Department for Environment Food & Rural Affairs

DARWIN INITIATIVE

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Darwin Initiative
Final Report

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

Darwin project information

Project Ref Number	20-001
Project Title	Managing the landscape-scale sustainability of Amazonian freshwater fisheries
Territory(ies)	Brazil
Contract Holder Institution	University of East Anglia (UEA)
Partner Institutions	SDS/CEUC, ICMBio, UFAM, INPA, UFRN, ASPROC, AMARU and COLPESCA (all in Brazil)
Total Grant Value	£253,508
Start/end date of project	1 July 2013/30 April 2016 (+ a 3-month extension awarded by the DI)
Project Leader Name	Prof Carlos Peres
Project website/Twitter/Blog etc.	http://www.projetomediojurua.org https://twitter.com/pmj_mediojurua https://www.youtube.com/channel/UCNoxlvEn33sZhmPBFDnuwkQ email: Paleotropical@gmail.com
Report author(s) and date	Prof Carlos Peres (UEA), Dr João Vitor Campos-Silva (UFRN), Carolina Tavares de Freitas (UFRN) and Dr Joseph Hawes (Anglia Ruskin University) 15th Feb 2017

1 Project Rationale

Around one third of all vertebrate species worldwide are freshwater organisms. With rapidly increasing human populations, freshwater bodies and wetlands are rapidly becoming the most threatened ecosystems worldwide, particularly in the tropics. Lowland Amazonia supports the largest expanses of seasonally flooded forests, the largest and most valuable freshwater fisheries, and the most species-rich fish fauna on Earth. Aquatic vertebrates (including fish, turtles and crocodilians) provide ~75% of the animal protein demands of rural Amazonians, who consume 369 – 800 g of fish person^{-1} day^{-1}, the highest per-capita fish protein intake recorded anywhere. Consequently, inland fisheries along major tributaries of the Amazon continue to be severely overexploited, particularly high-value large-bodied slow life-history species that are highly desirable by commercial extractivists. Yet basic life-history data and stock-recruitment relationships necessary to implement effective quantitative fisheries assessments and management are still lacking.

This ground-breaking Darwin Project aimed to develop a spatially-explicit set of guidelines to inform landscape-scale fishery management protocols that can be applied to any major watershed across all lowland Amazonian countries. In particular, we have been monitoring a network of 83 large focal oxbow lakes and 156 sandy fluvial beaches along the second-largest white-water tributary of the Amazon to (1) consolidate 'fishing agreements' to zone the spatial structure of commercial and subsistence fishing activities; (2) understand the relationship between spawning biomass and fish recruitment, and how these stock-recruitment relationships depend on baseline environmental variables such as lake size, productivity, and macrophyte cover; (3) understand the demographic importance of 'no-take' areas (i.e. strictly-protected lakes and fluvial beaches) in maintaining a sustainable fishery and the spatial dynamics of commercial fishing boats; (4) resolve political conflicts between commercial and subsistence fisheries; and (5) assist Brazilian government agencies in both developing exploitation management protocols for commercially valuable fish and *Podocnemis* turtle species and dealing with key human-wildlife conflicts in aquatic ecosystems.

This study was conducted along a 492-km section of the Central Juruá basin within and around two contiguous sustainable-use forest reserves (Fig. 1). The Juruá River is the second-largest white-water tributary of the Amazon (=Solimões) River, within the ~1.6 million km^2 State of Amazonas, Brazil. The area contains two main forest types: a broad swath of seasonally flooded (*várzea*) forests along the river channel and higher elevation (*terra-firme*) forests which are never exposed to the seasonal flood pulse; and unlike other major Amazonian tributaries of the main stem of the Amazon, these floodplain forests are relatively intact. The alternating wet and dry seasons and corresponding fluctuations in floodplain water-level are between January and June, and August and November, respectively.

The federally-managed Médio Juruá Extractive Reserve (RESEX Médio Juruá) was created in 1997. Situated on the left bank of the river (5º33'54"S, 67º42'47"W) this 253,227-hectare reserve is inhabited by nearly 2,000 people living across 13 well-established communities. The more sparsely populated state-managed 632,949 hectare Uacari Sustainable Development Reserve (RDS Uacari) (5º43'58"S, 67º46'53"W), which was created in 2005, is inhabited by some 1,200 people across 32 communities. Local livelihoods in both reserves are sustained primarily by floodplain and river channel fisheries, subsistence agriculture and non-timber forest products, such as oil-seeds, palm fruits and game. Although these two reserves have very different higher management structures, they represent a continuum of human population density and are virtually identical in their natural environments and the extractive livelihood patterns of local communities. We therefore decided to work with both of these reserves even though this involved a much larger focal area and number of local communities, and doubling the amount of project bureaucracy and communication with environmental agencies. Furthermore, we extended the original project proposal, which was restricted to these two reserves, to 15 communities outside protected areas to verify the possibilities to replicate our results in the wider unprotected landscape, through community-based management.

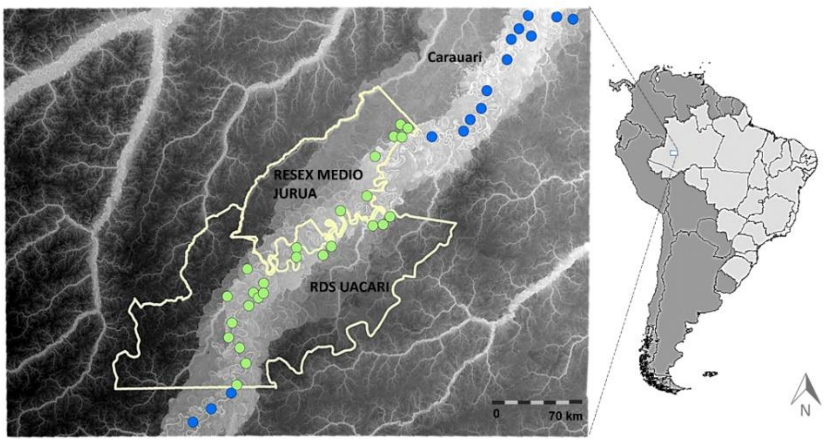

Figure 1. Core study area of Darwin Initiative Project 20-001 along the Juruá River of Western Brazilian Amazonia. Local communities engaged in the project

and located both inside and outside the two focal reserves, are indicated by green and blue circles, respectively.

2 Project Achievements

2.1 Outcome

Outcome:	Understand the spatial dynamics of resource productivity and exploitation of aquatic vertebrates — including fish, turtles and caimans — along the Rio Juruá, and create a spatially-explicit set of management guidelines to protect the landscape-scale sustainability of inland fisheries that can be feasibly enforced by local resource users.		
	Baseline	Change by 2016	Source of evidence
Indicator 0.1 Annual counts of adult pirarucu (*Arapaima gigas*) fish at 83 oxbow lakes under varying categories of protection status, as per 'fishing agreements' between local communities and commercial fishermen.	*Arapaima* counts at 23 lakes since 2008.	After 2012, annual *Arapaima* counts have been expanded to 87 lakes. This sampling has been done by local associations and is a precondition for management.	PhD thesis: João Vitor Campos-Silva (Appendix 1); Publication in Scientific Reports (Appendix 2).
Indicator 0.2 A range of research and management activities centred on suitable breeding sites where ovipositing female turtles (*Podocnemis expansa* and *Podocnemis unifilis)* converge. A total of ~28 protected and unprotected sandy beaches along the Juruá River will be monitored.	Participatory monitoring at 12 fluvial beaches inside protected areas.	A total of 14 beaches were monitored, followed by a robust analysis to understand the broad ecological effects of beach protection	PhD thesis: João Vitor Campos-Silva (Appendix 1, Chapter 5); Manuscript in preparation (*Unintended multi-species co-benefits of community-based fluvial beach protection in lowland Amazonia*), soon to be submitted to PNAS (Proceedings of the National Academy of Sciences)
Indicator 0.3 Limnological measurements conducted at 83 oxbow lakes along a ~492-km section of the Juruá River.	None	83 systematically sampled lakes	PhD thesis: João Vitor Campos-Silva (Appendix 1, Chapter 3)
Indicator 0.4 CPUE data from offtakes of all aquatic sources of animal protein recorded on a weekly basis over 24 months at ~420 households from 35 local communities along a ~492-km section of the Juruá River	None	A large interview-based weekly sampling effort targeting 35 local communities	Dataset completed and manuscript in preparation: "*The role of protected areas on the food security of rural Amazonians*"

Indicator 0.5 GPS monitoring of the movements of a fleet of commercial fishing boats over at least a 1-year period, following authorization from the Fishermen Cooperative of Carauarí and Eirunepé; and Monitoring of fish landings from fishing boats at the local markets of these urban centres.	None	We had severe problems with the GPS tracking of fishing boats (mainly due to uncooperative fishermen unwilling to be monitored), so we used an alternative TEK methodology to estimate the waterscape use by commercial fishermen, which was very successful	Dataset completed and manuscript in preparation: "*Incorporating distance functions into the economics of Amazonian freshwater fisheries*"
Indicator 0.6 Spatial modelling of oxbow-lake fish productivity under varying degrees of protection from commercial fishing and connectivity to the main river channel.	None	This outcome is being developed as the spatial modelling work is very data-hungry; and some of these data have only recently become available. A user-friendly software that allows local communities to perform the spatial planning of their own harvesting activities is now nearly ready (beta-version tested).	Spatial modelling and publication: post-project activities in 2017; and a user-friendly software that allows local communities to perform the spatial planning of their own harvesting activities is now nearly ready (beta-version being tested).

Our seminal project brought a strong understanding about the fisheries dynamics along a previously unknown white-water Amazonian floodplain ecosystem. The few planned outcome activities that have not been completed at this writing includes the 1) spatial modelling of oxbow-lake fish productivity under varying degrees of protection from commercial overfishing and connectivity to the main river channel (Activity 5.5); 2) GPS tracking of commercial fishing boats (Activity 1.6), replaced with a functionally equivalent activity; and 3) the human-wildlife conflict educational booklet (Activity 4.6), which is still in the making. Two of these critical 2017 post-project activity are currently being conducted through a partnership with a spatial modeller at Oregon State University, USA (as originally intended). It was not possible to execute this activity earlier because the spatial modelling work is very data-hungry; and only recently some of these input data have become available. We expected a stronger effect of landscape and environmental factors, but our analysis showed that the protection effect was by far the strongest variable driving the dynamics of *Arapaima* populations, undermining other variables. Our analyses were therefore delayed to understand how to quantify and incorporate social capital and socio-political organization variables into our models. To solve this issue, we conducted a 3-month expedition in 2016 along 1,500 km (or roughly one-third) of the length of the Juruá river, identifying and quantifying these social dimensions. We are now building a more realistic model, which allowed us to fully understand the local demand for aquatic resource management at a much larger scale.

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

Impact statement from logframe:

Understand the spatial dynamics of resource productivity and exploitation of aquatic vertebrates — including commercially valuable fish, turtles and caimans — along the Rio Juruá; understand how these dynamics are facilitated or hindered by local social capital; and create a spatially-explicit set of community-based management guidelines to protect the landscape-scale sustainability of inland fisheries that can be feasibly enforced by previously disenfranchised local resource users.

Our project makes a substantial contribution to the conservation science and management of freshwater resources in Amazonian lowlands via a range of novel approaches. The social, ecological and economic benefits from community-based freshwater resources are critical to successfully induce enhanced levels of social organization in low-governance regions, such as Amazonian floodplains occupied by politically neglected local communities. Mindful of our overall exit strategy to provide continuity for the activities introduced by our Darwin Project, we have worked on several long-term outcomes, each of which involving the social organization and empowerment of local communities

<u>Fishing Accords</u>

At first, following a participatory approach, we produced a document agreed by all interest parties, which describes the fishing rules of engagement and mapped all oxbow lakes included in the fishing accords. After that, we wrote a Technical Document (Fishing Accord, Appendix 3), which was sent to the Brazilian government for ratification of the agreement. In May 2016, a technical group from the appropriate government agency conducted a public consultation process in the town of Carauari. About 200 commercial fishermen attended this event to discuss, fine-tune and validate the fishing accord (see photographic evidence – Appendix 4).

In the short-term (within three years), this accord will allow the large-scale recovery of *Arapaima* populations, as demonstrated by our preliminary monitoring results to date (Campos-Silva & Peres 2016; Appendix 2). In the longer-term this fishing accord will benefit over 1,000 families of fishermen from the Medio Jurua region, and ensure food security for some 23,000 people living in the Carauari urban area. This is extremely important, since these newly protected lakes will be established within *the most overexploited parts of the region*, thereby bucking the spatial trends imposed by opportunity costs. Protecting fish stocks translates directly into ensuring food security for many rural and urban households. Another point to highlight is the paradigm shift which is now occurring in our study region. For many decades, “conservation” was an unpopular term, which local communities associated with severe restrictions and hardship. Now, people are becoming more likely to link the notion of ‘conservation’ with economic opportunities, mainly due to the widely observed recovery of commercially-valuable fish populations.

The fishing accord is already working in practice, as demonstrated by Letters of Acknowledgement from both the Fishermen Cooperative of Carauari and the Municipal Government of Carauari (see Appendices 5 and 6). Unfortunately, due to an unexpected bureaucratic delay within the Brazilian government, the Accord has not yet been officially published by the State Press Office but publication is expected in the first trimester of 2017 and the documents sent to government agencies can be found in Appendices 3.

<u>Creation of a Local Association</u>

We supported the creation of a local association for the protection of livelihoods (Associação de Desenvolvimento Sustentável da Agricultura Familiar da Região do Baixo Juruá do Lago Serrado – ARBLS) to help the local communities outside protected areas. This association will be managed by eight local leaders, who received several informal training sessions from the project (See photographic evidence). Documents attesting to the creation of the association are provided in Appendix 7. The ARBLS will become a very important structure for the implementation of fisheries management through established fishing accords. Furthermore, the association will also ensure the development of others income activities, such as the exploitation of oilseeds with a market in the Brazilian cosmetic industry.

Fisheries management outside Protected Areas

In our study area, overexploitation is currently the leading driver of biodiversity loss outside PAs, and monitoring the conservation performance of remote Amazonian areas remains a challenge. Local communities however can conduct effective surveillance of key strategic sites via the protection of lakes and fluvial beaches, deterring poachers and illegal fisherfolk and release the population recovery of several vulnerable to endangered species, including those of high economic value. This can also promote poverty alleviation including tangible socio-economic benefits for local livelihoods. For example, *Arapaima* management has been shown to provide a valuable source of income for local communities inside our focal reserves. In contrast, communities outside PAs rarely have any cash-earning opportunities, and are completely neglected by social welfare programs, including sustainable development initiatives; and surveillance of natural resource extraction from these areas is non-existent. To address this issue, we invested our efforts in greatly expanding fisheries management to previously unmanaged lakes outside existing PAs. The first annual harvest took place in 2016, and the sale of this high value species in a local fish market generated more than US$10,000 for three local communities (Appendices 5 and photographic evidence), which is unprecedented in their history.

Local Capacity Building

During the course of our project we have successfully conducted training workshops attended by over 50 local community leaders and stakeholders. This social capital will remain available for many decades to work in local conservation and development strategies, and can ‘snow-ball’ into secondary positive initiatives. Training workshops covered practical issues including the legal bureaucracy surrounding permit acquisition required to conduct local *Arapaima* management, fisheries management in general, field procedures of *Arapaima* counts, fluvial beach management, and logistical preparations for specific management activities (see Photographic evidence).

Management of freshwater turtle hatchlings

Community-based protection of fluvial beaches is one of the strongest conservation initiatives across the Amazon, with recent evidence showing that this approach pays invaluable ecological dividends (Appendix 1, Chapter 5). Notably, the ecological benefits are extremely high compared to the low cost of beach surveillance in terms of equipment and personnel, which costs Brazilian government and partners only US$ 110 per beach-guard each month, which is paid on a monthly basis in the form of a food hamper over the six months of the dry season. This means that each turtle hatchling released over the last five years cost only US$0.03! However, there remains a clear dissatisfaction with these rewards amongst beach-guards who continue to claim for a formal salary. If the willingness to meet these minimal costs cannot be found amongst local/federal government or NGO sources, then CBC programs could represent an alternative means to generate the income required for the long term continuity of this incredibly cost-effective conservation scheme.

One potential idea is to instigate a sustainable turtle harvest with associated income generation, as exemplified in the same study area by the *Arapaima* management model. To explore this concept, we began a research project to rear hatchlings of the largest turtle species, *Podocnemis expansa*. We collected some 500 wild-caught hatchlings, with two communities subsequently rearing them in nurseries inside small oxbow lakes. Hatchlings have been fed natural food items, and we expect communities to be able to sell semi-free ranging turtles in the 3rd year, when they reach approx. 5 kg in weight. The entire process is under the supervision of Project Partner, Dr Paulo Andrade, who recently completed his PhD at UFAM, and has extensive research experience in turtle conservation and cost-benefit analysis of hatchling management. This management scheme rests on the assumption that, after five years of sales of sustainably reared turtle hatchlings, sufficient income will have been generated by local communities to secure the future of this CBC activity. Should this initiative prove to be successful, we will set an example that could generate unprecedented benefits for more than one hundred similar initiatives spread across the entire Brazilian Amazon.

Mapping social-capital

Social organization appears to be the strongest factor driving the success of CBC schemes. To examine the potential for CBC on a basin-wide scale, we mapped the available social capital throughout more than 1,500 km of fluvial distance along the Jurua river. This information will now be available for any larger-scale projects to be conducted by Brazilian government agencies or other actors in the future. We identified the most important areas for the establishment of both fisheries management and fluvial beach protection. Social capital was quantified, considering: leadership, community engagement and neighbouring suitable environments, including lakes and fluvial beaches (Fig. 2).

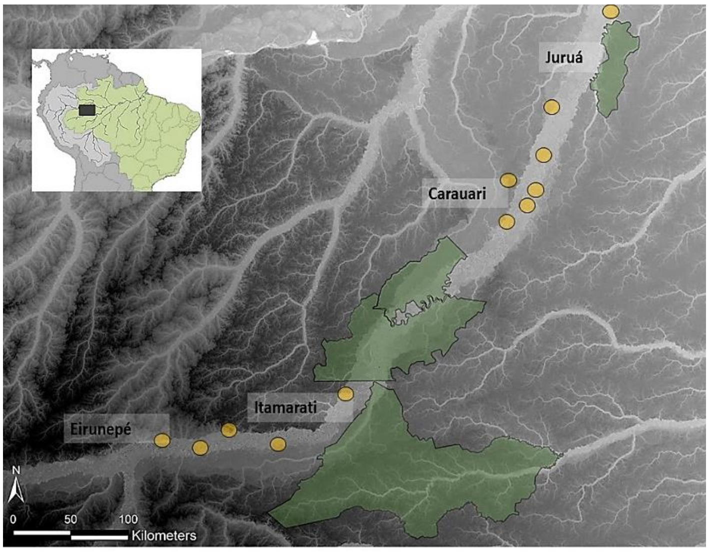

Figure 2. Social capital mapping along the Juruá river. Green polygons represent protected areas; orange circles indicate human settlements with strong leadership, social organization, community engagement and nearby suitable environments, including lakes and beaches.

2.3 Outputs

Output 1:	Design, local empowerment, consolidation and expansion of the landscape scale spatial management system concerning a large network of oxbow lakes		
	Baseline	Change recorded by 2016	Source of evidence
Indicator 1.1 Background research leading to the development of a spatially explicit management protocol of community-based freshwater fisheries management	None before project	Data collection of artisanal and commercial fish landing data was completed. Detailed analyses of the large amount of fisheries exploitation were conducted.	Dataset completed and manuscript in preparation
Indicator 1.2 Data from limnological sampling of 83 spatially-explicit oxbow lakes	None before project	Limnological lab analyses of physical, chemical and biological properties of lake water, with seasonal	PhD thesis: João Vitor Campos-Silva (Appendix 1, Chapter 3)

during both the wet and the dry seasons.		controls, have been completed.	
Indicator 1.3 Technical training Workshop deployed to both artisanal and commercial fishermen of the central Rio Juruá region; Technical training Workshop with key stakeholders including the Fishermen Cooperative, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and representatives of SDS/CEUC and ICMBio)	None before project	No further training workshops were conducted during this reporting period, but during our long field work campaign last year, several sampling protocols were reinforced including our data quality control measures. To address the query from the last review, we have previously conducted three training workshops over the course of the entire project, with an attendance around 50 people per workshop which was highly biased towards local community leaders.	Letter of acknowledgement from local fisherman cooperative (Appendix 5) photographs of training workshops (Appendix 8)
Indicator 1.4 Deliberations of negotiated settlement between commercial and artisanal fishermen thereby subsidizing a legal agreement ratified by the Fishermen Cooperatives of Carauarí	None before project	During the last year, we have completed efforts to formalize an official fishing agreement.	Bureaucratic delays within the Brazilian government mean that the fishing accords have not yet been officially published (in Diario Oficial, the governments' official newsletter) but all documents have been sent to the appropriate government agencies (Appendices 3 and 4) and publication is expected in the first trimester of 2017.
Indicator 1.5 Preparation of the *Handbook of Community-Based Freshwater Fisheries Management Techniques*	None before project	The illustrations and contents for a handbook of freshwater resource management techniques and the short video documentary are completed. The video is currently undergoing final editing.	*Handbook of Community-Based Freshwater Fisheries Management Techniques* (Appendix 10) Video documentary (final edits currently being done at the time of writing; final version to be posted to project YouTube channel)
Indicator 1.6 Dissemination of the *Handbook* to all institutions involved in resource management, particularly concerning fisheries	None before project	Once the Handbook is printed, we have made arrangements with our partners and FAS for the Portuguese version to be disseminated to all relevant institutions and rural communities across the State of Amazonas.	PDF copies of both the Portuguese and English versions of the Handbook will also be made available on the PMJ website. A Spanish version will also be produced for dissemination in other Amazonian countries.

			(Appendix 10)
Output 2:	Design, local empowerment, consolidation and expansion of the spatial management system addressing freshwater turtles and ovipositing sites on fluvial sandy beaches		
	Baseline	Change recorded by 2016	Source of evidence
Indicator 2.1 Training Workshop on turtle management to local stakeholders, namely the residents of RDS Uacari and RESEX Medio Jurua	None before the project	Three workshops conducted	Photographs of training workshops (Appendix 8).
Indicator 2.2 Discussions with Reserve Management Council on spatial zoning of all dry-season sandy beaches	None before the project	Five major discussions conducted	Photographs of talks (Appendix 8)
Indicator 2.3 Number of fluvial sand beaches protected along a 492-km section of the Rio Juruá	12 beaches poorly protected before the project into protected areas	16 beaches well implemented + 4 potential (not yet implemented) outside PAs now protected by CBC. We also mapped all social capital along 1,500 km of the Juruá river, identifying suitable locations for the establishment of new protected beaches.	Map with the locations of all potential beaches to be targeted by CBC to be sent to the Brazilian government (see 2.2 Long-term strategic outcome(s))
Indicator 2.4 Counts and electronic tagging of live turtle hatchlings dug from nests, quarantined, and released.	None before the project	>1000 hatchlings tracked	Dataset completed and manuscript in preparation in conjunction with UFAM partner, Dr Paulo Andrade.
Indicator 2.5 Large-scale movements of adult *Podocnemis* turtles over a 24-month period.	None tracked before the project	4 adult females tracked	Dataset completed and manuscript in preparation in conjunction with UFAM partner, Dr Paulo Andrade.
Output 3:	Design, local empowerment, and expansion of the management system addressing *Arapaima* fisheries in both oxbow lakes and the river channel (including *Arapaima* ecology)		
	Baseline	Change recorded by 2016	Source of evidence
Indicator 3.1 Initial presentation of subproject and training workshop to local	None	1 x presentation + 1 training workshop, attended by over 60	Photographs of training workshops (Appendix 8).

artisanal fishermen from 35 local communities on *Arapaima* census techniques		project participants from local communities.	
Indicator 3.2 Training workshop extension to key stakeholders outside the two protected areas (Fishermen Cooperative, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and representatives of SDS/CEUC and ICMBio)	None	Two workshops attended by ~45 participants from 35 communities, and including representatives of local cooperative associations.	Photographs of training workshops (Appendix 8).
Indicator 3.3 Total number of protected oxbow lakes negotiated with commercial fishermen cooperative under mutually-agreed "fishing accords".	Five inside the reserves None outside the reserves	We negotiated and implemented protection of 3 additional lakes inside the reserves, and 15 new lakes outside the reserves.	Fishing accords (Appendices 3 and 4) and letter of acknowledgement from local fisherman cooperative (Appendix 5)
Indicator 3.4 Time-series from at least 26 lakes beginning to show population recovery trends by the end of Project Year 3.	None	We have a huge dataset with *Arapaima* counts in 87 lakes, since 2012.	Publication in Scientific Reports (Appendix 2).
Output 4:	Design and establishment of a conflict-resolution management plan considering large vertebrates perceived to be "problem species" including key apex predators (e.g. *Pteronura* and *Melanosuchus*)		
	Baseline	Change recorded by 2016	Source of evidence
Indicator 4.1 Development and preparation of educational booklet with the goal of reducing conflicts between subsistence/commercial fishermen and *Pteronura* and *Melanosuchus*	None	Not yet completed; however we have: 1) Developed a study on the abundance and reproductive biology of Black Caimans, and the population recovery of giant river otter; 2) Deployed a study on human-wildlife conflicts pertaining freshwater realms;	Dataset on black caiman abundance; Dataset on black caiman nest abundance Photographs of talks in rural communities (Appendix 8) Thesis project: Cook, Patrick (2015) Human wildlife conflicts: a review of conflicts with freshwater mammals and reptiles in the tropics and subtropics. BSc

		3) Offered to serve an ecological advisory role on imminent prospects of lifting the ban on managing adult black-caiman populations along the Rio Jurua region.	dissertation, University of East Anglia. Meeting with technical staff at IBAMA, Brasilia, planned for 12 April 2017.
Indicator 4.2 Dissemination of a “problem-species” illustrated educational booklet to all Jurua communities.	None	Not yet completed	
Indicator 4.3 Population estimates combined intensive field surveys and information from interviews at 40 communities on the spatial distribution of occupancy records of *Pteronura and Melanosuchus*	None	We completed interviews in more than 40 communities	BSc dissertation: Patrick Cook (Appendix 9)
Indicator 4.4 Illustrated talks at seven venues bringing together representatives of 40 local communities of RESEX Medio Jurua and RDS Uacari	None	We completed talks about wildlife conflicts in 18 communities	Photographs of talks (Appendix 8)
Output 5:	Empirical and theoretical test of management protocols and expansion into other river basins of Brazilian Amazonia and other Amazonian countries		
	Baseline	Change recorded by 2016	Source of evidence
Indicator 5.1 Analytical approaches to data integration including productivity-based stock recruitment models; spatial modelling showing the importance of no-take areas under a source-sink population framework; an analysis of the socioeconomic benefits of no-take areas accrued to local communities.	None	This is a key project indicator; but has been delayed to the post-project phase of data analysis and writing. A user-friendly population modeller software that can be used by local communities to plan the spatial design of their harvesting activities was commissioned from and developed by a spatial modeller (final beta-version being tested)	Publication in Scientific Reports (Appendix 2); PhD Thesis in progress: Carolina Freitas, due to complete her PhD (with fieldwork fully financed by our project) at UFRN in 2018 Beta-version of *Population Modeller* software developed by Tasman Thenell, Oregon State University (Appendix XX)
Indicator 5.2	None	The Handbook is completed. Printing and	*Handbook of Community-Based Freshwater Fisheries*

Distribution of the *Fisheries Handbook* to all relevant institutions and government agencies involved in the management of freshwater fisheries in Brazilian, Bolivian, Colombian and Peruvian Amazonia		distribution costs will be shared with state management agencies of the State of Amazonas	*Management Techniques* (Appendix 10)
Indicator 5.3 Final Workshop held in Manaus to a target audience of natural resource management agencies, particularly government and nongovernment organizations responsible for fisheries management	None	Not completed This will be funded by the state government of Amazonas and therefore postponed to 2017 Many of the outreach extension information transfer to local users have also been delivered during activities in July-November 2016.	
Indicator 5.4 Presentations of project results at the Latin American Wildlife Management Congress, Association for Tropical Biology & Conservation meeting, and Society for Conservation Biology.	None	• Campos-Silva et al. 2015 Latin American Wildlife Management Congress, Havana, Cuba. • Campos-Silva et al. 2015 ATBC, Hawai'i, USA. • Campos-Silva et al. 2015 Brazilian Mammalogy Congress (Congresso Brasileiro de Mastozoologia), João Pessoa, Brazil • Hawes et al. 2016 ATBC, Montpellier, France. • Abrahams et al. 2016 ATBC, Montpellier, France • Campos-Silva et al. 2016. Fisheries Management Congress, Salvador, Brazil. • Peres et al. 2017 Local resource management in Amazonian extractive reserves (invited speaker). University of Florida, Gainesville, USA.	Conference abstracts and announcements of talks (Appendix 14)

Output 6:	Understand the co-benefits of community management for biodiversity conservation		
	Baseline	Change recorded by 2016	Source of evidence
Seasonal movement of terrestrial vertebrates	None	Large sampling effort on floodplains and upland forest	MSc dissertation: Hugo Costa
Terrestrial wildlife depletion envelopes near local communities	None	Large sampling effort and strong evidence of terrestrial wildlife depletion	PhD thesis: Mark Abrahams
Wattled Curassow population ecology	None	Ecology information generation	Dataset completed and PhD thesis in preparation: Gabriel Leite
Conservation programme of lowland paca and other nocturnal mammals	None	Activity suspended.	None; however, we have a complete dataset on nocturnal surveys and paca abundance from the 12 month period during which this activity was operating
Tambaqui management programme	None	Activity suspended.	None; as explained in a previous report we attempted to initiate this activity but for a number of reasons it was not possible to tag a sufficient number of Tambaqui so this activity was discontinued.

Output 1: Oxbow lake programme (protected vs unprotected lakes)

Fishing accords

Reported in Section 2.2 Long-term strategic outcome(s)

Oxbow-lake productivity and ecosystem function

Our oxbow lake management program has revealed a fascinating ecological case-study with huge potential "win-win" application of fisheries management. At first, we found that primary productivity is low during the wet season, probably because the high water level dilutes nutrient sources resulting in severe scarcity of key macronutrients. At this time of year, the energetic input into the ecosystem is predominantly allochthonous. However, during the dry season, phytoplankton concentrations increased dramatically and the energetic source became primarily autochthonous (Figure 3). This high primary productivity is very important for vertebrate populations when oxbow lakes become isolated from the main river channel.

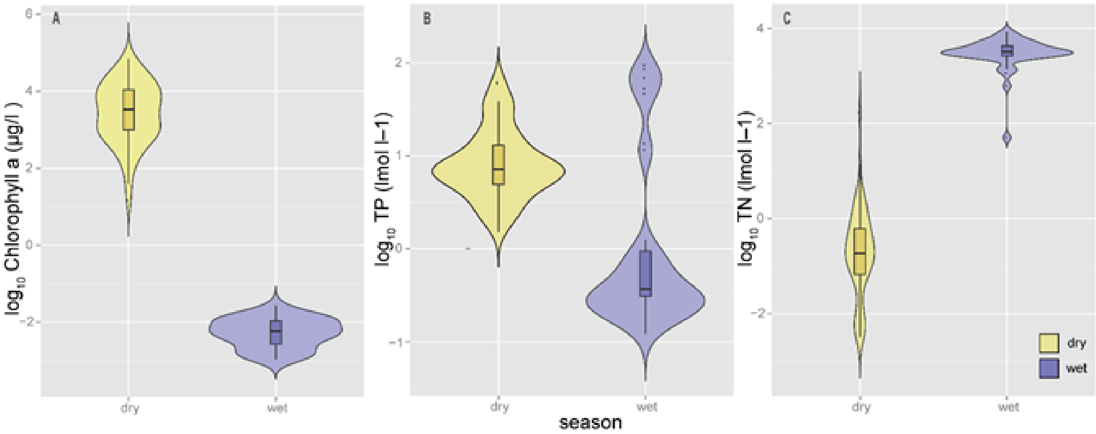

Figure 3. Primary productivity of oxbow lakes during the dry and wet seasons showing the A) phytoplankton biomass, B) phosphorus concentration and C) nitrogen concentration.

Using data from our completed household surveys, we have been able to explore the relationships between household CPUE and productivity. As expected, the bottom-up mechanism is mediated by phosphorus availability, which ensures a high phytoplankton biomass. However, in addition to this, we found that the level of lake protection against commercial fishing boats can also regulate phytoplankton biomass. This is because unprotected lakes represent an experimental model where top predators become largely extirpated by overharvesting. Without top predators, smaller-bodied zooplanktivorous fish are more likely to increase in abundance, thereby reducing zooplankton biomass. As a result, because zooplankton feed on phytoplankton, we can see a corresponding increase in phytoplankton biomass (Fig. 3). Phytoplankton is a key element determining detritivorous fish production, which represents almost 40% of the species (and a higher proportion of the consumed biomass) relied upon by local people for subsistence.

If a zoning approach is employed, this mechanism can ensure a "win-win" fisheries management strategy since protected lakes produce a high biomass of high-value, large-bodied fish species operating as apex predators (which can be harvested and sold to generate an important source of local revenue), while unprotected lakes can maintain a high biomass of smaller-bodied species that are important for direct local subsistence (Appendix 1). A manuscript describing these results is currently in preparation to be submitted by March 2017.

To further extend our examination of the functionality and ecosystem level consequences of lake protection status according to the fishing accords we included an investigation of the effects of fisheries management on waterbird abundance at 31 oxbow lakes spread across the floodplain (Appendix 1, Chapter 4).

Output 2: Freshwater turtles programme (protected vs unprotected fluvial beaches)

See Appendix 1, Chapter 5. A manuscript describing these results is also currently in preparation to be submitted in Feb 2017.

Output 3: *Arapaima* stock assessment and management programme

See Appendix 1, Chapters 2 and 6. These results have also been published in Scientific Reports (Appendix 2).

Arapaima gigas ecology

This project provides some very interesting results from our *Arapaima* fish telemetry work, confirming the long distances that *Arapaima* can travel into the flooded forest during the wet season. One of our focal *Arapaima* was recorded to have travelled over 30 km from its dry season lake, where it was killed by a fisherman outside the reserves (Fig. 4). At first, this was unfortunate, however, it also provided a very important message to better understand how *Arapaima* movement ecology affects the efficiency of *Arapaima* management. Using this example, we are able to illustrate to local people that, during the wet (high-water) season, fish resources cannot be monopolised by resource users. Several valued fish species can migrate up and down the river, colonising over-exploited environments, thereby providing food for families from different communities, including people outside protected areas. In this way the protected lakes can be seen to have wider benefits for subsistence households far from management sites.

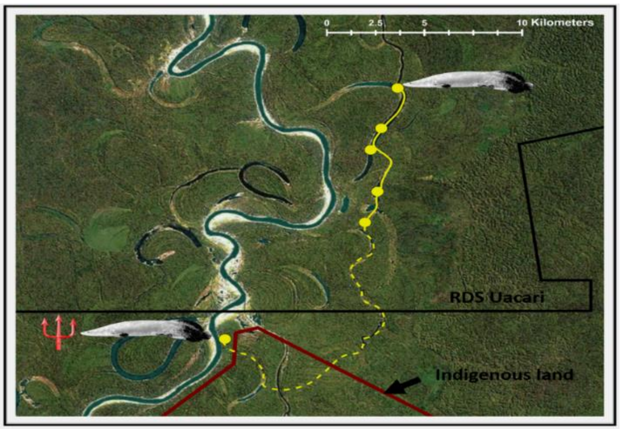

Fig. 4. Results of *Arapaima* telemetry, showing the remarkable movement of one individual over 30 km.

Our results also show that, at the onset of the dry season, after six months in the flooded forest, eight individuals returned to the same lakes where they were initially caught. With these results we confirmed a high level of site fidelity for protected lakes, which provides a strong incentive for local communities to introduce or maintain lake protection because, during the dry season (when oxbow lakes become more discrete geographic features) fish stocks can be monopolised and harvested for high financial returns.

Output 4: Conflict resolution

Our project has been able to collect a large amount of data on the ecology and abundance of Black Caimans, the premier "problem-animal" species in our study area and the most important aquatic apex predator threatening local lives and livelihoods. Our project documented at least nine cases of black caiman predation or attempted predation on humans throughout our wider study area over the 2011-2016 period. Data on caiman abundance and reproductive ecology will be analysed in 2017 to produce a document that may be used by local partners to formally lift the ban on managing caiman populations. We also deployed a study specifically examining human-wildlife conflicts, which was focused on black caimans, giant river otter, and both species of river dolphins, all of which cause property damage to gillnets used by local fishermen.

Our project has also been able to least partly solve some treacherous conflicts between local communities and professional fisherman, which in the past often escalated to armed violence. During our last field campaign, we helped to solve two historical conflicts around two lakes inside the reserves. The situation in each case was complex due to threats of violence and our role as an intermediary was valuable in helping the various parties reach a common accord. We have been able to show that it is possible to form a partnership between local communities and professional fisherman from nearby towns, perhaps the thorniest problem in fisheries management. These two lakes were then protected thereafter under a new (and as yet untested) model involving both professional fisherman and local fishermen.

Output 5: Empirical and modelling tests of management protocols

We established protection and annual counts for 15 new lakes outside protected areas to verify the possibility of replicating our earlier findings within the focal reserves. The results have been impressive; for example at Lago Grande, a 294-ha lake, where the *Arapaima* population increased from ~30 to over 1,200 individuals in only three years of CBM lake protection. Oral presentations were well received at the Environment and Development Convention (Convención Internacional sobre Medio Ambiente y Desarrollo) in Cuba (July 2015;

http://www.cubaambiente.com), the Association for Tropical Biology & Conservation (ATBC) meeting in Honolulu, Hawaii (July 2015; http://www.atbc2015.org/), the Brazilian Mammalogy Congress (Congresso Brasileiro de Mastozoologia) in João Pessoa, Brazil (Sept 2015; http://www.8cbmz.com.br/site/capa), and the Association for Tropical Biology & Conservation (ATBC) meeting in Montpellier, France (June 2016; http://www.atbc2016.org/).

We now know that given sufficient time, *Arapaima* and other commercially valuable fish populations will recover within managed lakes, and recovery rates are likely faster within a benign landscape scenario where source-sink dynamics at least partially operates. Modelling the theoretical basis of this approach is yet to be completed at this writing, but the basic principles of lake management are already well understood. Although our follow-up project funding request to Darwin was rejected, we will continue to work with project partners and government agencies to ensure full practical consolidation of these project results, which we expect will be strengthened even further when the spatial modelling work is completed and published. As a measure of this success, 3 years into the tenure of this project, fish sales for the first time became the most important regional scale source of revenues centred at the town of Carauarí.

Output 6: Understanding the co-benefits of community management for biodiversity conservation

Here we present project activities that were inappropriately listed in previous reports as additional outputs. On the advice in previous reviews, we successfully redirected our focus to ensure that the project's overall outcome was in not ultimately compromised.

Seasonal movement of terrestrial vertebrates: Available in the MSc thesis by Hugo Costa (MPEG/UFPA).

Terrestrial wildlife depletion envelopes: Available in the PhD thesis by Mark Abrahams (UEA)

Wattled Curassow population ecology: To be available in the PhD thesis by Gabriel Leite (INPA).

Lowland paca and nocturnal mammal conservation: Activity suspended for continuation outside the remit of this project.

Tambaqui management programme: Activity terminated, to be reconsidered for a future project.

3 Project Partnerships

A notable feature of this project was the strong and welcoming working relationship with the institutions involved in the co-management of natural resources across the vast project study area. These partnerships were successfully built by utilising the lengthy field experience of our staff in the area, and collaborative ties with certain key individuals that now go back as far as 10 years. As the project was designed to strengthen local capacity of our partners and consider their deficiencies, it was relatively easy to build a strong partnership considering both bottom-up demands and top-down constraints. As part of our exit strategy, our partners continue to share common objectives and consider the scaling-up development of a management structure at the watershed scale of the entire Jurua River within Brazil. Every two months they are planning to promote a meeting called a "Jurua territorial meeting" to plan and coordinate joint activities. Next, we describe our institutional partners as following:

A) SDS/CEUC – Secretaria do Meio Ambiente e Desenvolvimento Sustentável do Amazonas e Centro Estadual de Unidades de Conservação (http://www.sds.am.gov.br/)

This state institution is based in the state capital (Manaus) and is responsible for the bewildering task of managing a large number of state-level protected areas across the State of Amazonas. This partnership was of strategic and fundamental importance to the project objectives, because SDS/CEUC hopes to be able to roll out the applied knowledge generated by our project to other sustainable use forest reserves within Amazonas. This partner played an important role in our project, due their experience and social capital in Jurua river.

B) ICMBio – Instituto Chico Mendes de Conservação da Biodiversidade (http://www.icmbio.gov.br/portal/)

This federal government institution is responsible for managing the federal protected area where we work (RESEX Médio Juruá). We have had a strong relationship with this partner which participated in the project in a similar way to SDS/CEUC. All project activities were sent to and analysed by this partner. This will also become a strategic partner beyond the completion of the project because, with ICMBio's oversight, it will eventually be possible to scale up and apply the management models developed in our project to other protected areas in the other eight states of Brazilian Amazonia, other than the state of Amazonas.

C) UFAM – Universidade Federal do Amazonas (http://www.ufam.edu.br/)

The Universidade Federal do Amazonas is the oldest in Brazil. It has been an important partner of the project, particularly regarding the freshwater turtle ecology & management component of the project. Through *Projeto Pé de Pincha* (http://pedepincha.com.br/), UFAM has been studying the ecology and management of freshwater turtles for 15 years, and our project enabled these activities to be extended to the Juruá. UFAM contributed knowledge on the seasonal movements, foraging ecology, and management of freshwater turtles, as proposed by our project. These activities are intimately linked to zoning and protection of fluvial beaches along the Juruá during the critical egg-laying season of two large-bodies species of *Podocnemis* turtles. In addition to the turtle component, UFAM provided expertise for the genetic analysis of *Arapaima* tissue samples.

D) INPA- Instituto Nacional de Pesquisas do Amazonas (https://www.inpa.gov.br/)

INPA is the largest tropical ecology research institute in the world and has extensive research experience in Amazonia (although most of the activities are concentrated around Manaus in the Central Brazilian Amazon). INPA provided the laboratory structure for all limnological analysis, as well as beach substrate analyses.

E) UFRN – Universidade Federal do Rio Grande do Norte (http://www.ufrn.br/)

UFRN has recently excelled in Brazil in the area of ecology. As a counterpart, UFRN provided a Brazilian doctoral scholarship to a core project member (João Vitor Campos e Silva**)**. His completed thesis involved the management of aquatic resources in the Juruá floodplains and his field and lab work were funded by this Darwin project.

F) ASPROC – Associação dos Produtores Rurais de Carauari (http://www.asproc.org.br/)

ASPROC was the strongest local partner of the project, and provides a political voice for local natural resource users because it is a grassroots, community-based organization which was borne out of local demands following the emancipation of former rubber tappers from powerful rubber landlords and local trade monopolies and middlemen. ASPROC co-led several natural resource management components of this project, which were guided by a constant dialogue with project members. This partner strongly supports work on the ecology and management of the iconic *Arapaima* fish, and helped us build a close relationship with community leaders. The *Arapaima* ecology and management program has become a key cornerstone of the project, and is intimately related to the oxbow lake ecology and management components of the project.

G) AMARU – Associação dos Moradores da Reserva de Desonvolvimento Sustentável Uacari (http://amaru.org.br/)

Similarly to ASPROC, AMARU co-organizes the practice of resource management in rural communities where our project has been implemented. This has also been a key local partnership for the implementation of our activities. AMARU is closely in touch with local communities, and constantly helped us think about the demands and needs of the local population, so that we could build our goals based on two important, but often diametrically opposite challenges in modern conservation science and practice: biodiversity conservation and improving the standards of living of traditional populations.

H) COLPESCA – Colônia de Pesca de Carauari (Cooperative/Sindicate of Fishermen of Carauarí)

The township of Carauari is a convergence point for a fleet of over 800 variable-sized fishing boats that largely trades chilled fish with a few wholesale buyers, which export large amounts of fish to large urban markets such as Manaus (2 million people). This partner has been vital to the success of our work after overcoming the enormous political challenge to initially earn their trust and then encourage them to collaborate with our project, likely due to suspicion and resentment of outside researchers who may be mistrusted for blowing the proverbial whistle on commercial fishing activities. There is a large historical conflict in the Juruá, where COLPESCA fishermen often violate property rights and transgress community boundaries of oxbow lakes located in protected areas in order to plunder fish stocks. Our project helped open the doors for a more formal dialogue and, through our project, COLPESCA commercial scale fishermen are now working with local subsistence fishermen living within the project reserves.

We supported and developed a fisheries protocol to avoid or minimise stakeholder conflicts, promote the population recovery of harvest-sensitive fish stocks, and allow the wide acceptance of a large-scale spatial mosaic of locally-enforced fishing activities and fishing rights, whereby the land(water)scape stock renewal and source-sink dynamics can compensate for depletion effects induced by varying deployment and selectivity of fishing practices. This is crucial because fishing has now become the largest earner of monetary revenues in the Carauari municipal county, and commercial fishermen, who are themselves destitute and oppressed by powerful merchants up the trade chain, cannot be entirely excluded from the basin-wide spatial equation of fishery management. They also represent an important electorate, thereby harnessing support from local politicians.

4 Contribution to Darwin Initiative Programme Outputs

4.1 Contribution to SDGs

1. No Poverty: Our project has helped to boost income generation in rural communities of Amazonian floodplain resource users.
2. Zero Hunger: Our project has helped to protect food security by promoting and supporting the sustainable management of subsistence freshwater fisheries.
3. Good health and well-being: Our project has helped to support health and well-being through the promotion of sustainable managed fish offtake as an alternative to red meat and processed foods.
5. Gender Equality: Our project has helped to promote the involvement of women in fishery management, with gender-unbiased direct revenue streams.
6. Reduced inequalities: Our project has helped to support marginalised communities in one of the poorest regions of Brazil to reduce levels of inequality within one of the most unequal countries in the world.
7. Clean water and sanitation: Our project worked in a low-governance region of Amazonia, where essential services are virtually unavailable. Income generated by project activities however has aided local communities to meet a number of socioeconomic standards including access to sanitation facilities.
8. Affordable and clean energy: Our project worked in a low-governance region of Amazonia, where essential services are virtually unavailable. Income generated by project activities however has aided local communities to meet a number of socioeconomic standards including access to household electrification.
9. Life below water: Our project has worked to conserve and sustainably use the multiple aquatic resources present in the largest freshwater system on Earth. These resources are of fundamental importance for the communities of rural Brazilians who depend upon them for their subsistence and livelihood.
10. Life on land: While focussing on aquatic ecosystems, the nature of Amazonian floodplains means that our project is also intimately linked to the sustainable management of terrestrial systems and the conservation of forest biodiversity.
11. Responsible consumption and production: Our project providing a powerful educational experience, clearly demonstrating to rural communities the dangers of over-extraction and consumption, and the multiple benefits of sustainable management in terms of protecting important resources for future generations.
12. Climate action: Project goals are somewhat intertwined with social resilience to climate change goals in ensuring local food security from floodplain systems

13. Peace, justice and strong institutions: All of the above. This project has hugely strengthened the local self-governing framework under which local communities are newly empowered to practice lightly subsidized resource management.

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

The project provided a strong contribution to several CBD articles, including the Sustainable Use and Conservation of Biological Diversity, implementation of Protected Areas, Biodiversity Monitoring, Use of Local Traditional Knowledge, Research and Training, and Technical and Scientific Cooperation under the thematic areas of Ecosystems Approaches, Sustainable Use of Biodiversity, Protected Areas, and Forest Biodiversity. In addition, aquatic resource populations addressed here are sustained by increasingly degraded seasonally-flooded forests. As such, the project also supported RAMSAR, the Convention on Wetlands of International Importance, and provided a subsidiary body of scientific, technical and technological extension that can be applied not just to the Juruá region, but six of the other seven lowland Amazonian countries.

The project strengthened all five strategic goals of the Strategic Plan for Biodiversity (2011-2020) as agreed within the Aichi Biodiversity Targets framework. In particular, the project provided a decisive contribution to Target 11 of Strategic Goal A in relation to the effective implementation of *Sustainable-Use Protected Areas* in tropical forest regions. The project also aided the implementation of the Biodiversity Convention within Brazil via our collaboration with ICMBio and CEUC/SDS, the protected areas branch of the Brazilian Ministry of Environment (MMA) and the State of Amazonas, respectively, and supported integration with other initiatives, including MMA's ARPA protected areas programme for the Brazilian Amazon. The project policy advisory role will continue in years to come beginning with a forthcoming meeting (on 12 April 2017) between the PL and key staff at the Diretoria de Uso Sustentável da Biodiversidade e Florestas, Instituto Brasileiro do Meio Ambiente (IBAMA) to discuss a number of Amazonian floodplain management issues.

Finally, large turtles can migrate thousands of kilometres and the GPS tracking component of *Podocnemis* turtles therefore contributed to research priorities from the Strategic Plan of the Convention on Migratory Species of Wild Animals (CMS). A peripheral project contribution was also made in supporting a new GPS tracking study of fluvial beach migratory birds; to date the project has tracked the movements of four Orinoco Geese (*Neochen jubata*) and four Black Skimmers (*Rynchops niger*), in collaboration with Dr Lisa Davenport (Florida State Museum, USA).

4.3 Project support to poverty alleviation

Our project has delivered direct and tangible results towards alleviating poverty in rural Amazonian communities, and can be used as a model approach for future state-funded rural extension programs. *Arapaima* management, in particular, has been shown to provide a valuable source of income for local communities inside our focal reserves. We have successfully expanded this initiative and included vulnerable communities outside PAs that previously have rarely had any cash-earning opportunities, and are often completely neglected by social welfare programs and sustainable development initiatives. The first annual harvest from these newly protected and managed lakes took place in 2016, and the sale of this high value fish species in the local market generated an unprecedented windfall of more than US$10,000 for three local communities (Appendices 5 and 8). Beyond this initial financial return, these communities have benefited on a longer-term scale from project activities as ~80 people across 13 communities have received effective training and are fully empowered to continue the sustainable management of their own natural aquatic resources long after project completion. In addition, this approach has been particularly important for the empowerment of women in these communities – see next section on gender equality.

4.4 Gender equality

Arapaima management has been shown to be a powerful tool in reducing gender inequality both inside and outside PAs. Women are traditionally highly involved in conventional fisheries, but any monetary income is typically intercepted by men. Our results show that *Arapaima* management is changing this reality in that per capita revenues from this activity is much higher than conventional fishing for women (Fig. 5); women are key players in the handling and processing of Arapaima landings; and revenues are shared equally across all community members involved.

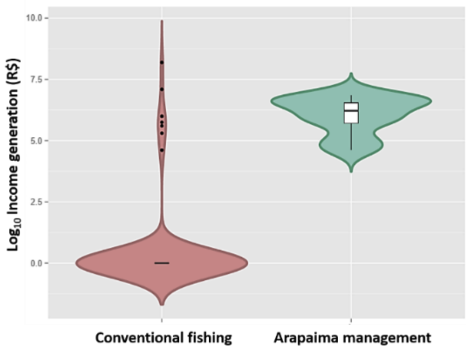

Figure 5. Income generation for women under previous conventional fisheries and *Arapaima* management instigated by this project.

4.5 Programme indicators

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

Yes, the prevalent management structure in this project is the local community; they maintain political influence even at higher scales of management; and many local communities are finding their political voice in both demanding resource access and strengthening the self-organization of local management structures.

- Were any management plans for biodiversity developed?

Yes, largely in consultation with local communities, this represent both a consolidation of previous efforts and fine-tuning of new management guidelines.

- Were these formally accepted?

Yes, as described above.

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

As mentioned previously, the main arena in which this project operates is characterized by a democratic management structure of two large sustainable-use forest and floodplain reserves, where all communities and male and female adults within communities are potentially represented.

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

Yes, some of these results are yet to be published, but a project output shows phenomenal household-scale seasonal windfalls in fish sales from sustainably harvested *Arapaima* (Appendix 1 and 2). These monetary gains are unprecedented in this region of Amazonia.

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

All households of local communities that participate in *Arapaima* management, which accounts for roughly 65% of the population of the two reserves.

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

Protected lakes derive total fishing revenues from *Arapaima* stocks alone averaging US$10,601 [95% CI: US$5,393, US$15,808] every year, provided that full compliance with management rules takes place and total allowable catches (TACs) are harvested. However, some exceptionally large white-water lakes could yield as much as US$52,093 yr^{-1} if the officially sanctioned TAC had been sold. This translates into mean annual revenues per community household of US$1,046.6 [95% CI, US$497, US$1,596], considering the 14.4 ± 8.5 families per community (range = 4 – 30) that were engaged in *Arapaima* management activities (Appendix 2).

4.6 Transfer of knowledge

Did the project result in any formal qualifications?

i. How many people achieved formal qualifications?
ii. Were they from developing countries or developed countries?
iii. What gender were they?

The project directly supported transfer of knowledge through the training of six PhD students (5 Brazilian, 1 British; 5 Male, 1 Female), two MSc students (2 Brazilian; 1 Male, 1 Female), and one BSc student (British; Male).

4.7 Capacity building

i. Did any staff from developing country partners see an increase in their status nationally, regionally or internationally? For example, have they been invited to participate in any national expert committees, expert panels, have they had a promotion at work?
ii. What gender were they?

In addition to formal academic qualifications, the project sought to transfer knowledge by focussing on local practitioners. Training workshops successfully built capacity for conservation and sustainable management of natural resources in previously marginalised communities.

One of the Brazilian PhD students (Campos-Silva) has benefited from the skills and experience developed during the course of the project (including presentations at international conferences and publications in academic journals) to successfully win a post-doctoral research position at the Universidade Federal de Alagoas (UFAL). Furthermore, Carolina Freitas was invited to share her experience in Australia and Thailand meetings about sustainable use of natural resources. Dr Paulo Andrade, a key collaborator who recently earned his PhD at INPA, will continue to lead discussions and management programs regarding a number of Amazonian turtle ecology and conservation issues. Julia Romero, a Brazilian political scientist, was inspired by her experience in the Jurua and will begin her PhD studies at University of Aarhus, Denmark. Finally, Gabriel Leite is analysing his Jurua data on large cracids, particularly the Wattled Curassow (*Crax globulosa*) and is expected to earn his PhD at INPA by late 2017.

4.8 Sustainability and Legacy

Due to the large geographic expanse and insufficient institutional governance and human resources, it is impossible to contemplate conservation in the Amazon without the inclusion of rural peoples as key components of this process. Community-based management (CBM) can be a powerful tool to promote conservation. The Brazilian government has attempted to implement some initiatives using a CBM framework, but these approaches are at best patchy and poorly monitored. Our project members developed a strong and amiable relationship with different spheres of the Brazilian government, all the way up to its maximum representation at IBAMA/Brasilia which oversees the federal scale management of all natural resources within the Brazilian territory. We are confident of convincing local, state and federal governments to implement the guidelines this project has developed in further consolidating activities in the Jurua valley and other major river basins of Amazonia.

We used a mixed approach between environmental predictors and traditional ecological knowledge (TEK), and consider it completely feasible and economically realistic to replicate our project lessons in other areas. Our priority post-project action will be to widely distribute Portuguese version of the *Handbook of Community-Based Freshwater Fisheries Management Techniques* to partner organisations, government departments, academic researchers and rural communities. Above all, we anticipate our project results to catalyse other grassroots initiatives to adopt management guidelines as the success story of this sustainable management model spreads well beyond our study area. There is a huge demand from local tribal and non-tribal communities right across the Amazon to sustainably manage natural resources, but there remains a dearth of research targeting many resource populations, and few technical extension programs to support local communities and spread the lessons. This project has gone some way to bridge this gap, particularly along the major meandering tributaries of the Amazon.

Finally, the core project members are formally creating a non-profit environmental NGO (Instituto Juruá) which will be based at an office in Carauari, Amazonas, Brazil, with a focal mission of rolling out resource management opportunities to local communities both within and outside formal protected areas. We are also planning to further scale-up project activities to many more communities both downriver and upriver of our study area. The philosophical motivation behind this NGO flows directly from our experience with local communities during this Darwin project, and we expect that our activities through this NGO will continue to make a difference in managing the interface between Amazonian terrestrial and aquatic ecosystems for many years to come.

5 Lessons learned

- **Lessons learnt: prioritising project outputs**

We found report reviews to be extremely useful in helping us identify where we may have strayed away from our original project outputs. Admittedly the scope of the project expanded considerably, particularly during Year 2, to take advantage of a number of policy-relevant applied research opportunities. We still consider some of our additional project activities to be valuable complementary contributions towards our main project outcome, and emphasise that these were achieved at minimal additional effort by maximising the existing project infrastructure and personnel. We were however able to identify certain aspects, including activities towards paca conservation and tambaqui management, that we were forced to discontinue or postpone to allow us to focus more effectively on our key original outputs.

- **Lessons learnt: logistical and financial difficulties**

Over the course of the project we have also learnt to cope more effectively with the difficulties posed by working in a remote region of Western Brazilian Amazonia. For example, we learned to cope much better with logistical difficulties in the town of Carauari, and budgeting for travel expenses and field costs. We developed contacts in the local business community during the course of the project which made a number of obstacles easier to overcome. In fact, the project has built up considerable socio-political capital not just with local authorities, but with business and societal leaders, which will help considerably to make our exit strategy more effective.

At the outset of this project, we indicated substantial promised matching financial commitments from as many as eight sources as detailed in our original grant application. However, these institutional commitments were represented by full-time staff salaries, or field contributions in-kind (e.g. salaries, transport costs) as there were no direct cash contributions made available to project expenditure from any sources other than the DI during any stage of this project. Moreover, HRT Oil & Gas, which had promised the project a large contribution in local flights (i.e. 48 free return flights in small aircrafts for project members from Manaus to Carauari), failed to honour their promise, as this Russian-capital oil company went bankrupt following two helicopter crashes in their operational area near the Jurua, both of which with loss of all crew and passengers. In addition, as explained in previous communication with the DI, field costs were inflated by a number of factors, not least rising fuel and local airfare (MAO-CAF-MAO) costs, and the loss of project equipment during a boat accident, both of which communicated to the DI.

- **Lessons learnt: health and safety**

While the nature of fieldwork in the Western Brazilian Amazon will always be relatively hazardous, we took every effort to learn from past experiences and we made our fieldwork as safe as possible for all project members and local field assistants. We reviewed our procedure for events such as venomous snake bites in remote areas in discussion with our local partners who agreed that, in the case of the accident with our field assistant, we acted in the most effective way possible. The most important thing in this scenario is to get the patient to hospital in a speedy but safe manner. We are delighted to report that, as a result of this action, our field assistant made a complete recovery with no permanent damage, and is back to full health. However, because of the potential seriousness of such events we were determined to minimise the risk of any future events of a similar nature. To this end we made sure to inform all subsequent project members and field assistants of the risks and best practise to avoid/minimise danger. In a similar nature, as a result of our experience in 2014, we took additional care when piloting boats in fast-flowing streams, avoiding travelling on these streams at dusk and ensuring that life jackets are always available.

- **Lessons learnt: responses of local communities to conservation initiatives**

We learnt that to do well in the implementation of a program we need to understand the paradigm of local communities. In general, local people are anxious to improve their quality of life, not necessarily in terms of access to technology, but rather in essential services such as primary schooling, basic sanitation and medical care which are typically lacking in all low-governance societies. Brazil in particular is one of the most polarized countries on Earth, ranging from a 20 million strong metropolis (São Paulo) to entirely uncontacted stone-age people in the western Amazon. To label Brazil as a high to middle-income country does no justice to the vast majority of unassisted and disenfranchised local communities in the Amazon. If conservation projects can provide opportunities to improve local livelihoods, we can more easily gain the hearts and minds of thousands of people as dedicated allies of surveillance and management of forest and floodplain resources. This Darwin project encapsulates a rare 'win-win' story in integrated conservation-development initiatives anywhere in the tropics, as can be seen by our large body of data, which will be made available to the formal literature in the next two years.

5.1 Monitoring and evaluation

A major success at the heart of our project is the ongoing monitoring and evaluation strategy that we introduced to enhance and support the autonomous (unsubsidised) long-term monitoring by local stakeholders to measure their progress in community-based conservation and management schemes. This strategy has also been extremely useful to allow us to track our achievements, and as part of the process of divulging feedback to partners and stakeholders.

• Monitoring *Arapaima* populations - Each year, *Arapaima* counts are now conducted at ~80 lakes by experienced fishermen from local communities, supported by a technician from one of our local partner organisations. Monitoring the *Arapaima* population is a critical step in setting sustainable harvest quotas, but also allows local communities to directly gauge the benefits and impact of their lake protection efforts. This activity will continue to be conducted in the future by our partners: ASPROC, FAS (http://fas-amazonas.org/), ICMBio and SDS/CEUC.

• Monitoring turtle nesting - Data from 14 strictly protected fluvial beaches are collected each year by local monitors, who record information on the number of nests, number of hatchlings emerged, and mortality rates. Again, these data are passed on to local management bodies (which have been strengthened by the project) but also local communities to see for themselves the direct impact of their conservation action. In both cases, our local partners promote an annual discussion about the information collected in a large meeting. In this way, all stakeholders can help analyse management trends and make relevant adaptive decisions.

Our project has strengthened the monitoring protocol of both *Arapaima* populations and turtle egg-laying, which provides us with a means to measure the success of our project. It also works well as an exit strategy, because this monitoring scheme was developed in close collaboration between ourselves, UFAM, the Brazilian Government, and local associations which were relatively frail prior to the project. We would like to highlight that this monitoring has now become entirely independent of Darwin financial support, meaning that local associations will be able to continue monitoring these key species after the conclusion of our project.

5.1 Actions taken in response to annual report reviews

In response to annual report reviews, we recognised over-stretching ourselves in committing to too many additional non-core activities and acted accordingly in suspending our work towards some elements (e.g. tambaqui and nocturnal mammals) and successfully redirecting our focus to ensure that the ultimate project's overall outcomes were not compromised. In particular, we took on board the advice to focus on making sure our project findings were made available to relevant institutions in Brazil and other Amazonian countries. As a result, we prioritised our work towards our key project outputs, including the fishing accords and management handbook, as well as important communication outputs, such as the development of a project website and production of a project video documentary which will help win badly needed hearts and minds in Brazilian governmental agencies. The fisheries handbook is currently completed in both Portuguese and English, and a Spanish version will also soon be made available.

In the feedback on our last annual report (Ref. 20-001 AR4R) we noted concerns over lack of evidence documented, which were not available to the referees. In this final report we attached all sources of evidence to verify the outputs described including PhD theses and dissertations, published papers, letters of support and photographs of workshops.

In this final report, we also address the omission from our last report of our contribution towards the SDGs. Another point raised was that many of our Indicators were not SMART, and read more as Activity or Output statements. We accept this point, and take it on board for the construction of more appropriate SMART Indicators in future projects.

Feedback provided in reviews was frequently discussed with partners and collaborators, particularly those at UFRN, SDS, ICMBio and UFAM.

6 Darwin identity

The Darwin Initiative logo has been used on all our project materials, including presentations to reserve management bodies, regional stakeholders, local communities and international scientific conferences. Darwin Initiative is recognised as the major support for Projeto Médio Juruá (PMJ), which is the name used locally for our project since its establishment in 2007 through the support of an earlier Darwin Initiative project (Ref: 16-001). Both federal and state government agencies and our collaborating institutions in Brazil are now very familiar with Darwin Initiative and the support it has provided for our long-term research activities in the region.

We have built a website and started a twitter account to publicise our Darwin Project online (Appendix 11). We plan to expand our use of both of these tools and to continue updating them with new material, even after the formal end of the project. We will also make more of our outputs available online, including a selection of videos on our YouTube channel.

7 Finance and administration

7.1 Project expenditure

This includes both 2015/16 and 2016/17 annual disbursements of £69,063 (April 2015 – March 2016) and £20,126 (April 2016 – Sept 2016) as originally approved by the DI grant; this last period includes a 3-month extension granted by the DI to the project.

Project spend (indicative) since last annual report	2015/17 Grant (£)	2015/17 Total actual Darwin Costs (£)	Variance %	Comments (please explain significant variances)
Staff costs (see below)				Local wages for project staff as defined here are part of 'Operating costs' (see DI grant)
Consultancy costs				
Overhead Costs				
Travel and subsistence				As detailed to LTSI, field costs including boat fuel, food supplies, and internal airfares were more expensive than anticipated. This excludes additional costs such as replacing equipment lost when one of our boats accidentally capsized in 2015 (reported in HYR3, and email to LTSI). This has been aggravated by rising local fuel/food costs and airfares to Carauari, Amazonas (one of the most expensive in Brazil), and the 20% post-Brexit devaluation of Sterling against the Real (R$).
Operating Costs + Staff Costs				This includes all food, fuel and many consumable costs plus Staff Costs (see below), which in our original grant was approved as part of "Operating Costs", see below
Capital items (see below)				A second-hand aluminium boat + outboard motor was purchased to replace our other mobile unit that had been badly damaged. We also

				needed additional VHF tags for the Arapaima telemetry work.
Others				Almost all items listed under this budget line were spent under the Capital items rubric
TOTAL	89,189	89,189		

Staff employed (not all project staff and assistants are listed)	**Cost (£)**
João Campos-Silva (Project Manager)	
Almir Rogério Nascimento (Logistical services and boat captain)	
Marcelo Gomes da Silva (Data collector)	
Raimunda Antonia G. de Souza (field assistant)	
José Roberto Silva de Souza (Data collector)	
Franciney Silva de Souza (Data collector)	
Adriano Souza de Araújo (Data collector)	
José Araujo Medeiros (Data collector)	
Sisomar Nascimento Lima (Data collector)	
Paulo Domingos C Soares (Data collector)	
Antonio Raimundo Benevides da Silva (Data collector)	
Claudio da Cunha Fiqueiredo (Data collector)	
Juniro Gomes de Araújo (Data collector)	
Antonio Francisco de Souza Araujo (Data collector)	
Edilson Lima de Cruz (Data collector)	
Eli Turi de Souza (Data collector)	
Sebastião da Silva e Silva (Data collector)	
Raimunda Pires de Araújo (Data collector)	
Sydnei Moreira Oliveira (Data collector)	
Juliana Cunha da Silva (Data collector)	
Sandra São Bento da Costa (Data collector)	
Antonio Francisco Souza (Data collector)	
Everaldo Araújo dos Santos (Data collector)	
Claudia da Costa Soares (Data collector)	
Ageu Nascimento de Souza (Data collector)	
Paulo Carvalho da Costa (Data collector)	
Sisomar Nascimento Lima (Data collector)	
Donizeti Gomes da Silva (Data collector)	
Antonia Regeane Farias (Data collector)	
Rizonete Araújo (Data collector)	
Antonio Passarinho de Araujo (Data collector)	
TOTAL	**49,177**

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

1 Garmin GPSMap 64 Handheld GPS Unit 1 second-hand aluminium boat + 50 HP Yamaha outboard motor 5 Biotracker 8 MHz Telemetry Receiver Beepers) $200CDN/each	
TOTAL	**4,316**

Other items in Operating costs – description (only major items listed)	**Other items – cost (£)**
Large central Diesel-powered wooden boat rental (over 15 mo) Data processing, archiving & retrieval service – Arbimon Boat motor repairs (two motors) Soil lab analysis – 300 samples Duracell batteries Memory cards Dr Joseph Hawes – assistance with fieldwork and data analysis (2 mo)	
TOTAL	**17,382**

Travel and Subsistence	**Other items – cost (£)**
10 Internal return flights (Manaus to/from Carauari) 2 International flights (UK – Manaus) Dr Joseph Hawes – flights to Brazil Turtle team expedition (4 people * 1 month) Flights to conference and project meeting Fuel supplies (Diesel, gasoline, and lubricating oil for the large wooden boat and smaller aluminium boats)	
TOTAL	**13,980**

7.2 Additional funds or in-kind contributions secured

Source of funding for project lifetime	**Total (£)**
João Vitor Campos e Silva (PhD studentship, UFRN)	
Carolina Tavares Freitas (PhD studentship, UFRN)	
Julia Romero (MSc studentship, Aarhus University))	
Mark Abrahams (PhD studentship, University of East Anglia)	
Dr Joseph Hawes (postdoctoral fellowship, ARU)	
Mr Patrick Cooke (3 months of fieldwork plus travel costs)	
Dr Taal Levi (salary, Oregon State University)	
Dr Paulo Andrade (salary, Federal University of Amazonas)	
UFAM Turtle research team other than Dr Paulo Andrade	
Support from UEA to attend conferences where project results were presented	
Dr Fernanda Michalski (Universidade Federal do Amapa)	
Various support staff salaries at FAS (Fundação Amazonas Sustentavel) for 36 months	
Prof Carlos Peres (0.15 FTE at UEA, 36 months)	
ASPROC (Arapaima counts and oxbow lake surveillance) £12,000/year	

Local extractive communities across two forest reserves comprising nearly 1 million hectares (oxbow lake surveillance) £7,000/year	
ICMBIO (Subsidies towards protected beach program and Arapaima management) ~£10,000/year	
CEUC (Subsidies towards protected beach program and Arapaima management) ~£18,000/year	
3 years of use of two field stations free of charge (SDS, ICMBio, FAS)	
Use of office space and facilities in Carauari over 36 mo	
Fieldwork contribution from SDS, ICMBio and FAS over 36 mo	
UEA Policy impact fund to attend policy meeting in Carauari	
TOTAL (over 3 yrs)	**£1,048,413**

Source of funding for additional work after project lifetime	Total (£)
João Vitor Campos-Silva (has a 5-year postdoctoral fellowship paid by the federal Brazilian government to continue researching community-based management in the project study area and to provide technical consultancy to local organizations).	
José Araujo Medeiros will be paid by ASPROC to coordinate future Arapaima counts	
José Alves de Moraes (Will be paid to coordinate the Arapaima management program outside protected areas)	
Fernanda Alves de Moraes (will be paid to coordinate the local association that was instigated and strengthened by this project)	
ASPROC (will coordinate the Arapaima management)	
Amaru/FAS (in staff salaries in local associations responsible for subsidizing the oxbow lake surveillance program)	
ICMBio (in salaries of staff charged with the protected beach program and arapaima management)	
CEUC (in salaries of staff charged with the protected beach program and arapaima management)	
Printing costs of 1,000 copies of Management Handbook	
TOTAL (this is a minimum annual estimate for several years to come; and this amount can grow as our program expands)	**£79,800 per annum**

7.3 Value for Money

There are a number of overlapping government agencies in Amazonian countries charged with implementing sustainable natural resource management. Unfortunately, the most obvious resource exploitation management problems that have implications on local livelihoods are neglected and management restrictions, if any, are difficult to enforce, resulting in negligible levels of compliance, particularly by the rural private enterprise sector, often serving powerful financial interests.

This project was fully endorsed by state agencies and in co-operation with local stakeholders — the legal occupants of two large sustainable-use Amazonian forest reserves — successfully implemented a comprehensive landscape-scale community-based fisheries management protocol that can now be used as an Amazon-wide model. Levels of financial and human resources that can be leveraged by government agencies in several Amazonian countries are hundreds of times greater than the total cost of this project, which is effectively a seminal demonstration project showing how CPRM (common-pool resource management) protocols that manipulate the spatial structure of harvesting activities over vast landscapes can be implemented. For example, we expect that some £80,000 will be spent every year by government agencies and NGO to fulfil project objectives well beyond the lifetime of this project (see above). The project was clearly good value for money in that it leveraged more than £1 million in salaries etc from a number of government agencies, universities, and NGOs (see above). We believe that overall we have been able to adapt to fluctuating circumstances and cover all project expenses at no additional costs, and achieve more than we originally projected at the beginning of the project. The results from our project are further expected to catalyse much larger financial investments, to emulate our working management model elsewhere in Brazilian, Peruvian, Bolivian and Colombian Amazonia, and the non-profit organisation that we are setting up (Instituto Juruá) will strive towards that end.

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

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

Project summary	Measurable Indicators	Means of verification	Important Assumptions
Impact: Effective contribution in support of the implementation of the objectives of the Convention on Biological Diversity (CBD), the Convention on Trade in Endangered Species (CITES), and the Convention on the Conservation of Migratory Species (CMS), as well as related targets set by countries rich in biodiversity but constrained in resources. The project is expected to enhance the implementation of sustainable-use tropical forest reserves, which account for 63.1 million hectares of new protected areas created in Brazilian Amazonia since 1991. We expect the project will achieve the ideal 'win-win' scenario in which both higher biomass yields per unit effort for local rural populations and clear population recovery for highly vulnerable harvest-sensitive species can be demonstrated. The project is expected to pioneer the design and field-test of a spatial model of natural resource management that can be enforced by local communities and applied by government agencies to most freshwater resources in Amazonian inland fisheries.			
Outcome: Understand the spatial dynamics of productivity and exploitation of aquatic vertebrates — including fish, turtles and caimans — along the Rio Juruá, a major tributary of the Amazon river, and create a spatially-explicit set of management guidelines to protect the landscape-scale sustainability of inland fisheries that can be feasibly enforced by local resource users. This will be based on community-based "fishing agreements" over an access-rights zoning system defining a spatio-temporal harvesting mosaic of commercial and subsistence fisheries including no-take areas (i.e. subsistence-only and strictly protected oxbow lakes). This will lead to measurable protein-acquisition benefits to small-scale artisanal fishermen resulting from	0.1 Annual counts of adult pirarucu (*Arapaima gigas*) fish in 83 oxbow lakes under varying categories of protection status, as per 'fishing agreements' between local communities and commercial fishermen. 0.2 A range of research and management activities centred on breeding sites where ovipositing female turtles (*Podocnemis expansa* and *Podocnemis unifilis)* converge. A total of ~65 protected and unprotected sandy beaches along the Rio Juruá will be monitored. 0.3 Limnological measurements conducted at 83 oxbow lakes along a ~492-km section of the Juruá River. 0.4 CPUE data from offtakes of all aquatic sources of animal protein recorded on a weekly basis over 24	0.1 Data sheets and Excel spreadsheets; photos/videos of Arapaima counts; photos/videos of Arapaima workshop; time series of Arapaima counts; analytical material on stock-recruitment model. 0.2 Data sheets and Excel spreadsheets; photos/videos of hatchling eclosion in protected beaches; data on hatchling releases; *MoveBank* data on GPS-tracked adult turtle movements; data on mark-recapture program using transponder chips; photos/videos of *Podocnemis* turtle workshop. 0.3 Data sheets and Excel spreadsheets; measurements of 11 limnological variables and patch metrics of 83 oxbow lakes; GIS maps of macrophyte cover on lakes. 0.4 Data sheets and Excel spreadsheets from ~420 households	0.1 Census techniques from dugout canoes, which have already been developed and tested for this air-breathing fish, can be implemented at a large number of oxbow lakes for this air-breathing fish. This is safe assumption. 0.2 Egg-laying female turtles can be counted at night during the breeding seasons, and that the nests can be marked for later retrieval (and quarantining) of turtle hatchlings at all protected beaches to reduce post-hatchling mortality. Adult females of both *P expansa* and *P unifilis* can be captured and GPS-tagged during egg-laying events. This is safe assumption. At least some adult males can be GPS-tagged – this is an unsafe assumption because males are far more difficult to capture.

population recovery of harvest-sensitive stocks.	months at ~420 households from 35 local communities along a ~492-km section of the Juruá River 0.5 (a) GPS monitoring of the movements of a fleet of commercial fishing boats over at least a 1-year period, following authorization from the Fishermen Cooperative of Carauarí and Eirunepé; and (b) Monitoring of fish landings from fishing boats at the local markets of these urban centers. 0.6 Spatial modelling of oxbow-lake fish productivity under varying degrees of protection from commercial fishing and connectivity to the main river channel.	monitored at 35 communities; large meta datafile containing offtake data from some 43,680 household interviews. 0.5 Composite maps of commercial fishing activities and movements of the entire fleet of 'freeze' boats. Fish landing data from urban markets. 0.6 Model simulations and predictive modelling results based on real-world data, but assuming different scenarios of oxbow lake protection from commercial fishing; and GIS mapping of all oxbow lakes, sandy beaches, and flood-pulse duration of the floodplain forests. Stock-recruitment model simulations under different protection scenarios. A source-sink dynamics model for at least one of the eight aquatic vertebrate species addressed in this study.	0.3 Measurements of 11 patch metrics and limnological variables can be gathered at all 83 oxbow lakes during the dry-season, and repeated once during the wet season. This is safe assumption. 0.4 Daily wages of R$40 to R$50 are available to pay a total of 35 reliable local field assistants or "*monitores*" (one per community) to work for the project for at least 5 days per month; each field assistant will sample a group of 12 households once each week. This is safe assumption. 0.5 (a) Commercial fishermen will both comply with the spatial monitoring scheme, following conditional directives from the Fishermen Cooperative, and will allow monitoring of boat movements. This would require that GPS receivers, which can operate for at least 72 hours on one set of batteries, are neither turned-off nor removed from the boats even when boats are unstaffed by project personnel. This is a sensitive assumption, so will require both creative negotiation with fishermen leaders and a verification mechanism of continuous functionality of GPS receivers to ensure that we are indeed recording honest movement data on fishing boats. This procedure has not been attempted before in Amazonia but is doable. (b) We are able to hire

			appropriate field assistants or recruit UFAM MSc students to monitor fish landing data at two urban markets. 0.6 (a) Background empirical data are collected to parameterize model simulations; (b) Cloud-free high-resolution *Rapid-Eye* satellite images can be purchased to cover the entire study area and ALOS PALSAR high-resolution radar images can be obtained from JAXA (Japanese Aerospace Agency) to map the dynamics of the flood pulse. The modelling work is certain; however, the robustness of model outputs reply heavily on data quality and quantity.
1. Design, local empowerment, consolidation and expansion of the landscape scale spatial management system concerning a large network of oxbow lakes.	1a. Background research leading to the development of a spatially explicit management protocol of community-based freshwater fisheries management. 1b. Data from limnological sampling of 83 spatially-explicit oxbow lakes during both the wet and the dry seasons. 1c.Technical training Workshop deployed to both artisanal and commercial fishermen of the central Rio Juruá region; Technical training Workshop with key stakeholders including the Fishermen Cooperatives, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and	Completed datasheets of household CPEU surveys; *Arapaima* counts; limnological surveys of oxbow lakes; turtle nest and hatchling counts; counts of giant otters; counts of black caimans.	All 83 oxbow lakes can be mapped using both low- (*Landsat*) and high-resolution (*Rapid-Eye*) land cover data; and physically accessed during both the dry and the wet season. Field measurement of lake limnology can be deployed without any problems.

	representatives of SDS/CEUC and ICMBio). 1d. Deliberations of negotiated settlement between commercial and artisanal fishermen thereby subsidizing a legal agreement ratified by the Fishermen Cooperatives of Carauarí and Eirunepé. 1e. Preparation of the *Handbook of Community-Based Freshwater Fisheries Management Techniques.* 1f. Dissemination of the *Handbook* to all institutions involved in resource management, particularly concerning fisheries.		
2. Design, local empowerment, consolidation and expansion of the spatial management system addressing freshwater turtles and ovipositing sites on fluvial sandy beaches.	2a. Training Workshop on turtle management to local stakeholders, namely the residents of RDS Uacari and RESEX Medio Jurua. 2b. Discussions with Reserve Management Council on spatial zoning of all dry-season sandy beaches. 2c. Number of fluvial sand beaches protected along a 492-km section of the Rio Juruá. 2d. Counts and electronic tagging of live turtle hatchlings dug from nests, quarantined, and released. 2e. Large-scale movements of adult *Podocnemis* turtles over a 24-month period.	Minutes of negotiation policy meetings with the Fishermen Cooperative of Carauari & Eirunepé.	Local discussions on turtle subproject go well following deliberation by the Management Councils of both RDS Uacari and RESEX Medio-Jurua.
3. Design, local empowerment, and expansion of the management	3a. Initial presentation of subproject and raining Workshop to local	Composite maps of commercial fishing boat activity within and	Local communities within the immediate proximity of 23 key

system addressing *Arapaima* fisheries in both oxbow lakes and the river channel.	artisanal fishermen from 35 local communities on Arapaima census techniques. 3b. Training Workshop extension to key stakeholders outside the two protected areas (Fishermen Cooperatives, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and representatives of SDS/CEUC and ICMBio). 3c. Total number of protected oxbow lakes negotiated with commercial fishermen cooperative under mutually-agreed "fishing accords". These will be invigilated during the dry-season, and will adhere to a sustainable offtake quota following a stock-recruitment assessment. 3d. Time-series from at least 26 lakes beginning to show population recovery trends by the end of Project Year 3.	outside target reserves within a 500-km section of the Rio Juruá. GIS analysis of oxbow lake patch metrics and aquatic plant (macrophyte) cover based on *Rapid-Eye* imagery.	oxbow lakes both agree to the Arapaima Conservation & Management Plan, and participate in field activities such as the critical invigilation of lakes ensuring protection from commercial fishing boats.
4. Design and establishment of a conflict-resolution management plan considering large vertebrates perceived to be "problem species" including key apex predators (e.g. *Pteronura* and *Melanosuchus*).	4a. Development and preparation of educational booklet with the goal of reducing conflicts between subsistence/commercial fishermen and *Pteronura and Melanosuchus.* 4b. Dissemination of a "problem-species" illustrated educational booklet to all Jurua communities. 4c. Population estimates combined intensive field surveys and information from interviews at 40 communities on the spatial		Population surveys and interviews concerning all "problem" apex-predators can be implemented smoothly.

	distribution of occupancy records of *Pteronura and Melanosuchus.* 4d. Illustrated talks at seven venues bringing together representatives of ~40 local communities of RESEX Medio Jurua and RDS Uacari.		
5. Empirical and theoretical test of established management protocols and expansion into other river basins of Brazilian Amazonia and other Amazonian countries.	5a. Analytical approaches to data integration including productivity-based stock-recruitment models; spatial modeling showing the importance of no-take areas under a source-sink population framework; an analysis of the socioeconomic benefits of no-take areas accrued to local communities. 5b. Distribution of the *Fisheries Handbook* to all relevant institutions and government agencies involved in the management of freshwater fisheries in Brazilian, Bolivian, Colombian and Peruvian Amazonia. 5c. Final Workshop held in Manaus to a target audience of natural resource management agencies, particularly government and nongovernment organizations responsible for fisheries management. 5d. Presentations of project results at the Latin American Wildlife Management Congress, Association for Tropical Biology & Conservation meeting, and Society for Conservation Biology.	Stock-recruitment models for key commercially-valuable fish species, including *Arapaima* and *Colossoma*. Development of quantitative techniques to inform the spatial management and mapping of exploited vertebrate populations.	Background field data that will feed all modelling approaches are of sufficiently high quality; and that the spatial extent of the sites investigated is meaningful.

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)

Activity 1.1 Seasonal limnological sampling of 83 oxbow lakes with one dry-season and one wet-season campaign

Activity 1.2 Household-level surveys of all types of aquatic resources extracted across ~420 households distributed across 35 local communities

Activity 1.3 Investigate the relationship between household CPUE and oxbow lake primary productivity under different categories of lake protection

Activity 1.4 Investigate the relationship between household CPUE e explanatory variables both at the patch and landscape scale

Activity 1.5 Examine the functionality and ecosystem level consequences of lake protection status according to the 'fishing accords' promoted by the project.

Activity 1.6 Downloading and processing of GPS tracking data and composite maps of commercial fishing boat forays and density of fishing activity both within and outside the focal reserves.

Activity 1.7 Design, preparation, printing and distribution of a Handbook of Freshwater Fisheries Management Techniques

Activity 2.1 Local agreements setting-aside a set of protected egg-laying sand beaches along a 492-km section of the Rio Jurua.

Activity 2.2 A 5-day training course (for 30 local assistants and village leaders) on the conservation & management of freshwater turtles.

Activity 2.3 Monitoring of numerical abundance and reproductive output of *Podocnemis expansa* and *P. unifilis* females during the breeding season along a subset of study beaches. This will include a minimum of 5,100 nests over a 3-yr period.

Activity 2.4 Monitoring the hatchling activity of some 300,000 hatchlings over a 3-year period; Record biometric data on ~5% of these hatchlings; organize and conduct quarantine period of turtle hatchlings; successful release of post-quarantine hatchlings.

Activity 2.5 GPS and VHF-transmitter tagging of 10 adult female turtles (5 *P. expansa* and 5 *P. unifilis*), which will be monitored for 24 months. This satellite tracking component will ensure that we understand turtle migrations and the role of oxbow lakes during the non-breeding season.

Activity 2.6 Electronic tagging of 5,000 post-quarantine hatchlings [using transponders microchips] prior to releasing from fluvial beaches

Activity 2.7 Design and production of an illustrated booklet on Freshwater Turtle Ecology & Management.

Activity 3.1 Reserve council and community meetings to ensure that this component of the project is understood. These meetings will include the selection of the key oxbow lakes.

Activity 3.2 Annual counts of adult pirarucu fish (*Arapaima gigas*) in at least 23 oxbow lakes

Activity 3.3 Mapping of lakes with varying probability of *Arapaima* occurrence

Activity 3.4 Training of 60 artisanal fishermen in *Arapaima* census techniques, to be included in annual counts

Activity 3.5 A target number of 26 large oxbow lakes to be included into stock assessments of *Arapaima* by Year 3 of the Project. These lakes will be managed thereafter following tightening of commercial access restrictions.

Activity 4.1 Investigate the spatial distribution and habitat selection of both Giant Otters and Black Caimans in relation to the spatial distribution of (human) fishing activity

Activity 4.2	Investigate levels of otter, caiman and human mortality and the intensity of conflicts between fishermen and large aquatic apex predators. Four resident fishermen were killed by large Black Caimans in the last 3 yrs so this is a raw issue.
Activity 4.3	Interviews at 40 communities to obtain species occupancy and incidence density data for a 500-km section of the Rio Juruá.
Activity 4.4	Mapping of all water bodies including oxbow lakes, overlaid with the occurrence probability of *Pteronura* and *Melanusuchus*
Activity 4.5	Conduct a spatio-temporal and resource overlap analysis between otters/caimans and fishermen
Activity 4.6	Design and production of an illustrated educational booklet to enhance the prospects of large predator conflict resolution across all local communities.
Activity 5.1	Stock-recruitment model to inform sustainable *Arapaima* offtakes from seasonally discrete water-bodies such as oxbow lakes
Activity 5.2	Elaboration of an *Arapaima* source-sink population model with and without no-take areas under varying degrees of primary productivity
Activity 5.3	A State of Amazonas wide *Podocnemis expansa* turtle conservation gap analysis involving all major river basins providing adequate nesting sites.
Activity 5.4	A cost-benefit analysis of implementation of no-take areas quantifying the opportunity costs to local communities, socioeconomic challenges to implementation, levels of compliance, and tangible benefits to local communities (e.g. increases in fish biomass yields or per capita intake of fish protein).
Activity 5.5	Identification of all likely sites across Brazilian Amazonia where our zonation-based fisheries management protocol can be replicated.

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

Note: For projects that commenced after 2012 the terminology used for the logframe was changed to reflect DFID's terminology.

Project summary	Measurable Indicators	Progress and Achievements in the last Financial Year	Actions required/planned for next period
Goal/Impact: Understand the spatial dynamics of resource productivity and exploitation of aquatic vertebrates — including fish, turtles and caimans — along the Rio Juruá, and create a spatially-explicit set of management guidelines to protect the landscape-scale sustainability of inland fisheries that can be feasibly enforced by local resource users.			Do not fill not applicable
Purpose/Outcome Understand the spatial dynamics of resource productivity and exploitation of aquatic vertebrates — including fish, turtles and caimans — along the Rio Juruá, and create a spatially-explicit set of management guidelines to protect the landscape-scale sustainability of inland fisheries that can be feasibly enforced by local resource users.	Indicator 0.1: Annual counts of adult pirarucu (*Arapaima gigas*) fish at 83 oxbow lakes under varying categories of protection status, as per 'fishing agreements' between local communities and commercial fishermen. Indicator 0.2: A range of research and management activities centred on suitable breeding sites where ovipositing female turtles (*Podocnemis expansa* and *Podocnemis unifilis*) converge. A total of 28 protected and unprotected sandy beaches along the Juruá River will be monitored. Indicator 0.3: Limnological measurements conducted at 83 oxbow lakes along a ~492-km section of the Juruá River. Indicator 0.4: CPUE data from offtakes of all aquatic sources of animal protein recorded on a weekly	0.1 Done 0.2 Done 0.3 Done 0.4 Done 0.5 We had a problem with this methodology. So, we decided to use another method to understand the spatial dynamics of fisheries. 0.6 In progress (to be completed post-project)	Do not fill not applicable

	basis over 24 months at ~420 households from 35 local communities along a ~492-km section of the Juruá River. Indicator 0.5: GPS monitoring of the movements of a fleet of commercial fishing boats over at least a 1-year period, following authorization from the Fishermen Cooperative of Carauarí and Eirunepé; and Monitoring of fish landings from fishing boats at the local markets of these urban centres. Indicator 0.6: Spatial modelling of oxbow-lake fish productivity under varying degrees of protection from commercial fishing and connectivity to the main river channel.		
Output 1. Design, local empowerment, consolidation and expansion of the landscape scale spatial management system concerning a large network of oxbow lakes.	Indicator 1.1: Background research leading to the development of a spatially explicit management protocol of community-based freshwater fisheries management. Indicator 1.2: Data from limnological sampling of 83 spatially-explicit oxbow lakes during both the wet and the dry seasons. Indicator 1.3: Technical training Workshop deployed to both artisanal and commercial fishermen of the central Rio Juruá region; Technical training Workshop with key stakeholders including the Fishermen Cooperative, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and	Progress towards Output 1 has been good in terms of data collection, analysis and publication. Data are currently presented as a PhD thesis but are also due for publication in peer-reviewed journals. The training workshops were successfully held, as acknowledged by the local fishermen's co-operative. We are particularly pleased to record near-completion of our key project outputs, specifically the 'fishing accords' (in all regards accepted by the Brazilian government and due to be published early in 2017), and the 'handbook' (finalised and submitted for printing in early 2017; to be printed in Portuguese and English and disseminated throughout 2017). Indicators were appropriate but were generally not SMART, and read more as Activities or Outputs. In particular, they could have been more effective if they had included time bounds.	

	representatives of SDS/CEUC and ICMBio). Indicator 1.4: Deliberations of negotiated settlement between commercial and artisanal fishermen thereby subsidizing a legal agreement ratified by the Fishermen Cooperatives of Carauarí. Indicator 1.5: Preparation of the Handbook of Community-Based Freshwater Fisheries Management Techniques. Indicator 1.6: Dissemination of the Handbook to all institutions involved in resource management, particularly concerning fisheries.	
Activity 1.1. Seasonal limnological sampling of 83 oxbow lakes with one dry-season and one wet-season campaign.		Completed.
Activity 1.2. Household-level surveys of all types of aquatic resources extracted across ~420 households distributed across 35 local communities.		Completed.
Activity 1.3. Investigate the relationship between household CPUE and oxbow lake primary productivity under different categories of lake protection.		Completed.
Activity 1.4. Investigate the relationship between household CPUE e explanatory variables both at the patch and landscape scale.		Completed.
Activity 1.5. Examine the functionality and ecosystem level consequences of lake protection status according to the 'fishing accords' promoted by the project.		Completed.
Activity 1.6. Downloading and processing of GPS tracking data and composite maps of commercial fishing boat forays and density of fishing activity both within and outside the focal reserves.		Not completed: Persuading local commercial fishermen to be spatially monitored during their multi-day fishing forays was one of the most difficult areas of the whole project. We attempted to do this for a full 2 years, but virtually all fishermen were recalcitrant in agreeing to take on-board GPS receivers, or the receivers were turned off soon after boat departure. However, we replaced this activity with a robust set of household surveys (see above) and spatial referencing of individual fishing trips (based on

		cognitive mapping) during fish-landing data acquisition in market towns, and both of these alternative activities proved to be successful.
Activity 1.7. Design, preparation, printing and distribution of a Handbook of Freshwater Fisheries Management Techniques.		The Handbook design and preparation has been completed. Printing of copies in both Portuguese and English has been arranged with management agencies of the State of Amazonas. Distribution to partners and rural communities will take place during 2017.
Output 2. Design, local empowerment, consolidation and expansion of the spatial management system addressing freshwater turtles and ovipositing sites on fluvial sandy beaches.	Indicator 2.1: Training Workshop on turtle management to local stakeholders, namely the residents of RDS Uacari and RESEX Medio Jurua. Indicator 2.2: Discussions with Reserve Management Council on spatial zoning of all dry-season sandy beaches. Indicator 2.3: Number of fluvial sand beaches protected along a 492-km section of the Rio Juruá. Indicator 2.4: Counts and electronic tagging of live turtle hatchlings dug from nests, quarantined, and released. Indicator 2.5: Large-scale movements of adult *Podocnemis* turtles over a 24-month period.	Progress towards Output 2 has been good in terms of expanding beach management and in data collection on turtle ecology. The training workshops were successfully held, new beaches were brought under protection and potential beaches to be targeted in the future were identified for the Brazilian government. Date collection from the monitoring of turtle reproductive success on protected beaches and tracking of adult females and hatchlings was successful, and the resulting manuscripts are in preparation for publication. Indicators were appropriate but were generally not SMART, and read more as Activities or Outputs. In particular, they could have been more effective if they had included time bounds.
Activity 2.1. Local agreements setting-aside a set of protected egg-laying sand beaches along a 492-km section of the Rio Jurua.		Completed.
Activity 2.2. A 5-day training course (for 30 local assistants and village leaders) on the conservation & management of freshwater turtles.		Completed.
Activity 2.3. Monitoring of numerical abundance and reproductive output of *Podocnemis expansa* and *P. unifilis* females during the breeding season along a subset of study beaches. This will include a minimum of 5,100 nests over a 3-yr period.		Completed.

Activity 2.4. Monitoring the hatchling activity of some 300,000 hatchlings over a 3-year period; Record biometric data on ~5% of these hatchlings; organize and conduct quarantine period of turtle hatchlings; successful release of postquarantine hatchlings.		Completed.
Activity 2.5. GPS and VHF-transmitter tagging of 10 adult female turtles (5 *P. expansa* and 5 *P. unifilis*), which will be monitored for 24 months. This satellite tracking component will ensure that we understand turtle migrations and the role of oxbow lakes during the non-breeding season.		Completed (We managed to successfully track 4 adult females)
Activity 2.6. Electronic tagging of 5,000 post-quarantine hatchlings [using transponders microchips] prior to releasing from fluvial beaches		Completed (We managed to successfully tag >1000 hatchlings)
Activity 2.7. Design and production of an illustrated booklet on Freshwater Turtle Ecology & Management.		Completed – see Activity 1.7. The Handbook due to be printed in Portuguese and English covers both *Arapaima* and turtle management.
Output 3. Design, local empowerment, and expansion of the management system addressing *Arapaima* fisheries in both oxbow lakes and the river channel (including *Arapaima* ecology).	Indicator 3.1: Initial presentation of subproject and training workshop to local artisanal fishermen from 35 local communities on Arapaima census techniques. Indicator 3.2: Training workshop extension to key stakeholders outside the two protected areas (Fishermen Cooperative, municipal county administrators of fishing licenses, managers of sustainable-use protected areas, and representatives of SDS/CEUC and ICMBio). Indicator 3.3: Total number of protected oxbow lakes negotiated with commercial fishermen cooperative under mutually-agreed “fishing accords”. Indicator 3.4: Time-series from at least 26 lakes beginning to show population recovery trends by the end of Project Year 3.	Progress towards Output 3 has been good in terms of expanding lake management and in data collection on *Arapaima* ecology. The training workshops were successfully held, new lakes were brought under protection, and results on populations trends were published in a peer-reviewed journal article. Date collection from the monitoring of *Arapaima* populations in protected lakes and tracking of adult *Arapaima* was successful, and further manuscripts are in preparation for publication. Indicators were appropriate but were generally not SMART, and read more as Activities or Outputs. In particular, they could have been more effective if they had included time bounds.

Activity 3.1. Reserve council and community meetings to ensure that this component of the project is understood. These meetings will include the selection of the key oxbow lakes.		Completed.
Activity 3.2. Annual counts of adult pirarucu fish (*Arapaima gigas*) in at least 23 oxbow lakes		Completed.
Activity 3.3. Mapping of lakes with varying probability of *Arapaima* occurrence.		Completed.
Activity 3.4. Training of 60 artisanal fishermen in *Arapaima* census techniques, to be included in annual counts		Completed (45 fishermen trained).
Activity 3.5. A target number of 26 large oxbow lakes to be included into stock assessments of *Arapaima* by Year 3 of the Project. These lakes will be managed thereafter following tightening of commercial access restrictions.		Completed (annual counts from 87 lakes, since 2012).
Output 4. Design and establishment of a conflict-resolution management plan considering large vertebrates perceived to be "problem species" including key apex predators (e.g. *Pteronura* and *Melanosuchus*).	Indicator 4.1: Development and preparation of educational booklet with the goal of reducing conflicts between subsistence/commercial fishermen and *Pteronura* and *Melanosuchus*. Indicator 4.2: Dissemination of a "problem-species" illustrated educational booklet to all Jurua communities. Indicator 4.3: Population estimates combined intensive field surveys and information from interviews at 40 communities on the spatial distribution of occupancy records of *Pteronura* and *Melanosuchus*. Indicator 4.4: Illustrated talks at seven venues bringing together representatives of ~40 local communities of RESEX Medio Jurua and RDS Uacari.	Progress towards Output 4 has been good in terms of data collection on the incidence of human-wildlife conflicts and in terms of acting as a mediator to resolve historical conflicts between communities that often arise as a result. Progress has been less satisfactory towards the planned educational booklet which has not been completed. This will remain a priority post-project and will be completed during 2017. We successfully conducted talks at 18 local communities. Indicators were appropriate but were generally not SMART, and read more as Activities or Outputs. In particular, they could have been more effective if they had included time bounds.

Activity 4.1. Investigate the spatial distribution and habitat selection of both Giant Otters and Black Caimans in relation to the spatial distribution of (human) fishing activity.		Completed
Activity 4.2. Investigate levels of otter, caiman and human mortality and the intensity of conflicts between fishermen and large aquatic apex predators. Four resident fishermen were killed by large Black Caimans in the last 3 yrs so this is a raw issue.		Completed.
Activity 4.3. Interviews at 40 communities to obtain species occupancy and incidence.		Completed.
Activity 4.4. Mapping of all water bodies including oxbow lakes, overlaid with the occurrence probability of *Pteronura* and *Melanusuchus*.		Completed.
Activity 4.5. Conduct a spatio-temporal and resource overlap analysis between otters/caimans and fishermen.		Completed.
Activity 4.6. Design and production of an illustrated educational booklet to enhance the prospects of large predator conflict resolution across all local communities.		Not completed (to be completed post-project).
Output 5. Empirical and theoretical test of management protocols and expansion into other river basins of Brazilian Amazonia and other Amazonian countries.	Indicator 5.1: Analytical approaches to data integration including productivity-based stock recruitment models; spatial modelling showing the importance of no-take areas under a source-sink population framework; an analysis of the socioeconomic benefits of no-take areas accrued to local communities. Indicator 5.2: Distribution of the Fisheries Handbook to all relevant institutions and government agencies involved in the management of freshwater fisheries in Brazilian, Bolivian, Colombian and Peruvian Amazonia. Indicator 5.3: Final Workshop held in Manaus to a target audience of natural resource management	Progress towards Output 5 has unfortunately not been as successful as planned. Presentations at international conferences have been conducted and were well received, and the 'handbook' is due to be printed and disseminated imminently (see above). Unfortunately, it has not been possible to complete the spatial modelling analyses, primarily because the necessary data only became available at a late stage in the project. Following a 3-month expedition in 2016, along one -third of the Juruá river, we have now identified and quantified social variables to help us build a more realistic model and allow us to understand local demand for aquatic resource management at this larger scale. This key component will now become a post-project priority. Indicators were appropriate but were generally not SMART, and read more as Activities or Outputs. In particular, they could have been more effective if they had included time bounds.

	agencies, particularly government and nongovernment organizations responsible for fisheries management Indicator 5.4: Presentations of project results at the Latin American Wildlife Management Congress, Association for Tropical Biology & Conservation meeting, and Society for Conservation Biology.	
Activity 5.1. Stock-recruitment model to inform sustainable *Arapaima* offtakes from seasonally discrete water-bodies such as oxbow lakes.		Completed.
Activity 5.2. Elaboration of an *Arapaima* source-sink population model with and without no-take areas under varying degrees of primary productivity.		We discovered that the main factor driving *Arapaima* populations is the community-based protection of lakes. We therefore mapped all social capital along 1200 km of the Juruá river, to identify potentially suitable sites for future protection. These information are available for future projects and government plans.
Activity 5.3. A State of Amazonas wide *Podocnemis expansa* turtle conservation gap analysis involving all major river basins providing adequate nesting sites.		We have started to discuss this in a manuscript on turtle conservation across Amazon, which is being submitted to PNAS. We are also preparing another paper analysing suitable places for the establishment of protected beaches and the bottlenecks for their implementation.
Activity 5.4. A cost-benefit analysis of implementation of no-take areas quantifying the opportunity costs to local communities, socioeconomic challenges to implementation, levels of compliance, and tangible benefits to local communities (e.g. increases in fish biomass yields or per capita intake of fish protein).		Not completed (We are still analysing this dataset.)
Activity 5.5. Identification of all likely sites across Brazilian Amazonia where our zonation based fisheries management protocol can be replicated.		Not completed (We are still analysing this dataset.)
Output 6. Understand the co-benefits of community management for biodiversity conservation.	Insert **agreed** output level indicators	We recognise that Output 6 represents a catch-all heading for some of the additional activities that were conducted in association with this project. On the advice in previous reviews, we suspended our work towards some elements (e.g. tambaqui and nocturnal mammals) to successfully redirected our focus and ensure that the project's overall outcome was in not ultimately compromised.

		Other project activities (i.e. 6.1, 6.2, 6.3) were conducted in parallel with project priorities. While benefiting from the project infrastructure they did not interfere with our main project objectives and provide useful complementary information to inform our understanding of the wider ecological impacts of aquatic resource management. We accept that the Indicators previously listed under this additional Output are more accurately described as Activities or Outputs.
Activity 6.1. Seasonal movement of terrestrial vertebrates.		Completed.
Activity 6.2. Terrestrial wildlife depletion envelopes near local communities.		Completed.
Activity 6.3. Wattled Curassow population ecology.		Completed.
Activity 6.4. Conservation programme of lowland paca and other nocturnal mammals.		Suspended.
Activity 6.5. Tambaqui management programme.		Suspended.

Annex 3 Standard Measures

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
Training Measures							
1a	Number of people to submit PhD thesis	6	5 Brazilian, 1 British	5 M 1 F	Campos e Silva, João V. (2016) Manejo participativo nas várzeas amazônicas e seus efeitos multi-tróficos. PhD thesis. Univ. Federal do Rio Grande do Norte, Natal, Brazil. Santos, Davi Teles (2016) Watershed scale conservation planning across Amazonia. PhD thesis. University of East Anglia, Norwich, UK Abrahams, Mark I. (2016) Wildlife responses to anthropogenic disturbance in Amazonian forests. PhD thesis. University	4 Portuguese, 2 English	We are confident that all six PhD theses resulting from this project will catapult these young investigators into a career in ecology and conservation.

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
					of East Anglia, Norwich, UK Andrade, Paulo C.M. 2016. Manejo Comunitário de Quelônios (Família Podocnemididae, Podocnemis unifilis, P.sextuberculata, P.expansa) no Médio Rio Amazonas e Juruá. PhD thesis. INPA, Manaus, Brazil Leite, Gabriel. 2017. Ecologia e manejo de cracídeos no Rio Jurua, Brazil. INPA, Manaus, Brazil		
1b	Number of PhD qualifications obtained	5	4 Brazilian, 1 British	4 M 1 F	See 1a	See 1a	
2	Number of Masters qualifications obtained	2	2 Brazilian	1F, 1M	Romero, Julia (2015) Human security and environmental conservation: the	English	

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
					role of protected areas in the welfare of traditional Amazonian communities. MSc thesis, University of Aarhus, Denmark Costa, Hugo C. M. (2014) Seasonal movements of terrestrial vertebrates between Amazonian flooded and unflooded forests. MSc thesis, UFPA/MPEG, Belem, Brazil		
3	Number of other qualifications obtained						
4a	Number of undergraduate students receiving training	1	British	M	Cook, Patrick (2015) Human wildlife conflicts: a review of conflicts with freshwater mammals and reptiles in the	English	BSc

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
					tropics and subtropics. BSc thesis, Univ East Anglia, UK		
4b	Number of training weeks provided to undergraduate students						
4c	Number of postgraduate students receiving training (not 1-3 above)	2	Brazilian	1F, 1M	Leite, G.A. 2017, Ecology of large cracids in Amazonian floodplain forests Freitas, Carolina. 2017. Etnoecologia da pesca na Amazonia brasileira. PhD thesis. Univ. Federal do Rio Grande do Norte, Natal, Brazil.		PhD
4d	Number of training weeks for postgraduate students						
5	Number of people receiving other forms of long-term (>1yr) training not leading to formal qualification(e.g., not categories 1-4 above)						
6a	Number of people receiving other forms of short-term education/training (e.g., not categories 1-5 above)	130	Brazilian	90 males 40 female	Fisheries management, biodiversity monitoring, social organization	Portuguese	

Code	Description	Total	Nationality	Gender	Title or Focus	Language	Comments
6b	Number of training weeks not leading to formal qualification						
7	Number of types of training materials produced for use by host country(s) (describe training materials)	1	4 Brazil, 1 UK	1F, 4M	*Handbook of Community-Based Freshwater Fisheries Management Techniques*	Portuguese and English (also to be translated into Spanish)	(Appendix 10)

Research Measures		Total	Nationality	Gender	Title	Language	Comments/ Weblink if available
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (ies)	1	Brazil		Fishing Accord proposals	Portuguese	Participatory process? Yes
10	Number of formal documents produced to assist work related to species identification, classification and recording.	0					
11a	Number of papers published or accepted for publication in peer reviewed journals	21	12 Brazil, 4 UK, 3 USA, 1 Spain, 1 Colombia	7 F, 14 M			This is only a small fraction of the all outputs that will be produced from this project
11b	Number of papers published or accepted for publication elsewhere	0					

12a	Number of computer-based databases established (containing species/generic information) and handed over to host country	8					Located at INPA, UFAM, UFRN, andUFPA.
12b	Number of computer-based databases enhanced (containing species/genetic information) and handed over to host country	0					
13a	Number of species reference collections established and handed over to host country(s)	0					
13b	Number of species reference collections enhanced and handed over to host country(s)	0					

Dissemination Measures		**Total**	**Nationality**	**Gender**	**Theme**	**Language**	**Comments**
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	2	Brazil	Male and female	Management techniques	Portuguese	
14b	Number of conferences/seminars/ workshops attended at which findings from Darwin project work will be presented/ disseminated.	5	UK, Brazil	Male and female	Biodiversity conservation	English, Spanish and Portuguese	

Physical Measures		**Total**	**Comments**
20	Estimated value (£s) of physical assets handed over to host country(s)		This includes portable laptops; 2 outboard motors; 2 aluminium boats; telemetry equipment for turtles and Arapaima fish; 60 camera traps; and GPS receivers.
21	Number of permanent educational, training, research facilities or organisation established	None	
22	Number of permanent field plots established	200	As part of the protected beach and floodplain project components

Financial Measures		**Total**	**Nationality**	**Gender**	**Theme**	**Language**	**Comments**
23	Value of additional resources raised from other sources (e.g., in addition to Darwin funding) for project work		UK and Brazil	n/a	n/a	n/a	See above and total project value

Annex 4 Aichi Targets

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

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

Annex 5 Publications

Type * (e.g. journals, manual, CDs)	Detail (title, author, year)	Nationality of lead author	Nationality of institution of lead author	Gender of lead author	Publishers (name, city)	Available from (e.g. web link, contact address etc)
J	Peres, C.A., Emilio, T., Schietti, J., Desmoulière, S.J. and Levi, T., 2016. Dispersal limitation induces long-term biomass collapse in overhunted Amazonian forests. Proceedings of the National Academy of Sciences, 113(4), pp.892-897.	Brazil	UK	M		http://dx.doi.org/10.1073/pnas.1516525113
J	Leite, G.A., Mello Barreiros, M.H., Pires Farias, I. and Peres, C.A., 2016. Description of the nest of two Thamnophilidae species in Brazilian Amazon. Revista Brasileira de Ornitologia, 24(2), pp.83-85.	Brazil	Brazil	M		http://www4.museu-goeldi.br/revistabrornito/revista/index.php/BJO/article/view/1280/pdf_956
J	Leite, G.A., Pires Farias, I. and Peres, C.A., 2016. Parental care of Chestnut-capped Puffbird Bucco macrodactylus on the middle Juruá River, Amazonas, Brazil. *Revista Brasileira de Ornitologia*, *24*(2), pp.80-82.	Brazil	Brazil	M		http://www4.museu-goeldi.br/revistabrornito/revista/index.php/BJO/article/view/1267/pdf_955
J	Morellato, L.P.C., Alberton, B., Alvarado, S.T., Borges, B.,	Brazil	Brazil	F		http://dx.doi.org/10.1016/j.biocon.2015.12.033

	Buisson, E., Camargo, M.G.G., Cancian, L.F., Carstensen, D.W., Escobar, D.F., Leite, P.T., Mendoza, I., Peres, C.A., 2016. Linking plant phenology to conservation biology. Biological Conservation, 195, pp.60-72.					
J	Lees, A.C., Peres, C.A., Fearnside, P.M., Schneider, M. and Zuanon, J.A., 2016. Hydropower and the future of Amazonian biodiversity. *Biodiversity and Conservation*, *25*(3), pp.451-466.	UK	Brazil	M		http://dx.doi.org/10.1007/s10531-016-1072-3
J	Endo, W., Peres, C.A. and Haugaasen, T., 2016. Flood pulse dynamics affects exploitation of both aquatic and terrestrial prey by Amazonian floodplain settlements. *Biological Conservation*, *201*, pp.129-136.	Brazil	Norway	M		http://dx.doi.org/10.1016/j.biocon.2016.07.006
J	Hawes, J.E. and Peres, C.A., 2016. Patterns of plant phenology in Amazonian seasonally flooded and unflooded forests. *Biotropica*, *48*(4), pp.465-475.	UK	UK	M		http://dx.doi.org/10.1111/btp.12315
J	Mendoza, I., Peres, C.A. and Morellato, L.P.C., 2016. Continental-scale patterns and climatic drivers of fruiting phenology: A quantitative Neotropical review. *Global and Planetary Change*.	Spain	Brazil	F		http://dx.doi.org/10.1016/j.gloplacha.2016.12.001

J	Nichols, E., Peres, C.A., Hawes, J.E. and Naeem, S., 2016. Multitrophic diversity effects of network degradation. *Ecology and Evolution*, *6*(14), pp.4936-4946.	USA	Brazil/USA	F		http://dx.doi.org/10.1002/ece3.2253
J *	Campos-Silva, J.V. and Peres, C.A., 2016. Community-based management induces rapid recovery of a high-value tropical freshwater fishery. *Scientific Reports*, *6*.	Brazil	Brazil	M		http://www.nature.com/articles/srep34745
J	Campos-Silva, J.V., da Fonseca Junior, S.F. and da Silva Peres, C.A., 2015. Policy reversals do not bode well for conservation in Brazilian Amazonia. *Natureza & Conservação*, *13*(2), pp.193-195.	Brazil	Brazil	M		http://dx.doi.org/10.1016/j.ncon.2015.11.006
J	de Marques, A.A.B., Schneider, M. and Peres, C.A., 2016. Human population and socioeconomic modulators of conservation performance in 788 Amazonian and Atlantic Forest reserves. *PeerJ*, *4*, p.e2206.	Brazil	Brazil	F		https://peerj.com/articles/2206/
J	Ripple, W.J., Abernethy, K., Betts, M.G., Chapron, G., Dirzo, R., Galetti, M., Levi, T., Lindsey, P.A., Macdonald, D.W., Machovina, B. and Newsome, T.M., Peres, C.A. 2016. Bushmeat hunting and extinction risk to the world's	USA	USA	M		http://rsos.royalsocietypublishing.org/content/3/10/160498

	mammals. *Royal Society Open Science*, *3*(10), p.160498.					
J	Antunes, A.P., Fewster, R.M., Venticinque, E.M., Peres, C.A., Levi, T., Rohe, F. and Shepard, G.H., 2016. Empty forest or empty rivers? A century of commercial hunting in Amazonia. *Science Advances*, *2*(10), p.e1600936.	Brazil	Brazil	M		http://advances.sciencemag.org/content/2/10/e1600936
J	de Marques, A.A.B. and Peres, C.A., 2015. Pervasive legal threats to protected areas in Brazil. *Oryx*, *49*(01), pp.25-29.	Brazil	Brazil	F		http://dx.doi.org/10.1017/S0030605314000726
J	Bush, M.B., McMichael, C.H., Piperno, D.R., Silman, M.R., Barlow, J., Peres, C.A., Power, M. and Palace, M.W., 2015. Anthropogenic influence on Amazonian forests in pre-history: An ecological perspective. *Journal of Biogeography*, *42*(12), pp.2277-2288.	USA	USA	M		http://dx.doi.org/10.1111/jbi.12638
J	Bello, Carolina, Mauro Galetti, Marco A. Pizo, Luiz Fernando S. Magnago, Mariana F. Rocha, Renato AF Lima, Carlos A. Peres, Otso Ovaskainen, and Pedro Jordano. 2015. "Defaunation affects carbon storage in tropical forests." *Science Advances* 1, no. 11: e1501105.	Colombia	Brazil	F		http://advances.sciencemag.org/content/1/11/e1501105

J	Ferreira, J., Aragão, L.E.O.C., Barlow, J., Barreto, P., Berenguer, E., Bustamante, M., Gardner, T.A., Lees, A.C., Lima, A., Louzada, J. and Pardini, R., Peres, C.A. 2014. Brazil's environmental leadership at risk. Science, 346(6210), pp.706-707.	Brazil	Brazil	F		http://science.sciencemag.org/content/346/6210/706
J	Hawes, J.E. and Peres, C.A., 2014. Ecological correlates of trophic status and frugivory in neotropical primates. *Oikos*, *123*(3), pp.365-377.	UK	UK	M		http://dx.doi.org/10.1111/j.1600-0706.2013.00745.x
J	Hawes, J.E. and Peres, C.A., 2014. Fruit–frugivore interactions in Amazonian seasonally flooded and unflooded forests. *Journal of Tropical Ecology*, *30*(05), pp.381-399.	UK	UK	M		http://dx.doi.org/10.1017/S0266467414000261
J	Endo, W., Haugaasen, T. and Peres, C.A., 2014. Seasonal abundance and breeding habitat occupancy of the Orinoco Goose (Neochen jubata) in western Brazilian Amazonia. *Bird Conservation International*, *24*(04), pp.518-529.	Brazil	Norway	M		http://dx.doi.org/10.1017/S0959270914000173
Book chapter	Hawes, J.E. and Peres, C.A., 2016. Forest Structure, Fruit Production and Frugivore Communities in Terra firme and Várzea Forests of the Médio Juruá. *Forest Structure, Function and*	UK	UK	M	John Wiley & Sons, Ltd, Chichester, UK	http://dx.doi.org/10.1002/9781119090670.ch4

	Dynamics in Western Amazonia, pp.85-100.					
Book chapter	Peres, C.A. 2013. Biodiversity Conservation Performance of Sustainable-Use Tropical Forest Reserves. In: “Conservation Biology: Voices from the Tropics.” (eds. P.H. Raven, N.S. Sodhi and L. Gibson).	Brazil	UK	M	Blackwell-Wiley, Oxford.	http://dx.doi.org/10.1002/9781118679838.ch29
Thesis, PhD	Endo, Whaldener (2016) Game vertebrate responses to rural populations in neotropical protected areas. Doctoral thesis. Norwegian University of Life Sciences.	Brazil	Norway	M	NMBU	http://statisk.umb.no/ina/forskning/drgrader/2016-Endo.pdf
Thesis, PhD *	Campos e Silva, João V. (2016) Manejo participativo nas várzeas amazônicas e seus efeitos multi-tróficos. Doctoral thesis. Universidade Federal do Rio Grande do Norte (UFRN).	Brazil	Brazil	M	UFRN	Included in Appendices.
Thesis, PhD	Santos, Davi Teles (2016) Watershed scale conservation planning across Amazonia. Doctoral thesis. University of East Anglia.	Brazil	Brazil	M	UEA	https://ueaeprints.uea.ac.uk/61722/
Thesis, PhD	Abrahams, Mark I. (2016) Wildlife responses to anthropogenic disturbance in Amazonian forests. Doctoral thesis. University of East Anglia.	UK	UK	M	UEA	Final corrections; web link not yet available.

Thesis, PhD	Leite, Gabriel.A. 2017, Ecology of large cracids in Amazonian floodplain forests. PhD, Instituto Nacional de Pesquisas da Amazonia, INPA.	Brazil	Brazil	M		In final preparation; this is a 2017 output.
Thesis, PhD *	Andrade, Paulo C.M. 2016. Manejo Comunitário de Quelônios (Família Podocnemididae, Podocnemis unifilis, P.sextuberculata, P.expansa) no Médio Rio Amazonas e Juruá. PhD thesis. INPA, Manaus, Brazil	Brazil	Brazil	M	UFAM	Included in Appendices.
Thesis, MSc	Romero, Julia (2015) Human security and environmental conservation: the role of protected areas in the welfare of traditional Amazonian communities. MSc thesis, Aarhus University, Denmark	Brazil	Brazil	F	Aarhus	Link at Univ of Aarhus unavailable
Thesis, MSc	Costa, Hugo C. M. (2014) Seasonal movements of terrestrial vertebrates between amazonian flooded and unflooded forests. Msc thesis, Museu Paraense Emiliio Goeldi (MPEG).	Brazil	Brazil	M	MPEG	Link at MPEG/UFPA unavailable
Dissertation, BSc *	Cook, Patrick (2015) Human wildlife conflicts: a review of conflicts with freshwater mammals and reptiles in the tropics and subtropics. BSc dissertation, University of East Anglia.	UK	UK	M	UEA	Included in Appendices.
Handbook *	Peres, CA, Freitas, CT, Campos-Silva, JV,	Brazil	UK	M	UFRN/UEA/ARU/UFAM	Included in Appendices.

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Annex 6 Darwin Contacts

Ref No	20-001
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