Darwin Initiative Innovation Annual Report

To be completed with reference to the "Project Reporting Information Note":
(https://www.darwininitiative.org.uk/resources/information-notes/)

It is expected that this report will be a maximum of 20 pages in length, excluding annexes)

Submission Deadline: 30th April 2024

Submit to: BCF-Reports@niras.com including your project ref in the subject line

Darwin Initiative Project Information

Project reference	DARNV014
Project title	Pioneering approaches for drone use in biodiversity conservation - Madagascar
Country/ies	Madagascar
Lead Partner	Durrell Wildlife Conservation Trust
Project partner(s)	Liverpool John Moores University (LJMU) Madagascar National Parks (MNP)
Darwin Initiative grant value	£197,959
Start/end dates of project	01 April 2023 – 31 March 2025
Reporting period (e.g. Apr 2023 – Mar 2024) and number (e.g. Annual Report 1, 2, 3)	01 April 2023 – 31 March 2024 Annual Report 1
Project Leader name	Dr Mike [redacted]
Project website/blog/social media	
Report author(s) and date	Andriatsitohaina [redacted] (Tsito)

1. Project summary

The use of drones in this project aimed at reducing deforestation, enhancing reforestation, habitat and species monitoring, and improving monitoring of conservation targets throughout Madagascar represents an innovative approach to addressing environmental challenges. Despite representing a modern technological solution to several conservation challenges, drones are currently under-used in Madagascar. This project seeks to deliver approaches and capacity for the effective use of drones to help monitor conservation targets and interventions, and respond to threats more effectively, helping to reverse the decline in natural resources on which four out every five of Malagasy people depend.

More specifically; the project seeks to develop a system for drone-based monitoring of tree survival and carbon sequestration using AI processing of drone-imagery and LiDAR, which will provide a scalable method for tracking progress of the National Reforestation Program which aims to reforest a fifth of the trees on Madagascar which equates to 60 million trees and requires growth monitoring over many years.

During the project a community of conservation-based drone practitioners will be built to boost engagement in the drone sector and build capacity to apply methods established in protected area

management across Madagascar, through working closely with environmental NGO partners and the Ministry of Environment. It will also assess the effectiveness of drones as a method of deterrence against environmentally damaging behaviour as a tool in protected area management.

Furthermore, the project will build on previous work that demonstrated that drone-based infra-red detection of Aloatran gentle lemurs is possible and expand this to a range-wide survey of this Critically Endangered species and set a precedent for the use of this technology in Madagascar.

The results will likely shape national conservation policy and set a standard in how drones can be used to monitor its impact on biodiversity, carbon capture, and climate change. By conserving and restoring biodiversity in Madagascar, the project contributes to the well-being of both people and nature, ensuring a sustainable future for generations to come.

The project specially focuses within Menabe Antimena Protected Area (22 in the map below) and Lac Alaotra (16) but is not restricted to this area as the drone training program has included regional Ministry of Environment representatives from each region throughout Madagascar.

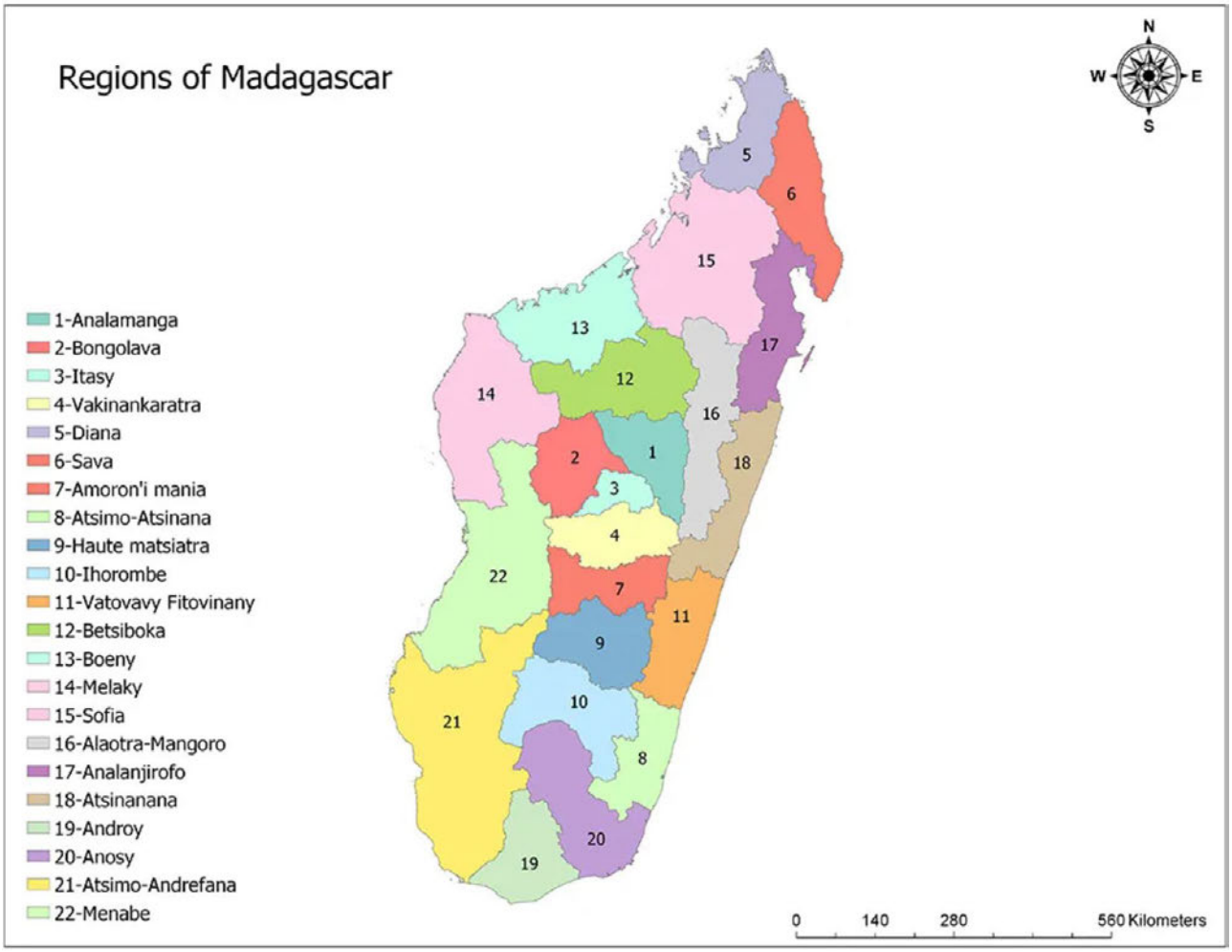

Figure 1 Map of Madagascar

2. Project stakeholders/partners

This project involves wide-spread collaboration and capacity building within local authorities including the Ministries of Environment and sustainable development, as well as environmental NGOs and Protected Area managers of Madagascar National Parks. Liverpool John Moores University is also supporting the project in AI improvement for data-processing.

Throughout the last year, the partnership has been involved and expanded to include more NGOs and MoE (Ministry of Environment) regional departments, now representing regional coverage across the country.

By sharing our knowledge and expertise gained during the project, the conservation community sees drones as potential to benefit environmental protection and biodiversity conservation. We are seeing partners become more knowledgeable on how drones can be used and high levels of interest in the shared results of drone usage for tree monitoring and lemur detection, which we expect to see adopted by partners and stakeholders in the next few years.

The “train, share and apply” approach involve partners and stakeholders at each level of the project. This starts at British Embassy by supporting activities related to environment protection and biodiversity conservation like the reforestation program and celebration of World Environment day, and MoE level by the minister supporting drone-based reforestation activities and monitoring strategies, while public institutions such as the Civil Aviation Authorities of Madagascar allows and approves the developed drone training program increasing safety and legal use of these aircraft in environment field.

3. Project progress

3.1 Progress in carrying out project Activities

Output 1. Techniques established for semi-automated reforestation monitoring using drones

1.1 *Drone flights to describe the state of reforestation plots*: Flight map saved for Alaotra reforestation plots. First flights for each plot conducted in the dry season and second flights conducted after the rainy season. Done as planned on the initial activities planning. Next assessment will be done with the LIDAR sensor in the dry season and after the rainy season.

The first reforestation plot mapping and data collection conducted in Alaotra was over a 200Ha reforestation area, followed by ground sample measurement and tree species manual inventory. Two flights were conducted in Alaotra in the dry and after rainy season of about 200ha dispersed in different areas inside the site. Flight plans are saved on drone software during the first flights (dry season) and was verified after rainy season. This will allow first data comparison for year 1. Machine learning code were customised based on collected data. Flight results from Alaotra reforestation plots are stored in local server ready for processing. These flights used the same flight planning to allow data comparison across the 6 months interval. Data processing with AI will give the survival rate of each plot. The first-year assessment was done with the RGB drone, the Y2 confirmation will be done with the LIDAR drone. The LIDAR sensor and drone frame received in Tana but still waiting for the batteries as they are considered as dangerous goods for air cargo, finding freight company who can ship them takes time and procedures. It is in progress with the UK team.

The reforestation area for drone mapping for Menabe was conducted in June and October-23. Menabe reforestation plot is smaller than Alaotra and located inside the PA restoration zone. The actual RGB sensor allowed for mapping only and the comparison will wait for the LIDAR sensor.

1.2 *Ground truth survey to ground truth drone data*: Manual measurement for ground truth done after each drone flights. Conducted as planned in activities planning. Each young tree is identified by its GPS coordinates on the map.

1.3 *Algorithm/pipeline developed to process drone data for the effective monitoring of sapling survival rate and reforestation success and rates of carbon sequestration*: An AI pipeline was built with the student to create the young trees recognition algorithm based on Python language, and data collected from drone flights have been integrated into machine learning to allow the knowledge database feeding. Ground truthing based on manual measurement of young trees sample on each reforestation spot. Data integrates in AI for height accuracy verification. Each young tree is identified by its GPS coordinates on the map.

1.4 *AI algorithm training on identification of tree species and coverage across reforestation plots*: A trainee has been hired for semi-automated reforestation assessment algorithm. He is working on algorithm development since October 23 and almost working on machine learning database and code. First assessment and test were done in January to identify any required improvements.

1.5 *Workshop delivered to disseminate newly developed reforestation monitoring techniques*: Two sessions of training conducted with partners to share the new standardised drone-based

reforestation monitoring. This includes flight planning and data processing methodology and tools. Two further sessions planned for next year with the new program improvement.

1.6 *Paper writing*: Data analysis and post processing has been recorded and will be integrated to be included in an international publication with the paper by the end of the project.

See Annex 1 for evidence.

Output 2: Capacity developed for using drones for environmental conservation in Madagascar

2.1 *Madagascar practitioners gathered to form a working group:* Done, the group is called Madagascar Conservation Drone Community including people who attend the training sessions for Tana and Fianarantsoa. The next training session will group the new members from other regions and NGOs and MoE of Madagascar. The Madagascar Conservation Drone Community was created on February 24th to form a group of drone users working in Environmental Conservation. Membership increases with the number of trainings delivered across Madagascar.

2.2 *Working group meetings chaired by Durrell project staff:* Ongoing

2.3 *Knowledge sharing workshops delivered to working group (at least 1 per year):* Two knowledge sharing workshops will be delivered to working group participants at project midterm and project year end: First sharing workshop planned to be delivered on May 3rd due to attendants' availability being limited, involving the British Embassy, MoE, Civil Aviation Authority, NGOs and partners working in the field of environmental conservation in Madagascar. Further project end workshop is then also planned.

2.4 *Seven-day full-time training course and refresher sessions delivered for 50 people for drone piloting - 5 conducted in total (25 people each session) by project end*: 3 sessions were held; 2 in Tana and 1 in Fianarantsoa. 71 people trained in total from the start date to March 2023 including 20 Civil Aviation Staff for drone control and safety (not prior but necessary to allow our certificate to be recognised).

Five staff from Durrell in Alaotra have been trained in drone operation and got their Drone Pilot licence. These pilots have been declared as official Durrell Drone Pilots in the Operation manual. The training was focused on mapping and Bandro detection inside the march of Alaotra.

Twenty (20) staff from Civil Aviation Authority were trained and obtained their certificates. This step was required to allow our training program to be validated and recognised by the national Civil Aviation Authority.

Twenty-nine (29) (Men: 18, Women: 11) people trained in Antananarivo from MoE and different NGOs including MNP working in Environment and conservation domain.

Twenty-two (22) people (Men: 18, Women: 4) trained in Fianarantsoa, from MoE regional department, NGO working in Amoron'i Mania, and Haute Matsiatra region.

Four training sessions in different regions are planned for Y2.

A total of 71 professionals were trained and obtained their drone licences in Y1.

2.5 *Advanced training delivered to four people on drone maintenance through regular sessions at the Durrell drone lab*: Two staff members of the MoE drone department have been trained in drone maintenance and advanced drone operations including VTOL aircraft

See Annex 2 for evidence.

Output 3: Drones demonstrated as an effective detection and deterrence mechanism for environmentally damaging behaviour and informing and responding to SMART patrol activity

3.1 *Experimental framework developed for the testing of drones as deterrence measure in Menabe-Antimena National Park and* 3.2 *Drone flights conducted across two fire seasons during project in experimental framework, for at least four weeks at a time*

Two field work operations have been conducted in Menabe Antimena by the drone team:

1. Aerial patrol and mapping based on SMART information in June 2023. The notifications and log from SMART patrol was transformed into a map to identify the area where ground patrols cannot enter. The first field period allowed us to detect the cutting area (possibly to be burnt in the next fire season), the illegal camps inside the PA and provided information to be shared with the ground patrol. Photos and videos will be used as proof for law enforcement on the actual situation inside the PA.

2. The second field work was conducted during the fire season (September-October 2023) working with the ground patrol. This methodology allows us to detect fire as soon as it starts and redirect the fire agent to reach the area in a safe manner and by the shortest access point for firefighting. At the same time, drone flying above the PA and burnt area is seen by local communities and helps in communication and sensitisation. This allows reactivity and intervention by the ground patrols, to help in minimising the area of burnt forest. This methodology is shared in real time with the local team to be used during weekly and daily ground patrol, particularly in the fire season.

Results:

1. Three fire starting points detected, notified and managed by the local firefighters.

2. Daily Aerial patrol and ground patrol enforcement conducted with local rangers reduced the illegal access inside the PA through deterrence: the fact that local people are aware that the drone is perform daily flight and surveillance.

3. Reduction of fire points during drone field work and aerial patrols. Without drone flights, at least three fire points per day are noticed by the ground patrol. This number decreases with daily drone flights in random hours of the day.

3.3 *Longitudinal monitoring using SMART by local village patrols to understand the impact of drone flights on distribution and prevalence of illegal activities in Menabe-Antimena:* Ongoing

3.4 *Drone detection data is integrated into SMART to inform community patrol activity*: SMART raw data integrated to drone flight log database for the last 04 field works (2 in Menabe and 2 in Alaotra for reforestation mapping and habitat monitoring).

Output 4: The first robust, range-wide survey of Alaotran gentle lemur is delivered using drone-based infra-red detection of lemurs as a model for animal detection using this technology in Madagascar

4.1 *Systematic flights conducted to assess the population of Alaotran gentle lemurs across their marsh range:* Field work was conducted in Alaotra marshes, based on the new methodology-the flight path follows a transect 500meters by 250 meters, at height of 25 -30 meters which ensures the lemurs are not disturbed by noise Each flight takes 25-30 minutes. Flight protocol has been updated based on field experiences such as weather condition (fog); which has an impact on lemurs wake-up time, as well as flights performed in full moon condition. Lemurs are active earlier and the interval time varies depending on light conditions. Lemurs' temperature as detected by the drone stay the same through winter and summer. The start of their activity is influenced by sunrise. Vegetation type impacts the number of lemurs living inside the marsh. Each area is divided by zone and by different vegetation types. The lemurs are more visible in vegetation dominated by papyrus.

4.2 *Ground truthing surveys in pirogues conducted to validate drone footage and image processing*: Ground verification has been done with patrols to confirm the detected species as Bandro

4.3 *Semi-automated pipeline for the detection of gentle lemurs from thermal infra-red imagery trained on data collected during the first field season*: On screen counting has provided an approximation of the number in one group. Video footages have been sent to the LJMU (Liverpool John Moores University) team for machine learning and to calculate the exact number of lemurs detected along transects. These numbers will be used to estimate the population size following distance sampling principles.

4.4 *Training given to students to enable them to assist in lemur surveys*: Training to students in Madagascar was delivered in February 2024. We trained one student in lemur detection and one student in reforestation assessment.

4.5 *Paper writing*: This will be done towards the end of the project (after two full years of data).

See Annex 3 for evidence.

3.2 Progress towards project Outputs

1. Techniques established for semi-automated reforestation monitoring using drones

An evaluation standard based on survival rate and growth rate using images collected with drones is developed and gradually personalized according to new variables such as shrub height and other tree species that can be detected during flights. This standard is assisted by Artificial Intelligence, allowing for a more precise projection compared to evaluation based solely on reforested area. These techniques are assisted by AI algorithms and these algorithms are being developed, which will be aided by the LIDAR drone once it arrives in Madagascar. We consider that we are therefore on track to complete this output by project end.

2. Capacity developed for using drones for environmental conservation in Madagascar

The project is making good progress towards this project output, having created the cross NGO/government 'Madagascar Conservation Drone Community' working group and having provided drone pilot training for 51 professionals from environmental NGOs and the Ministry of Environment, as well as advanced training for 2 MoE pilots in drone maintenance and operations (essential for the longer term sustainability of operating drones in Madagascar). Twenty members of the Civil Aviation Authority were also trained in Y1.

The MoE engagement is illustrated by the integration of regional management, head management and drone acquisition by the government to enforce the monitoring and PA protection. By the end of this first year, the project supported the MoE to add more powerful aircraft (four VTOLs models) for large and long-range surveillance and monitoring.

3. Drones demonstrated as an effective detection and deterrence mechanism for environmentally damaging behaviour and informing and responding to SMART patrol activity

With systematic drone overflights in the protected area during fieldwork, the rate of intrusion into restricted zones has decreased and we have noticed a reduction in fire points when drones are flying. Additionally, we raise awareness and inform local communities about the parallel work between SMART ground patrols and drone overflights. The information about drones' capability to take photos and videos to support law enforcement spreads rapidly among the communities living around protected areas.

4. The first robust, range-wide survey of Alatroan gentle lemur is delivered using drone-based infra-red detection of lemurs as a model for animal detection using this technology in Madagascar

Drone flights conducted during different seasons have allowed for the identification of optimal conditions for detection, leading to accurate counting of lemurs. Additionally, each flight provides more precise information depending on weather conditions, lake water level, vegetation height, and the hours when lemurs are active and visible through thermal imaging. All these parameters have allowed for the customization and refinement of detection settings at both the drone and machine learning levels. We are therefore on track to complete this output.

3.3 Progress towards the project Outcome

Outcome: Drones are being used to effectively monitor and improve biodiversity conservation in Madagascar

Since the beginning of the project with the support of the Darwin Initiative, the government through the Ministry of Environment and Sustainable Development of Madagascar, partners in the field of biodiversity conservation at both national and international levels, as well as civil society, have been considering integrating the use of drones into their conservation and environmental protection tasks. During information sessions, we also observe the interest shown by stakeholders in the agricultural sector regarding the potential and opportunities provided using drones for monitoring and evaluation activities. Therefore, we consider that the outcome is very likely to be achieved by the end of the project.

0.1 Drones are being utilised for reforestation monitoring, including individual survival, across at least four reforestation plots by end of project

This is in progress and on track – first round of flights for each plot have been completed and second round of flights are on track to be completed as planned. Each flight has been ground-truthed. AI detection is being developed – individual tree detection has been tested and is being customised.

0.2 A conservation drone working group drives the uptakes of drones for conservation in at least 10 protected areas across Madagascar by project end

The Madagascar Conservation Drone Community has been set up. Drone technology is being adopted in government departments – for example we recently assisted the MoE in mangrove restoration as part of the use of drones for conservation and habitat restoration. 50Ha was restored by drones in southwest Morondava.

0.3 Drones are adopted in management plans for the deterrence of illegal activities in core protected zones in at least two protected areas

Not yet formally adopted but the deterrence effect has been tested in Menabe PA – illegal activities reduced from 17 to 16 from April 2023 to March 2024. The project team also assisted the government to add more powerful aircraft to their department (four VTOLs models) for large and long-range surveillance and monitoring, and we have carried out systematic overflights in protected areas to integrate with SMART data.

0.4 A range wide survey of the Alaotran gentle lemur using drone-based infra-red data is completed and provides a model for infra-red animal monitoring in Madagascar

This is not yet complete, but we have made good progress - field work was conducted in Alaotra marshes, based on new methodology which ensures the lemurs are not disturbed by noise. Ground verification has confirmed the detected species as Bandro. On screen counting has provided an approximation of the number in one group. Video footages have been sent to the LJMU (Liverpool John Moores University) team for machine learning and to calculate the exact number of lemurs detected along transects. These numbers will be used to estimate the population size following distance sampling principles.

3.4 Monitoring of assumptions

Assumption 0.1a: The model for processing drone-imagery to track individual tree survival on reforestation plots is developed successfully

Comments: With the first hypothesis on reforestation monitoring by drone combined with artificial intelligence, we planned tests and the use of this protocol in reforestation areas managed by Durrell. After the knowledge sharing and training sessions we conducted, participants expressed their willingness to follow and apply this protocol as soon as it is officially published. The same is true for the reforestation and landscape management department of the Ministry of Environment and Sustainable Development, which collaborates with us on identifying species with optimal survival rates according to regions and climatic conditions. The reforestation assessment will be improved using the LIDAR sensor for the next seasons

Assumption 0.1b: Reforestation efforts continue post-election

Comments: Official national reforestation campaign for 2023-2024 started in February and in Menabe Antimena drones were used for 50 hectares of mangroves restoration in Marofandilia with the MoE and local community to provide Avicenia seeds.

Assumption 0.2: Conservation drone users continue to engage in our workshops and meetings

Comments: Close communication on WhatsApp group with Conservation drone users is maintained after each training session. This group allows each user/pilot to ask details on drone use, maintenance, technical specification and improvement on data processing. Creating the conservation drone website as social media platform is the next step to show drone use activities and results for each user.

Assumption 0.3: Experiment shows that drones are successful in deterring illegal behaviours in protected areas, and do not displace activities to other areas of the park.

Comments: According to drones demonstrated as an effective detection and deterrence mechanism for environmentally damaging behaviour and informing and responding to SMART patrol activity, illegal intrusion detected by SMART patrol decreased from 27 in 2022 to 16 for 2023. Drone flights based on alarms and notifications from SMART team improve the accuracy and allow drone team to extend the aerial patrol zone.

Assumption 0.3b: Drone maintenance enables sufficiently regular flights to maintain deterrent effect

Comments: Drone training include maintenance and regular inspection on each aircraft. This is the guarantee that the aircraft stay in operational state. Otherwise, adding more battery will increase the number of flights to maintain deterrent effect.

Assumption 0.3c: Deterrent effect does not wane, significantly, through time

Comments: Regular drone flights allow to maintain continuous deterrent effect. Flying in different area inside the PA keep element of surprise as only the patrol can take off at any time in any area based on civil aviation authorization.

Assumption 0.4a: Development of semi-automated detection of drones in the infra-red imagery continues to progress successfully

Comments: Temperature signature becomes more accurate with the latest semi-automated detection of drones in the infra-red imagery. By processing with customised AI code, we can identify more accurately the lemurs.

Assumption 0.4b: No negative reaction to drones is observed during surveys (not to date, but regularly monitored)

Comments: By maintaining the safety distance from the lemurs, no negative effects have been observed. This distance is now set and respected for optimal resolution without disturbing the animals.

Assumption 1.3a: GNSS resolution is high enough to ensure individual trees can be identified aerially across multiple longitudinal images

Comments: Photogrammetry methodology with high GNSS accuracy allows for photos processing to give high resolution orthophotos which can be integrated into AI algorithm for tree aerial identification.

Assumption 1.3b: Trees can be distinguished from background vegetation in drone imagery at all life stages

Comments: AI colour and form recognition allows for tree to be distinguished from background vegetation. This process take time but offer improvements in algorithm customisation for difference detection between bush and young trees.

Assumption 1.4: AI can be trained to detect differences in RGB imagery between tree species

Comments: Depending on season and weather condition during flights, the RGB imagery offers details in colour and forms which conduct to tree species identification. This step is in progress as it is only available for android operating system for the moment and need to be customised for PC to be developed more.

Assumption 1.5: There is interest amongst working group for the session

Comments: When the training session registration was launched and published on Durrell Madagascar Facebook page, in the first week 45 people registered. From December 2023 to March 2024 450 people registered on the google form. We must filter MoE staff and NGO working in conservation field for the first sessions.

Assumption 1.6: Techniques for processing drone data for reforestation monitoring are successful and scalable

Comments: Young trees are clearly visible from drones' imagery. For the moment, there is no free dedicated software for reforestation monitoring by drones. The aim of the developed algorithms is to offer open platform for MoE and NGOs for accurate reforestation monitoring. First results shows that it is more efficient than manual monitoring.

Assumption 2.2: Government officials can regularly attend working group meetings alongside drone professionals

Comments: By giving the first drone training session to Civil Aviation Authority, this allows our drone course to be validated as effective and meet the safety requirements for drone users in conservation domain. This step convinced government officials about the efficiency as well as the necessity of undergoing training and joining the community.

Assumption 2.4: If the Madagascar government creates its own theory exam, this target would change to completion of this exam

Comments: The official exam website for drone pilot in Madagascar will be hosted at Civil Aviation Authority server. The online platform development is in progress for drone exam, and we worked closely with civil aviation staff to provide technical support. The exam is based on ICAO drone topics and the UK-CAA platform is the best reference for interactive and secured platform.

Assumption 2.5: MNP / Government / NGO staff are able to attend regular drone training sessions

Comments: For capacity building and drone piloting training, the initial assumption was to train 50 people from different entities until the end of the project. However, after the initial sessions, we received requests from other NGOs and regional departments of the Ministry of Environment and Sustainable Development. This demand is not limited to the conservation field but also extends to agriculture. Given the limited number of slots in the initial sessions, we have planned to conduct at least one session per province until the end of the project.

Assumption 3.1: Illegal activities are not displaced to other areas of the protected area (control sites). This will be monitored.

Comments: Drone aerial patrol allows for deterrence and illegal activities detection. These flights are based on ground patrol received from SMART ground patrol and verified. Illegal activities displacement will be monitored but from last flights we noticed their reduction.

Assumption 4.1: No adverse reactions observed in lemurs in response to drone flights (none to date, but constantly reviewed)

Comments: drone flight path and height are regularly reviewed to keep safe and less disturbance for the lemurs. For the first flights, no adverse reactions observed.

Assumption 4.3: Thermal infra-red continues to successfully detect lemurs in different habitats across the marsh

Comments: conducting thermal infra-red flights inside the marsh in different season, different time of the day/night and different habitats was successful and continuous improvements are done to offer more accuracy in thermal signature and forms.

Assumption 4.4: Thermal infra-red system continues to successfully detect lemurs enabling development of semi-automated algorithm

Comments: Drone detection of lemurs in Lake Alaotra has also seen advancement in accuracy compared to the initial hypotheses, which aimed to detect individuals during the season when the lake water level is low. After the latest fieldwork, we were able to identify the optimal conditions both in terms of weather conditions and lemur activity hours. The images used to feed the machine learning knowledge base offer higher resolution after the modifications of the protocol used and the configuration parameters of the drone during flights. During training sessions, we showcase samples of thermal images that have attracted participants' attention towards using drones with thermal cameras for their monitoring.

3.5 Impact: achievement of positive impact on biodiversity and poverty reduction

Impact: Reduction in deforestation, enhanced reforestation monitoring and improved monitoring of conservation targets throughout Madagascar

Impact on biodiversity: innovative tools for measuring and monitoring biodiversity. Previous monitoring techniques have been relying on direct field measurements which are often time-consuming and labour intensive. The use of drone allows for an improved detection and population estimate of the critically endangered gentle lemur that will inform conservation actions. Community livelihoods are still highly dependent on forest and natural resources, improvement on environmental protection through deterrence therefore has significant impact on poverty reduction. Communities will benefit through a reduction in deforestation and therefore maintaining the natural capital and ecosystem services they rely on.

4. Project support to the Conventions, Treaties or Agreements

- Convention on Biological Diversity (CBD)
- Ramsar Convention on Wetlands (Ramsar)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Global Goals for Sustainable Development (SDG)

The project will build the capacity of Protected Area and MNP professionals, as in this first year of the project where we have trained 71 professionals to use drones for environmental conservation in Madagascar. One knowledge sharing workshop has also been held and the Madagascar Conservation Drone Community was formed in February 2024. This is contributing to Madagascar's National Development Plan target 5 – to enhance natural capital and build resilience to disaster risks. The project also contributes to their National Biodiversity Strategy and Action Plan's strategic objectives; 2 (recognise and integrate biodiversity values and benefits from sustainable use); 5,14 (protect and restore habitats and ecosystems); 11 (manage PAs more effectively); and 12 (improve the conservation status of threatened species). Better monitoring and deterrence mechanisms will benefit efficient management and governance of the forestry sector (Malagasy Forestry Policy). More efficient adaptive management of reforestation efforts and improved methodology for measuring carbon sequestration contributes to Madagascar's National

Policy against Climate Change, Axis 5 (promoting research, technological advances, and adaptive management) and towards the UNFCCC. Furthermore, 2 members of the government drone department have been trained in drone maintenance and advanced drone operations, helping towards the sustainability of these contributions.

This project promotes the value and importance of biodiversity conservation (CBD Target 1). Improving adaptive management of ecosystem restoration, through reforestation monitoring (particularly in Protected Areas) contributes to CBD Targets 5, 11, 14 and 15, and Ramsar Targets 5, 7, and 12. Developing methodology for monitoring Critically Endangered lemurs contributes to CBD Target 12 and building capacity for conservation monitoring using drones across the Madagascar PA landscape contributes strongly to CBD Targets 19 and 11, and Ramsar Targets 14 and 16.Through our direct work on biodiversity and ecosystems we support the United Nations SDGs: Life on Land (15). Due to the better management of ecosystem services this work will also contribute to No Poverty (1) and Clean Water and Sanitation and naturally be part of Partnerships for the Goals (17). Better deterrence and detection mechanisms for illegal behaviours in Protected Areas will also contribute to management of protected areas and promoting the value and importance of biodiversity conservation.

5. Project support for multidimensional poverty reduction

Direct poverty reduction: Training and capacity building for drone use in environmental conservation across a large number of protected area and government staff will help local people to gain valuable skills and knowledge that will overall improve their employability and socio-economic status; conducting systematic patrol and aerial flights will reduce the intrusion and illegal activities inside the Protected Area, helping to contribute to better security in the area. By showing the benefit of reforestation and ecotourism brought by biodiversity existing in the region this will create guide work for local people and villages around the Protected Area.

Indirect poverty reduction: Keeping the natural habitat intact by increasing the efficiency of restoration, and through improved fire detection, will contribute to maintaining essential ecosystem services, and availability of resources for these extremely resource dependent communities. This will help to contribute to overall community resilience and help to keep resources available for the essential day-to-day livelihoods of these communities. During Y1, we have been able to respond to fires detected in real time detected by drone sights, thus being able to directly respond to threats to local ecosystems upon which communities rely.

6. Gender Equality and Social Inclusion (GESI)

Please quantify the proportion of women on the Project Board[1].	25%
Please quantify the proportion of project partners that are led by women, or which have a senior leadership team consisting of at least 50% women[2].	60%

GESI Scale	Description	Put X where you think your project is on the scale
Not yet sensitive	The GESI context may have been considered but the project isn't quite meeting the requirements of a 'sensitive' approach	

[1] A Project Board has overall authority for the project, is accountable for its success or failure, and supports the senior project manager to successfully deliver the project.

[2] Partners that have formal governance role in the project, and a formal relationship with the project that may involve staff costs and/or budget management responsibilities.

Sensitive	The GESI context has been considered and project activities take this into account in their design and implementation. The project addresses basic needs and vulnerabilities of women and marginalised groups and the project will not contribute to or create further inequalities.	
Empowering	The project has all the characteristics of a 'sensitive' approach whilst also increasing equal access to assets, resources and capabilities for women and marginalised groups	X
Transformative	The project has all the characteristics of an 'empowering' approach whilst also addressing unequal power relationships and seeking institutional and societal change	

7. Monitoring and evaluation

Internal monitoring and evaluation procedures are based on activities conducted by outputs. All progress is reported to and reviewed by an internal M&E steering group every quarter.

Drone flight route tracking and logs are integrated within the SMART database, allowing analysis and development of an interactive platform for adaptive management. SMART patrol data also provides on ground verification of drone patrols for fires and illegal activities.

All drone flights for reforestation and for lemur population monitoring are also confirmed using ground truthing.

Fifty-one pilots, including staff from Environment NGO regional direction of MoE, have been trained from 2 provinces of Madagascar (Antananarivo and Fianarantsoa) and received their UK theory exam licence. They demonstrate their competence by sharing their flight log, and we also use the submission of these flight logs as a way to follow-up on trainees and see how they are getting on.

The newly formed Madagascar Conservation Drone Community provides a way of monitoring developments with all drone users within the sector, and allows us to assess the success of implementation of drone technology across partners in the conservation and environment sphere, and to discuss barriers, challenges and opportunities.

8. Lessons learnt

- Best practices in drone training for staff and partners including government were established the last year. Train the field staff in drone use is more efficient as they know exactly what they need to do with the drones and have enough knowledge in terrain and field conditions.
- Standard communication between partners who are using drones become clearer on how to use drones in their activities (patrol, animal detection, reforestation assessment and mapping).
- Direct approach to the community for drone tasks in the PA is more efficient as they are aware about the goal of flying drones as part of the patrol tasks. This is illustrated as sensibilisation for the community.

Recommendations

- For partners and MoE, identifying the right goal of using drones is the priority instead of buying directly the aircraft and sensors and noticed that it does not meet the planned objective.
- For staff and partners, getting the right training in drone use including operational tasks and maintenance is prior even they already have the aircraft. Securing the activities to avoid incident is mandatory regarding the new drone regulations applied in Madagascar.

- Before using drones in PA or national parks, better to start with community sensibilisation and communication. Working closely with social organisation needs to be improved. The members of social organisation, needs to be involved in drone training at any time.
- For equipment purchase, better to buy them locally and assign this as door delivery, if possible, to avoid shipping constraints.
- Involving students in the project provide a lot of advantages as they can learn and improve their knowledges in drone technology, but at the same time, work in professional environment to help them in project activities management.
- Maintaining strong relationship with MoE and regional staff is the best way to improve conservation efforts including drone use (workshops, publication, interactive activities).
- Keeping interactive platform for near real time discussions worked and need to be improved. The future is to create dedicated website as social media for conservation domain and where each partner can publish their activities, asking for advice and maintain a near real time interaction.
- Extending the trainee/students work period is required as they help a lot in activities like training, field work and data processing.

We don't currently plan to change the project as a result of this learning.

9. Actions taken in response to previous reviews (if applicable)

We have responded to feedback received when the project was funded in the half year report.

10. Risk Management

Have any new risks arisen in the last 12 months that were not previously accounted for?

Not for the year one.

Has the project made any significant adaptations to the project design this year to address risk?

No. We keep the risk assessments done during project design phase.

An updated version of the risk register is attached to this report.

11. Sustainability and legacy

The use of drones in environment and biodiversity conservation increased in the last three months as we conducted the training and shows the potential for drone use in the field. At least 5 NGOs have asked for recommendations and plan to buy the right aircraft for their conservation activities. In Y1 we have been able to provide training to **51** government and NGO staff**,** in addition to over 5 Durrell staff, creating a cadre of trained drone operators in Madagascar across the sector.

Training has been open to all NGOs working in the environmental domain. Advice and technical supports offered to Madagascar Conservation Drone Community members. In addition, up to date information about drone use and regulation shared to all NGO and MoE staff as they are published by the Civil Aviation Authority. We have been assisting the MoE and NGOs on the procedures around the drone regulations required by the National Civil Aviation Authority to fly legally and safely their aircraft.

The projects encourage NGOs and the MoE to consider the use of drones in their activities, and we observe their enthusiasm during the training and information organized so far by asking us where they can buy the aircraft which will meet their needs. The MoE added more drones for PA protection after the training session.

Considering the project's current progress, the intended benefits post-project remains valid. However, ongoing evaluation and adaptation are essential to ensure alignment with evolving needs and circumstances. We are continuously assessing the effectiveness of our approach and are adjusting it as needed to optimize outcomes.

Regarding mainstreaming the innovation into "business as usual," we have developed a comprehensive strategy that includes:

- **Integration into existing workflows**: We are actively working to incorporate the use of drones into our standard operating procedures (patrol, reforestation assessment, lemurs' detection), ensuring that they become an integral part of our operations. Building standards in drone technology update and procedures for environmental use.
- **Capacity building:** we will keep continuous and up-to-date training programs to equip our team members and partners with the necessary skills and knowledge.
- **Stakeholder engagement**: We are engaging with key stakeholders (MoE, MNP, ACM, LJMU), including staff members, partners, and relevant authorities, to foster buy-in and support for the integration of drones into our everyday practices.
- **Continuous improvement:** We are committed to a culture of continuous improvement, regularly reviewing our processes and seeking feedback to identify areas for refinement and optimization.

By implementing these strategies, we are confident that the innovation introduced by the project will become firmly entrenched in our organization's operations, ensuring sustained benefits well beyond the project's completion.

12. Darwin Initiative identity

- **Project Publications and Reports**: The Darwin Initiative logo is included in project publications, reports, and promotional materials. This ensures that stakeholders, including donors, partners, and the public, are aware of the funding source and the project's connection to the Darwin Initiative. For example, all our drone training workshop materials use the Darwin and UK International Development logos (as requested from the project team).
- **Workshops, Conferences, and Events**: The project has actively promoted the Darwin Initiative during workshops, conferences, and events related to biodiversity conservation and sustainable development. This includes displaying banners or posters with the Darwin Initiative logo and distributing informational materials about funding or projects supported by the initiative.
- **Media Outreach**: The project engages with the media to raise awareness about biodiversity conservation efforts supported by the Darwin Initiative. This may include press releases, interviews, or articles highlighting the impact of Darwin-funded projects. For example, we posted about Darwin’s support on a news post on our website here: https://www.durrell.org/news/reforesting-madagascar/
- **Participation in Events and Meetings**: Representatives from the UK Government in Madagascar have been invited to participate in project events, workshops. Their presence provides an opportunity to showcase their support for the project and engage with stakeholders directly as the ministry of environment and partners.
- **Collaboration and Partnership**: We collaborate closely with UK Government agencies and departments involved in biodiversity conservation efforts. By working together on shared objectives, we demonstrate the UK Government's active involvement in addressing global conservation challenges.

The Darwin Initiative funding is part of a larger program with a national-level impact. This is evident through the mention of the Darwin Initiative as the main funder during visits, training sessions, and fieldwork conducted in Madagascar's regions.

During meetings and workshops with the Ministry of Environment, NGOs, and partners, we present the Darwin Initiative while highlighting the support it provides to the project on the use of drones for biodiversity conservation in Madagascar. Additionally, we also discuss other areas where the Darwin Initiative intervenes, such as sustainable development and agriculture.

13. Safeguarding

Has your Safeguarding Policy been updated in the past 12 months?	No
Have any concerns been reported in the past 12 months	No
Does your project have a Safeguarding focal point?	Yes [*If yes, please provide their name and email]* [redacted] Lantotiana – Head of People and Values [redacted]
Has the focal point attended any formal training in the last 12 months?	Yes [*If yes, please provide date and details of training*] - October 18th 2023 Protection of Children - June 21st 2023 Community Feedback Mechanism (learning exchange session)
What proportion (and number) of project staff have received formal training on Safeguarding?	Past: 100% [and number 104] Planned: 100% [and number 108 with 4 new starters]

Has there been any lessons learnt or challenges on Safeguarding in the past 12 months? Please ensure no sensitive data is included within responses.

How to understand if something is a safeguarding concern or not. Most staff find this difficult to understand. The next refresh session for all staff will be focused on this (case studies).

Does the project have any developments or activities planned around Safeguarding in the coming 12 months? If so please specify.

- Continue to train and orient new starters on safeguarding policy and whistleblowing policy
- Doing refresh session during the annual meeting, one line meeting for all staff and during the field visit.
- Organise Specific training (training of trainer) for technical field team and Socio Organizer per site
- Continue to Implement the safeguarding policy into the local community where Durrell is implementing its activities with field team's collaboration
- Code of conduct signature follow up

Please describe any community sensitisation that has taken place over the past 12 months; include topics covered and number of participants.

Topics:

1. Why is safeguarding important and necessary
2. Safeguarding meaning
3. How can share feedback or to report complaint

Number of participants

Aboalimena region:

Local Community Leader per region and authority leader, 3 women and 23 men
VSLA group 12 women
Local community VOI and KMMFA around 12 men

Ankaivo region:

VSLA group and VOI: 23 women
KMMFA and VOI: 48 men
In total: 121

Sofia region (Bealanana):

Public session around 400 population in 4 villages Amberovery, Marofamara, Andraredona, Analakely

Have there been any concerns around Health, Safety and Security of your project over the past year? If yes, please outline how this was resolved.

Durrell staff were attacked by bandits during road trips to the Durrell field site in Ambondrobe, money and materials stolen, without injury.

Durrell has implemented a prevention and security measure such as: buddy system which allows the team to know at any time what is happening during the day and the two pairs do daily reporting, in the event of silence, action should be taken be taken, staff no longer travel alone, at least two, and with escort, convoy from the gendarmes for the passage to the red zone

The site manager regularly inquires with the authorities in the event of rumors of bandit attacks, or possible intervention by the gendarmes in a site so that Durrell cancels and postpone the trip and activity as a precaution.

Activities are suspended in all areas with a high level of insecurity during the electoral campaign

14. Project expenditure

Table 1: Project expenditure during the reporting period (1 April 2023 – 31 March 2024)

DRAFT FIGURES:

Project spend (indicative) since last Annual Report	2023/24 Grant (£)	2023/24 Total Darwin Initiative Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (se below)	[redacted]			
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				The software licence was not bought because of the Lidar drone not yet operational
Capital items (see below)				The lidar drone and its components were purchased and the drone is in Madagascar. The batteries are still in the UK. So far we haven't found a shipment agent who accept to send it to Madagascar. The variance is the supposed cost for the transport and customs fees.
Others (see below				[redacted] in this budget line was allocated to train the staff on the use of the Lidar , but because it cannot be operated yet, the amount was not used.
TOTAL	**108,373**	**93,813.99**		

DETAILED EXPLANATIONS

Capital items: The lidar drone and its components were purchased, and the drone is in Madagascar. The batteries are still in the UK. So far, we haven't found a shipment agent who accept to send it to Madagascar. The variance is the supposed cost for the transport and customs fees.

Other: [redacted] in this budget line was allocated to train the staff on the use of the Lidar, but because it cannot be operated yet, the amount was not used.

Operating costs: The software licence was not bought because of the Lidar drone not yet operational

Table 2: Project mobilised or matched funding during the reporting period (1 April 2023 – 31 March 2024)

	Secured to date	Expected by end of project	Sources
Matched funding leveraged by the partners to deliver the project (£)			
Total additional finance mobilised for new activities occurring outside of the project, building on evidence, best practices and the project (£)			

15. Other comments on progress not covered elsewhere

- Supported the MoE in Mangroves restoration as part of the use of drones for conservation and habitat restoration. 50Ha restored by drones in the Southwest-Morondava.
- Support of MoE and partners in drones' documents to be legal with the Civil Aviation Authority.
- Support of MoE by creation of technical specification for long range drone dedicated for PA surveillance.

16. OPTIONAL: Outstanding achievements or progress of your project so far (300-400 words maximum). This section may be used for publicity purposes

I agree for the Biodiversity Challenge Funds to edit and use the following for various promotional purposes (please leave this line in to indicate your agreement to use any material you provide here).

File Type (Image / Video / Graphic)	File Name or File Location	Caption including description, country and credit	Social media accounts and websites to be tagged (leave blank if none)	Consent of subjects received (delete as necessary)
				Yes
				Yes / No

				Yes / No
				Yes / No
				Yes / No

Annex 1: Report of progress and achievements against log frame for Financial Year 2023-2024

Project summary	Progress and Achievements April 2023 - March 2024	Actions required/planned for next period
Impact: Reduction in deforestation, enhanced reforestation monitoring and improved monitoring of conservation targets throughout Madagascar		
Outcome: Drones are being used to effectively monitor and improve biodiversity conservation in Madagascar		
Output 1: Techniques established for semi-automated reforestation monitoring using drones		
Output indicator 1.1: Three PA reforestation plots surveyed by drones in both dry and rainy season by end of year 1.	Two flights conducted in Alaotra in Dry and after rainy season about 200ha dispersed in different area inside the managed site. These flights used the same flight planning to allow data comparison between 6 months interval. Data processing with AI will give survival rate of each plot. First year assessment was done with the RGB drone, the Y2 confirmation will be done with the LIDAR drone.	LIDAR verification after 6 months. This will be the third flight in the reforestation spots but the first with LIDAR sensor.
Output indicator 1.2: Three PA reforestation plots surveyed for ground truthing in both dry and rainy season by the end of year 1	Ground truthing based on manual measurement of young trees sampled on each reforestation spot. Data are integrated in AI for height accuracy verification. Each young tree is identified by its GPS coordinates on the map.	Next ground truthing is planned for the next 6 months at the same plots for manual measurement and data comparison.
Output indicator 1.3: 1 training session delivered to new working group on standardising drone-based reforestation monitoring in Madagascar by the end of project	Two sessions of training conducted with partners to share the new standardised drone-based reforestation monitoring. This includes flight planning and data processing methodology and tools.	Two training sessions planned for the next year with the new program improvement with AI algorithm.

1.4 Paper submitted to an international journal, on effective monitoring of reforestation using drones by end of project	Paper writing in progress based on data collection with LJMU and students	Continue paper writing to be ready for submission by the end of project.
Output 2. Capacity developed for using drones for environmental in Madagascar		
2.1 Cross NGO/government working group created on drone use by Y1Q2	Madagascar Conservation Drone Community created on February 2024 to form a group of drone users working in Environment and Conservation Domain. There has been a steady increase in the number of members in the Drone Community, through sign ups from training participants.	Next workshop session will group the drone community member and planned for the Y2-Q1.
2.2 Two knowledge sharing workshops delivered to working group participants by end of project (middle and end)	First sharing workshop planned for the 3rd of May involving, British Embassy, MoE, Civil Aviation Authority, NGOs and partner in Conservation in Madagascar.	The second workshop is planned for the end of the Y2 by sharing the results and standards developed all along the project.
2.3 At least 50 pilots trained and passing UK theory exams (or equivalent) to demonstrate competency by the end of project.	51 pilots including staff from Environment NGO regional direction of MoE, have been trained for 2 provinces of Madagascar (Antananarivo and Fianarantsoa) and got their UK theory exam licence and demonstrate their competence by sharing their flight log.	Training of 04 provinces left for the next few months including Majunga, Toliara, Toamasina and Diego-Suarez. All registration done and training dates fixed.
2.4 Advanced training provided in drone maintenance to 4 people (2 from MNP, 2 from MoE) by end of project	02 staff members of MoE drone department have been trained in drone maintenance and advanced drone operations including VTOL aircraft.	Training of 2 staff member from MNP will be trained in the next few months for advanced maintenance and drone operations.
Output 3. Drones demonstrated as an effective detection and deterrence mechanism for environmentally damaging behaviour and informing and responding to SMART patrol activity		
Output indicator. 3.1 Reduced illegal activity detected by SMART community patrols after deterrence flights	02 field works conducted in Menabe Illegal activities reduced from 17 to 16 from April 2023 to March 2024	Improve field staff skills on drone use for the next three months. Assign at least one staff to conduct at least two aerial patrols each month.

Output indicator 3.2 Drone data integrated into Durrell's SMART database and informing SMART adaptive management by end of project	Drone flight route and logs integrated in SMART database. Interactive platform development in progress for adaptive management.	Build the standard format for SMART and Drone logs to be used by all staff involved in ground and aerial patrol.
3.3 Drones tested to see if we can use them for smoke detection	First tests conducted with existing aircraft. With thermal drone, it is feasible on daylight and night but with standard sensor, smokes are only detected in daylight.	Assign thermal drones to Menabe PA to continue patrol at night and early in the morning.
3.4 Drones being used for supporting firefighters in bushfires to guide activity and provide information about fire progression (advising PA management)	During fire season in Menabe, we used drone to indicate the fire points to firefighters and help them to find the easiest way to reach the points. Two fire points managed using drones for firefighters' assistance.	Improve fire detection and communication between ground patrol and drone team during interventions.
Output 4. Techniques for using drones for lemur surveys solidified and being utilised		
Output indicator 4.1 Drone flights conducted for lemur surveying in 2 protected areas by end of year 1	One flight in Alaotra and one in Menabe for year one combined with the aerial patrol flights. Detection for lemur survey in Alaotra was positive and the student was trained to use the thermal drone for lemur survey.	Improve the machine learning capability for data processing and collect more data in Alaotra to allow lemur counting.
4.2 Ground truthing surveys conducted for lemur populations and compared to drone data by end of year 1	Done in Alaotra. Ground truthing done with local community patrol and Durrell staff. Lemurs detected by drone are verified by ground patrol to ensure that it is the right number is correct and what we detect from the air is lemur.	Continu the improvement of detection and ground truthing protocol to be standardized and could be conducted by trained people in the field.
4.3 4 students recruited and using drone footage to analyse lemur populations by end of project	Students recruited for six months to be trained and analyse the drone footage. They built the framework based on Python language. This framework serves as knowledge database and coding is oriented	Need to renew the students contract to continue for the next six months to finalise the framework and automated data processing.

Annex 2: Project's full current logframe as presented in the application form (unless changes have been agreed)

Project Summary	SMART Indicators	Means of Verification	Important Assumptions
Impact: Reduction in deforestation, enhanced reforestation monitoring and improved monitoring of conservation targets throughout Madagascar			
Outcome: Drones are being used to effectively monitor and improve biodiversity conservation in Madagascar	0.1 Drones are being utilised for reforestation monitoring, including individual survival, across at least four reforestation plots by end of project 0.2 A conservation drone working group drives the uptakes of drones for conservation in at least 10 protected areas across Madagascar by project end 0.3 Drones are adopted in management plans for the deterrence of illegal activities in core protected zones in at least two protected areas 0.4 A range wide survey of the Alaotran gentle lemur using drone-based infra-red data is completed and provides a model for infra-red animal monitoring in Madagascar	0.1 Drone flight maps and monitoring reports 0.2 Training records and flight logs and usernames will determine those actively using drones for PA management alongside reports from regular meetings of the working group 0.3 Longitudinal SMART data and research report 0.4 Report on the outcome of the range-wide survey, with recommendations for transference to other systems	0.1a The model for processing drone-imagery to track individual tree survival on reforestation plots is developed successfully 0.1b Reforestation efforts continue post-election 0.2 Conservation drone users continue to engage in our workshops and meetings 0.3 Experiment shows that drones are successful in deterring illegal behaviours in protected areas, and do not displace activities to other areas of the park. 0.3b Drone maintenance enables sufficiently regular flights to maintain deterrent effect 0.3c Deterrent effect does not wane, significantly, through time 0.4a Development of semi-automated detection of drones in the infra-red imagery continues to progress successfully 0.4b No negative reaction to drones is observed during surveys (not to date, but regularly monitored)
Outputs:	1.1 Three reforestation plots surveyed by drones in both dry and rainy season by the end of Y1	1.1 Drone flight path maps 1.2 Survey reports 1.3 Quarterly progress reports	1.3a GNSS resolution is high enough to ensure individual trees

1. Techniques established for semi-automated reforestation monitoring using drones	1.2 Three reforestation plots surveyed for ground truthing n both dry and rainy season by end of Y1 1.3 Technique developed for the processing of drone imagery to track individual survival of trees in reforestation plots allowing carbon sequestration to be accurately tracked, alongside correlates of tree survival 1.4 AI based system developed to accurately detect tree species and coverage in reforestation plots to enable post-hoc monitoring of reforestation plots 1.5 One training session delivered to new working group on standardising drone-based reforestation monitoring in Madagascar by end of project 1.6 Paper submitted to an international journal, on effective monitoring of reforestation using drones by end of project	1.4 Quarterly progress reports 1.5 Workshop minutes and attendance sheet 1.6 Submitted to peer-reviewed journal and received receipt of submission	can be identified aerially across multiple longitudinal images 1.3b trees can be distinguished from background vegetation in drone imagery at all life stages 1.4 AI can be trained to detect differences in RGB imagery between tree species 1.5 There is interest amongst working group for the session 1.6 Techniques for processing drone data for reforestation monitoring are successful and scalable
2. Capacity developed for using drones for environmental conservation in Madagascar	2.1 Cross NGO/government working group created on drone use by Y1Q2 2.2 At least four meetings of the drone working group in each year of the project 2.3 Two knowledge sharing workshops delivered to working group participants by end of project (middle and end) 2.4 At least 50 pilots trained and passing UK theory exams (or equivalent) to demonstrate competence by end of project	2.1 Working group meeting attendance report 2.2 Working group meeting attendance report 2.3 Workshop minutes and attendance sheet 2.4 Copies of theory exams successfully completed (names redacted for privacy) 2.5 Training attendance log and feedback	2.2 Government officials are able to regularly attend working group meetings alongside drone professionals 2.4 If the Madagascar government creates its own theory exam, this target would change to completion of this exam 2.5 MNP / Government / NGO staff are able to attend regular drone training sessions

	2.5 Advanced training provided in drone maintenance to four people (Two from MNP, Two from MoE or major NGO using drones) by end of project		
3. Drones demonstrated as an effective detection and deterrence mechanism for environmentally damaging behaviour and informing and responding to SMART patrol activity	3.1 Reduced illegal activity detected by SMART community patrols after deterrence flights in treatment plots 3.2 Drone monitoring flights are being used for to detect smoke and illegal activity by project end 3.3 Drone tracks and incursion data integrated into Durrell's SMART database and informing SMART adaptive management by end of project	3.1 SMART patrol data 3.2 Project report and drone detection rate 3.3. SMART reports including drone patrol tracks	3.1 Illegal activities are not displaced to other areas of the protected area (control sites). This will be monitored.
4. The first robust, range-wide survey of Alatroan gentle lemur is delivered using drone-based infra-red detection of lemurs as a model for animal detection using this technology in Madagascar	4.1 Drone flights conducted for lemur detection across the Lac Alaotra marsh by the end of Y1 4.2 Ground truthing surveys conducted for lemur populations and compared to drone data by end of Y1 4.3 Semi-automated infra-red processing algorithm developed enabling processing of range-wide survey data 4.4 Manuscript submitted on the detection of Alaotran gentle lemurs with drone-based thermal infra-red	4.1 Drone flight path maps 4.2 Survey reports 4.3 Students research reports 4.4 Submitted to peer-reviewed journal and received receipt of submission	4.1 No adverse reactions observed in lemurs in response to drone flights (none to date, but constantly reviewed) 4.3 Thermal infra-red continues to successfully detect lemurs in different habitats across the marsh 4.4 Thermal infra-red system continues to successfully detect lemurs enabling development of semi-automated algorithm
Activities 1.1 Drone flights to collect raw data on each reforestation plot 1.2 Ground surveys to ground truth drone data on each reforestation plot 1.3 Algorithm/pipeline developed to process drone data for the effective monitoring of sapling survival rate and reforestation success and rates of carbon sequestration 1.4 AI algorithm training on identification of tree species and coverage across reforestation plots 1.5 Workshop delivered to disseminate newly developed reforestation monitoring techniques			

1.6 Paper writing
2.1 Madagascar practitioners gathered to form a working group
2.2 Working group meetings chaired by Durrell project staff
2.3 Knowledge sharing workshops delivered to working group (at least one per year)
2.4 Seven-day full-time training course and refresher sessions delivered for 50 people for drone piloting - five conducted in total (10 people each session) by project end
2.5 Advanced training delivered to four people on drone maintenance through regular sessions at the Durrell drone lab
3.1 Experimental framework developed for the testing of drones as deterrence measure in Menabe-Antimena National Park
3.2 Drone flights conducted across two fire seasons during project in experimental framework, for at least four weeks at a time
3.3 Longitudinal monitoring using SMART by local village patrols to understand the impact of drone flights on distribution and prevalence of illegal activities in Menabe-Antimena
3.4 Drone detection data is integrated into SMART to inform community patrol activity
4.1 Systematic flights conducted to assess the population of Alaotran gentle lemurs across their marsh range
4.2 Ground truthing surveys in pirogues conducted to validate drone footage and image processing
4.3 Semi-automated pipeline for the detection of gentle lemurs from thermal infra-red imagery trained on data collected during the first field season
4.4 Training given to students to enable them to assist in lemur surveys
4.5 Paper writing

Annex 3: Standard Indicators

Table 1 Project Standard Indicators

DI Indicator number	Name of indicator	Units	Disaggregation	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
DIA01	Number of people in eligible countries who have completed structured and relevant training	People	Men	50				(50 total)
DI-A01	Number of people in eligible countries who have completed structured and relevant training	People	Women	21				(50 total)
DIA03	Number of local/national organisations with improved capability and capacity as a result of project (Two people per organisation)	Number	Type	15				2
DIA03	Number of local/national organisations with improved capability and capacity as a result of project	Number	Training weeks	71				50
DI-C18	Number of unique papers submitted to peer reviewed journals.	Number		0(in progress, not submitted yet)				2
DIC02	Number of new conservation or species stock assessments published12.	Number		0 (Apalemur Alaotrensis) in progress not submitted				1

Table 2 Publications

Title	Type (e.g. journals, best practice manual, blog post, online videos, podcasts, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Protection de l'environnement : les drones au service des aires protégées	Journals	2024-News Mada website-Sera R.	M	Madagascar	News Mada local online news paper-Madagascar	https://newsmada.com/2024/05/06/protection-de-lenvironnement-les-drones-au-service-des-aires-protegees/
Ateliers dur les drones pour la conservation de la biodiversité à Madagascar	Post	2024-UK Embassy in Madagascar	F	Madagascar	UK Embassy-Madagascar	https://www.facebook.com/ukinmadagascar
KIVALO-MORONDAVA : LA JOURNÉE DE LA VIE SAUVAGE MARQUÉE PAR LA PLANTATION DES MANGROVES PAR DRONE	Post	2024- Ministry of Environment	M	Madagascar	Ministry of Environment -madagascar	https://www.environnement.mg/?p=8307
Aligner conservation de la biodiversité et régulation des drones : approches stratégiques, responsible, environnement durable"	Post	2024-Orange Actu	F	Madagascar	Orange actu-Madagascar	https://www.instagram.com/orangeactu/p/C6mCrw1r62H/
Afin d'acquérir les compétences techniques nécessaires pour piloter efficacement les drones, les maintenir en bon état de fonctionnement et exploiter les données collectées.	post	2024-Projet Tefiala	F	Madagascar	Facebook	https://www.facebook.com/projet.tefiala
DRONES ET ENVIRONNEMENT	Post	2024-Aviation Civil de Madagascar	F	Madagascar	Facebook	https://www.facebook.com/permalink.php?story_fbid=pfbid0fMCV1LcvV2td4Rv6DCknGDrNHpYrq8bmkzfNmJp5HcLXMLENTnNHC43Y1E4vrGqvl&id=100090997000049
PILOTAGE DE DRONES CIVILS ET TRAVAUX AERIENS	Post	2024-Aviation Civile de Madagascar	F	Madagascar	Facebook	https://www.facebook.com/permalink.php?story_fbid=pfbid0YAZZcAJiki6wNzJNsPvdCZRwwW41ztjsKkyVxjy1y6HdQzDFEKYapt1Z9j5FeW4gl&id=100090997000049

Checklist for submission

	Check
Different reporting templates have different questions, and it is important you use the correct one. Have you checked you have used the **correct template** (checking fund, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	X
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	X
Is your report more than 10MB? If so, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	X
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	X
If you are submitting photos for publicity purposes, do these meet the outlined requirements (see section 16)?	
Have you involved your partners in preparation of the report and named the main contributors	X
Have you completed the Project Expenditure table fully?	X
Do not include claim forms or other communications with this report.	