Darwin Initiative Main & Extra: Final 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: no later than 3 months after agreed end date.

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

Darwin Initiative Project Information

Scheme (Main or Extra)	Main
Project reference	30-022
Project title	Ecosystem restoration of watering holes in Cambodia's Northern Plains
Country(ies)	Cambodia
Lead Organisation	Wildlife Conservation Society
Project partner(s)	1. Laos Buffalo Dairy (LBD), 2. Centre for Biodiversity Conservation of the Royal University of Phnom Penh (CBC-RUPP) 3. Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) 4. Ministry of Environment (MOE)
Darwin Initiative grant value	£300,000
Start/end dates of project	01 April 2023 to 31 March 2025
Project Leader name	Nev Broadis
Project website/blog/social media	https://cambodia.wcs.org/
Report author(s) and date	Nev Broadis, Emeline Auda - July 2025

1 Project Summary

Cambodia supports the largest remaining Indochinese Dry Forests on earth. A significant proportion of this habitat is located within the protected areas of the Northern Plains Landscape (NPL) and managed by the Ministry of Environment (MOE) (Figure 1). The NPL supports some of the rarest species in the world, such as Giant Ibis, White-shouldered Ibis and Banteng, as well as a large human population reliant on subsistence use of natural resources and small-scale farming.

Despite conservation actions, the NPL has lost significant populations of large herbivores, Historically, elephants, rhinoceros and four species of wild cattle would have grazed and browsed extensively across grasslands and forests. These natural processes helped open the forest and maintain large areas of grassland by preventing succession, while also creating, maintaining seasonal forest pools through bathing and wallowing. These seasonal ponds provide vital habitat for a wide range of species; particularly globally threatened bird species such as the White-shouldered Ibis, Giant Ibis, White-winged Duck and the Eastern Sarus Crane, which rely on them as key feeding grounds.

Seasonal ponds are also a resource for local communities, who depend on them for water, food and in some cases for the medicinal properties of the species found within them. The demise of the seasonal pond network presents significant challenges for both biodiversity and local communities.

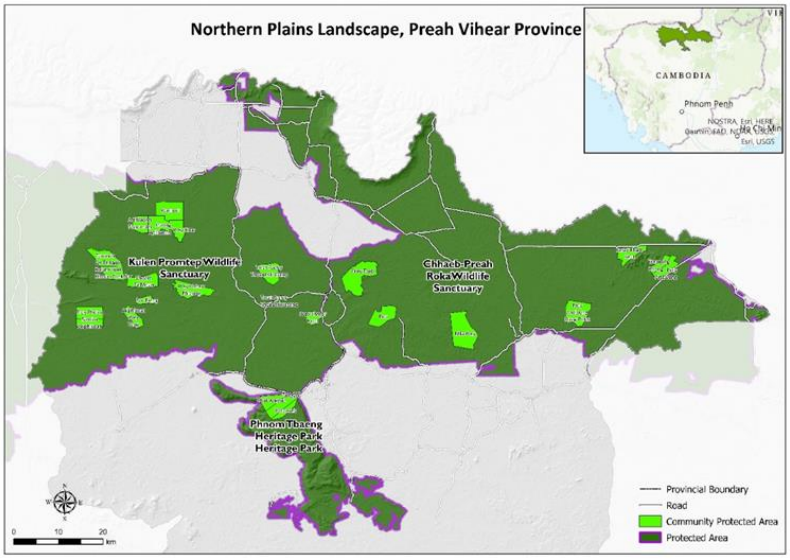

Figure 1: Map of the Northern Plains Landscape

The NPL is home to a predominantly rural population, which has been shown to correlate with lower literacy rates than urban populations, and with a majority of the workforce (78.9%) engaged in agriculture labour. Within the protected area network, access to healthcare, education and employment is further restricted. Capacity and capability of the communities where WCS focuses our activities are inherently low.

2 Project Partnerships

Laos Buffalo Dairy

The partnership with LBD has been strong from before project inception to the completion of the project. In addition to the five exchange trips, the project initiated a Telegram chat group to allow for constant project involvement by LBD on the day-to-day activities and to provide a valuable resource for husbandry, veterinary or food production queries. The project lead from WCS and the lead from LBD have regular calls and, when possible, in-person meetings to follow-up on project evolution. Challenges from the long distance between Luang Prabang and the project site are overcome through these regular calls and real-time communication channels such as Telegram. It can often be challenging linking businesses with communities, however in the case of the LBD, with their clear track record of working with local communities, these challenges were foreseen and mitigated in advance. The strong and mutually beneficial relationship between WCS and LBD is expected to continue beyond the life of the project, particularly through future training exchanges and joint technical collaboration. LBD contributed actively, remaining engaged in project planning and adaptive management, monitoring and evaluation and decision making. A final report was produced by LBD (Annex 4) the contents of which were used to produce this report.

Centre for Biodiversity Conservation (CBC) of the Royal University of Phnom Penh (RUPP), Cambodia

The project successfully enlisted a Master of Science student from the CBC-RUPP early in the project. Project staff have collaborated with the student on the design of his thesis, which focused on biodiversity survey methodologies in seasonal pond habitats. Through attending the defence of his thesis with his supervisors, project staff were able to assist in the necessary revisions to both the thesis and subsequently the Biodiversity Survey Protocols. The CBC-RUPP provided valuable input on the survey techniques through the Master's student. While CBC-RUPP was not directly involved in project planning or decision-making, their technical contribution via the

student was significant. The institution was not involved in writing the final report but reviewed and endorsed the student's final thesis (Annex 7). The student is preparing to publish articles based on his research, which will support broader dissemination of project findings. The partnership is expected to continue beyond the life of the project, with WCS planning to host future research students from CBC-RUPP.

Provincial Department of Agriculture, Forestry and Fisheries (PDAFF), Cambodia
PDAFF have participated in vaccination trainings across the four CPAs of the project over the course of the project and have supplied certain vaccinations free of charge as per government provisions. PDAFF have village veterinarians in each of the target villages who are the initial responders for veterinary interventions.

Ministry of Environment (MOE)
Through the delegation of duty to the Provincial Department of Environment, the MOE have been involved in the project through the inclusion of its staff in aspects of community work. WCS supports a staff member from the Livelihoods department who is involved in all community projects supported by WCS – including the buffalo project. In addition, law enforcement rangers have supported project activities where appropriate – such as overnight biodiversity surveys at project ponds. The MOE established a Technical Working Group for restoration of ponds using buffalo. Unfortunately, this became inactive during the Covid-19 pandemic and reinitiating regular meetings has not yet happened. This would be an effective way to involve the partner more in the project, and it is planned to include an MOE staff member on a future exchange trip to Laos Buffalo Dairy.

3 Project Achievements

3.1 Outputs

Output 1: Livelihoods are developed and diversified through CPA-led buffalo banking schemes linking producers to markets.

Activity 1.1 Community Protected Areas (CPA) assessment across the landscape to select suitable locations for buffalo bank restoration project.

The activity has been completed in Year 1 and the assessment drew on biodiversity data, institutional knowledge, and field visits to 6 CPAs. The report on the assessment (Annex 1) culminated in a clear pathway to CPA selection. Criteria were established, upon which assessments were made of the 20 CPAs available. Criteria were: (1) presence of seasonal ponds that are within close proximity to the CPA, (2) accessibility and distance of seasonal ponds around the CPA and the villages where the CPA members reside, (3) Areas of high populations of domestic water buffalo and cows considered as a negative, (4) knowledge and experience of community members in buffalo husbandry, or presence of experienced buffalo herdsmen in the CPA – a willingness to learn and participate, (5) CPAs currently active in other projects with WCS – bird nest protection, IBIS Rice production, etc – should not be considered. On the contrary, CPAs with little interaction on conservation actions should be considered, (6) Areas of high importance for bird nests, (7) Areas of high biodiversity importance for threatened species, (8) CPAs that have experience of ecotourism, (9) Presence of schools close to CPAs or dairy locations, (10) CPA proximity to one another to maximise production of buffalo products. Following in-depth discussion based on extensive desk-based research, field visits to selected CPAs resulted in the decision to work with Akphivoat Prey Veng, Mlu Prey Keub, Sambour Akphivoat and Prey Phdao – 4 CPAs, 1 in Chhaeb Preah Roka Wildlife Sanctuary and 3 in Kulen Promtep Wildlife Sanctuary. Of these, only 1 – Sambour Akphivoat was an existing CPA Buffalo Project member. With the selection of the CPAs, this activity is considered as complete.

Activity 1.2 Using existing buffalo herds a starter stock, purchase new buffalo locally to create adequate herds for restoration projects.

Sambour Akphivoat Community Protected Area had a population of 22 buffalo at the start of the Darwin Initiative Project (taken as 1st April 2023). Over the course of the project, a total of 11 buffalo were a result of breeding. An additional 11 buffalo (10 female) were purchased to increase

milk production and improve herd dynamics. A total of 12 buffalo (10 female) were transferred to other project CPAs to improve herd dynamics, and 4 males were sold for revenue raising, resulting in a net increase of 6 buffalo. The buffalo population in this CPA at the end of the project was 28 (20 female). Akphivoat Prey Veng Community Protected Area was a new CPA for this project, part of the scaling up aspect of this important work. From a starting herd of zero, a total of 21 buffalo were purchased, 12 resulted from breeding efforts and 3 were transferred in from partner CPAs. A total of 3 buffalo were transferred out to partner CPAs to assist with herd dynamics and 2 buffalo died resulting in a net increase of 31 buffalo (21 female) for this CPA. Prey Phdao Community Protected Area was also a new CPA for this project and had a population of 3 buffalo at the end of Year 1. With 3 buffalo born, 3 purchased and 8 transferred in from partner CPAs, the resulting population increase over the span of the project was 17 buffalo (14 female). There were no deaths in this CPA over the life of the project. Mlu Prey Keub Community Protected Area began with a starter stock of 18 buffalo, but this CPA struggled with the sex ratio of buffalo in the herd with majority of male births, and low breeding success of the few females in the herd. This led to more sales for meat and no possibility of milking. Over the course of the project, a total of 6 buffalo were born, and 1 transferred in from partner CPAs to attempt to influence herd dynamics. There were 3 deaths over the course of the project and 8 buffalo were sold for revenue raising. This resulted in a net decrease over the project timespan of 4 animals. In summary, the total combined herds increased from 39 animals at the start of the project to 90 by the close: a net increase of 51 animals (Annex 2).

Activity 1.3 Collaborating with project partners, conduct training workshops both in-situ and at Laos Buffalo Dairy on animal husbandry, breeding, herd management, and milking techniques.

Over the course of Year 1, 4 separate training workshops were held, 3 in Cambodia and 1 in Lao PDR. Project partners, Laos Buffalo Dairy provided the training and schedules for all training events based on the needs of the community and in consultation with the Community Liaison Officers at WCS. The first workshop involved two specialists from the Laos Buffalo Dairy traveling to Cambodia and focused on the existing herds, conducting a full inventory, and creating a management plan for maximizing dairy production. Ear-tagging, pregnancy checks, vaccination and deworming were all conducted. An initial training on milking was also conducted, after building a simple miking stall. Milk products were then used in preparation of 2 dishes and warmed milk for consumption by local schoolchildren. During this trip, the CPAs were also assessed for their ability to conduct buffalo project activities. The second workshop was held at the Laos Buffalo Dairy in Luang Prabang, Lao PDR. A total of 6 community members who had been assessed for their skills during the first exchange trip were accompanied by WCS Community Technical Advisor on a 6-day trip to the fully functioning buffalo dairy managed by our partners. The community members were exposed to all the aspects of buffalo husbandry, dairy production, cheese-making and many more aspects of the working dairy over the course of the trip. Receiving hands-on practical experience in an environment such as this was invaluable for both the participants but also the trainers who were able to assess which community members could progress faster when returning to their respective communities in Cambodia. Exchange trip three focused mainly on herd management, purchasing the required buffalo to expand the project in the two new CPAs of Akphivoat Prey Veng and Prey Pdhao. A total of 13 buffalo were purchased, dewormed, vaccinated and general health check including pregnancy check provided. This allowed for further training of community members in these techniques. Time was also spent with Mlu Prey Keub CPA who were experiencing issues with a newborn calf. A fourth exchange trip took place from 21-27 March 2024 with our partners at LBD sending two experts – 1 in animal husbandry and 1 chef, specializing in producing products from buffalo milk such as cheese, yoghurt and ice cream. The objectives of the visit were to conduct health checks and training, vaccination as per the annual calendar, milk production, and yogurt making and business discussions. The trip was well received and involved many community members in each target village. For those villages not yet producing milk, or not producing in a great enough quantity, travel support was provided to allow for lessons learned exchange trips to visit more advanced dairies. The last exchange trip saw LBD staff visiting the 4 partner CPAs from 14-19 August 2024. The primary objectives of the workshop were to assess milking, pregnancy

checking, deworming and vaccination, ear-tagging, and cassava silage demonstration. A compilation of the Exchange trip reports can be found in Annex 3.

Activity 1.4 Create 4 community buffalo dairies using simple structures and locally-sourced equipment and associated protocols for keeping buffalo in suitable environment.

Over the course of Year 1 of the project, buffalo dairies were successfully built in all 4 target CPAs. Technical advice was provided by LBD, with all labour provided by the membership of the CPA in each location. Locally available materials, including timber that had been confiscated from the illegal timber trade, were used to construct the dairy, the adjacent milking stall, a simple crush for vaccination and pregnancy checks and separate stalls for newborn calves and their mothers. In addition to the housing for the buffalo, the project invested in a biodigester producing methane gas for cooking for each of the four CPAs. These were installed by the company ATEC with support provided for training and follow up as necessary. In Year 2, training was provided on creating supplementary food for the buffalo, especially cassava silage. Cassava is readily available in the nearby villages, especially in these four CPA where cassava is a common crop. Its leaves can be processed into various forms of food for feeding animal, and cassava silage is a valuable option for herdsmen to feed the buffalo in dry season. Partners at LBD produced and distributed training materials and associated protocols to all CPAs (Annex 4).

Activity 1.5 Assessment of community needs, and development of either school meals programme or community nutrition groups

During the fourth exchange trip, nutrition featured heavily in the training, with local community members encouraged to look at the types of food and drink available to them from a nutritional perspective. The first year of this project was geared towards initiating the groundwork to produce milk and milk products. As part of this process, a local taste for milk was essential. By inviting schoolchildren to sample milk and foods made with milk, we have successfully created a taste for what previously did not exist in the villages. During the project, 4 families from 4 CPAs have been trained by technical staff from LBD in partnership with WCS in milking techniques to generate income to improve their livelihood and support healthier diets in the communities. Over the duration of the project the total daily fresh milk production was an average of 2.60 L per participating CPA, representing a total average of 7.80 L milk per day for the project. However, this daily average vastly improved over the life of the project, with the final month's average daily production being 5.8 L per day – twice as high as project start (Table 1). The milk was pasteurised through heating and either provided fresh to schoolchildren or made into yoghurt for consumption and/or sale. This initiative provided income and addressed the concerns of low nutrition rates among schoolchildren in project villages (Annex 5).

Table 1: Milking results from 3 out of 4 participating CPAs

CPA	Total Milk Production (litres)	Average Daily Production (litres)	Maximum Daily Production (litres)	Consumers of Milk Products (total persons)	Consumers of Milk Products (female)
Sambour Akphivoat	1,326	2.33	7.90	8,509	3,856
Akphivoat Prey Veng	817	2.69	5.30	4,189	2,234
Prey Pdao	584	2.78	4.30	2,758	1,529
Total	**2,727**	**2.60**	**17.50**	**15,456**	**7,619**

Output 2: Restoration of the ecological functionality of tropeangs through community-led and managed buffalo herds.

Activity 2.1 Train community members on tropeang rotation for buffalo herds and create herding schedule based on tropeang area and herd size.

To implement Activity 2.1, the project first conducted a comprehensive assessment of seasonal ponds across the four participating CPAs. This assessment involved both desk-based analysis and field visits with community members to select suitable ponds for buffalo rotation based on criteria in Activity 1.1. The final selection included a total of 26 ponds, with 9 designated as experiment ponds for buffalo rotation and 17 as control ponds. The Sambour Akphivoat CPA built on their experience with buffalo herding and pond use already ongoing. For the three new CPAs, herding schedules were developed in close collaboration with the community, considering the number of buffalo available, herd size, and distances between ponds. To build local capacity, community members from the three new CPAs received practical training from experienced herders from Sambour Akphivoat CPA. By project end, all four CPAs were successfully implementing buffalo rotation through community-led herding, contributing directly to the restoration goals of the project and improved their livelihoods. The mean duration of a restoration event ranged from 1 hour 51 mins to 10 hours and 32 mins (Table 3, Annex 6).

Activity 2.2 Collaborating with project partners, create a tropeang survey protocol as a means to assess biodiversity value and complete surveys in project tropeangs.

Throughout the reporting period, the project team worked closely with both internal WCS staff and official project partners, including a master student and academic supervisors from the Royal University of Phnom Penh (RUPP), to develop a standardized biodiversity survey protocol for seasonal ponds. This protocol was designed to assess the ecological and biodiversity value of ponds subject to buffalo restoration activities. Given that this biodiversity monitoring formed the core of a Master thesis research project, the protocol development was informed by an iterative process of consultation, field testing, and academic review. Discussions with WCS biodiversity staff, the RUPP Master student (with the support of university supervisors) focused on identifying appropriate and feasible survey methods suitable for remote community-managed sites. Field trials were conducted in February 2024 to test different sampling approaches for fish and amphibians; the two taxonomic groups selected as indicator species for pond biodiversity. These trials helped refine techniques to balance scientific rigor with practical constraints faced by community members conducting fieldwork. The first component of his thesis project provided a detailed methodology for monitoring key hydrological characteristics of the ponds, including dissolved oxygen, temperature, pH, and turbidity. These methods were field-tested and applied by the student and WCS staff, with measurements taken monthly at selected ponds from February to July 2024 when feasible. The second component focused on assessing biodiversity, specifically targeting fish and amphibians as indicator taxa. Survey methods included passive trapping (bamboo and centipede traps) for fish and both visual encounter surveys and dip-netting for amphibians. Sampling was conducted across control and experiment ponds during both the dry and wet seasons to compare species richness, abundance, and diversity. These protocols were then used to conduct the full set of planned hydrological and biodiversity surveys at the selected project ponds. Full details of the hydrological and biodiversity protocol, including dissolved oxygen, temperature, pH, and turbidity measurements, species identification processes, survey effort, and data sheets, are documented in Ly Kunthy's MSc thesis (Annex 7). In total, biodiversity and hydrological surveys were completed across six ponds (three experiment and three control ponds) in three CPAs in KPWS. Analysis of the survey data has provided baseline and comparative information on the ecological effects of buffalo-led pond restoration. The combined protocols and field survey results now offer a scientifically robust dataset and a strong framework for evaluating restoration success and guiding future seasonal pond restoration efforts across the NPL.

Activity 2.3 Conduct both community workshops including field training, and extended support for tropeang monitoring using previously-developed pragmatic tropeang monitoring protocols

In the first part of Year 1, the "Monitoring of Seasonal Forest Ponds Protocol for Community Researchers" was translated into Khmer to ensure accessibility for community members, and shared with other organisations working on restoration of seasonal ponds. The protocol was extensively tested in the field by WCS Biodiversity staff to ensure it was practical and user-

friendly. Following these trials, a dedicated KoboCollect digital data form was developed to streamline data collection by community members. Using the Khmer-language protocol and KoboCollect form as teaching aids, the WCS Biodiversity Team conducted a series of community workshops and field training sessions across the four target CPAs. Community members were selected based on criteria including availability, willingness to commit time each month to monitoring, ability to learn to draw accurate sketch maps, capacity to use digital data collection tools and be compliant under protected area management rules through the WCS Compliance Monitoring Unit. Training followed a stepwise capacity-building approach. Initially, WCS staff conducted all monitoring activities with community members observing. Over time, community members were given increasing responsibility for each part of the monitoring process, including water depth measurement, substrate classification, soil penetrability testing, and producing hand-drawn sketch maps of pond substrates and boundaries. By the end of Year 1, community members were leading most data collection steps, with WCS Biodiversity staff providing only oversight and targeted technical support during monthly visits. In Year 2, the level of WCS involvement was further reduced. Only one WCS Biodiversity Team member was assigned per CPA, primarily to conduct periodic quality assurance, troubleshoot any issues, and provide occasional refresher training. By this stage, community members had become largely autonomous, demonstrating the capacity to carry out pond monitoring with minimal external support.

Activity 2.4 Conduct community monitoring of tropeangs on a monthly basis and adaptively update the herding schedule based on results.

From the point of training onward, community members conducted monthly monitoring of all selected project ponds following the standardized protocol. Data collected included water presence/absence, water depth, soil penetrability, and detailed mapping of substrate types within each pond. Monitoring was conducted at all 26 project ponds (both control and experiment ponds) across the four CPAs. The community monitoring data were reviewed monthly by the WCS Biodiversity Team. These data were then integrated into decision-making around buffalo herding schedules. Specifically, when monitoring data indicated that a pond had dried out or had excessive vegetation regrowth, buffalo were scheduled to rotate to that pond to achieve restoration objectives. Conversely, when monitoring showed that a pond had been sufficiently impacted or was holding water well, herds were rotated to other target ponds. This adaptive herding approach was particularly well-demonstrated at Sambour Akphivoat CPA, where higher visitation frequency allowed more dynamic scheduling. A total of 355 pond monitoring events were conducted between September 2023 and February 2025, with communities and the biodiversity team working together to collect accurate data, providing a valuable time series for assessing seasonal changes in pond condition and buffalo impact (Annex 8 and Annex 9). Community participation has been critical to the project's ability to collect consistent, site-specific data across a geographically dispersed set of seasonal ponds.

Activity 2.5 Conduct camera trapping surveys during the dry season to assess use of tropeangs by mammal and bird species.

The project successfully implemented a dry season camera trap survey targeting 8 seasonal ponds across four CPAs. From 14 January to 24 July 2024, camera traps collected a total of 74,150 images across sites. The project recorded 14,018 wildlife image events and 10,819 records were confidently identified to species level. Total survey effort amounted to 138 GB of image data, covering multiple locations and time points throughout the dry season. From January to March in 2024, the camera trap data was analysed by informal partners at the School for Field Studies (SFS) and used as a training tool for the undergraduate thesis of a group of visiting SFS students. The full report for this first camera trap survey can be found in Annex 10. From April to July 2024, image classification was carried out by trained WCS biodiversity researchers using Timelapse, a specialized software designed for reviewing and annotating time-series images from camera traps. Developed by the University of Calgary, Timelapse enables efficient sorting, filtering, and tagging of large volumes of wildlife images. One of its key advantages is the ability to customize tagging schemes, which allowed to create a species list tailored specifically to the

NPL, including both common names in English and Khmer. This locally adapted list helped reduce identification errors and made the software more accessible to staff. The results for the full camera trap survey can be found in Annex 6, under the section titled *Camera Trap Study*. The project successfully achieved the intended output of conducting camera trap surveys to assess wildlife use of seasonal ponds during the dry season. Despite logistical challenges, a substantial dataset was collected, and over 10,000 wildlife records were identified to species level. These results provide strong evidence that the method was effective in capturing species presence and behaviour around seasonal ponds, contributing valuable insight into the ecological role of restored and buffalo-accessible habitats.

Table 2: Camera trap photos of species utilising ponds at varying stages of restoration

	
Giant Ibis (*Pseudibis gigantea*) - CR	Lesser Adjutant (*Leptoptilos javanicus*) - NT
	
Green Peafowl (*Pavo muticus*) - EN	Northern Red Muntjac (*Muntiacus vaginalis*) - LC

While the camera trap surveys successfully generated a large volume of data, several logistical and technical challenges were encountered during implementation. The sheer size of the dataset required substantial time and human resources for image sorting, even with the support of Timelapse software. Additionally, the placement of camera traps near seasonal ponds introduced specific vulnerabilities. Cameras were frequently knocked over or damaged by buffalo, which often rubbed against them during wallowing. In some sites, cameras were also stolen or tampered with due to their visibility and the high level of human passage through the area. Moreover, several cameras were rendered non-functional due to flooding when water levels rose unexpectedly. Given these limitations, the project recommends incorporating complementary monitoring techniques in future assessments. Methods such as environmental DNA sampling from pond water could help detect the presence of a broader range of species, including those not easily captured by camera traps. Similarly, targeting indicator taxa, as demonstrated in the MsC thesis research by Ly Kunthy, which focused on fish and amphibian diversity provides a more sensitive measure of habitat health. The use of bioacoustics monitoring could also offer a non-intrusive way to detect vocal species such as frogs and birds that may be underrepresented in camera trap datasets. These approaches, used alongside camera traps, would enable a more comprehensive understanding of how buffalo activity influences biodiversity and pond ecosystem function.

Output 3: Globally threatened wetland biodiversity is protected through community conservation activities.

Activity 3.1 Train and build capacity of CPA patrol teams on the use of SMART and patrol techniques used in trapeang protection, with a focus on poisoning and snaring.

Annual SMART training was conducted for all four CPA patrolling groups in both years of the project duration. The trainings are on-the-job, and their objective is to reinforce the community's ability to use the SMART Mobile application for collecting field observations in their project area. The training also strengthens participants' capacity to detect and report illegal human activities, such as snaring or poisoning, in and around the pond areas Additionally, the training built the community capacity on report writing to ensure participants could effectively communicate with the Provincial Department of Environment rangers during monthly meetings with the protected area management. Training materials include the evaluation form, SMART Mobile user manual, Avenza map user manual, observation exercise, wildlife identification charts, human activity guides, training checklist, and attendance list. The training reports can be seen in Annex 11 – 14.

Activity 3.2 Conduct monthly community patrols in the project area, in collaboration with MOE to ensure forest crimes are adequately addressed.

Over the course of the project, 654 patrol days were completed across the 4 target CPAs by a collaboration of local communities and 23 Ministry of Environment rangers. A total of 483 participants (91 female) covered 9,376 kilometres (Table 3).

Table 3: Patrol Summary

CPA Name	Number of Days	Coverage	Total Participants
Sambour Akphivoat	140	1,639 km	150 (32F)
Akphivoat Prey Veng	94	739 km	144 (27F)
Prey Pdao	147	1,203 km	117 (21F)
Mlu Prey Keub	273	5,795 km	72 (11F)
Total	**654**	**9,376 km**	**483 (91 F)**

As a result of patrolling, a total of 128 illegal logging sites, 78 land clearance locations, and 65 instances of seized gear were recorded (Annexes 15–18).

Activity 3.3 Community members conduct bird nest monitoring and protection based on species requirements.

Throughout the project period, community-led bird nest monitoring and protection focused on globally threatened wetland species such as the Lesser Adjutant (*Leptoptilos javanicus*), Sarus Crane (*Grus antigone*), and Giant Ibis (*Pseudibis gigantea*). During Year 1, a total of 40 nests were protected by trained community members. All 40 monitored nests successfully hatched and fledged chicks, representing a 100% nesting success rate during the first year. In Year 2, the nest protection program expanded, with 75 nests monitored weekly or protected daily by community members. Of the 75 nests, 72 (96%) were successful, with only three nest failures recorded. Two nests failed due to natural causes, one as a result of strong winds, and the other due to predation by another bird. One additional nest was abandoned by the parents, but notably, the pair immediately rebuilt a new nest in proximity, which was subsequently protected and successfully fledged chicks (Annex 19).

Activity 3.4 Enlist an MSc Student from a national university to conduct research on habitat biodiversity of restored tropeangs.

In June 2023, we formally welcomed Mr. Ly Kunthy as an intern with WCS Cambodia (Figure 1), conducting his Master's research on the habitat biodiversity of restored ponds in the Northern

Plains Landscape in collaboration with RUPP. Kunthy worked closely with the WCS Biodiversity Team to develop his research methodologies, ensuring they were both scientifically rigorous and aligned with the specific data needs of the project.

Figure 1: MSc Student, Ly Kunthy, at the Royal University of Phnom Penh, Cambodia

After successfully defending his thesis proposal in February 2024, Kunthy began an intensive field season, collecting data on hydrological parameters and biodiversity (fish and amphibians) across the project's experiment and control ponds. His research directly supported the project's biodiversity monitoring objectives under Output 2, while also fulfilling the requirements of his Master's degree program. In February 2025, Kunthy formally submitted his thesis, titled "Ecosystem Biodiversity Analysis of Seasonal Ponds in Northern Cambodia", to RUPP. Following a successful oral defence (Annex 20), he was awarded an "Excellent" grade, the highest category under the university's evaluation system. This reflects the strong quality of both his fieldwork and analytical outputs. Kunthy's thesis now serves as a key technical reference for the project, with full documentation of survey methodologies, data analysis, and ecological findings. His research has not only contributed directly to project monitoring and reporting but also built national research capacity in wetland biodiversity and restoration ecology.

3.2 Outcome

Outcome: Globally threatened wetland biodiversity is restored through community-owned buffalos performing important ecosystem processes and protected through sustainable income, community-led monitoring, and patrolling.

0.1 At least 16 tropeangs will be monitored and at least 8 will be restored by buffalo herds by project end.

The project has successfully met and exceeded the target set in the logframe for Outcome Indicator 0.1. Progress toward the Outcome was measured using two primary indicators, as outlined in the project logframe: (1) Monthly community tropeang monitoring reports, including digital sketch maps of physical characteristics, and (2) Habitat survey reports focused on biodiversity, produced by the project lead and partners. By project end, 26 seasonal ponds were regularly monitored (including both control and experiment ponds) across the four target CPAs. Monitoring was conducted monthly through a community-led program supported by the WCS Biodiversity Team, with over 355 pond monitoring records collected between September 2023 and February 2025. Of these monitored ponds, 9 were designated as experiment ponds, receiving targeted buffalo restoration through managed herding and rotational grazing schedules (Annex 6, Table 1). Evidence of ecological impact from the buffalo restoration is well documented through both the community monitoring dataset and the MSc thesis by Ly Kunthy. The data demonstrate that experiment ponds consistently retained water longer into the dry season, had greater average water depth, and exhibited increased soil penetrability compared to control ponds (Annex 6, *Physical Characteristics*; Annex 7; Annex 8; Annex 9). These hydrological improvements are directly relevant to the Outcome's goal of restoring wetland habitat for globally threatened biodiversity. To assess the ecological benefits of buffalo activity on biodiversity, fish and amphibian surveys were conducted on a subset of ponds. Results showed that experiment

ponds supported greater species richness and higher abundance of both fish and amphibians compared to control ponds (Annex 7). These findings indicate that buffalo passage promotes more balanced and biodiverse aquatic ecosystems, contributing to improved habitat conditions for wetland-dependent species. Overall, the project provides strong evidence that community-managed buffalo restoration is a viable and scalable approach for enhancing the ecological health and resilience of seasonal ponds within Cambodia's wetland ecosystems.

0.2 4 CPA that are managing buffalo will have at least 2 community patrols (total 8) with participation from at least 25% women supported by income from buffalo products by the end of Year 1.

The project successfully achieved its aim to support patrolling with buffalo product revenue. Revenue from buffalo products increased greatly in Year 2, as was to be expected from the groundwork of Year 1. Whilst milk and yoghurt were produced in 3 out of 4 of the CPAs, only two chose to sell yoghurt, with the third CPA instead using yoghurt to boost the nutritional input for local children only. Sales of buffalo for meat created revenue for 2 CPAs, with the remaining 2 CPAs benefitting from disproportionate number of milk-producing cattle.

CPA Name	Revenue Stream	Income	Annex
Sambour Akphivoat	Yoghurt		Annex 21
Sambour Akphivoat	Buffalo		Annex 21
Sambour Akphivoat	Buffalo		Annex 22
Akphivoat Prey Veng	Yoghurt		Annex 23
Mlu Prey Keub	Buffalo		Annex 24
	Total	**$6,768**	

The revenue from buffalo products was used to support patrolling in project CPAs. The standard patrol cost equates to $12.50 per person per day. The combined revenue of the 2-year project equates to more than 540 person/patrol days. Results of community patrolling in Table 3 show that female participation on patrols was between 15% and 21% depending on the CPA. Whilst this number fell short of the target 25%, it is still an improvement in an area of conservation with strong cultural norms around women on patrol.

0.3 By project end, bird nests of globally threatened species within the project area (vicinity of tropeangs) will be stable compared to the baseline at project start, based on multi-year biodiversity surveys results already conducted.

The project successfully achieved its intended outcome of maintaining the stability of nesting activity for globally threatened bird species within the project area, particularly around seasonal ponds. As outlined in the original logframe, this outcome was to be measured through the ongoing presence, monitoring and breeding success of wetland-dependent species of global conservation concern. Throughout the project, community-led bird nest protection efforts focused on key species including the Giant Ibis (*Pseudibis gigantea*), White-shouldered Ibis (*Pseudibis davisoni*), Sarus Crane (*Grus antigone*), Lesser Adjutant (*Leptoptilos javanicus*), and Woolly-necked Stork (*Ciconia episcopus*). In Year 1, 40 nests were actively protected by trained local community members, with 100% nesting success recorded, all nests hatched and fledged chicks. Of these, 10 nests (25%) were located near seasonal ponds including in the restoration project, demonstrating a direct ecological link between wetland restoration and breeding activity. In Year 2, the program expanded to include 75 nests, of which 8 were again situated near restoration sites. Nest success remained high, with 72 of 75 nests (96%) successfully fledging chicks. Failures were limited and largely due to natural causes (e.g., strong wind, predation), and one abandoned nest was quickly replaced by a successful re-nesting attempt in the same area. These results indicate a consistently high level of breeding success for threatened wetland bird species across both years of implementation. Additionally, stable nesting records for Giant Ibis, White-shouldered Ibis, and Sarus Crane continue to be observed at the wider landscape level, further reinforcing long-term trends. Summary data and supporting evidence are available in the biodiversity monitoring reports provided in the annex (Annexes 25 – 27). Census data collected during the project period support stable or improving trends for key species. In 2024–2025, the

peak count for Sarus Crane reached 36 individuals in May 2025, the highest count over the past decade, while the White-shouldered Ibis census recorded a peak of 80 individuals in July 2024, also the highest to date (Annex 28 and Annex 29).

3.3 Monitoring of assumptions

Assumption 0.1 Extreme weather events do not impact seasonal tropeangs to the extent that project interventions are negated.

This assumption remained a consistent risk throughout the project period, but ultimately held true, with project interventions continuing to deliver measurable ecological benefits despite climatic challenges. From project inception in May 2023, extreme weather patterns influenced seasonal pond conditions. The wet season began earlier than normal in 2023, causing many seasonal ponds to fill rapidly. This early onset complicated baseline assessments and delayed the start of some monitoring activities. In contrast, the wet season ended early in 2024, followed by prolonged periods of unusually hot and dry weather extending into March 2024. This resulted in critically low water availability across all ponds in the landscape during the 2023–2024 dry season. Despite these weather extremes, monitoring data collected over the full project cycle indicate that experiment ponds demonstrated significantly greater resilience compared to control ponds, particularly in their ability to retain water during dry periods. On average, control ponds held water for 11.25 months, while experiment ponds retained water for a longer duration, averaging 12.78 months annually (Annex 6, *Physical Characteristics*). Conversely, control ponds experienced an average of 3.75 months without water, which was notably higher than the experiment ponds, where water was absent for only 2.22 months on average. This represents an approximate 1.5-month increase in water presence in buffalo-restored ponds compared to controls, underscoring a significant positive impact of buffalo activity on water retention. These results provide strong evidence that buffalo-managed ponds exhibited greater persistence of water availability throughout the year, even under variable and at times extreme climatic conditions, highlighting the value of this community-led restoration approach for improving the ecological resilience of seasonal wetlands in the NPL. Overall, the assumption held true across the full project period, as extreme weather did not fully negate the impact of restoration interventions. The data collected under Output 2 provide clear evidence that buffalo-led restoration contributed to enhanced pond resilience, although continued climate variability remains a long-term risk factor for wetland restoration success in this landscape.

Assumption 0.2 Mortality rates and disease can be mitigated to create healthy and productive herds.

Mortality rates and disease were monitored throughout the project by partners at LBD, and project staff. This assumption held true, and by mitigating disease through vaccination programmes and decreasing mortality rate through health programmes, the herds quickly became productive both in terms of meat quality for sale and milk productivity. This is evident from the increase in average yield from the start of the project to the completion (Annex 5).

Assumption 0.3 Poisoning events do not cause crashes in populations of globally threatened species.

Poisoning remained an ongoing threat to biodiversity throughout the project period, particularly in the context of illegal fishing and hunting practices targeting seasonal ponds in the NPL. This risk was clearly demonstrated in Year 1, when chemical poisoning was used to harvest fish, amphibians, and other wildlife at a monitored pond within KPWS. In this instance, the community monitoring team responded quickly, working alongside key WCS staff to implement the pond cleaning protocol and rescue surviving fish and other wildlife. This rapid response helped minimize the immediate biodiversity impacts. In addition, the project took preventative action by coordinating with local community patrol teams and government rangers to increase patrolling efforts around seasonal ponds during the dry season, when the risk of poisoning is typically highest. In Year 2, a second suspected poisoning incident was recorded, although this one involved livestock. In late January 2025, three dead cows were discovered near Tmat Paeuy village. The carcasses, found in a cashew plantation, were suspected to have died from poisoning, as photos shared by the village chief showed a large aluminium bowl with blue residue,

commonly associated with chemical poison. During follow-up fieldwork on February 4th, 2025, as part of poisoning cleanup efforts, led the biodiversity team to discover several bottles of pesticide, likely used in the cashew plantation. WCS biodiversity team documented the incident, interviewed stakeholders, and proposed sample collection and carcass removal. Importantly, no wildlife carcasses were found in association with this second incident, and no population crashes of globally threatened species were recorded during the project period. However, the recurrence of poisoning incidents highlights the ongoing threat this practice poses to conservation efforts. While the underlying risk of poisoning remains across the landscape, the assumption held true during the full project period, with no recorded population crashes of globally threatened species attributable to poisoning events within the project area. Continued monitoring and collaboration with law enforcement and community patrol units will be essential to sustain this outcome beyond the life of the project.

Assumption 1.1 Emerging disease does not affect herds in terms of reducing productivity or increased infant mortality.

Testing of herds for diseases such as brucellosis took place throughout the project period and remains part of the monitoring process. Additionally, new or emerging disease is closely monitored by project staff. These remain a risk, as shown by the report towards the end of Year 1 on the outbreak of Anthrax in neighbouring Lao PDR. The project team considered the benefit of adding anthrax vaccination to the schedule; however it was not possible to source the vaccination.

Assumption 1.2 Travel restrictions (such as Covid-19) do not restrict training workshops being conducted at the Laos Buffalo Dairy.

This risk did not present itself during the life of the project.

Assumption 1.3 Community nutrition groups or local schools are engaged and willing to diversify their nutrition sources.

Buffalo milk or milk products had not been used by local communities in any of the 4 target CPAs and so this risk was assumed. To mitigate this risk, the buffalo dairies in Sambour Akphivoat, Akphivoat Prey Veng and Prey Pdao distributed milk and yogurt products free of charge to local community members who were interested in sampling the products. This created a local demand for products and helped reduce the risk of non-uptake.

Assumption 2.1 Buffalo numbers can be increased through purchase of appropriate animals and successful breeding.

Except for Mlu Prey Keub CPA, all CPAs were able to grow their initial starter stock through successful breeding producing female calves. The risk of producing an all-male herd remains but can be countered by purchasing new stock or trading between CPAs. Both measures were employed over the duration of the project.

Assumption 2.2 Project collaborators are able to refine techniques used to survey tropeangs, and survey techniques are possible in a local setting.

This assumption largely held true over the course of the project. Developing and refining effective survey techniques for seasonal pond monitoring that were both scientifically sound and feasible for local implementation required considerable investment in capacity-building and field-based testing. One of the primary challenges was the limited baseline capacity within target communities, particularly about literacy and data recording skills. In many cases, community members with the necessary literacy skills were unable to commit sufficient time to the project. This required the project team to adapt training materials, use simplified Khmer-language protocols, and introduce digital tools (such as KoboCollect) to reduce the burden of manual data entry. Another ongoing challenge was gender imbalance in community participation. Survey and monitoring work was predominantly undertaken by male community members, largely due to cultural norms and availability of participants, which limited female engagement in the fieldwork component. Despite these constraints, the WCS Biodiversity Team in collaboration with the MSc student successfully refined the monitoring protocols through iterative testing and feedback

loops, making them feasible for community-level implementation. By Year 2, community members in all four CPAs were able to conduct monthly monitoring with reduced technical oversight, demonstrating that the techniques were both adaptable and locally implementable.

Assumption 2.3 Protected area land under the management of the MoE can be protected adequately, including preserving locations of project trapeangs.

Land conversion remained a threat with both high likelihood and high impact. Market prices of crops such as cashew and cassava drive land conversion and remained a threat throughout the project.

Assumption 3.1 Community patrol teams are permitted to operate in the project areas, either with or without support from MOE.

With some ponds being outside of Community Protected Areas, patrolling relies on the joint patrol model, which in turn relies on local agreements with the Provincial Department of Environment to conduct these patrols. There were no cases where this was seen during the life of the project and communities were able to patrol ponds with full participation from MOE.

Assumption 3.2 Nesting birds return to the project area in significant numbers and their populations are not affected by factors outside of the project area such as hunting or poisoning.

This assumption remains valid over the course of the project. While the project maintained a strong level of control over habitat management and threat mitigation within the target project areas, the ecology of key bird species means they routinely forage and move outside protected area boundaries. Throughout the project, Biodiversity team, local communities and PDoE rangers continued to monitor known nesting and roosting sites, with no evidence of major declines in nesting bird populations attributable to external threats such as hunting or poisoning during the project period. However, as acknowledged in the original logframe, the project has limited influence over threats occurring outside project boundaries. Continued vigilance and landscape-level conservation efforts remain necessary to mitigate ongoing external risks to wide-ranging bird species. At project end, this assumption is considered to hold true, with no recorded population-level impacts from external threats during the project period.

Assumption 3.3 A suitable candidate to conduct freshwater surveys can be enlisted.

This assumption held true for the full duration of the project. As reported in Year 1, the project successfully enlisted Mr. Ly Kunthy, a Master's student from RUPP, to lead the freshwater biodiversity surveys. The main identified risk at the end of Year 1 was that he might not complete his thesis. To mitigate this, WCS staff maintained close and ongoing support, providing technical guidance, field supervision, and mentorship throughout the research and writing process. This support proved effective. Kunthy successfully completed all fieldwork in 2024, submitted his thesis in February 2025, and defended his work with an "Excellent" grade, the highest classification under RUPP's grading system. The successful completion of Kunthy's research demonstrates that this assumption was fully met, with risks effectively managed throughout the project lifecycle.

3.4 Impact

Impact: Tropeangs within the Northern Plains Landscape are restored by buffalos that are owned by communities with sustainable livelihoods, safeguarding threatened biodiversity and creating a scalable model for other protected areas.

The multi-faceted approach of this project means that biodiversity conservation is impacted on different levels. By supporting communities to monitor the seasonal forest ponds, they are gaining a deeper understanding of their importance. This lends itself to direct protection of these habitats, which is further bolstered by community/government patrols and direct protection of bird nests. The restoration project itself is safeguarding the vital sources of water in the dry season that local biodiversity depends on. By incorporating university students in the process, biodiversity of this critical ecosystem is kept on the agenda at a national level. The project takes place in villages

that suffer from high levels of poverty. Livelihoods are dependent on forest resources and agriculture. Through diversification of livelihoods, poverty reduction is mitigated, and resilience is introduced. The project provides direct income to a range of positions, from those caring for buffalo (herding and husbandry), those involved in milk production through dairy activities, and producers of milk products such as yoghurt. In addition, community members involved in pond monitoring, bird nest protection and patrolling all receive direct benefits from the project. Throughout the project, milk products were supplied to those at risk of nutrient deficiency free of charge, directly benefitting the well-being at risk children.

4 Contribution to Darwin Initiative Programme Objectives

4.1 Project support to the Conventions, Treaties or Agreements

Data gathered during the project was used to inform a response to a survey established by a consultant to the Ministry of Environment on an update to the National Biodiversity Strategy and Action Plans (NBSAP). Anecdotal observations on habitats frequented by staff and communities helped guide responses, and direct observations from the restoration project were included in responses. At the close of the project, we hosted a visit to the project site of Sambour Akphivoat by Marc Thayre, Deputy Head of Mission, British Embassy and Theb Chey, Lower Mekong Landscape Coordinator, Biodiverse Landscapes Fund who discussed ways of incorporating lessons learned into public policy.

4.2 Project support for multidimensional poverty reduction

Cambodia is designated as a Least Developed Country (LDC). The project is centered on the rural communities of 4 villages located within the protected area network of the Northern Plains Landscape. These represent some of the poorest communities in the country; heavily reliant on subsistence agriculture and natural resources – both climate vulnerable sources of income. Seasonal forest ponds are disappearing due to the extirpation of large ungulates in the landscape. By bringing buffalo back to the habitat, this trend is being influenced. Ponds that have been restored by buffalo are deeper, retain water for longer periods during the dry season and have an increased value for biodiversity (Annex 6). Ponds are vitally important for poverty reduction of these remote communities, and restored ponds offer a lifeline both in terms of water but also other resources for local communities who depend on a healthy forest environment for their survival. Direct income benefits herdsmen, milk technicians, delivery staff, cooks and community members who actively patrol or conduct research. Revenue from buffalo products go directly to the community bank account before being disbursed by the community for their activities. Other project activities improve the local economy in these small villages leading to poverty reduction for other households not directly involved with the project. For example, income from the buffalo project can be used at the discretion of the CPA committee to aid conservation action.

4.3 Gender Equality and Social Inclusion (GESI)

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	
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	

GESI Scale	Description	Put X where you think your project is on the scale
	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	

Working with CPA Committees, the project sought to include vulnerable groups as is standard for our community activities. This is written into both the contract with the CPA for the buffalo project (Annex 30) and existing bird nest protection guidelines (Annex 31) where stipulations such as "disadvantaged groups, youth or women should be encouraged and given priority to participate" are clearly written as guidance for project staff. Some of the project activities are predominantly male led (such as patrolling) so the project staff actively promote the involvement of women in these activities. The project faced early difficulties in recruiting women community members for roles on the project that took them outside of the village. Through direct encouragement from our female staff, this hesitation was short-lived - with the exception of patrolling, which is still male-dominated (Buffalo, biodiversity, and breaking barriers – Darwin Initiative Newsletter, May 2025)

4.4 Transfer of knowledge

In addition to the two Darwin Newsletters that the project contributed to, WCS Cambodia and project partners have promoted the project on their social media. Additionally, through dairy visits by multiple donor agencies and government partners, the dairies themselves have promoted the work of the project to restore these critical habitats. By engaging early on in the project with provincial government, support for this grass-roots initiative is strong. On a national level, through engaging with the Royal University of Phnom Penh, we have highlighted an area of biodiversity restoration that has been overlooked. On the international stage, the project will be presented in upcoming conferences on biodiversity. The project has produced protocols that will be shared with national policy makers on upcoming workshops on habitat restoration.

4.5 Capacity building

Notably, some of the community members who participated in pond monitoring for this project are now actively involved in a new research initiative focused on bats, working alongside a PhD student investigating how seasonal pond characteristics and landscape context influence bat assemblages in the NPL. This project, which focuses on understanding how water availability shapes the use of waterholes by echolocating bat species, builds directly on the community monitoring capacity developed through this Darwin project. Buffalo herdsmen from two target CPAs have been requested by other CPAs to train their members in seasonal pond restoration, creating a new revenue stream for these community members in becoming trainers. Finally, Ly Kunthy, master's Student, was invited by the Deputy Head of Mission, Marc Thayre, to present on the Darwin Project to select members of British Embassy staff and the Biodiverse Landscapes Fund and consequently encouraged to present his work further.

5 Monitoring and evaluation

There were no major changes to the project design. The core project activities were managed by WCS and the main partner Laos Buffalo Dairy. A telegram group was established allowing for

direct communication between partners and field staff ensuring clear messaging for the communities and instant support for buffalo husbandry and veterinary needs. The project also utilized AirTable for project management and our in-house M&E Officer tracked all project activities through this system. WCS has been employing long term biodiversity monitoring in the Northern Plains Landscape for more than two decades. This gives us a good understanding of the baseline situation on the species that we are monitoring and allows us to assess contributions towards the project outcome from the activities conducted. Project indicators such as pond characteristics, hydrological and biodiversity changes allowed us to compare experiment ponds with control ponds that have not experienced restoration from buffalo activity. Nest protection success allowed us to gauge the benefit to bird population from increasing productivity. Monitoring of CPA bookkeeping allows the project team to assess income generation that leads to support of further community conservation projects. Whilst the M&E work is the sole responsibility of WCS, this information is shared through regular reporting with Ministry of Environment and other project partners. The project was subject to an audit by NIRAS, which was successfully completed in June 2025.

6 Lessons learnt

Lesson 1: Building community capacity for ecological monitoring requires sustained investment, adaptive training approaches, and realistic timeframes. One of the most consistent challenges was developing community capacity to conduct scientifically credible, monthly ecological monitoring of seasonal ponds. Early in the project, it became clear that literacy levels, time availability, and previous fieldwork experience among community members varied widely across CPAs. To address this, the project team invested heavily in stepwise training, translated and simplified monitoring protocols, and digitized data collection tools. The capacity-building approach required more time than originally anticipated. By Year 2, community monitors had become largely autonomous but still required light-touch oversight to ensure data quality. Gender imbalance also persisted reflecting both cultural norms and time availability for women. Future Darwin projects involving community monitoring should realistically budget for long-term capacity support and adaptive, context-specific training methods.

Lesson 2: Integrating local knowledge with academic research creates stronger conservation outcomes and fosters local ownership. A major success of this project was the collaboration between local community members, WCS biodiversity staff and the MSc student from RUPP. The community's deep knowledge of local pond ecology greatly enriched the student's research design and fieldwork logistics. In turn, the student provided scientific rigor and technical expertise, helping standardize data collection protocols that remain in use for ongoing community monitoring. This mutual learning process fostered stronger local ownership and interest in biodiversity research. As a result, community members have shown increased interest in continuing ecological monitoring and better understand the link between habitat health and wetland species conservation. Future projects should actively design opportunities for university-community collaboration, including co-training, shared fieldwork, and two-way knowledge exchange.

7 Actions taken in response to Annual Report reviews

Not applicable

8 Risk Management

No new risks emerged, and no changes were made to the risk analysis.

9 Scalability and Durability

The projects main stakeholders are the communities where seasonal ponds are found and the CPA members who use these areas for their livelihoods. In these areas, word of mouth is paramount, and this project generated interest from neighbouring CPAs. As the project began to produce yoghurt and this was consumed by communities across the NPL, interest quickly turned

into enthusiasm to try this type of project. Direct communication between experienced herdsmen in the target CPAs and potential adopters in other communities occurred during the project lifetime, and at least two CPAs are now interested in replicating the process. The herdsmen, in addition to their gained knowledge, now have several training aids to perform this role. WCS maintains an active presence in the landscape and is well placed to support replication efforts, including contributing to capital costs where CPAs lack funding. Seasonal ponds in the project area were historically misused – the tragedy of the commons – but since project inception, and with a new arm of the community who are knowledgeable in the benefits of a healthy pond ecosystem, ponds are now well protected and benefits are visible to those using the ponds as a resource for fish, water or more. To further reinforce this change, key findings from Ly Kunthy's Master's research on pond biodiversity were presented back to the communities, helping them understand the scientific value of restored ponds and strengthening local ownership of conservation outcomes. The project durability lies in the success of creating income streams from conservation action. As milk yields improve, and buffalo quality is obtained, a higher revenue is expected that will support the project and raise funds for CPA activities. The cessation of Darwin funding may lead to a reduction in monitoring, particularly of control ponds, but as we improve marketing and sales, the main parts of the project will persist.

10 Darwin Initiative identity

The project was highlighted in the Darwin Newsletter: Food for thought with the article "Grabbing poverty by the horns" in March 2024. In May 2025, in the Gender Equality and Social Inclusion edition of the Darwin Newsletter, we again featured an article – "Buffalo, Biodiversity, and breaking barriers". These were further boosted by through WCS social media, including the Telegram channel of the Northern Plains Landscape REDD Project. There were cross links to the Darwin Biodiversity Challenge Funds and the Ministry of Environment. The 2024 piece was later picked up by news outlets in the country. Darwin Initiative logo has been used on materials for publication – including the Community Research Protocol on Monitoring Seasonal Ponds that will be shared with government and non-government institutions alike and proposed to be adopted by the Technical Working Group on Buffalo Restoration of the Department of Wetlands at the Ministry of Environment. We feature the logo and QR code links to Darwin Initiative on the sales and marketing of our buffalo yoghurt (Annex 32)

11 Safeguarding

12 Finance and administration

12.1 Project expenditure

Project spend (indicative) since last Annual Report	**2024/25 Grant (£)**	**2024/25 Total actual Darwin Initiative Costs (£)**	**Variance %**	**Comments (please explain significant variances)**
Staff costs (see below)				
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items (see below)				

Others (see below)				
Audit cost				
TOTAL	£147,479.00	£147,479.00		

Staff employed (Name and position)	Cost (£)
Nev Broadis, Technical Advisor	
Mao Khean, Biodiversity Team Leader	
Tan Sophan, Biodiversity Research Officer	
Phann Sithan, Community Technical Advisor	
Men Ratha, Senior Geospatial Analyst	
Lean Minea>>Lom Vanna, Biodiversity Research Officer	
Lor Sokhoeurn>>Din Pech, Conservation Technology Officer	
Sun Khunni>>Chhat Sophim, Community Liaison Officer Lead	
Neang Kheang, Community Liaison Officer	
Keo Sovanna, Community Engagement Team Lead	
Sun Tola, Compliance Officer	
Hang Meta, Community Liaison Officer	
Sean Sokny, Admin officer	
Hom Sakuna, Operation manager	
Uy Sitha, Logistics Officer	
Huot Leakhena, Deputy finance manager	
Im Sophanna->Phork Sokphearum>>San Sokunthea	
Vann Sarann>>Chan Sophanna	
Sarath Tao, Finance manager	
Kang Davan>>Prom Sopheara, Grant manager	
Ory Nita, M&E coordinator	
Khon Kannitha->Hieng Chhunhy, Senior Grant officer	
TOTAL	**£76,650.09**

Capital items – description	Capital items – cost (£)
1. 02VIVO smart phone for PVH 2. Materials for buffalo and relevant	
TOTAL	

Other items – description	Other items – cost (£)
1. Vehicular Fuel (Glob 2. 22 buffalo and relevant supplies to it 3. Trnsprtn-MV Dmstc 4. Meals (Domestic) 5. Meetings/Lunch-Dmstc 6. Bank Fees 7. Communications	
TOTAL	

12.2 Additional funds or in-kind contributions secured

Matched funding leveraged by the partners to deliver the project	Total (£)
Wildlife Conservation Society (WCS)	
TOTAL	

12.3 Value for Money

The project consistently looked for ways to obtain value for money throughout the project. Key aspects of project design, such as biodigesters to turn waste product into gas for pasteurisation, or KoboCollect to gather data from remote field locations were implemented from the outset. Training community members to become biodiversity researchers meant that we could cover large areas of ponds, with very few staff. This also lends itself to the legacy of the project – community members now fully understand what they are doing and why.

13 Other comments on progress not covered elsewhere

During the project lifetime, an exciting collaboration between a CPA in the project area and a conservation enterprise, Sam Veasna Conservation Stays has culminated in a world class ecotourism lodge being constructed in an annexed part of the CPA. Featuring a modern kitchen, and with access to many national and international visitors, it is hoped that this location can be used to produce high quality buffalo products such as cheese and ice cream for sale to larger markets. This will lead to improved revenue streams for the participating CPAs and will allow for a greater uptake in milk production. It is hoped that a brand will be developed that will utilise milk from all participating CPAs in the landscape within a number of years.

14 OPTIONAL: Outstanding achievements of your project (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).

Successful community conservation projects hinge on a crucial element: local ownership. The collaboration with the Darwin Initiative exemplifies this, empowering four focal communities to spearhead their own conservation initiatives centred around buffalo dairy activities. From herdsmen to milkers and habitat monitors, the entire community is deeply invested. This project is interwoven into their very way of life, as these community members have relied for generations on subsistence farming and collecting non-wood forest products within an ecosystem increasingly threatened by climate and land-use change. Protecting this landscape requires assigning them tangible value and direct investment. However, such investment can introduce its own set of risks. By partnering with WCS and the Darwin Initiative, control over this investment remains firmly with the community members actively participating in the project. The benefits are directly tied to the successful production of high-quality buffalo milk and products, derived from animals that are actively restoring a degraded ecosystem. This translates into vital financial injections for the Community Protected Area (CPA) committee, enabling them to sustainably protect the resources their entire community depends on. One of the projects most significant achievements has been this profound realization within the community.

File Type (Image / Video / Graphic)	File Name or File Location	Caption, country and credit	Online accounts to be tagged (leave blank if none)	Consent of subjects received (delete as necessary)
Image		© Everland		Yes
Image		© Everland		Yes
Image		© Everland		Yes
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Image		© Filip Agoo & Everland		Yes
Image		© Everland		Yes
Image		© Everland		Yes
Image		© Everland		Yes
Image		© Everland		Yes
Image		© Everland		Yes

Annex 1 Report of progress and achievements against logframe for the life of the project

Project summary	Progress and achievements
Impact Tropeangs within the Northern Plains Landscape are restored by buffalos that are owned by communities with sustainable livelihoods, safeguarding threatened biodiversity and creating a scalable model for other protected areas.	Seasonal ponds within the target villages show an improvement according to an array of factors, community members in 4 communities have diversified their livelihoods and improved their income creating a model that is being adopted by other communities in the landscape.
Outcome Globally threatened wetland biodiversity is restored through community-owned buffalos performing important ecosystem processes and protected through sustainable income, community-led monitoring, and patrolling.	
Outcome indicator 0.1: At least 16 tropeangs will be monitored and at least 8 will be restored by buffalo herds by project end.	A total of 26 ponds (tropeangs) were monitored, of which 9 were restored by buffalo (Annex 6).
Outcome indicator 0.2: 4 CPA that are managing buffalo will have at least 2 community patrols (total 8) with participation from at least 25% women supported by income from buffalo products by the end of Year 1	All 4 CPAs completed well in excess of 2 community patrols supported by income from buffalo products (Annex 21 through 24, and Section 3.1, Activity 3.2, Table 3). Women participation was lower than 25%, due to cultural norms around women patrolling.
Outcome indicator 0.3: By project end, bird nests of globally threatened species within the project area (vicinity of tropeangs) will be stable compared to the baseline at project start, based on multi-year biodiversity surveys results already conducted.	Successfully achieved stable numbers of nests of globally threatened species as shown in long term biodiversity monitoring reports shown in Annexes 25 through 29.
Output 1: Livelihoods are developed and diversified through CPA-led buffalo banking schemes linking producers to markets.	
Output indicator 1.1: By the end of Y1, buffalo herds across 4 CPAs will increase through purchasing 25 buffalo and breeding from a baseline of 30 animals up to 60 animals with herd dynamics at optimum levels for milk and meat production.	Output exceeded, to 90 animals by the end of Year 2 with the three main dairies having optimal breeding females for milk production and the remaining CPA producing males for meat sales (Section 3.2, Activity 1.2, Annex 2).
Output indicator 1.2: By end of Q1, Y2, at least 20 community members (at least 60% women) will be managing buffalo banks and trained in animal husbandry techniques that maximize production to provide income generation to the CPA Committee of at least $2,400 per year per CPA.	Over the course of 5 workshops, 45 community members (30 women – 66%) were trained in animal husbandry, and or milk and yoghurt making (Section 3.2, Activity 1.3, Annex 3) producing a revenue of $6,768. The community decided to provide milk products free of charge to undernourished children resulting in lower income than expected (Section 3.2, 0.2, Annex 21 through 24).
Output indicator 1.3: By end of Q2, Y2, buffalo herds will be producing a combined daily average of 10 litres of milk to support 100 children (50 girls/50 boys) across 4 communities.	Buffalo herds could produce a combined daily amount of 17.5 L of milk by project end, which could be used to support 100 children receiving 100 ml of yoghurt each and still leave 7.5 L of milk to create yoghurt for sales (Section 3.1, Activity 1.5, Annex 5).
Output 2: Restoration of the ecological functionality of tropeangs through community-led and managed buffalo herds.	

Output indicator 2.1: By end of Y1, 4 buffalo herds of at least 10 individuals per herd frequent at least 8 tropeangs on a rotational basis, increasing water depth by an average of least 30cm when compared against 16 control tropeangs without buffalo.	By end of the project, 4 buffalo herds with an average herd size of 22 were frequenting 9 ponds (Annex 6) on a rotational basis with an average increase in depth of 23 cm (Annex 8). Throughout the project it became clear that buffalo expand ponds rather than deepen them significantly (Annex 6).
Output indicator 2.2: By end of Y1, a biodiversity survey protocol, used to assess restoration of tropeangs, will be developed with project partners and will have been conducted in at least 8 tropeangs within the project area.	A biodiversity protocol was created through collaborations with project partners and used to compare 3 experiment and 3 control ponds in the project area (Annex 7). Whilst this was 2 less than expected, the biodiversity protocol is more thorough than initially expected.
Output indicator 2.3: By end of Y1, 16 community members from 4 CPA (8 women/8 men) trained in habitat survey methods for biodiversity monitoring and tropeang monitoring protocols for physical characteristics and using these skills on a monthly basis to monitor and adapt use of tropeangs by buffalo herds.	A total of 16 community members (7 female) were successfully trained in habitat surveys (Annex 6, Table 2), and used these skills on a monthly basis to produce a total of 335 monitoring reports over the project duration approximately 14 pond surveys per month (Annex 6).
Output 3. Globally threatened wetland biodiversity is protected through community conservation activities.	
Output indicator 3.1: By project end, at least 240 patrol days by community patrol teams comprising at least 8 members (6 women) monitor and protect 24 tropeangs and surrounding habitat.	A total of 654 patrol days were conducted by a total of 483 community members of which 91 were women monitored all ponds in the project area (Section 3.1, Activity 3.2, Annex 15 – 18).
Output indicator 3.2: By end of Q1, Y2 at least 68 bird nests of globally threatened species in habitats containing project tropeangs monitored or protected by community members of which 20% are women	A total of 115 nests were monitored or protected by community members over the course of the project (Section 3.3, Activity 3.3, Annex 19), only 10% were women.
Output indicator 3.3: By project end, at least 4 tropeangs show an improvement in biodiversity value based on surveys conducted by the close of Q2, Y1. Note that the project will create a protocol to assign a biodiversity value as part of Output 2.	By end of project a total of 9 tropeangs (ponds) showed an improvement in biodiversity index as shown in Annex 7, and in general physical characteristics as shown in Annex 6.

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: Tropeangs within the Northern Plains Landscape are restored by buffalos that are owned by communities with sustainable livelihoods, safeguarding threatened biodiversity and creating a scalable model for other protected areas.			
Outcome: Globally threatened wetland biodiversity is restored through community-owned buffalos performing important ecosystem processes and protected through sustainable income, community-led monitoring, and patrolling.	0.1 At least 16 tropeangs will be monitored and at least 8 will be restored by buffalo herds by project end. 0.2 4 CPA that are managing buffalo will have at least 2 community patrols (total 8) with participation from at least 25% women supported by income from buffalo products by the end of Year 1. 0.3 By project end, bird nests of globally threatened species within the project area (vicinity of tropeangs) will be stable compared to the baseline at project start, based on multi-year biodiversity surveys results already conducted.	0.1 Monthly community tropeang monitoring reports (including digital sketch map of physical characteristics). Habitat survey reports (focused on biodiversity) by project lead and partners. 0.2 Financial Records of CPA Committees including bookkeeping and patrol financial clearance documents. 0.3 Nest Survey and Protection Reports from biodiversity monitoring team and SMART Patrol Data from biodiversity monitoring, community, and Ministry of Environment patrols.	0.1 Extreme weather events do not impact seasonal tropeangs to the extent that project interventions are negated. 0.2 Mortality rates and disease can be mitigated to create healthy and productive herds. 0.3 Poisoning events do not cause crashes in populations of globally threatened species.
Output 1 Livelihoods are developed and diversified through CPA-led buffalo banking schemes linking producers to markets.	1.1 By the end of Y1, buffalo herds across 4 CPAs will increase through purchasing 25 buffalo and breeding from a baseline of 30 animals up to 60 animals with herd dynamics at optimum levels for milk and meat production. 1.2 By end of Q1, Y2, at least 20 community members (at least 60% women) will be managing buffalo banks and trained in animal husbandry techniques that maximize production to provide income generation to the CPA Committee of at least $2,400 per year per CPA. 1.3 By end of Q2, Y2, buffalo herds will be producing a combined daily average	1.1.1 Community studbooks on herd dynamics. 1.1.2 Purchase reports and pre-assessments of animals by partners. 1.2.1 Workshop reports from both in-country and exchange trips, including assessments of CPA skills (where possible, disaggregated by gender) by partners 1.2.2 Income generation tracked using the CPA bookkeeping/financial records process already in place for participating CPA.	1.1 Emerging disease does not affect herds in terms of reducing productivity or increased infant mortality. 1.2 Travel restrictions (such as Covid-19) do not restrict training workshops being conducted at the Laos Buffalo Dairy. 1.3 Community nutrition groups or local schools are engaged and willing to diversify their nutrition sources.

	of 10 litres of milk to support 100 children (50 girls/50 boys) across 4 communities.	1.3.1 Daily farmer diaries expanded to incorporate milk production records. 1.3.2 Nutrition group reports, with combined participant lists of participating families/children (disaggregated by gender).	
Output 2 Restoration of the ecological functionality of tropeangs through community-led and managed buffalo herds.	2.1 By end of Y1, 4 buffalo herds of at least 10 individuals per herd frequent at least 8 tropeangs on a rotational basis, increasing water depth by an average of least 30cm when compared against 16 control tropeangs without buffalo. 2.2 By end of Y1, a biodiversity survey protocol, used to assess restoration of tropeangs, will be developed with project partners and will have been conducted in at least 8 tropeangs within the project area. 2.3 By end of Y1, 16 community members from 4 CPA (8 women/8 men) trained in habitat survey methods for biodiversity monitoring and tropeang monitoring protocols for physical characteristics and using these skills on a monthly basis to monitor and adapt use of tropeangs by buffalo herds.	2.1.1 Buffalo herd diaries and studbooks used to compile and track herd data and schedule of tropeang restoration. 2.1.2 Community tropeang monitoring reports (monthly) to track changes in physical characteristics or tropeangs. 2.2.1 Report/publication on the development of the protocol, including contributors (disaggregated by gender). 2.2.2 Assessment report on each of the tropeangs assessed using the protocol outlining results. 2.3.1 Participant lists (disaggregated by sex) from training sessions for community members. 2.3.2 Monthly tropeang monitoring surveys and field training conducted in conjunction with the project lead	2.1 Buffalo numbers can be increased through purchase of appropriate animals and successful breeding. 2.2 Project collaborators are able to refine techniques used to survey tropeangs, and survey techniques are possible in a local setting. 2.3 Protected area land under the management of the MoE can be protected adequately, including preserving locations of project trapeangs.
Output 3 Globally threatened wetland biodiversity is protected through community conservation activities.	3.1 By project end, at least 240 patrol days by community patrol teams comprising at least 8 members (6 women) monitor and protect 24 tropeangs and surrounding habitat. 3.2 By end of Q1, Y2 at least 68 bird nests of globally threatened species in habitats containing project tropeangs	3.1.1 SMART reports from CPA Patrol teams, number of patrols, locations of tropeangs, tropeang specific crimes (such as poisoning) targeted, participants (disaggregated by sex). 3.1.2 Financial records from CPA Committees highlighting beneficiaries of patrols.	3.1 Community patrol teams are permitted to operate in the project areas, either with or without support from MOE. 3.2 Nesting birds return to the project area in significant numbers and their populations are not affected by factors

	monitored or protected by community members of which 20% are women. 3.3 By project end, at least 4 tropeangs show an improvement in biodiversity value based on surveys conducted by the close of Q2, Y1. Note that the project will create a protocol to assign a biodiversity value as part of Output 2.	3.2.1 Nest protection reports from biodiversity team 3.2.2 Participant lists (disaggregated by sex) from community members actively monitoring bird nests. 3.3.1 Reports of biodiversity surveys conducted in collaboration with partner institutions. 3.3.2 Results of MSc Student thesis.	outside of the project area such as hunting or poisoning. 3.3 A suitable candidate to conduct freshwater surveys can be enlisted.

Activities

Output 1: Livelihoods are developed and diversified through CPA-led buffalo banking schemes linking producers to markets.

1.1 CPA assessment across the landscape to select suitable locations for buffalo-bank restoration project based on pre-defined criteria such as importance for threatened species

1.2 Using existing buffalo herds as starter stock, purchase new buffalo locally to create adequate herds for restoration projects

1.3 Collaborating with project partners, conduct training workshops both in-situ and at Laos Buffalo Dairy on animal husbandry, breeding, herd management, and milking techniques

1.4 Create 4 community buffalo dairies using simple structures and locally-sourced equipment and associated protocols for keeping buffalo in suitable environment

1.5 Assessment of community needs, and development of either school meals programme or community nutrition groups

Output 2: Restoration of the ecological functionality of tropeangs through community-led and managed buffalo herds.

2.1 Train community members on tropeang rotation for buffalo herds and create herding schedule based on tropeang area and herd size

2.2 Collaborating with project partners, create a tropeang survey protocol as a means to assess biodiversity value and complete surveys in project tropeangs

2.3 Conduct both community workshops including field training, and extended support for tropeang monitoring using previously-developed pragmatic tropeang monitoring protocols

2.4 Conduct community monitoring of tropeangs on a monthly basis and adaptively update the herding schedule based on results

2.5 Conduct camera trapping surveys during the dry season to assess use of tropeangs by mammal and bird species

Output 3: Globally threatened wetland biodiversity is protected through community conservation activities.

3.1 Train and build capacity of CPA patrol teams on the use of SMART and patrol techniques used in tropeang protection, with a focus on poisoning and snaring

3.2 Conduct monthly community patrols in the project area, in collaboration with MOE to ensure forest crimes are adequately addressed

3.3 Community members conduct bird nest monitoring and protection based on species requirements

3.4 Enlist an MSc Student from a national university to conduct research on habitat biodiversity of restored tropeangs

Project Title: Ecosystem restoration of watering holes in Cambodia’s Northern Plains

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, scheme, type of report (i.e. Annual or Final), and year) and **deleted the blue guidance text** before submission?	Yes
Is the report less than 10MB? If so, please email to BCF-Reports@niras.com putting the project number in the Subject line.	Yes
Is your report more than 10MB? If so, please consider the best way to submit. One zipped file, or a download option, is recommended. We can work with most online options and will be in touch if we have a problem accessing material. If unsure, please discuss with BCF-Reports@niras.com about the best way to deliver the report, putting the project number in the Subject line.	No
If you are submitting photos for publicity purposes, **do these meet the outlined requirements** (see section 14)?	Yes
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.	Yes
Have you provided an updated risk register? If you have an existing risk register you should provide an updated version alongside your report. If your project was funded prior to this being a requirement, you are encouraged to develop a risk register.	Yes
Have you involved your partners in preparation of the report and named the main contributors	Yes
Have you completed the Project Expenditure table fully?	Yes
Do not include claim forms or other communications with this report.	