Darwin Initiative: Half Year Report

(due 31 October 2014)

Project Ref No	20-001
Project Title	Managing the landscape-scale sustainability of Amazonian freshwater fisheries
Country(ies)	Brazil
Lead Organisation	University of East Anglia
Collaborator(s)	SDS/CEUC (Environmental Agency – State of Amazonas), ICMBio (Brazil's Ministry of Protected Areas & the Environment), UFAM (University of Amazonas), INPA (National Institute of Amazonian Research), UFRN (University of Rio Grande do Norte), ASPROC (Association of Rural Extractivists of the Rio Jurua), and AMARU (Association of Reserve Residents of the Médio Rio Juruá)
Project Leader	Prof Carlos Peres (UEA)
Report date and number	HTR2
Project website	Not yet available

1. Outline progress over the last 6 months (April – Sept) against the agreed baseline timetable for the project (if your project has started less than 6 months ago, please report on the period since start up to end September).

We have advanced a great deal on the execution of a broad range of important activities right across the spectrum of proposed and new project initiatives. From August-November 2014, we conducted an intensive field work campaign during the dry season in our study region. This is a particularly critical time of year for this project as it is only during the low-water season that conflicts over aquatic resources are exacerbated along the Rio Juruá; the fluvial beaches become exposed (for turtle and bird nesting); and oxbow lakes become isolated from the main river channel, stranding potentially large stocks of commercially valuable fish (when and where *Arapaima* and *Colossoma* harvested). The following programmes were implemented or revisited during this year:

1. ***Podocnemis* turtle conservation project - Fluvial beach programme (protected vs unprotected beaches)**

   Historically, Amazonian *Podocnemis* freshwater turtles have been very important as both socio-economic value (subsistence and sales) and the cultural integrity of rural Amazonians, with their meat and eggs representing a key source of dietary protein. The overexploitation caused by such high consumption led to a massive decline in turtle abundance, with a concomitant retraction of their geographic range (>90% in the case of *P. expansa*). Our project showcases one the most interesting turtle conservation programmes implemented across the Amazon, in terms of community-based protection of fluvial beaches as female turtle nesting grounds. These white-sand beaches are often 150-300m in width and range from 1 to 5 km in length, and represent the concave bend of a segment of the meandering river channel, immediately opposite a cut-bank. To test the value of this initiative for three *Podocnemis* species and the trophic cascade effect of this protection on other species across the ecosystem, we sampled 28 fluvial beaches (14 protected and 14 unprotected) using a wide

range of techniques. We hope to quantify the ecological co-benefits and implementation costs of the fluvial beach protection programme, which has the potential to be one of the most important conservation tools for vertebrate species of Amazonian floodplains. This research initiative is unique and will help us and policymakers understand the full consequences of strictly protecting key egg-laying habitats within or outside multiple-use Amazonian forest reserves. The activities that were developed include:

a. Turtle abundance

   Local monitors were trained to record the number of nests by the two largest *Podocnemis* species on each of the 14 protected beaches along the medium reaches of the Rio Jurua. In collaboration with these monitors, we expanded this program to sample nest abundance on 14 adjacent unprotected beaches, thereby achieving a statistically robust pairwise design. The entire beach is surveyed on a daily basis during the turtle ovipositing season, and the date of each nest is also recorded during the morning following a nocturnal egg-laying event.

b. Turtle nesting success and hatchling emergence

   Previously trained local monitors also record nesting success for the two larger *Podocnemis* species on all protected beaches. This includes hatchling counts and a measure of hatchling survivorship until they reach a water body.

c. Fluvial beach bird censuses

   We conducted comprehensive surveys of the entire community of birds nesting on fluvial beaches. Two observers slowly walked the full length of 28 beaches (14 protected and 14 unprotected) recording the abundance of all bird species present and their nesting activity. Surveys were conducted during the morning (06.00 – 10.00h) with two adjacent beaches (protected vs unprotected) surveyed each day. We recorded the presence of up to 12 bird species nesting on beaches and adjacent habitats over the course of the entire survey.

d. Animal track census (including nest and avian predators)

   Following the bird census, all 28 beaches were also surveyed for animal tracks including those of nest and bird predators.

e. Camera-trapping (including nest and avian predators)

   To detect further use of beaches by other animals we installed camera traps on 10 beaches (5 protected, 5 unprotected) with two cameras per beach. Camera traps were deployed for at least 30 days per CT station from August to November 2014.

f. Caiman population censuses

   We conducted nocturnal surveys for two caiman species (*Melanosuchus niger* and *Caiman crocodilius*) along riparian zones adjacent to all 28 beaches surveyed. Spotlight surveys for eyeshine of caimans and other vertebrates were conducted slowly by boat along both the beach and the opposite bank of the river, recording the species and size class for each

individual.

g. River dolphin censuses

We conducted observations of dolphin activity all our focal beaches, recording the number of individuals and number of surfacing events for the two Amazonian dolphin species (*Inia geoffrensis* and *Sotalia fluviatilis*). Twenty minute observations were conducted at three points along each beach, one at the centre and one at each point. This work was led by an undergraduate student (Patrick Cook) from UEA under a project research internship.

h. Underwater sonar surveys (underwater topography, fish and aquatic mammal census)

We used conventional short-range FishFinder® sonar equipment adapted to an aluminium boat of dugout canoe to record the river depth distribution and bathymetry profile along georeferenced river transects immediately opposite all 28 focal beaches. Using this methodology we concurrently recorded the presence and number of fish shoals or large aquatic mammals such as dolphins and manatees.

i. Pitfall-trapping (beach arthropod abundance)

To record the invertebrate community and biomass, we installed pitfall traps exposed for 48 hours along all 28 beaches (10 traps per beach, spaced by 100 m). This work was led by an undergraduate student (Patrick Cook) from UEA. All specimens were preserved in alcohol for subsequent identification and processing through collaborators at the Entomological Collection of INPA, Manaus.

j. Nest predation experiment

To quantify the levels of nest predation on protected and unprotected beaches we designed an experiment using artificial nests containing chicken eggs. We first attempted to simulate turtle nests by burying chicken eggs into the sand but this was unsuccessful and had to be adapted to imitate bird nests by placing eggs on the surface of the sand. We exposed 20 eggs for 48 hours at 20 stations per beach (spaced by 50 m). Any predation events were recorded, including the identification of the predator species from tracks or other signs.

k. Large catfish abundance and stomach contents

Using an experimental fishing approach, large siluriform catfish were sampled along the main river channel immediate along the 28 focal beaches we surveyed – this is meant to coincide with the turtle hatchling emergence season as large catfish represent one of the most important sources of natural predation for hatchlings. In addition, our intention was to quantify any trophic effects on aquatic predators resulting from the sudden resource pulse created by an abundant supply of turtle hatchlings reaching the water.

l. Local interviews

We continue to carry out local interviews quantifying the overall consumption of aquatic resources at the local household level. This sampling programme

has also been expanded to 8 new communities downriver of Carauari, where a large section of the Rio Jurua remains entirely unprotected.

m. Quantifying illegal turtle offtake

We conducted anonymous questionnaire-based interviews at the main urban center (Carauari) to determine the level of illegal turtle captures for both urban subsistence and sales within the region. Turtle harvesting is nominally legal for local subsistence but legally banned for any commercial use. Since the town of Carauari accounts for 53% of the population of the entire 2,588,100 hectare municipal county of Carauari, this obviously represents a significant regional scale sink of both terrestrial and aquatic resources.

2. Oxbow Lake programme (protected vs unprotected lakes)

We continued the oxbow lake sampling programme to understand both trophic cascade effects of spatial zoning and the benefits of community-based protection. This large work package included a number of sampling components as following:

a) Lake productivity

Last year, we collected 64 water samples from 64 lakes during both the dry and the wet seasons. We found that primary productivity is low during the wet season, probably because the high water level dilutes nutrient sources resulting in severe unavailability of some nutrients. At this time of year, the energetic input into the ecosystem is predominantly allochthonous. However, during the dry season, the phytoplankton concentrations increased dramatically and the energetic source became primarily autochthonous. This high primary productivity is very important for vertebrate populations when oxbow lakes become isolated from the main river channel. To verify the annual variation of this pattern we collected additional water samples from 20 lakes again. At this writing. the chemical and limnological analysis are being carried out at the INPA Limnology Lab; and this work in the abiotic foundation for understanding variation in lake productivity for all fishery resources across our study landscape.

b) Bird community census

We maintained bimonthly sampling on the piscivorous bird community of some 40 species at 32 oxbow lakes. Results so far show that the species richness and abundance are high in both protected and unprotected lakes of varying size and geochemistry but vary in response to the water level, possibly as a function of the seasonality in fish resource density, and these responses are likely to be specie-specific.

c) Caiman censuses

Last year the caiman census was conducted mainly along the main river channel. This year we concentrated the sampling within a focal group of 30 lakes to verify the benefits of protection for this group, which is likely to be affected by sizes of fish stocks.

d) Dolphin censuses

During the dry season the two species of dolphins are restricted to a few types of lakes. To identify the drivers of dolphin habitat occupancy, we carried out visual censuses within all of our study lakes and interviews with lake users.

f) Turtle censuses

We have now started the *Podocnemis* turtle sampling on our study lakes. Apparently there is a marked difference in turtle abundance between protected and unprotected lakes. The lakes are very important as a food supply to adult turtles, and serves as refugia for the growth and survivorship of turtle hatchlings, so the lake management class is likely to be very important to strengthen the conservation objectives of this group.

g) Manatee censuses

We conducted focal surveys assisted by highly experienced local assistants, who were former manatee spear-hunters, to estimate the abundance and distribution of Amazonian manatees (*Trichechus inunguis*) in both protected and unprotected lakes, both inside and outside the two extractive reserves hosting the project. The sampling also occurred on the main river channel because manatee abundance is higher on the river during the dry season. This is an ongoing part of the project that will require many more visits to individual lakes and segments of the river.

h) Sonar censuses of large aquatic vertebrates

We started the aquatic vertebrate censuses with a conventional short-range FishFinder® sonar, as described above, but specifically targeted to our focal group of oxbow lakes.

i) Local interviews

We carried out local interviews with more than 100 fishermen who routinely use lakes for both subsistence and commercial fishing activities. We collect information about the physical accessibility, level of protection, human-wildlife conflicts, and local agreements (i.e. *fishing accords*) to initiate the often thorny legalization process of fishery agreements, so that the spatial coverage of protected lakes can be consolidated or expanded.

j) Household-level surveys

We have kept household-level survey data on the use of all types of aquatic resources obtained from ~400 households distributed across 35 local communities (villages). This sampling protocol will help us understand the variance in ecological and landscape features of different water bodies that govern the behaviour of key fish stocks.

3. *Arapaima* management programme

We initiated a comprehensive research programme to investigate the sustainability of pirarucu (*Arapaima gigas*) – one of the largest freshwater fishes of Earth – under a community-regulated population management regime. This programme consists of several ecological approaches and includes the involvement of local fishermen number tagging and the installation of radio-telemetry transmitters. We also trained a local field assistant to use the receivers to track the seasonal movements of the first radio-tagged pirarucus which will be monitored over a full year. These activities include:

a) *Arapaima* census inside and outside protected areas

With our agengy and local partners, we conducted Arapaima censuses (based on surfacing rates for air-breathing) in more than 70 oxbow lakes within the RDS Uacari

and RESEX Médio Juruá. We then expanded this work to other nominally unprotected areas by conducting censuses in more than 15 lakes outside these two reserves. This was carried out under a cooperation agreement with the Fishermen Cooperative of Carauari and the Carauari Municipal Council. This project component also involves training and capacity building in fish censusing techniques, such as systematic air-breathing counts of Pirarucu.

b) *Arapaima* harvesting

We recorded offtake levels and quantified fishing effort by professional and subsistence fishermen during the annual harvest in the six lakes where *Arapaima* management has been conducted within the reserves. In collaboration with ASPROC, we recorded the weight, total length, sex, and reproductive status for all harvested individuals, incorporating this into a database that now number thousands of harvested Arapaima.

c) *Arapaima* mark-recapture protocol (number tagging)

We successfully tagged a total of 58 juvenile *Arapaima* individuals at four lakes, and established a protocol for the return of number-tags recovered by local fishermen to ASPROC. All individuals were weighed and measured before release. This project component is therefore well placed to be expanded during the next field campaign.

d) *Arapaima* telemetry

We successfully fitted radio-transmitters to six *Arapaima* individuals, two in each of three connected lakes. We trained a local field assistant to conduct weekly surveys throughout the year to track their movements and have established a strong involvement of all the local communities. This technique is still under experimental development, so we plan to learn from any mistakes to boost this sampling program during the rest of the project time frame. This work package included the training of local field assistant in radio-tagging and animal telemetry monitoring.

e) *Arapaima* DNA samples

We collected DNA samples (muscle tissue) from a large number of *Arapaima* harvested during the local management programme. All samples therefore have associated body-size and other morphometric data. We collected a total of almost 210 samples (30 samples in each of seven lakes), which will be analysed in collaboration with a molecular ecology lab at University of Amazonas, Manaus. The microsatellite DNA technique we will use will also help understand the patterns of gene flow both along the Rio Jurua, and across the width of the floodplain in relation to the historical fluvial geomorphology.

f) *Arapaima* scale and otolith samples

To determine the age of harvested individuals we collected scales from all 210 adult *Arapaima* from which we collected DNA samples. We also extracted otoliths from the skulls of 8 *Arapaima* individuals to more accurately estimate their age and calibrate the more extensive (and straightforward) use of scales for this purpose.

g) Local interviews

We conducted more than 60 interviews with fishermen and local residents from all communities to record grassroots opinions about the overall implementation and possible socioeconomic dividends flowing from the *Arapaima* management programme.

4. *Colossoma macropomum (Tambaqui)* management programme

We started the Colossoma work package during this phase of the project**.** This work was led by Brazilian MSc student, Talles Colaço, from INPA.

a) *Colossoma* censuses

We conducted censuses at almost 20 lakes within the RDS Uacari and RESEX Médio Juruá. This component forced us into a strong learning curve about the biology of *Colossoma*. Capturing this species is very hard and we had a low success capture. Next year we will improve our approach using another type of gillnet.

b) *Colossoma* offtake

We recorded offtake levels and quantified fishing effort during the annual harvest in the 6 lakes where *Colossoma* management has been conducted within the reserves. In collaboration with ASPROC, we recorded the weight, and length for all harvested individuals.

c) *Colossoma* mark-recapture (number tagging)

We started the mark-recapture program but unfortunately we obtained a low capture success, so few individuals were marked.

d) *Colossoma* scale samples

Due to the low catch, few scales were collected

e) Local interviews

We conducted more than 60 interviews with fishermen and local residents about the *Colossoma* management programme, partly to understand the importance of this resource to local livelihoods.

5. Human-wildlife conflicts

a) Caiman and dolphin surveys (see above)

b) Giant river otter interviews

We conducted more than 60 interviews at all local communities to determine the abundance, distribution and conservation status of giant river otters (*Pteronura brasiliensis*), one of the apex predators in aquatic systems along the Rio Juruá. This aquatic carnivore is widely listed as an endangered species in Brazil, yet represents an important source of human-wildlife conflicts with local fishermen.

c) Fishermen conflict interviews

We conducted 60 interviews at all communities (both inside and outside the reserves) to determine the magnitude of conflicts between fishermen and aquatic wildlife, including Giant otters, Amazon pink dolphins, Amazon grey dolphins, and Black caiman, which represent the main apex predators in the aquatic ecosystems we have been studying.

d) Focal species interviews

We conducted more than 60 interviews at all communities to determine the potential population recovery of key harvest-sensitive species (including birds, mammals, reptiles and trees) that were heavily exploited in the past, and have seen their numbers dwindle right across the Amazon with concomitant shrinkage in their geographic distributions.

6. Urban monitoring of commercial fishery activities

We add another point of data recovery for commercial fishery sampling based in the town of Carauari, so we are now intercepting the vast majority of commercial fishing boats, and monitoring the three most important points of commercial fish landings. Part of this strategy aims to show local authorities how fishing activities can be monitored at relatively low costs.

7.Seasonal movements of terrestrial vertebrates between floodplain (várzea) forest and upland (terra firme) forest

We continued the effort to camera-trap wildlife populations in both terra firme and várzea forests at different times of year. An MSc student from Universidade Federal do Pará, UFPA (Hugo Costa) has been conducting this work. This project component is crucial to understand how terrestrial game species harvested by subsistence hunters interact with the dry-phase and flood pulse of várzea forests when the floodwaters rise and recede on a seasonal basis.

8. Game depletion envelopes of wildlife in várzea floodplain and terra firme forests (NEW COMPONENT)

We have consolidated a sampling program based on camera-trapping, line-transect censusing, and animal sign data to document how distance to local subsistence communities affect the population abundance of key terrestrial vertebrates. This work package, which combines a field based and interview approach, is led by a University of East Anglia PhD student (Mark Abrahams).

9. Wattled curassow (*Crax globulosa*) conservation program (NEW COMPONENT)

We addes this new component to our project because the Wattled Curassow, a floodplain forest specialist that is widely considered as a highly Endangered species that has dwindled to very small populations across the western Amazon. Overunting is almost certainly the main driver of population declines. Along the Juruá River, an unusually large population of this species survives in várzea forests, so we have an excellent scenario to develop guidelines for the conservation of this species. A Brazilian PhD student (Gabriel Leite) who is currently based at Instituto Nacional de Pesquisas da Amazonia (INPA) has begun to conduct this work. The activities that have been implemented include: (a) population censuses; (b) radio tagging; (c) local interviews; and (d) a study of the reproductive and foraging ecology of Wattled Curassows.

9. Lowland paca (*Cuniculus paca*) conservation program (NEW COMPONENT)

Pacas are large nocturnal caviomorph rodents that date back to the Oligocene rodent fauna of South America. This is one of the most hunted game species right across the Neotropics, yet a population monitoring protocol is unavailable. We have therefore implemented an embryonic program with the goal of developing a local population monitoring protocol. The activities consist of standardised nocturnal censuses along the suitable riparian habitats of pacas and will be executed by trained local people. Any information gained from this work package will go far beyond the original objectives of this project.

10. Protected areas, community management and local food security (NEW COMPONENT)

This component is designed to examine the discrepancies in terms of social welfare, patterns of livelihoods, and access to key biological resource populations both inside and outside of the two focal reserves. The work, carried out at 38 communities, consisted of systematic interviews with local stakeholders, as well as community leaders in relation to the overall dynamics and socio-economic status of local communities, as well as their relationship with the environment and dependency on key ecosystem services. This series of interviews have both quantitative and qualitative components, allowing for a thorough analysis of local security in relation to state, municipal, and federal inputs in the area. This work has been led by a Brazilian MSc student (Julia Romero) who is currently based at Aarhus University, Denmark.

Here we include a set of photographs to illustrate a number of project components:

2a. Give details of any notable problems or unexpected developments that the project has encountered over the last 6 months. Explain what impact these could have on the project and whether the changes will affect the budget and timetable of project activities.

This project can be considered successful to highly successful so far. However, we have had a fair share of logistical problems in the field, given the exceptional extenuating circumstances of the project. We now list below five items of concern, but none of which represents an unbearable threat to the main project goals:

1) **General logistical difficulties.** Working in a remote portion of Western Brazilian Amazonia is never easy. For example, the entire town of Carauari lacks an automatic cash machine and internet connection for the majority of time, rendering project activities rather difficult.

2) **Flights to Carauari.** Air transportation from the state of Amazonas capital city (Manaus) to Carauari – which are spaced by ~850 km as the crow flies -- has become gradually more expensive, as this route is now monopolized by a single small airline, who is allowed to charge up to R$1100 (≈ GBP278) per one-way ticket. This puts a huge amount of pressure on the project budget, forcing us to divert some resources from other budget lines towards travel costs.

3) **Field costs.** Our local field costs have escalated for a number of reasons that we have begun to discuss with LTS. This means that we require a certain amount of funds transferred from other budget line to Travel & Subsistence (under the UEA administrative categories). On balance, however, we are not requesting any more project funds, but simply that we are able to use the underspend of one budge line to compendate for the overspend in another budget line. We can bring this up again in our next Annual Report.

4) **Fieldwork hazards.** Fieldwork in the Western Brazilian Amazon along a vast white-water floodplain is at the very least a dangerous proposition. We routinely see 5.5 m Black Caymans and villagers are often killed or wounded by large predators. For example, one of our field assistants was recently bitten by a poisonous serpent – the Bushmaster *Lachesis muta*, the largest pit viper on Earth -- during fieldwork, so we immediately provided urgent rescue by sending him to the state hospital in the town of Carauari. Upon admission at the hospital, he was deemed to be in a critical condition and, had we not intervened by taking an immediate second medical opinion, he would have lost a leg through a medical order of amputation just below his left knee joint. This field assistant was forced to remain in hospital under a stable condition for 30 days. Fortunately, we have been able to save both his life and his leg, and anything less would have represented a huge blow to the entire project, not least because he has a family to support and we would have been liable to damages to his family. This illustrates the perils of working in this part of the world, but so far we have been fortunate to have experienced remarkably few detrimental incidents, despite the sheer scale all of our field activities and the number of people involved.

5) **Other incidents.** We have had a number of minor and more serious incidents involving project activities, including the boat-wreck of one of our 6-m aluminium boats which was transporting 8 people at the time. This incident occurred on the lower reaches of a tributary of the Jurua and it happened at dusk when visibility was poor, although the boat driver was highly experienced. No one was hurt at the time despite the fast-flowing conditions of this large stream, but we lost most of the equipment contained in this boat. We have had to replace this equipment including an expensive set of gillnets (used for experimental fishing) and this delayed a number off project activities.

2b. Have any of these issues been discussed with LTS International and if so, have changes been made to the original agreement?

Discussed with LTS:	Yes
Formal change request submitted:	No
Received confirmation of change acceptance in our next Annual Report.	Partly: we were asked to bring this up again

3a. Do you currently expect to have any significant (eg more than £5,000) underspend in your budget for this year?

Yes ☐ **No** X Estimated underspend: £

3b. If yes, then you need to consider your project budget needs carefully as it is unlikely that any requests to carry forward funds will be approved this year. Please remember that any funds agreed for this financial year are only available to the project in this financial year.

If you anticipate a significant underspend because of justifiable changes within the project and would like to talk to someone about the options available this year, please indicate below when you think you might be in a position to do this and what the reasons might be:

4. Are there any other issues you wish to raise relating to the project or to Darwin's management, monitoring, or financial procedures?

No, other than what has been discussed above.

If you were asked to provide a response to this year's annual report review with your next half year report, please attach your response to this document.

Please note: Any planned modifications to your project schedule/workplan can be discussed in this report but should also be raised with LTS International through a Change Request.

Please send your **completed report by email** to Eilidh Young at Darwin-Projects@ltsi.co.uk . The report should be between 2-3 pages maximum. **Please state your project reference number in the header of your email message eg Subject: 20-035 Darwin Half Year Report**