

Darwin Initiative Main Annual Report

To be completed with reference to the “Writing a Darwin/IWT Report” Information Note:
(<https://www.darwininitiative.org.uk/resources-for-projects/reporting-forms-change-request-forms-and-terms-and-conditions/>).

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

Submission Deadline: 30th April 2021

Darwin Project Information

Project reference	26-002
Project title	Integrating conservation and health in Papua New Guinea’s vulnerable rainforests
Country/ies	Papua New Guinea
Lead organisation	University of Sussex
Partner institution(s)	Binatang Research Center, Madang, Papua New Guinea
Darwin grant value	£355,353
Start/end dates of project	1 April 2019 – 31 March 2022
Reporting period (e.g. Apr 2020 – Mar 2021) and number (e.g. Annual Report 1, 2, 3)	April 2020 – March 2021, Annual Report 2
Project Leader name	Dr Alan J A Stewart
Project website/blog/social media	
Report author(s) and date	AJA Stewart, J Middleton, V Novotny, S Sui, F Dem, B Ruli, R Hazell 30 th June 2021

1. Project summary

Papua New Guinea (PNG) includes the world’s third largest rainforest, supporting 5% of global biodiversity. However, 24% of PNG forests have been cleared or degraded in 30 years, nearly half caused by commercial logging. Only 4.5% of land is officially protected, and this is largely ineffectual. In PNG, 97% of land is owned by clans as communal property, offering a potential counterweight against logging. However, without alternative development options, many communities are attracted by inducements from extractive industries and opt for logging.

Much of PNG is remote and lacks development resources. It is notably low on health service provision, being ranked 155 of 188 countries by Sustainable Development Goal (SDG) 3’s health indicator scores. Medical neglect has left the top causes of health problems unchanged for fifteen years. Life expectancy is low; maternal and infant mortality rates are high.

Sustainable development requires protecting life on land (SDG 15), and supporting good health (SDG 3), but these goals can seem in conflict to PNG forest communities. Logging companies’ offers of roads and income can decrease remoteness from health services, making desire for health a driver for forest destruction and erosion of health-related ecosystem services.

Conservation success in PNG thus requires synergies be developed with delivery of other SDGs, particularly those pertaining to health.

Our integrated health and conservation project includes (i) a community health intervention tied to conservation, (ii) community and school-based education in the health-related ecosystem services of intact forests, (iii) creation of two new conservation areas, expansion of an existing one, creation of a no-impact zone within it and two new buffer zones on its borders (Figure 1), (iv) an evidence synthesis of related projects across the tropics, and a multi-site assessment of the effect on biodiversity and public health of conserving compared to logging forests in PNG.

Our project is focused primarily on the remote village of Wanang in Madang Province, in northern PNG. Wanang village is located in the Gama local-level government (LLG) of the Usino-Bundi District of the Madang Province of Papua New Guinea (see insert in Fig. 5). It is about 100 km from the Madang township, along mostly unsealed logging roads followed by two hours on foot, including unbridged river crossings. Wanang is a relatively small community (population ~600 people), but they own a significant amount of intact forest (c.15,000 ha) within the Ramu Block I Forest Management Area. It is surrounded by the neighbouring communities of Wabusarik, Teberasik, Koromasarik and Middle-Ramu area.

Wanang is a village community whose nine clans collectively established multi-stakeholder agreements to preserve 10,000 hectares of their forest in the face of financial incentives from logging companies and pressure from surrounding communities who allowed their lands to be logged. The Wanang Conservation Area (WCA) is a village-owned and run reserve in a CBD priority area, one of only two large conservation areas in PNG surviving in direct contact with logging. The WCA is directed by the Conservation Board with nine members, who are also leaders of the nine clans that combined their lands to create the WCA.

2. Project partnerships

The project continues to benefit from the long-standing close partnership between the University of Sussex (UoS) as lead institution and the Binatang Research Center (BRC), the principal partner in PNG, based in turn upon the long history of association in research between the two partners (Alan Stewart and Vojtech Novotny), including on six previous Darwin Initiative projects. Alan Stewart remains responsible for overall management of the project and report writing. BRC, under the directorship of Prof Novotny, is our principal partner in project management, training and research. It is the leading biological research institution in PNG with a staff of 35 researchers, students and highly skilled research technicians (para-ecologists). We have been using monthly Zoom meetings between UoS and BRC staff for planning, decision making and monitoring of the project.

The continued success of the medical aspects of the project are critically dependent on the input of Jo Middleton and Jackie Cassell (Brighton & Sussex Medical School). We have also developed a valuable collaboration with the PNG Institute of Medical Research (IMR), the largest medical research organisation in the country, principally through its Director (Dr William Pomat) and Dr Moses Laman, a Principal Research Fellow and Head of the Vector Borne Diseases Unit, who is based in the nearest regional centre of IMR in Madang.

The project would not be possible without our continuing collaboration with those involved in the long-term development of the Wanang Conservation Area (WCA): the nine clan leaders, the WCA project management board and the village residents. The Aid Post was planned at the request of the WCA, who identified health provision as the next step along their path of sustainable development. The excellent relationships that we have with them is proving to be essential for the future success of the project. Dr Emilie Beauchamp (IIED) maintains general oversight of project M&E and has contributed to summarising the M&E in this report.

3. Project progress

We are delighted with progress this year in establishing the aid post, supplying it with equipment and medicines, and appointing a full-time nurse. The community has responded especially positively to this development. We are also pleased to report a considerable expansion of the area of primary forest that has been brought under protection and the establishment of a series of land parcels to act as a buffer zone arc around the eastern flank of the existing Wanang Conservation Area.

The Covid-19 global pandemic has inevitably impacted certain activities within this project. Though PNG has had relatively few cases (primarily due to stringent national border controls), it has had around seventeen thousand and these have been accompanied at times by considerable disruption resulting from control measures (e.g. school and university closures, restrictions on internal and international travel etc.). Some activities remain therefore somewhat behind schedule, but we are confident that we can catch up and achieve the outputs by the end of the project.

We report below only on those activities that were due to progress within the reporting period (please refer to logframe for complete list of activities).

Output 1:

Activities: 1.1 Collect and analyse qualitative and quantitative health and wellbeing data before and after the health intervention. 1.3 Trained Wanang community members respond to trauma and evacuation incidents as required. 1.4 Construct Aid Post, equip it, stock it with medicine, and recruit a nurse. 1.5 Establish and train community health committee. 1.6 Nurse staffed Aid Post receives and treats patients, maintains patient records.

1.1: Baseline health data from the Wanang participating communities have been collected and analysed, have informed health post service planning, and are being prepared for journal submission to *Transactions of the Royal Society of Tropical Medicine & Hygiene*. In addition, the protocol and free-to-use data collection tools that we developed have now been published Open Access in *British Medical Journal Open* (see publications in Annex 3, Table 2). Since publication in October 2020 it has been viewed at full text 1484 times and downloaded as a PDF 292 times. We have done this as we feel the novel inter-disciplinary methods and tools developed for Wanang can be of real use to others setting up health services in remote previously medically under-served areas elsewhere.

1.3: *Wilderness First Aid* training was provided in Year 1 in which twelve community members learned how to respond to medical emergencies and how to move sick or injured persons safely so they can be evacuated to hospital by Binatang Research Centre staff (also trained) by vehicle from the nearest road head (c.4 hours carry from Wanang). There has been one case in the current reporting period of traumatic leg injury (from domestic violence, Table 2) where the witnesses were not confident enough to assist. However, the Wanang aid post nurse assisted, controlling the bleeding, monitoring the patient, providing analgesia, and treating preventatively with antibiotics until a BRC vehicle transported the victim to hospital. From this experience, it is clear that community members require follow-up practical lessons to make them confident to act in such situations. One such refresher course by Jo Middleton (who conducted the original training) was planned for August 2020 but has had to be postponed due to the pandemic.

1.4: The Wanang Aid Post building was constructed in Year 1 and is now equipped with a new fridge for the storage of various medicines, especially vaccines, and a filing cabinet for the safe storage of patient records (Fig 1). The lights and fridge are powered by a new solar power system. The Aid Post was officially registered by the Provincial Health Authority on 13th August 2020 and is attached to the Usino Health Center.

The health structure in Papua New Guinea comprises three levels of health facilities. The first level is an aid post which is a rural health out-post. The hospitals are in towns and cities. The Health Centre is a second level health facility, bigger than an aid post but not big as the hospitals, and could also be in a rural setting. Since the hospitals are not accessible to the people in rural communities, the health centres manage the aid posts and facilitate the distribution of medical supplies to them. The Wanang aid post will report to the Usino Health Centre. The nurse (Michelyn John, a PNG national and trained research nurse with a qualification in primary care) started work at the Aid Post on 11th November 2020 and has been treating residents of the conservation collaboration area as well as Wanang Primary school teachers and their students. Both BRC and the Wanang community have indicated that they

are very pleased with her performance. The following statement was made by Filip Damen, Wanang clan leader:

'Wanang community appreciate and thank Darwin for the newly build Aid post. Darwin has taken the initiative to give this Aid post to Wanang community that is very unique and outstanding in most of the rural areas in PNG and within the surrounding community. The Aid post has fridge, solar system the makes it possible for the nurse to work both day and night. We are very happy with the nursing sister who is very committed in utilizing the medical facilities and medicine that was also funded by Darwin and also attentive to the patients. The Aid Post is one of the basic services that really satisfied the needs of the community and we thankful for Darwin to taken the initiative to help up.

I also acknowledge other Darwin's ongoing project such as the Biodiversity and Buffer Zone that is working towards supporting conservation in the community. Darwin's involvement in the community, and its contribution will encourage us, our people and our children in Wanang community to work in collaboration to support and look after our forest, rivers and land to maintain this conservation project.

Wanang community is looking forward to continue to work together with Darwin and its ongoing projects in the future projects.'

The Wanang aid post has been sourcing most of its medical supplies locally through the Provisional Health Authority system, but this arrangement has been unreliable at times (a very common problem with the Aid Post system nationally) so we have been discussing with the health authorities how to improve the situation. In the meantime, BRC is helping with the purchase of medication to support the project and exploring strategies to prevent this happening after the end of the Darwin project.



Figure 1: Fridge for the storage of medicines; storage area; solar power; filing cabinet for patient records

1.5: In early 2020, the Wanang community elected six of its community (with equal gender representation) as members of the Health Committee (Table 1, Fig. 2) who will lead and manage any matters relating to the operation of the Aid Post. This is the first community organisation in Wanang with overt female membership. The committee has had one meeting since its formation but now plans to have meetings once every month. They have received training from BRC staff on how to conduct committee business and record the minutes of meetings.

Table 1: Wanaang Health Committee

Health Committee Member	Gender	Position
Tony Jori	M	Health Committee Chairman
Lonis Dima	M	Secretary
Roy Tom	M	Treasurer
Jayroldine Mansa	F	Member
Ancy Philip	F	Member
Doris Samuel	F	Member



Fig. 2. Wanaang Health Committee members (L-R): D. Samuel, T. Jori, J. Mansa, L. Dima, A. Philip, R. Tom

1.6: The nurse started working at the Wanaang aid post in November 2020. Between then and 31 March 2021, c.600 patients have had consultations and treatments/referrals for various diseases. This is in line with our expectations. A 10-week snapshot is provided in Tables 2 and 3. Skin conditions such as Yaws, tropical ulcers, and *Tinea imbricata* (Fig 3) are especially prevalent, as is Malaria, but a wide range of other conditions are also being treated at the Aid Post. Anonymized summary data of all treatments in the period is available for audit. In addition to routine Aid Post work the Nurse has also conducted ante-natal classes and a community Water, Sanitation & Hygiene audit. She has also provided clinical interventions that, while within the scope of her certified clinical practice, is at a level not expected for most Aid Posts. For example, she removed the retained placenta of a patient who gave birth suddenly in the community, which in this setting if she had not done so could reasonably have been expected to have killed the patient. This was made possible by the supply of a mobile phone by the project, the purposeful citing of the Aid Post at the top of the hill with best reception, and arrangements put in place by the nurse for tele-medicine supervision for emergency cases from the provincial hospital.

Table 2: 10-week snapshot of general disease diagnoses, treatments/referrals

Condition	Cases
Yaws	102
Malaria	100
Other skin, including infections	84
Pneumonia	65
Other cases	36
Diarrhoea	18
Other respiratory	7
Eye infection	7
Asthma	5
Ear infection	5
Food poisoning	3
Psychological stress	2
Beating and Achilles tendon injury (domestic violence)	1

Table 3: Vaccinations and medications carried out during Maternal Child Health and Polio Clinics

Vaccinations and medications	Recipients
Oral Polio Vaccination	112
Vitamin A	106
Mebendazole	102
Sabin (polio vaccine)	85
Albendazole	84
Vitamin A	60
DTP-HepB-Hib (Pentavalent)	54
PCU 13	51
Measles Rubella	51



Fig. 3. Neglected Tropical Skin Diseases at Wanang. Left to Right: *Tinea imbricata*, yaws, tropical ulcers.

The nurse has also visited the Health Departments in the province and at the district level, consulting the authorities to organize medical supplies, and also made sure that her registration in the government system will allow for the payment of her salary beyond the Darwin project lifetime.

All records of individual patient consultations, treatments and inoculations are kept at the Aid Post in a secure locked filing cabinet that is accessible only by the nurse. Once a month,

carbon copies of the latest patient records (redacted of patient names) and medicine stock takes are released by the nurse to a designated member of BRC staff who transports them to BRC in a sealed and locked container where forms are scanned and uploaded onto the University of Sussex secure cloud content management system. To ensure maximum security and confidentiality of the records, only the nurse and the BRC Deputy Director (Dem) hold keys to the transportation folder. Analyses of the anonymised data are performed at Sussex (Middleton).

Output 2:

Activity 2.1: Establish new 1,000ha no-impact core conservation area (no hunting, no gardening), map with GPS verified boundaries, and declare in operation by WCA.

The nine local clans in Wanang have all signed forms agreeing to the establishment of a new 1,000 ha no-impact zone (NIZ) with a stricter conservation regime (no hunting, no gardening) within the existing Wanang Conservation Area (WCA) and in addition to the NIZ that was already in operation (Fig 4; for signed agreements, see Annex 4). The boundary has been agreed with the landowners, mapped using GPS and the boundaries marked in the field using indelible paint on trees at major access points (Figs. 4, 5).

Activity 2.2: Carry out mammal and bird surveys of new no-impact zone.

Surveys of mammals and birds were conducted in the NIZ in July 2020. A four-day examination of the bird community was based on 7 point-count surveys. The mammal team used a combination of snap traps and spot lighting. Detailed results are given in Annex 5.

Activity 2.3: Establish two additional primary forest fragments (c900ha total), map with GPS verified boundaries, and declare in operation by WCA.

Two primary forest areas of 300 ha and 1,484 ha originally outside the WCA have been established as the new conservation areas through agreement with local communities that had been previously engaged with the logging operation in the area (Figs. 4, 5) (for signed agreements, see Annex 4). This comprises nearly double the total area of forest that was originally planned to be brought under protection (900ha). The larger of these two areas is contiguous with the existing WCA (see map, Fig 5), providing further conservation benefit through minimized fragmentation.



Fig.4. Clan leaders showing signed agreements on the establishment of the no-impact core conservation zone on their land (left); a field assistant marking the boundary of the no-impact zone in the Wanang forest (centre left); and landowners Albert Mansa (centre right) and Samuel Jepsi (right) signing agreements for the protection of the two new forest fragments.

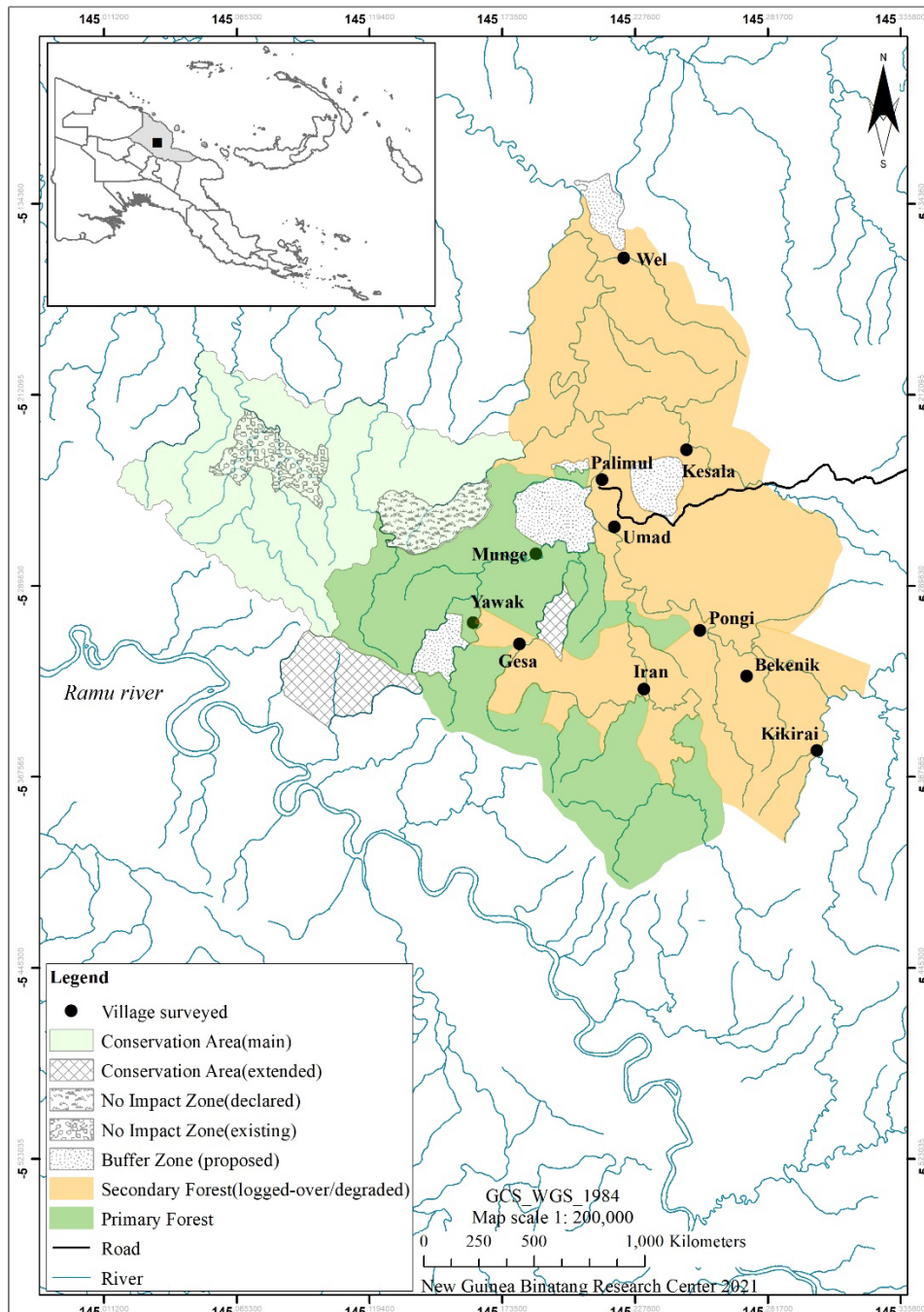


Fig. 5. Land-use map of the Wanang Conservation Area (WCA) showing the new primary forest fragments, the new extra No Impact Zone (declared) within WCA, and the new Buffer Zone areas. Please note that the buffer zone areas have now been confirmed (although listed in the legend as 'proposed').

Activity 2.4: Carry out plant and bird surveys of the two additional primary forest fragments.

Plant and bird surveys were completed in the two new primary forest fragments in July 2020. Point counts were used as sampling units to compare species richness of birds among the three sites. Vegetation surveys were conducted in three 20x20 m plots in each of the two forest fragments. All stems with a DHB of 5cm and above were measured, identified and tagged. Both fragments were found to comprise high quality primary forest with many large trees, few signs of disturbance and very few species typical of secondary forest. A total of 116 bird species were recorded across the two fragments (mostly forest canopy species), which is comparable in community richness to the WCA 50ha plot (100 species). Detailed results are given in Annex 5.

Activity 2.5: Establish buffer zones of 3,000ha of selectively logged forests with indigenous landowners, map with GPS verified boundaries, and declare in operation by WCA.

Five parcels of land have now been declared by local communities as 'buffer zone' areas (Fig.5) with a combined estimated area of 2,342 ha. The area owned by the Unalingu

community is entirely primary forest, but the other four parcels are comprised of a spatially heterogeneous mixture of primary and secondary forest. The actual areas (based on ground surveys) or estimated areas (based on GIS) of the land parcels are as follows: Yawak: 426 ha (actual); Palimul: 63 ha (estimated); Kesala: 513 ha (estimated); Wel: 399 ha (estimated); Unalingu: 941 ha (actual).

We have been in discussion with the Musak community who have yet to confirm how much of their forest they will set aside as buffer zone, but we expect this will bring the total up to at least the target of 3,000 ha. The separate parcels of land form a broad protective arc around the eastern side of the WCA. We are in negotiation also with landowners from Munge about them including an area of their primary forest to consolidate the arc by linking the existing parcels. This would help to ensure the protection of the substantial area of primary forest between these buffer zone areas and the pre-existing WCA. Whilst the concept of a 'buffer zone' normally involves land that provides a protective border along the side of a protected area, we suggest that the arrangement here effectively serves the same function and may even ultimately result in a larger area of land protected from logging, even if the intervening area is not formally part of the protected land.

Activity 2.6: Record and analyse vegetation community composition yearly in the two buffer zones.

The Yawak parcel was surveyed in December 2020 using six 20x20m plots: three in primary and three in secondary forests. All woody plants with DBH of 5cm+ were recorded. 80 species were recorded across the primary forest plots, with 24% of individual stems recruited from three plant families, compared to just 18 species in the secondary forest plots. Tree species composition showed a clear difference between the primary and secondary forests, although there was considerable variation between plots. The bird community in the Yawak parcel was also recorded as an extra output. Detailed results are given in Annex 5. Three other buffer areas have been surveyed (data not reported here), and one buffer area is yet to be surveyed due to land disputes.

Birds were not originally a target group for surveying in the buffer zone areas, but they were included as an additional taxon because their species diversity is also affected by forest disturbance and change in forest structure and they are therefore informative about overall forest condition.

Activity 2.7 BRC staff carry out forest inspections every six months of new no-impact conservation area, two additional primary forest fragments, and 3,000ha buffer zone forests.

Inspections of the new no-impact zone and the two forest fragments were carried out in February 2021. A checklist system has been employed to assess whether there have been any signs of disturbances at these sites such as evidence of hunting or creating gardens. In summary, there were no indications of disturbance within and around the survey plots, the forest fragments and the NIZ (Fig. 6; see inspection reports in Annex 4). The buffer zone areas are currently being surveyed. All forest target areas will be inspected at six-month intervals through to the end of the project.



Fig. 6. Photos taken during forest condition inspections in the NIZ (left), forest fragment 1 (centre) and forest fragment 2 (right)

Activity 2.8 Collect and analyse household survey data on attitudes to conservation in buffer zone communities outside pre-existing WCA boundary and agreements, before and after health intervention.

The protocol and consent forms for the social surveys were finalised by September 2020. The social research team have completed the first phase (pre-health-intervention) survey of attitudes to conservation in 11 buffer zone communities including Wel, Kesala, Palimul, Umad, Munge, Yawak, Gesa, Iran,,Bekenik, Kikirai and Pongi (Fig. 5). 140 households were surveyed and 269 people gave their consent and participated in the interviews. Audio recordings of consent were used *in lieu* of written consent where necessary. New female research technicians were trained and recruited to the field team, further increasing the proportion of female research staff in the project, and enabling greater ability to obtain the perspectives of younger women who may not have otherwise felt confident in voicing their opinions. The survey in the village of Iran had to be suspended temporarily due to law and order issues but has since been completed. All the data have now been digitised.

The data have yet to be analysed in detail. In general, however, attitudes to conservation have been mixed. The buffer zone communities are new to the concept of forest conservation and do not have adequate knowledge of what it is and the benefits it could bring. Some people expressed the view that their previous community decision to allow logging was a mistake because the benefits that they were promised by logging companies never materialised. 95 percent of participants responded that they would not allow access for logging again after experiencing the destructive effect it had had on their forest and animals. On the other hand, the majority preferred cash crop farming or subsistence gardening rather than conservation for their land. Our objective will be to test the extent to which these attitudes have changed by project end.

Activity 3.1. Produce curriculum and materials for school and community level educational programmes on health and well-being benefits of forest conservation.

The education materials have been finalized and we have received comments from the Research and Conservation Foundation (RCF), an NGO in Goroka that specializes in environmental education of teachers. We have shared the draft curriculum and the pre-test questions with the Grade 8 teacher and the Head Teacher for the Wanang primary school for their feedback (Fig.7, left). The teachers gave very positive feedback on the materials and stressed the importance of using more pictorial diagrams and giving examples to help students to grasp the concepts. They have recommended that, instead of teaching the material as a separate subject, it could be integrated and taught in line with other subjects such as social science etc. We trained the teachers in ecosystem services mapping and impact-chain mapping, in preparation for student practical exercises (Fig. 7, centre & right).



Fig.7. Wanang teachers in discussion with the BRC team on the curriculum material (left) and doing a training activity on concept mapping (centre & right).

Activity 3.2 Provide educational programme in Wanang School (c250 pupils, 35% female), making any necessary improvements to programme following delivery.

This activity has been somewhat delayed as the Wanang school has been closed for much of the reporting period as a result of COVID-19. However, the educational material is ready for first delivery in Wanang primary school in May 2021, two weeks after the students take the pre-

test. Improvements following delivery will then be incorporated for roll-out in other partner schools.

Activity 3.3. Provide educational programme in BRC network of 5 village schools (c 750 pupils, not in the new buffer zone), making any final necessary improvements to programme following delivery.

After trialling the delivery of the curriculum and gaining some experience in Wanang school, the material will be rolled out to schools in other partner communities with whom BRC are already working in the Madang region. These will include Ohu, Ambarina, Baiteta, Bundi, and Sinopass primary schools (Fig.8).



Fig. 8: Map showing locations of other partner communities where educational programme will be delivered to schools.

Activity 3.4. Provide educational programme in BRC partner communities across PNG (c5000 pupils), making any necessary improvements to programme following delivery.

Provision of the education programme in BRC partner communities across PNG will come after the finalization of the material and its delivery in the Madang region.

Activity 4.1. Collect and analyse health, well-being, and livelihood data from 10 villages with forests that are either (i) intact, (ii) logged, or (iii) with ongoing logging.

Ethical approval for the survey was approved by the PNG University of Technology in March 2021. Masters student Ben Ruli has secured agreements with ten suitable village communities in which to conduct this survey: four communities with intact forest, includes Sepu, Lainbuai, Kumbakap and Warabruk; three communities with ongoing logging includes Baisarik, Amaimon and Wanna, and three communities with ceased logging activities includes Kelengap, Kwanang and Mungem.

The start of field work was delayed because female interviewers recruited to assist with data collection were not able to travel freely due to Covid-19 restrictions. The travel restrictions have now been relaxed, so the field work will start with a reconnaissance trip, planned for the last week of May, to visit these identified communities.

Activity 4.2. Collect and analyse biodiversity data from 10 sites also visited for 4.1.

This activity is yet to be implemented and will take place after the activity for 4.1.

Activity 4.3. Systematic review of efficacy of integrating health services into tropical forest conservation projects worldwide.

Focusing first on other projects funded by the Darwin Initiative, we performed a review of all Darwin-funded projects which ever had a focus explicitly related to human health, as identified

in the project information on the Darwin Initiative website (see report in Annex 7). We then expanded our search more broadly, including through published and grey literature, and professional recommendations with the aim of producing a systematic picture of projects worldwide.

Our mapping quickly indicated that many of these interventions are carried out by non-governmental organisations in response to local needs and are not subsequently published in the academic literature. We therefore reached out to the wider Planetary Health community to help us find projects, especially those that might only ever have been published in grey literature, or not reported at all. Our current total list comprises 64 projects led or co-led by 48 different organisations, including WWF, Pathfinder International, Health in Harmony, the Jane Goodall Institute and Margaret Pyke Trust. Key members of all identified projects have been invited to contribute data on their interventions through an online form. We also sent invitations to collaborate to members of the IUCN WCPA Health and Well-Being Specialist Group Advisory Committee, and to the wider community of clinicians working on integrated health and conservation projects via (1) a correspondence piece published in the journal *The Lancet Planetary Health* (Middleton et al. Mapping evidence on integrated conservation and health projects worldwide: an appeal for help in identifying past and ongoing interventions'), and (2) inclusion in the newsletter of the Planetary Health Alliance (a network of c230 academic institutions and NGOs working at the nexus of health and environment).

The online form enables submission of data usually more detailed than included in published reports, and in addition allows us to synthesise data from across projects which have never been publicly reported. Data categories include: location; start and end dates; size of the target population; nature of the health focus; nature of the conservation component; existence of baseline and follow-up data; theory of change and metrics used to measure outcomes. At present, it has generated 29 completed responses and 21 are in progress. The Qualtrics form can be viewed using this link:

https://universityofsussex.eu.qualtrics.com/jfe/preview/SV_4NGAvL7iM6k43VX?Q_CHL=preview&Q_SurveyVersionID=current. We expect to have completed all data collection by August 2021 and for the output publication/s to be ready for submission by project end.

Activity 5.1. Train 14 para-ecologists over 3 years in biodiversity survey methods. Total 280 person-days of training.

In total during the reporting period, we have trained 14 para-ecologists (1 female, 13 males) and four MPhil students: 150 person-days in total (see table in Annex 4). The land boundaries for the protected areas and the plant and bird surveys in the WCA and buffer zones have been used also as training exercises, training junior BRC para-ecologists and also the four resident MPhil students in the following activities:

1. GPS location of land boundaries in the field, map creation in GIS software
2. Plant taxonomy, sampling, preservation and databasing of herbarium specimens
3. Setting up, mapping and surveying of botanical plots
4. Bird taxonomy, bird voice recording and analysis
5. Quantitative bird surveys using point count methods
6. Ecological data analysis, biostatistics, ordination methods

Activity 5.2 Train 25 BRC staff and students in 'Wilderness First Aid - Advanced'. Two courses at BRC HQ and field sites for a total of 25 BRC staff and students (all PNG nationals, 25% female).

Training of a further 15 BRC staff and students (all PNG nationals, 25% women) has had to be postponed due to the Covid-19 pandemic that has prevented Jo Middleton (trainer) from travelling to PNG. Pending lifting of travel restrictions, the training may be possible in August/September 2021.

Activity 5.3 Train 5 BRC & 1 IMR research staff in UK. 1-month intensive training in: biodiversity survey; conservation project evaluation; ecology; microbiology; evidence synthesis

and meta-analysis; rapid anthropological assessments; health research. Visits to partner institutions.

The visits by one BRC para-ecologist and one IMR clinician/lead for training in the UK had to be postponed due to the Covid-19 pandemic. We are planning that these may be rescheduled for later in 2021, alongside the remaining two BRC staff due to come to the UK in the final reporting year.

Activity 5.4 Supervise research projects by 1 MSc student for 2 years and 1 BSc Hons student for 1 year based at the University of PNG.

Three Masters students (Ben Ruli, Daniel Okena & Gabriel Petuel; all enrolled at the PNG University of Technology) have been working on their research projects. Ben Ruli (Masters student) has been developing the questionnaire for the field survey of health, wellbeing and livelihoods (4.1) and is contributing to the systematic review (4.3). Brief progress reports for the other two students are presented in Annex 6.

3.1 Progress towards project Outputs

Output 1: Community health and health service provision for Wanang and surrounding communities has been improved, managed by a new community committee with equal gender representation (workstream 1).

A community health service for Wanang and other partner villages based on a full-time nurse-staffed Aid Post has been operational since November 2020. Records of clinical assessments, treatments and vaccinations are being made by the nurse, with copies transported to BRC and then loaded onto a secure cloud server. These data will allow us to measure overall improvement in community health and health service provision at Wanang by the end of the project through comparison with baseline health data.

Output 2: Wanang conservation Area has been upgraded and expanded with improved attitudes to conservation in new partner communities (workstream 1)

The no-impact zone within the WCA and the two new primary forest fragments that were agreed with landowners have been inspected. An absence of adverse factors (gardening, hunting, other disturbance) has been confirmed; future inspections will be done at six-month intervals. Biodiversity surveys have been completed: birds and mammals in the no-impact zone and plants and birds in the new forest fragments. Results for species richness and community composition in the new fragments compare favourably with those for the core WCA. Five parcels of land have been agreed with landowners as 'buffer zones', forming an arc around the eastern side of the existing WCA. Social surveys of attitudes to conservation have been completed in eleven communities in the buffer zone areas.

Output 3: Knowledge and understanding of the health and well-being benefits of forest conservation amongst school pupils and partner villagers has improved (workstream 2).

A full educational pack has been drafted and revised with input from school teachers and an education NGO and is now ready for delivery in Wanang School from the beginning of their next term (May 2021) after pupils have taken a pre-intervention knowledge test. Experience from this will then be used in a roll-out to schools in other partner villages.

Output 4: New evidence has been produced on the interlinkages between logging, forest conservation, health, well-being, and livelihoods in PNG, and tropical rainforests globally (work stream 3)

Significant progress has been made in assembling case studies of health and conservation programmes in tropical forest environments around the world and extracting relevant information from them. Ethical approval and agreement from ten village communities have been obtained for surveys of health, well-being, and livelihoods, including four in intact forest, three in previously logged and recovering forest and three in forests currently undergoing logging.

Output 5: Capacity has been expanded, and gender balance improved, in PNG environmental and health research (workstream 4)

Within-employment training of para-ecologists continues at BRC in a range of taxonomic, ecological and quantitative skills. Unfortunately, the global pandemic has prevented further planned training in Wilderness First-Aid, and has also precluded bringing further personnel to the UK for intensive training. Once current restrictions are lifted (in UK and PNG), this programme of visits will be restarted. A group of female research staff have been recruited from partner communities, trained, and employed to carry out surveys on attitudes to conservation and surveys on health, well-being, and livelihoods as part of the Darwin project. This has improved the gender balance within environmental and health research carried out by BRC. In addition, the female research nurse now employed at Wanang has joined the team in the reporting year and is benefiting from professional development as part of the project.

3.2 Progress towards the project Outcome

Project outcome: Enhanced human health resulting from health service provision promotes improved knowledge, awareness and positive attitudes towards rainforest conservation and facilitates enhanced biodiversity protection in PNG's remote and vulnerable village communities.

The Aid Post and nurse have been enthusiastically welcomed into the Wanang village community (see testimonial, Annex 4). Already, a large number of patients have presented at the aid post and been treated for a range of both chronic and acute conditions, some of which have necessitated referral to hospital. A substantial vaccination round has been completed. Considerable interest has been engendered in other communities, facilitating agreements with landowners for the establishment of new buffer zone areas in addition to the declared protection of two new primary forest fragments and establishment of a further no-impact zone within the existing WCA. The indicators remain adequate for measuring the intended outcome.

3.3 Monitoring of assumptions

Outcome:	Still holds true?	Comments	Source of evidence
The Wanang community continues to cooperate with our approach and remains committed to forest conservation; Health service provision is accepted and used by the community; A sufficient number of survey participants can be recruited; Community expectations of health service provision and health benefits can be managed; Formal approval is obtained from ethics review committees of University of Sussex and PNG Institute of Medical Research.	Yes	The Wanang community remains enthusiastic about the Aid Post and is starting to reap the rewards through improved health service provision; clan leaders have signed agreements for establishing 'buffer zone' forest fragments	Testimonial from clan leader, Filip Damen; medical records; signed agreements
Outputs:			
1.1 A sufficient number of trained community members remain resident in the community.	Yes	No changes apparent	
1.2 Suitably qualified nurse can be recruited and retained for aid post; suitable equipment can be sourced and maintained; access to medical supplies can be maintained.	Yes	Nurse recruited and actively treating patients; all equipment in place; medical supplies provided.	Patient records; monthly stock takes of medical supplies
1.3 Wanang community continue to support the principle of the Aid Post and resident nurse.	Yes	Wanang community remains enthusiastic about the Aid Post and nurse	
2.1 No hunting / no gardening instruction for new no-impact zone is respected by Wanang community.	Yes	No-impact zone established with clan agreement	Signed agreement; 6-monthly inspection records
2.2 Protection of isolated forest fragments can be maintained effectively.	Yes	6-monthly inspections initiated	6-monthly inspection records
2.3 Selectively logged forest can be protected effectively from further adverse impact or disturbance.	Yes	6-monthly inspections initiated	6-monthly inspection records
2.4 Village communities in the new buffer zones are prepared to maintain participation in attitudinal surveys.	Yes	5 'buffer zone' areas established; attitudinal surveys completed in 11 communities	Verbal agreements (to be followed later by written agreements)
3.1-3.3 BRC partner communities, and schools beyond Wanang, are prepared to participate in educational programme.	Yes	Wanang School keen to participate based on meetings with teachers	Record/photo of meeting with teachers

3.4 Department of Education remains receptive to idea of national educational package on the health and well-being benefits of forest conservation.	Yes	No meetings yet with DoE, but approval given by Provincial Education Authority	Signed approval on letter, 25.6.20 (see previous annual report)
4.1-4.2 Sufficient communities are prepared to, (i) participate in health assessments (clinical examinations, focus groups, key informant's interviews, ethnography), and (ii) allow biodiversity transect counts on their lands.	Yes	Ten village communities agreed to participate, based on visits to communities by BRC	Verbal agreements (to be followed later by written agreements)
4.3 Sufficient conservation organisations and other repositories of conservation case studies will co-operate by making internal evaluation documentation available for evidence synthesis.	Yes	64 projects across 48 organisations identified for online survey	Preliminary report (Annex 7)
5.1-5.4 A sufficient number of para-ecologists and BRC/IMR staff are interested in developing and broadening their skills base; suitable MSc and BSc Hons candidates can be recruited.	Yes	3 M.Phil. students continue their projects	Research project updates (see Section 3.1).

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

The planned impact in our original application form was: *Improved health status and support for rainforest protection in Wanang, and improved evidence and debate on the interaction between health and conservation in the tropics, reflected in PNG government policy.* The Aid Post is already making a tangible and quantifiable impact on the health status of the Wanang community, evidenced by the number of patients treated (in some cases for serious medical complaints). This represents an additional and direct contribution to poverty alleviation. A significant total area of additional primary forest has been brought into protection, hunting and gardening is no longer allowed in an additional tenth of the existing WCA and nearly the target area of buffer zone has been established, all evidenced by written agreements with local clans and checked in six-monthly inspections.

4. Contribution to the Global Goals for Sustainable Development (SDGs)

The project has made a direct contribution in the reporting year to the following SDGs: **SDG 03 (Good Health & Well-Being)**: A fully equipped Aid Post is operational in Wanang and a registered nurse is receiving and treating patients who previously lacked access to primary care services, thus contributing to 'access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all' (SDG target 3.8). As the section on activities towards output 1.6 show, the project has directly reduced risks of maternal mortality (target 3.1) and preventable deaths <5y (target 3.2), and targeted cases of malaria and neglected tropical diseases (yaws and scabies) (target 3.3). Previous training of BRC staff in emergency procedures was put to good use when a patient was evacuated to the hospital in Madang.

SDG 04 (Quality Education): The Forest Conservation and Health education curriculum has been written, discussed with schoolteachers in Wanang and revised accordingly. It will be introduced at the Wanang primary school in the next school term and then rolled out to schools in other partner communities across PNG. In line with SDG target 4.3 ('By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university') the project is providing university education for three masters students, and technical training for 14 para-ecologists. All recipients are PNG nationals, many from marginalised communities who would not normally have access to such educational opportunities (target 4.5).

SDG 15 (Life on Land): Two new primary forest fragments totalling 1784 ha are now under conservation agreements and the new 1000 ha no impact zone has been inspected to secure its status. The target of 3,000 ha of forest to be allocated as buffer zone (consisting of a mix of primary and secondary forest) around the pre-existing 10,000 ha core area has nearly been reached. Together, these actions have contributed to conservation of primary forest (target 15.1) and restoration of degraded forest (target 15.2).

Additional indirect contributions have been made to other goals, including SDG 01 (No Poverty) through health service provision and employment of staff supporting biodiversity research and monitoring and SDG 05 (Gender Equality), see below.

5. Project support to the Conventions, Treaties or Agreements

PNG had committed to doubling its total protected area of land by 2010, a plan not fully achieved since. However, the Conservation & Environment Protection Agency (CEPA), which is the government contact point for the CBD in PNG, includes the WCA in their strategy to achieve this goal, to which the addition of two new primary forest fragments by our project makes a significant contribution. CEPA has worked with BRC since 2011 on the development of the WCA and regards it as a transferable model for sustainable development and forest conservation in PNG and elsewhere. In 2020, BRC and the Wanang CA were included in the CEPA/GEF/UNDP Project on Sustainable Financing of PNG's Protected Area Network as an example of such sustainable financing. Although the AICHI target for 2010 has not been achieved, a new target has been set for 2022, where PNG aims to have 17.9 % of its total land as protected area.

6. Project support to poverty alleviation

The main contribution of this project to poverty alleviation will be through measurable improvements to community health and health service provision. Access to healthcare is defined as one of the poverty benefits that biodiversity conservation projects can bring (Information Note: *Poverty and the Darwin Initiative*, 2019). As indicated by Table 2 and 3, the Aid Post is already providing significant levels of healthcare to communities (10 villages, c2000 people) highly burdened with disease, but previously neglected by medical services.

Additionally, the project is bringing new income to the population of Wanang village (~600 people) in the form of salaries for assisting in field research, biodiversity surveys and forest status inspection work (such as porters, field assistants), construction of the aid post and conducting social surveys.

7. Consideration of gender equality issues

In our last annual report, we explained the particular background to gender issues in PNG: a strongly patriarchal society in which discussions around gender equality have to be approached sensitively. The recruitment of a female nurse and the establishment of an equal-gender six-person health committee in Wanang is helping to encourage a culture in which women are seen as having a useful contribution to make to society beyond their traditional role. Conventional advertising of opportunities (e.g. para-ecologist positions; first-aid training) tends to attract few women, although we do strongly encourage them to apply. We have deliberately recruited female survey staff from partner communities.

8. Monitoring and evaluation

We have been operating a system of continuous monitoring and evaluation of the project through the following measures:

- Sussex staff have weekly meetings about the project, and two-hour monthly Zoom meetings are held between Sussex (Stewart, Middleton) and BRC (Novotny, Dem, Sui, Ruli, Philip) to review progress of all activities and plan ahead, tracking against the logframe and checking that assumptions still hold.
- The Aid Post nurse provides monthly copies of all patient consultation and treatment documents and a monthly stock-take of medicines, anonymized versions of which are uploaded onto secure University of Sussex storage for semi-continuous audit by Middleton (Brighton and Sussex Medical School). Similarly, data from activities such as

ecological surveys are uploaded onto the same system by BRC on a rolling base, and are assessed by Stewart.

- Newly declared forest fragments and the no-impact zone receive 6-monthly inspections for evidence of hunting or gardening and any other signs of human disturbance
- Masters students are based at BRC and thereby receive continuous oversight of their progress
- M&E is inherently built into the design of the project in that we are evaluating (against baseline data) the impact of the provision of the Aid Post and associated medical services on: (1) shifting ecological composition of the new recovering buffer zone, (2) attitudes to conservation in buffer zone communities, and (3) metrics of health service provision and community health across the target population.

The universal adoption of teleconferencing (via Zoom) and secure cloud storage has revolutionised our ability to monitor and evaluate progress on the project continuously. Communication between BRC and the Wanang aid post has been facilitated by the rapid adoption of mobile phones: something that was simply not possible in previous projects.

9. Lessons learnt

Things that worked well:

The strategy of using BRC's contacts to approach and negotiate with villages targeted for the buffer zone and the new primary forest fragments has worked very well, at least partly because many of the para-ecologists working at BRC come from or have strong connections with these communities. The result is that we have successfully increased the total area of protected forest from c.10,000 ha to nearly 14,000 ha. Involvement of the Wanang community from the start has also facilitated the successful development of the aid post. Careful selection amongst the candidates for the nurse position, including involvement and approval of the community, has ensured that the nurse has been both accepted and welcomed by the community. Our new collaboration with the PNG Institute of Medical Research (IMR) enabled us to recruit a good quality candidate: a fully qualified nurse, but also someone recruited from a research background who is familiar with research methods and culture. We also believe that a multi-disciplinary project of this complexity would not have been possible without the central involvement of BRC on the ground and our long-standing history of collaboration with them.

Things that worked less well:

Certain activities in our project have experienced significant delays as a result of a variety of circumstances. The Covid-19 pandemic has undoubtedly had an effect, although rather less severely than might have been expected. Nevertheless, it has delayed testing and implementing the new curriculum in Wanang school because it has been closed for a whole term. Other contributory factors have been: delays in recruitment (of nurse); significant delays in getting ethical approval for field surveys of the relationship between logging and wellbeing and livelihoods; social unrest in partner communities making it unsafe for staff to visit; the amount of time needed to negotiate with landowning communities for the release of their land as new protected forest fragments or as buffer zone areas.

Recommendations for other project leaders:

Our top recommendation would be always to work with a well-established local in-country partner organisation, rather than expecting to be able to run a project remotely from the UK. In our case, we have built up a 20-year history of collaboration with BRC which has been a vital partner and facilitator for our projects. Importantly, this means that the on-the-ground work has been carried out by PNG nationals with strong connections with local communities. The Covid-19 pandemic has shown that our project has been able to continue in circumstances where other remotely run projects may have struggled.

Related to this, we strongly recommend that projects appoint a locally based project manager (full-time or otherwise) who has full responsibility for coordinating and facilitating the project on the ground. This is especially important where projects are logistically complex and have multiple components (as ours).

The other lesson that arises out of the Covid-19 pandemic is that project leaders should anticipate that unforeseen crises that fundamentally threaten the success of their project may happen (whether these are the result of social or political unrest, disease epidemics such as Covid-19, loss of key staff, environmental disasters such as floods, fires, earthquakes etc.) and factor them into their plans. This could mean having to assume that a certain proportion of project time will be lost as a result of these unpredictable circumstances.

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

The reviewer's comments on our first Annual Report were both timely and helpful. Our responses are contained in other sections of this report (see table below):

Reviewer's comment	Our response
1. The Report presents minimal supplementary evidence, and would benefit from material such as meeting minutes, training reports and so on. This should be provided with the next annual report	Please see Annex 4 for testimonial letter, landowner agreements, minutes of Wanang Health Committee meeting, training log, forest inspection reports.
2. More detail could be provided in future reports on how the project is contributing to poverty alleviation in particular, and also support for conventions, treaties or agreements	Please see section 6, above
3. The Report should provide more detail on how well the M&E has worked in practice throughout the year, and the individuals and organisations involved	Please see section 8, above

11. Other comments on progress not covered elsewhere

There have been no changes to the design of the project over the year. However, there have been significant delays in completing some of the biodiversity surveys and attitudinal surveys. This has partly been due to temporary local unrest in certain communities making it unsafe for staff to carry out their survey work (e.g. in the Musak community, since largely resolved). The other factor has been Covid-19. These delays have narrowed the interval between the pre- and post-intervention survey times, resulting in a risk that positive changes may be harder to demonstrate. Whilst we remain confident that we will be able to demonstrate changes in attitudes and certain biodiversity metrics by the end of the project, the magnitude of those changes may not be as great as we might previously have expected.

12. Sustainability and legacy

The progress in the approval of the health post and the salaried position of the nurse indicates that our assumption that the aid post could ultimately be made sustainable was correct and we envisage achieving this by the end of the DI project. The Provincial Health Authority has agreed to sustain the aid post after the Darwin project finishes.

The Covid pandemic demonstrated that our funding model combining income linked to research with community development projects linked to conservation is robust, as evidenced by the fact that the WCA continued to execute research throughout the reporting period 2020-21, including [i] Czech Science Foundation project testing the Janzen-Connell hypothesis in tropical vegetation, [ii] the ForestGEO 50ha plot vegetation surveys, [iii] the University of South Bohemia (Czech Rep.) project surveying forest regeneration in seedling plots, and [iv] Smithsonian Tropical Research Institute long-term insect abundance surveys.

13. Darwin identity

We acknowledge the contribution of the Darwin Initiative on all publications and publicity materials including press releases. All presentations and talks by students, staff and collaborators at conferences and seminars use the Darwin logo on their slide presentations, as do all training workshops conducted by UK trainers and PNG staff. All our papers in (1) *Oecologia* on plant and bird diversity in the WCA, (2) *The Lancet Planetary Health* on mapping evidence on integrated health and conservation projects, (3) *Sustainability Science* on the rationale, experience and ethical considerations underpinning the project, and (4) *Proceedings of the National Academy of Sciences* on the decline in language diversity and ethnobiological skills in PNG (see Publications in Annex 3) acknowledge the Darwin Initiative as a co-funder.

The Darwin Initiative contribution is acknowledged on the websites for the Centre for Postgraduate Biology (<http://binatangstudents.weebly.com/partners.html>) and the Binatang Research Center (<http://baloun.entu.cas.cz/png/parataxoweb.htm>) as well as our personal websites (<http://www.sussex.ac.uk/lifesci/stewartlab/research>), and our team twitter account (https://twitter.com/Surfaces_PNG).

14. Impact of COVID-19 on project delivery

At the point when our last Annual report was written, PNG had reported only a limited number of cases of COVID-19 and very few deaths by international standards. Unfortunately, that is no longer the position as there has been a significant recent increase in cases (now >17,000 confirmed cases and 174 deaths) and every indication that they will continue to rise especially in the main cities. The population of over 9 million people is served by only c.500 doctors and the health system is poorly equipped to cope with a major pandemic, not helped by poor uptake of vaccines offered as a result of widespread conspiracy theories. At the moment, it is unclear how the virus will spread in rural areas where village communities may be protected to some extent by their isolation. We continue to monitor the situation carefully both locally and nationally. Fortunately, we are especially well placed to do this as (1) one of our in-country Co-Is (Dr Moses Laman) has been leading much of the COVID-19 test and trace programme nationwide, and (2) Sussex Co-Is with health service backgrounds (Middleton, Cassell) are engaged in multiple UK public health research projects on COVID-19 (for example, UKRI 'Epidemic modelling and statistical support for policy: sub-populations, forecasting, and long-term planning': <https://gtr.ukri.org/projects?ref=EP%2FV027468%2F1>) which informs our understanding and planning.

BRC has also been contracted by FAO to provide them with the village community surveys on the COVID situation, local responses to COVID and the livelihood impacts of COVID, including Wanang and other communities in the wider area.

The COVID-19 pandemic has seriously impacted our project in the following ways:

- Preventing international travel and therefore visits to the UK by para-ecologists and IMR staff as well as visits to PNG by UK staff.
- This has postponed various activities planned for UK staff visits, including: the Wilderness First Aid refresher training for BRC staff; training in immediate trauma care and evacuation procedures for Wanang community.
- Travel restrictions within PNG, delaying capacity to do biodiversity surveys, attitudinal surveys, forest inspections, negotiation with landowners for setting up buffer zone areas, and the collection of health & well-being data from remote communities.
- Extended school closures slowed progress on the school-based educational work.

We are confident that we can deliver on all the outputs by the end of the project in spite of these challenges. The main impact, however, has been delay in the opening of the Aid Post and on the timing of the biodiversity and attitudinal surveys, such that the intervals between the pre- and post-health intervention surveys have narrowed considerably. This in turn may mean that insufficient changes have occurred by the end of the project for us to be able to demonstrate a distinct effect of health service provision.

We have made regular use of virtual meetings to continue management of the project: monthly progress meetings between Sussex staff and BRC to monitor progress; weekly progress meetings between the Sussex staff; ad-hoc meetings for resolving emerging issues. This facility has been hugely beneficial and these arrangements will undoubtedly continue until the end of the project.

Knowing that biodiversity conservation in PNG is mainly conducted by small organisations (mostly NGOs) with relatively small budgets, we have become concerned to find out how the long-term viability of these organisations and the sustainability of their conservation projects has been affected by the pandemic. Accordingly, we applied to the Darwin COVID-19 Rapid Response call in November 2020 with a project entitled *Covid-19 impacts on biodiversity conservation and research in PNG*. This was not successful, so we responded to a University of Sussex internal call, funded jointly by the International Development Challenge Fund (funded from Sussex's allocation from the Global Challenges Research Fund) and the Sussex Sustainability Research Programme for projects limited in scope (maximum £100,000 for 7-month projects, 1.1.21-31.7.21). We were successful with a project entitled: *Mapping COVID-19 impacts on Papua New Guinea conservation and building a collaboration between ecology, arts, and the humanities to help preserve forests and indigenous land rights*. This has two work packages:

1. *Assessing COVID-19 impacts on biodiversity conservation and research in PNG*: We are combining an internet based questionnaire for NGOs, universities and research institutes with PNG field teams visiting three conservation communities to evaluate threats to biodiversity from opportunistic resource exploitation including logging, shifts in community priorities if conservation-related income streams fail, and decline in research and student training. This will allow us to anticipate the long-term effects on biodiversity and develop mitigation plans. Field teams surveying our partner communities will also disseminate protective medical supplies and up-to-date COVID-19 advice produced in collaboration with our partners in the PNG Institute of Medical Research.
2. *Mobilising the Arts and Humanities for conservation and indigenous land rights in PNG*: We believe that the Arts and Humanities (A&H) can valuably contribute to biodiversity conservation by enlarging knowledge of the human dimensions of environmental challenges, and being a vehicle for interventions, including defending indigenous land rights. However, in PNG A&H have not been fully utilized in the service of these linked issues, so we are building new links between A&H in the University of Sussex and A&H in the University of PNG, together with our partners at BRC. We are conducting a landscape review of PNG A&H research and its relationship to biodiversity protection and land rights through a series of four interactive, iterative online workshops to establish its status and capacity building needs.

15. Safeguarding

No safeguarding or human rights violations have occurred during this financial year.

The University of Sussex (as lead organisation) has a safeguarding policy (<https://www.sussex.ac.uk/safeguarding/>) that covers all the issues around bullying, harassment and sexual exploitation and abuse. This has been shared with our main partners at BRC who have been developing their own local policy in this area (see Annex 4 which reproduces Section 2.7 of their Operational Manual and Section 16.4 of their Employment Manual). This includes clear protocols for how individuals can raise their concerns and how those concerns will be dealt with.

16. Project expenditure

As agreed, this table will be completed by the University of Sussex's Research Finance department and forwarded to the Darwin secretariat separately.

Table 1: Project expenditure during the reporting period (1 April 2020 – 31 March 2021)

Project spend (indicative) since last annual report	2020/21 Grant (£)	2020/21 Total Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)				
Consultancy costs				
Overhead Costs				
Travel and subsistence				
Operating Costs				
Capital items (see below)				
Monitoring & Evaluation (M&E)				
Others (see below)				
TOTAL				

Annex 1: Report of progress and achievements against Logical Framework for Financial Year 2020-2021

Project summary	Measurable Indicators	Progress and Achievements April 2020 - March 2021	Actions required/planned for next period
<p>Impact</p> <p>Improved health status and support for rainforest protection in Wanang, and improved evidence and debate on the interaction between health and conservation in the tropics, reflected in PNG government policy.</p>		<p>Following opening of the Aid Post, a large number of patients have been treated, resulting in the immediate improvement in health of the Wanang and wider community, accompanied by more favourable attitudes to forest protection.</p>	
<p>Outcome Enhanced human health resulting from health service provision promotes improved knowledge, awareness and positive attitudes towards rainforest conservation and facilitates enhanced biodiversity protection in PNG's remote and vulnerable village communities.</p>	<p>0.1 Improved community and individual health status by Y3 end measured against SDG and other health targets, and improved ability to provide first aid and emergency evacuation, in the ten communities (Wanang + 9 others) that have accessed the health post.</p> <p>0.2 Protected areas expanded and enhanced for biodiversity by end of year 3, through: (i) increase of 1,000 ha to the core no-impact zone of the Wanang Conservation Area (WCA); (ii) buffer zones of 3,000 ha bordering WCA of selectively logged forests created by neighbouring communities; (iii) declaration of two new conservation areas, totalling 900ha, thus increasing total protected area by 10%. People in protected area communities show more positive attitudes towards forest conservation by the Y3 end, compared to baseline, as a result of health intervention.</p> <p>0.3 School pupils and village residents have improved understanding and attitudes towards the health and wellbeing benefits of forest conservation in: (i) Wanang school</p>	<p>Provision of health services has encouraged agreements with landowners to establish buffer zone areas totalling nearly the target of 3,000ha.</p> <p>New school curriculum on the health and wellbeing benefits of forest conservation has been written, discussed with teachers and modified accordingly, ready for delivery to Wanang School at start of new term in May 2021.</p> <p>Systematic map developed of interaction between biodiversity and human health, well-being, and livelihoods from projects across the tropics.</p>	<ol style="list-style-type: none"> 1. Continue to receive & treat patients in Aid Post 2. Negotiate, declare and survey further buffer zones around existing WCA to bring total area covered to target of 3,000ha. 3. Roll out new curriculum on health and wellbeing benefits of forest protection across network of schools in PNG 4. Continue to gather, collate and synthesise evidence on integrated health and conservation programmes in tropical forest systems 5. Train M.Phil. students and para-ecologists 6. Collect end of project data, and compare to baselines, on (1) health service provision and community health metrics in target population, (2) plant community composition in recovering secondary forest, and (3) attitudes to conservation in buffer zone communities.

	<p>(250 pupils, by Y1 end), (ii) 5 villages in BRC's schools network (750 pupils, by Y2 end), and (iii) BRC's partner communities (5,000 pupils, by Y3 end). 0.4 Improved understanding by project end of the interlinkages between biodiversity and human health, well-being, and livelihoods in PNG rainforests, and the efficacy of combined tropical forest conservation and health projects worldwide (through evidence synthesis). 0.5 Enhanced national capacity for biodiversity and anthropological survey and research, first aid and health research, by Y3 end, through training of BRC and IMR staff, paraecologists, and students.</p>		
<p>Output 1. Community health and health service provision for Wanang and surrounding communities has been improved, managed by a new community committee with equal gender representation (workstream 1)</p>	<p>1.1 By 6 months from project start, 12 WCA community members (25% female) are able to carry out immediate trauma care and evacuation procedures. 1.2 By Y1 end, Aid Post built, suitably equipped, staffed, and operational. 1.3 By Y1 end, new community health committee is able to manage the aid post and has equal gender representation. 1.4 Setting-adapted SDG health and health service indicators (https://sustainabledevelopment.un.org/sdg3) at in-community level have improved compared to baseline data collected in new WCA buffer zones at project start, or in the 2018 Wanang community health needs assessment (carried out in preparation for this application, in part to determine community health service priorities). Specifically: SDG 3.D.1 health worker density, by beginning of last quarter of Y1 an increase from baseline of 0:2000 to 1:2000 in the target population; SDG</p>	<p>Full-time nurse-staffed Aid Post has been treating patients and improving community health in Wanang, managed by a newly constituted community health committee with equal gender representation (evidence provided in section 3.1 of report).</p>	

	<p>3.B.1 proportion of the [paediatric] target population covered by all vaccines included in their national programme [measles and three doses of DTP-HepB-Hib pentavalent vaccine], has improved from <10% at baseline [Wanang] to 60% of those children across the target population 1-years old in Y3; SDG 3.1.2 proportion of births attended [in-community] by skilled health personnel has improved from 0% at baseline to 60% in Wanang, and at least 20% in buffer zone communities; SDG 3.3.5 number of people requiring interventions against neglected tropical diseases [specifically in this setting mycoses, scabies, yaws] has decreased 50% by Y3 end. By Y3 end, average self-reported current health status has improved at least 1 point along a 5-point scale. Re SDG 3.3.3 malaria, in-community availability of malaria Rapid Diagnostic Test and treatment has improved from 0% baseline availability to 70% availability to all who seek aid.</p> <p>1.5 Long-term health care plan supported by clinical data, targeting vulnerable groups (women, elderly) for WCA and surrounding communities produced by Y3 end.</p>		
<p>Activity 1.1 Collect and analyse qualitative and quantitative health and wellbeing data before and after the health intervention.</p>		<p>Baseline community health data was collected prior to health care intervention (Aid Post). Health data collected by nurse. Protocol for health assessments published in <i>British Medical Journal Open</i>.</p>	<p>Nurse to continue collecting quantitative data in standard format and transferring it to Sussex for audit, and with wider team collect end of project data</p>
<p>Activity 1.2, Train Wanang community members in immediate trauma care and evacuation procedures</p>		<p>Follow-up training prevented by pandemic. Requirement for refresher training identified.</p>	<p>Deliver refresher training.</p>

Activity 1.3 Trained Wanang community members respond to trauma and evacuation incidents as required.	One incident reported; patient successfully evacuated to hospital.	Nurse to record any incidents in monthly report to BRC.
Activity 1.4 Construct Aid Post, equip it, stock it with medicine, and recruit a nurse.	Aid post fully operational since 11.11.20. Medical equipment and medicines sourced and supplied. Female nurse (Michelyn John) started work 11.11.20.	Aid Post / nurse will continue to receive and treat patients, conduct vaccinations, record all consultations to supply data on community health.
Activity 1.5 Establish and train community health committee.	Six-person Wanang health committee established (20.4.20), with equal gender representation, and trained in conduct of meetings and minute taking.	Monitor programme of committee meetings; continue to provide training in conduct and recording of meetings.
Activity 1.6 Nurse staffed Aid Post receives and treats patients, maintains patient records.	Start delayed due to delay in recruitment of nurse and Covid-19, but Aid Post opened 11.11.20.	Ongoing treatment of patients, delivery of vaccinations and record keeping.
<p>Output 2. Wanang conservation Area has been upgraded and expanded with improved attitudes to conservation in new partner communities (workstream 1)</p>	<p>2.1 By Y1 end, core no-impact conservation area (no hunting, no gardening) in WCA is 2,000 ha (an expansion in area of 100% from 1,000 ha), as a response to the health intervention. New 1,000ha no-impact zone within WCA shows 25% increase in abundance of previously hunted mammal and bird species by project end.</p> <p>2.2 By Y1 end, WCA has two additional primary forest fragments (totalling 900ha, ~10% increase) protected from logging, as a response to the health intervention. By project end, the extra 900ha in two forest fragments will provide protection for an additional average of: (i) 34 individual birds/ha (across all species), based on previous WCA surveys showing a density of 1697 birds/50ha; (ii) 11.5 individuals of each of the ten rarest bird species (those with population densities of 1 individual or less per 50ha, based on surveys of the WCA 50ha plot); (iii) 15 tree species recorded across the combined protected areas, based on</p>	<p>WCA has received greater protection from logging through agreements with landowners for the declaration of five buffer zone areas, in addition to the previous imposition of an extra no-impact zone within the WCA and the declaration of two new primary forest fragments (evidence provided in section 3.1 of report). Social surveys have been done in these buffer zone areas before they were able to have the benefit of access to the Aid Post, providing a pre-intervention picture of attitudes to conservation.</p>

	<p>established plant species accumulation curves for the WCA.</p> <p>2.3 By Y1 end, an additional 3,000 ha of previously selectively logged forests have been protected from further logging or conversion to agriculture, and form a buffer zone around WCA, as a response to the health intervention. Buffer zones show post-selective-logging recovery of vegetation community by project end, measured as a statistically significant shift along a successional trajectory towards the community composition of primary forest.</p> <p>2.4 At Y3 end, buffer zone communities (9 villages: c1800 people, c300 households) outside pre-existing WCA boundary show improved positive community attitudes to conservation compared to baseline, as a response to the health intervention. Specifically, by Y3 end scored household attitudes to conservation show improvement in at least 144 of the 300 total households. (Based on expectation that 60% of total households will have sought medical support from the conservation collaboration by Y3 end, and in 80% of such households this results in improved attitudes to conservation).</p>		
<p>Activity 2.1 Establish new 1,000ha no-impact core conservation area (no hunting, no gardening), map with GPS verified boundaries, and declare in operation by WCA.</p>	<p>No-impact zone declared in previous report.</p>	<p>Survey at project end to assess change in mammal and bird abundance (target = 25% increase).</p>	
<p>Activity 2.2 Carry out mammal and bird surveys of new no-impact zone.</p>	<p>Full surveys completed.</p>	<p>As 2.1</p>	
<p>Activity 2.3 Establish two additional primary forest fragments (c900ha total), map with GPS verified boundaries, and declare in operation by WCA.</p>	<p>Two primary forest fragments declared in previous report.</p>	<p>Survey at project end to assess protection afforded to bird and tree species as defined in logframe</p>	
<p>Activity 2.4 Carry out plant and bird surveys of the two additional primary forest fragments.</p>	<p>Full surveys completed.</p>	<p>As 2.3</p>	

<p>Activity 2.5 Establish buffer zones of 3,000ha of selectively logged forests with indigenous landowners, map with GPS verified boundaries, and declare in operation by WCA.</p>	<p>Five buffer zone areas declared around eastern flank of WCA, totalling 2,342ha.</p>	<p>Agree, map and formally declare an extra buffer zone area to bring total to target of 3,000ha.</p>
<p>Activity 2.6 Record and analyse vegetation community composition yearly in the two buffer zones</p>	<p>Vegetation surveys completed.</p>	<p>Re-survey vegetation at project end to measure post-selective-logging recovery in plant community composition.</p>
<p>Activity 2.7 BRC staff carry out forest inspections every six months of new no-impact conservation area, two additional primary forest fragments, and 3,000ha buffer zone forests.</p>	<p>Inspections completed.</p>	<p>Carry out inspections at 6 months in Yr3 and at project end.</p>
<p>Activity 2.8 Collect and analyse household survey data on attitudes to conservation in buffer zone communities outside pre-existing WCA boundary and agreements, before and after health intervention</p>	<p>Attitudinal surveys completed in 11 buffer zone communities before Aid Post opened, involving 140 households and 269 people.</p>	<p>Re-survey buffer zone communities at project end for comparison with attitudes pre-health intervention.</p>
<p>Output 3. Knowledge and understanding of the health and well-being benefits of forest conservation amongst school pupils and partner villagers has improved (workstream 2).</p>	<p>3.1 By Y1 end, c260 pupils (35% female) at Wanang school will have improved knowledge and understanding on the health and well-being benefits of forest conservation, compared to baseline pre- educational programme. 3.2 By Y2 end, c750 pupils in BRC's established network of 5 village schools will have improved knowledge and understanding on the health and well-being benefits of forest conservation, compared to baseline pre- educational programme. 3.3. By Y3 end, c5000 people in BRC partner communities across PNG have improved knowledge and understanding of the health and well-being benefits of forest conservation, compared to baseline pre-educational programme. 3.4 In Y3, the Department of Education has a pre-trialled educational package on the health and well-being benefits of forest conservation, which can be rolled out to other communities and</p>	<p>A Forest Conservation and Health education programme on the health and well-being benefits of forest conservation has been developed for the PNG school curriculum, tested on children at Wanang School and modified in the light of comments from their teachers and the Research and Conservation Foundation (an education charity that specializes in environmental education of teachers) and prepared for roll-out in schools.</p>

	incorporated into nationally' set school curricula.	
Activity 3.1 Produce curriculum and materials for school and community level educational programmes on health and well-being benefits of forest conservation.		Feedback from testing collated and curriculum materials modified accordingly and finalised, ready for roll-out in schools. Full delivery of new Forest Conservation and Health curriculum in Wanang School, followed by roll-out in schools in other partner communities.
Activity 3.2 Provide educational programme in Wanang School (c250 pupils, 35% female), making any necessary improvements to programme following delivery.		Educational programme tested on pupils in Wanang School; feedback received from teachers and pupils and independent education charity; content modified and improved. Deliver educational programme in Wanang School; continue to receive feedback on curriculum content and modify accordingly.
Activity 3.3 Provide educational programme in BRC network of 5 village schools (c750 pupils, not in the new buffer zone), making any final necessary improvements to programme following delivery.		Not achieved. Roll out educational programme to village schools
Activity 3.4 Provide educational programme in BRC partner communities across PNG (c5000 pupils), making any necessary improvements to programme following delivery.		Not achieved. Roll out educational programme to village schools
Activity 3.5 Hold meetings with educational stakeholders, including Department of Education to arrange incorporation of educational package into educational plans nationally.		Correspondence with Department of Education to make them aware of educational package development. Hold meetings with DoE
Activity 3.6 Provide pre-trialled educational packages to PNG Department of Education for further roll-out beyond project and distribute editable version of package throughout international partners in the Planetary Health Alliance primary/secondary education working group.		Not achieved. Deliver final educational package to PNG Department of Education and Planetary Health Alliance education working group.
Output 4. New evidence has been produced on the interlinkages between logging, forest conservation, health, well-being, and livelihoods in PNG, and tropical rainforests globally (work stream 3)	4.1 By Y2 end, data collection is complete on the effects of forest status (intact, undergoing logging, or logged) on community health well-being, and livelihoods in 10 villages (3-4 villages in each land use category) in 100,000 hectare logging concession located near WCA. Data will include: (i) individual level data including demographics, social and occupational history, current health status and interventions, past medical history (including reproductive and child survival), present clinical observations (including Gross Development Index [children]), qualitative and quantitative	Ten communities identified and agreement reached for conducting health, well-being and livelihood surveys in communities of different forest status: four with intact forest, three with ongoing logging and three with previously logged forest that is now undergoing restoration. Sixty-four integrated health and conservation projects identified led or co-led by 48 different organisations. Data collection due to be complete by August 2021 (29 projects so far), with output publication/s by end of project.

	<p>data on subjective wellbeing, monetary income, (ii) community level data, including top-five (community ascribed) health problems, and livelihood benefits of differing forest status, including food sources and security (such as forest-use for swidden agriculture, hunting and harvesting plants), income, use of non-timber forest products; access to health provision (including the politics of access, transport etc.)</p> <p>4.2 By Y3 end, data collection complete on the biodiversity status of the 10 sites (as 4.1). Data will include: abundance and species diversity of plants, birds, and butterflies recorded along fixed 300m transects.</p> <p>4.3 By Y2 end, an evidence synthesis (in line with Collaboration for Environmental Evidence guidelines; reference #10) has been completed on the impacts of integrating health services into tropical forest conservation projects worldwide (based on our current evidence mapping, expected to be c60 projects).</p>		
<p>Activity 4.1 Collect and analyse health, well-being, and livelihood data from 10 villages with forests that are either (i) intact, (ii) logged, or (iii) with ongoing logging.</p>		<p>Ten villages identified across the 3 categories; agreement to participate in surveys obtained.</p>	<p>Collect and analyse data from the selected villages.</p>
<p>Activity 4.2 Collect and analyse biodiversity data from 10 sites also visited for 4.1.</p>		<p>Not achieved.</p>	<p>Collect biodiversity data.</p>
<p>Activity 4.3 Systematic review of efficacy of integrating health services into tropical forest conservation projects worldwide.</p>		<p>Review completed of Darwin-funded projects with a human health focus (additional output). Systematic map produced of projects integrating human health and biodiversity conservation worldwide: 64 projects (incl. 17 DI projects) led by 48 organisations. Online Qualtrics survey of these organisations/ individuals initiated: 29 completed responses received so far.</p>	<p>Complete survey, populate database of evidence and complete synthesis.</p>

<p>Output 5. Capacity has been expanded, and gender balance improved, in PNG environmental and health research (workstream 4).</p>	<p>5.1 By Y3 end, 14 PNG nationals (25% female) are able to carry out biodiversity surveys across multiple taxa and environments, to a scientifically sound standard. 5.2 By six-months into Y1, 25 BRC staff and students are able to do first aid techniques which may be required in remote fieldwork settings. 5.3 By end of first quarter of Y3, 5 BRC & 1 IMR research staff (all PNG nationals, at least one female) have gained knowledge and skills to acceptable standards in biodiversity survey; conservation project evaluation; ecology; microbiology; evidence synthesis and meta-analysis; rapid anthropological assessments; health research. 5.4 By end of first quarter of Y3, 2 PNG nationals (recruited on merit, from an expected 1:1 gender balance of application – see section 15 Gender) will be able to do health/environmental research projects at, respectively, masters and undergraduate level.</p>	<p>M.Phil. students continue their research topics; visits to UK by 2 para-ecologists and first aid training suspended due to travel restrictions. Redressing gender balance amongst students and trainees remains challenging; expected 1:1 gender balance amongst applicants for training positions not realised due to few female applicants for scientific positions overall (see Annual Report Yr1).</p>	
<p>Activity 5.1 Train 14 para-ecologists over 3 years in biodiversity survey methods. Total 280 person-days of training.</p>	<p>14 para-ecologists and 4 MPhil students trained (total = 150 person-days) using plant and bird surveys in WCA, new fragments and buffer zones for training in: plant & bird taxonomy, sampling etc; GPS/GIS; data analysis.</p>	<p>Ongoing training: 130 person-days</p>	
<p>Activity 5.2 Train 25 BRC staff and students in ‘Wilderness First Aid - Advanced’. Two courses at BRC HQ and field sites for a total of 25 BRC staff and students (all PNG nationals, 25% female).</p>	<p>Training suspended due to pandemic.</p>	<p>15 to be trained in 2021-22.</p>	
<p>Activity 5.3 Train 5 BRC & 1 IMR research staff in UK. 1-month intensive training in: biodiversity survey; conservation project evaluation; ecology; microbiology; evidence synthesis and meta-analysis; rapid anthropological assessments; health research. Visits to partner institutions.</p>	<p>Visits suspended due to pandemic.</p>	<p>3 BRC staff members (social scientist + 2 others, incl. 2 female) to visit UK in autumn-winter 2021-22 for intensive training. 1 staff member of PNG Institute of Medical Research (IMR) to visit UK in 2021-22 for advanced</p>	

		training and development of scientific networking opportunities.
Activity 5.4 Supervision of research projects by 1 MSc student for 2 years and 1 BSc Hons student for 1 year based at the University of PNG.	Ongoing supervision of 3 M.Phil. research students.	Continued supervision of 3 M.Phil. research students; completion of 3 MPhil projects.

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

Project summary	Measurable Indicators	Means of verification	Important Assumptions
<p>Impact: Improved health status and support for rainforest protection in Wanang, and improved evidence and debate on the interaction between health and conservation in the tropics, reflected in PNG government policy. (Max 30 words)</p>			
<p>Outcome: (Max 30 words)</p> <p>Enhanced human health resulting from health service provision promotes improved knowledge, awareness and positive attitudes towards rainforest conservation and facilitates enhanced biodiversity protection in PNG's remote and vulnerable village communities.</p>	<p>0.1 Improved community and individual health status by Y3 end measured against SDG and other health targets, and improved ability to provide first aid and emergency evacuation, in the ten communities (Wanang + 9 others) that have accessed the health post.</p> <p>0.2 Protected areas expanded and enhanced for biodiversity by end of year 3, through: (i) increase of 1,000 ha to the core no-impact zone of the Wanang Conservation Area (WCA); (ii) buffer zones of 3,000 ha bordering WCA of selectively logged forests created by neighbouring communities; (iii) declaration of two new conservation areas, totalling 900ha, thus increasing total protected area by 10%. People in protected area communities show more positive attitudes towards forest conservation by the Y3 end, compared to baseline, as a result of health intervention.</p> <p>0.3 School pupils and village residents have improved understanding and attitudes towards the health and wellbeing benefits of forest conservation in: (i) Wanang school (250 pupils, by Y1 end), (ii) 5 villages in BRC's schools network (750 pupils, by Y2 end), and (iii) BRC's partner communities (5,000 pupils, by Y3 end).</p> <p>0.4 Improved understanding by project end of the interlinkages between biodiversity and human health, well-being, and livelihoods in PNG rainforests, and the efficacy of combined tropical forest conservation and health projects worldwide (through evidence synthesis).</p>	<p>0.1 Data detailing health services provided compared to previously accessible services; clinical data from returning individuals; focus groups and interviews before and after health service provision (clinical individual primary care assessments, interviews with key respondents)</p> <p>0.2 Written approval by the WCA Conservation Board of enhanced no-impact zone. Conservation agreements with landowners in the villages neighbouring WCA regarding buffer zones and new conservation areas. Results of biodiversity surveys. Household survey data, before and after health service provision, on attitudes towards conservation, disaggregated by social group.</p> <p>0.3 Results of attitudinal surveys and knowledge tests.</p> <p>0.4 Database of case studies on interactions between rainforest integrity and human health. Evidence synthesis.</p> <p>0.5 Records and certificates from skills and knowledge tests and assessments.</p>	<p>0.1-0.4 The Wanang community continues to cooperate with our approach and remains committed to forest conservation; Health service provision is accepted and used by the community; A sufficient number of survey participants can be recruited; Community expectations of health service provision and health benefits can be managed; Formal approval is obtained from ethics review committees of University of Sussex and PNG Institute of Medical Research.</p>

	<p>0.5 Enhanced national capacity for biodiversity and anthropological survey and research, first aid and health research, by Y3 end, through training of BRC and IMR staff, para-ecologists, and students.</p>		
<p>Outputs: 1. Community health and health service provision for Wanang and surrounding communities has been improved, managed by a new community committee with equal gender representation (workstream 1).</p>	<p>1.1 By 6 months from project start, 12 WCA community members (25% female) are able to carry out immediate trauma care and evacuation procedures. 1.2 By Y1 end, Aid Post built, suitably equipped, staffed, and operational. 1.3 By Y1 end, new community health committee is able to manage the aid post, and has equal gender representation. 1.4 Setting-adapted SDG health and health service indicators (https://sustainabledevelopment.un.org/sdg3) at in-community level have improved compared to baseline data collected in new WCA buffer zones at project start, or in the 2018 Wanang community health needs assessment (carried out in preparation for this application, in part to determine community health service priorities). Specifically: SDG 3.D.1 health worker density, by beginning of last quarter of Y1 an increase from baseline of 0:2000 to 1:2000 in the target population; SDG 3.B.1 proportion of the [paediatric] target population covered by all vaccines included in their national programme [measles and three doses of DTP-HepB-Hib pentavalent vaccine], has improved from <10% at baseline [Wanang] to 60% of those children across the target population 1-years old in Y3; SDG 3.1.2 proportion of births attended [in-community] by skilled health personnel has improved from 0% at baseline to 60% in Wanang, and at least 20% in buffer zone communities; SDG 3.3.5 number of people requiring interventions against neglected tropical diseases [specifically in this setting mycoses, scabies, yaws] has decreased 50% by Y3 end. By Y3 end, average self-reported</p>	<p>1.1 Post-training skill assessments; audit of records of trauma/evacuation incidents throughout project 1.2 Building plans, builders' invoice, completion certificate, photo; equipment inventories at opening and at 3-month intervals; equipment inventories and staff and aid post activity logs reviewed every two months until project end. 1.3 Minutes and membership list (disaggregated by sex) of community health committee. 1.4 Analysed individual level clinical data from primary care assessments and interviews before and after health intervention: 120 participants at Wanang July 2018 (63% of population of 189 [all ages]), and expected minimum 360 participants (all ages) across buffer zone communities (20% of population, all ages); patient treatment records; aid post staffing records and inventories. 1.1-1.4. Manuscript #1 for submission to peer reviewed journal ('The Lancet Planetary Health'). "Clinical and conservation attitudinal changes following introduction of health services into an expanding community-led conservation project in Papua New Guinea" [note this publication also will report findings as given below in 2.4]. 1.5 Long-term health care plan for Wanang and buffer zone communities</p>	<p>1.1 A sufficient number of trained community members remain resident in the community. 1.2 Suitably qualified nurse can be recruited and retained for aid post; suitable equipment can be sourced and maintained; access to medical supplies can be maintained. 1.3 Wanang community continue to support the principle of the Aid Post and resident nurse.</p>

	<p>current health status has improved at least 1 point along a 5-point scale. Re SDG 3.3.3 malaria, in-community availability of malaria Rapid Diagnostic Test and treatment has improved from 0% baseline availability to 70% availability to all who seek aid.</p> <p>1.5 Long-term health care plan supported by clinical data, targeting vulnerable groups (women, elderly) for WCA and surrounding communities produced by Y3 end.</p>		
<p>2. Wanang conservation Area has been upgraded and expanded, with a resultant increase in biodiversity and improved attitudes to conservation in new partner communities (workstream 1)</p>	<p>2.1 By Y1 end, core no-impact conservation area (no hunting, no gardening) in WCA is 2,000 ha (an expansion in area of 100% from 1,000 ha), as a response to the health intervention. New 1,000ha no-impact zone within WCA shows 25% increase in abundance of previously hunted mammal and bird species by project end.</p> <p>2.2 By Y1 end, WCA has two additional primary forest fragments (totalling 900ha, ~10% increase) protected from logging, as a response to the health intervention. By project end, the extra 900ha in two forest fragments will provide protection for an additional average of: (i) 34 individual birds/ha (across all species), based on previous WCA surveys showing a density of 1697 birds/50ha; (ii) 11.5 individuals of each of the ten rarest bird species (those with population densities of 1 individual or less per 50ha, based on surveys of the WCA 50ha plot); (iii) 15 tree species recorded across the combined protected areas, based on established plant species accumulation curves for the WCA.</p> <p>2.3 By Y1 end, an additional 3,000 ha of previously selectively logged forests have been protected from further logging or conversion to agriculture, and form a buffer zone around WCA, as a response to the health intervention. Buffer zones show post-selective-logging recovery of vegetation community by project end, measured as a statistically significant shift along a</p>	<p>2.1 WCA Conservation Board conservation agreement including map with GPS verified boundaries; reports from forest inspections carried out by BRC staff every six-months during project; mammal and bird data from surveys in new no-impact zone.</p> <p>2.2 Conservation agreement with village landowners of two extra forest fragments, including map with GPS verified boundaries; reports from forest inspections carried out by BRC staff every six-months during project; results of bird and plant surveys.</p> <p>2.3 Conservation agreement with landowners in the villages neighbouring WCA, including map with GPS verified boundaries; reports from forest inspections carried out by BRC staff every six-months during project; results from multivariate analysis of changes in plant community composition in buffer zones since conservation agreement.</p> <p>2.4 Database, with analysis, of data from household surveys on attitudes to conservation (disaggregated by sex and age) in each community, prior to health service provision in Y1, and after in Y3 (all c300 households targeted for recruitment).</p> <p>2.4 Manuscript #1 as detailed in means of verification for 1.1-1.3 above.</p>	<p>2.1 No hunting / no gardening instruction for new no-impact zone is respected by Wanang community.</p> <p>2.2 Protection of isolated forest fragments can be maintained effectively.</p> <p>2.3 Selectively logged forest can be protected effectively from further adverse impact or disturbance.</p> <p>2.4 Village communities in the new buffer zones are prepared to maintain participation in attitudinal surveys.</p>

	<p>successional trajectory towards the community composition of primary forest.</p> <p>2.4 At Y3 end, buffer zone communities (9 villages: c1800 people, c300 households) outside pre-existing WCA boundary show improved positive community attitudes to conservation compared to baseline, as a response to the health intervention. Specifically, by Y3 end scored household attitudes to conservation show improvement in at least 144 of the 300 total households. (Based on expectation that 60% of total households will have sought medical support from the conservation collaboration by Y3 end, and in 80% of such households this results in improved attitudes to conservation).</p>		
<p>3. Knowledge and understanding of the health and well-being benefits of forest conservation amongst school pupils and partner villagers has improved (workstream 2).</p>	<p>3.1 By Y1 end, c260 pupils (35% female) at Wanang school will have improved knowledge and understanding on the health and well-being benefits of forest conservation, compared to baseline pre-educational programme.</p> <p>3.2 By Y2 end, c750 pupils in BRC's established network of 5 village schools will have improved knowledge and understanding on the health and well-being benefits of forest conservation, compared to baseline pre-educational programme.</p> <p>3.3. By Y3 end, c5000 people in BRC partner communities across PNG have improved knowledge and understanding of the health and well-being benefits of forest conservation, compared to baseline pre-educational programme.</p> <p>3.4 In Y3, the Department of Education has a pre-trialled educational package on the health and well-being benefits of forest conservation, which can be rolled out to other communities and incorporated into nationally' set school curricula.</p>	<p>3.1 & 3.2 School records of tests before and after educational programme (disaggregated by sex, age and social group).</p> <p>3.3 Records of assessments before and after educational programme (disaggregated by sex, age and social group).</p> <p>3.4 Copy of pre-trialled educational package; minutes of meetings with education stakeholders, including Department of Education.</p>	<p>3.1-3.3 BRC partner communities, and schools beyond Wanang, are prepared to participate in educational programme.</p> <p>3.4 Department of Education remains receptive to idea of national educational package on the health and well-being benefits of forest conservation.</p>
<p>4. New evidence has been produced on the interlinkages</p>	<p>4.1 By Y2 end, data collection is complete on the effects of forest status (intact, undergoing</p>	<p>4.1 Database on community health and well-being effects of forest status.</p>	<p>4.1-4.2 Sufficient communities are prepared to, (i) participate in health</p>

<p>between logging, forest conservation, health, well-being, and livelihoods in PNG, and tropical rainforests globally (work stream 3)</p>	<p>logging, or logged) on community health well-being, and livelihoods in 10 villages (3-4 villages in each land use category) in 100,000 hectare logging concession located near WCA. Data will include: (i) individual level data including demographics, social and occupational history, current health status and interventions, past medical history (including reproductive and child survival), present clinical observations (including Gross Development Index [children]), qualitative and quantitative data on subjective wellbeing, monetary income, (ii) community level data, including top-five (community ascribed) health problems, and livelihood benefits of differing forest status, including food sources and security (such as forest-use for swidden agriculture, hunting and harvesting plants), income, use of non-timber forest products; access to health provision (including the politics of access, transport etc.)</p> <p>4.2 By Y3 end, data collection complete on the biodiversity status of the 10 sites (as 4.1). Data will include: abundance and species diversity of plants, birds, and butterflies recorded along fixed 300m transects.</p> <p>4.3 By Y2 end, an evidence synthesis (in line with Collaboration for Environmental Evidence guidelines; reference #10) has been completed on the impacts of integrating health services into tropical forest conservation projects worldwide (based on our current evidence mapping, expected to be c60 projects).</p>	<p>4.2 Database on biodiversity effects of forest status.</p> <p>4.1-4.2 Manuscript #2 for submission to peer reviewed journal ('The Lancet Planetary Health'): What is the impact of logging on health and biodiversity in Papua New Guinea?</p> <p>4.3 Database of evidence synthesis of published and grey literature.</p> <p>4.3 Manuscripts #3 and #4 for submission to peer reviewed journal (both 'Environmental Evidence').</p> <p>"Efficacy of integrating health services into tropical forest conservation projects worldwide: evidence synthesis protocol. An evidence synthesis of the efficacy of integrating health services into tropical forest conservation projects worldwide."</p>	<p>assessments (clinical examinations, focus groups, key informant's interviews, ethnography), and (ii) allow biodiversity transect counts on their lands.</p> <p>4.3 Sufficient conservation organisations and other repositories of conservation case studies will co-operate by making internal evaluation documentation available for evidence synthesis.</p>
<p>5. Capacity has been expanded, and gender balance improved, in PNG environmental and health research (workstream 4).</p>	<p>5.1 By Y3 end, 14 PNG nationals (25% female) are able to carry out biodiversity surveys across multiple taxa and environments, to a scientifically sound standard.</p> <p>5.2 By six-months into Y1, 25 BRC staff and students are able to do first aid techniques</p>	<p>4.1 Participant training logs, periodic learning assessments/tests, and certifications.</p> <p>4.2; 4.3 Training records; skill and knowledge assessments; certification for participants</p> <p>4.4 MSc and BSc Hons theses; graduation certificates</p>	<p>4.1-4.4 A sufficient number of para-ecologists and BRC/IMR staff are interested in developing and broadening their skills base; suitable MSc and BSc Hons candidates can be recruited.</p>

	<p>which may be required in remote fieldwork settings.</p> <p>5.3 By end of first quarter of Y3, 5 BRC & 1 IMR research staff (all PNG nationals, at least one female) have gained knowledge and skills to acceptable standards in biodiversity survey; conservation project evaluation; ecology; microbiology; evidence synthesis and meta-analysis; rapid anthropological assessments; health research.</p> <p>5.4 By end of first quarter of Y3, 2 PNG nationals (recruited on merit, from an expected 1:1 gender balance of application – see section 15 Gender) will be able to do health/environmental research projects at, respectively, masters and undergraduate level.</p>		
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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. Community health and health service provision for Wanang and surrounding communities has been improved, managed by a new community committee with equal gender representation (workstream 1).

1.1 Collect and analyse qualitative and quantitative health and wellbeing data before and after the health intervention. Baseline data for the community at Wanang has already been collected through a combined clinical and Rapid anthropological Assessment Procedure (RAP) carried out by team members in July 2018 in preparation for stage 2 of this application. Following the same protocol (available on request and due to be submitted in Jan 2019 to 'BMJ Open' for publication), data will be collected in the buffer zone communities at baseline, and towards project end (alongside Wanang). Multidisciplinary teams will do individual clinical assessments (available to all, expectation based on field experience is over 50% will request), structured interviews with key informants (4-6 per community: clan leaders, ward councillors, traditional healers), ethnography, and focus groups (8-12 people in each focus group, 4 groups in each community carried out separately with young females, older females, young males, older males).

1.2 Train Wanang community members in immediate trauma care and evacuation procedures. WCA community members (25% female) receive training over 5 days in immediate trauma care and evacuation procedure (total 60 person-days of training). Training will largely follow standard Wilderness First Aid-Advanced syllabus (as developed by American Academy of Orthopaedic Surgeons and Wilderness Medical Society), tailored to fit learner requirements and specific needs of community as identified in 2018 health needs assessment (see 1.1 above).

1.3 Trained Wanang community members respond to trauma and evacuation incidents as required. Reports of incidents audited throughout, with appropriate add-on/refresher training provided as required.

1.4 Construct Aid Post, equip it, stock it with medicine, and recruit a nurse. Stock in line with PNG Health Extension Officer base supplies, with the addition of specific medicines and equipment required as identified in the 2018 community health needs assessment (for example: treatments for neglected tropical skin diseases, a bed for supervised births [if expected to be uncomplicated], malaria rapid tests and treatments, sexual and reproductive health supplies).

1.5 Establish and train community health committee. Carry out training adapted from the good practice guide developed by colleagues at London of School of Hygiene and Tropical Medicine who have advised on this aspect, specifically re their projects on community mobilisation to improve the health of mothers and babies.

1.6 Nurse staffed Aid Post receives and treats patients, maintains patient records. Provides range of services including emergency treatment to all who seek it at aid post (irrelevant of community background), and diagnosis, treatment, and referrals for routine and chronic clinical presentations for the target population (2000 people).

1.7 Produce long-term healthcare plan. Developed jointly by community health committee and medical partners, report will provide planning basis of long term care when aid post support is transferred from funded project to local health authority at Y3 end (as already discussed with them).

Output 2. Wanang conservation Area has been upgraded and expanded with improved attitudes to conservation in new partner communities (workstream 1)

2.1 Establish new 1,000ha no-impact core conservation area (no hunting, no gardening), map with GPS verified boundaries, and declare in operation by WCA.

2.2 Carry out mammal and bird surveys of new no-impact zone.

2.3 Establish two additional primary forest fragments (c900ha total), map with GPS verified boundaries, and declare in operation by WCA.

2.4 Carry out plant and bird surveys of the two additional primary forest fragments. Our previous comprehensive bird survey of WCA recorded a density of 1,697 individuals per 50ha across 93 species, ten species of which have densities of one individual/50ha or less (amounting to <200 individuals across the entire 10,000ha area of WCA). The proposed extra 900ha of primary forest would be expected to protect an extra c.30,500 individual birds (across all species) and an average of 11.5 individuals of each of the ten rarest species: Cinnamon Ground dove (*Gallicolumba rufigula*), Long-tailed Honey buzzard (*Henicopernis longicauda*), Streak-headed Mannikin (*Lonchura tristissima*), Rainbow Bee-eater (*Merops ornatus*), Little Pied Cormorant (*Microcarbo melanoleucos*), Papuan Boobook (*Ninox theomacha*), Marbled Frogmouth (*Podargus ocellatus*), Channel-billed Cuckoo (*Scythrops novaehollandiae*), Grey Crow (*Corvus tristis*) and Rufous Monarch (*Symposiachrus rubiensis*). Plant species accumulation curves for the WCA indicate that an extra 900ha would be expected to generate an additional 15 tree species recorded within the combined protected areas.

2.5 Establish buffer zones of 3,000ha of selectively logged forests with indigenous landowners, map with GPS verified boundaries, and declare in operation by WCA.

2.6 Record and analyse vegetation community composition yearly in the two buffer zones (based on species composition of all trees ≥ 5 cm DBH in ten randomly-located permanent 20x20m plots in each buffer zone, repeat sampled in each of 3 years), followed by multivariate analysis of community composition change over the 3 years.

2.7 BRC staff carry out forest inspections every six months of new no-impact conservation area, two additional primary forest fragments, and 3,000ha buffer zone forests.

2.8 Collect and analyse household survey data on attitudes to conservation in buffer zone communities outside pre-existing WCA boundary and agreements, before and after health intervention.

Output 3. Knowledge and understanding of the health and well-being benefits of forest conservation amongst school pupils and partner villagers has improved (workstream 2).

3.1 Produce curriculum and materials for school and community level educational programmes on health and well-being benefits of forest conservation.

3.2 Provide educational programme in Wanang School (c250 pupils, 35% female), making any necessary improvements to programme following delivery.

3.3 Provide educational programme in BRC network of 5 village schools (c750 pupils, not in the new buffer zone), making any final necessary improvements to programme following delivery.

3.4 Provide educational programme in BRC partner communities across PNG (c5000 pupils), making any necessary improvements to programme following delivery.

3.5 Hold meetings with educational stakeholders, including Department of Education, to arrange incorporation of educational package into educational plans nationally.

3.6 Provide pre-trialled educational packages to PNG Department of Education for further roll-out beyond project, and distribute editable version of package throughout international partners in the Planetary Health Alliance primary/secondary education working group.

Output 4. New evidence has been produced on the interlinkages between logging, forest conservation, and human health & well-being in PNG, and tropical rainforests globally (work stream 3)

4.1 Collect and analyse health, well-being, and livelihood data from 10 villages with forests that are either (i) intact, (ii) logged, or (iii) with ongoing logging. Collect health related data by carrying out combined clinical and Rapid anthropological Assessments Procedures (RAP, further methodological detail in 1.1 above). Use focus groups, structured interviews, and ethnography to collect qualitative and quantitative data on subjective wellbeing, and livelihood benefits of differing forest status, including food sources and security (such as forest-use for swidden agriculture, hunting and harvesting plants), income, use of non-timber forest products, etc.

4.2 Collect and analyse biodiversity data from 10 sites also visited for 4.1. Abundance and species diversity of plants, birds, and butterflies recorded from fixed 300m transects visited at each site four times (twice in wet season, twice in dry).

4.3 Carry out systematic review of efficacy of integrating health services into tropical forest conservation projects worldwide. Based on our current evidence mapping exercise, expected to be c60 projects.

Output 5. Capacity has been expanded, and gender balance improved, in PNG environmental and health research (workstream 4)

5.1 Train 14 para-ecologists over 3 years in biodiversity survey methods. Total 280 person-days of training. The training includes instruction by PhD level researchers on study design, sampling methods, specimens processing, identification and ecological data analysis and report/manuscript writing for focal plant, insect and vertebrate taxa focused on rainforest ecosystems.

5.2 Train 25 BRC staff and students in 'Wilderness First Aid - Advanced'. Two courses at BRC HQ and field sites for a total of 25 BRC staff and students (all PNG nationals, 25% female). These courses will give BRC staff and students working in remote settings the skills and knowledge to help each other in many potential fieldwork emergencies, and evacuate colleagues to outside care. Total 125 person-days of training.

5.3 Train 5 BRC & 1 IMR research staff in UK. 1-month intensive training in: biodiversity survey; conservation project evaluation; ecology; microbiology; evidence synthesis and meta-analysis; rapid anthropological assessments; health research. Visits to partner institutions.

5.4 Supervise research projects by 1 MSc student for 2 years and 1 BSc Hons student for 1 year based at the University of PNG. The student positions will be advertised nationwide and students selected on merit. They will be resident at BRC to conduct their dissertation research under joint supervision of DI project team and university-based supervisors. The dissertation research will be defined based on the students' strengths and professional interests to contribute to Outputs 2, 3 or 4.

Annex 3: Standard Measures

Table 1 Project Standard Output Measures

Code No.	Description	Gender of people (if relevant)	Nationality of people (if relevant)	Year 1 Total	Year 2 Total	Year 3 Total	Total to date	Total planned during the project
2	M.Phil.	3M	PNG					3
3	Wilderness First Aid		PNG	12	0			25
5	Ongoing training (M.Phil.)	3M	PNG		3			3
6A	Ecology / botany / zoology field course	14M, 6F	PNG	20	0			60
6B	Ecology / botany / zoology field course	14M, 6F	PNG	3	0			9
11A & 11B	Oecologia; Sustainability Science; BMJ Open; The Lancet Planetary Health			2	2			6
14B	Consortium of Universities for Global Health conference (USA)							1
20	Aid Post building; nurse's house; fridge, solar panels; secure cabinet; medical equipment							
21	Community Health Committee	3M, 3F	PNG	1				1
22	Permanent vegetation succession plots in buffer zone areas				6 (3 primary forest; 3 secondary forest)			6

23	Match funding							
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Table 2 Publications

Title	Type (e.g. journals, manual, CDs)	Detail (authors, year)	Gender of Lead Author	Nationality of Lead Author	Publishers (name, city)	Available from (e.g. weblink or publisher if not available online)
Spatial scaling of plant and bird diversity from 50 to 10,000 ha in a lowland tropical rainforest	Journal	Hazell, R.J., Chmel, K., Riegert, J., Paul, L., Isua, B., Kaina, G.S., Fibich, P., Molem, K., Stewart, A.J.A., Peck, M.R., Weiblen, G.D., Novotny, V.	Male	UK	Springer	
Rationale, experience and ethical considerations underpinning integrated actions to further global goals for health and land biodiversity in Papua New Guinea *	Journal	Middleton, J., Cassell, J.A., Colthart, G., Dem, F., Fairhead, J., Head, M.G., Inacio, J., Jimbudo, M., Novotny, V., Peck, M., Philip, J., Pomat, W., Sui, S., West-Oram, P. & Stewart, A.J.A.	Male	UK		
Health service needs and perspectives of remote forest communities in Papua New Guinea: study protocol for combined clinical and rapid anthropological assessments with parallel treatment of urgent cases *	Journal	Middleton, J., Abdad, M.Y., Beauchamp, E., Colthart, G., Cooper, M.J.F., Dem, F., Fairhead, J., Grundy, C.L., Head, M.G., Inacio, J., Jimbudo, M., Jones, C.I., Konecna, M., Laman, M., McGregor, H., Novotny, V., Peck, M., Paliau, J., Philip, J., Pomat, W.,	Male	UK		

		Roberts, C., Sui, S., Stewart, A.J.A., Walker, S.L., & Cassell, J.A.				
Mapping evidence on integrated conservation and health projects worldwide: an appeal for help in identifying past and ongoing interventions *	The Lancet Planetary Health	Middleton, J., Kalema-Zikusoka, G., Jennings, J., Hazell, R. & Stewart, A.J.A	Male	UK	Elsevier	
ForestGEO: Understanding forest diversity and dynamics through a global observatory network.	Biological Conservation	157 co-authors. PNG & BRC author: Jonah Filip (BRC).	Male	USA		
Language and ethnobiological skills decline precipitously in Papua New Guinea, the world's most linguistically diverse nation	Proceedings of the National Academy of Sciences	Kik, A., Adamec, M., Aikhenvald, A. Y., Bajzekova, J., Baro, N., Bower, C., Colwell, R. K., Drozd, P., Duda, P., Ibalim, S., Jorge, L. R., Mogina, J., Ruli, B., Sam, K., Sarvasy, H., Saulei, S., Weiblen, G. D., Zrzavy, J. & Novotny, V.	Male	PNG		

PDFs of publications marked with an asterisk have been attached to the email submitting this report.

Checklist for submission

	Check
Is the report less than 10MB? If so, please email to Darwin-Projects@ltsi.co.uk putting the project number in the Subject line.	Yes
Is your report more than 10MB? If so, please discuss with Darwin-Projects@ltsi.co.uk about the best way to deliver the report, putting the project number in the Subject line.	No
Have you included means of verification? You should not submit every project document, but the main outputs and a selection of the others would strengthen the report.	Yes
Do you have hard copies of material you need to submit with the report? If so, please make this clear in the covering email and ensure all material is marked with the project number. However, we would expect that most material will now be electronic.	No
Have you involved your partners in preparation of the report and named the main contributors	Yes
Have you completed the Project Expenditure table fully?	No (see note in Section 16)
Do not include claim forms or other communications with this report.	