



Darwin Initiative Final Report

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

Darwin project information

Project reference	21-002
Project title	Building mycological capacity for sustainable resource management in Lao PDR
Host country(ies)	Lao PDR
Contract holder institution	The James Hutton Institute
Partner institution(s)	Royal Botanic Garden Edinburgh; Biotechnology and Ecology Institute, Ministry of Science and Technology, Laos
Darwin grant value	£243619
Start/end dates of project	April 2014 – March 2017
Project leader's name	Andrew Taylor
Project website/blog/Twitter	<p>Main project page: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr</p> <p>Workshops: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/workshop-may2015</p> <p>http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/workshop-may2016</p> <p>Fieldwork: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/field-work-may2015</p> <p>http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/field-work-may2016</p> <p>Fungarium: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/fungarium</p> <p>Laboratory: http://www.hutton.ac.uk/research/projects/building-mycological-capacity-sustainable-resource-management-lao-pdr/laboratory</p>
Report author(s) and date	Andrew Taylor, Mark Newman, Kongchay Phimmakong 29th June 2017

1 Project Rationale

Lao PDR (Fig. 1) is one of Asia's most forested countries and supports some of the richest biodiversity within the region. However, Lao is also one of the poorest countries within the region with ca. 75% of the population still relying upon non-timber forest products for food and income generation. Fungi have long been utilised in this context being consumed by locals but also sold at markets and, increasingly, exported to neighbouring countries – often in large quantities. Fungi are pivotal organisms in forest ecosystems but in Lao their functions and diversity are virtually unknown: they are absent from the Laotian National Biodiversity Strategy to 2020. This is despite the fact that fungi constitute a major income source in some regions. This project originated from an expression of need raised by the Lao biological community for training and capacity building to enable Lao to realise its commitments to the CBD and manage the mycological resources sustainably.

The project addressed the lack of formal mycological expertise *via* a number of avenues. These included training workshops, both theoretical and practical, and the establishment of a National reference collection of mycological materials, including dried fungal collections. A molecular laboratory would be established to allow the extraction and amplification of DNA from fungal materials. This laboratory would also act as a focal point to encourage foreign interest and visits. Fatal fungal poisoning was considered to be an issue within Laos – initial estimates of deaths due to fungi were 15-20 people annually - but evidence was essentially anecdotal. The project tried to gather information of poisoning cases and to identify which fungi were involved. In collaboration with local aid agencies, field studies were planned to assess the ecological and economic importance of wild fungi harvesting. In particular, a special study would be made of the highly-prized Matsutake mushroom as recent international interest may be encouraging unsustainable harvesting techniques in Xieng Khouang province (Fig.1), where it is collected for export to China and Japan.



Figure 1. Political map of Lao PDR. The capital Vientiane and Xieng Khouang province, where training courses were held and field studies carried out.

2 Project Partnerships

There are a number of partners within the project and they can be grouped based on their roles within the project.

Stakeholders/Partners within Laos:

The main partner in Laos was the Biotechnology and Ecology Institute (BEI), Vientiane, with the main contact person being Ms Kongchay Phimmakong, Director, Technical Service Division. Dr Souriodong, former Director General of BEI, who was the named partner in the application, was promoted within the ministry just after the project started and unfortunately had no further direct involvement in the project. However, there was good contact between Dr Souriodong and Ms Phimmakong and his support for the project was still evident. The partnership with BEI continued to develop throughout the course of the project and the success of the training workshops and the establishment of the National Fungarium is largely due to the very good collaborative relationship developed between BEI and project principal UK partners (AT and MN). Ms Phimmakong acted as coordinator for logistics during project visits to Vientiane and with training course held at BEI. The involvement of ministerial personnel within Laos is critical in initiating contacts and arranging visits to other ministries and other national institutions. Members of Ms Phimmakong's staff have provided excellent support during visits with letters of introduction, transportation, secretarial and translation issues.

Also within BEI, Mrs Somsanit Bouamanivong, Director, Ecology Division, who is also head of the National Herbarium of Lao PDR, has been directly involved in planning and development of the project. The National Herbarium under Mrs Bouamanivong is the recipient of equipment and

several of the outputs generated from the project. Members from the National herbarium have received training both in workshops and during field surveys. Mrs Bouamanivong was involved in the development of Outputs 1 and 2: Establishing a reference database and fungal collection (see section 3 for further details).

National University of Laos: The partnership with the University strengthened greatly during the project after an initial minor involvement. This has been largely due to the support of Dr Somchanh Bounphanmy, who was the head of the department of Biology when the project started, she then became Dean of the Science Faculty, and who is now vice principal of the University. Dr Bounphanmy has been hugely supportive of the project. She allocated to the project two laboratories rooms within the department of Biology to house molecular laboratory at the University. A staff member of the Biology Department, Mrs Toulaphone Keokene, was also given responsibility for overseeing the establishment and running of the laboratory. Mrs Keokene and the PI have been in regular email contact and have had many face to face meetings during the project. Mrs Keokene participated in training courses held in 2015 and 2016 and was also responsible for selecting students for the training courses (two MSc students from the University attended courses). Mrs Keokene was also one of the two Laotians who spent 10 weeks in Aberdeen, UK, receiving further training in 2016. The partnership at the University has established the basis for part of Output 2: a functional molecular laboratory (see section 3 for further details).

IUCN Laos: The named partner Mr Banethom Thepsombath left IUCN between the scoping trip and the stage 2 application. His successor was Adam T. Starr and the PI had one meeting with Adam early on to discuss the project. After an initial interest from Adam, no further interest was shown despite repeated attempts to engage in dialogue by the PI.

AgroBiodiversity Project (ABP): Mr Ole Pedersen is chief technical advisor in the ABP and has been proactive from the inception of this project. Ole has been invaluable for the development of the project with his local knowledge and network of contacts and the partnership has been a major contributor to the success of the project, particularly for the field surveys in Xieng Khouang province. Ole was integral in project planning and development and to achieving several of the project outputs (see section 3). We have worked closely with Ole particularly on the planning and logistics for the field work in Xieng Khouang province in May 2015 and 2016. Data collected together with Ole during these field surveys were used in producing a number of the project outputs. The collaboration planned with TABI was essentially replaced by that with ABP.

The Agrobiodiversity Initiative (TABI): Mr Chris Flint was chief technical advisor at TABI. Initial collaborations planned with TABI did not materialise and joint ventures with TABI have not advanced.

New Contacts in Laos:

Following a meeting with the Plant Pathology group, Ministry of Agriculture, in Vientiane during 2014, contact was made with Mrs Viengkham Sengsourivong, who heads the group, and arrangements were made for two of her junior colleagues to take part in the training workshops in May 2015 and 2016. One of these, Ms Khonesavanh Chittarhat, is a gifted individual and is one of the two Laotians who came to Aberdeen for training in 2016. Partly through her involvement with the project, Ms Chittarhat became interested in fungal poisonings and has become the national contact person for fungal poisonings. A joint effort between her and the project has subsequently identified perhaps the major unknown causal agent of the fatal poisonings which occurred during the period of the project.

Professor Paul Newton (Oxford) heads a Wellcome Trust funded research group embedded within the Microbiology Laboratory of Mahosot Hospital, Vientiane. Prof Newton and his team are interested in the problem of fungal poisonings and the PI has been in regular contact with him via email and face to face meetings. Prof Newton is involved in developing Output 2: a functional molecular laboratory and Output 3: Investigating poisonous fungi and poisonings in Laos (see section 3.3 for further details).

UK Partners:

Mark Newman, based at the Royal Botanic Garden Edinburgh, is the sole UK partner. Mark's experience in working in Laos and his linguistic skills have been invaluable throughout the project. The PI and Mark have been in regular contact via email and face to face meetings, to develop the infrastructure of the project and in planning the training workshops.

European partners:

Unfortunately, due to changes in his personal circumstances, Dr Manfred Binder, Munich, who was a named partner on the project could no longer take part in the project after the first visit in November 2014. Manfred was to consult on the development and setup of the molecular lab and in teaching molecular aspects of mycology during training workshops. The project was very fortunate to gain the aid of Dr Ursula Eberhardt, Stuttgart, who has many years' experience in molecular approaches to mycology. Dr Eberhardt was a teacher during the 2016 workshops. The project also benefited greatly from the involvement of Dr Thomas Freitag (James Hutton institute) who together with the PI, established the molecular lab and taught a course using the new equipment all in the space of two weeks in November 2016. Without Thomas Output 2 would have been very difficult to achieve fully. The project has also gained the experience of Mr Neville Kilkenny, a Scottish based, freelance mycologist who has considerable experience in teaching mycology to beginners and in collecting and the identification of fungi. The PI was in regular contact with the two academic partners (Prof. Urmas Kõljalg, Estonia; Prof Mieke Verbeken, Ghent) to develop strategies and ideas for knowledge transfer and for achieving the outputs for the project, especially Outputs 1, 2 and 3. Although not listed as a partner, a special mention must be made here of the contribution made by Dr Thomas Læssøe, Copenhagen, who worked as a consultant on the project. His vast teaching experience and knowledge of working with fungi from around the world is extraordinary and a truly invaluable asset to the project and to the legacy the project has left in Laos.

Achievements, lessons, strengths or challenges with partnership

Most of the partnerships have developed during the course of the project and have functioned well. A major lesson learnt has been that face to face meetings are an essential pathway to facilitate and foster understanding among and between partners, particularly the Laotian partners. An early lesson learnt was that a scoping trip does not necessarily prepare the way for a smooth start to a project. The time lag between the scoping trip and the start of the project was sufficient for some contacts to be lost as they moved to other jobs. It took a considerable amount of time to establish the most effective means of communication with partners. The need for courtesy one to one meetings cannot be underestimated. Partners are much more likely to respond to emails when a personal contact has been made.

The hardest lesson to learn was that the unexpected should be expected and that verbal agreements, however well-developed, may change at any time for undisclosed reasons. Alternative backup plans should be considered especially for major outputs and associated assumptions. The project had a number of setbacks relating to partnerships. Two of the initial partnerships did not develop further after either the scoping meeting or after the first meeting once the project had started. After initial enthusiasm for the project, Mr Chris Flint at TABI then showed little interest in carrying out any collaborative work, even though TABI's work on non-timber forest products would have greatly benefited from the mycological expertise within the project. Subsequent discussions with other Laotian partners indicated that TABI usually works alone on projects. Fortunately, the in-kind contributions that would have come from TABI were more than made up by increased involvement in the project of Ole Pedersen and ABP, so the withdrawal of TABI had little impact on the outputs from the project. The IUCN involvement was the other partnership which failed to develop. The details are unknown to the PI but the IUCN office in Vientiane appears to have gone through some troubled times over the last few years and Adam Starr is no longer Country Manager.

As stated above a major strength has been the partnership with Technical Service Division at BEI, facilitated by Ms Kongchay Phimmakong. The work which Ms Kongchay and her team have contributed to the project has been crucial throughout the project period. Kongchay's inputs in the planning and execution of any of the meetings and workshops at BEI have been excellent. She has been involved in writing the reports for each of the workshops and in reporting of the project. Contact has been maintained with Kongchay and future collaborations are being discussed.

However, the project faced a number of challenges which were a result of interdivisional differences at BEI. One of these related to the molecular laboratory placement. During the first year of the project, considerable effort was given to finding a suitable location for the molecular laboratory and an agreement was reached with personnel at a division of BEI that the lab could be sited there. However, during the visit to Vientiane in November 2014 when the exact requirements for the lab were to be finalised, the head of the division reversed his decision. No

explanation was forthcoming. Fortunately Dr Somchanh Bounphanmy, the then head of the Biology department at NUoL, saw this as a great opportunity and allocated the project two adjacent laboratories for the project (as noted above). She has been extremely supportive of the project. In retrospect, this is actually a much better outcome for building mycological infrastructure within Lao and for the long term legacy of the project. The lab now has a dedicated manager, Mrs Toulaphone Keokene, can be used for training students at the University and Dr Bounphanmy plans to open a Biotechnology department based around the lab. This should ensure the long-term functioning and utilisation of the lab. Contacts will certainly be maintained between the PI and Mrs Keokene and Dr Bounphanmy.

The change in General Directorship at BEI delayed or prolonged a number of issues for the project. For example, it took almost 18 months to get the letter of agreement between BEI and the Contract Holder Institute, even though this had been agreed before the change in personnel. However, a major cross-divisional achievement at BEI was in setting up the Material Transfer Agreements and the Letters of Origin Certification for the duplicates of the fungal collections in the National Fungarium to be transferred to the UK. This is the first time that these documents have been arranged and issued in accordance with provisions of the CBD and the Nagoya protocol. This should facilitate future collaborations between international and Laotian mycologists.

A major strength was the partnership with Ole Pederson, who in both a professional and a personal capacity, has been very supportive and critical to the success of the project.

As noted above Ms Khonesavanh Chittarhat, became a major part of the project, travelling to Aberdeen for intensive training and becoming the national contact for fungal poisonings. She is an ideal candidate for a Darwin fellowship and this will be followed up by the PI.

A project brought together a number of Laotians from different partners institutes, in particular Mrs Keokene and Ms Chittarhat, and they are continuing to work together in the lab at the NUoL. Overall, the partnerships within the project worked well with working relationships being fundamentally sound. This is reflected in the fact that most major challenges were overcome, with the exception of finding a suitable candidate to take the Masters course in Edinburgh. This proved impossible and an alternative strategy had to be prepared and organised – this involved training two Laotians in Aberdeen for a shorter period of time (details below in Annex 1).

3 Project Achievements

3.1 Outputs

- 1. Mycological training workshops involving international experts training national participants. Establishment of databases.*

Baseline: At the start of the project period there were no academically trained mycologists in Lao PDR. There was no National fungal collection in Lao PDR.

Change: A total of 19 people received formal training over the course of the project. Two, two-week courses were run in 2015 and 2016 which combined one week of formal seminars and laboratory training sessions and one week in the field for an intensive training for a smaller group. Keeping the participant group as similar as possible between the two years enabled participants to receive a more in-depth knowledge, as the information imparted during 2015 could be built on in 2016. Two Nationals received intensive training in Aberdeen for 10 weeks. Five smaller training courses were also run either for individuals or for smaller numbers on specific mycological topics. A national fungarium has now been setup and is housed in the National Herbarium at the Ecology Division of BEI.

Evidence: In total, there were 18 weeks of formal training over the course of the project. This included: formal seminar and lab based training in general mycology in 2015 and 2016; field based teaching on collecting, describing and preserving fungi; lab based tuition on curation and data basing dried fungal material and working with dried collections, and training in molecular techniques (in Laos and UK) [see webpages]. International experts spent a combined total of 33 weeks teaching and training in the country. A total of ca. 800 fungal collections have been made during the course of the project. These have been documented with all available metadata, short field notes and most have been photographed. The collections and associated data are archived at BEI to serve as reference material to aid with any national inventory of fungi in Laos. The database is stored at BEI on a top of the range laptop bought by the project. Prof Urmaz Kõljalg

from the University of Estonia has kindly covered the cost for sequencing most of the collections. The data are publically available through the UNITE database (<https://unite.ut.ee>). This hugely increases the value of the collections to Laos and it will also greatly facilitate interest in the mycological resources of Laos leading to further projects from the international community.

2. *A functional molecular laboratory supported by training manuals and SOPs for processing and establishing mycological collections from material collected locally and nationally.*

Baseline: No molecular facilities for carrying out mycological investigations

Change: Functioning molecular laboratory established and in use [see webpages]. The necessary protocols for DNA extraction and amplification are available for lab users. Personnel are trained on the equipment.

Evidence: Establishing the laboratory was one of the major challenges and outputs of the project. Training Lao nationals in molecular approaches to the study of fungi is a first step in building infrastructure within the country but without access to dedicated facilities the acquired skills would soon be lost. As detailed above in partner challenges and lesson learned, an initial location for the lab was arranged at BEI but this fell through and the final location for the lab was secured at NUoL. This is actually a much better outcome as the facility will have much more readily accessible to a wide range of interested parties. In addition, the backing of the vice principal of the University should ensure that the lab continues to be utilised and receive funding. Acquiring the necessary equipment, consumables and chemicals for the lab was a major task. Delivery of the major pieces of equipment took the best part of one year. The training course in November 2016 ensured that all the equipment was working and that Lao nationals were familiar with its use [see page pages]. So there is now a fully functional molecular lab in which all basic molecular techniques can be achieved. During the final project visit by the PI in March 2017, it was very gratifying to see that the lab was in use by members of the University and the Plant Pathology Institute.

3. *Report on poisonous fungi and poisonings collected from markets and medical establishment.*

Baseline: Anecdotal information that between 15-20 people die every year from fungal poisonings

Change: Firm evidence acquired on the extent of fungal poisonings and identification of the toxic fungi consumed.

Evidence: It proved very difficult to amass evidence on the extent of fungal poisonings in Laos. There was no central information system to which cases are reported. We were fortunate to make contact with Prof Paul Newton at Mahosot hospital in Vientiane, who has an interest in poisonings. He had dealt with a small number of cases in the years before the start of the project, but had no information regarding the causal agents. He agreed to try and raise the profile of the project and to get any material that was involved in poisoning cases. In Europe, the symptoms exhibited by poisoned persons are diagnostic of the toxic fungi consumed. The symptoms exhibited by Laotians involved in poisoning cases did not correspond to any known toxin. In addition, examination of the material involved in two poisoning cases which occurred in 2015 did not indicate the consumption of a known toxic fungus. However, near the end of the project period, a joint effort between Ms Chittarhat and the project has subsequently identified the major unknown causal agent of the fatal poisonings which occurred during the period of the project. This appears to be fungus known from North America but unknown in Europe. This investigation is ongoing between Ms Chittarhat and the PI as confirmation is required and if confirmed, then this needs to be publicised in Lao and the medical establishment made aware of potential remedial treatments after consumption. Ms Chittarhat is using the newly established lab facilities to extract DNA from fungi involved in poisonings cases to aid identification – this was not possible before the project. As a result of her connections and training received during the project, Ms Chittarhat is now the contact person for fungal poisonings in Laos. This is a major achievement as she can now amass countrywide evidence of the problem.

The PI is also involved in a book on edible and poisonous fungi of Laos which is being prepared by Ole Pedersen (ABP) and Thomas Læssøe (Denmark).

4. *Report on the fungi sold at markets, including ecological data.*

Baseline: Little information on the fungi sold at markets in Lao PDR

Change: Representative collections would be made of fungi sold at markets

Evidence: It was originally planned that a Lao national local would make regular visit to markets in order to gather information about the fungi on sale at the markets. Until late 2015, no suitable persons have been found to carry out this task. However, quite unexpectedly Kongchay Phimmakong at BEI came into contact with a Laotian, Phongeun Sysouphanthong, who had recently completed an MSc in Mycology in Thailand. We met up with Phongeun at BEI during August 2015 and he was well trained in observing and recording fungi from field collections. On our recommendation, Phongeun was employed at BEI from April 2016 as part of the annual uptake of personnel. The intention was that Phongeun would work at BEI but carry out specific tasks for the project and for Ole Pedersen. This included making the market visits and working on identifying the fungi already in the collections. Phongeun took part in the training workshops and in the field training in May 2016. He agreed to make regular visits to the local market near BEI to gather information on the fungi being sold. Despite reassurances that this was taking place, when the project visit was made in November 2016 by the PI, no evidence of any market visits was forthcoming. So unfortunately this output was not achieved. However, the project worked with Ole Pedersen to compile data on fungi collected and sold at markets in Xieng Khouang Province and this has been published (see Annex 7)

5. *Data generated from molecular study of fungal communities in logged and unlogged areas, analysed and written up.*

Baseline: Little information regarding the impact of logging on fungal communities particularly edible fungi

Change: Information will be available on how the removal of particular trees will impact on the fungal communities, in particular edible fungi.

Evidence: The main reason behind this output was because from the scoping trip it was clear that many of the edible fungi in the markets were from a group that grows in obligate associations with particular trees and removal of these trees would therefore remove the fungi from the forest. These associations between the fungi and the trees are crucial to both the fungi and the trees. At the start of the project there was no information of the trees involved in this type of association in Lao PDR and the Laotians were unaware of this obligate association. So their importance for local production and consumption of the associated fungi was unknown to Laotians.

This output was based on the assumption that we would find suitable areas where we could collect samples to make the comparisons between logged and unlogged. We underestimated the difficulty in finding suitable areas. Due to rapid population growth and uncontrolled logging activities the only remaining unlogged areas are in zones with highly restricted access due to being in nature reserves, border areas or areas with civil unrest. In addition, the huge problem of unexploded ordnance in Laos restricted our ability to take samples where small areas of potentially forest were located. In the small areas of reasonably undisturbed forest that we did find in the northern province of Xieng Khouang, it was not possible to take root samples: the locals got highly agitated whenever we tried to take soil or root samples for analysis. This really highlighted the extent of the unexploded ordnance problem.

Finally, during the November 2016, an area of pine forest near the reservoir 3 hours north of the capital Vientiane was identified and deemed safe to retrieve root samples. These were taken, the DNA extracted and the associated fungi have been sequenced. These data (comprising > 800,000 sequences) are being analysed and in combination with an analysis of the symbiotic fungi found in Laos during the project and a species list of the Laotian trees forming this specialised association will be written up as a scientific publication. The latter has been prepared by Mark Newman and the PI (Annex 8).

6. *Data collected from interviews with local villagers involved in harvesting Matsutake, processed and written up.*

Baseline: Only anecdotal information available on harvesting which suggested that locals were using unsuitable methods for harvesting, which including digging out the mushrooms and thus damaging the growing mycelium in the soil.

Change: Information gathered on the collecting and importance of the Matsutake harvest to locals in Lao PDR.

Evidence: During the two field training trips in May 2015 and 2016 data was gathered on the collecting of wild edible fungi by local villagers, this focused on the occurrence and harvesting of Matsutake. A similar trip had been planned in May 2014 but had to be cancelled due to the PI developing a blood clot. Contrary to what we had been told during the scoping trip, no evidence was found of locals using unsustainable harvesting techniques for collecting Matsutake. On the contrary, local collectors were aware of the association between Matsutake and particular tree species and the need to harvest the fruiting structures without disturbing the underlying soil. The information gathered during the field trips was incorporated into a report which focused on the value chain analysis of Matsutake in Xieng Khouang Province. This was compiled by Ole Pedersen and published by ABP, FAO and UNPD (see Annex 9). The report contains information on harvesting techniques and the ecology of Matsutake. Collections made during the project in the Province suggested that the fungus called Matsutake in Laos is not the true Matsutake known from further north in the boreal forest. This was investigated using DNA sequence data produced by Prof Kõljalg in Estonia and it was found that the Matsutake in Laos is actually a related taxon called *Tricholoma fulvocastaneum*.

3.2 Outcome

Outcome: There will be an increased academic and technical capacity in Lao PDR to carry out fundamental mycological research thereby contributing to safeguarding harvesters, consumers and the national fungal capital.

In order for the outcome to have been successfully achieved, a number of criteria had to be fulfilled as outlined by the indicators in the logframe. The increased academic capacity was achieved through the formal training workshops which combined seminars and lab sessions. With only one or two exceptions (the two Masters students from NUoL), baseline mycological knowledge prior to the workshops was very limited. The short examinations carried out after the training weeks clearly showed both a capacity and enthusiasm for learning and greatly increased knowledge. The workshop participants received good basic theoretical and, perhaps more importantly, practical hand on experience and knowledge of traditional and molecular taxonomy. They all learned about fungal conservation and ecology, how to photograph, collect, describe and publish new species. Smaller groups received more intensive training on working on and the curation of dried fungal collections. A number of individuals also received molecular lab training, in particular the two Laotians who spent 10 weeks in the molecular Lab at the James Hutton Institute in Aberdeen. All of this training increased the academic and technical mycological capacity in Lao PDR. Working in conjunction with Prof Paul Newton on the cases of fungal poisoning increased the knowledge of causal agents and through her involvement with the project Ms Chittarhat has become the central contact person for poisoning cases. Prior to this there was no national contact point. The identification of the unknown fungus causing the poisonings will contribute to safeguarding Lao nationals via now being able to raise awareness concerning this fungus and being able to offer guidance to medical practitioners for the treatment of poisoned patients. The case study of Matsutake demonstrated the importance of the fungus for generating income at a local level. In addition, our surveys showed that the fungus was not being harvested in an unsustainable manner. The assembled list of Lao tree species involved in symbiotic associations with fungi coupled with the data from the analysis of the root samples from pine and the data of the collections from the National Fungarium will demonstrate the importance of these symbiotic fungi on Lao.

The appointment of Mr Sysouphanthong at BEI to work as a mycologist in the Ecology division was largely due to the support of the project. With him in place there is increased capacity to develop national level knowledge of the fungi of Lao.

Overall, the project largely achieved the outcome on many fronts and initiated a drive within the country which has raised the profile, awareness and perceived importance within the country of its incredible wealth of fungal taxa

3.3 Impact: achievement of positive impact on biodiversity and poverty alleviation

Impact statement from logframe: To enable Laos PDR to manage its mycological resources and fulfil CBD commitments through increasing awareness of fungi, their conservation, economic sustainability, and ecological importance.

The fungal material which forms the basis of the National Fungarium was collected primarily during two, one-week trips to Xieng Khouang province in 2015 and 2016. Around 800 collections were made during these two collecting periods. A large, but yet unknown number of these are undoubtedly new species waiting to be described. This highlights the incredible biological diversity encountered during the project, but it also highlights the scale of the task which faces Lao PDR in fulfilling its commitments to the CBD in developing strategies for safe guarding its natural mycological capital. The task of assessing the vast array of fungi in Laos will be enhanced through the internationalisation of the effort via making DNA sequence data generated within the project publically available. This will generate interest out with the country and encourage future collaborations. The current project was a first big step in developing the capacity for Laos to manage this capital. The increased skill sets and knowledge which Lao nationals received as part of the project will enable them to both carry out research and to transfer the knowledge and skills to others, particularly students at NUoL. Increased awareness of the potential for fungal poisonings and the identification of an unknown toxic fungus both directly support the alleviation of poverty (see Section 4.3 below).

4 Contribution to Darwin Initiative Programme Objectives

4.1 Contribution to Global Goals for Sustainable Development (SDGs)

The project contributed to following SDGs

1. Food – Around 70% of Laotians still rely on non-timber-forest products for food and income generation and fungi are a major NTFP. The project contributed to the first analyses of the diversity, importance and sustainable use of this valuable natural resource.
2. Health – by investigating the annual poisonings that occur, we addressed the wellbeing of the people. We obtained the fungal material involved in a number of incidents which have been identified, allowing us to raise awareness about the risks of this species.
3. Education – We have educated a cohort of individuals who will be able to continue and pass on new knowledge and skill sets.
4. Infrastructure – The project built the intellectual capacity, personnel and laboratory facilities to enable Lao PDR to carry out assessments of its natural capital.
5. Ecosystems – the fungal group the project focussed on are not only the major edible fungi collected but they are also essential to the health of the forests: they are symbiotic the trees, which rely upon for nutrient uptake.
6. Sustainability - The project supported the sustainable utilise of fungi as a valuable natural resource. The value chain assessment of Matsutake demonstrated the importance of this fungus for income generation and highlighted the need for sustainable harvesting approaches.

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

An almost total lack of mycological knowledge and expertise in Laos meant that the outputs from the project (reference collections, trained personnel, laboratory facilities, field evaluations) directly addressed the CBD convention objectives of -

1. The conservation of biological diversity
2. The sustainable use of the components of biological diversity

3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources

and supports Lao PDR to meet its obligations under the convention. Specifically the project addressed the following CBD articles: 6 (Conservation & sustainable use); 7 (Identification and Monitoring, 12 (Training); 14 (Impact Assessment and Minimizing Adverse Impacts, and 16 (Access and transfer of technology). Similarly, the project contributes to several cross-cutting themes including Public Awareness and Education; Global Taxonomy Initiative; Identification, Monitoring and Indicators; Sustainable use of Biodiversity.

In addition, in order for the duplicates of the fungal collections in the National Fungarium to be transferred to the UK, it was necessary for Material Transfer Agreements and the Letters of Origin Certification to be issued by BEI. This is the first time that these documents have been arranged and issued in accordance with provisions of the CBD and the Nagoya protocol. Through the project, BEI staff now have experience in arranging and dealing with these provisions.

4.3 Project support to poverty alleviation

The project is the first attempt to raise awareness and increase understanding of the critical roles that fungi have in Laotian ecosystems. Raising the appreciation of these roles increases the capacity to safeguard this natural capital and the ecosystem services they provide. In particular the knowledge about the beneficial and obligatory links between many of the edible fungi collected and living forest trees was new to workshop participants and to many of the local villagers with whom we interacted during the field surveys. This realisation provides a direct incentive to maintain the forests. Enhancing the capabilities of current and future teachers at the NUoL with both knowledge and materials (digital copies of seminars and references) will enable them to deliver a much more comprehensive overview of the importance of fungi to students and other groups with whom they interact.

The country as a whole will benefit from improved adherence to the conditions of the CBD which will result from a deeper understanding of the diversity of fungi in Laos.

The project investigated the fungi involved in poisonings. It proved very difficult to gather case information concerning poisonings and the symptoms involved. Details are given in Section 3.3. However, in the final year Ms Chittarhat managed to obtain several collections involved in poisoning cases and we were able to suggest an identity of the causal agent. This directly links to alleviating poverty by reducing the possibility that people are poisoned by eating toxic fungi and hence the amount that poor people have to spend on treating illness owing to misidentification of fungi. Fatalities resulting from poisonings would also have considerable collateral impacts if the victims are the primary income generators within households. Reducing such occurrences would diminish such associated hardships.

One aim of the project was to investigate the harvesting of the highly prized Matsutake. There was anecdotal evidence that harvesting of this fungus was done using techniques which damaged the ability of the fungus to survive. However, we found no evidence to support this among the villages where Matsutake was harvested. A report on the harvesting and value chain of Matsutake collecting in Xiang Khouang province was made in conjunction with Ole Pedersen.

4.4 Gender equality

There was no gender equality objective explicitly stated within the original project programme. Women are well represented within the participants of the project, as partners and as collaborators within the country. The majority of the personnel who are involved in the project at the technical services at BEI and at the NUoL were women. If there is a gender issue then it is with a bias towards women. Of the participants at the workshops in May 2015 and 2016, most were women. The proportion of women to men within the National Herbarium staff is more balanced with a 50:50 split between genders. Many of the top positions within BEI with the exception of the overall Director are held by women. As part of the project, we have encouraged the appointment of Mr Phongeun Sysouphanthong at the herbarium. Mr Sysouphanthong is Laotian with an MSc degree in mycology from Thailand. He is an ideal person to take on the responsibility of developing the mycology section of the herbarium. We selected two Laotians to travel to Aberdeen for an intensive training in molecular techniques. The two best candidates were women – Mrs Keokene and Ms Chittarhat. The training they received will help them

progress in their careers as well as support the development of mycology within Laos. Mrs Keokene has been appointed manager of the molecular lab at the NUoL and Ms Chittarhat has become the contact person for fungal poisonings in Lao.

4.5 Programme indicators

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

The project was not designed to directly lead to greater representation of local poor people in biodiversity management structures. However, through the support of the project Mr Phongeun Sysouphanthong was appointed a member of staff at the Ecology division in the herbarium at BEI. The ecology division is tasked with assessing the biodiversity of Laos and Mr Sysouphanthong has responsibility for further developing the capacity to assess the mycological diversity in Laos.

- **Were any management plans for biodiversity developed?**

No

- **Were these formally accepted?**

N/A

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

N/A

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

The project was not directly measuring gains by households

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

N/A

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

N/A

4.6 Transfer of knowledge

Knowledge transfer was a major focus of the project. During the scoping visit to Lao in July 2012, by PI and Mark Newman, it was clear that there was no recognised mycological expertise at any of the partner institutes or organisations. At NUoL, fungi were given scant attention in the official curriculum. This large gap in knowledge was highlighted by local partners and the project workshops and training course sought to address this. In order for the mycological biodiversity in Lao PDR to be appreciated and assessed, people need both academic knowledge and practical skills. Emphasis was placed on transferring skills that would allow Lao nationals to carry out mycological surveys, generate reference collections and to publish their findings in international outlets. Workshop participants came from a number of different institutes and organisations to ensure that knowledge was spread across as broad a base as possible. However, staff at BEI were given more intensive lab and field training as they have responsibility for maintaining and increasing the National Fungarium. All of the course participants have the materials, relevant references and protocols supplied as digital form on memory stick.

Did the project result in any formal qualifications?

The original plan was for one Laotian to complete a Master degree at The University of Edinburgh, but we were unable to find a person with a sufficient level of English skills to be accepted on the course.

4.7 Capacity building

Capacity building was both material in the form of equipment (new microscope and equipment for BEI, Molecular laboratory facilities established) and in personnel. Through the instigation and support of the project, Mr Phongeun Sysouphanthong has been employed at BEI on a permanent contract. Phongeun was trained in Thailand to Masters level and is undoubtedly the best field mycologist in Lao at the present time. If the project had not encouraged him and BEI to come to an employment arrangement, his expertise would most likely have been lost (either to China or Thailand). Ms Khonesavanh Chittarhat has become the National contact person for reporting and dealing with fungal poisoning cases in Laos. Her contact details were recently provided during an independent enquiry to the PI from the FAO concerning poisonings from wild collected foods in Lao. Mrs Toulaphone Keokene has received increased status as a result of her appointment as the manager of the molecular laboratory set up at the NUoL. This is the only molecular facility at the university.

5 Sustainability and Legacy

The involvement of BEI as the main contact point had the benefit that other ministerial agencies were informed of the project and its objectives. So the existence of the project has been disseminated within the government. Similarly, initial contact with the British Embassy has spread awareness of the project with aid agencies and individuals. The contact with Prof Paul Newton at Mahosot Hospital in Vientiane, who is interested in fungal poisonings, was via the British Embassy. The PI is in contact with Paul and Ms Chittarhat about fungal poisoning with a view to developing findings from the project concerning the identity of poisonous fungi and treatment of patients.

Through Ole Pedersen the project had good contact with the main FAO representative in Laos and the whole project team met up with him in 2016 for discussions about the project and possible assistance from FAO. Ole is now working with the FAO on small production systems for edible fungi. These are for both personal consumption and for income generation. It is possible that a further Darwin project could be established around these production systems using local fungi. As a result of the project the PI was contacted by 'Serving SE Asia', a foundation working in Lao PDR also using small scale production systems for edible fungi. The PI has been assisting with the design of production systems.

A large part of the legacy of the project is the molecular laboratory set up at the NUoL. The appointment of University lecturer Mrs Keokene, who participated in both training workshops in Vientiane course and in the intensive training in Aberdeen, as manager of the lab ensures to some extent that the lab will be maintained and utilised. Dr Somchanh Bounphanmy, who is now vice principal of the University and has been very supportive of the project, is very aware of the research and training potential of the Lab. She intends to develop a Department of Biotechnology around the lab facilities, which would further support its survival.

The establishment of the National Fungarium and the appointment of Mr Phongeun Sysouphanthong at BEI, with our assistance, also ensure that there will be a mycological legacy at the National herbarium.

Unfortunately due to the issues relating to the IUCN office in Vientiane, the potential awareness and legacy effects within this organisation in Laos are likely to be limited.

6 Lessons learned

There have been some important lessons learned since the inception of the project, particularly during the first 18 months, which if we had known them at the beginning of the project would have helped at all levels.

- a) On the scoping trip and at the start of your project, contact as many local aid and conservation agencies as you can – from different nationalities – they can often provide you with much better knowledge and experience of local issues than government organisations.
- b) Contact the local British Embassy as they often have a good contact network and knowledge of other groups/projects working in the country.

- c) Some of the best contacts made are often via chance encounters and word of mouth. Talk to as many people in the country as you can to publicise the project. A small leaflet or flyer that you can hand out would be a good idea.
- d) Ask how much it will cost for people (local and official) to participate in workshops, training course, field trips etc. They may require a 'per diem' payment to take part.
- e) Work out the logistic train for participation of locals – this may involve several levels of administration from central to local government. The initial sorting out of permissions on the ground may take several days – something to bear in mind when you have a weeks field work planned. Do not underestimate how long local permissions can take to be given.
- f) Give priority to getting letters of agreement established – these may take much longer than you anticipate. AND without them in place it will be much harder to get support from within the organisation or to arrange things between organisations.
- g) Expect the unexpected – for training courses have alternative methods of teaching prepared in case 'someone steals the local electricity transformer'.
- h) In South East Asia – check local area for war history – use of antipersonnel mines and current state of Unexploded Ordnance (UXO) clearance. Contact the local MAGs office for advice.
- i) Although you are likely to have a number of partners within the country, there may be one contact who can act as a focal point, who will disseminate information for you and who can arrange meetings between all host country partners much more easily than you can when you are out of the country. It may help if the contact person/group is part of a government organisation.
- j) Arranging repeated face to face meetings within the host country with partners is very important. People are much more likely to respond to emails if they know you. Hosting meals after project meetings may be part of the accepted culture and important in establishing good relations with partners. Find out on your scoping trip how the system works and budget accordingly.

What worked well, and what didn't work well?

Working with Kongchay and her team at BEI in general worked extremely well. They organised the participants and the logistics for the project visits to Vientiane, workshops and training courses. The early establishment of a good working relationship between the PI, Mark Newman and Kongchay greatly helped in promoting an easy interaction with BEI and other government organisations. Kongchay was quite open about how things were organised and what would work and what wouldn't. This was a huge help in trying to optimise our efforts to achieve the project goals.

There was one area with BEI (which was out with Kongchay's control) which unfortunately did not work so well. Leaving tasks for local staff to carry out did not always go to plan. Other issues took priority or agreements with the project were superseded. In hindsight arranging for regular (weekly or monthly) transfer of evidence that tasks were being carried out would have been prudent.

We underestimated the difficulty in finding suitable areas to carry out the study on the impact of logging on edible fungi. Due to rapid population growth and uncontrolled logging activities the only remaining unlogged areas are in zones with highly restricted access due to being in nature reserves, border areas or areas with civil unrest. In addition, the huge problem of unexploded ordnance in Laos restricted our ability to take samples where small areas of potentially forest were located.

In retrospect it would have been very beneficial to have a social scientist involved in the project to allow greater development to the social aspects of project. Our experiences with the villagers were, without exception, positive and we could have made much more of these interactions. Greater experience in developing questionnaires and in dealing with social data would have been beneficial.

6.1 Monitoring and evaluation

The most significant change to the project was that the output of having one Laotian student trained to MSc level at Edinburgh could not be realised due to the lack of any suitable candidates with the necessary level of English to be accepted on the course. After discussions with UK and Lao partners, an alternative plan was developed in which two Lao nationals (Mrs Keokene NUoL and Ms Chittarhat, Plant Protection Institute) would come to Aberdeen for a shorter period of intense training in molecular techniques. This worked out very well and it does mean that the acquired skill set is now spread between two individuals instead of a single person. Another change was due to the lack of suitable areas for looking at the impact of logging on edible symbiotic fungi. The focus shifted to looking at fungi associated with particular tree species – the reasoning being that removal of the trees would result in the loss of the fungi.

The design of the M & E system is very usual for focussing objectives during the development of the project application. However, project development in real time is a much more fluid process and it can be difficult to strictly adhere to the monitoring system. This is particular true when project personnel are only on the ground for relatively short periods of time to arrange and monitor progress in the field. With hindsight monitoring procedures on a shorter time scale would have been very useful.

The system does allow for a very clear reference for showing progress to partners and stakeholders.

Evaluations were done on an approximately yearly basis during visits to Lao by the project partners and the Lao members of the steering group (PSG). The complement of the PSG partners was rather fluid with some original members taking very little interest in the functioning of the project: some lost interest in the project when the direction did not coincide with their agendas. However, other partners become more important during the progress of the project and this benefitted the project as it became more focused. In particular, the now vice principal of the National University of Laos, Dr Somchanth Bounphanmy, became an important influence. Similarly, the influence and guidance of Kongchay Phimmakong and her team at BEI were crucial to the project. Evaluations of how the project objectives could be achieved while navigating the administration system within Lao PDR was a frequent discussion topic with Kongchay and Dr Bounphanmy.

The M & S system made measuring the progress of achievements straightforward and inexpensive for a number of project outputs. The physical existence of the National reference collection, literature, and lab and field equipment allow these achievements to be readily assessed. Similarly the progressive development of the functioning laboratory was easy to assess. Improved skills sets and knowledge are rather more difficult to assess. During the final days of the formal courses, participants were given small exams where they were asked a number of questions relating to the topics covered. They were also shown photos of fungi and asked to answer a set of questions relating to which taxonomic group they were in and why. They did this as a small group exercise and then discussed the questions and the reasoning behind their answers.

6.2 Actions taken in response to annual report reviews

Comments from review in 2nd year

1. Project indicators at all levels of the logframe would merit revision to ensure that they are SMART. (Currently many read as activity statements)

After discussions with UK partners where careful consideration was given to this comment, we would agree to some extent that some of the indicators are activities but they are largely specific and measurable within a given time frame. Activities as indicators within this project seemed appropriate and relevant to achieve the outcome. A comment from LTS was that this issue could be addressed in the report.

2. How has the situation concerning the need to pay Laotian staff to participate in courses and training been resolved?

This situation was resolved by partly utilising workshop expenditure and partly by using funds that would have been allocated to BEI to pay for assistance in the project. So the extra expenditure did not affect any of the project outcomes. But it is a lesson that should be passed onto other prospective Darwin project.

3. IUCN has been mentioned as a partner in both Annual reports to date, but was not listed in the Stage 2 application. What is its role in the project?

Mr Banethom Thepsombath left IUCN between the scoping trip and the stage 2 application. IUCN was not included in the stage 2 proposal as at that time there was no head of office in place. The PI met his successor was Adam Starr at the start of the project but there was no continued interest from IUCN as the project developed.

4. Now that TABI is no longer an implementation partner of the Project, how have you covered the £63,000 of confirmed co-funding (41% of the total) that was due from them?

The collaboration planned with TABI was essentially replaced by that with ABP. The inputs by Ole Pedersen and ABP more than compensated for the withdrawal of TABI.

5. Ensure assumptions – at all levels of the logframe are reviewed / commented on.

Efforts have been made to include comments on assumptions in this final report.

The reviews and comments have been discussed with the main partners. However, the interest from some of the local partners in the local steering group was somewhat limited.

7 Darwin identity

During the early phase of the project it was covered in a number of online media coverage outlets which mention both Defra and the Darwin initiative: *Deadly or delicacy? Fungi experts go East* [Scotland on Sunday] <http://technews.tmcnet.com/news/2014/05/04/7809903.htm>
<http://www.scotsman.com/news/scotland/top-stories/deadly-or-delicacy-scottish-fungi-experts-go-east-1-3398245>. Articles on the project also appeared in 2014 in *The Scotsman* and *The Press and Journal*. However, reference to the Darwin Initiative was removed over the objection of the reporter and the project PI by the editor prior to publication.

During the course of the project the PI has been involved in a number of events where the project and Darwin Initiative has been promoted. These have included presentations within the UK at national events e.g. the annual Kew meeting of the British Mycological Society, and at local KE events (Café Scientifique Aberdeen, Science show on local Aberdeen radio). 2015 was the International Year of Soils, and the PI was involved in a number of events where the project and the Darwin initiative were included in presentations, including 5th December World Soils Day a public event at the Royal Botanic Garden Edinburgh. Project presentations have also been given to local naturalist groups, to staff at the James Hutton Institute, to Botanic garden groups. The project has been covered in a number of online media coverage outlets which mention both Defra and the Darwin initiative:

An article appeared in the *Botanics* magazine of RBGE in spring 2015 (<http://www.rbge.org.uk/assets/files/Publications/botanics60spring15lores.pdf>), mentioning the Darwin Initiative in the title and the text.

The project and the Darwin Initiative was highlighted in an article in Danish [Læssøe et al (2016), see Annex 3].

The Darwin Initiative was also publicised during presentations by the PI at Universities in Sweden, Finland and Norway during the reporting period. The project was recognised as a distinct entity with Darwin Initiative support.

The Darwin initiative logo and the project are included in the email signature of the PI.

The success of a previous Darwin Initiative project (13007) that was carried out in Laos by the UK partner Mark Newman has left a lasting legacy of familiarity with the Initiative. Personnel within the BEI and the National University of Laos are familiar with the Darwin Initiative. The

support from Darwin Initiative for the present project has been emphasised during face to face meetings with local members of international organisations in Laos, including IUCN and FAO.

8 Finance and administration

8.1 Project expenditure

Project spend (indicative) since last annual report	2016/17 Grant (£)	2016/17 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)			24.55%	The change from funding one MSc student for one year to funding training for 10 weeks for two Lao Nationals altered the allocation of time for staffing costs between the 2 nd and final year of the project.
Consultancy costs			0%	
Overhead Costs			13.23%	The overhead costs were lower because the staff costs were lower
Travel and subsistence			-69.25%	As with the changes in the staff costs the alteration of training plans altered the costs for travel and subsistence in the final year. An additional trip was also made by the PI at the end of the project in order to facilitate a final meeting of the Laotian partners.
Operating Costs			7.93%	
Capital items (see below)				
Others (see below)			2.80%	
TOTAL	45,796	46,677.84		

Staff employed (Name and position)	Cost (£)
Andrew Taylor, Researcher	
Duncan White, Technician	
Thomas Freitag, Researcher	

TOTAL	14,308.67

Capital items – description	Capital items – cost (£)
TOTAL	

Other items – description	Other items – cost (£)
Vaccinations for Thomas Frietag	
Estimated Audit Fee	
TOTAL	1,944.00

8.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	Total (£)
Contribution to cover overheads from the Contract holder Institute	
In kind contributions from tutors (only T & S were covered by the project) (estimated)	
Costs of staff and sequencing costs – covered by Prof Kõljalg at Tartu University, Estonia (estimated)	
Costs to ABP (staff, vehicles, publishing) (estimated 25K USD)	
TOTAL	129500

Source of funding for additional work after project lifetime	Total (£)

TOTAL	
--------------	--

8.3 Value for Money

The greatest direct expenditure for the project was staff costs at the James Hutton Institute. However, due to in-kind contributions from the tutors and especially from Ole Pedersen at ABP, Ole, salary costs were kept to a minimum. Over the whole project tutors contributed a total of 13 weeks (including Saturday and Sunday), giving a total of 91 days and Ole estimated he had spent 150 days in connection with the project. The consultancy costs for Thomas Laessoe were extremely good value. Thomas is well known as a world expert and has a huge amount of experience in working with and dealing with fungi in many ecosystems around the world. The project and the workshop participants benefited hugely from his knowledge and inputs. Because of his experience, Thomas is very efficient in processing field samples and most of the collections in the National Fungarium were actually collected by him.

In addition to the time in-kind contributions, considerable added value has been given to the project by Prof Kõljalg at the University of Tartu, who has kindly covered the costs of sequencing many of the collections (both staff and sequencing costs). This would amount to ca £20K. Prof Kõljalg has also incorporated the data from the Lao National Fungarium into the public access database PlutoF collections, so the collection and sequence data is freely available for taxonomic studies.

Mrs Keokene and Ms Chittarhat spent 10 weeks in Aberdeen in early 2016 and received one to one tuition for much of that period from a highly experienced lab technician and they had frequent tutorials with the PI. So although the costs were relatively high for travel and subsistence, the amount of training they received justifies the expenditure.

Equipment costs were high due to having to work through companies based in Laos. The alternative was to purchase equipment using European based companies but most could not provide cost estimates for getting the equipment delivered safely or they could not provide this service. Most of the small consumables were actually taken over during project visits by the PI. This reduced transport costs greatly and ensured the safe arrival of the materials.

Travel and subsistence were a considerable and unpredictable expenditure. Fluctuating flight prices could vary by as much as 50%. However, efforts were made to keep costs low by booking flights well in advance once dates had been fixed for visits and workshops.

Annex 1 Project's original (or most recently approved) logframe, including indicators, means of verification and assumptions.

Note: Insert your full logframe. If your logframe was changed since your Stage 2 application and was approved by a Change Request the newest approved version should be inserted here, otherwise insert the Stage 2 logframe.

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Impact: To enable Laos PDR to manage its mycological resources and fulfil CBD commitments through increasing awareness of fungi, their conservation, economic sustainability, and ecological importance.</p>			
<p>Outcome: There will be an increased academic and technical capacity in Laos PDR to carry out fundamental mycological research thereby contributing to safeguarding harvesters, consumers and the national fungal capital.</p>	<p>Knowledge assessments will be made as part of the workshops. Present baseline = no knowledge of fungi. Post workshops the participants should have a good basic theoretical and practical knowledge of traditional and molecular fungal taxonomy, conservation, and ecology. Intensive molecular training for two Laotian for 10 weeks in Aberdeen, UK.</p> <p>Present baseline = no fungal reference material, little literature or knowledge of ethnomycology - vernacular names and uses. Post project: Representative reference collections made of fungi for sale in markets and of fungi collected during workshops. Each collection associated with a fact sheet and photos in web-accessible database.</p> <p>Currently only word of mouth reports exist of poisonings due to fungi. Documented cases will be compiled. Increased awareness of potential toxicity being the desired end state.</p> <p>Currently there is no knowledge of the impact of logging or of</p>	<p>Assessments will take the form of short practical and written exams. Workshop satisfaction surveys will be given out to all participants and analysed. Two Laotian nationals trained in molecular techniques..</p> <p>The project leader and tutors will inspect all reference collections to ensure agreed quality standards, including fact sheets and photos. Project leader and local Project Steering Committee will be responsible for ensuring online access is created and fully functional.</p> <p>Project leader, the local assistant and aid agencies will ensure proper use of standard reporting forms in data acquisition from medical establishments and will also make sure the storage/filing of these records takes place in these establishments. Verification of awareness of both buyers and sellers will be established using market surveys carried out by project leader, local assistant and aid agencies. Project leader will ensure</p>	<p>There is an assumption that there will be 10-15 participants who will benefit and value participation in the workshops. The level of spoken English may be an issue and a translator may have to be employed. That the international experts who have already agreed to participate will actually be available or will find alternatives.</p> <p>Two candidates can be found who would have the necessarily English skills and knowledge base to receive intensive molecular training in the UK.</p> <p>That there will be fungal fruit body material to gather and process for inclusion within the National Mycological collection. That conditions can be maintained where dried fungal collections can be kept free from insect attack.</p> <p>That it is possible to obtain information regarding fungal poisoning cases from hospitals and doctors.</p>

	<p>harvesting techniques on sustainable utilisation of edible fungi associated with forest trees in Laos. Case studies will provide this data.</p>	<p>consistency of approach and analysis of findings.</p> <p>Quality of survey data on logging impacts will be ensured as project leader is directly involved in collecting it. The quality and consistency of household and field surveys of fungi harvesters will be ensured by the project leader overseeing all the work.</p>	<p>There is an assumption that accessible suitable logged and unlogged areas can be found in which to do the analyses</p>
<p>Outputs:</p> <p>1. 1. Mycological training workshops involving international experts training national participants. Establishment of databases.</p>	<p>1.1 Measure = Workshops taking place and attract the required participants</p> <p>1.2 Expected change: 10-15 participants trained (previously 0)</p>	<p>1.1 Trained personnel</p> <p>1.2 Usable database</p> <p>1.3 National reference collection</p>	<p>There is a risk that insufficient suitable participants may be found for the workshops and that they can be taught over the three consecutive years. This may be countered by having a number of BEI and NUoL employees as participants.</p>
<p>2. A functional molecular laboratory supported by training manuals and SOPs for processing and establishing mycological collections from material collected locally and nationally.</p>	<p>2.1 Measure = development of a dedicated facility for preparation of fungal DNA.</p> <p>2.2 Training manuals and SOPs - project leader and tutors will correspond monthly to ensure progress on track</p> <p>2.3 Local collections will be checked by project leader (and tutors) 3x per year to ensure satisfactory progress. Expected change: existence of manuals and collections not previously available.</p>	<p>2.1 Training manuals and protocols for processing fungal material</p> <p>2.2 DNA prepared in the laboratory</p>	<p>That it will be possible to transport and maintain <i>in situ</i> the equipment required for the workshops and new lab. That suitable personnel can be found to maintain the facility</p>
<p>3. Report on poisonous fungi and poisonings collected from markets and medical establishment.</p>	<p>3.1 Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: empirical data on quantification of severity and frequency of this issue, not</p>	<p>3.1 Report on fungal poisoning in Laos</p>	<p>That it is possible to obtain information regarding fungal poisoning cases from hospitals and doctors</p>

	previously available and critical for addressing this in the future		
4. Report on the fungi sold at markets, including ecological data.	4.1 Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: There is currently little empirical data on the diversity of fungi sold at markets and no information on their ecology. The report will provide this, enabling future comparative assessments.	4.1 Report on the diversity of marketed fungi in Laos	There is a risk that there may be poor fruiting years during the period covered by the project, which could significantly impact on the number of collections and observations that can be made. However, the seasonality experienced in Laos is much more dependable than the vagaries of the temperate zones.
5. Data generated from molecular study of fungal communities in logged and unlogged areas, analysed and written up.	5.1 Report will be compiled by project leader to ensure quality control and timeliness. Progress will be reported regularly to project steering committee. Expected change: There is no data or awareness within Laos on how logging impacts on edible fungi, the report will redress this deficit.	5.1 Publication on logging impacts	There is an assumption that suitable study areas can be found.
6. Data collected from interviews with local villagers involved in harvesting Matsutake, processed and written up.	6.1 Report will be compiled by project leader, TABI and ABP progress will be checked once a year at the end of the fruiting season of Matsutake. Expected change: currently little information available on scale of harvesting, none of harvesting approaches or local knowledge. The study will provide this information to assess if harvesting approaches appear sustainable.	6.1 Publication on Matsutake harvesting	The participation of the villagers in surveying local knowledge and harvesting techniques for Matsutake is critical for the case study.

Activities (each activity is numbered according to the output that it will contribute towards, for example 1.1, 1.2 and 1.3 are contributing to Output 1)

Output 1

Activity 1.1: Setting up the logistics for the workshops. Recruiting participants for the workshops from BEI and NUoL and other interested parties.

Activity 1.2: Run three workshops, including field excursions and lab practical sessions.

Activity 1.3: Finding suitable servers, hardware and software for initiating and developing of databases

Output 2

Activity 2.1: Identifying a secure, suitable location within BEI or NUoL to house the fungal laboratory. Acquiring the suitable consumables and equipment for the lab.

Activity 2.2: Liaising with other tutors for the development of the necessary manuals for the workshops

Activity 2.3: Preparing manuals for each workshop

Output 3

Activity 3.1: Contacting medical establishments for cases of confirmed or suspected fungal poisonings. Checking newspapers for poisoning articles. Interviewing traders.

Activity 3.2: Checking and collating the data

Activity 3.3: Preparing the final report in conjunction with TABI and ABP

Output 4

Activity 4.1: Working with TABI and ABP on gathering data from different markets to establish the diversity and identity of fungi sold. Local Laotian project assistant to participate in this.

Activity 4.2: This will be done during the May-August season each year with yearly reports prepared

Activity 4.3: The final report will be compiled with TABI and ABP

Output 5

Activity 5.1: Suitable logged and unlogged sites will be identified in collaboration with TABI and ABP. The impact on the above ground tree vegetation will be assessed. Root samples will be taken and dried for shipping to JHI.

Activity 5.2: Samples will be extracted and processed for high throughput sequencing. Data will be analysis and community analyses carried out.

Activity 5.3: A report will be prepared and a scientific paper produced for publication.

Output 6

Activity 6.1: Suitable areas producing Matsutake will be identified in collaboration with TABI and ABP. Observations will be made of harvesting techniques and interviews will be carried out with the harvesters.

Activity 6.2: Data will be collated from different areas to identify potential differences in knowledge and harvesting approaches

Activity 6.3: A final report will be prepared in conjunction with TABI and ABP

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

Project summary	Measurable Indicators	Progress and Achievements
<p>Impact:</p> <p>To enable Laos PDR to manage its mycological resources and fulfil CBD commitments through increasing awareness of fungi, their conservation, economic sustainability, and ecological importance.</p>		<p>The project highlighted the incredible biological diversity in terms of fungi in Lao PDR and illustrated the immense scale of the task which faces Lao PDR in fulfilling its commitments to the CBD in developing strategies for safe guarding its natural mycological capital. The current project was a first big step in developing the capacity for Laos to manage this capital. The increased skill sets and knowledge which Lao nationals received as part of the project will enable them to both carry out research and to transfer the knowledge and skills to others, particularly students at NUoL. The laboratory and the reference collections will enable trained personnel to carry out research on the fungi – including plant pathogen diagnostics. The combined skills sets spread over a number of personnel from a range of organisations and the permanent facilities will enhance the legacy of the project. Increased awareness of the potential for fungal poisonings and the identification of an unknown toxic fungus will both lead to alleviation of poverty among a population who rely heavily on non-timber forest products.</p>
<p>Outcome There will be an increased academic and technical capacity in Laos PDR to carry out fundamental mycological research thereby contributing to safeguarding harvesters, consumers and the national fungal capital.</p>	<p>Knowledge assessments will be made as part of the workshops. Present baseline = no knowledge of fungi. Post workshops the participants should have a good basic theoretical and practical knowledge of traditional and molecular fungal taxonomy, conservation, and ecology. Intensive molecular training for two Laotian for 10 weeks in Aberdeen, UK.</p> <p>Present baseline = no fungal reference material, little literature or knowledge of ethnomycology - vernacular names and uses. Post project: Representative reference collections made of fungi for sale in markets and of fungi collected during workshops. Each collection</p>	<p>As detailed in Section 3.2 and in Annex 3 below, a total of 19 Lao Nationals ranging from undergraduate to MSc and University lecturers received training in a number of aspects of mycology. Most workshops were a combination of seminars and practical sessions. Emphasis was placed on hands on tuition to enable participants to take forward the acquired skills to carry out their own research. The two Laotians who received intensive molecular training in Aberdeen are now able to extract and amplify fungal DNA from a range of substrates in the laboratory established at NUoL by the project.</p> <p>The setting up of the National Fungarium at BEI is a major achievement and personnel were trained in both the curation and maintenance of the collection but also in how to collect and add further collections to the Fungarium. The collections are associated with field descriptions and photographs and stored on a high spec computer bought by the project at BEI. Meta data and sequence data from the collections are available publically via the PlutoF database hosted by Prof Kõljalg at Tartu University, Estonia. The fungi in the Fungarium primarily come from the field surveys carried out in 2015 and 2016 in Xieng Khouang Province. A smaller number are from local markets.</p>

	<p>associated with a fact sheet and photos in web-accessible database.</p> <p>Currently only word of mouth reports exist of poisonings due to fungi. Documented cases will be compiled. Increased awareness of potential toxicity being the desired end state.</p> <p>Currently there is no knowledge of the impact of logging or of harvesting techniques on sustainable utilisation of edible fungi associated with forest trees in Laos. Case studies will provide this data.</p>	<p>It proved very difficult to acquire evidence on the extent of fungal poisonings in Laos as there no central information system to which cases are reported. However, as a result of her connections and training received during the project, Ms Chittarhat at the plant pathology Institute has become the contact person for fungal poisonings in Laos. This is a significant step forward as she can now amass countrywide evidence of the problem. We managed to cases notes from two poisoning cases from Prof Paul Newton at Mahosot hospital in Vientiane, who has an interest in poisonings and some fungal material that had been involved in poisoning cases. From these it was clear that an unknown fungus was involved. Near the end of the project period, a joint effort between Ms Chittarhat and the project led to a tentative name for the unknown causal agent of the fatal poisonings. This investigation is ongoing between Ms Chittarhat and the PI as confirmation is required and if confirmed, then this needs to be publicised in Lao and the medical establishment made aware of potential remedial treatments after consumption. Ms Chittarhat is using the newly established lab facilities to extract DNA from fungi involved in poisonings cases to aid identification – this was not possible before the project.</p> <p>After much difficulty in locating a suitable site for obtaining samples to examine the impact of tree removal on fungi, samples were obtained late in the project. These have been processed and the fungal DNA sequenced (>800,000 sequences produced). This data will be analysed and published along with information on the diversity of edible symbiotic fungi and their associated hosts in Lao PDR.</p> <p>A detailed analysis of the economic importance and harvesting of the highly prized Matsutake was carried out and the data was published by Ole Pedersen at ABP (Annex 9).</p>
<p>Output 1. Mycological training workshops involving international experts training national participants. Establishment of databases.</p>	<p>1.1 Measure = Workshops taking place and attract the required participants</p> <p>1.2 Expected change: 10-15 participants trained (previously 0)</p>	<p>The number of workshops carried out during the course of the project exceeded that projected. This was primarily due to seizing opportunities to hold training sessions. The low level of academic knowledge and skill sets meant that nearly every activity was novel and thus opportunities for semiformal training were frequent.</p> <p>A total of 19 Lao Nationals received training.</p> <p>The indicators were simple and easily assessed.</p>

Activity 1.1 Setting up the logistics for the workshops. Recruiting participants for the workshops from BEI and NUoL and other interested parties.	Completed.
Activity 1.2. Run three workshops, including field excursions and lab practical sessions.	Completed
Activity 1.3. Finding suitable servers, hardware and software for initiating and developing of databases	Completed
<p>Output 2. A functional molecular laboratory supported by training manuals and SOPs for processing and establishing mycological collections from material collected locally and nationally.</p>	<p>2.1 Measure = development of a dedicated facility for preparation of fungal DNA.</p> <p>2.2 Training manuals and SOPs - project leader and tutors will correspond monthly to ensure progress on track</p> <p>2.3 Local collections will be checked by project leader (and tutors) 3x per year to ensure satisfactory progress. Expected change: existence of manuals and collections not previously available.</p> <p>The laboratory is set up and running with all the equipment installed and functioning. A training course was held in November 2016 and DNA was extracted and amplified. All training manuals relative to the equipment and protocols for relevant procedures are in place.</p> <p>The National Fungarium has been set up with an accompanying searchable database with all the meta data associated with each of the collections. A total of 1448 collections are included.</p> <p>The indicators for this Output were straight forward and easily assessed.</p>
Activity 2.1. Identifying a secure, suitable location within BEI or NUoL to house the fungal laboratory. Acquiring the suitable consumables and equipment for the lab.	Completed
Activity 2.2. Liaising with other tutors for the development of the necessary manuals for the workshops	Completed
Activity 2.3. Preparing manuals for each workshop	Completed
<p>Output 3. Report on poisonous fungi and poisonings collected from markets and medical establishment.</p>	<p>3.1 Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: empirical data on quantification of severity and frequency of this issue, not</p> <p>The indicator was not very useful as it was based on the assumption ‘That it is possible to obtain information regarding fungal poisoning cases from hospitals and doctors’. Since there was no central system for recording poisoning cases, it was very difficult to obtain information. However, since Ms Chittarhat is now the acknowledged National contact person, she is receiving both case studies and the material involved in the cases. The local villagers</p>

	previously available and critical for addressing this in the future	are aware of many species which are poisonous but the causal agent involved in the cases which occurred during the project was unknown. Having the possible identification for this is a major step forward, which if confirmed, can then be used to raise awareness among collectors.
Activity 3.1. Contacting medical establishments for cases of confirmed or suspected fungal poisonings. Checking newspapers for poisoning articles. Interviewing traders.		Completed as far as was possible
Activity 3.2. Checking and collating the data		The data that was forthcoming has been collated
Activity 3.3 Preparing the final report in conjunction with TABI and ABP		No report has been prepared thus far but the PI is in regular contact with Ms Chittarhat and Prof Newton and it is hoped that a strategy for raising awareness of poisonous fungi will be forthcoming. The PI is also involved in a book on edible and poisonous fungi of Laos which is being prepared by Ole Pedersen (ABP) and Thomas Læssøe (Denmark).
Output 4. Report on the fungi sold at markets, including ecological data.	4.1 Report will be compiled by project leader, TABI and ABP – progress will be checked 3x per year. Expected change: There is currently little empirical data on the diversity of fungi sold at markets and no information on their ecology. The report will provide this, enabling future comparative assessments.	This was the most disappointing output of the project and it should have been one of the simplest to achieve. It involved collecting representative edible fungi from the local market near BEI and documenting them and preparing them for inclusion in the Fungarium. No suitable personnel were available during the first two years. In the final year a member of BEI was reportedly gathering the necessary information from the local market but this proved to be incorrect. Only data gathered during visits in 2014 were included in a report by ABP (Annex 7)
Activity 4.1. Working with TABI and ABP on gathering data from different markets to establish the diversity and identity of fungi sold. Local Laotian project assistant to participate in this.		TABI was not involved in the output.
Activity 4.2. This will be done during the May-August season each year with yearly reports prepared		Not achieved
Activity 4.3. The final report will be compiled with TABI and ABP		A report was produced by ABP which contained some data generated by the project but this was not the intended output.
Output 5. Data generated from molecular study of fungal communities in logged and	5.1 Report will be compiled by project leader to ensure quality control and timeliness. Progress will be reported regularly to project	Due to rapid population growth and uncontrolled logging activities the only remaining unlogged areas in Laos are in zones with highly restricted access due to being in nature reserves, border areas or areas with civil unrest. In addition, the huge problem of unexploded ordnance in Laos restricted our

unlogged areas, analysed and written up.	steering committee. Expected change: There is no data or awareness within Laos on how logging impacts on edible fungi, the report will redress this deficit.	ability to take samples where small areas of potentially forest were located. However, an area with pine forest was finally selected north of the capital Vientiane and samples were taken and processed. This output should have been relatively straightforward but due to unforeseen circumstances was severely delayed.
Activity 5.1. Suitable logged and unlogged sites will be identified in collaboration with TABI and ABP. The impact on the above ground tree vegetation will be assessed. Root samples will be taken and dried for shipping to JHI.		Completed but without TABI involvement
Activity 5.2. Samples will be extracted and processed for high throughput sequencing. Data will be analysis and community analyses carried out.		80% completed. Community analyses to be completed
Activity 5.3. A report will be prepared and a scientific paper produced for publication.		To be completed
Output 6. Data collected from interviews with local villagers involved in harvesting Matsutake, processed and written up.	6.1 Report will be compiled by project leader, TABI and ABP progress will be checked once a year at the end of the fruiting season of Matsutake. Expected change: currently little information available on scale of harvesting, none of harvesting approaches or local knowledge. The study will provide this information to assess if harvesting approaches appear sustainable.	This was carried out without the assistance of TABI. Data collected on harvesting and the ecology of Matsutake during the 2015 and 2016 field surveys were used in the production of a value chain analysis report of Matsutake harvesting by Ole Pedersen
Activity 6.1. Suitable areas producing Matsutake will be identified in collaboration with TABI and ABP. Observations will be made of harvesting techniques and interviews will be carried out with the harvesters.		Completed but without TABI involvement
Activity 6.2. Data will be collated from different areas to identify potential differences in knowledge and harvesting approaches		Completed
Activity 6.3. A final report will be prepared in conjunction with TABI and ABP		Completed but without TABI involvement (Annex 9)

Annex 3 Standard Measures

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
Training Measures							
1a	Number of people to submit PhD thesis						
1b	Number of PhD qualifications obtained						
2	Number of Masters qualifications obtained						
3	Number of other qualifications obtained						
4a	Number of undergraduate students receiving training	1	Laotian	Male		English, Lao	A student taking the biotechnology course at NUoL received training while the lab equipment was being installed and tested.
4b	Number of training weeks provided to undergraduate students	2	Laotian	Male		English, Lao	As above.
4c	Number of postgraduate students receiving training (not 1-3 above)	2	Laotian	Female		English, Lao	Two Masters students were working on their project which included fungal identification and they took part in the taught courses

							in 2015 and 2016
4d	Number of training weeks for postgraduate students	2	Laotian	Female		English, Lao	As above
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification (e.g., not categories 1-4 above)						
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)	16	Laotian	4 male 12 Female		English, Lao	
6b	Number of training weeks not leading to formal qualification	18					Two formal week-long workshops ran in 2015 and 2016, two field training courses were ran in 2015 and 2016, there was a 10 week training period in Aberdeen for two Laotians. A 2 week training course ran in November 2016 in the molecular Laboratory. Two separate weeks of training were given for members of

							the Ecology division on how to collect, store and work with dried fungal material.
7	Number of types of training materials produced for use by host country(s) (describe training materials)	4				English	<p>Most training materials have been supplied to course participants on individual memory sticks.</p> <p>1) All lectures have been made available and can be used for own learning or for teaching purposes.</p> <p>2) Handouts have been prepared to accompany each lecture</p> <p>3) Instructions sheets have been prepared for both field and lab practices relating to collecting fungi</p>

							for the Fungarium. 4) Laboratory protocols were prepared for extracting fungal DNA and processing DNA from a range of substrates.
Research Measures		Total	Nationality	Gender	Title	Language	Comments/ Weblink if available
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)						Participatory process?
10	Number of formal documents produced to assist work related to species identification, classification and recording.						
11a	Number of papers published or accepted for publication in peer reviewed journals	(1)				English	Prof AnneMeike Verbeken and the PI have submitted a paper describing new species of fungi from Laos based collections

							made during the project
11b	Number of papers published or accepted for publication elsewhere	1			Mushroom hunting in the Xieng Khouang province of Laos.	Danish	Laessoe T, Pedersen OS, Taylor AFS (2016) Svampe Vol 74:6-17
12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	1				English	The National Fungarium was established in Excel and contains all the relevant information relating to each of the 1448 fungal collections made during the project period
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country						
13a	Number of species reference collections established and handed over to host country(s)	1448					Fungal collections made during the project. These collections

							form the National Fungarium of Laos which is maintained by the Ecology division of BEI.
13b	Number of species reference collections enhanced and handed over to host country(s)						

Dissemination Measures		Total	Nationality	Gender	Theme	Language	Comments
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work						
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	3	UK/Norway			English	

Physical Measures		Total	Comments
20	Estimated value (£s) of physical assets handed over to host country(s)		The bulk of this cost was the equipment and consumables for the molecular laboratory. In addition, 10 teaching microscopes were donated by the Belgium Partner for use by the staff of the Ecology Division at BEI. The value of these was undetermined
21	Number of permanent educational, training, research facilities or organisation established	2	The molecular laboratory is an excellent educational, training, research facility. The National Fungarium represents a huge research facility as it houses many identified reference species but there are also numerous undescribed species that could be used for future research.
22	Number of permanent field plots established		Please describe

Financial Measures		Total	Nationality	Gender	Theme	Language	Comments
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work						

Annex 4 Aichi Targets

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

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

Annex 5 Publications

Type * (e.g. journals, manuals, CDs)	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. web link, contact address etc)
Journal paper	Mushroom hunting in the Xieng Khouang province of Laos. Laessoe T, Pedersen OS, Taylor AFS (2016) Svampe Vol 74:6-17	Danish	Danish	Male	<i>Narayana Press</i> Kalvsømadevej 75, Gylling, 8300 Odder, <i>Danmark</i>	https://www.researchgate.net/publication/306038781_Pa_svampejagt_i_Xieng_Khouang-provinsen_i_Laos_Mushroom_hunting_in_the_Xieng_Khouang_province_of_Laos

Annex 6 Darwin Contacts

Ref No	21-002
Project Title	Building mycological capacity for sustainable resource management in Lao PDR
Project Leader Details	
Name	Andy Taylor
Role within Darwin Project	Overall co-ordinator for the project
Address	The James Hutton Institute Craigiebuckler Aberdeen AB15 8QH Scotland UK
Phone	
Fax/Skype	
Email	
Partner 1	
Name	Mark Newman
Organisation	Royal Botanic Garden, Edinburgh
Role within Darwin Project	Dr Mark Newman has a strong network of contacts in a range of organisations in Lao from previous visits and projects (including Darwin Initiative projects). He has previously supported training for a Lao botanist at the RBGE. His experience in working in Laos and his linguistic skills was an invaluable asset to this project. In addition, he provided taxonomic expertise on the plants during the recording of metadata for fungal collections.
Address	Arboretum PI, Edinburgh EH3 5NZ
Fax/Skype	
Email	
Partner 2	
Name	Kongchay PHIMMAKONG Ms.
Organisation	Biotechnology and Ecology Institute
Role within Darwin Project	Kongchay and her team at BEI organised all the logistics of the workshops and training course held at BEI. They also provided letters of invitation and introduction to the various government officials that had to be contacted during the project. Their inputs were critical to the running of the project in Laos.

Address	Biotechnology and Ecology Service Center Biotechnology and Ecology Institute Ministry of Science and Technology Doon Teaw, Km 14, Thangon Road Xaythany District, PO Box 2279, Vientiane, Lao PDR
Fax/Skype	
Email	
Partner 3	
Name	Urmas Kõljalg
Organisation	University of Estonia
Role within Darwin Project	Workshop Tutor
Address	Institute of Ecology and Earth Sciences, University of Tartu, 40 Lai St, Tartu 51005, Estonia
Fax/Skype	
Email	
Partner 4	
Name	Mieke Verbeken
Organisation	University of Ghent
Role within Darwin Project	Workshop Tutor
Address	K.L. Ledeganckstraat 35, L10 9000 Gent, Belgium
Fax/Skype	
Email	
Partner 5	
Name	Ole Sparre Pedersen
Organisation	ABP: Agrobiodiversity Project
Role within Darwin Project	Ole was the chief technical advisor for ABP and was integral in project planning and development and in collaborations in producing project outputs. Ole and his team were responsible for the Lao-based planning and logistics of the field work in Xieng Khouang province in May 2015 and 2016.
Address	The ABP programme has now finished so Ole is best contacted via email
Fax/Skype	
Email	