



## Darwin Initiative Final Report

To be completed with reference to the Reporting Guidance Notes for Project Leaders (<http://darwin.defra.gov.uk/resources/>) it is expected that this report will be a **maximum** of 20 pages in length, excluding annexes)

### Darwin Project Information

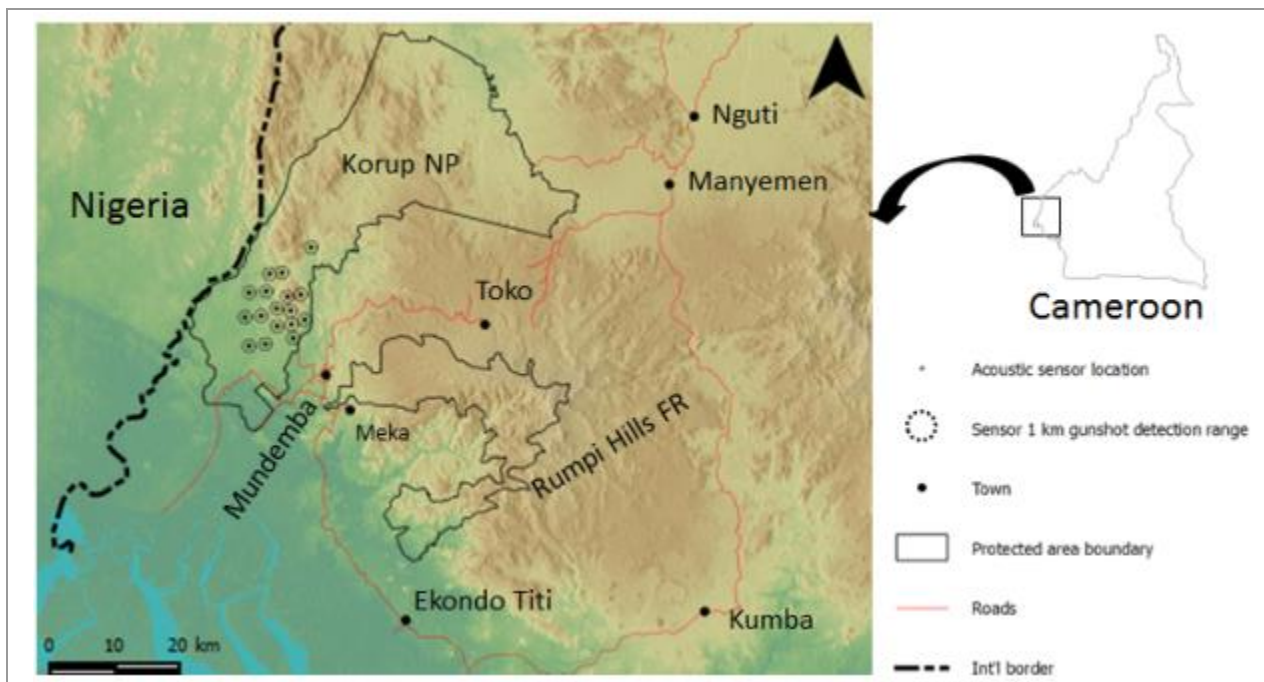
Project Ref Number	20-012
Project Title	Improving anti-poaching patrol evaluation and design in African rainforests
Host country(ies)	Cameroon
Contract Holder Institution	Wildlife Conservation Research Unit (WildCRU), University of Oxford
Partner Institutions	Cornell University (CU), James Madison University (JMU), Korup Rainforest Conservation Society (KRCS), Coastal Forests Program of WWF-Cameroon (WWF-CFP), Programme for the Sustainable Management of Natural Resources – Southwest Region (PSMNR-SWR), Ministry of Forest and Wildlife (MINFOF)
Grant Value	£240,024
Start/end date of project	April 2013 – March 2016
Project Leader Name	Prof. David W. Macdonald
Project website	<a href="http://bioacousticmonitoring.wordpress.com/">http://bioacousticmonitoring.wordpress.com/</a>
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### 1 Project Rationale

The importance of wild animal meat (“bushmeat”) for the livelihood of forest-dependent people in the Congo basin is well documented (e.g. DI-10004). Yet, in many parts of the African tropical forest zone, commercialized bushmeat hunting has dramatically increased harvest rates, reduced many game species populations, and altered forest structure and composition. Conservation efforts have largely been unable to curtail the intense, pervasive, and often illegal commercial bushmeat hunting even within the region’s most important tropical forest protected areas – the cornerstones of biodiversity conservation and critical strongholds for many threatened species. Importantly, these protected areas serve as critical “source” populations for species hunted in surrounding forest “sinks”, and therefore poaching undermines the sustainable and equitable sharing of wildlife benefits and threatens the food security of the rural poor who mostly depend on bushmeat protein. Moreover, poaching also cultivates contempt for wildlife laws in a way that undermines the PAs’ integration as part of the fabric of sustainable development.

Recognizing this, species action plans, protected management plans and Biodiversity Strategies and Action Plans in the region – the primary CBD implementation instrument at the national level – highlight the need for mechanisms to monitor wildlife populations and enforce wildlife legislation. Anti-poaching patrols are widely used as such mechanism, utilizing substantial conservation resources. However, few studies have systematically examined their efficacy in Afrotropical rainforests and none using experimental design. Lack of critical evaluation renders anti-poaching strategies – practically – blindfolded.

With this project, we are developing and providing training for a novel, evidence-based decision-support system to design and assess the efficacy of anti-poaching patrols using novel application of bioacoustic monitoring techniques. This system will improve the efficiency of PA biodiversity conservation, including of “source” populations for species that can be sustainably and legally exploited in adjacent non-protected areas. By adapting it for use beyond the Korup National Park area of Cameroon’s Southwest Region where it is being developed and tested (see map below), the project’s legacy will be multiplied.



**Figure 1:** Location of Korup National Park in Southwest Region of Cameroon, as well as the acoustic grid established in June 2013. [Coordinates of Mundemba town: N 4.9707° E 8.9101°]

## 2 Project Achievements

### 2.1 Outcome

We believe that the project has achieved its intended outcome, having successfully demonstrated the feasibility and importance of evaluating the current anti-poaching strategies in African rainforest PAs using direct evidence of unprecedented spatial/temporal resolution on the level of gun hunting activity. The study's findings, based primarily on the use of bioacoustics monitoring, have already shaken into action the management authorities in the broader Korup region and has generated discussions for further adoption of similar protocols in other PAs of the country and beyond. Our findings on the inability of current anti-poaching patrols – even after a significant restructuring in the patrol protocol (see Annex 7.1) – to curb gun hunting patterns in Korup NP is exactly the type of robust and transparent evaluation of current anti-poaching strategies that can guide the conservation community towards the development of evidence-supported new and effective strategies in the fight against the illegal and unsustainable bushmeat trade in Central Africa. Evidence to support our belief of having achieved the project's outcome is provided in the table below.

<b>Outcome:</b>	Poaching in Central Africa imperils wildlife, is illegal and undermines the sustainability of local livelihoods while legitimising a corrupted attitude between people and protected areas. The project uses robust but innovative technology, centred on acoustic monitoring, to design, implement and evaluate anti-poaching strategies, leading to the development of a novel decision-support system to be rolled out across Central Africa. Developed first for Korup NP (Cameroon), this evidence-based anti-poaching protocol is intended to efficiently protect wildlife source populations within protected areas, while laying the foundation for sustainable forest uses, and thus increased food security, job opportunities, and – ultimately – poverty alleviation.		
	Baseline	Change by 2016	Source of evidence
<b>Indicator 1</b>  By year 3, KNP management maintains an acoustic monitoring grid which it actively uses to collect and analyse data on spatio-temporal patterns of gun hunting and wildlife activity, in order to design adaptively its anti-poaching patrols.	Prior to the project, KNP management relied only on the collection of indirect, potentially biased and difficult to interpret evidence to evaluate the success of its anti-poaching strategies (e.g. collection of spent cartridges, number of arrests). The resolution (esp. temporal) afforded by the analysis of such indirect evidence was very low, making the interpretation of findings problematic (and subjective/non-transparent) and therefore of very limited use for guiding future anti-poaching patrols.	<p>By the end of the project period the Korup NP management had ~3 years' worth of acoustic data analysed for gun hunting patterns, providing continuous field evidence of unprecedented spatio-temporal resolution. The data show clear seasonal patterns that persist across years including a dramatic increase in gun hunting in the weeks leading to the Christmas/New Year celebrations (~400-500% increase over previous months). Moreover, there are clear weekly and 24hr patterns which persist across years. Such detail was impossible to obtain from the hunting signs data reported by the ranger patrols.</p> <p>Already by the end of Yr1 (baseline data) the management was impressed (and shocked) by the intensity of hunting in what is the best patrolled parts of the park. As a result, the management agreed to adopt a new patrol protocol that addressed the main Yr1 findings (i.e. add night patrols, increase patrol duration, patrol off trails). Although the protocol was not at first fully adhered (due to imperfect supervision of the rangers by site managers), the DI data were used again to show in an undisputed way that there was a 12% gun hunting increase in Yr2. The park responded by executing in full a DI prepared 4-month patrol strategy that saw ~400-500% increase in patrol effort (days + kilometres) during the 2015/16 Xmas/NY period. The DI data was used to evaluate the impact of this strategy, showing – perhaps surprisingly – that just increased effort does not achieve the anti-poaching goals. Never before did the park, or to our knowledge any other Central African PA, have access to such fine resolution data on hunting to adaptively design its patrols. The effort to develop and effective anti-poaching strategy continues.</p> <p>The DI team has trained locally 8 KNP rangers in acoustic data collection and 4 in data analysis (and 5 KRCS members in both) during workshops held in Dec. 2014 and Dec. 2015.</p> <p>The park uses all the DI acoustic sensor equipment and they are since the beginning of Yr3 deployed by a new wildlife monitoring team consisting of KNP and KRCS (ex-DI) members. Batteries for Yr4 (post-DI) have been acquired, sensors will be deployed in other parts of KNP, and there are talks of replacing the quickly aging sensors with new more efficient ones.</p> <p>The gunshot detection algorithm was improved during the study and is available for use by all.</p> <p>The use of acoustic sensors has not been incorporated in the KNP management plan as its update has – beyond the control of DI project – been postponed beyond the original 2013-14 period. It has been included in the wildlife monitoring protocol since late 2014.</p> <p>Although KRCS has the capacity to analyse now the gunshot data locally, the original plan of establishing a data analysis centre in Mundemba has not yet materialized. The delay has to do with plans to instead develop a bigger acoustic data analysis “hub” in Buea (MINFOF/PSMNR Headquarters) where a trained team will analyse acoustic data from 3-4 PAs.</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p> <p>Annex 7.2: Patrol protocol for Yr2</p> <p>Annex 7.3: Patrol Protocol for Xmas/NY 2015-16</p> <p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p> <p>Annex 7.4: Photographs from 2014 - 2015 workshops in Mundemba</p> <p>Annex 7.5: MoU between KRCS and PSMNR on the delivery of monthly monitoring in KNP</p> <p>Annex 7.6: Screen capture of gunshot analysis software – self-standing (no need for MatLab)</p> <p>Annex 7.7: Wildlife monitoring plan for KNP</p>

<p><b>Indicator 2</b></p> <p>Gun hunting pressure is significantly reduced in monitored areas within KNP during year 2 compared to baseline data collected in year 1. The reduction is higher in the core area of KNP (-30%) where the new anti-poaching regime will be tested, compared to monitored control-sites in the periphery of the core (-15%) and near farms (<math>\pm</math> no change).</p>	<p>The baseline was obtained from the Yr1 data on gunshot intensity and it showed a mean number of gunshots per sensor per day being 0.48 (total: 2,044 gunshots per year within the 54 km<sup>2</sup> acoustic survey area – 12 sensors). The sensors in the periphery of the “core” has a marginally higher gun hunting intensity already in Yr1.</p>	<p>The analysis of the acoustic data provided undisputed evidence of actual hunting incidents (not just indirect signs of hunting incidents). The comparison of Yr1 and Yr2 data showed a 12% <i>increase</i> in total gunshots. This was disheartening of course, but not especially surprising given that the agreed increased patrol effort protocol developed by the DI team and introduced to the rangers was not wholly implemented primarily due to ineffective supervision of the rangers which was not within the power of the DI team to address.</p> <p>An additional complication in year 2 was the outbreak in West Africa (and arrival in neighbouring Nigeria in Aug. 2014) of the Ebola virus. This led to the closure of Nigerian bushmeat markets severely affecting for the months of August-September (Yr2) the trade of bushmeat in the Korup region, as most bushmeat is taken across the border for sale in Nigeria where the bushmeat prices are ~double. This provided a unique opportunity to document the impact of a major zoonotic disease outbreak and subsequent market closures on hunting intensity, documenting a sharp but short lived decrease in hunting intensity over the previous months and previous/following years. This “dip” in hunting inside the study area was detected by our acoustic sensors and by the concurrent hunter surveys, but not in the bushmeat price surveys. There are important lessons to be learnt from this perturbation despite the unavoidable complexities that it introduced in comparing Yr2 data with the Yr1 baseline. It showed the power of political will to combat wildlife crime, even if it was for health and not conservation reasons. Moreover, it highlighted the power of the acoustic monitoring protocol used to detect such changes in field situations – power that was not matched by typical bushmeat monitoring tools used.</p> <p>Due to the challenges described, we compared the effect of massively increasing anti-poaching patrol effort on gun hunting intensity not by comparing Yr1 and Yr2 data, but instead comparing three 4-month periods (Nov – Feb) for 2013/4, 2014/5, and 2015/6. This comparison showed that patrol effort (e.g. days, km walked, % night patrols) were not good predictors of overall hunting intensity, unlike rainfall (negative) and moon luminosity (positive). However disappointing this finding may seem, it shows clearly that it is not just the quantity but also the quality/nature of the patrols that need to change. Additionally, our results indicate that other measures (such as crack down on bushmeat markets, raising awareness of national laws) should be considered as anti-poaching strategies.</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p> <p>Annex 7.8: Presentation on the effect of the market closures on bushmeat hunting in Korup NP during the Ebola outbreak in neighbouring Nigeria (presented at the UK Bushmeat Working Group + Presented during the final DI project workshop in Yr3/Buea – Cameroon).</p> <p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p>
<p><b>Indicator 3</b></p> <p>Korup’s endangered species are better protected in the core of the park, increasing the region’s potential to generate sustainable benefits for local stakeholders from their protection</p>	<p>Before the DI project, the KNP management had no reliable information on the level of bushmeat extraction from the park. Moreover, no systematic and robust monitoring of wildlife populations was in place.</p>	<p>The estimated gunshots made within the park (47,500-52,500 per year) combined with the information on hunting success and offtake species obtained from hunter surveys acted as a wakeup call to both the KNP management authorities and the PSMNR partner whose mission is to promote sustainable management of resources in the SW region of Cameroon (including Korup).</p> <p>Until the DI data, no detailed KNP wildlife monitoring strategy existed and there was no systematic/scientifically robust wildlife monitoring taking place. In the wake of the DI data reports in 2014 and 2015 respectively, we partnered with the park to develop, for the first time in the history of the park, a wildlife monitoring strategy that does not focus solely on primates/duikers and has established a KRCS/KNP wildlife monitoring team that is employed full-time to survey multiple times a year (via transects, acoustic sensors, recce walks) all sectors of the park.</p> <p>Importantly, the monthly monitoring plan for the park incorporates the line transect surveys within the DI sector, which constitutes the sole long-term (since 1990s) wildlife monitoring dataset for KNP. The DI project surveyed these transects monthly for 3 years and now they are absorbed by the</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p> <p>Annex 7.9: Village Survey report (Hunter-Household)</p> <p>Annex 7.7: Wildlife monitoring strategy</p> <p>Annex 7.23: DI transect survey report</p> <p>Annex 7.5: MoU between KRCS and PSMNR on the</p>

		<p>wildlife monitoring team. The data from the transects, when combined with the acoustic data, allow for comparisons on wildlife populations over time to be made.</p> <p>Our hunter + household survey data showed for the first time the complex socioeconomic background within which illegal hunting occurs in the broader region. We were able to show that not all local villages are similar in their reliance on hunting, and therefore would suffer differently from a collapse of wildlife populations within KNP should the current declining wildlife population trends continue. Specifically, two villages had professional/full-time hunters operating throughout the year. The households of these villages have higher % of meals with protein but most of it is not from bushmeat. In the third village, hunting was more infrequent, there was a greater seasonal hunting pattern (lowest intensity during the rainy season), and the households had significantly lower % of meals with protein but almost all of it was from bushmeat. The subsistence level reliance on bushmeat from this village is threatened from the market-driven intense hunting happening in the other villages. Recognizing these differences it becomes apparent that different strategies need to be adopted by rural development projects operating in the region promoting sustainable management of natural resources. Both types of villages however are going to face serious food security issues if the wildlife populations of the park are not effectively protected; the former via a collapse of their economy and the latter via a collapse of their protein sources.</p> <p>As already reported in earlier reports, the tourism satisfaction surveys were quickly abandoned as there were for all practical reasons too few tourists to the park to really be able to extract meaningful patterns during the duration of the project.</p>	<p>delivery of monthly monitoring in KNP.</p> <p>Annex 7.9: Village Survey report (Hunter-Household)</p> <p>Annex 7.10: IPS/APS Congress presentation</p>
<p><b>Indicator 4</b></p> <p>KNP's protocol to design and evaluate anti-poaching patrols using evidence from acoustic monitoring techniques is adopted in at least two other protected areas in Central Africa by the end of the project (even as a pilot study).</p>	<p>The intention of this project is not only to develop an improved anti-poaching protocol for KNP, but to change the current complacent reliance on poorly scrutinized anti-poaching strategies throughout the rainforest zone of the continent</p>	<p>Following the lessons learned from the acoustic monitoring grid in Korup NP, we have helped to expand acoustic monitoring of gun hunting in five additional protected areas in Cameroon, one in Bangladesh, one in Indonesia, and one in Greece. Specifically:</p> <ul style="list-style-type: none"> <li>- A grid of 10 acoustic sensors was deployed for one year in Cameroon's Rumpi Hills Forest Reserve (funded by USFWS "Wildlife Without Borders" grant F14AP00503), with the data analysed for gunshot hunting activity.</li> <li>- PSMNR (a DI partner) has bought acoustic sensors which are rotated across Takamanda NP, Mt Cameroon NP, and Banyang-Mbo Wildlife Sanctuary (led by DI trained Kelly Boekee / attended workshops in 2014 and 2015). The Born Free Foundation also acquired sensors for Banyang-Mbo.</li> <li>- The African Wildlife Foundation is currently deploying 2 acoustic sensors next to inselbergs in Dja Faunal Reserve (a UNESCO World Heritage site) to help inform anti-poaching patrols.</li> <li>- Pilot studies of acoustic sensors for recording illegal human activities were already conducted in Bangladesh's Sundarban and is about to be started in Greece's Evros River delta.</li> <li>- An acoustic grid of ~10 acoustic sensors is to be established in Indonesia's Kerinci sealt NP (Sumatra) with the aim of monitoring illegal human activities (esp. gun hunting) as part of a broader tiger conservation initiative (collaboration WildCRU, University of Oxford and Flora and Fauna Int'l – more information from Prof. D.W. Macdonald at WildCRU).</li> <li>- The Yr3 final workshop in Cameroon (Buea, Dec. 10-11, 2015) was well attended by representatives of Cameroonian and Nigerian NGOs, scientists, conservation practitioners, and government agencies.</li> <li>- The DI project's website shares information on the web on our findings and practical advice.</li> </ul>	<p><a href="https://www.fws.gov/international/pdf/project-summaries-africa-2014.pdf">https://www.fws.gov/international/pdf/project-summaries-africa-2014.pdf</a> (USFWS project summary)</p> <p>Annex 7.11: Photos of acoustic monitoring pilot studies</p> <p>Project website: <a href="https://bioacousticmonitoring.wordpress.com/">https://bioacousticmonitoring.wordpress.com/</a></p> <p>Annex 7.12: Photographs and list of participants from final workshop</p>

## 2.2 Impact: achievement of positive impact on biodiversity and poverty alleviation

### Impact statement from logframe:

The extent of the African bushmeat trade has reached crisis levels, threatening entire ecosystems as well as the food security and livelihoods of forest dependent rural populations. Protected areas are a key component in the strategy to address the crisis, and enforcement of wildlife legislation is critical to protected areas' success. By developing an improved design and evaluation of anti-poaching patrols in Central Africa, the project contributes to the *mitigation* of the bushmeat crisis overall, protecting endangered biodiversity, fostering the sustainable use of legitimate resources in park periphery, and generating alternative training and employment opportunities to hunting.

The link between sustainable management of wildlife resources and rural poverty alleviation is well understood.

The unparalleled insight on the baseline gun hunting intensity and patterns in Korup NP afforded by the analysis of the acoustic data collected in Yr1 (Annex 7.1) and presented to the DI partners in July 2014 + Dec. 2015 workshops (Annex 7.17) created a stir, as it became clear that natural resources of Korup were exploited at rates not previously thought, even at the core of the park. It was this realization that led our PSMNR and KNP DI partners to accept DI suggestions to re-haul current anti-poaching patrol strategies by supporting the increase patrol protocol for Yr2 (Annex 7.2) and eventually the Nov. 2015 – February 2016 patrol “flooding” of the acoustic grid area (Annex 7.3).

The finding that patrols are not effectively curbing gun hunting intensity even after the massive increase in Yr3 (Annex 7.1) is a shocking awakening as to the challenges faced by the region's wildlife management authorities. This uncomfortable (but invaluable) truth leads to the conclusion that the most widely used tool for combatting bushmeat trade – the foot patrol – needs to be rethought completely. It is not a just a matter of hiring more people or throwing more money to the problem. Patrols need to be planned carefully, evaluated frequently and robustly, and adaptively redesigned based on feedback from the field. As the patrol evaluation and design protocol developed by this project is rolled out in more areas (see Annex 7.11), the regional authorities' ability to effectively protect the source populations of game species that can be legally hunted in adjacent communal forests will increase, helping directly to improve the food security and livelihoods of forest dependent rural populations. Importantly, our project has not only highlighted the need for change, but also developed the tool for achieving it.

Our findings in Korup also led to the development of a wildlife monitoring strategy plan by the DI project (Annex 7.7) and the establishment of a KRCS/KNP monitoring team to deliver it. All wildlife collected data until now in the park were collected by the anti-poaching patrols on an ad-hoc (and wholly inconsistent – and hence unusable) basis. This development has already improved the management and monitoring of the KNP wildlife resources.

The hunter survey data provided information on the very significant financial incentives for continuing hunting for some hunters (Annex 7.9) – another shocking finding on the challenges of mitigating the bushmeat trade. Development/poverty alleviation projects focusing on promoting sustainable alternatives to hunting must provide income generating activities that compare favourably to the quick and significant profits from hunting. Otherwise, the opportunity cost from being involved in new economic activities will be too high to make them viable. The hunter surveys also showed that hunting patterns are different not only at the level of individuals, but at the level of entire communities. The drivers of these community-level differences need to be understood (e.g. distance to markets? cultural?) in order to develop targeted actions that are likely to be successful both in terms of rural development and biodiversity conservation. This knowledge is currently taken into consideration by PSMNR who leads the community development initiatives within and in the periphery of KNP.

The household data also shows that bushmeat is certainly an important component of local diet but the species diversity is lower than that of the species extracted from the forest (Annex 7.9). The data generated are helping to understand better the bushmeat trading patterns across communities, as it is important to ensure that both food security and biodiversity conservation is achieved in the long run in the region. The outbreak of the Ebola virus in West Africa in 2014 and the ensuing bushmeat market closures across the border from Korup for over a month

showed that if political will exists, then bushmeat outlets can be quickly shutdown (Annex 7.8). This important point for biodiversity conservation planning would not have been missed if it were not for the acoustic monitoring grid in Korup NP. The effect on the region's gun hunting was not as clearly captured by either the hunter or the bushmeat market surveys (Annex 7.9).

Beyond fostering the sustainable use of legitimate resources in KNP periphery, our project also provides training and employment opportunities to local communities. In Year 1, we provided training (e.g. acoustic monitoring, various survey techniques) to 14 locals (mostly former hunters). In Year 2, we provided similar training to the 11 participants of the December 2014 workshop (KRCS/KNP/WWF staff) and to six people at the village of Meka, where the Rumpi Hills acoustic monitoring team was recruited from. In Year 3, the project led to the establishment of the KRCS/KNP wildlife monitoring team and the long-term employment of 4 KRCS members in it.

Our project has also continued to provide support to the local conservation NGO – and DI partner – KRCS. Through projects like this one, KRCS gains important project management and data collection/analysis skills that will enable it be a positive catalyst for promoting research-related benefits in the region, and hence increasing local valuing of wildlife for something other than hunting. In fact, already in Year 3 facilitated two MSc wildlife research projects in the Korup region (Oxford Brookes - MSc in Primate Conservation students), creating additional local wildlife-focused employment opportunities.

Finally, while our project alone may not be able to drive tourist revenue for the region, with time the improved conservation of charismatic species in the region's protected areas (combined with the commitment of the government for infrastructural improvements via an international grant) could bring change in this economic sector as well.



## 2.3 Outputs

Output 1:	“KNP staff are trained and able to implement the new anti-poaching evaluation and design protocol (year 2/3).”			
	Baseline	Change recorded by 2016	Source of evidence	Comments
<p>Indicator 1.1</p> <p>The new anti-poaching protocol is approved by MINFOF and included in the new KNP management plan (Yr2).</p>	<p>The KNP management plan was planned to be updated for the 2013-2016 period.</p>	<p>The KNP management plan has not been updated as originally planned for reasons beyond the control of the DI project (the current plan was also updated with 1-2 years delay). Nevertheless, the DI partners developed a wildlife monitoring plan for KNP in 2014 which already serves as the basis of the new wildlife monitoring protocol for the park, and the acoustic grid has been incorporated in it and is currently maintained by the KNP/KRCS team. The wildlife monitoring plan is a lot more detailed in what would have ever been included in the management plan.</p>	<p>Annex 7.7: Wildlife monitoring plan for KNP</p>	<p>The wildlife management plan has not been officially finalized yet by MINFOF/KNP.</p> <p>We still believe it will be important to include the use of acoustic sensors as an anti-poaching tool in the management plan when it is updated, and we follow the relevant development so as to do this.</p>
<p>Indicator 1.2</p> <p>A group of 8 KNP game guards is trained in setting and maintaining the ARU grid in the field, while 4 KNP management staff are trained in analysing the acoustic monitoring data (Yr2).</p>	<p>There were no personnel of KNP or another Cameroonian PA who were trained in the use of ARUs and the analysis of acoustic data before the project.</p>	<p>In a workshop held in Dec. 2014 we trained 12 people (4 KNP game guards including the heads of the Wildlife Monitoring Unit and the Anti-poaching Unit; 2 WWF-CFP park advisors to KNP; 5 KRCS members; 1 PSMNR employee who would lead acoustic surveys in other PAs) on how to maintain the acoustic grid (i.e. tree climbing, sensor set up, battery/SD card change, data management) and how to review the data using the audio software Raven. In Dec. 2015, just before the final workshop, we trained 5 people (4 KRCS members including those who now form the core of the KNP-KRCS's wildlife monitoring team; the PSMNR employee) on more advanced data analysis techniques.</p>	<p>Annex 7.4: Photographs from 2014 - 2015 workshops in Mundemba</p>	<p>While KRCS/PSMNR now have people trained to undertake the gunshot analysis, the acoustic monitoring hub has not been established in Mundemba as originally planned as it was agreed during the final workshop that a more centrally located hub in Buea (MINFOF regional HQs) would be preferable to provide analysis for several SW region PAs.</p>
<p>Indicator 1.3</p> <p>First anti-poaching report using acoustic monitoring data collected and analysed by KNP staff is submitted to PSMNR-SWR/MINFOF (Yr3).</p>	<p>The reports submitted to KNP for patrol design only used crude measures of patrol effort and hunting signs.</p>	<p>Since January 2016 the KNP/KRCS monitoring team has been maintaining the acoustic grid on their own. However, the analysis was done at Cornell (Peter Wrege) while we await the establishment of the analysis hub in Buea. The KNP/KRCS's computer power would make the analysis too slow to be able to advise the design of patrols in a timely manner. PSMNR collected data from other PAs were analysed in Cameroon (fewer days) and double checked by Cornell.</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p>	



Output 2:	<i>"Poaching patterns within KNP are understood so as to be effectively combated with available resources, affording wildlife in the park's core area (at least) a markedly higher level of protection (year2/3)."</i>			
	Baseline	Change recorded by 2016	Source of evidence	Comments
<p>Indicator 2.1</p> <p>Report submitted to MINFOF presenting gun hunting and wildlife activity pattern changes between year 1 and year 2 (24 months; 12 ARUs + 4 line transects + hunter interviews) (year 3).</p>	<p>The KNP was relying on crude reports on illegal sign encounters in the park, based on data irregularly collected during the game guard patrols. The reports had no informational value practically.</p>	<p>The DI has presented preliminary and final results on gun hunting intensity + transect survey findings to the DI partners (incl. PSMNR, KRCS, WWF-CFP, KNP) throughout the project. Specifically, the Yr1 gunshot results from the acoustic grid were presented during a workshop held in Buea on July 2014, which led to the agreement that a wildlife monitoring strategy should be developed for the park using acoustic sensors and that a new patrol was needed for Yr2. Additional results were presented during the Dec. 2014 workshop in Mundemba. The Yr1-2 gunshot results and the worrisome patterns on wildlife encounter rates for some species based on the results from the transect surveys were presented to all DI partners and the final workshop participants during a series of 5 presentations delivered in Dec. 2015 (Buea / MINFOF headquarters). Finally, a final report including Yr1-3 gunshot data and the evaluation of the 4 month intensive patrol during Xmas/NY 2015-16 on hunting was presented during the final report to partners.</p> <p>The findings presented in the final Yr1-3 report regarding the effect of a marked anti-poaching patrol effort on gun hunting intensity within the acoustic grid area in Xmas/NY period 2015-16 compared to previous years, constitutes the first ever robust evaluation of anti-poaching methods within a Cameroonian and possibly C. African PA as far as we are aware. The fact that a ~400% patrol increase effort from Nov. 2015 to Feb. 2016 did not manage to curb the high gun hunting pressure on KNP's wildlife is perhaps shocking, but it is nevertheless an invaluable lesson as to the complex nature of poaching and the need to robustly understand its drivers so that effective measures can be developed.</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p> <p>Annex 7.23: Di report on transect survey findings</p> <p>Annex 7.13: Final workshop presentations</p>	<p>The level of spatio-temporal detail on the distribution of actual gun hunting activity (and not of indirect indicators) in KNP is unprecedented and constitutes a revolution in a rainforest PA management.</p> <p>The project's findings on current levels of gun hunting pressure in KNP (and preliminary findings in other regional PAs where the DI-project protocol has been piloted) were in part responsible for PSMNR's decision to hire a person who will be explicitly focusing on improving the efficacy of anti-poaching patrols which PSMNR funds.</p>
<p>Indicator 2.2</p> <p>Report submitted to MINFOF presenting the findings of the socioeconomic surveys on the role of</p>	<p>Bushmeat market surveys had been conducted previously in the Korup region, but the emphasis</p>	<p>Preliminary findings from the hunter, bushmeat price, and household consumption surveys were presented to the DI partners during the final workshop and formed the basis of the analysis by Kennedy Kariuki's (WildCRU postgraduate-diploma student) independent project in 2015. That analysis examined the efficacy of the different survey methods – compared to the actual gunshot intensity in the</p>	<p>Annex 7.9: Village Survey report (Hunter-Household-Bushmeat Prices)</p>	

<p>bushmeat in the livelihoods (food/income) of local communities (year 1-2 data; 3 villages) (year2).</p>	<p>was not on price. Household meal consumption surveys had not been conducted to that extent and duration in the Korup region since the 1990s. No tourist satisfaction surveys had been ever attempted. Hunter surveys of short duration had been conducted previously in the Korup region but not for several years since the start of the project.</p>	<p>study area calculated from the acoustic data – to detect a known pronounced but short term perturbation in the hunting pattern. Specifically, in August 2014 the Ebola virus reached neighbouring Nigeria, leading the government to quickly shut down bushmeat markets until the end of Sept. 2014, when the country was declared Ebola free. While the acoustic data clearly detected a significant decline in hunting intensity inside the KNP for ~1.5-2 months as compared to previous months that year and the same period in other years, that decline was only detected (less pronounced) by hunter surveys. The bushmeat market surveys did not capture the change either in volume of bushmeat carcasses traded or the price of bushmeat. The findings of this study were also presented at the Student Conference in Conservation Science in Cambridge (March 2016) and the UK Bushmeat Working Group meeting in London (April 2016).</p> <p>As reported in earlier reports and in section 2.1 (Indicator 3) above, the tourism satisfaction surveys were abandoned in Yr1 as there were too few tourists to the park to extract meaningful patterns during the duration of the project.</p> <p>In section 2.1 (Indicator 3) we have also explained the significance of the hunter survey data for understanding the local drivers of poaching within the park and how they differ among villages. We found that the quality of hunting and the degree to which people hunt for subsistence and commercial reasons vary across villages. For example, in Yr2, one of the hunters of the IKK village hunted singlehandedly more animals in a year than all 10 hunters surveyed in the Ngenye village. Our data also suggest that certain individuals will require significant positive or negative reinforcement to be dissuaded from hunting given the significant profits that they can make from hunting. It also shows that incentives at village level, often delivered via development projects, will be unlikely to change behaviours of professional hunters as the benefits per individual are only a fraction of the opportunity costs to these hunters.</p>	<p>Annex 7.8: Presentation on the effect of the market closures on bushmeat hunting in Korup NP during the Ebola outbreak in neighbouring Nigeria</p>	
<p>Indicator 2.3 Peer-reviewed manuscript on the efficacy of anti-</p>	<p>The KNP has never undertaken a robust evaluation of its patrolling</p>	<p>We ran two types of analyses to assess whether foot anti-poaching patrols have a measurable effect on gun hunting activity within the KNP. The first analysis involved running general linear models with gunshot intensity (shots per week/per sensor) as the response parameter, and rainfall</p>	<p>Annex 7.1: Yr1-3 data on gun hunting activity patterns in KNP</p>	

<p>poaching patrols to combat hunting pressure within protected area is accepted for publication (year 3).</p>	<p>strategy's ability to combat hunting pressure.</p>	<p>and patrol effort (both at the level of sensor or the grid) being the predictor parameters. Once accounting for the strong negative relation between rainfall and gun hunting, there was no significant effect of patrols on gun hunting. This first analysis used data from 15 months (2013-2014 period) prior to any manipulation to the patrolling pattern and extended across rainy and dry seasons. The results were presented in preliminary format during the final workshop in Buea (Dec. 2015). The second analysis examined – using similar statistical methods – the impact of the massive increase (&gt;400%) in patrol effort in the 2015-2016 period leading to and following the Xmas/NY celebrations (Nov. 2015 – Feb. 2016), comparing the patterns of gun hunting during that period against the two previous years (2013-2014 and 2014-2015). Surprisingly, our data showed that once accounting for rainfall and moon luminosity, the patrol effort was a poor predictor of gun hunting intensity. The results have been presented to the DI partners via a short report and we are currently working on the preparation of a peer reviewed manuscript for publication.</p> <p>The findings have led the DI partner PSMNR to seriously reconsider the format of the patrols, as they are funding the per diems of the rangers, and to hire a person who will be in charge of reorganizing/advising the restructure of the anti-poaching efforts.</p>	<p>Annex 7.13: Final workshop presentations</p>	
<p><b>Output 3:</b></p>	<p><i>“The need to critically examine current anti-poaching design and evaluation strategies in Central African rainforests is recognized by key government agencies and conservationists in Cameroon, Gabon, Equatorial Guinea, Central African Republic, Congo-Brazzaville, DR Congo.”</i></p>			
	<p><b>Baseline</b></p>	<p><b>Change recorded by 2016</b></p>	<p><b>Source of evidence</b></p>	<p><b>Comments</b></p>
<p>Indicator 3.1 Project website is developed and used as a communication forum for sharing the project findings with conservation. Material posted in English and French (Yr1-3).</p>	<p>There was no information online on the potential of using acoustic sensors as a gun hunting monitoring and patrol evaluation and design tool.</p>	<p>During Year 2, the project website was created. The website's forum page is used to share project updates regarding preliminary findings, conference presentations and the latest developments in equipment and field techniques.</p> <p>The website has seen moderate traffic, but we have had people approach us with questions about the possibility of applying the acoustic protocol in their own study areas who found out about the DI project via the website. However, the final workshop in Cameroon and a series of talks given by J. Linder (IPS Congress) and C. Astaras (UK Bushmeat Working Group) made the biggest difference in terms of</p>	<p>Project website <a href="https://bioacousticmonitoring.wordpress.com/forum/">https://bioacousticmonitoring.wordpress.com/forum/</a></p>	<p>We have not translated any of the website content in French yet. We hope to do that in the near future, however we consider this a lower priority task compared to the publication of more of our findings in peer reviewed journals.</p>

		generating interest within the conservation community.		
<p>Indicator 3.2</p> <p>A workshop providing introduction to acoustic monitoring and anti-poaching patrol design and evaluation is held for 20 Central African conservationists (Yr3).</p>	<p>Prior to the project no one had used acoustic sensors in Cameroon to estimate gun hunting intensity. The method was completely new to all participants.</p>	<p>The final workshop was held from Dec. 10-11, 2015 at the MINFOF/PSMNR HQs in Buea, rather than in Mundemba as it was originally planned, in order to reduce the travelling time and cost of many of the participants. It was well attended by a total of 35 people, including representatives from 9 PAs in Cameroon and Nigeria (Conservators, heads of units, or site advisors), 6 conservation NGOs/programmes and the Cameroonian Ministry of Forests and Wildlife (incl. a representative of the Director of Wildlife and Protected Areas). The workshop concluded with a group session where participants discussed with the co-PIs ways that the acoustic monitoring tool presented could be best incorporated in their own activities/sites.</p>	<p>Annex 7.13: Final workshop presentations</p> <p>Annex 7.12: Photographs and list of participants from final workshop</p>	
<p>Indicator 3.3</p> <p>Project partners are invited to advise management teams of protected areas wishing to incorporate the new anti-poaching protocol/acoustic monitoring in their area (2 PAs; year 3).</p>	<p>No other area in Central Africa has been using acoustic monitoring to inform anti-poaching patrol design and evaluation.</p>	<p>Following the lessons learned from the acoustic monitoring grid in Korup NP, acoustic sensors for monitoring of gun hunting activity has been or is about to be introduced at pilot level (following consultation with the DI project for equipment/design/analysis advice) at 5 protected areas in Cameroon and 3 beyond Africa. See section 2.1 Indicator 4 for a list of these projects.</p> <p>We are currently in the early stages of these projects, but we are confident that the results will be as revolutionary in spatiotemporal resolution of gun hunting activity patterns in these areas as they were in KNP. We remain in contact with the people who sought our advice on the equipment, grid design and analysis of these acoustic monitoring projects, and we continue to provide additional information to them both via direct communication and the Di project's website.</p>	<p><a href="https://www.fws.gov/international/pdf/project-summaries-africa-2014.pdf">https://www.fws.gov/international/pdf/project-summaries-africa-2014.pdf</a> (USFWS project summary)</p> <p>Annex 7.11: Evidence of acoustic monitoring protocol roll out beyond Korup NP</p>	

### 3 Project Partnerships

Since its inception, our project has been a partnership among Cameroonian government (MINFOF/Korup NP management) and conservation NGOs (WWF-CFP, KRCS), an international development programme (PSMNR-SWR) and international research institutions (JMU, CU, WildCRU). All these partners are part of the wildlife conservation stakeholders in the region. The partnership has remained strong during the project and beyond and all partners contributed as expected towards the completion of the project's activities.

Specifically, WWF-CFP assisted with the custom clearance of batteries and other consumables for the acoustic sensors during the project period. PSMNR and MINFOF provided the necessary research permits. KRCS oversaw the data collection of all the survey data and maintained the acoustic grid. KRCS was also the partner charged with raising local awareness about the project among local communities, especially those where hunter/household/bushmeat data survey data were collected. CU (via co-PI Peter Wrege) oversaw the acoustic data analysis, JMU (via co-PI Joshua Linder) oversaw the transect data analysis, and WildCRU (via PI David Macdonald and co-PI/project coordinator Christos Astaras) oversaw the coordination of the programme including the preparation of reports and establishment/maintenance of the project website. Representatives of all partners were present in the final workshop held in Buea, Cameroon in December 2015.

The collaboration established by Year 3 between two DI partners – a local conservation NGO (KRCS) and a government KNP management team – to oversee the delivery of the DI-proposed wildlife monitoring strategy for the park is a rare achievement and a lesson for the region. It shows that local stakeholders (i.e. the KRCS members) can be directly involved in delivering the mission goals of a protected area, in partnership with the government authorities, rather than being limited to participatory projects aimed at managing the local communities' use of the PA natural resources. Having said that, we believe that there is still a lot to be learnt how best to broker such partnerships in the broader region, as the government agencies remain overall reluctant to share management tasks with third parties especially when there are no external funds to support the given activities. The real challenge for the future would be to maintain the current KRCS/KNP collaboration even if PSMNR were to stop funding the implementation of the KNP monitoring scheme.

### 4 Contribution to Darwin Initiative Programme Outputs

#### 4.1 Contribution to SDGs

The project has been relevant to the following three Sustainable Development Goals:

- **Zero Hunger:** By helping to develop better evaluation and design mechanisms for anti-poaching patrols, the project contributes towards combatting the unsustainable exploitation of wildlife resources within Central African protected areas and therefore protecting the “source” populations of economically important species that can be sustainably and legally exploited in surrounding forest “sinks”. This in turn helps to improve the food security of rural communities in the region.
- **Responsible Consumption and Production:** The project helps protect the “source” populations of game/economically important species within PAs. With them safeguarded, sustainable harvest schemes – which have been long proposed but rarely successfully implemented – can be developed in communally managed forests peripheral to the PAs. This is difficult to achieve while there is a culture of contempt for wildlife laws undermining the PAs missions. Sustainable harvests and consumption make only sense when all are playing by the rules – respecting the common goods.
- **Life on Land:** The anti-poaching patrol design and evaluation protocol developed by the project increases significantly the ability of PA managers to effectively protect the biodiversity of their management areas. We foresee the protocol becoming in the near future an established conservation tool that will feed directly into leading law enforcement monitoring schemes being adopted widely in the region and globally (i.e. the Spatial Monitoring and Reporting Tool “SMART”). Moreover, it can be used to assess the impact of a broader range of activities (not just anti-poaching patrols) on illegal hunting, like rural development initiatives or large developments such as agribusiness and resource extraction schemes. In doing so, the developers/organizers will have the opportunity (or responsibility) to transparently monitor their project's impact in the area of operation against reliable pre-development baseline levels of hunting, and to take mitigation measures to protect local biodiversity should it be required.

## **4.2 Project support to the Conventions or Treaties (CBD, CMS, CITES, Nagoya Protocol, ITPGRFA)**

Both the CBD (Article 7a,b “Identification and Monitoring”; Article 8k,l “In-Situ Conservation”) and the National Biodiversity Strategy and Action Plans in the region – the primary CBD implementation instrument at the national level – highlight the need for mechanisms to monitor wildlife and enforce wildlife legislation. The project, having developed, tested and helped roll out a robust, evidence-based law enforcement monitoring tool that helps evaluate and adaptively design anti-poaching strategies, directly contributes to fulfilling Cameroon’s and eventually other Central African countries’ objectives under these articles.

In addition, the training provided to KNP and KRCS members contributed towards CBD Article 12a,c “Research and Training” compliance; namely the establishment of training programmes for the identification and conservation of biological diversity in developing countries, and the promotion and cooperation “in the use of scientific advances in [...] developing methods for conservation...”.

Finally, given that a large proportion of bushmeat poached within KNP is traded in large market towns across the border in Nigeria, the project also strengthened Cameroon’s ability to comply with CITES Article III (“Regulation of Trade in Specimens of Species Included in Appendix I”) and Article VIII a,b (“Measures to Be Taken by the Parties”) objectives. The latter states that signatories should “provide for the confiscation” of and take measures to “penalize trade in, or possession” of CITES species.

## **4.3 Project support to poverty alleviation**

The project is working towards reducing poaching in Korup NP, therefore protecting the “source” populations of economically important species that can be sustainably and legally exploited in surrounding forest “sinks”, indirectly improving the food security and income-generating opportunities of local communities (28 villages within KNP’s 3-km peripheral zone; >40,000 people in Korup region). In doing so, the project promotes the interests of the many rural poor over the short-term benefits of the few poachers (avoiding another “tragedy of the commons”). The data obtained from the household surveys, hunter and bushmeat price surveys provide insight into the nature and scale of these benefits for local communities.

Though these economic benefits are anticipated in the medium and long term, the project has already directly employed since Year 1 (and continued to do so in Year 2) 14 local people (part-time 6; full-time 8) and offered economic benefits via occasional employment (e.g. porters, drivers, rent) to a lot more. Since the USFWS funded monitoring started in Rumpi Hills Wildlife Reserve, an additional 5-6 have been employed every three months to maintain the acoustic grid. After its completion, 5 KRCS members continue to be employed on wildlife related positions as a result of the project.

Finally, we anticipate the anti-poaching patrol evaluation and design protocol tested at Korup to be rolled out at additional protected areas in the region than those already piloting it, creating new employment positions in the wildlife management sector.

## **4.4 Gender equality**

The project was not designed with actions aimed specifically at addressing gender equality issues. However, the success of our project has encouraged men and women from the Korup and Rumpi Hills area to become members of KRCS and to participate in other research project. For example, J. Linder is currently engaged in a study examining local perceptions of zoonotic, infectious diseases in the Korup area and has recruited several women (including those from Ikonkondo and Meka Ngolo) who have now been trained in anthropological methods. These women were already aware of the DI project and understood the value of effective, applied research.

By indirectly improving the food security and income-generating opportunities of local communities, our project also benefits all community members equally regardless of their sex, age or ethnic group. Although female household heads are those who decide and prepare the family meals, improved food security would benefit all household members.

## 4.5 Programme indicators

- Did the project lead to greater representation of local poor people in management structures of biodiversity?

The incorporation of the DI partner and local conservation NGO KRCS in the wildlife monitoring of Korup NP is an unprecedented involvement of local people in the management of the park. Until now, local organizations were only involved in brief contracts to clean up trails or to lead tourists in the park. Any wildlife monitoring activities inside the park were either via internationally-coordinated projects (e.g. like the DI project), or via international NGOs like WWF/WCS.

- Were any management plans for biodiversity developed?

Yes – the project developed from scratch the first detailed wildlife monitoring plan for Korup NP and the DI partner KRCS is directly involved in its implementation as of January 2016 (Annex 7.5 and 7.7).

- Were these formally accepted?

The wildlife monitoring plan awaits “validation” which is typically a prolonged process. In the mean time, PSMNR (DI Partner) has adopted de facto the plan and established the KRCS/KNP joined wildlife monitoring team that delivers the wildlife monitoring plan.

- Were they participatory in nature or were they ‘top-down’? How well represented are the local poor including women, in any proposed management structures?

The wildlife monitoring plan developed involved the DI partners (OU, JMU, WWF, PSMNR, KRCS). KRCS represents the local communities, as it is a local NGO with all its members being residents of the area. PSMNR and MINFOR represent the top levels of wildlife management in the country. JMU/OU represent the international scientific community. In that sense, the wildlife monitoring plan involved a wide range of conservation stakeholders. There were no specific measures taken to represent women interests in the development of this monitoring plan.

- Were there any positive gains in household (HH) income as a result of this project?

Not possible to estimate, other than for the households of the people who were employed as a result of the DI project during its lifetime and after its completion. For the families of the DI field team employees, the DI project provided long-term employment for 24-36 months. The 4 KRCS members forming the KRCS/KNP wildlife monitoring team, this employment continues after the completion of the course.

- How many HHs saw an increase in their HH income?

The DI project employed regionally 10 KRCS members from a same number of HHs for 3 years. After the completion of the project, 5 of these members (HHs) continue to be employed as a result of the DI project.

- How much did their HH income increase (e.g. x% above baseline, x% above national average)? How was this measured?

We are not aware of the national average salary (as it varies greatly among sectors/urban vs. rural areas). However, the salary agreed for the KRCS wildlife monitoring people would be >200-300% higher than that of a primary school teacher in the region.

## 4.6 Transfer of knowledge

The project did not result in any formal qualifications.

### **4.7 Comment on the extent to which the project has sought to transfer knowledge (including new knowledge generated by Darwin projects) to practitioners or policy makers to apply this thinking to practical conservation challenges. What form has this transfer of knowledge taken e.g. national platforms, international platforms, print media etc.? Capacity building**

At the national/regional level, we transferred the knowledge generated from the project to conservation practitioners involved directly with applied conservation strategies in the tropical rainforest zone of Cameroon and Nigeria via the final workshop held in Bua, Cameroon (Annex 7.12/7.13 / Output Indicator 4). The workshop was very well attended by a range of professionals ranging from Ministry of Forestry and Wildlife staff (i.e. Regional Director of MINFOR, rep of the national Director of Protected Areas), park top (conservators) and mid-range managers, and conservation NGOs project and field team managers. The presentations were also circulated in electronic format to the participants after the completion of the workshop, and they were invited to monitor the project website for additional material. Post-workshop



and following the request of the representative of the MINFOF Director of Protected Areas, we produced a short report with a series of specific recommendations for the Ministry (Annex 7.15).

At the local level, we enhanced the Korup NP and KRCS staff capacity to use passive acoustic monitoring as a tool for evaluating and designing anti-poaching patrols via two workshops held on Dec. 2014 and Dec. 2015 (Annex 7.4).

At the international platform, we shared findings about the application of passive acoustic monitoring for evaluating the impact of anti-poaching patrols via the submission of an article at a peer-reviewed journal (Annex 7.14), the project website's forum section (<https://bioacousticmonitoring.wordpress.com/>), presentations at conservation-focused graduate programmes (Oxford Brookes' MSc in Primate Conservation – Oct. 12, 2015; Annex 7.17; University of Oxford PG Diploma in International Wildlife Conservation Practice in 2014/2015/2016), two Darwin Initiative Newsletter articles (see section Annex 5 for links), and presentations at two international and one national conferences/workshop (see Annex 5 for details).

We are currently working on the completion and submission of two additional peer-reviewed manuscripts: one focusing on the relation between gun hunting and anti-poaching patrols and a second on the impact of the bushmeat market closure due to the Ebola outbreak in Nigeria.

The project has also helped further establish the regional/national recognition of our DI partner KRCS as a reliable and skilled conservation partner worth considering as a partner in future projects. KRCS members currently form the backbone of the wildlife monitoring team in KNP (Annex 7.5) and the KRCS member Robinson Orume (originally the DI national coordinator) is to be employed by PSMNR to oversee the wildlife monitoring data analysis of multiple protected areas, based in Buea.

#### **4.8 Sustainability and Legacy**

As a direct result of our project and presentation of our results at local, regional, and international conference and workshops (see section 2.1 indicator 4), managers of five additional African protected areas have adopted the use of acoustic sensors to quantify spatiotemporal patterns of gun hunting and inform anti-poaching strategies, thereby maximizing return on investment of their anti-poaching funds and ultimately increasing the protection of wildlife resources. This is why we were requested to provide an additional report with recommendations to the Ministry of Forests and Wildlife (Annex 7.15). The wider adoption of acoustic sensors as a tool for critically examining anti-poaching strategies has already commenced (see section 2.1 indicator 4; also Annex 7.11), increasing the region's PA managers ability to maximize return on investment of their anti-poaching funds – and hence to increase the protection of wildlife resources. As more sites adopt the acoustic monitoring tool (whether following our advice in the near future or sharing experiences with one of the currently running pilot projects), the legacy of the project will increase.

The development and promotion by Cornell University of new and more efficient and affordable acoustic "SWIFT" sensors has helped to further increase the likelihood that PA managers across Africa will continue to adopt this tool. The SWIFT sensors (see Sept 15, 2016 forum post at DI project's website - <https://bioacousticmonitoring.wordpress.com/forum/>) are currently 1/4 the price and have 1/6 the energy consumption of the sensors that we used. This is a significant reduction in the cost of an acoustic grid. Peter Wrege is currently testing these sensors in the tropics and Christos Astaras in temperate climates. The findings on the robustness of these more affordable sensors are shared via the project website.

In the Korup region, the sustainability of the DI acoustic grid is safeguarded by the adoption of the running costs of the data collection (and data analysis) by PSMNR. A data analysis hub is developed now in Buea to oversee the analysis and long term storage of acoustic data not only from Korup but also from the other PAs in the region. This ensures that the impact of the DI project in Korup will continue after the completion of the project.

The equipment of the DI acoustic grid in Korup NP has been absorbed by the DI partner KRCS (climbing equipment, laptops, software) and they are using it to maintain the acoustic grid (sensors/cards) adopted by the KNP management under the agreed collaboration on wildlife monitoring that the DI partners helped broker. The KRCS/KNP combined wildlife monitoring team maintains the grid with the same 3-month frequency (Annex 7.5 – see ToR section). As sensors eventually fail, the PSMNR/MINFOF collaboration will help replace them. In the meantime, we have made available some of the USFWS-funded acoustic sensors used until recently in the nearby Rumpi Hills Forest Reserve to replace faulty sensors in Korup. In the long run, we foresee the Wildlife Acoustics SM2+ sensors being replaced with the SWIFT sensors of Cornell.

Three of the four KRCS field assistants that constituted the DI acoustic monitoring grid are now employed by PSMNR to lead (together with a KNP ranger) the newly established KRCS/KNP wildlife monitoring team, putting in direct use the skills provided to them during the DI project (Annex 7.5). In addition, the 2013-2014 period in-country DI coordinator, Robinson Orume, completed his MSc on protected area management in Australia (2015/16 period) and is to be employed by PSMNR to lead the data analysis hub in Buea that will be handling the wildlife (incl. acoustic) monitoring data from KNP and the region's PAs. The remaining KRCS members involved in the DI project and trained by it remain involved with KRCS projects in the broader Korup region.

## 5 Lessons learned

Overall, we consider the DI team's expertise to have been sufficient and the time frame for delivering the planned activities to be realistic. Nevertheless, we experienced certain challenges that are worth mentioning here for the benefit of future DI projects.

As explained in previous half-year/annual reports, the bad condition of the roads during the rainy season meant that travel from Mundemba to Limbe for posting via a courier the acoustic data for analysis was often delayed for weeks. This created a backlog in the analysis of the acoustic data. In one occasion we also had problems with the Cameroon customs clearance of the empty SD memory cards which were returned for reuse. In our case, the large size of the acoustic data (~650 Gb per 3 month deployment) meant that transferring the files via an FTP site was not feasible given the low internet speeds in Cameroon. There was therefore no easy way around this challenge. We did however – and highly recommend so for other projects – plan for multiple backups to be made both in Cameroon and abroad of all the data, in case data were lost during transport. The acquisition of backup hard drives was included in the original budget. The long term storage of large datasets is something that needs to be explicitly considered in similar projects.

Another challenge that we encountered had to do with the 6V lantern batteries that we used to run the acoustic sensors. Each sensor used 6 such batteries per 3 months. With 12 sensors operating at a time, our field team was left with 72 semi-empty batteries in the forest at the end of each maintenance trip... Shorter duration studies in other countries have buried these batteries on site, but we could not do that in Korup NP given that it is a national park (and anyway burying 1 battery at a time in a deep pit takes time/labor which we had not planned for). We therefore ported the batteries out of the forest to the town of Mundemba. There are however no battery recycling or disposal sites in Cameroon. We gave away the batteries to local people to use for running radios and other small electrical appliances. This helped disperse the batteries around (rather than having them dropped altogether in a landfill) but it did not really address the problem that the batteries (as all batteries used in Cameroon) would eventually become discarded. We did consider the use of solar panels at the design stage of our project but they were not suitable as the sensors were operating under thick canopy. We strongly encourage that future acoustic monitoring projects do consider whether solar panels are appropriate for their sites, despite the higher initial acquisition cost. Moreover, we also recommend that projects explicitly consider the disposal of any research consumables at the design/budgeting stage.

The outbreak of the Ebola virus in West Africa in the summer of 2014 – and especially the arrival of the disease in Nigeria – led the Nigerian government to crack down on bushmeat markets across the country for a brief period of time in August 2014, including the neighbouring state of Cross River (where most of the bushmeat extracted from Korup NP is sold). This development was monitored by us both in terms of issues pertaining to the safety of our field team (i.e. during bushmeat surveys) and because it created "noise" in the gunshot data that we were collecting in the forest. While this development was not planned for, we adapted to the reality and indeed used it as an opportunity to examine the effect of a bushmeat market closures (driven by a top-down political decision) on gun hunting and the bushmeat trade. Our data show clearly the ability of passive acoustic monitoring to capture with unmatched resolution the perturbation in the hunting pattern due to this development.

One of the limitations that we experienced in terms of team expertise was the low levels of computer literacy among local partners. Unfortunately, the most skilled members of our DI team in Cameroon in computer skills (i.e. data input in Excel) were also the ones most skilled in the field. The volume of the survey data obtained from the village surveys each month was high, and the rate of transferring them to datasheets was lower than expected because the team members were burned out from long field deployments. Attempts to find other partner members who were able to undertake the task were not successful. We partially resolved this issue by acquiring a scanner for the project at the end of Year 1 so that the survey forms could be scanned and emailed to UK/US based DI partners where student volunteers could be used to input them in datasheets. This was however only a half measure and it distanced the data input step from the data collectors/survey supervisors who ideally should have been involved. During the Year 2 and Year 3 workshops held in Mundemba we used the opportunity to provide crash courses in basic MS Office computer skills to KRCS members, trying to in part address the local shortage of computer skilled people. This measure helped in part. Sadly, there were no local ECDL

schools available for the partners to take intensive, quality computer classes. We explored that option but on-site inspection of the facilities and course content/teaching style by C. Astaras/J. Linder showed them to be of very low standard and a waste of resources. We strongly suggest that future DI projects think about providing intensive computer training classes to local partners in areas where computer literacy is low, in order to both increase the capacity of the local partners and to improve the management efficiency of the project's data.

Finally, we underestimated the challenges of obtaining call examples from the field for some of the primate species for the development of detection algorithms for all 8 diurnal primates. In retrospect, rather than relying on the field team to collect these calls using a digital recorder/microphone during regular trips, we should have budgeted for a couple of field trips exclusively dedicated to tracking down some of the most elusive primate species (e.g. the Preuss's red colobus and the Preuss's guenon). We eventually got control sounds for most species, but the development of the detection algorithms was delayed as a result. Beyond the limitation of funds, the very tight field schedule by our DI field team members meant that it was difficult to add additional field trips without affecting the quality of the other datasets collected or the well-being of our field team members. We obtained some control sounds by manually browsing the sound files collected by the acoustic sensors. A search of online sound databases provided a few more call examples.

## **5.1 Monitoring and evaluation**

We are satisfied with the M&E system adopted for our project as the outcome and output indicators (and associated milestones) were incremental and relatively easily evaluated as to whether they were achieved or not. There was no additional external or internal evaluation of the project's progress during the project period beyond the M&E system developed during the project's design phase.

The main change in the M&E system was stopping to collect tourist satisfaction surveys (as described in previous reports and section 2.1/Indicator 3 above) because there were too few tourists visiting the park to obtain meaningful data.

In addition, analysis of other survey data showed bushmeat price surveys to be poor in capturing seasonal/annual fluctuations in supply/demand of bushmeat even during the pronounced "dip" in bushmeat trading/hunting in August-September 2014 when the bushmeat market closures were in effect in neighbouring Nigeria due to the Ebola virus outbreak there (Annex 7.8). The price of bushmeat stayed practically unchanged even though supply – as clearly documented by other sources of ours – collapsed. Discussions with colleagues during the final workshop suggested that bushmeat price surveys would have been more informative if they were done at the hunter level. It appears that the fluctuation in supply even during the market closure period affected the suppliers (hunters) and not the middlemen who totally control the price paid to the hunters. The middlemen maintained the same price to the consumers. The fact that the volume of bushmeat traded by these middlemen also did not decline in this period suggests that the number of bulk bushmeat sellers surveyed were only trading a small fraction of the bushmeat moved across the region and therefore could be trading at capacity even when supply collapsed. That is another reason why their monitoring was probably less informative than price monitoring at hunter level. Having said that, we were already surveying hunters monthly and had made a conscientious effort to exclude any information related to money generated from hunting (often a local taboo). By doing so, we hoped to maximize the hunters' cooperation in sharing the other information requested during these hunter surveys, including the critical information on hunting success rates.

Beyond the M&E changes/concerns described above (and as described in section 21.1/Indicator 1 + 2), the most significant change in the project design was that instead of comparing Yr1 and Yr2 gun hunting data in order to evaluate the effectiveness of increased anti-poaching patrol effort on hunting in KNP, we compared the hunting and patrol data from November – February of 3 years instead (peak hunting period). This was both due to the Ebola virus outbreak in Nigeria in Yr2 and the ensuing bushmeat market closure which created an unplanned perturbation in the annual hunting cycle, and the delayed adoption of the DI-developed new patrol protocol by KNP rangers in Yr2. The well-executed dramatic increase of patrols in the 2015/16 Xmas/NY period allowed us to confidently evaluate the effect of increased patrol effort on gun hunting – a key project goal.

## **5.2 Actions taken in response to annual report reviews**

We received feedback on two annual reports (Yr1 and Yr2) and we responded to the issues raised by the report reviewers. The feedback received was discussed with the DI partners pertaining to the issues flagged.

### Year 1 annual report review

There were three issues raised by the Yr1 annual report reviewer. The first concern had to do with the Terms of Reference (ToR) between two DI partners - KRCS and PSMNR-SWR (supplied at Annex 4.6 of the Yr1 report). The reviewer felt that the ToR did not clearly show how it was a binding contract between

the two signatories. We replied in the following annual report explain that we had provided the ToR as evidence that the two DI partners had progressed with preparations for the surveys, and that PSMNR-SWR was stepping up to the matched funding that they had agreed they would provide for the surveys. We explained that we did not believe that the DI project should dictate to each partners how to word their bilateral contracts. The ToR prepared was sufficient for PSMNR-SWR to manage German Government money, and therefore we naturally considered it to be sufficient for the project's purposes. Moreover, both KRCS and PSMNR-SWR had signed the DI project collaboration agreement which detailed the role of each partner in delivering the planned project activities. In a sense the ToR was not needed by our DI project, but was prepared for the internal records of the two project partners. It was appended in our Yr1 annual report only as evidence of progress towards planned activities.

The second issue raised by the reviewer noted a discrepancy in the Yr1 annual report's Annex 4.8 table and the main body of the report. Specifically, while the report mentioned that the development of three species' detection algorithms was delayed because of lack of training calls, the table mentioned a fourth one – the Red-eared guenon. This was a valid comment and an omission on our side. We explained in the Yr2 report that the Annex 4.8 table was accurate and that we had forgotten to mention the fourth species in the report's text.

The third issue had to do with the lack of reference in the Yr1 annual report about the progress towards Activity 2.5 (i.e. report on scoping analysis of household/hunter data to DI partners). Due to the delayed start of the household/hunter in Year 1 (as mentioned in the Yr1 annual report), Activity 2.5 did not commence in Year1-Q1. Since that report, we have presented the preliminary findings to our partners in Cameroon in Cameroon during the final workshop (see Annex 7.13) and the dissemination of the Yr1 final report.

#### Year 2 annual report review

The reviewer of the Yr2 annual report commented on the importance of the project website in achieving Output 3 and the participation in the final project workshop. We have continued to use the website's forum as a medium of sharing developments/equipment regarding passive acoustic monitoring with the broader public (<https://bioacousticmonitoring.wordpress.com/forum/>) as suggested. We identified all participants of the final workshop via discussions with all our DI partners and collaborators operating in C. Africa (rather than the website). It is also worth noting that all the requests for guidance in rolling out the passive acoustic monitoring approach we tested in Cameroon to new sites came following presentations at the final workshop, and presentations at international conferences. We also anticipate that the publication of the manuscript which is currently under review (see Annex 7.14) will have a markedly higher reach to relevant audience than the project website. Regardless, we have continued to maintain/update the project website following the completion of the project in March 2016 as we believe its value will increase further as more and more people hear about our project's findings.

## **6 Darwin identity**

The project has always been – and still remains – identified among all project partners as the “Darwin Initiative” project and not as the sole initiative of any partner's institution or as part of a larger programme. All of our correspondence to USFWS for instance, regarding their support of activities in Rumpi Hills Forest Reserve, identified the project activities in Korup NP as being funded by the UK government under the DI scheme. Moreover, any references to the project (e.g. in presentations at the Student Conference on Conservation Science, Cambridge – March 2016; the UK Bushmeat Working Group meeting, ZSL, London – April 2016; the International Primatological Society's Congress, Chicago – August 2016) and the final workshop (Buea, Cameroon – December 2015) clearly identified the project as a DI project and used the DI logo.

Within Cameroon, familiarity with the Darwin Initiative mission is typically limited to university educated members of the conservation and development sector who have at one point or another in their career considered applying to or applied for a DI grant or worked for a DI project. Beyond these individuals, the recognition of DI among sector professionals is limited to those who attended the final workshop. The rest probably only recognize DI as a “funding scheme”.

## 7 Finance and administration

### 7.1 Project expenditure

Table 1 project expenditure during the reporting period (1 April 2015 – 31 March 2016)

Project spend since last annual report	2015/16 Grant (£)	2015/16 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)			0%	
David W. Macdonald Project Leader			0%	
Christos Astaras Project coordinator			0%	
Consultancy costs			0%	
Overhead Costs			0%	
Overheads costs - Partners			0%	
Travel and subsistence			X	
Travel and subsistence - Partners			0%	JMU & BRP £1994 each
Operating Costs			X	We spent less on courier postage of the acoustic data because we sent sometimes the memory cards to or from Cameroon hand to hand with DI partners or colleagues travelling to/from SW Cameroon. We deemed that option not only cheaper but also safer/faster at times.
Operating Costs - Partners			0%	KRCS £5000 / JMU £170
Capital items (see below)			-	
Others (see below)			X	
Raven sound analysis software (UK/Cameroon)			+108%	We had to acquire extra licences of the Raven acoustic analysis software for the pre-workshop training that we held in Cameroon.
Translation of reports to French (Cameroon)			-100%	As the reports were completed after the final workshop, we have not translated them in French yet. All the participants at the workshop (including those operating in the Francophone part of Cameroon) spoke English fluently. Having said that, we do intend to translate some reports in French in the near future, in collaboration with our Cameroonian partners.

Project spend since last annual report	2015/16 Grant (£)	2015/16 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Website development/ hosting (Cameroon)			-100%	We eventually set up the website in the UK using DI team skills and free online hosting.
Field supplies (torches, boots, f. aid kit etc.)			-	We covered the cost of some supplies for the final workshop (~£100 incl. nametags, stationary etc.) and some supplies for our field teams (~£190 incl. first aid kit, mosquito nets, batteries) that were not in the original budget as planned 3 years ago.
KRCS – Village/Hunter surveys			0%	KRCS
<b>TOTAL</b>				

## 7.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
PSMNR - Village surveys (hunter/household/bushmeat price)	
PSMNR - Anti-poaching patrol funds	
PSMNR - Shipping costs of batteries for Year 3	
WildCRU - Quatermain Foundation – Acoustic sensor batteries (Yr1-2)	
WildCRU - Legacy equipment/laptop	
JMU - Matched-funding (salary)	
BRP - Matched-funding (salaries/overheads)	
BRP - Acoustic data storage (matched funding)	
WWF - Equipment importation aid	
<b>TOTAL</b>	

Source of funding for additional work after project lifetime	Total (£)
PSMNR – Acquisition + Shipping costs of batteries for continuation of the Korup NP acoustic grid beyond the completion of the course (1/2 year batteries bought until now, pending the acquisition of new sensors which will require fewer batteries)	
<b>TOTAL</b>	

## 7.3 Value for Money

We believe that the project has provided exceptional value for money both in terms of the cost associated with the project activities and the overall benefits for the broader Central African region ensuing from the broader roll-out of the anti-poaching design and evaluation protocol developed and piloted by the project.

Specifically, the acoustic monitoring protocol we have developed is efficient not only in its unparalleled spatio-temporal resolution of the data it generates on gun hunting activity, but also in its overall cost as a law enforcement monitoring tool. The cost of operating each acoustic sensor per day (accounting for deployment costs and battery acquisition + shipment to Cameroon – after the initial cost of equipment acquisition) was £1.12. That sensor monitors 24 hr the gun hunting activity in an area of approximately 4.5 km<sup>2</sup>. In contrast, the per diem costs of a 4-ranger patrol team was in 2013 £13.5 (in addition to the monthly salary). That 4-man team would probably effectively monitor a similar area with varying consistency for only 8 hrs. So, in effect the acoustic grid as a whole (12 sensors) achieves for the same ~£13.5 cost the monitoring of a ~54 km<sup>2</sup> area for three times as long a period (24 hr), making it in effect 36 times as cost effective a monitoring method as foot patrols. Importantly, the acoustic monitoring protocol frees up the more expensive rangers from the monitoring task so as to concentrate their efforts on the actual enforcement of the law. Moreover, the law enforcement monitoring data generated are robust, consistent, transparent and detached from the people whose activities they are in effect evaluating. The data on hunting activities in the park collected by the rangers during the duration of the DI project were wholly inconsistent and – despite lengthy efforts by C. Astaras to clean them – practically unusable as they did not capture in any way the gun hunting spatio-temporal variation recorded continuously by the acoustic sensors for 3 years. In effect, we can say that in terms of law enforcement monitoring the £13.5/day of a 4-ranger patrol were “wasted” resources, making the use of our acoustic methods even more valuable as they actually made the evaluation of anti-poaching patrols feasible for the first time – an activity that costs annually the PSMNR (a DI partner) ~£35,000-40,000 in per diems only.

So, the acoustic monitoring protocol has clearly been a cost effective way of improving our understanding of hunting activities in Korup NP. This in turn enables the more targeted and effective use of KN management’s anti-poaching resources to protect the park’s wildlife resources – source populations of “bushmeat” species that could be legally (and potentially sustainably) harvested in forest “sinks” outside the park. However, the benefits of project – and hence the medium to long term return on investment of the DI funds invested in it – are already multiplied as additional sites adopt our anti-poaching evaluation and design protocol we developed.



# Annex 1 Project's original logframe, including indicators, means of verification and assumptions.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p><b>Goal:</b></p> <p>The extent of the African bushmeat trade has reached crisis levels, threatening entire ecosystems as well as the food security and livelihoods of forest dependent rural populations. Protected areas are a key component in the strategy to address the crisis, and enforcement of wildlife legislation is critical to protected areas' success. By developing an improved design and evaluation of anti-poaching patrols in Central Africa, the project contributes to the <i>mitigation</i> of the bushmeat crisis overall, protecting endangered biodiversity, fostering the sustainable use of legitimate resources in park periphery, and generating alternative training and employment opportunities to hunting.</p>			
<p><b>Outcome:</b></p> <p>Poaching in Central Africa imperils wildlife, is illegal and undermines the sustainability of local livelihoods while legitimising a corrupted attitude between people and protected areas. The project uses robust but innovative technology, centred on acoustic monitoring, to design, implement and evaluate anti-poaching strategies, leading to the development of a novel decision-support system to be rolled out across Central Africa. Developed first for Korup NP (Cameroon), this evidence-based anti-poaching protocol is intended to efficiently protect wildlife source populations within protected areas, while laying the foundation for sustainable forest uses, and thus increased food security, job opportunities, and – ultimately – poverty alleviation.</p>	<ul style="list-style-type: none"> <li>By year 3, KNP management maintains an acoustic monitoring grid which it actively uses to collect and analyze data on spatiotemporal patterns of gun hunting and wildlife activity, in order to design adaptively its anti-poaching patrols.</li> <li>Gun hunting pressure is significantly reduced in monitored areas within KNP during year 2 compared to baseline data collected in year 1. The reduction is higher in the core area of KNP (-30%) where the new anti-poaching regime will be tested, compared to monitored control-sites in the periphery of the core (-15%) and near farms (± no change).</li> <li>Korup's charismatic and endangered species are better protected in the core of the park, increasing the region's potential to generate sustainable benefits for local stakeholders from their protection through research and tourism employment opportunities.</li> <li>KNP's protocol to design and evaluate anti-poaching patrols using evidence from acoustic monitoring techniques is adopted in at least two other protected areas in Central Africa by the end of the project (even as a pilot study).</li> </ul>	<p><u>Indicator 1:</u></p> <ul style="list-style-type: none"> <li>Project report detailing the field protocol for setting, maintaining and extracting data from the ARU grid (year 1; WildCRU/KRCS)</li> <li>Code of species-specific detection algorithms (year 1; BRP)</li> <li>Raw acoustic data from the sensors, stored at BRP (year 1-3).</li> <li>KNP summary report of gun hunting and wildlife activity patterns (acoustic and line transect data; year 2-3; MINFOF).</li> <li>KNP Management Plan (2013-2016) identifying acoustic-monitoring as a decision-support tool for anti-poaching patrol design and evaluation (year 2; MINFOF).</li> <li>Cybertracker data recording the movement of anti-poaching patrols, in accordance to pre-determined routes (year 3; MINFOF/PSMNR-SWR).</li> </ul> <p><u>Indicator 2:</u></p> <ul style="list-style-type: none"> <li>Project report presenting summarized baseline gun hunting and wildlife activity data from 12 ARUs and 4 line transects for year 1 (WildCRU/JMU/KRCS).</li> <li>KNP report to PSMNR-SWR on the anti-poaching patrol activities in the core area during year 2 (year 3; MINFOF).</li> <li>Project report presenting gun hunting and wildlife activity pattern changes between year 1 and year 2 (year 3; WildCRU/JMU/KRCS/ MINFOF).</li> </ul>	<ul style="list-style-type: none"> <li>Socioeconomic and political realities in Cameroon and neighbouring Nigeria (Cross River State) remain relatively stable – Although in the past decade there have been brief periods of instability in Cameroon (most recently in January 2009), these are typically short lived (1-2 weeks), affect primarily life in the urban centers, and have little to no impact on the management of the protected areas. Tensions in Nigeria are currently limited to the north of the country, far away from the study area.</li> <li>There is no dramatic increase in the hunting technology available to local communities (12-gauge shotguns) – The use of locally made single-shell shotguns is ubiquitous in the region, so there is no room for a massive increase in the capability of hunters. Modern rifle guns are used only rarely by elephant hunters, and unless there is a collapse of Cameroonian civil-law, there is no expectation that the use of automatic rifles (currently strictly illegal) will become widely used.</li> <li>The Ministry of Forest and Wildlife (MINFOF) of</li> </ul>

		<p><u>Indicator 3:</u></p> <ul style="list-style-type: none"> <li>Project report presenting summarized baseline wildlife activity data from 12 ARUs and 4 line transects for year 1 and year 2 (core and control sites) (WildCRU/JMU).</li> <li>Completed tourist satisfaction questionnaires (year 1-3; KRCS) and annual KNP report of tourist numbers.</li> <li>Project report presenting results from (a) household economic surveys (~36/household/year; 30 households; KRCS/JMU) and hunter surveys (12 villages/year; 10 hunters/village; KRCS).</li> </ul> <p><u>Indicator 4:</u></p> <ul style="list-style-type: none"> <li>Project website content (WildCRU)</li> <li>Online and printed training material</li> <li>List of participants attending training workshop; photographs/video (KRCS)</li> <li>Official documents from protected areas adopting the new anti-poaching protocol, stating their intention to do so.</li> </ul>	<p>Cameroon remains committed to the German-Cameroonian cooperation programme of PSMNR-SWR – The PSMNR-SWR programme is currently in its second phase which will continue for at least a half-year after the completion of this project. Given the success of the Phase 1 of the programme, there is a good chance that it will be extended by 5 years more (Phase 3).</p>
<p><b>Outputs:</b></p> <p>1. KNP staff are trained and able to implement the new anti-poaching evaluation and design protocol (year 2/3).</p>	<p>1a. The new anti-poaching protocol is approved by MINFOF and included in the new KNP management plan (year 2).</p> <p>1b. A group of 8 KNP game guards is trained in setting and maintaining the ARU grid in the field, while 4 KNP management staff are trained in analysing the acoustic monitoring data (year 2).</p> <p>1c. First anti-poaching report using acoustic monitoring data collected and analyzed by KNP staff is submitted to PSMNR-SWR/MINFOF (year 3).</p>	<p><u>1a.</u></p> <ul style="list-style-type: none"> <li>KNP Management Plan (2013-2016) (year 2)</li> <li>Cybertracker data on game guard patrol routes (year 3)</li> </ul> <p><u>1b.</u></p> <ul style="list-style-type: none"> <li>Visual inspection of acoustic monitoring data analysis centre at KNP headquarters (Mudemba) (end year 2)</li> <li>Participants list of workshop training KNP staff in acoustic data analysis and interpretation (year 2/3)</li> </ul> <p><u>1c.</u></p> <ul style="list-style-type: none"> <li>Annual KNP report (year 3) to PSMNR-SWR on anti-poaching patrols</li> </ul>	<ul style="list-style-type: none"> <li>Autonomous recording units (ARUs) function properly in Korup rainforest and are not vandalized/stolen</li> <li>Development of species-specific detection algorithms for calls of Korup's eight diurnal primates is possible</li> </ul>
<p>2. Poaching patterns within KNP are understood so as to be effectively combated with available resources, affording wildlife in the park's core area (at least) a markedly higher level of protection (year 2/3).</p>	<p>2a. Report submitted to MINFOF presenting gun hunting and wildlife activity pattern changes between year 1 and year 2 (24 months; 12 ARUs + 4 line transects + hunter interviews) (year 3).</p>	<p><u>2a.</u></p> <ul style="list-style-type: none"> <li>Hunter survey reports, KRCS (years 1-3)</li> <li>Tourist survey reports, KRCS (years 1-3)</li> <li>Bush-meat price survey reports, KRCS (years 1-3)</li> <li>Summary project reports of acoustic monitoring and line</li> </ul>	<ul style="list-style-type: none"> <li>Autonomous recording units (ARUs) function properly in Korup rainforest and are not vandalized/stolen</li> <li>The three survey villages will remain open to surveys on the importance of bushmeat to</li> </ul>

	<p>2b. Report submitted to MINFOF presenting the findings of the socioeconomic surveys on the role of bushmeat in the livelihoods (food/income) of local communities (year 1-2 data; 3 villages) (year2).</p> <p>2c. Peer-reviewed manuscript on the efficacy of anti-poaching patrols to combat hunting pressure within protected area is accepted for publication (year 3).</p>	<p>transect data (years 1-2)</p> <ul style="list-style-type: none"> <li>• KNP annual reports to PSMNR-SWR/MINFOF</li> </ul> <p><u>2b.</u></p> <ul style="list-style-type: none"> <li>• Hunter survey reports, KRCS (years 1-3)</li> <li>• Tourist survey reports, KRCS (years 1-3)</li> <li>• Bush-meat price survey reports, KRCS (years 1-3)</li> <li>• Summary project reports of acoustic monitoring and line transect data (years 1-2)</li> <li>• KNP annual reports to PSMNR-SWR/MINFOF</li> </ul> <p><u>2c.</u></p> <ul style="list-style-type: none"> <li>• Peer-reviewed publication on the efficacy of anti-poaching patrols to combat hunting pressure within protected area</li> </ul>	<p>local livelihoods</p>
<p>3. The need to critically examine current anti-poaching design and evaluation strategies in Central African rainforests is recognized by key government agencies and conservationists in Cameroon, Gabon, Equatorial Guinea, Central African Republic, Congo-Brazzaville, DR Congo.</p>	<p>3a. Project website is developed and used as a communication forum for sharing the project findings with conservation practitioners (field protocols, data analysis protocols, project reports and publications). Material posted in English and French (year 1-3).</p> <p>3b. A workshop providing theoretical introduction to and practical training on acoustic monitoring and anti-poaching patrol design and evaluation techniques is held in Mundemba for 20 Central African conservationists (year 3).</p> <p>3c. Project partners are invited to advise management teams of protected areas wishing to incorporate the new anti-poaching protocol/acoustic monitoring in their area (2 PAs; year 3).</p>	<p><u>3a.</u></p> <ul style="list-style-type: none"> <li>• Content of the project's website</li> </ul> <p><u>3b.</u></p> <ul style="list-style-type: none"> <li>• Project developed data collection and data analysis training material (to be used during the workshop).</li> <li>• List of final workshop participants</li> </ul> <p><u>3c.</u></p> <ul style="list-style-type: none"> <li>• Agreement records (formal letters, MoUs) of project partners to share know-how on anti-poaching design/ evaluation and acoustic monitoring in general with protected area managers beyond Korup.</li> </ul>	<ul style="list-style-type: none"> <li>• Autonomous recording units (ARUs) function properly in Korup rainforest and are not vandalized/stolen</li> <li>• Development of species-specific detection algorithms for calls of Korup's eight diurnal primates is possible</li> <li>• The villages of Ekon I, Ikondokondo and Ngenye will remain open to conducting surveys on the importance of bushmeat consumption and trading to local livelihoods</li> </ul>
<p><b>Activities</b> (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)</p> <p>Activity 1.1 Acoustic monitoring grid (12 ARUs) and line transect network established in KNP; KRCS members trained</p> <p>Activity 1.2 Collection of ARU and line transect data on gun hunting intensity and wildlife activity patterns in KNP</p> <p>Activity 1.3 Species-specific detection algorithms developed; detection range of ARUs for wildlife calls/gunshots determined</p> <p>Activity 1.4 Inclusion of novel anti-poaching protocol in the KNP Management Plan</p> <p>Activity 1.5 Scoping analysis of year 1 baseline gun hunting/wildlife activity data completed; development of optimal algorithms for deployment of game guards (cooperation with Dr Niki</p>			

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- Activity 1.6 Development of anti-poaching patrol design and evaluation protocol; posted on project website
- Activity 1.7 Acoustic monitoring data analysis centre established in Mundemba
- Activity 1.8 Train 8 KNP staff in maintaining the ARU grid and 4 on analysing and interpreting the acoustic data (end year 2).
- Activity 1.9 KNP staff fully absorb maintenance, data collection and data analysis tasks from project staff
  
- Activity 2.1 Bushmeat price surveys undertaken
- Activity 2.2 Hunter surveys undertaken (level of involvement in hunting)
- Activity 2.3 Household socioeconomic surveys undertaken (bushmeat use/value)
- Activity 2.4 Tourist satisfaction surveys undertaken
- Activity 2.5 Project report on the scoping analysis of year 1 survey data (household/hunter/tourist) on the baseline local use/value of important conservation and bushmeat species and poaching patterns
- Activity 2.6 Analysis of year 1-2 data; project report on the effect of increased KNP anti-poaching initiatives on gun hunting pressure, wildlife activity, and local use/benefits from hunted species (submitted to MINFOF).
- Activity 2.7 Peer reviewed paper submitted
  
- Activity 3.1 Launch project website
- Activity 3.2 Upload year 1/year 2 summary reports to website / translated
- Activity 3.3 Decide on dates/content of final workshop; circulate flyer among C. African conservation community
- Activity 3.4 Select workshop members; make necessary travel arrangements for international participants
- Activity 3.5 Hold workshop in Mundemba
- Activity 3.6 Select most promising sites for exporting the anti-poaching protocol; formalize cooperation with project partners involved
- Activity 3.7 Provide follow up support for the establishment of pilot studies in at least two new protected areas.

## Annex 2 Report of progress and achievements against final project logframe for the life of the project

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016
<p><b>Goal/Impact</b></p> <p>The extent of the African bushmeat trade has reached crisis levels, threatening entire ecosystems as well as the food security and livelihoods of forest dependent rural populations. Protected areas are a key component in the strategy to address the crisis, and enforcement of wildlife legislation is critical to protected areas' success. By developing an improved design and evaluation of anti-poaching patrols in Central Africa, the project contributes to the <i>mitigation</i> of the bushmeat crisis overall, protecting endangered biodiversity, fostering the sustainable use of legitimate resources in park periphery, and generating alternative training and employment opportunities to hunting.</p>		<p>In the first 2 years of the project we provided the KNP managers with unprecedented insight on the spatial and temporal patterns and intensity of gun hunting in the park. In the third year we robustly evaluated for the first time in C. Africa (as far as we are aware) the effectiveness of anti-poaching patrols to curb poaching. Our project truly empowers the region's PA authorities to evaluate the impact of current anti-poaching strategies so as to improve them based on robust field evidence.</p>
<p><b>Purpose/Outcome</b></p> <p>Poaching in Central Africa imperils wildlife, is illegal and undermines the sustainability of local livelihoods while legitimising a corrupted attitude between people and protected areas. The project uses robust but innovative technology, centred on acoustic monitoring, to design, implement and evaluate anti-poaching strategies, leading to the development of a novel decision-support system to be rolled out across Central Africa. Developed first for Korup NP (Cameroon), this evidence-based anti-poaching protocol is intended to efficiently protect wildlife source populations within protected areas, while laying the foundation for sustainable forest uses, and thus increased food security, job opportunities, and – ultimately – poverty alleviation.</p>	<ul style="list-style-type: none"> <li>• By year 3, KNP management maintains an acoustic monitoring grid which it actively uses to collect and analyze data on spatiotemporal patterns of gun hunting and wildlife activity, in order to design adaptively its anti-poaching patrols.</li> <li>• Gun hunting pressure is significantly reduced in monitored areas within KNP during year 2 compared to baseline data collected in year 1. The reduction is higher in the core area of KNP (-30%) where the new anti-poaching regime will be tested, compared to monitored control-sites in the periphery of the core (-15%) and near farms (± no change).</li> <li>• Korup's charismatic and endangered species are better protected in the core of the park, increasing the region's potential to generate sustainable benefits for local stakeholders from their protection through research and tourism employment opportunities.</li> <li>• KNP's protocol to design and evaluate anti-poaching patrols using evidence from acoustic monitoring techniques is adopted in at least two other protected areas in Central Africa by the end of the project (even as a pilot study).</li> </ul>	<ul style="list-style-type: none"> <li>• Since January 2016 the KNP management is implementing a wildlife monitoring plan (developed by DI; Annex 7.7) which is delivered by the newly established KRCS/KNP wildlife monitoring team (Annex 7.5). This team is responsible for maintaining the acoustic grid which was established by the DI project. The plan is to establish shorter term acoustic grids in other parts of the park as well, so that extrapolations about gun hunting patterns across the park can become more accurate.</li> <li>• Our robust evaluation of the anti-poaching patrols impact on levels of gun hunting intensity in the park (Annex 7.1) showed that there has been no decline in overall hunting in the acoustic grid area even during the 4-month period of Nov. 2015 – February 2016 when the park rangers massively increased their patrol effort in terms of overall days patrolled, overall kilometres patrolled in total and per day, and the spatial and temporal extent of the patrols. This finding was a wake up call for the region's managers as to the importance of robustly evaluating their anti-poaching activities using the protocol we have developed as well as the complexity of combating the bushmeat trade. The KNP management is considering new approaches in its patrol delivery, which will be in turn evaluate against the available baseline data – something that no other PA in Central Africa has been able to do as far as we are aware.</li> <li>• While gun hunting pressure in the acoustic monitoring area did not decline, the KNP charismatic and endangered species are better protected because the KNP management is now a) better informed of the pressure that the park's wildlife is under (Annex 7.1), b) aware of the ineffectiveness of current anti-poaching patrols to curb current hunting pressure (Annex 7.1), c) able to robustly evaluate future anti-poaching strategies it employs, and d) operating for the first time a wildlife monitoring plan that extends across the park and which includes not ad-hoc observations but well-designed survey grids that combine recce walks + acoustic monitoring (Annex 7.5/7.7).</li> <li>• The anti-poaching evaluation and design protocol (based on acoustic data) developed and tested in Korup by our project was also rolled out at the Rumpi Hills Forest Reserve in 2015 (funded by USFWS "Wildlife Without Borders" grant F14AP00503), is used in Mt. Cameroon NP/Banyang-Mbo Wildlife Sanctuary/Takamanda NP by PSMNR/MINFOF in short-term deployments 7.11, and is to be trialled in Dja Faunal Reserve by African Wildlife Foundation (contact: Jef Dupain <a href="mailto:jdupain@awf.org">jdupain@awf.org</a>).</li> </ul>

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016
<p><b>Output 1.</b> KNP staff are trained and able to implement the new anti-poaching evaluation and design protocol (year 2/3).</p>	<ol style="list-style-type: none"> <li>1. The new anti-poaching protocol is approved by MINFOF and included in the new KNP management plan (year 2).</li> <li>2. A group of 8 KNP game guards is trained in setting and maintaining the ARU grid in the field, while 4 KNP management staff are trained in analysing the acoustic monitoring data (year 2).</li> <li>3. First anti-poaching report using acoustic monitoring data collected and analyzed by KNP staff is submitted to PSMNR-SWR/MINFOF (year 3).</li> </ol>	<ol style="list-style-type: none"> <li>1. The Ministry of Forests and Wildlife (MINFOF) has not completed the review of the KNP management plan for reasons beyond the control of the DI project. Such delays in management plan updates are unfortunately common. The DI project however has helped develop a wildlife monitoring plan which is now implemented since January 2016 (Annex 7.7). It explicitly includes continuing the DI established acoustic monitoring grid in the southern sector (Annex 7.7).</li> <li>2. In year 1 we trained the KRCS members than have been running the acoustic grid. In Year 2 we trained a total of 12 KNP/KRCS/WWF-CFP staff in the acoustic grid deployment, maintenance and data analysis. In Year 3 we provided additional training to 5 people (4 KRCS members including those who now form the core of the KNP-KRCS's wildlife monitoring team; the PSMNR employee) on more advanced data analysis techniques (Annex 7.4) .</li> <li>3. While the acoustic grid is maintained by the KRCS/KNP team, while the data analysis hub is awaiting completion in Buea (PSMNR funds for equipment + staff), the analysis of the acoustic data has continued to take place at Cornell (peter Wrege) as the power of KNP/KRCS computers is such that the analysis would be too time consuming and impractical. Having said that, PSMNR collected data from other PAs were analysed in Cameroon and double checked by Cornell. This was possible because the deployments (and hence size of the data to be scanned with the detection algorithms for gunshots) were shorter.</li> </ol>
<p>Activity 1.1 Acoustic monitoring grid (12 ARUs) and line transect network established in KNP; KRCS members trained</p>		<p>The acoustic monitoring grid was set by CU's Peter Wrege in early June 2013 and it has been running without problems since then. Since January 2016 the maintenance of the grid was handed to the KNP management, as per the project's plan. The line transect monitoring network operate during the DI period (see Annex 7.23) and it currently included in the KNP wildlife monitoring plan (Annex 7.5).</p>
<p>Activity 1.2 Collection of ARU and line transect data on gun hunting intensity and wildlife activity patterns in KNP</p>		<p>The collection of ARU (acoustic) and line transect data (monthly) started as per schedule in Year 1 and continues to date. The monitoring grid will continue in Year 3 as planned.</p>
<p>Activity 1.3 Species-specific detection algorithms developed; detection range of ARUs for wildlife calls/gunshots determined</p>		<p>In Year 1, we improved the automatic detection algorithms for gun shots and elephant rumbles, and developed new ones for four of the most vocal primate species in Korup (<i>Cercocebus torquatus</i>, <i>Cercopithecus mona</i>, <i>C. pogonias</i> and <i>C. nictitans</i>). In Year 2 we improved considerably the efficiency of the gunshot detector, tested a detector for chimpanzee calls (but have not found yet chimpanzee (<i>Pan troglodytes ellioti</i>) calls in the Korup data we have searched). In Year 3, we worked on the Preuss's red colobus (<i>Piliocolobus preussi</i>) detection algorithm after obtaining example calls from online acoustic databases. The algorithm works well but requires further fine tuning. We have not managed to obtain sufficient sample calls for the <i>C. erythoris</i>, and the detector for the drill monkey (<i>mandrillus leucophaeus</i>) is still in need of further development (Annex 7.19).</p>
<p>Activity 1.4 Inclusion of novel anti-poaching protocol in the KNP Management Plan</p>		<p>The Ministry of Forests and Wildlife (MINFOF) has not pushed forward with the review of the KNP management plan. We have developed however a new wildlife monitoring plan for KNP which is implemented since Jan. 2016, and it includes explicitly the inclusion/maintenance of the DI established acoustic monitoring grid in the southern sector (Annex 7.5/7.7).</p>

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016
Activity 1.5 Scoping analysis of year 1 baseline gun hunting/wildlife activity data completed; development of optimal algorithms for deployment of game guards (cooperation with Dr Niki Trigoni)		The scoping analysis of Year 1 baseline data has been completed and the findings were presented in Buea, Cameroon by C. Astaras to all Cameroon-based DI project partners (PSMNR/MINFOR/KNP/KRCS/WWF) (Annex 7.17). The development of optimal deployment algorithms were not completed as planned, because the evaluation of the Year 2 anti-poaching patrols strategies was in effect pushed into Year 3. Now that we have a clearer understanding of the impact of current anti-poaching patrol strategies on poaching (or, to be exact, the lack of impact), it will be possible to develop more complex strategies on patrol designs in collaboration with our DI partners (esp. KNP/PSMNR) that can be in turn evaluated using the acoustic grid that is in place. This remains an activity that will have to be pursued after the lifetime of the project.
Activity 1.6 Development of anti-poaching patrol design and evaluation protocol; posted on project website		The project website was developed in Year 2. We have shared project findings in it via posts in the forum section of the website, esp. the presentation at the IPS/ASP Congress by Joshua Linder (see also Annex 7.10) and the acoustic sensor deployment protocol. We are also sharing technical information on new equipment that can be used by people adopting the protocol in their areas. We will continue to upload more information on the site.
Activity 1.7 Acoustic monitoring data analysis centre established in Mundemba		Following discussions with the DI partners during the final workshop (Buea, Dec. 2015), we agreed that it would be more efficient (in terms of the long term sustainability of the data analysis hub, if it were to be established in Buea (HQs of the regional office of MINFOR and PSMNR HQs). Realistically, establishing such a hub so that it could analyse data from multiple PAs (since acoustic monitoring has been already rolled out to more PAs in the SW region of Cameroon) would be more economical (fewer but better equipment – a realistic number of dedicated staff assigned to it). This hub is under development and the previous DI country coordinator (Robinson Orume) is likely to be responsible data analyst.
Activity 1.8 Train 8 KNP staff in maintaining the ARU grid and 4 on analysing and interpreting the acoustic data (end year 2).		We have already trained 12 KNP/KRCS/WWF-CFP members in December 2014 (Year 2) in acoustic grid deployment and data analysis. In Dec. 2015 (Year 3) we provided additional follow up training to more KRCS people who now form part of the KNP/KRCS wildlife monitoring team. This team maintains the acoustic grid in Korup (among other tasks).
Activity 1.9 KNP staff fully absorb maintenance, data collection and data analysis tasks from project staff		The KNP/KRCS wildlife monitoring team has fully absorbed the maintenance and data collection of the KNP acoustic grid established by the DI project. As explained earlier, the data analysis is still undertaken by the DI partners (CU – Peter Wrege) until the data analysis hub is completed in Buea.
<p><b>Output 2</b></p> <p>Poaching patterns within KNP are understood so as to be effectively combated with available resources, affording wildlife in the park's core area (at least) a markedly higher level of protection (year2/3).</p>	<ol style="list-style-type: none"> <li>1. Report submitted to MINFOR presenting gun hunting and wildlife activity pattern changes between year 1 and year 2 (24 months; 12 ARUs + 4 line transects + hunter interviews) (year 3).</li> <li>2. Report submitted to MINFOR presenting the findings of the socioeconomic surveys on the role of bushmeat in the livelihoods of local communities (year 1-2 data) (year 2).</li> <li>3. Peer-reviewed manuscript on the efficacy of anti-poaching patrols to combat hunting within PA is accepted for publication (year 3).</li> </ol>	<ol style="list-style-type: none"> <li>1. The findings of Year 1-2 findings of the project were presented to MINFOR and other DI partners via a) a presentation in Bua, July 2014 (Year 1 data only; Annex 7.17), b) the final workshop presentations (Buea, Dec. 2015; Annex 7.12/13), c) a report to MINFOR on Jan. 2016 (Annex 7.15), and d) the final report on the effectiveness of anti-poaching patrols to curb poaching (Annex 7.1).</li> <li>2. We have submitted a report to MINFOR and DI partners on the findings of the socioeconomic surveys (Annex 7.9). Analysis of the same data (in conjunction with gunshot data) were also presented during the final workshop (Annex 7.13).</li> <li>3. We completed the analysis patrol effect on gun hunting. Only near the end of Year 3 (data collection extended to Feb. 2016). The shocking findings on the inability of patrols to curb hunting are included in the final report (Annex 7.1). The submission of a manuscript for peer-reviewed publication is the number one priority for us now.</li> </ol>



Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016
Activity 2.1 Bushmeat price surveys undertaken		As with all the surveys, there was an original delay in the on start of the data collection face in Year 1, but since October 2013 twice-monthly data are collected from bushmeat bulk sellers, local eateries and markets on the price of bushmeat and regular meat. These surveys continued as per schedule (Annex 7.20 – survey forms; Annex 7.9 report).
Activity 2.2 Hunter surveys undertaken (level of involvement in hunting)		The hunter surveys were collected from a total of 30 hunters (10 in each of three villages) as per the project’s proposal (Annex 7.21; Annex 7.9 report). The data from these surveys have proven especially useful for the interpretation of the gun hunting patterns observed in the acoustic data in the park.
Activity 2.3 Household socioeconomic surveys undertaken (bushmeat use/value)		The 2-month intensive household surveys were conducted in Jan-Feb 2014, Aug-Sept 2014, Jan-Feb 2015, and Aug.-Sept. 2015 (Annex 7.22; Annex 7.9 report).
Activity 2.4 Tourist satisfaction surveys undertaken		The tourist satisfaction surveys were stopped soon after they were established due to the small number of tourists visiting the park. They would not have been informative given the small sample size.
Activity 2.5 Project report on the scoping analysis of year 1 survey data (household/hunter/tourist) on the baseline local use/value of important conservation and bushmeat species and poaching patterns		The findings of the survey data (hunters/households/bushmeat price) were included in the presentations of the final workshop (Buea, Dec. 2015; Annex 7.13) and the final report submitted to the partners (7.9).
Activity 2.6 Analysis of year 1-2 data; project report on the effect of increased KNP anti-poaching initiatives on gun hunting pressure, wildlife activity, and local use/benefits from hunted species (submitted to MINFOF).		The analysis on the efficacy of the increased anti-poaching efforts to combat illegal gun hunting in KNP was included in the final report (Annex 7.1). The analysis of the survey data was included in the report of Activity 2.5 (Annex 7.9).
Activity 2.7 Peer reviewed paper submitted		We submitted the first peer-reviewed manuscript in Sep. 2016 at the Frontiers in Ecology and the Environment (Annex 7.14). It has gone through the review stage and we await the decision of the editor.
<p><b>Output 3</b></p> <p>The need to critically examine current anti-poaching design and evaluation strategies in Central African rainforests is recognized by key government agencies and conservationists in Cameroon, Gabon, Equatorial Guinea, Central African Republic, Congo-Brazzaville, DR Congo.</p>	<ol style="list-style-type: none"> <li>1. Project website is developed and used as a communication forum for sharing the project findings with conservation practitioners (field protocols, data analysis protocols, project reports and publications). Material posted in English and French (year 1-3).</li> <li>2. A workshop providing theoretical introduction to and practical training on acoustic monitoring and anti-poaching patrol design and evaluation techniques is held in Mundemba for 20 Central African conservationists (year 3).</li> <li>3. Project partners are invited to advise management teams of protected areas wishing to use the new anti-poaching protocol in their area (2 PAs; year 3).</li> </ol>	<ol style="list-style-type: none"> <li>1. During Year 2, the project website was created. The website’s forum page is used to share project updates regarding preliminary findings, conference presentations and the latest developments in equipment and field techniques. No material has yet been translated in French, but it remains a goal for the future.</li> <li>2. The project’s final workshop was held in Dec. 2015 (Buea, Cameroon) and it was well attended (and received) by conservation practitioners representing government agencies and protected areas, conservation NGOs (international and local), and international researchers (Annex 7.12/13).</li> <li>3. We have already secured funds from USFWS and established a new acoustic grid in the Rumpi Hills Wildlife Reserve (established Nov. 2014). Moreover, we advised the establishment of shorter acoustic monitoring deployments in Mt. Cameroon NP/Banyang-Mbo WR/Takamanda NP (Annex 7.11). In August 2016 we also advised the African Wildlife Foundation in adopting a pilot acoustic grid in Dja Faunal Reserve. All above projects focus primarily on monitoring the illegal gun hunting activity in these areas. Also, the use of the acoustic monitoring protocol for evaluating illegal human activity patterns and intensity has also been piloted in Bangladesh, and it about to be tested in Greece.</li> </ol>
Activity 3.1 Launch project website		We created the project website in Year 2.

Project summary	Measurable Indicators	Progress and Achievements April 2015 - March 2016
Activity 3.2 Upload year 1/year 2 summary reports to website / translated		The website contains summary reports of our findings (forum section) via the presentation of J. Linder at the IPS/ASP Congress (see also Annex 7.10), a Mongabay.org article, and two DI Newsletter articles (see Annex 5 for links to all of the above).
Activity 3.3 Decide on dates/content of final workshop; circulate flyer among C. African conservation community		The final workshop was held in Buea, Cameroon at the Regional MINFOF HQs from Dec. 10-11 (Annex 7.12). A call for the workshop was placed on the DI project website.
Activity 3.4 Select workshop members; make necessary travel arrangements for international participants		The majority of the participants were informed via direct contact by the organizers (WildCRU/KRCS). The list of participants was agreed in collaboration with all partners.
Activity 3.5 Hold workshop in Mundemba		The final workshop was eventually held in MINFOF's regional HQs in Buea, as it was agreed that it would be logistically much easier for the participants to reach the site. It would have required an extra day of travel to/from Mundemba for many of the participants not based in SW Region of Cameroon.
Activity 3.6 Select most promising sites for exporting the anti-poaching protocol; formalize cooperation with project partners involved		We have already roll-out the acoustic monitoring element of our work in Rumpi Hills Forest Reserve and three more protected areas in SW Region of Cameroon where DI partner PSMNR operates (Annex 7.11). There was no need to formalize the arrangement with AWF for Dja Faunal Reserve. J. Linder, P. Wrege and C. Astaras advised Jef Dupain and his team on the equipment that would be needed given the nature/extent of their pilot study around two inselbergs in Dja.
Activity 3.7 Provide follow up support for the establishment of pilot studies in at least two new protected areas.		See comment for Activity 3.6.

## Annex 3 Standard Measures

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
<b>Training Measures</b>							
1a	Number of people to submit PhD thesis						
1b	Number of PhD qualifications obtained						
2	Number of Masters qualifications obtained						
3	Number of other qualifications obtained						
4a	Number of undergraduate students receiving training						
4b	Number of training weeks provided to undergraduate students						
4c	Number of postgraduate students receiving training (not 1-3 above)						
4d	Number of training weeks for postgraduate students						
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification(e.g., not categories 1-4 above)						
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)	42	Cameroonian (37), Nigerian (2), Dutch (1), German (2)	Male (39), Female (3)	Acoustic monitoring (deployment/maintenance/analysis) + general wildlife monitoring + survey coordination	English	Training of KRCS & KNP staff in the deployment and maintenance of an acoustic monitoring grid (7 in 1 week/Y1 + 8 in 1 week in Y2); training of KRCS members as survey coordinators and animators (4 in 1 week/Y1); training of KRCS/KNP staff in acoustic data analysis (4 in 1 week/Y2 and in ½ week in Y3); training 2 KNP rangers in wildlife monitoring (multiple weeks in Y3); education of 20 final workshop participants on the use of acoustic monitoring as a tool for evaluating and designing anti-poaching patrols (1/2 week - final workshop/Y3).

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
6b	Number of training weeks not leading to formal qualification	10					5 weeks for all the training workshops (40 people) + 5 weeks of hands-on training on wildlife monitoring of the two KNP rangers who joined the ex-DI team to form the new KRCS/KNP wildlife monitoring team.
7	Number of types of training materials produced for use by host country(s) (describe training materials)	2			Manual detailing the field protocol for setting, maintaining and extracting data from the ARU grid	English	Created by CU <a href="https://bioacousticmonitoring.files.wordpress.com/2016/11/acousticprogram-korup_deployment-protocol_newer.pdf">https://bioacousticmonitoring.files.wordpress.com/2016/11/acousticprogram-korup_deployment-protocol_newer.pdf</a> ; Annex 7.24 Acoustic Monitoring: Sound-File Organization and Signal Detection manual

Research Measures		Total	Title	Language	Comments/ Weblink if available
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)	2	"Monitoring wildlife status and population trends in Korup national park" Christos Astaras, Joshua Linder, Philip Forboseh 2014/ "Summary Report on Gun Hunting Intensity in Korup National Park – Recommendations", C. Astaras and J. Linder – Jan. 2016	English	The wildlife monitoring plan was developed in 2014 by C. Astaras – J. Linder in conjunction with Cameroon DI partners (PSMNR/WWF) (Annex 7.7) / The series of recommendations on the adoption of acoustic monitoring as an anti-poaching evaluation and design protocol was prepared solely by DI partners and was submitted to the Cameroonian Ministry of Forests and Wildlife (MINFOF) upon request following the completion of the final workshop (Y3) (Annex 7.15)
10	Number of formal documents produced to assist work related to species identification, classification and recording.				
11a	Number of papers published or accepted for publication in peer reviewed journals	1	"Passive acoustic monitoring as a law enforcement monitoring tool for Afrotropical rainforests", Astaras C., Linder J, Wrege P.H, Orume R, Macdonald D.W.	English	Currently pending final decision (peer review has been completed) – Frontiers in Ecology and Environment (Annex 7.14)
11b	Number of papers published or accepted for publication elsewhere	3	"Eavesdropping on Cameroon's poachers to save endangered primates", Salisbury C., 20 April 2016, "Reducing illegal poaching which harms local communities leads to greater food and livelihood security in Cameroon", Astaras C., June 2014, "Acoustic monitoring in African tropical protected areas: improving biodiversity and social outcomes", Astaras C., May 2016	English	Mongabay.org (1) <a href="https://news.mongabay.com/2016/04/eavesdropping-cameroons-poachers-save-endangered-primates/">https://news.mongabay.com/2016/04/eavesdropping-cameroons-poachers-save-endangered-primates/</a> ; DI Newsletter (2) <a href="http://www.darwininitiative.org.uk/assets/uploads/2014/05/Darwin-Initiative-Newsletter-June-2014-Final21.pdf">http://www.darwininitiative.org.uk/assets/uploads/2014/05/Darwin-Initiative-Newsletter-June-2014-Final21.pdf</a> ; <a href="http://www.darwininitiative.org.uk/assets/uploads/2016/05/May-2016-IDB-Newsletter-FINAL.pdf">http://www.darwininitiative.org.uk/assets/uploads/2016/05/May-2016-IDB-Newsletter-FINAL.pdf</a>

12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	1	Acoustic monitoring data collected from Korup NP (Years 1-3)		The database can be used to extract not only information on gun hunting activity, but also for all other sounds (human or wildlife). It constitutes in effect a baseline/historical record of a forest soundscape that can be analysed in a multiple of ways by the Cameroonian state (or international institutions interested in the area).
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country				
13a	Number of species reference collections established and handed over to host country(s)				
13b	Number of species reference collections enhanced and handed over to host country(s)				

Dissemination Measures		Total	Theme	Language	Comments
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	3	Workshop organized in July 2014 by Oxford/PSMNR in Buea/Cameroon to present preliminary results of the DI project on gun hunting activity during the baseline Yr1 period / Workshop organized in December 2014 in Mundemba, Cameroon to present additional findings on the DI project findings to local partners (esp. KNP management – WWF site advisors) / Final workshop organized in December 2015 in Buea, Cameroon to PA managers across the rainforest zone of Cameroon + Nigeria	English	
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	3	Presentation at the International Primatological Society/American Society of Primatologists' Congress (Chicago, Aug. 2016); Presentation at the Student Conference in Conservation Science (Cambridge, UK; March 2016), Presentation at the UK Bushmeat Working Group Meeting (London, April 2016)	English	

Physical Measures		Total	Comments
20	Estimated value (£s) of physical assets handed over to host country(s)	£22,640	Acoustic grid sensors for Korup NP (including SD cards), computer for data analysis at Korup NP HQ in Mundemba, laptops (2), tree climbing gear (Yr1), software for acoustic analysis (Yr1), flatbed paper-fed scanner (yr1), GPS units (y1), 10 new acoustic sensors for Rumpi Hills Grid + 2 for IKK village (Yr2)
21	Number of permanent educational, training, research facilities or organisation established	1	Acoustic (plus other wildlife) data analysis facility being prepared in Buea (MINFOF Regional Office HQs) by PSMNR where DI trained staff will oversee the analysis of wildlife monitoring data not only from Korup NP, but also from 3 additional PAs. (under development).

22	Number of permanent field plots established	1	The Di established acoustic monitoring grid in Korup NP has been adopted as part of the wildlife monitoring plan of Korup NP and therefore it becomes a permanent grid/plot.
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<b>Financial Measures</b>		<b>Total</b>	<b>Comments</b>
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work	£162,333	The additional resources consists of the £159,833 matched funds mentioned in the project proposal (originally: £161,906 but was lower since the contribution by the Quatermain Foundation was lower by £2,023 than originally stated since the batteries for the acoustic sensors ended costing less than originally budgeted for) plus £2,450 additional funds provided by PSMNR after the end of the DI project to ensure the continuation of the acoustic monitoring in KNP (see section 7.2 for detailed breakdown of funds raised).

## Annex 4 Aichi Targets

	Aichi Target	Tick if applicable to your project
1	People are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	✓
2	Biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	
3	Incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	
4	Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	✓
5	The rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	
6	All fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	
7	Areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	✓
8	Pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	
9	Invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	
10	The multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	
11	At least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	✓
12	The extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	✓
13	The genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	



14	Ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	✓
15	Ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	
16	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	
17	Each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	✓
18	The traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	
19	Knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	✓
20	The mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	

## Annex 5 Publications

Type *	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers	Available from (e.g. weblink, contact address, etc.)
*Manuscript	"Passive acoustic monitoring as a law enforcement monitoring tool for Afrotropical rainforests", Astaras C., Linder J, Wrege P.H, Orume R, Macdonald D.W.	Greek	UK	Male	Frontiers in Ecology and the Environment (under review)	Annex 7.14, <a href="mailto:christos.astaras@zoo.ox.ac.uk">christos.astaras@zoo.ox.ac.uk</a> (until publication – then accessible online)
Presentation	"Using acoustic monitoring to improve tropical forest protected area management", Linder J., Astaras C., Wrege P.H., Macdonald D.W., August 2016	US	US	Male	International Primatological Society - Congress	<a href="https://bioacousticmonitoring.files.wordpress.com/2016/09/ips-2016_presentation_final.pdf">https://bioacousticmonitoring.files.wordpress.com/2016/09/ips-2016_presentation_final.pdf</a>
Newsletter	"Acoustic monitoring in African tropical protected areas: improving biodiversity and social outcomes", Astaras C., May 2016	Greek	UK	Male	Darwin Initiative	<a href="http://www.darwininitiative.org.uk/assets/uploads/2016/05/May-2016-IDB-Newsletter-FINAL.pdf">http://www.darwininitiative.org.uk/assets/uploads/2016/05/May-2016-IDB-Newsletter-FINAL.pdf</a>
*Article	"Eavesdropping on Cameroon's poachers to save endangered primates", Salisbury C., 20 April 2016	UK	US	Female	Mongabay.org	<a href="https://news.mongabay.com/2016/04/eavesdropping-camerouns-poachers-save-endangered-primates/">https://news.mongabay.com/2016/04/eavesdropping-camerouns-poachers-save-endangered-primates/</a> (Annex 7.25)
*Report	"Summary Report on Gun Hunting Intensity in Korup National Park: Recommendations", Astaras C., Linder J., Jan. 2016	Greek	UK	Male	DI project	Annex 7.15, <a href="mailto:christos.astaras@zoo.ox.ac.uk">christos.astaras@zoo.ox.ac.uk</a> (submitted to the Cameroon Ministry of Forests and Wildlife)
*Manual	"Acoustic Monitoring: Sound-File Organization and Signal Detection", Wrege P.H., Nov. 2015	US	US	Male	Elephant Listening Project, The Cornell Lab of Ornithology, Ithaca, NY	See Annex 7.24; <a href="mailto:christos.astaras@zoo.ox.ac.uk">christos.astaras@zoo.ox.ac.uk</a>
*Report	"Report on Line Transect Surveys – Korup NP 2013-2105", Linder J., Astaras C., Wrege P.H., May. 2015	US	US	Male	DI project	Annex 7.23, <a href="mailto:christos.astaras@zoo.ox.ac.uk">christos.astaras@zoo.ox.ac.uk</a> (submitted to the Cameroon Ministry of Forests and Wildlife and DI partners)
Newsletter	"Reducing illegal poaching which harms local communities leads to greater food and livelihood security in Cameroon", Astaras C., June 2014	Greek	UK	Male	Darwin Initiative	<a href="http://www.darwininitiative.org.uk/assets/uploads/2014/05/Darwin-Initiative-Newsletter-June-2014-Final21.pdf">http://www.darwininitiative.org.uk/assets/uploads/2014/05/Darwin-Initiative-Newsletter-June-2014-Final21.pdf</a>
Manual	"Acoustic Monitoring Project – Korup N.P. SM2 Deployment Instructions", Wrege P.H., Griffiths E.T., Powers M.E., Kingensmith A., Allen P.E., Ross J.C., Aug. 2013	US	US	Male	The Cornell Lab of Ornithology, Ithaca, NY	<a href="https://bioacousticmonitoring.files.wordpress.com/2016/11/acousticprogram-korup_deployment-protocol_newer.pdf">https://bioacousticmonitoring.files.wordpress.com/2016/11/acousticprogram-korup_deployment-protocol_newer.pdf</a>

## Annex 6 Darwin Contacts

Ref No	20-012
Project Title	Improving anti-poaching patrol evaluation and design in African rainforests
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## **Annex 7 Supplementary material**

**(Please refer to separate MS Word file titled: “Final\_Report\_Ref20-012-Macdonald DW - Annex 7 Supplementary material”)**