened by the presence of illicit crops and hunting.

But by 2017, 13 voluntary agreements were signed to include approximately 29 hectares of the Sanctuary into a passive restoration process. Active restoration began in 2021 with activities that enriched ecologically and culturally important flora species in the Sanctuary's Cultural Ecological Restoration Zone. However, in the buffer zone adjacent to the restoration area, there are still threats such as the expansion of the agricultural frontier, urbanization, natural vegetation loss and fragmentation, human-wildlife conflicts including fear of felines (jaguar, puma, ocelot), oil spills, and loss of traditional knowledge and natural references.

The ASL project has supported the Sanctuary since 2018 via implementation of its management plan (with vigilance and control interventions) and support to local Cofán indigenous people. Management effectiveness of the area has been tracked showing positive outcomes, as well as patches under natural regeneration. Additionally, the Sanctuary is located in the Putumayo basin where a new GEF project will be developed: Integrated watershed management of the Putumayo Ica. This project is also implemented by the World Bank and executed by WCS. WCS' work in the area will nurture the Putumayo project which connects with the ASL.

As information on large to medium mammals and birds in the area was not available before this consultancy, the key questions that were raised in Workshops 1 and 2 ranged from exploratory questions to management-oriented questions, including:

1. What species are present in the area? How does the presence of species differ between the Sanctuary, the well-preserved buffer area, and the altered buffer area (e.g., the buffer area with anthropogenic impacts)?
2. What is the occupancy of the species that present conflict with human populations? How does it vary according to the study areas mentioned in Question 1?
3. What role does the Sanctuary play in conservation for the species present (mainly game species and species with conflict potential) compared to the well-preserved buffer area and altered buffer area?

Data collection and processing

The Sanctuary team designed a camera trap survey to cover the three areas of interest: 1) within the Sanctuary protected area, 2) in the well-preserved buffer area, and 3) in the altered buffer area (Figure 4). A team made up of two members of the protected area staff and seven people from the local community were trained to use and install 57 camera traps in the three areas. As the Sanctuary does not own its own camera traps, they borrowed camera traps from WCS to carry out this pilot project. In the altered buffer area, the field team first socialized the project with local communities to request permission to install camera traps on their private properties. The eleven invited property owners agreed to the installation of cameras as many of them have had previous conflicts with wildlife and were interested in non-lethal management techniques[6].

[6] Documented signatures and agreement to install camera traps on private land can be found in Annex 1 of the Orito Ingi-Ande case study.

More than 5,000 images were collected and processed by the Sanctuary's monitoring professional and field teams and nearly 60% of the images captured were images of wildlife. Both professionals, operators and technicians of the Sanctuary agreed that WI is a fast and efficient means to process camera trap data. The technicians estimate that WI reduced processing time by 50% compared to the time required to manually process images from the 2019-2020 camera trap sampling effort.

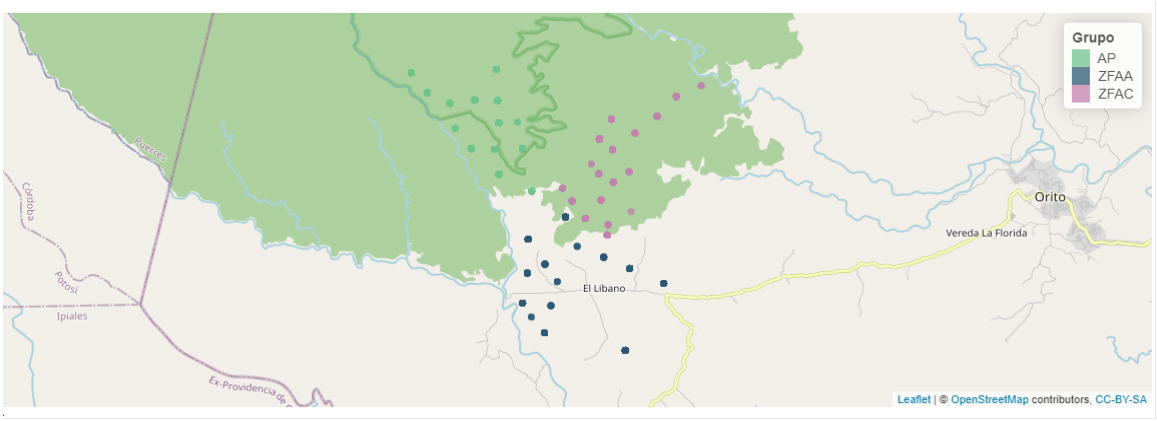

Figure 4. Map showing the locations of the cameras set in the Orito Ingi-Ande Sanctuary. Green dots are cameras set in the Protected Area (AP), blue dots are cameras set in the altered buffer area (ZFAA), and pink dots are cameras set in the well-preserved buffer area (ZFAC).

Data analysis

Results from the WI Data Explorer tool show that the Sanctuary and the well-preserved buffer zone have similar observed species richness, while species richness in the altered buffer zone is lower.

In the combined (altered and well preserved) buffer zone, four species of feline exist – jaguar *(Panthera onca),* puma *(Puma concolor),* ocelot *(Leopardus pardalis)* and margay *(Leorpardus wiedii*). However, the results indicate that in the altered buffer zone where communities are located, only one feline species - the puma - is present. The well-preserved buffer zone also shows higher occupancy for puma compared to the altered buffer zone. Given there are no records of hunting in the area, and the low occupancy of feline species in the altered buffer zone area, these results suggest that the frequency of human-wildlife conflicts could be lower than expected, could be more associated with people's perception, or there is more illegal hunting in the area than recorded. Since species occupancy may vary with the time of year, it is necessary to explore this issue further. These results also suggest that the Sanctuary and well-preserved buffer zone provide some degree of improved conservation for species overall.

Within the sampling area, several traditionally hunted species were also identified, such as the tapir, the cerillo, the deer, the boruga, the guara and the diurnal curassow. However, occupancy for larger species such as the tapir, the cerillo and the diurnal curassow were low, even in areas with good natural cover (the Sanctuary and the well-preserved buffer area). Given there are no current hunting records in the area, and it is known that hunting has decreased considerably in recent years, these results suggest that

the pressures from hunting activities in the past have likely led to the decline of these species' populations. Results from the data show that it is possible that smaller species such as the boruga and the guara, which have shorter reproductive cycles, have begun to recover, but species with longer reproductive cycles and more habitat requirements have not begun to recover yet.

Impact

The results from this pilot provide Sanctuary stakeholders and ASL project team members with a baseline understanding of the biological richness in the area. This information also allowed the Orito Ingi-Ande team to develop the following management recommendations in coordination with WCS:

- Establish conservation agreements with the Libano community, which lies within the buffer zone of the protected area and has recently begun implementing restoration projects, in order to contribute to improved conditions for species in the altered buffer area. This may include activities to protect intact forests, restoration processes, and reduce illegal hunting activity that may be currently unrecorded.
- Design and implement monitoring for species of cultural importance in the Sanctuary like the jaguar (*Panthera onca*) and black jaguar (*Panthera onca melanica*). These species can serve as indicators of change in ecological and cultural restoration processes and would help to better understand restoration effectiveness.
- Continue monitoring the species in the Sanctuary and its buffer areas, in order to understand changes in the richness and occupancy of priority species and the effects of management actions on them in the long term.

This pilot project has provided valuable knowledge that enriches previously anecdotal knowledge, and has provided opportunities for the Sanctuary stakeholders to leverage information for improved management and continued monitoring activities. Additionally, the pilot project was an opportunity for community members to engage in monitoring in a meaningful way. One of the community members said of the project, "I thought it was very nice that parks chose my property among so many properties in the town to put camera traps and see the amount of biodiversity that I have on my farm, a very small piece of land. I loved being a part of that process! And seeing all the birds that I have, because I didn't know what I had, because I'm working, and I don't realize all the animals that are on my land. I thought it was great that everywhere, not just on my property, they wanted to see that one has great biodiversity, to show Colombia and internationally the animals that we have here in the town of El Libano."

The Sanctuary team believes that WI will also help fundraising efforts for subsequent monitoring, as fewer resources are needed to process and analyze the data, allowing monitoring staff to support other conservation processes. Given that the Sanctuary does not own its own camera traps and borrowed cameras from WCS for this project, the team is still seeking the required financing to purchase camera traps that can be used for long-term monitoring in the Sanctuary. The next camera trap monitoring phase in the Sanctuary is planned to be carried out in 2023 or 2024 through *Proyecto Vida Silvestre* and will allow stakeholders to determine the effectiveness of actions that are currently implemented or are

planned to be carried out by including covariables in the data analysis. The data and results from this next monitoring project will contribute to the park's monitoring protocol.

Rio Negro Sustainable Development Reserve, Brazil

Background and key questions

The Rio Negro Sustainable Development Reserve (Rio Negro) is an IUCN category VI protected area created by State Law No. 3355 of December 26, 2008 and is managed by the State Secretariat for the Environment of the State of Amazonas, Brazil. It is located in the region of the lower Rio Negro, covering the municipalities of Iranduba, Manacapuru and Novo Airão (Figure 5). Rio Negro is part of the Lower Rio Negro Mosaic of Protected Areas, which includes 12 areas managed at federal, state and municipal levels. Rio Negro is also part of the Central Amazon Biosphere Reserve and part of the recently created Rio Negro Ramsar Site. These conservation designations result from planning actions developed by government agencies, such as the Ministry of Environment and the Secretary of Environment of Amazonas and are also linked with the ASL initiative.

According to Rio Negro's Management Plan, 791 families are distributed between 19 riparian communities, with different levels of anthropogenic pressure. These families depend on fishing, family farming, timber extraction and selling artisan handicraft for their livelihoods. Tourism has also become an important source of income for the communities.

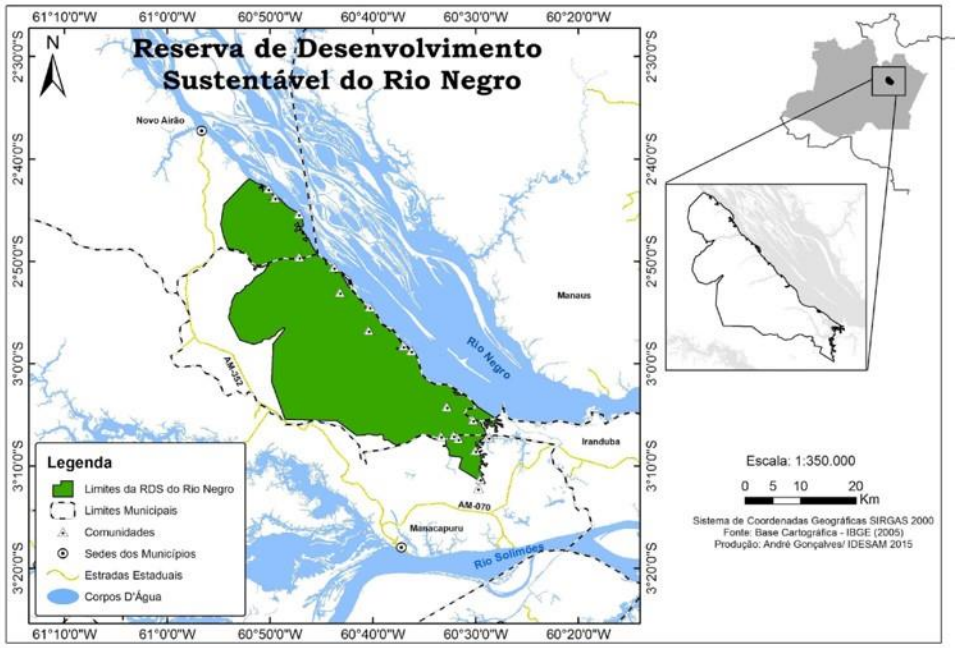

Figure 5. The green area shows the area covered by the Rio Negro Sustainable Development Reserve.

Rio Negro has a long history of logging and was also a hotspot for hunting and the wild animal trade in the Amazon until the 1970s. Illegal logging is now prohibited by law and hunting became a crime in

1967, with efforts to ban it more effectively beginning in the 1970s. Despite these legal developments, Rio Negro still experiences pressures from illegal logging, land grabbing, poaching, drug trafficking and uncontrolled tourism. It is important to note that some sections of the mosaic of protected areas suffer as a result of urban growth in the Manaus metropolitan region and, therefore, those sections closest to the core of this urbanized area suffer greater pressures, especially increased intensity of land use and consequent deforestation. Collaborative efforts between protected areas, NGOs (including implementing partner WCS) and local communities, some of which have been supported by the ASL project, have been developed to address these issues and promote the sustainable management and protection of biodiversity in Rio Negro and other areas in the mosaic.

To best inform the management of the Rio Negro reserve, the following key questions were identified by Rio Negro participants, which included SEMA staff and other researchers active in the area, during the pilot workshops:

1. What species are present in Rio Negro?
2. Are large species present near the local communities?
3. Is Rio Negro's management plan sufficient to support the medium and large terrestrial mammals found within its boundaries?
4. How can the relationship between medium and large mammal distribution and forest conservation status be leveraged to inform the spatial zoning of the Rio Negro Reserve?

Data collection and processing

To answer these questions, 30 cameras were set out for two months in an area in Rio Negro that had never been sampled with camera traps before (Figure 6). Since SEMA have few technicians working in their protected areas, SEMA suggested that this pilot project and field activities in the Rio Negro RDS be carried out by Ms. Dayse Ferreira, a WCS consultant and doctoral student who had been conducting research in the region prior to the pilot. While the WCS consultant set out cameras, she was supported by local residents who helped to navigate the region in poor weather conditions and were trained to set up camera traps and field activities were monitored by SEMA staff. While 30 cameras were set, only 20 cameras were retrieved at the end of the field sampling period. One camera was stolen and nine had defects during the sampling period. These issues are common in the Amazon as high humidity conditions degrade the lifetime of camera traps.

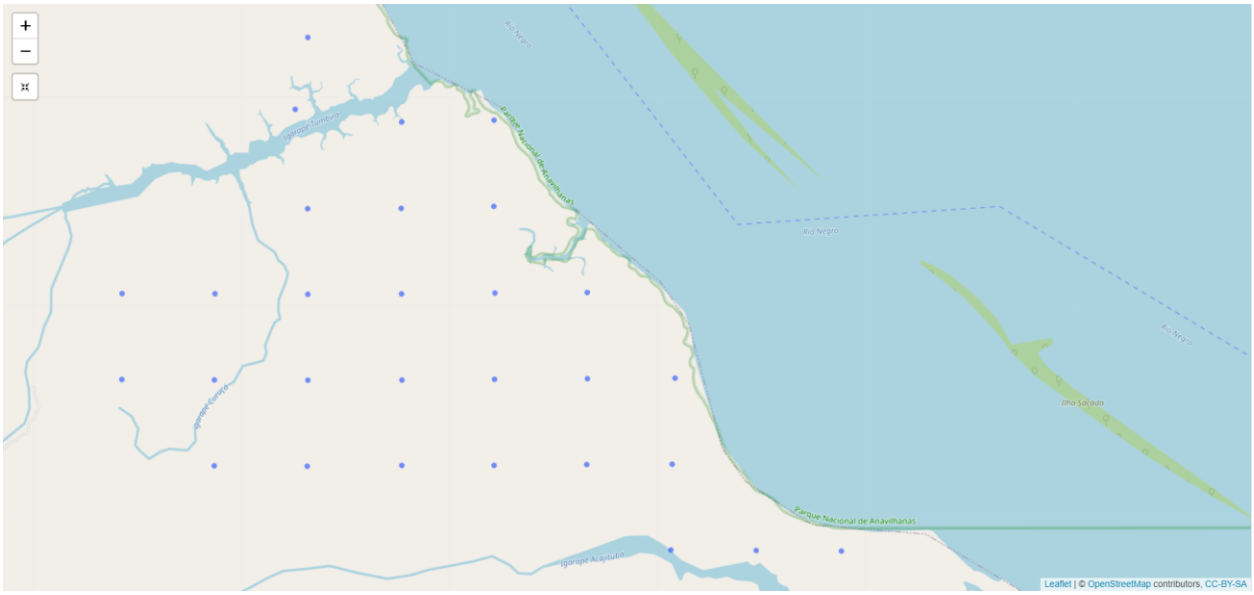

Figure 6. Distribution of camera traps in the Rio Negro Sustainable Development Reserve.

More than 5,000 images were captured and processed by the WCS consultant under the supervision of WCS researchers. Typically, community members from the Rio Negro reserve participate in management of the protected area, but due to logistical difficulties during the pandemic period, they were not trained or involved in the data processing steps. Nearly 20% of these images captured animals or humans, while the remaining 80% were blank images and had no object or animal of interest in them. The research consultant reported that using Wildlife Insights drastically reduced data processing and analysis time compared to other data processing techniques.

Data analysis

Using the Data Explorer tool and Wildlife Insights, the Rio Negro team was able to quickly assess which camera-trappable species are present in the area. Thirty-six taxa were recorded, which includes 27 mammal species, six bird species, and three higher taxonomic identifications for images that could not be identified to the species level (e.g., *Bird, Mammal, Squirrel*). The most common species included the ochre-winged trumpeter and the black agouti. Six IUCN endangered species were also photographed, including the jaguar, puma, tapir, white-lipped peccary, giant anteater, and marbled wood quail.

Despite the relatively low number of images collected, there were several big cat sightings including of the jaguar and puma (Figure 7). These results were positive signs, as it provided evidence that Rio Negro is still able to maintain populations of large carnivores despite the impact of human activities.

Figure 7: Images of big cats captured by camera traps in Rio Negro. Left: Puma (Puma concolor). Right: Jaguar (Panthera onca) and jaguar cub captured less than 3km from the community Santa Helena do Inglês.

Species such as tapir, paca, red deer, white-lipped peccary and collared peccary are considered important food for local communities[7] and are also targets of commercial hunting by people from outside Rio Negro. The data collected during this pilot show low occupancy values for these species near local communities. Given the illegal hunting activities observed during the field activities carried out in this pilot project, this suggests that their populations may be under pressure from hunting and may be perceived as a threat due to the damage they can cause to agriculture.

The experience with the platform and the Data Explorer was positive. The Rio Negro team found the tools easy to use[8] and intuitive and believes the tools can be easily adopted by other researchers or local communities involved in biodiversity monitoring to compare data between different areas or generate analytical graphs.

Impact

The data collected during this pilot provides evidence of presence and absence of key species in Rio Negro. When combined with data from hunting surveys, these findings can help provide insights into the impact of human pressures on biodiversity and will help target the places that need greater vigilance to combat illegal activity.

[7] While commercial hunting is illegal, in 1998, a new law was launched (9605 Federal Law) which made subsistence hunting by indigenous peoples and local communities legal.

[8] "We could feel that the use of WI gives agility to the work of processing the collected image." – Dayse Ferriera, PhD candidate and WCS consultant who collected and processed images in Rio Negro.

More specifically, one of the key questions raised during the design of the pilot project centered on the effectiveness of Rio Negro's management plan on the protection of terrestrial mammals. This question supports ongoing work by the WCS consultant, who has been developing her doctoral studies in the Reserve to support management of the distribution and abundance of terrestrial fauna. The results from this pilot project provide important indicators that when combined with other data (such as patrol data, assessments of pressures in the reserve, and detections of illegal activities collected by the WCS consultant), show a relationship between low species detections and observed illegal use of the area for logging and poaching. These findings (links between species and illegal activities) will be presented to the management of the Río Negro Reserve by WCS for use in evaluating and updating its management plan.

These findings provide verifiable evidence to facilitate conversations around the need for increased regulations and protection of the territory and species. WCS team believes that the management plan should consider the data from this study to inform their strategy and that the findings should be discussed with local communities in order to promote sustainable hunting practices and income generation to combat illegal activity in the area.

In future efforts, the Rio Negro team suggests incorporating the Wildlife Insights platform into the management routine of the RDS Rio Negro. This would facilitate easy access to scientific data for both protected area managers and other researchers with interest in the region's conservation.

Guaviare Prioritized Conservation and Management Corridor of the Jaguar, Colombia

Background and key questions

The "Prioritized Conservation and Management Corridor of the Jaguar" (Jaguar Corridor) contains 75,000 hectares and extends from the Serranía La Lindosa National Protective Forest Reserve to the town of Charras in the northeast, in the department of Guaviare, Colombia. The area is a transition zone between the Amazonia, Orinoquia, Andes and Guiana Shield regions and is also a core area for connectivity between 3 National Parks (Chiribiquete, Macarena and Nukak) and the Nükak Makú Indigenous Reservation. The Serranía La Lindosa, Chiribiquete and Nukak are among the investment portfolio of ASL in Colombia. Additionally, this area is within one of the seven strategic corridors identified by ASL as critical to the connectivity of the Colombian Amazon (Ciribiquete-Nukak corridor). The region has nearly half of its natural forest remaining but is threatened by anthropic pressures and livestock activity. Additionally, conflicts between communities and big cats like the jaguar are frequent and threaten the protection of these iconic species. Therefore, involvement of local communities is essential to ensure the corridor is effective in providing connectivity and habitat for jaguar and other species. The WWF Colombia team is working closely with the stakeholders of the Jaguar Corridor by engaging in dialogue and activities to promote the corridor and management of the corridor. This pilot project is the base for future work in the area that WWF is currently planning with the communities to ensure the integrity of the corridor at large.

The main goals of the pilot intervention were to provide evidence for the ecological value of the corridor region by confirming the presence of the jaguar, the species it depends on, and the state of the landscape. Additionally, the pilot team wished to reduce the vulnerability of livestock systems to jaguars, making it a source of human-wildlife conflicts.

To address these goals, the main questions established during this pilot project were:

1. What is the population status of jaguars and their prey species?
2. How vulnerable are the livestock systems where jaguar incidents occur?
3. What capacity and willingness do institutions and rural communities have to efficiently manage these conflicts?

Data collection and processing

Training was carried out in rural communities surrounding the Jaguar Corridor to socialize members of the community with the activity, encourage participation, and instill a sense of ownership in the project activities and outcomes. Twenty members of the community were trained to install 55 camera traps in key sites along the Jaguar Corridor. The design of the camera trap survey was based on a 2012 feline study at the Serranía La Lindosa RFPN. The design was a joint effort between community monitors and WWF staff and used results from the La Lindosa study to indicate presence of big cats in the corridor area. The exact locations for cameras were determined by ecological characteristics and also dependent on the participation of landowners to participate in the study.

The cameras were set out for two and half months, between December 2021 and February 2022 (Figure 8). The cameras collected 43,082 images from this period with nearly 80% of the images capturing animals. Three pilot team members (1 person from CDA, 1 community member and 1 staff from WWF) uploaded and reviewed the image identifications in Wildlife Insights over a period of two weeks. These stakeholders found that the AI model performed well in detecting animals in images, reporting that it was helpful to have bounding boxes in images taken at night. One setback for the team was that the platform requires a stable internet connection to catalog and process images. This presented difficulties for stakeholders as the internet connectivity in regional capitals in Guaviare is limited and is even less reliable in more rural areas. Despite these difficulties, they reported that the platform was very agile, and the integrated features made it easy to process information.

Figure 8. Location of cameras set out in the Jaguar Corridor and surrounding areas. Red dots within the blue outline represent individual cameras set within the Corridor. Red dots outside of the blue outline represent cameras set outside of the Corridor.

Data analysis

After the images were uploaded and reviewed in Wildlife Insights, WWF worked with local communities (approximately 5 people each community) in the field to analyze and understand the data using the Data Explorer tool. The results from this study provide data to support continued efforts by the ASL and partner organizations to promote the Jaguar Corridor. The results confirm a significant jaguar presence in the corridor, as well as diverse and abundant species that are important prey for the jaguar. Of the 57 species of mammals and 43 bird and reptile species captured in images, at least 12 jaguar prey species were commonly found. In addition to the jaguar, four other species of felines were detected – Puma *(Puma concolor),* jaguarundi *(Herpailurus yagouaroundi),* margay *(Leopardus wiedii)* and ocelot *(Leopardus pardalis).* There were also various at-risk species detected (for example the white-lipped peccary, *Tayassu pecari;* giant anteater, *Myrmecophaga tridactyla*) and the images captured a species that had never been detected in the region before (Greater grison, *Galictis vittata)* (Figure 9).

Figure 9. Image of the Greater grison, a species that had never been detected in the region prior to this pilot project. This image was captured in the second camera trapping season, carried out in February 2022. The Greater grison detection mentioned in this report was captured on video.

Using the Data Explorer tool, the team found that overall species richness in the Jaguar Corridor area is higher than in areas outside the corridor. However, these findings may not be significantly different and could be attributed to the difference in number of cameras set out in each area. Further investigation is needed to verify this finding.

Despite the high anthropic intervention and high fragmentation of the landscape, the data collected also supports the claim that the basic natural conditions exist in the area to restore the ecological connectivity for jaguar populations.

Impact

Local communities reported a positive experience with the pilot project. After presentations of the project results in community meetings, community members became very interested in the corridor and the variety of species that are found on and around their property. This has given community members a new perspective on the value of biodiversity in their region and has motivated interest in alternative conservation efforts, including eco-tourism and ecological certifications/branding for products contributing to jaguar conservation.

The project has also sparked interest in alternative ways to designate the corridor as a Civil Society Nature Reserve (a private conservation category within Colombia's National System of Protected Areas) and Other Effective Conservation Measures (a designation for areas that are achieving conservation outcomes outside of protected areas).

Overall, this project has been a successful example of engaging and motivating local communities to support conservation-focused efforts. This is a promising model to replicate across other sites, as it not

only establishes verifiable evidence to validate conservation efforts, but also ensures the activities are sustainable by placing ownership of the project and outcomes in the hands of local communities.

Tabaconas - Namballe National Sanctuary, Peru

Background and key questions

The Tabaconas – Namballe National Sanctuary (SNTN) is a protected natural area located between the Tabaconas and Namballe districts of Cajamarca, Peru, and lies within a landscape mosaic of private conservation areas and local communities (Figure 10). The sanctuary is administered by the National Service for Protected Areas of Peru (SERNANP) and was established in 1988 to conserve one of the remaining paramo ecosystems in southern South America. The area hosts a diversity of flora and fauna species, including species in danger of extinction such as the Mountain tapir (*Tapirus pinchaque)* and the Andean bear (*Tremarctus ornatus*).

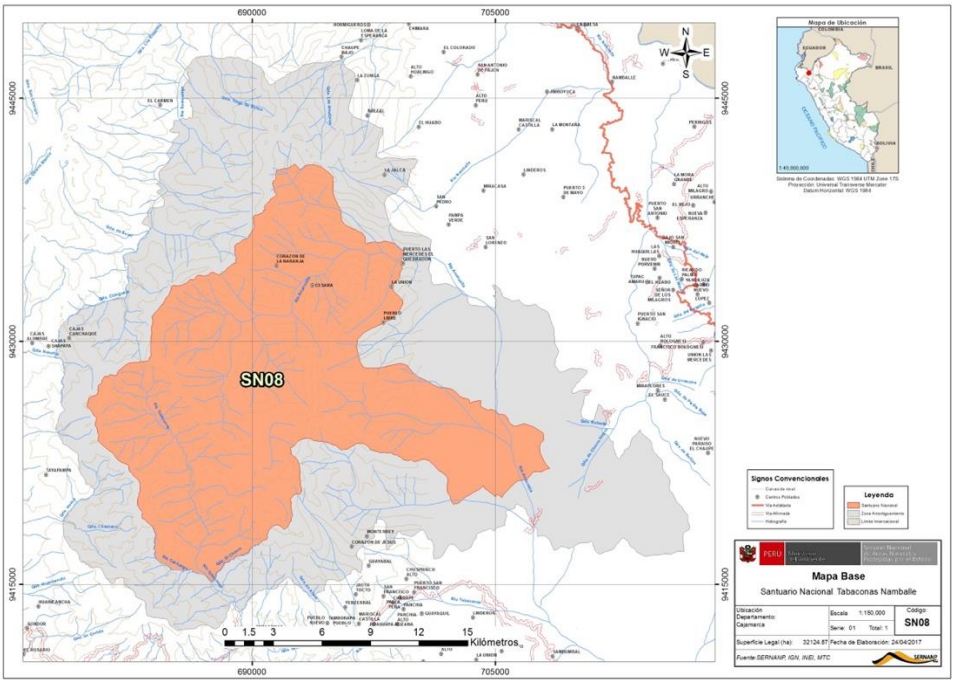

Figure 10. The boundaries of the Tabaconas Namballe National Sanctuary are shown in the map above. Tabaconas is highlighted in orange.

The main threats that affect the conservation of these ecosystems and the diversity of species are concentrated in the areas surrounding the limits of the sanctuary. There is great pressure to develop agricultural areas for coffee plantations, as well as pressure from cattle ranching and logging for commercial use. Other current threats include poaching, uncontrolled burning, and illegal mining.

The ASL project is being implemented by SERNANP with supervision from WWF included SNTN among the areas of intervention for on the ground activities. complementing these efforts. WWF Peru is

supporting activities in the SNTN including community monitoring, especially with camera traps, and to establish the baseline population of the Mountain tapir. In the past, this participatory approach has resulted in positive outcomes to mitigate threats. Carolina Guevara, the SNTN Manager, believes it's necessary to continue these efforts to strengthen conservation efforts and address the threats to umbrella species.

To assess species status, SNTN managers have used indicators for presence/absence in the past. However, the aim is to generate occupancy rates to assess habitat use and inform the next update of the SERNANP Master Plan[9]. In addition, for the Mountain tapir, there's a need to scale work to a multi country level and connect with other tapir conservation efforts throughout its range, including in Ecuador.

Data collection and processing

No additional data collection was completed for SNTN, as a collection period had already been planned for 2022. Still, SNTN had collected camera trap data between 2014 to 2017 to monitor the populations of the Andean bear and Mountain tapir. This dataset, which included over 57,000 photos collected from 351 deployments, was originally processed using a different software product (CameraBase). About 83% of the photos collected contained animals, while the remaining 17% of images were blank (i.e., had no object or animal of interest). For this pilot case, the data was uploaded to Wildlife Insights through a backend process (a direct connection to the database, rather than through the WI website tools) that retained all metadata recorded with the images, including species identifications, locations and individual animal details. The code written for this pilot project will be added to the Wildlife Insights Data Migration code repository, which is a publicly available service offering code to convert data from other camera trap data software into the Wildlife Insights data standard. The code written for this project, along with existing code in the repository, offer tools for users to easily migrate their work from their old systems to Wildlife Insights.

While this data had already been identified, in-person workshops were held with SNTN staff to train them in the use of Wildlife Insights and the ASL Data Explorer tool.

Data analysis

The dataset recorded 99 animal species, with the most common species being the black agouti, the great spotted pigeon, the South American coati, the ocelot and the mountain tapir.

During the in-person workshop, SNTN staff used the ASL Data Explorer tool to investigate outcomes in the two priority ecosystems: the montane forest and the páramo (Figure 11). The montane forest shows a higher species richness compared to the páramo and also shows higher occupancy for the Andean

[9]The Master Plan is a management tool for NPAs and is considered a high-level planning document that guides the development of participatory management. It is elaborated through participatory processes that integrate all stakeholders involved in its conservation, including regional and local authorities, the private sector, and citizens. Read more at Tabaconas Namballe National Sanctuary Master Plan 2015 - 2019 (in Spanish).

bear. However, the páramo shows a higher occupancy for mountain tapir. The SNTN staff were excited about the potential for the tool to help answer questions around the temporal differences between dry and rainy seasons for these species' occupancy. In addition, SNTN staff will be collecting information on other variables, such as intervention strategies (effectiveness of patrolling in the conservation of species) and the agricultural activities (livestock and crops), which can be analyzed in the ASL Data Explorer tool through the selection and grouping of points in a polygon.

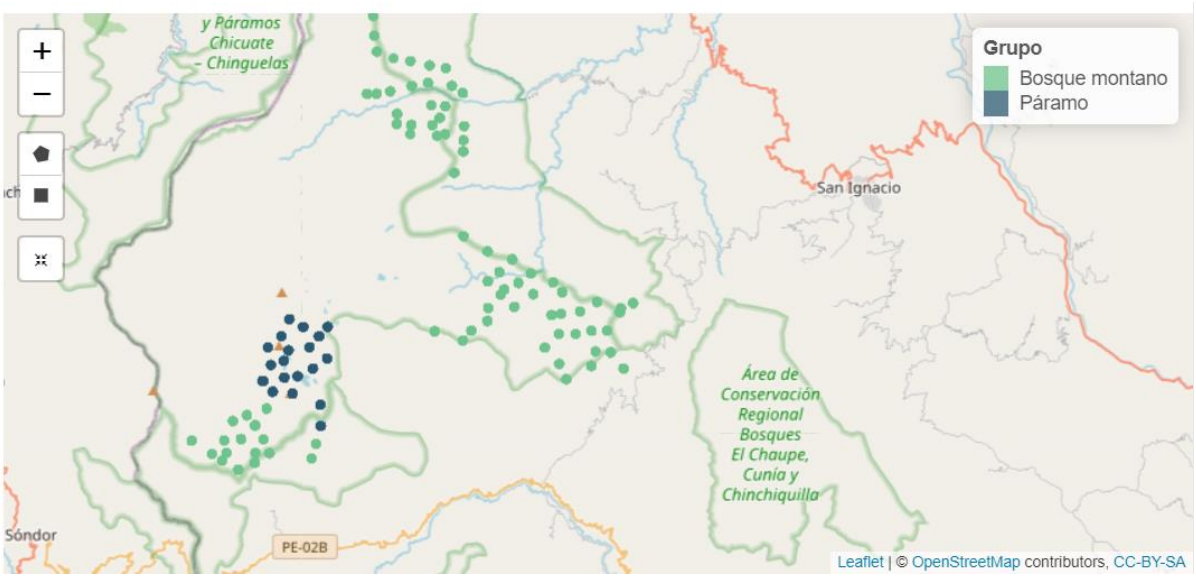

Figure 11. Cameras set in the Tabaconas-Namballe National Sanctuary. Green dots represent cameras set in the montane forest while blue dots represent cameras set in the páramo.

Impact

All SNTN staff believe that the WI platform can help them with the area's conservation challenges by providing a way to easily manage data and analyze information to assess impacts of climate change or conservation actions. Reporting from the in-person workshop shows that they found that species richness and occupancy indices were the most important in helping to answer the area's conservation questions.

The ASL Data Explorer tool will also allow them to continue analyzing long-term monitoring data, by providing the ability to analyze temporal data. In December 2022, the Sanctuary will be installing cameras for the mountain tapir baseline, for which Wildlife Insights will be a key tool in the management and data analysis process. Once data is collected, they'll be able to compare outcomes in the dry and rainy seasons and answer questions around species behavior and seasonality. These data from Tabaconas will ultimately help SERNANP build a monitoring protocol that will help to improve the park's management plans.

Benefits of the Wildlife Insights and the ASL Data Explorer Tool

All sites were able to successfully answer their conservation questions using Wildlife Insights to process the data collected and the ASL Data Explorer tool to derive insights from the data. The results from pilot studies provided valuable information about biodiversity in each pilot site and in each case validated the effectiveness of the protected and conserved area. Many sites reported that the results from this consultancy also motivated stakeholders to explore other conservation activities. For example, stakeholders from Rio Negro and Guaviare reported that WI could be useful for ecotourism activities (as a tool to show visitors biodiversity of the area and to support biodiversity-friendly products) and to manage biodiversity data for the purpose of managing subsistence hunting and other local natural resource use agreements.

The ASL Data Explorer tool is an interactive and intuitive tool that facilitates data collection and analysis at the program level for ASL. By aggregating data across multiple sites and providing analyses both at the individual site and program level, the ASL Data Explorer tool can help identify opportunities for collaboration and knowledge exchanges between sites.

Additionally, the tool allowed anyone participating in the pilot projects to explore the data and see first-hand how wildlife indicators differed between comparison groups or different study areas. Several features of the tool were built out to promote inclusivity in data exploration and analysis. For example, common names for species can be customized for each site, icons of specific species are presented alongside analytics, and there is no need for advanced technical skills to be able to use the tool. Building an inclusive platform and analytical tool is a priority for this project, as engaging local communities is seen as essential to the success of conservation projects. In the case of Guaviare, the implementing team found that the use of the platform and tool has been successful in engaging communities and promoting conservation efforts as a source of pride and value for the region.

Further, WI has opened opportunities for the ASL and the pilot sites to scale their efforts to monitor and protect wildlife. By using WI and the ASL Data Explorer tool, sites can use staff time more efficiently and direct more resources toward other activities, like further analysis or interventions. This is helpful for existing monitoring activities as well as in the process of fundraising for future projects. The tool will be password protected to ensure locations of sensitive species (endangered or critically endangered species with a high threat of illegal hunting) are adequately protected.

Section 2: Challenges and Lessons Learned

There are several challenges and opportunities that are important to consider for any future scaling up of the effort supported by the ASL. From the discussions during Workshop 3 and the Case Study reports, the following topics emerged as priority for consideration in any follow up activity:

Unlocking resources for monitoring

The stakeholders involved in the knowledge and capacity building activities in all the pilot sites benefited from the support provided by existing projects including those with the involvement of the WI implementing partners support (WCS or WWF). In the case of Orito Ingi-Ande Sanctuary, the data collection phase was only possible thanks to an equipment loan from WCS as the Sanctuary does not currently own any cameras and doesn't have the budget to purchase new cameras. Following this pilot project, the Sanctuary is interested in continued monitoring and is actively looking for financing to purchase equipment and support future field efforts.

Additionally, all long-term monitoring efforts must ensure adequate funding is available to regularly maintain and replace camera trap devices. This issue is further exacerbated in the Amazon, where high humidity and frequent rain can degrade camera performance rapidly and result in a higher-than-normal turnover for camera traps. In the case of Rio Negro, 30 camera traps were installed but 9 had defects during the sampling period and 1 camera was stolen, leaving only 20 cameras actively photographing. Camera traps are more affordable and more efficient than other monitoring techniques such as manual surveys conducted by staff on foot, but still require some amount of funding to support equipment purchases over time.

Besides equipment costs, continued wildlife monitoring also requires human resources to set up and collect cameras, upload and review images in Wildlife Insights, and finally analyze data. Although the WI platform and ASL Data Explorer tool expedite the latter two of these activities, it still requires some degree of manual effort. While all three of these activities have typically been undertaken by protected area staff or visiting scientists, this can be an opportunity to establish community-based wildlife monitoring programs in which community members are involved in the various monitoring tasks. Case studies from Orito Ingi-Ande and Guaviare demonstrate the success that can be achieved with close community involvement. In both sites, several community members were trained to use and install camera traps (7 community members from Orito Ingi-Ande and 20 from Guaviare). In Guaviare, the community members were also trained to review images in Wildlife Insights and use the ASL Data Explorer tool. As a result, the community members were motivated to continue monitoring beyond the scope of the pilot project. Community-based monitoring would be a win-win, as it would support capacity building and job creation in local communities and support long-term wildlife monitoring.

Illegal hunting

Several of the sites reported illegal hunting and poaching as one of the main threats facing wildlife in their areas. During the knowledge exchange discussion in Workshop 3, participants mentioned several ideas to mitigate this problem. In protected areas such as Orito Ingi-Ande and Tabaconas, park managers reported using on-foot surveys and patrols to identify signs of illegal hunting and organizing

this information using SMART (Spatial Monitoring and Reporting Tool)[10]. However, they also pointed out that patrolling units, despite support from some projects, are underfunded and have very large areas of patrolling per unit, making the process difficult and incomplete. There is also an increased interest in using new technologies, such as drones to increase the area surveyed, find active hunters and improve overall security of patrol units. The ASL Data Explorer can be used to identify areas where hunted species are more likely to be detected and thus can help prioritize areas for increased surveillance.

Outside of protected areas, such as in the Guaviare pilot site, community members expressed concern on how to mitigate illegal hunting, since corridors are not legally protected. Discussions focused on how to increase vigilance by community members, organize awareness campaigns across several neighboring communities, and the possibility of changing the legal status of these corridors to "Civil Society Nature Reserves" as an additional conservation designation that is active in Colombia. Similar conservation schemes are available in Brazil (Reservas Particulares do Patrimônio Natural, RPPNs). The issue of illegal hunting is widespread in many countries in the Amazon but improving knowledge on the species that are being hunted can contribute to finding solutions to mitigate this grave threat for wildlife.

Building capacity and ownership within neighboring communities

Participants in the final workshop emphasized the importance of engaging local communities and stakeholders throughout the pilot project. In some cases, like with the Jaguar Corridor project in Guaviare, community members participated directly in capacity building exercises in Workshops 1 and 2. In other pilot sites, like Orito Ingi-Ande, local community members were involved and consulted on various aspects of the project. Orito Ingi-Ande staff participated in the workshops and then held additional trainings with local community members to engage them in field activities to set and collect camera traps. Orito Ingi-Ande pilot site leads also socialized the project with local community members to request permission to install camera traps on their private land. Tabaconas staff who attended workshops held additional trainings with staff at the protected area, to engage them in the platform, analysis and plans for using the tools in future activities. WCS and WCS consultants engaged with local community members, who were essential to execute field activities as they are most familiar with local conditions and access.

One challenge during this pilot project was the lack of available resources in Spanish and Portuguese. While the Wildlife Insights platform is translated into both languages, most of the onboarding guides and presentations are created in English. During the course of this pilot project and as a result of feedback from participants, onboarding presentations and guides were created in Spanish and Portuguese. These guides are now available to all Wildlife Insights users as downloadable PDFs on our website's help page.

[10] The SMART platform consists of a set of software and analysis tools designed to help conservationists manage and protect wildlife and wild places. This includes tools like a desktop and a mobile-based application to record data about animals, illegal activities, and conservation actions. Data can then be quickly analyzed, visualized, mapped and acted upon so that park managers can rapidly respond to threats.

Capacity building in neighboring communities and local staff is an essential component to ensure monitoring activities continue in the long-term. Close involvement with these stakeholders promotes active participation and instills a sense of community ownership in the project and its outcomes. In Guaviare, the photos not only served as proof that the surrounding area was indeed an important area for jaguars and other species, but also generated excitement amongst community members to engage in the activity and other means to support conservation efforts. Their demonstrated interest and motivation are promising, as it confirms that the conditions for locally led conservation efforts, many of which have been supported by the ASL projects, are strengthening.

Supporting remote regions with offline tools

The Wildlife Insights platform is cloud-based, so it's currently only accessible in areas with an internet connection. Even in areas with limited internet, it remains a challenge to access the site and benefit from the most useful tools like computer vision models for species identification and data management features due to the time required to load pages. This presented a challenge for areas where internet connectivity is limited. For sites like Tabaconas, this hurdle was overcome by planning platform access and analytical tool demonstrations for times when staff were in areas with reliable internet access. However, in Guaviare, connectivity is very limited in rural areas and accessing the site in the regional capital was still difficult and unreliable. All participants from Guaviare highlighted the need for tools that worked offline.

Many other Amazon priority areas for camera trapping and biodiversity conservation are in remote areas where internet access is limited or unavailable. An offline version of Wildlife Insights is essential to support protected areas staff, communities and researchers working in these regions. The goal of Wildlife Insights is to support data-driven conservation action and the WI team firmly believes that internet access should not be a barrier to access any of the AI or analytical tools that can enable improved biodiversity outcomes. Conservation International has obtained some funding to develop a fully offline version of Wildlife Insights (i.e., a desktop client). It is expected that the first version of this tool will be available by July 2023 and WI will likely share development versions with some of the pilot project partners for testing.

In response to pilot site feedback, a second version of the ASL Data Explorer tool was created for offline use, which will enable pilot site participants to analyze outcomes even in remote areas. The offline version is now available as a self-contained application that can be run without internet connectivity (for example on a thumb drive). As new data is incorporated into the tool, the application will be updated and re-deployed to ASL users who need it.

Summary of lessons learned

Overall, pilot site participants reported that Wildlife Insights and the ASL Data Explorer tool opened new opportunities to engage local stakeholders, promote conservation, search for funds to support

continued monitoring efforts and ultimately drive conservation outcomes. Several participants also viewed Wildlife Insights and the ASL Data Explorer tool as useful in building stronger networks and partnerships across different organizations, states, and countries. For example, Wildlife Insights allows users to create an *Initiative*, which is a way for different organizations to easily share data with one another directly in the platform. Initiatives provide an overview of the shared projects, showing a map of project locations, a summary of data and the ability to download a standardized dataset from all projects with just one click.

Building on the concept of the *Initiative,* the ASL Data Explorer tool showcases camera trap data and more advanced analytics at the project and multi-project level. This allows the user explore data across multiple projects, for example, to see what the most common camera trapped species or to see which species have the highest detection rates across the entire ASL program. By analyzing data across multiple projects, users will be able to derive insights into how species are faring at the local level as well as across the entire species' range. This is particularly important for decision-making at the landscape or national level. The landscape level is baked into ASL's DNA as it is a regional program supporting conservation at scales that transcend traditional conservation areas (e.g., protected areas). For example, as part of its support for biodiversity conservation, ASL might want to ensure that a particular set of species is present in its entire portfolio and that these species are thriving at each of these sites regardless of whether they are protected areas, corridors, or indigenous lands.

The information provided by camera traps collected and replicated in time along several ASL sites, and the tools provided by Wildlife Insights, can answer these questions easily by checking the status of a species across the portfolio of sites and within sites. This shifts the lens away from the local scale (only) and enables ASL to fulfill its objectives (in biodiversity conservation) at the regional scale it was intended for. This knowledge will only continue to improve as more data is uploaded to Wildlife Insights and the ASL Data Explorer tool is updated. With a more comprehensive understanding of the state of key species, ASL, its partners and stakeholders can monitor and improve actions to protect wildlife.

Section 3: Scaling the use of Wildlife Insights across the ASL network

Based on the results and experiences from this knowledge and capacity building experience, ASL would benefit from the establishment of a flexible approach to implement wildlife monitoring systems (WMS) along its investment portfolio. A WMS is a system of passive sensors[11] deployed in the ground with the purpose of documenting the presence/absence of species in a given area and using this information to calculate indicators of population abundance. Sensors can be camera traps, acoustic sensors or a combination of both. Wildlife Insights would be essential to process, manage and effectively analyze all

[11] A passive sensor is a sensing device that collects information in response to an input from the environment. This input can be heat, movement, sound, visible light or any type of radiation.

data coming from this effort (for now from camera trap data only, but in the future acoustic data as well). The approach to deploy a WMS should be flexible, in the sense that it might not be constrained by rigorous experimental design but adaptable to local circumstances, while retaining minimum technical guidelines (e.g., number of sensors deployed per unit area, minimum number of sensors, groups responsible for implementation, etc.).

We propose a scaling approach that is closely integrated with ASL's strategic components to deliver activities in the Amazon areas of intervention: Integrated Protected Areas, Integrated Productive Landscapes, Policies/Incentives for Protected and Productive Landscapes and Capacity Building and Regional Collaboration[12]. Along these components there are different thematic areas where camera trapping and Wildlife Insights can improve integrated landscape management, biodiversity monitoring and the reporting of biodiversity outcomes. As ASL expands its interventions in Bolivia, Ecuador, Suriname, and Guyana (plus the original three countries in ASL, Brazil, Colombia and Peru), WMS provides an opportunity to measure biodiversity baselines and test the effectiveness of these interventions and their impact on biodiversity outcomes and ultimately livelihoods.

At the policy-level, countries signatory to the Convention of Biological Diversity are required to report progress on their plans to conserve and restore biodiversity at the national scale. These National Biodiversity Strategies and Action Plans (NBSAPs) can receive and synthesize information coming from a WMS, with Wildlife Insights tools providing results and outcomes relevant to this plan. This would be an ideal use of this WMS-derived information as it helps inform the effectiveness of biodiversity conservation in ASL countries and shares these insights with the convention at large. This applies to all the thematic areas discussed below.

Protected Areas

Protected areas are a cornerstone element of ASL's strategy, seeking to create new ones, strengthening the management of existing ones, restoring degraded areas within them (and next to them) and improving their connectivity and sustainability across the region.

The current ASL portfolio plan includes interventions in 241 protected areas distributed in Brazil (72.2%), Peru (15.8%), Colombia (5.8%), Bolivia (2.9%), Suriname (1.7%), Guyana and Ecuador (0.8% each). This portfolio covers 110.8M ha in a similar proportion to the number of protected areas invested in each country. We believe that a scaling of WMS across the ASL portfolio should follow a similar proportion to maintain representativeness of the current investment, but this is just one criterion. Additional criteria are discussed below.

[12] Amazon Sustainable Landscapes Program. Progress Report 2021. Supported by GEF. https://documents1.worldbank.org/curated/en/099725205032232624/pdf/P15923300966ab0340bcc60725666248086.pdf

Wildlife Monitoring Systems and Wildlife Insights for protected areas and other effective area-based conservation measures (OECMs)

Based on the results of the current consultancy, the WI team has identified several areas where a camera trap-based WMS in conjunction with Wildlife Insights would be useful to protected area and OECM stakeholders:

- **Establishment of biodiversity baselines:** a well-designed camera trap-based WMS can quickly and adequately collect information on the presence of 40-60 medium and large mammals and birds in a non-invasive way in areas with little or no access to infrastructure. Although camera trapping does not produce a complete inventory of all species in a given area, it captures the large and medium-sized megafauna in a forest, which are usually species of conservation interest (top predators, large herbivores, medium and large omnivores) and a large proportion of the animal biomass. Data can be quickly processed in the platform and results and relevant indicators obtained within days (number of species, species accumulation curves, functional diversity, detection rates and relative abundance of most species). All this information is very useful and relevant when creating new protected areas or assessing biodiversity for the first time in existing ones. It is also important information to gain recognition of OECMs and evaluate their potential for conservation along with protected areas.
- **Monitoring effectiveness of protected areas as measured by biodiversity outcomes**: a camera trap-based WMS can provide quantitative and verifiable information to assess the effectiveness of protected areas in maintaining/enhancing biodiversity outcomes that can feed into current tools (e.g., Management Effectiveness Tracking Tool, or METT-4.0). For example, data from a WMS can provide answers to several questions from the METT tool including question 9 (Do you have enough information to manage the area?), question 37 (Has the status of key indicator species changed?), and questions 35a-c (What is the condition of important natural values in the protected area as compared to when it was first designated?).
- **Evaluation of protected area buffer zones:** Buffer zones are an important component of protected areas as they cushion them from impending threats such as illegal deforestation, illegal hunting, induced habitat degradation, and facilitate connectivity between corridors for species. As demonstrated by the case study in Orito Ingi-Ande, a camera trap-based WMS can assess the effectiveness of buffers of different types (the legally recognized buffer for the protected area, and an additional area of natural habitat that acts as a buffer but it is not formally protected) in maintaining species integrity within it (i.e., a well preserved buffer zone had more species overall and more large cat species compared to an altered buffer zone with greater anthropogenic threats). This approach can also help designate an appropriate buffer width for a protected area that is being established. Camera traps can be deployed within the protected area and at different distances from the border of it to evaluate when species richness and other indicators converge to similar values. In protected areas dissected by rivers —like many in the Amazon which can provide easy access to illegal hunting and deforesting activities— a WMS can evaluate the optimal width of a river buffer by placing camera traps at different distances from the border and observing key species, signs of people, etc. These data

can help inform patrolling activities by focusing on the areas where most human activity is concentrated.

- **Job generation:** The deployment of a successful WMS requires the setup of camera traps, in addition to the subsequent processing and management of data. Setup of camera traps in the field is best done with the help of local people that live in the area, make key decisions on natural resources use, and have a better understanding of the physical and biotic environment around them. This provides job opportunities for local people who, under the guidance of protected area personnel, are able not only in performing the field work that this requires, but also providing assistance in the processing of the data. Local community members can be easily trained in field techniques and in data processing (which was demonstrated in this project's activities). In addition, this could lead to community-based WMS where local stakeholders feel empowered in collecting information that will help manage the areas they live in and provide ownership over the projects and data. These activities can also lead to the exploration of new opportunities in camera-trap-based ecotourism[13] where local communities would play a leading role and derive additional economic benefits. Indigenous communities and local communities could also be an important stakeholder in this front since many of them live close to or inside protected areas and have holistic knowledge of the environment around them.
- **Capacity building:** There are numerous capacity building opportunities associated with the implementation of WMS and Wildlife Insights, not only for park personnel in protected areas, but also for the local communities living around them. Implementing WMS more widely is an opportunity to strengthen ASL's Capacity Building and Regional Collaboration activities. This project has generated various materials that can be used to train people in the implementation of WMS and its processing in Wildlife Insights. These capacity building activities could lead to new job opportunities as described above and even new professional streams (like a certification or "diplomado") that could improve livelihoods and conservation as a clear win-win. For example, certification programs could be created for *Field Camera Trapping Specialist*, *Wildlife Insights Data Specialist* and even *Wildlife Insights Analysis Specialist*. These professional roles would have wider application beyond ASL and allow individuals to, for example, work in the deployment of camera traps in other areas in the country (field specialist), process data for other camera trap data projects (data specialist), and even help analyze and synthesize data for camera trap projects as a service. Partnering with universities or technical learning institutions in the countries were ASL works, would be essential to implement professional certifications like these.

[13] Camera-trap based ecotourism is an emerging activity where tourists pay for setting up camera traps in protected areas, picking them up and sometimes managing the information. It has been gaining popularity in some countries in southeast Asia allowing tourists to be more immersed in the process of collecting wildlife information. See here for an example in Cambodia and Thailand.

Protected areas with sustainable use

Many of the protected areas in ASL's portfolio classify as IUCN Category VI (Protected area with sustainable use of natural resources). Out of the 126 protected areas in the current investment, 59 are either Sustainable Reserves (16) or Extractive Reserves (43), all of them in Brazil. There is also one Indigenous community reserve in Peru (Communal Reserve Machigenga). These areas have the dual role of conservation and production which brings additional challenges compared to more "traditional" protected areas (IUCN Categories I, II and III) and requires separate management plans for each of these components. One of the pilot sites participating in this project - Rio Negro in Amazonas, Brazil - is a sustainable reserve which demonstrated how a camera-trap based WMS can be used to answer specific questions related to the effectiveness of their management plan.

Wildlife Monitoring Systems and Wildlife Insights for protected areas and indigenous reserves with sustainable use

Based on the results of this consultancy, the implementing team identified several areas where a camera trap-based WMS in conjunction with Wildlife Insights would be useful to improve, evaluate and complement the management of sustainable reserves:

- **Evaluation of management plans:** the success of sustainable reserves strongly depends on the solid foundation of a well-designed management plan and a monitoring system that allows the plan to be evaluated and validated regularly. One common use of sustainable reserves is to provide hunting and fishing grounds for wildlife species as an important source for the communities living nearby. Camera trap-based WMS in conjunction with hunting surveys, can be an effective tool to evaluate whether areas designated for wildlife use are indeed being sustainable. From the Rio Negro case study, which is not designated as a reserve for sustainable hunting (only fishing is allowed), we were able to verify that the reserve is home to many of the key wildlife species that are expected in the area, despite the fact there is an active and pervasive illegal hunting pressure over the area.
- **Capacity building and job opportunities:** Similar to strict protected areas and ecological corridors, a camera trap-based WMS offers capacity building and job opportunities for local community members. In addition to empowering local communities to monitor their own resources, a WMS can generate opportunities in tourism and other revenue opportunities. In general, WMS implemented in protected areas with sustainable use, can provide incentives for protected and productive landscapes and increase the sense of control of communities over the wildlife resources in the area.

Ecological Corridors

The establishment of habitat corridors that connect multiple protected and natural areas is another key activity in ASL's Integrated Protected Areas program. A good example is the work that ASL and GEF have supported in Colombia with *Corazón de la Amazonía* in partnership with the Ministerio del Medio

Ambiente y Desarrollo Sostenible to identify and characterize eight ecological corridors in the Colombian Amazon. These corridors are critical to ensure the continuity of habitat, species and flows of ecosystem services between the Amazon basin, Orinoco River basin and the Andean region. One of the pilot sites from this project (Corredor del Jaguar, Guaviare, Colombia) was implemented in the northern section of the Chiribiquete-Nukak corridor and provided important insights on how WMS in conjunction with Wildlife Insights can be an important component to ensure the effectiveness of ecological corridors. The ASL together with the GEF funded Global Wildlife Program is conducting a capacity building activity to their project teams on ecological corridors and connectivity. The tool developed by this consultancy could be a key piece in what can be offered and scaled up.

Wildlife Monitoring Systems and Wildlife Insights for ecological corridors

Based on the results of the consultancy, several areas were identified where a camera trap-based WMS in conjunction with Wildlife Insights would be useful to ecological corridor implementation and stakeholders:

- **Evaluation of biodiversity outcomes:** Testing the effectiveness of ecological corridors in maintaining connectivity for wildlife species can be challenging. A well-designed camera trap-based WMS can provide valuable information on the presence of keystone species in corridors to verify their effectiveness. Working with local communities, one of the pilot projects - Corredor del Jaguar, Guaviare, Colombia - demonstrated this clearly by deploying a WMS with 55 camera traps in the northern section of the Chribiquete-Nukak corridor. After uploading the information to Wildlife Insights and analyzing the data, they were able to confirm the presence of jaguar, several other cat species and many of the prey species jaguars depend on (see details of case study here). The analytical tool designed for the ASL would be an essential one to support the portfolio of ecological corridors being implemented by the ASL partnership.
- **Participatory monitoring activities:** Because corridors are usually not protected areas themselves, it is up to the communities living in these areas to implement monitoring systems for wildlife in collaboration with partners and local authorities. Camera trap-based WMS are an excellent opportunity to get communities to lead and implement participatory monitoring projects as they have agency over the landscape at various scales and levels. The experience with members of the communities working in Orito Ingi-Ande and Corredor del Jaguar, demonstrated high motivation of community members to work together and become part of the solution. They cherished the ability to collect the information, visualize it and participate in the analysis.
- **Capacity building and job opportunities:** Similar to protected areas, ecological corridors offer many capacity building and job opportunities for local community members. Implementing WMS more systematically in ASL's portfolio of ecological corridors is an additional way to strengthen ASL's Capacity Building and Regional Collaboration activities and provide incentives for protected and productive landscapes generating additional economic and financial opportunities to local communities.

Restoration

Restoration is another key activity for ASL as a component of its Integrated Productive Landscapes theme with a target of restoring 48,500 hectares of degraded lands in Brazil, Colombia, Peru and Suriname. Restoration is not only a nature-based solution to mitigate climate change through increased carbon sequestration, but also offers co-benefits such as increased biodiversity, restoration of various ecosystem services and landscape resilience. Moreover, the long-term success of restoration programs is highly dependent on the recolonization of key wildlife species to degraded areas, such as pollinators and seed dispersers, that actively accelerate restoration processes[14]. The growing presence of larger predators and herbivores can also serve as another important indicator of the ecosystem returning to its "original" state as restoration and regeneration progresses. Despite the importance of biodiversity co-benefits as a key outcome of restoration, most restoration programs do not have systems in place to measure and verify if wildlife is returning, at what pace, and which species.

Wildlife Monitoring Systems and Wildlife Insights for restoration

Based on the results of this consultancy we identified several areas where a WMS in conjunction with Wildlife Insights could be useful to restoration programs. Similar to ecological corridors described above, a WMS could:

- **Evaluate and verify biodiversity outcomes:** Documenting the biodiversity co-benefits of restoration programs can be challenging. A well-designed camera trap-based WMS can provide valuable information on the presence (or absence) of species as they recolonize the area being restored. Initially, biodiversity targets can be modest, but as the project matures, more large and medium-sized mammal and bird species are expected to recolonize the area, including top predators and their prey. In addition to a target for tree biomass (or percent forest cover) for a 20–30 year restoration project, there could be also a biodiversity target measured by the number of species present, functional diversity (diversity of guilds) and expected abundances/densities of key indicator species, which should closely resemble these values for a non-degraded habitat.
- **Participatory monitoring activities:** The success of many restoration programs depends on the involvement and close participation of local communities and Indigenous peoples in the area. In many cases, restoration activities are started by local communities themselves (such is the case in the Corredor del Jaguar pilot site). Camera trap-based WMS are an excellent opportunity for communities to lead and implement participatory monitoring projects that can measure biodiversity co-benefits that are being restored. Again, the experience with members of the communities working in Orito Ingi-Ande and Corredor del Jaguar, demonstrated the value derived by community members by participating in conservation solutions, and the motivation to continue activities beyond the scope of the initial project.

[14] Elliot, S., Blakesley, D. and Hardwick, K. 2014. Restoring tropical forests: a practical guide. Royal Botanical Garden, Kew. 356 pp.

- **Capacity building and job opportunities:** Similar to protected areas and ecological corridors, restoration programs offer many capacity building and job opportunities for local community members. Implementing WMS more systematically in ASL's restoration portfolio is an additional way to strengthen ASL's Capacity Building and Regional Collaboration activities and provide incentives for protected and productive landscapes generating additional economic and financial opportunities to local communities.

Implementation of Scaling Plan

The following sections outline an initial proposal for a scaling plan of camera trap-based WMS across the ASL network. This should be considered as a very preliminary version of a plan that can be further refined and discussed. To begin, the scaling plan shall be structured around the four distinct thematic areas described in the previous section: 1) protected areas (at large), 2) protected areas with sustainable use, 3) ecological corridors and 4) restoration initiatives. The proposal starts with the premise that a scaling plan of this nature should be completed in no more than five years to start generating biodiversity information for countries to report progress towards the Convention of Biological Diversity Post-2020 Biodiversity Framework, which has targets for 2030 and 2050. A holistic budget of the plan at this stage is not included but ballpark estimates on setup and annual recurring costs of a typical camera trap-based WMS.

Planning and Site Selection

The process starts with developing the main goals, targets, indicators, and outcomes of a WMS for ASL sites. Many of the elements of that framework have been proposed already in the previous headings of the scaling section, however a framework should be collaboratively defined and discussed with ASL governments and leadership and partners, based on strategic Program goals.

Assuming the scaling will center around implementation of a WMS for protected areas and ecological corridors[15], the next step is the selection of intervention sites across the ASL network where camera trap-based WMS would be implemented and deployed throughout a period of 5 years. Out of the ASL's portfolio of 241 protected areas, we suggest selecting 40% (100) that would be implemented throughout these 5 years and distributed in proportion to the current number of protected areas in ASL's projected portfolio (ASL1 + ASL2)[16]. Similarly, the proposal suggests the selection of 25 ecological corridors distributed roughly in proportion to the number of protected areas in each country:

Country	# of PAs	# of corridors
Brazil	70 (35 in cat VI)	14

[15] In this first iteration of the plan, we do not include restoration programs as there are several unknowns about ASL restoration activities for the consultant to propose specific recommendations. We are happy to incorporate these into future versions of the scaling plan if required.

[16] This number is a starting point for the discussion. The optimal number will depend on program and strategic priorities and funding among other considerations.

Peru	16	4
Colombia	6	4
Bolivia	3	2
Suriname[17]	2	0
Guyana	2	1
Ecuador	2	1
Total	100	25

Table 1. Distribution of camera trap-based WMS among protected areas and corridors.

Protected areas with sustainable use (IUCN category VI) would comprise half of the portfolio only in Brazil (35), given that the ASL portfolio is not planning to add protected areas in this category in other countries (as far as we know). Sites would be selected based on multiple criteria, depending on ASL's priorities, but we propose that the following dimensions are considered:

- Selection process is open and transparent to all ASL partners
- New protected areas are represented along current ones
- WMS are distributed more/less evenly throughout the Amazon areas of intervention both across a latitudinal and latitudinal gradient
- WMS are implemented in protected areas distributed across a range of threats (deforestation, hunting pressure, agricultural frontiers, etc.)
- Implementation of WMS sites with more technical experience is done first so they can act as trainers for subsequent sites
- Sites share similar questions and issues as the ones proposed in the sections on protected areas, protected areas with sustainable use and ecological corridors.

Rather than dividing evenly the implementation over the 5 years we propose a scale-up regime were the number of sites increases gradually over time:

The rationale for this schedule is that the sites implemented in the first year train the second cohort and the sites in this cohort become the trainers for the third cohort, etc. (train the trainers model). Although the number of sites implemented increases every year, there are more trainers available every year and the work is more distributed among the networks. A similar regime would be proposed for the 25 ecological corridors.

[17] Corridors might be less important in countries with a large proportion of forest cover such as Suriname or Guyana

Country	Year 1	Year 2	Year 3	Year 4	Year 5	Totals/country
Brazil	3	6	12	20	29	70
Peru	2	4	5	4		15
Colombia	1	2	2	1		6
Bolivia	1	1	1			3
Suriname	1	1				2
Guyana		1	1			2
Ecuador		1	1			2
Totals/year	8	16	22	25	29	100

Table 2. Implementation schedule for camera trap-based WMS in protected areas

Capacity Building

After site selection there will be a process of capacity building where existing technical expertise within the ASL network and partners can be transferred to sites with no experience in camera trapping. Main components of a capacity building program will follow closely the structure of Workshops 1 and 2 implemented in this project, namely:

- **WMS design:** This will include conceptual elements such as, what is the WMS for; who are the major stakeholders, beneficiaries and actors; which questions can be answered with it; identification of major design contrasts (e.g. managed area vs. non-managed area); statistical design (e.g. how many cameras, how far apart are they, how are they distributed in the landscape, how long are they left in the field, how often are they deployed).
- **Field techniques:** Basic concepts delivered would include, what are camera traps, how are they programmed, how are they set up in the field for optimal detection of wildlife, design and implementation of field campaigns for setup and pick up of equipment, basic maintenance and repair.
- **Data management in Wildlife Insights:** This section will include a full training on the use of Wildlife Insights once camera trap data is collected and will include how to create projects, how to upload camera deployment metadata, image upload, image identification and cataloging, verification and data download.
- **Principles of data analysis and exploration of camera trap data:** this training will allow stakeholders to learn the major principles of data exploration and analysis of camera trap data using Wildlife Insights tools (e.g., Data Explorer tool, standard analytics within the platform).

Capacity building activities will be offered every year (or in line with the schedule agreed for site implementation). ASL should draw on the expertise of the organizations who already have strong expertise in this field to implement capacity building activities. The implementing partners in this project

would be a good start, but additional partners/organizations in the region can be explored. One important point would be to include sites that have been trained, as potential trainers of new cohorts of sites that are trained progressively in a trainer to trainers model (four sites have already been trained through this current consultancy). This improves the capacity of the network gradually and gives more autonomy to the units implementing the WMS moving forward.

Field Implementation and Data Processing

After capacity building activities have been completed, sites are ready to deploy the camera trap-based WMS in the field according to the design and specifications agreed upon during the design stage. These activities should involve a mix of community members, technical experts and field coordinators who can manage field campaigns. Field implementation, that is installing cameras and then retrieving them, should take no more than three weeks (sometimes much less depending on the number of teams in the field) and cameras should be operational for a period of 30-45 days in the field. After cameras are retrieved, images can be uploaded on Wildlife Insights if internet connectivity is available or processed in WI's desktop client (in development) which does not require connectivity[18]. This process should take no more than two weeks, sometimes less depending on the number of images collected and the number of people processing the data.

After data has been processed, each site should be able to generate a report with the main findings of the field survey using existing Wildlife Insights analytical tools (e.g., ASL Data Explorer tool, platform analytics). Field campaigns can be redeployed to coincide with METT assessments or other national-level PA effectiveness systems (e.g., every 1-5 years) to measure progress in species trends and other biodiversity outcomes and threats depending on local site conditions.

Knowledge Exchange Workshops

Similar to what was implemented in this consultancy, there should be an annual knowledge exchange workshop bringing together teams from the different participating sites. These workshops will allow sites to learn from each other's experiences, present interesting results and report back to ASL at large on progress.

ASL Indicator dashboard

To summarize and track progress in the deployment of the WMS, Wildlife Insights and partners would deploy an indicator dashboard that would keep track of various Key Performance Indicators (KPIs) agreed upon from the start of the scaling plan. KPIs would include operational-based indicators - such as number of sites and people involved, number of cameras and effort, area monitored, etc. - and outcome-based indicators, such as number of species monitored, trends of wildlife populations, number of interventions implemented at different sites, livelihoods improved, economic gain of communities, etc. This tool would be an important asset to keep track of the plan's progress, identify issues early and adapt to changing circumstances.

[18] Images will be automatically synchronized with Wildlife Insights in the cloud when internet is available.

Communications Plan

One of the nice things about a camera trap-based WMS is that it can generate a large number of stories based on the images collected, the people working with them, unexpected discoveries, new reports of species, implementations of new actions and policies, etc. It would be important to implement a communications plan that is consistent and pervasive so it maintains interest in the project and might open additional funding opportunities. Starting with the tools already in place at ASL (newsletter, annual report, etc.), this plan could add additional communication tools like video stories, social media presence, camera trap image contests and others.

Organizational structure and governance

The planning and execution of a scaling plan of this nature requires involvement of ASL partners at different levels from the regional coordinating unit to the national ASL programs. We propose an initial organizational structure for consideration and discussion.

- **Regional Coordinator:** This person would sit at the regional ASL coordination office in the World Bank and would be responsible for overall high-level coordination and implementation in coordination with ASL country staff and implementing partners.
- **Country ASL Coordinator:** each ASL country would have a similar position as above where she/he would oversee the high-level general implementation of the WMS in that country in coordination with local partners. This person would sit at the relevant government office implementing the project (usually ministry level).
- **Country ASL Technical Manager:** this person would be the technical contact for the project at the country level and provide technical leadership and advice on WMS implementation. She/he would have the relevant technical experience and knowledge on survey design, field methods, Wildlife Insights and associated tools. This person would sit at the relevant government office implementing the project (usually ministry level) or could be at a partner organization working closely with the government.
- **Local site-level managers:** Ideally at each site, in each country, there would be a local manager who would be responsible for deploying and coordinating field work and organizing the data in collaboration with local personnel and stakeholders. These local managers could also be responsible for WMS implementation of several sites within a state, province or department, depending on the particulars of the situation.
- **Wildlife Insights Manager:** This person will be responsible for coordination of activities between ASL and Wildlife Insights. They will provide guidance on tools, approaches and indicator dashboards developed for the project. They will also supervise a technical support specialist who will resolve issues and assist with data migration when required. The manager will sit at Wildlife Insights at one of the core partner organizations (CI or WCS).
- **Wildlife Insights Technical Support Specialist:** This person will provide technical support to ASL partners and stakeholders in all things Wildlife Insights including data management and upload, use of the cloud and desktop client tools, use of analytics and associated tools, etc. This person will sit at Wildlife Insights at one of the core partner organizations (CI or Smithsonian).

- **Communication specialist**: This person will be responsible for proposing and implementing a communications strategy for the project featuring stories, videos, blogs, social media and other assets. She/he will collaborate closely with communication staff from ASL partners and others to ensure internal as well as external visibility. We believe this person should also be based at the World Bank.

We propose that the project is overseen by a Steering Committee, which reports to the ASL Steering Committee. The WMS Steering Committee would include the Regional coordinator, Country ASL coordinators, Country ASL technical managers, and the Wildlife Insights manager. The committee should be chaired by the Regional coordinator and meet annually to evaluate and discuss progress, challenges, successes and failures. It should also invite the Communication specialist to report on planned communication activities and developing stories.

Estimated costs

Here we provide estimated costs for different activities discussed in this plan. This should not be interpreted as a comprehensive budget but should give a ballpark estimate for annual and total costs of the plan.

- **Capacity building costs**: The implementation of one capacity building in-person event per year that would involve the activities described above in the capacity building section. Each event would last approximately 5-7 days and would rotate among participating countries. Number of participants would vary per year depending on the number of sites trained each year. Annual estimated cost US$25,000 - $35,000 per event. Total cost: US$125,000 - $175,000.
- **Field implementation costs first year**: based on published estimates of camera trap survey deployment costs[19], field costs for the first year of implementation are between $15,000 - $20,000, if cameras traps need to be purchased and depending on the number of camera traps needed (usually 30-40 per site). Assuming all sites will have to buy new camera traps (upper limit) the first-year implementation costs will run between US$1.5M - $2M. It should be noted that this expense can be lowered if sites already have camera traps, or they can be shared between sites within a state, province or department. Staff expenses for field implementation usually run between US$2,000 - $3000 per site per year. This will add US$200,00 - $300,000 for all sites in the first year. Total field implementation first year: $US1.7M - 2.3M
- **Field implementation costs subsequent years**: Replacement costs of camera traps are usually 10% of the original value and recurrent staff costs add an additional US$2,000 - $3000 per year. Sites will vary in the number of subsequent years of deployment depending on when they started (Table 2). For example, the 8 sites started in year 1, will have four subsequent years of implementation but the 16 sites started in year 2 will have one year less of implementation

[19]Ahumada, J. A.; O'Brien, T. G.; Badru, M.; Hurtado, J. (2016). Camera trapping as a monitoring tool at national and global levels. In F. Rovero & F. Zimmerman (Eds.), *Camera Trapping for Wildlife Research* (p. 320). Pelagic Publishing.

(three). Adding all this up gives a total of 149 WMS redeployments over 5 years at an estimated total cost of US$298,000 - $447,000.

- **Wildlife Insights subscription costs**: Wildlife Insights will need resources to cover platform development and maintenance costs, dashboard development costs and technical support. Subscription costs for a project of this extent would run between US$100,000 - $150,000 per year for a total estimated cost of US$500,000 to $750,000.
- **Communications costs**: We expect annual communication costs to run at about US$10,000 - $15,000 depending on whether audiovisual materials are produced (highest expense). Total cost: US$50,000 -$75,000.
- **Coordination costs**: It is difficult for us to estimate coordination costs at this time since we do not have enough information for all the parties. This would include personnel costs for the positions outlined above in the Organizational structure and governance section. We can revisit these costs in subsequent iterations of the plan.

  In summary, we expect the cost of this implementation plan to range between **US$2.7M and US$3.7M** for five years, excluding coordination staff costs. As discussed, these represent rough estimates that would need to be checked and validated, but they are an initial starting point.

Closing Summary

Implementation of this project has been a wonderful experience for Conservation International and all its implementation partners at WCS Brazil, WCS Colombia, WWF Colombia and WWF Peru. In the middle of the COVID-19 pandemic we were able to connect with people at these four pilot sites, deliver the training and develop the collaborations necessary for the pilot sites to define their questions, collect additional data, process and analyze that data and generate meaningful insights, all in a period of less than one year. Additionally, the challenges faced during the implementation of this project (e.g., lack of offline tools and onboarding materials in Spanish and Portuguese) and the outcomes from addressing those challenges have better prepared the Wildlife Insights team to promote the platform more widely in the Amazon region. We also learned a great deal from interacting with various stakeholders in the region including local community members, protected area managers, government officials (among others) during the various workshops. These interactions gave us a perspective of the needs of these additional stakeholders which are not our most common Wildlife Insights users (technical people and scientists) and a new perspective of how the tool can inform wildlife conservation on the ground, in addition to answering global questions about how wildlife is changing as a response to the global threats of climate change, illegal hunting and land transformation.

This project would not have been possible without collaboration from teams based in Peru, Colombia and Brazil. We want to thank all the individuals who contributed to this process, but in particular to Juliett Gonzales (Monitoring professional, Santuario de Flora Plantas Medicinales Orito-Ingi Ande, Colombia), Carolina Guevara (Protected area manager, Santuario Nacional Tabaconas-Namballe, Peru), Jaime Boanerges (Protected area coordinator, Reserva de Desarrollo Sostenible de Rio Negro, Brazil) and

Norbey Rojas (Community leader, Corredor del Jaguar, San Jose del Guaviare, Colombia). Their leadership and enthusiasm really helped make this project a successful and enjoyable experience. We also want to thank all the ASL program staff that were involved for the support of this project and for allowing us to enter your world. Finally, we want to thank the World Bank and Global Environmental Facility for their financial support.

Supporting Materials

Training and onboarding guides

- The Wildlife Insights Getting Started Guide- a comprehensive step by step guide to learn how to use the Wildlife Insights platform. Available in English, Spanish and Portuguese.
- Usar Wildlife Insights - an abridged 40-page guide created for workshops held in Tabaconas.
- Protocolo de Uso de Wildlife Insights - a quick 8-page guide created for onboarding users at Orito Ingi-Ande Sanctuary.
- Practice assignments for hands-on trainings to use Wildlife Insights. Available in Spanish.

Presentations

- Getting started with Wildlife Insights - a presentation walking through the primary steps to get started with Wildlife Insights to manage camera trap data. Available in Spanish.
- Designing and analyzing camera trap data- a presentation describing the process to design a biodiversity monitoring study with camera traps and the analyses possible with the data collected. Available in Spanish.