Biodiversity and functional value of Amazonian primary, secondary and plantation forests: Final report

Jos Barlow

Carlos A. Peres

&

Leandro V. Ferreira

21/08/2006

Table of contents

Darwin Initiative

Final Report

1. Darwin Project Information

Project Reference No.	*162/12/014*
Project title	Biodiversity and functional value of Amazonian primary, secondary and plantation forests
Country	UK, BRAZIL
UK Contractor	UNIVERSITY OF EAST ANGLIA
Partner Organisation (s)	MUSEU PARAENSE EMILIO GOELDI (MPEG/CNPq)
Darwin Grant Value	£125,999
Start/End date	1/MAY/2003 – 30/APRIL/2006
Project website	http://www.uea.ac.uk/~e079/Projects/Jari.html
Author(s), date	Barlow, Jos; Peres, Carlos; Ferreira, Leandro 05/08/2006

2. Project Background/Rationale

- This project is being conducted in the 1.7 million ha landholding owned by Jari Celulose S.A./ORSA Florestal, located on the border between Amapá and Pará in the north-eastern Amazon basin (00^{o}27'00" -- 01^{o}30'00" S; 51^{o}40'00" -- 53^{o}20'00" W). This landholding was purchased in 1967 for the establishment of large-scale fast-growing tree plantations of *Gmelina arborea*, *Pinus caribaea*, and *Eucalyptus urograndis*. The area is currently dominated by extensive areas of plantation forestry dominated by *Eucalyptus urograndis*, undisturbed primary forest, and second-growth that has regenerated on plantations that were harvested but not replanted.
- The project aims to identify the biodiversity consequences of land-use change from natural to planted forests, and to describe the relative benefits of native versus non-native regeneration on degraded lands. By doing so, it is expected to contribute to the setting of restrictions and provision of incentives relevant to this land use change.
- Conservation biologists are divided over the extent to which extensive areas of regenerating and planted forests will be able to offset the loss of biodiversity from tropical deforestation. Both habitats have increased in size rapidly in recent years. Globally, tropical secondary forests reclaimed one-sixth of all primary forests that were clear-cut in the 1990s, and are likely to be a dominant feature of tropical forest landscapes in the future, while tree plantations have become increasingly favoured in the tropics where production is more economically efficient. Their coverage in the tropics increased from ~17.8 Mha in 1980 to ~70 Mha in 2000, 50% of which are *Eucalyptus* spp. Understanding the full value of these habitats for conservation is therefore crucial – and this is especially so in the Brazilian Amazon, where It is

estimated that around 30% of the deforested area has subsequently been abandoned, resulting in the rapid proliferation of secondary forests. Furthermore, one of the key objectives of Brazil's National Forest Program (2000) is the expansion of the forest base on degraded lands through plantation forestry, with plans to cultivate 2.2 Mha of tree plantations on private properties and abandoned agricultural lands in the near future. There is therefore a strong regional interest in this issue, both among local research institutions (following on from biodiversity workshops held in Macapá and Belém in 1999 and 2002) and from forestry enterprises. Although the need for the project was initially identified by the principal UK-based PI (CAP), good international links and Brazilian nationality enabled immediate collaboration with regionally based researchers, who made significant contributions to the experimental design at the outset of the project, the methodologies for the faunal surveys, facilitated almost all of the identification and curation of the collected specimens, and are contributing towards the subsequent publication of results and analysis.

3. Project Summary

- The original purpose of this project was to "To quantify the biodiversity value of exotic plantation forests and native second-growth stands in Amazonia, critically assessing their value in terms of ecosystem functions and carbon sequestration, helping the Brazilian government and other developing countries to optimise their options in meeting international biodiversity and carbon commitments". This was refined following consultation with Patrick Hardcastle (Mid-Term Review), so that the overal purpose was to make a "First stage analysis of biodiversity and livelihood impact of forest clearance, plantation establishment and forest recovery in Jari, Brazil". Project outputs are summarised in our revised logical framework (Annex 1), and are as follows: To 1) sample and identify key biodiversity taxa in three forest types – plantation, secondary and primary forest; 2) undertake comparative analyses of indicator taxa in three forest types, 3) improve national capacity in forest biodiversity surveys in terms of technician skills, trained students and the compilation reference biological material, and to 4) study the socio-economic and livelihood values derivable from the three forest types. In addition, we added a 5th output, which was a pilot study that was complementary to the main objectives which was to understand phenology and rates of litter turnover in three forest types. This revised logical-framework provided us with the basis for all subsequent monitoring of the project.
- The project was significantly revised following the very useful mid-term review (MTR) process and two Annual Reviews (AR1 & AR2). As a result, the proposed research became considerably more focussed on the consequences of land-use change for biodiversity. The changes and their rationale are detailed below.

  Sampling was significantly augmented from the original plan, with the addition of many additional faunal taxa (see figure 1 in appendix) including all six groups of terrestrial vertebrates and 9 groups of invertebrates. These groups were added due to the important contribution they make to Amazonian biodiversity and ecosystem functioning, the availability of high level relevant expertise within our principal collaborating institution (Museu Goeldi, MPEG), and in some cases the low marginal cost and field effort associated with the sampling of additional groups.

  Outputs 1 and 2 were rewritten following the MTR to focus on the biodiversity component rather than on ecosystem functioning. This allowed for a more effective focus on the area that characterises the primary strengths of the project. Furthermore, Jari Celulose itself has undertaken detailed studies on soil carbon and hydrology within plantations and areas of second growth. However, the project did include a detailed examination of litter cycling and decomposition across the three habitats. Although both the MTR and AR2 expressed doubt about the wisdom of

maintaining this output, it required very little addiitonal field time, and the data had considerable independent value (and has already been submitted for publication) and was useful as an important environmental variable that has helped explain the observed patterns of biodiversity. We have thus added this as a 5th output to our logical framework.

Since beginning our fieldwork we also became increasingly aware of the number of small extractive communities (n = 32) lying within the plantation/second-growth/primary forest matrix in the study region. We were able to secure additional funding to initiate a year long sustainable livelihood analysis in 5 of these communities, adding a strong and highly complementary social component to the project and the subsequent analyses.

The training component was modified to concentrate on more intensive one-to-one supervision of a smaller number of Brazilian undergraduate students, MSc students, and research technicians. We felt this was preferable over the original objective of organising cost-inefficient short courses for 30+ students, as it allowed our capacity building program to achieve a much longer-term contribution towards improving future biodiversity surveys in the Brazilian Amazon (we are particularly encouraged by the success of many of these people in finding relevant post-project employment and further study). Participating students benefited from very high supervision levels that are otherwise unavailable to them in the Amazon region, and they have been trained in field techniques, analytical methods and statistics, as well as receiving help with publishing some of their previous work in international scientific journals.

- The project is best described by articles 6) "To Develop national strategies that integrate conservation and sustainable use", 7) "To identify and monitor components of biological diversity, particularly those requiring urgent conservation", 10) " To integrate conservation and sustainable use in national decisions and support local populations to implement remedial actions", and article 20) "To establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components and promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries".

- Overall, the project has been very successful in meeting the revised objectives discussed during the MTR and the year 2 review. Objectives 1-4 from the revised logistical framework are dealt with in turn:

  1) <u>To sample and identify key biodiversity taxa in three forest types – plantation, secondary and primary forest.</u> This was successfully achieved (see Figure 1 in the appendix for results summarised as species accumulation curves and multivariate community analyses - MDS ordination), although we are still awaiting the final revision of the Euglossine bee taxonomy (being completed at time of writing).

  2) <u>To undertake comparative analysis of indicator taxa in three forest types.</u>This objective is currently being undertaken as part of the ongoing multi-taxa analyses. Results will be disseminated at the INTERNATIONAL CONGRESS ON CULTIVATED FORESTS: Planted Forests and Sustainable Development (Bilbao, October 2006 – co-organised by the Centre for International Forestry Research, CIFOR and the International Union for the Conservation of Nature, IUCN), and will be submitted to a high impact journal before the end of 2006. We have already made substantial progress towards the identification of focal taxa that could be used as biodiversity indicators in subsequent work (see Appendix Figure 1; and dissemination plans for Bilbao conference). These findings allow us to make a much more comprehensive assessment of plantation forestry and the

wider landscape, addressing issues of high relevance for FSC, ITTO, and other international forestry bodies (Darwin post-project).

3) To improve national capacity in forest biodiversity surveys in terms of technician skills, trained students and reference material. We have significantly added to reference collections at MPEG and INPA for many faunal groups, and to the herbarium at Jari for sterile plant material. Table 6 summarises the training dimension of the project (Output 3). All MSc candidates (six in total, one more than noted in the yr2 logistical framework) have now successfully defended their theses. The undergraduates who took part in training programs are involved in publishing the results from the relevant parts of the project, and are continuing their degrees. Of the research associates who already held Masters degrees, one has enrolled on a PhD program, and a second candidate has applied for a Fulbright fellowship in the US after working for the federal bird research centre (CEMAVE). Research technicians from Belem and the surrounding region were all fully competent in their field procedures, and one has found new work using the skills developed during the project.

4) To study the socio-economic and livelihood values derivable from the three forest types. This has been completed, and peer reviewed articles are in preparation. The results will be disseminated for the first time at the Bilbao meeting (see above) and they are expected to be submitted before end of October.

5) Pilot study to understand phenology and rates of litter turnover in three forest types. We have successfully examined three critical aspects of ecosystem functioning in the three forest types (litter decomposition, litter fall and phenology, and above-ground biomass storage) and a paper has been submitted to a peer-reviewed journal. Data from this output has also been used in submitted publications that relate seasonal changes in the abundance of butterflies and birds to seasonality within each forest type.

4. Scientific, Training, and Technical Assessment

- **Project research work**

This section outlines project research work, starting with the list of senior collaborators involved and their principle research focus (Table 1), before addressing methodologies used (Tables 2-5). Finally, we list all peer-reviewed work to date (it should be noted that many of the manuscripts are in preparation and review, and that this is often a lengthy process: This list will therefore be added to substantially in the coming 12-18 months, with contributions from many different PIs).

Table 1. Senior collaborators and their institutions and research focus

Name	*Institution*	*Association with project*	*Principle focus*
Dr. Carlos A. Peres	*UEA*	*Project coordinator (UK)*	*Midsized to large vertebrates*
Dr. Leandro V. Ferreira	*MPEG*	*Project coordinator (host country)*	*Floristics/host country principle collaborator*
Dr. Jos Barlow	*UEA*	*Field coordinator*	*Birds (mist-netting), butterflies, bees*
Dr. Teresa Cristina Avila-Pires	*MPEG*	*Senior Collaborator*	*Herpetofauna (lizards)*

Dr. Marlucia B. Martins	*MPEG*	*Senior Collaborator*	*Drosophilids*
Dr. Alexandre B. Bonaldo	*MPEG*	*Senior Collaborator*	*Arachnids*
Dr. William L. Overall	*MPEG*	*Senior Collaborator*	*Lepidoptera*
Prof. Marinus Hoogmoed	*MPEG*	*Senior Collaborator*	*Herpetofauna (amphibians)*
Dr. Maria Nazareth Ferreira da Silva	*INPA/ Coleções Zoológicas*	*Senior Collaborator*	*Small non-volant mammals*
Dr. Jay Malcolm	*University of Toronto*	*Senior Collaborator*	*Small non-volant mammals*
Dr. Pedro Vasconcelos	*IEC*	*Senior Collaborator*	*Bats*
Dr. Maria Cristina Esposito	*MPEG*	*Senior Collaborator*	*Diptera: Calliphoridae*
Dr. Augusto L. Henriques	*INPA*	*Senior Collaborator*	*Diptera: Tabanidae*
Fernando Vaz de Mello	*IdE*	*Senior Collaborator*	*Scarabaeinae*
Dr. Malva M.I Herández	*UFPb*	*Senior Collaborator*	*Scarabaeinae*
Ana Lúcia Nunes Gutjahr	*MPEG*	*Senior Collaborator*	*Orthoptera*
Dr. Heraldo Vasconcelos	*IB/UFU*	*Senior Collaborator*	*Forest functioning*
Dr Catarina da Silva Motta	*INPA*	*Senior Collaborator*	*Sphingid and Saturniid moths*
Dr. Mike Hopkins	*EMBRAPA/UFRA*	*Senior Collaborator*	*Floristics/Botany*
Dr. Giorgio Venturieri	*EMBRAPA/CPATU*	*Senior Collaborator*	*Euglossines and Melliponine bees*
Dr. Patricia Shanley	*CIFOR*	*Senior Collaborator*	*Sustainable livelihoods analysis*

Methodologies for multi-taxa sampling were refined following liaison with experienced taxonomists and ecologists and our own field experience in tropical forest environments. Some methods that apparently work well in temperate areas or in other areas of the tropics (for example, funnel trapping for herpetofauna, the use of sugar-baited coloured plates for the stingless bees) have proved of very limited value in this region, while other novel methods have been strikingly effective. Where possible, we have used more than one method for each faunal group. A list of all successfully completed work is shown below in Tables 2 - 5, including a brief description of the methodologies that were used. Note the removal of two invertebrate groups that were included in the AR2 and MTR. After repeated attempts it became clear that a meaningful survey of the stingless bees and the Ithomiinae butterflies would not be possible given the limited amount of time and the experimental nature of the methodologies available. We therefore followed advice from the MTR and the AR2, and focussed on completing the achievable outputs.

Table 2. Basic methodological details for sampling vegetation and examining ecosystem functioning

Sampling target	*Sampling methodologies used*
Large vascular plants	*1-ha plots for trees ≥10cm DBH and lianas ≥5 cm DBH. Sterile material collected and Identified at Embrapa.*
Vegetation structure	*Twenty 10m radius circles at each site, measuring foliage stratification, understorey density, leaf litter depth, basal area, ground cover, and density estimates of herbaceous plants/saplings/lianas.*
Phenology	*300 50cm x 50cm litter traps examined over 13 months. Litter dried and split into 1) leaves, 2) branches, 3) fruits and 4) flowers.*
Litter decomposition bags	*1200 litter bags placed in 15 sites (80 per site). Each bag contains 6g of dried leaves from one of 4 species (*Vismia guianensis, Eucalyptus urograndis, Bertholettia excelsa, Bellucia dichotoma*). 300 litter bags were collected, dried and weighed every 3 months to calculate decomposition rates over 12 months.*
Humidity, temperature and rainfall	*15 temperature data loggers, 5 humidity data-loggers (one each site, >1 year data). 38 year-long rainfall and temperature record from Jari Celulose (3 sites).*

Table 3. Basic methodological details for sampling invertebrates

Sampling target	*Sampling methodologies used*
Frugivorous butterflies (Nymphalidae)	*Canopy and understorey traps baited with fermented banana*
Moths (Sphingidae, Saturniidae, Arctiidae)	*Nocturnal light trapping using 2x2 m sheets and UV/Mercury vapour bulbs. Sheets checked hourly (6:30PM – 6:30 AM).*
Orthoptera	*Sweep netting along 1km transects. Nocturnal light trapping using 2x2 m sheets and UV/Mercury vapour bulbs.*
Fruit flies (Drosophilidae)	*PVC canopy and understorey traps baited with fermented banana*
Carrion flies (Calliphoridae, Muscidae, Sarcophagidae)	*"Tin can" traps with inverted funnel tops, baited with rotten (24 hour old) cow lung.*
Dung beetles (Scarabaeinae)	*Pitfall traps, baited with human faeces*
Euglossine bees (Euglossinae)	*Methyl Salicate baited bottle traps*
Army ants	*Collection of all swarms encountered along line-transect surveys.*
Terrestrial spiders and other arachnids	*Pitfall traps (see herpetofauna)*
Invertebrate orders	*Counts of arthropods caught in malaise traps, sticky traps, pitfalls, sweep net samples, and winkler leaf-litter traps.*

Table 4. Basic methodological details for sampling vertebrates

Sampling target	*Sampling methodologies used*
Midsized to large vertebrates	*5-km line transect censuses.*
Bats	*Nocturnal (18:00 – 00:30) understorey and canopy mist netting (12 nets total), combined with canopy and understorey recordings of calls (using AVISOFT).*
Small mammals	*160 baited Tomahawk & Sherman live traps at each site. Pitfalls captures.*
Birds	*Mist nets (24 nets along each transect) and direct observation using point counts.*
Reptiles	*Pitfall, funnel traps, sticky traps, and 500 m line transect censuses*
Amphibians	*Pitfall, funnel traps, sticky traps, and 500 m line transect censuses*

Table 5. Basic methodological details for sustainable livelihoods analysis

Sampling target	*Sampling methodologies used*
Game harvest surveys	*Trained community assistants recorded all hunting and fishing activities within 3 small communities, with an emphasis on the respective value of primary, secondary and plantation forests.*
Forest Activities	*The daily activities of 10 males per community are monitored, in relation to time spent harvesting forest products versus cash-crop agricultural labour etc.*
Household animal protein acquisition	*Consumption of purchased meats and domestic livestock also recorded.*

The following papers are currently published, in press or have been submitted for peer review:

Barlow, J., C. A. Peres, L. M. P. Henriques, P. C. Stouffer, and J. M. Wunderle. 2006. The responses of understorey birds to forest fragmentation, logging and wildfires: An Amazonian synthesis. Biological Conservation 128:182-192.

Gardner, T.G., Barlow, J. Parry, L.T.W., Peres, C.A. (in press) Predicting the future of tropical forest species in a data vacuum. Biotropica

Bonaldo, A.B., Rheims, C.A., and Brescovit, A. D. (in press) Four new species of Drymusa Simon, 1981 (Araneae, Drymusidae) from Brazilian Oriental Amazonia. Zootaxa

Leite, R. N., da Silva, M.N.F., and Gardner, T.A. (in review). New records of Neusticomys oyapocki (Ichthyomyini, Sigmodontinae) from a human-dominated forest landscape in northeastern Brazilian Amazonia. Mammalian Biology

Gardner, T.G., Ribeiro, M.A., Barlow, J., Ávila-Pires, T.C.S., Hoogmoed, M. and Carlos A. Peres (in review) The biodiversity value of primary, secondary and plantation forests for a neotropical herpetofauna. Conservation Biology

Gardner, T.G., Barlow, J., Peres, C.A. (in review) Paradox, presumption and pitfalls in conservation biology: research on the consequences of habitat change for amphibians and reptiles. Biological Conservation.

Parry, L.T.W, Barlow, J., Peres, C.A. (in review) Large vertebrate assemblages of primary and secondary forests in the Brazilian Amazon. Journal of Tropical Ecology

Barlow, J., Mestre, L.M., Gardner, T.A. & Peres, C.A. (in review) The value of primary, secondary and plantation forests for Amazonian birds. Ecological Applications

Barlow, J., Gardner, T.A., Ferreira, L.V. & Peres, C.A. (In review) Litter fall and decomposition in primary, secondary and plantation forests in the Brazilian Amazon. Forest Ecology and Management

Barlow, J. Overal, W.L., Araujo, I.S., Gardner, T.G., & Peres, C.A. (in review) The value of primary, secondary and plantation forests for fruit-feeding butterflies in the Brazilian Amazon. Journal of Applied Ecology

Ribeiro-Junior, M.A., Gardner, T.A., and Avila-Pires, T.C.S. (in review) Evaluating the effectiveness of glue traps to sample lizards in the Brazilian Amazon. South American Journal of Herpetology

The following presentations have been given or have been accepted following peer review of submitted abstracts:

Barlow, J., W. Overal, G. Venturieri, L. Mestre, L. Ferreira, T.A. Gardner, and C. Peres. The biodiversity value of primary, secondary and plantation forests in the Brazilian Amazon. Invited symposium: Large-scale conservation in expanding Amazonian frontiers: integrating across scales and disciplines. Society for Conservation Biology, Brasilia, Brazil.

Gardner, T.A., M.A.R. Riberio, T.C.S. Avila-Pires, J. Barlow, M. Hoogmoed, and C. Peres. The herpetofauna of primary, secondary and plantation forests in the Brazilian Amazon. Association for Tropical Biology and Conservation, Uberlandia, Brazil.

Parry, L.T.W. et al (3 authors). Game vertebrate densities and local hunting patterns within primary and secondary forests of the Brazilian Amazon. Association of Tropical Biology and Conservation: Frontiers in Tropical Biology and Conservation (Uberlandia, Brazil, July 2005).

Parry, L.T.W. et al (3 authors). Game vertebrate densities and local hunting patterns within primary and secondary forests of the Brazilian Amazon. 19th Annual Meeting of the Society for Conservation Biology (Brasilia, Brazil, August 2005).

Parry, L. T.W. A challenge for large vertebrate conservation: sustainable hunting in fragmented landscapes. Center for International Forestry Research (CIFOR) (Belém, Brazil, December 2005).

Parry, L.T.W. et al (3 authors). The conservation importance of secondary forests and their role in Amazonian subsistence hunting. Invited seminar. Zoological

Society of London (London, February 2006).

Parry, L.T.W. et al (3 authors). The role of secondary forests in Amazonian subsistence hunting. The 7th International Conference for the Management of Wildlife in Amazonia and Latin America (Ilehus, Brazil, September 2006).

Ribeiro, M.A. Evaluating methods for sampling forest herpetofauna. Brazilian Society of Herpetofauna annual meeting. (Belo Horizonte, June 2005)

Mestre, L.M. Frugivorous birds and silviculture. Brazilian Ornithological Congress, (Belem, November 2005)

Barlow et al. (22 authors) The role of plantation forestry in biodiversity conservation in the humid tropics. International congress on cultivated forests: Planted Forests and Sustainable Development (Bilbao, October 2006)

Gardner et al. (22 authors) Evaluating the effectiveness of biodiversity sampling in tropical forest landscapes: a cost benefit analysis from a multi-taxa project in the Brazilian Amazon. International congress on cultivated forests: Planted Forests and Sustainable Development (Bilbao, October 2006)

Parry, L.T.W. et al (5 authors) The role of eucalyptus plantations and post-clearance regrowth in Amazonian subsistence hunting. International congress on cultivated forests: Planted Forests and Sustainable Development (Bilbao, October 2006)

- **Training and capacity building activities**

Students from partner institutions (Museu Goeldi/Insitituto Nacional de Pesquisas da Amazonia) were chosen through consultation with host country researchers and academics. We modified our initial aim (which was to give a limited amount of training to many students) following the MTR, opting instead to deliver a more focussed and high-level tiered training program. The highest level of training was given to a limited number of Masters students and PhD candidates, placing them in a strong position to enter into a PhD program, and continue their research in the wider field of Amazonian biodiversity conservation. Assessment and accreditation for Masters students was through their various host institutions.

The second tier of training relates to undergraduate or “estagarios” of local and regional institutions such as the Rural Universtiy of Amazonia (UFRA), and aimed at providing specific skills within a core subject area that would encourage students to enter into MSc programs and pursue conservation as a vocation, and give them a good experience of working within an international project. Many of these students were directly involved in identification of arthropod taxa, taxonomic revisions, the development of dichotomous keys for the jari fauna, and the subsequent publication of the project results. Accreditation for undergraduate students comes through the Museu Goeldi, and their training/work experience programs.

The final tier related to locally-based field technicians. As stated in the MTR, the project has made “a notable impact” towards improving the capacity of locally-based field technicians to undertake biodiversity surveys. Many of these entered into the project from poor backgrounds (being mainly composed of migrant workers) and most were illiterate. We therefore encouraged basic evening classes in literacy, and have trained them to a very high level of proficiency in a range

of field techniques. For the local field assistants we developed CV's where we outlined the skills they have leaned with us, and the level of proficiency they gained. We have also circulated a list of names and skills of these people to partner institutions (Jari Celulose, ORSA Florestal, MPEG), making them aware of the skill base available in the region. We were particularly pleased to see one such field technician finding employment which made use of the skills developed during the project.

5. Project Impacts

- Our achievement of outputs 1-5 mean that we have gone some way to fulfilling the project purpose, and have a much greater understanding of the impact of forest clearance, plantation establishment and forest recovery for biodiversity and rural livelihoods in tropical forest landscapes. An additional and unexpected impact has been our contribution to the creation of the first ever management plan for the 230,000-ha Estação Ecológica do Jari. Our close contact with local IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis) officials in charge of the reserve led to us undertaking the first ever survey of the avifauna and large vertebrates of this reserve.
- Translating knowledge and information resulting from this project into policy that could be adopted by regional and national government has been identified as the weak-link in both the MTR and the AR2. Clearly influencing the government of a country so large and complex as Brazil is not easy, especially when there are so many conflicting interests at play. As academics, much of our primary effort goes into publishing scientific papers. This is, after all, how we are evaluated. However, although we expect our papers to attract substantial media coverage on publication, this is highly unlikely to be enough to influence even regional level politics and decision making. We have therefore adopted two additional approaches. One of these is to disseminate our findings to forestry specialists at the conference in Bilbao to be held in October 2006, ensuring our results are taken in across a wide spectrum of academic, non-governmental and private sector institutions. The second is to use our post-project funding to organise and hold a workshop in Belém in 2008. The MTR and AR2 identified the importance of developing the projects wider impact in any post-project follow up, and we are very pleased to have the opportunity to do this with continued DI funding. We aim to bring together people from the private sector, regional government, international and national NGOs, as well as established academics, and to provide a forum for debate and the exchange of ideas as well as a lasting output in the form of a written workshop proceedings, targeted at a general readership. This workshop has already been discussed with regional organisations, and has received a high level of interest.
- Our training program has made a significant contribution to the ability of trainees to undertake biodiversity work within Amazonia. The outcomes of their training are summarised in Table 6. MSc student Marco Antonio Ribeiro has built upon his experience in Jari and is now co-ordinating Brazilian Biodiversity projects from Belém (PPBio, Programa de Pesquisa em Biodiversidade/Biodiversity research Program). Ivanei Araujo is working alongside the Darwin post-project, and Rafael Leite is applying to study Amazon-wide conservation issues at a US institution. We fully expect these individuals to continue to make a significant impact within their areas of expertise.

  Undergraduate students have all expressed great interest in developing the skills learned during their time at the Museum, and all have become involved in the publishing and analysis of the results in areas where they contributed. The

research associates are either still in the process of applying for doctoral positions, or have already been accepted on courses. Three of the local field technicians were able to use their skills to find employment in the region, either through the Darwin post-project or through the local forestry company Orsa Florestal.

Table 6. Students and technicians who received training through the project

PhD students	***Institution***	***Outcome***	***Subject area***
Toby Gardner	*UEA*	*Preparing thesis for 31/12/06*	*Dung beetles/herpetofauna*
Sandra Peters	*University of Toronto*	*Preparing thesis for 31/12/08*	*Bats*
MSc Students			
Luke Parry	*UEA*	*7/8/04 Successful, undertook CIFO fellowship in Jari (see below)*	*Sustainable livelihood analysis*
Joseph Hawes	*UEA*	*7/8/05 Successful, applying for PhD program in UK.*	*Sphingid moths*
Gita Kasthala	*UEA*	*7/8/05 Successful, working on biodiversity project in Tanzania.*	*Camera trapping/Malaise trapping*
M. A. Ribeiro Jr.	*MPEG*	*30/03/06 Successful, working coordinating Amazonian biodiversity project (PPBio) and applying to PhD program at MPEG.*	*Herpetofauna*
Rafael Leite	*INPA*	*01/05/06 Successful, applying to PhD program at in USA*	*Small mammals*
Ivanei Araujo	*MPEG*	*25/06/06 Successful, working on Darwin post-project and applying to PhD program at MPEG.*	*Ithomiianae butterflies*
Undergraduates			
Celene da Silva Carvalho	*UFRA*	*Continuing degree*	*Blowfly identification*
Arthur Gleydson Deus de Melo	*UFRA*	*Continuing degree*	*Blowfly identification*
Fernando da Silva Carvalho Filho	*UFRA*	*Continuing degree*	*Blowfly identification*
Isabela Carvalho Brcko	*UFRA*	*Continuing degree*	*Blowfly identification*
Fernanda da Silva Mendes	*UFRA*	*Continuing degree, involved in publishing work undertaken.*	*Satyrinae butterfly identification and curation*
Gleicyane de Fatima C. Aguiar	*UFRA*	*Continuing degree, involved in publishing work undertaken.*	*Euglossine bee identification and curation*

Research associates			
Luke Parry	*CIFOR*	*PhD candidate (enrolled UEA 1/1/06)*	*Sustainable livelihood analysis*
Elias de Souza Braga	*MPEG*	*MSc Candidate (applying to MPEG)*	*Orthoptera*
N. Oi Chan Li	*MPEG*	*MSc Candidate (applying to MPEG)*	*Arachnids*
J. E. Costa	*MPEG*	*MSc Candidate (applying to MPEG)*	*Drosophila*
Ronildon Miranda	*MPEG*	*PhD Candidate (enrolled MPEG 2005)*	*Drosophila*
Luiz A.M. Mestre	*INPA*	*Worked for 12 months at CEMAVE (Brazilian bird study centre) and is currently applying for Fulbright fellowship to undertake a PhD in the US.*	*Avifauna (point counts)*
Technicians from Belém			
Oswaldo Araujo	*IEC*	*na*	*Bats*
Paulo R.N. da Silva	*MPEG*	*na*	*Lepidoptera*
Jarilson G. Vilar	*MPEG*	*na*	*Lepidoptera*
Agostinho Lima	*Embrapa/CPATU*	*na*	*Euglossines and Melliponine*
Local field technicians			
Edivar Dias Correia	*na*	*Working with Darwin post-project*	*Large vertebrate surveys, leaf litter decomposition experiments*
Manoel Oliveira do Santos	*na*	*Working with Darwin post-project*	*Butterfly and bird sampling*
Natalino da Silva	*na*	*Working with project of Sandra Peters (radiotracking bats)*	*Bat and bird sampling*
Francisco Oliveira do Santos	*na*	*na*	*Herpetofauna and dung beetle sampling*
Lurival Barreto	*na*	*Orsa florestal, working as field-based tree specimen collector*	*Tree identification and collection and preparation of sterile material*

- All project PIs continue to be in regular contact through the ongoing publication of results. Collaboration between the UK based researchers and Brazil was strengthened when Jos Barlow was awarded a CNPq (Brazilian Science Research Council) fellowship to work at the Museu Goeldi (June 2006-June 2007). The planned post-project workshop (Jan 2008) also promises to maintain strong links between the UK and local partners. The project has helped link NGOs and local stakeholders, with CIFOR beginning to take a more prominent role in the decision

making of Orsa Florestal with regard to the marketing of NTFPs and their community management programs. It also seems likely that Jari Celulose and Orsa Florestal will continue to collaborate with MPEG to ensure they achieve the monitoring of biodiversity required for certification (MTR point 93).

- The rural-livelihoods project was designed as a pilot study that would examine the livelihood values derivable from the 3 forest types (Output 4, logical framework). As such, it did not explicitly aim to deliver an immediate positive impact to the communities, and many of these issues are rather insignificant at the local level when compared to the scale of the logging and plantation forestry (see point no. 94 in MTR) . However, this component has ensured these communities are not overlooked, and reduces the chance that any regional decision making will have a negative impact on their livelihoods (MTR, point 95). Furthermore, it has helped facilitate links between NGOs involved in rural livelihood programs (CIFOR) and the communities, and it is hoped that this could bring about positive impacts through the effective marketing of NTFPs.

6. Project Outputs

Many of the differences relate to the time lag between analysing data and writing articles and their eventual publication. We are confident that we will attract media attention once our articles are published. Other outputs were altered as a result of the review process (see training). An important additonal output was the examination of litter cycling and decomposition across the three habitats. Although both the MTR and AR2 expressed doubt about the wisdom of maintaining this output, very little additional field time was required to achieve it, and the data was both valuable in its own right (and has already been submitted for publication) and was useful as an important environmental variable that has helped explain the patterns of biodiversity we found. We have added this as a 5th output to our logical framework.

- As academics, scientific articles are our principle dissemination tool. All PIs aim to continue the ongoing publication process, and we fully expect to publish over 25 peer-reviewed articles in the coming 12 months. The disadvantage of this is that the target audience consists in the most part of other academics. This will be partly remedied though oral presentations at a leading forestry conference, and the proposed multi-stakeholder participation workshop scheduled for January 2008. Furthermore, as suggested by both the MTR and the AR2, dissemination of the results to the private sector and government is a high priority for the post-project work.

7. Project Expenditure

	2003/2004		2004/2005		2005/2006		2006/2007		**TOTAL**	
	budget	spent	budget	spent	budget	spent	budget	spent	**budget**	**spent**

- Variation in the budget (in yellow) was due to the virement of funds from printing and conferences to fieldwork (travel and subsistence and consumables). This virement was discussed and proposed during the MTR and AR2, and was the most pragmatic course of action to maximise the chance of success of outputs 1-5.

8. Project Operation and Partnerships

Many more host-country partners became involved in this project than was originally anticipated as the project developed. This was mostly due to specialist taxanomic skills being spread across a large number of institutions. However, the main partners remained MPEG, Jari Celulose and Orsa Florestal. MPEG is a leading museum and centre for biodiversity research in the Amazon. Jari Celulose and Orsa florestal are private companies, but have an interest in maintaining FSC accreditation for their forestry activities. Monitoring biodiversity is a crucial part of this (Principle 8 of the FSC Charter). MPEG was highly active in all parts of the project, from the planning and implementation of the fieldwork, the taxonomy and curation of the collected specimens, conference presentations, and in the analysis and publication of results. Jari Celulose and Orsa florestal helped with some decision making and planning at the outset, and logistical issues on a day to day basis. However, scientific decision making was left to project partners from UEA and MPEG, and it was obviously important that we maintained this academic independence from stakeholders with such vested interests.

- We developed and maintained good links with two ongoing projects – PPBio (Biodiversity Research Program) and TEAM (Tropical Ecology, Assessment and Monitoring Initiative) – that monitor biodiversity in primary forests in the Amazon. These links involved us exchanging information about the success or failure of different sampling methodologies, and the development of species identification tools and manuals.
- A total of twelve international institutions were involved in this project, either through project PIs (UEA, MPEG), their students (UEA, MPEG, UfRA, INPA, UoT), provision of specialist advice (UoT, UFPb, UFU), identification of collected material (INPA, EMBRAPA, UFPb, IdE), and their research assocates or technicians (CIFOR, IEC). These are listed below.
- *UEA (University of East Anglia, Norwich, UK)*

- *MPEG (Museu Paraense Emilio Goeldi, belem, Para)*
- *INPA (Instituto Nacional de Pesquisa da Amazonia, Manaus, Amazonas)*
- *EMBRAPA (Empresa Brasileira de Pesquisas Agropecuárias, Belém, Pará)*
- *UFPb (Universidade Federal da Paraiba, João Pessoa, Paraiba)*
- *UoT (University of Toronto)*
- *UfRA (Universidade Federal da Rural Amazonia)*
- *IB/UFU (Instituto de Biologia, Universidade Federal de Uberlândia, Minas Gerais)*
- *IEC (Instituto Evandro Chagas, Belem, Para)*
- *CIFOR (Center for International Forestry Research)*
- *IdE (Instituto de Ecologia, Xalapa, Mexico)*

- Many of these local partnerships have continued beyond the EoP. For example, through the work of Luke Parry, CIFOR have been collaborating with Jari cellulose/Orsa florestal to assist in the marketing and growth of the non timber forest projects from the local communities of Jari. Jari has also strengthened its links with MPEG, and this has developed further with post-project funding – it is confidently anticipated that the future monitoring of the effects of Orsa/Jari activities on biodiversity will be carried out in conjunction with MPEG. The potential role of the private sector to contribute towards the protection and maintenance of biodiversity in production landscapes will be evaluated during the proposed EoP workshop to be held in Belem in 2008, which will be attended by NGO's, governmental institutions, as well as relevant private sector companies.

9. Monitoring and Evaluation, Lesson learning

- Project monitoring and evaluation were initially poorly received by the AR1, this being mainly due to the poor construction of the initial logical framework (Project PIs were inexperienced in this approach, and unaware that this framework could form the main M&E tool).
- The main problems was the inexperience of the PIs with this form of M&E tool. The MTR was incredibly helpful in revising the framework and teaching us how this can aid M&E. The resulting work plan (MTR Table 6) helped us to identify a timeline for achieving outputs 1-4.
- As well as the MTR, an audit of account expenses took place at the UEA.
- The MTR was very useful in maximising projects outputs, and focussing them more critically towards the aims of the DI. Training in the use of logical-frameworks would be useful (if not essential) if these are to remain a crucial part of the M&E process.

10. Actions taken in response to annual report reviews

Review 1 highlighted many potential flaws in the project management, including an overall lack of focus, excessive slippage, and poor financial reporting. Some of these, such as the slippage due to visas, were beyond our control at the time (see MTR). Others were remedied at the time and during the subsequent MTR, when we modified the overall project purpose, clarified the outputs, and established indicators and means of verification. AR2 commented on how this process had made a substantial improvement in project reporting and chances of success. Both the MTR and AR2 highlighted the need for further work to maximise the project outputs

and the dissemination of results into the forestry industry and national policies. We were therefore pleased that our application for post-project support was successful and allowed us the opportunity to build on the successful dissemination of projects outputs.

11. Darwin Identity

- Logos were used in letterheads, all oral presentations, and in the acknowledgements of all published papers.
- The extensive level of consultation and contact with a range of Brazilian scientists from many institutions has helped raise the profile of the DI within the Brazilian scientific community. All collaborating PIs are aware of the DI and its aims. The project has become known as “o projeto de Darwin” within MPEG, and is widely acknowledged as one of the most important international projects within MPEG. Presentations at conferences across Brazil will have raised the profile of the DI to many researchers not involved in the project. Moreover, the project continues to be warmly received within the management team of Jari Celulose and Orsa Florestal, and the company managers are aware of the funding of DI, and its aims.
- The project was seen as a separate and clearly defined entity as it was the only project to examine biodiversity in plantations and regenerating forests. However, In terms of it’s impact it was compared with other existing or developing projects that monitor biodiversity in the Brazilian Amazon, such as TEAM (Tropical Ecology, Assessment and Monitoring).

12. Leverage

- A number of additional funds were raised during the project, including money from the National Geographical Society ($15,000), the Conservation Food and Health Foundation ($12,000), and a Rufford Grant for Nature Conservation (£5000). CNPq (Brazilian research council) and CIFOR (Center for International Forestry Research) provided fellowships for two project investigators, as well as stipends for MSc students.
- Project partners played were intimately involved in the development and application of grant proposals which provided matching support for the core Darwin funding. This exercise provided critical training in key grant writing skills as well as skills in grant research. To aid the success of project partners in securing financial support from international donors for future projects a comprehensive database of grant-making bodies and trust funds was compiled during the project and disseminated widely among all partner institutions. Communication with project partners has revealed that this database has been instrumental in helping secure funds for independent biodiversity projects and student work.

13. Sustainability and Legacy

- The long-term collaboration between UEA and MPEG, MPEG and Jari Celulose/Orsa florestal, and UEA and Jari Celulose/Orsa florestal seems highly likely, and a MoU has been drawn up highlighting all the interest of all partners in this. Project resources will remain in use for the Darwin post-project. Staff have all remained at their instutions, with the exception of Jos Barlow, who has begun a

one-year fellowshiop at the Brazilian partner instution (MPEG). All partners are therefore still in touch on a regular basis.

- The projects purpose was modified during the MTR to be a first stage analysis of biodiversity and livelihood impact of forest clearance, plantation establishment, and forest recovery. As such, its focus was on identifying indicator groups that could be used in a follow on project to explore issues of wider relevance. The full legacy of the project will be determined by the success of the post-project in producing results and disseminating them to the widest possible audience (see MTR points 109-112, and AR2 section on impact and sustainability)
- The Darwin post-project is aimed at producing strategies that will help maintain biodiversity in forest production landscapes. The CNPq fellowship for JB focuses on the particular role of primary forest corridors. Both funding programs are aimed at producing and disseminating results that can make a substantial difference to Brazilian national policy (through the Brazilian National Forest Code) and the practice of the private sector.

14. Value for money

- To our knowledge this is the most ambitious comprehensive multi-taxa assessment of primary, secondary and plantation forests yet conducted for any tropical landscape (see Appendix). We used a robust and replicated experimental design (a feature missing from many studies on biodiversity), and sampled plots that were 2-3 orders of magnitude larger than many previous studies (minimising edge-effects), as well as being geographically isolated to ensure spatial independence. The efficiency and value for money were highlighted in the MTR (point 45-48 and129). This was in part achieved by very hard work and high levels of commitment from all project participants, who formed a cohesive and dedicated field team (MTR points 45-48). It was also achieved through sensible and pragmatic decision making regarding transport and accommodation.

15. Appendix I: Project Contribution to Articles under the Convention on Biological Diversity (CBD)

Project Contribution to Articles under the Convention on Biological Diversity		
Article No./Title	**Project %**	**Article Description**
6. General Measures for Conservation & Sustainable Use	20	Develop national strategies that integrate conservation and sustainable use.
7. Identification and Monitoring	20	Identify and monitor components of biological diversity, particularly those requiring urgent conservation; identify processes and activities that have adverse effects; maintain and organise relevant data.
8. In-situ Conservation	0	Establish systems of protected areas with guidelines for selection and management; regulate biological resources, promote protection of habitats; manage areas adjacent to protected areas; restore degraded ecosystems and recovery of threatened species; control risks associated with organisms modified by biotechnology; control spread of alien species; ensure compatibility between sustainable use of resources and their conservation; protect traditional lifestyles and knowledge on biological resources.
9. Ex-situ Conservation	0	Adopt ex-situ measures to conserve and research components of biological diversity, preferably in country of origin; facilitate recovery of threatened species; regulate and manage collection of biological resources.
10. Sustainable Use of Components of Biological Diversity	20	Integrate conservation and sustainable use in national decisions; protect sustainable customary uses; support local populations to implement remedial actions; encourage co-operation between governments and the private sector.
11. Incentive Measures	10	Establish economically and socially sound incentives to conserve and promote sustainable use of biological diversity.
12. Research and Training	20	Establish programmes for scientific and technical education in identification, conservation and sustainable use of biodiversity components; promote research contributing to the conservation and sustainable use of biological diversity, particularly in developing countries (in accordance with SBSTTA recommendations).
13. Public Education and Awareness	5	Promote understanding of the importance of measures to conserve biological diversity and propagate these measures through the media; cooperate with other states and organisations in developing awareness programmes.

14. Impact Assessment and Minimizing Adverse Impacts	0	Introduce EIAs of appropriate projects and allow public participation; take into account environmental consequences of policies; exchange information on impacts beyond State boundaries and work to reduce hazards; promote emergency responses to hazards; examine mechanisms for re-dress of international damage.
15. Access to Genetic Resources	0	Whilst governments control access to their genetic resources they should also facilitate access of environmentally sound uses on mutually agreed terms; scientific research based on a country's genetic resources should ensure sharing in a fair and equitable way of results and benefits.
16. Access to and Transfer of Technology	0	Countries shall ensure access to technologies relevant to conservation and sustainable use of biodiversity under fair and most favourable terms to the source countries (subject to patents and intellectual property rights) and ensure the private sector facilitates such assess and joint development of technologies.
17. Exchange of Information	5	Countries shall facilitate information exchange and repatriation including technical scientific and socio-economic research, information on training and surveying programmes and local knowledge
19. Bio-safety Protocol	0	Countries shall take legislative, administrative or policy measures to provide for the effective participation in biotechnological research activities and to ensure all practicable measures to promote and advance priority access on a fair and equitable basis, especially where they provide the genetic resources for such research.
Total %	**100%**	**Check % = total 100**

16. Appendix II Outputs

Code	Total to date (reduce box)	Detail (←expand box)
Training Outputs		
1a	Number of people to submit PhD thesis	2
1b	Number of PhD qualifications obtained	0
2	Number of Masters qualifications obtained	6
3	Number of other qualifications obtained	6
4a	Number of undergraduate students receiving training	6
4b	Number of training weeks provided to undergraduate students	76
4c	Number of postgraduate students receiving training (not 1-3 above)	
4d	Number of training weeks for postgraduate students	440
5	Number of people receiving other forms of **long-term** (>1yr) training not leading to formal qualification(i.e not categories 1-4 above)	5
6a	Number of people receiving other forms of **short-term** education/training (i.e not categories 1-5 above)	-
6b	Number of training weeks not leading to formal qualification	320
7	Number of types of training materials produced for use by host country(s)	-
Research Outputs		
8	Number of weeks spent by UK project staff on project work in host country(s)	110
9	Number of species/habitat management plans (or action plans) produced for Governments, public authorities or other implementing agencies in the host country (s)	0
10	Number of formal documents produced to assist work related to species identification, classification and recording.	4
11a	Number of papers published or accepted for publication in peer reviewed journals	3
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	1
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)	12
13b	Number of species reference collections enhanced and handed over to host country(s)	1

Dissemination Outputs		
14a	Number of conferences/seminars/workshops organised to present/disseminate findings from Darwin project work	0
14b	Number of conferences/seminars/ workshops **attended** at which findings from Darwin project work will be presented/ disseminated.	4
15a	Number of national press releases or publicity articles in host country(s)	0
15b	Number of local press releases or publicity articles in host country(s)	0
15c	Number of national press releases or publicity articles in UK	0
15d	Number of local press releases or publicity articles in UK	0
16a	Number of issues of newsletters produced in the host country(s)	0
16b	Estimated circulation of each newsletter in the host country(s)	0
16c	Estimated circulation of each newsletter in the UK	0
17a	Number of dissemination networks established	0
17b	Number of dissemination networks enhanced or extended	0
18a	Number of national TV programmes/features in host country(s)	0
18b	Number of national TV programme/features in the UK	0
18c	Number of local TV programme/features in host country	0
18d	Number of local TV programme features in the UK	0
19a	Number of national radio interviews/features in host country(s)	0
19b	Number of national radio interviews/features in the UK	0
19c	Number of local radio interviews/features in host country (s)	0
19d	Number of local radio interviews/features in the UK	0
Physical Outputs		
20	Estimated value (£s) of physical assets handed over to host country(s)	£10,000
21	Number of permanent educational/training/research facilities or organisation established	0
22	Number of permanent field plots established	10
23	Value of additional resources raised for project	£20,000

17. Appendix III: Publications

Provide full details of all publications and material that can be publicly accessed, e.g. title, name of publisher, contact details, cost. Details will be recorded on the Darwin Monitoring Website Publications Database that is currently being compiled.

Mark (*) all publications and other material that you have included with this report

Type * (e.g. journals, manual, CDs)	**Detail** (title, author, year)	**Publishers** (name, city)	**Available from** (e.g. contact address, website)	**Cost £**
Journal	**The Responses of Understorey Birds to Forest Fragmentation, Logging and Wildfires: an Amazonian Synthesis. Barlow, J. et al. 2006**	**Elsevier**	**http://www.elsevier.com/wps/find/journaldescription.cws_home/405853/description#description**	**n.a.**
Journal	**Predicting the future of tropical forest species in a data vacuum. Gardner, T. et al. in press**	**Blackwell**	**http://www.blackwellpublishing.com/journal.asp?ref=0006-3606&site=1**	**n.a.**

18. Appendix IV: Darwin Contacts

To assist us with future evaluation work and feedback on your report, please provide contact details below.

Project Title	Biodiversity and functional value of Amazonian primary, secondary and plantation forests
Ref. No.	*162/12/014*
UK Leader Details	
Name	Carlos A. Peres
Role within Darwin Project	PI
Address	School of Env Sci. Univ. of East Anglia
Phone	
Fax	
Email	
Other UK Contact (if relevant)	
Name	Jos Barlow
Role within Darwin Project	Post-doctoral researcher
Address	School of Env Sci. Univ. of East Anglia
Phone	
Fax	
Email	
Partner 1	
Name	Leando Ferreira
Organisation	Museu Paraense Emilio Goeldi
Role within Darwin Project	Host country PI
Address	Av.Magalhães Barata, 376 - São Braz, Caixa Postal 399 CEP: 66.040-170, Belém, Pará, Brasil
Fax	
Email	
Partner 2 (if relevant)	
Name	
Organisation	
Role within Darwin Project	
Address	
Fax	
Email	

Annex 1. *REVISED LOGICAL FRAMEWORK (FOLLOWING MTR 02/2005)(with additional output #5)*

Intervention Logic	***Indicators***	***Means of Verification***	***Assumptions***
Purpose			
First stage analysis of biodiversity and livelihood impact of forest clearance, plantation establishment and forest recovery in Jari (Pará, Brazil)	Useful indicator taxa identified for comparative studies between and within 3 forest types	Validated report from sample analysis Curated specimens available for use	Groups sampled will include discriminating indicator species
	Local capacity increased for forest biodiversity surveys	Field competent scientists and technicians available and utilised	Local partners interested in future surveys and resources available to them for this
Outputs			
1 Sample and identify key biodiversity taxa in 3 forest types – plantation, secondary and primary forest	Sample design agreed and laid out in field by month 12	Transects mapped and labelled on Jari GIS database	Transport available at time required Brazilian partners cooperate as agreed in MoU Majority of collected material can be identified
	Field data collection completed by month 26 and identification of specimens completed by month 30	Field data sheets processed and specimens curated in MPEG Relational database created and validated	
	Peer reviewed conference paper reporting field work	Papers accepted for SCB July 2005 Brasilia conference	
2 Undertake comparative analysis of indicator taxa in 3 forest types	Bulk of analysis completed by month 30	Detailed report on findings Peer reviewed scientific papers	Full cooperation with data exchange and identification
3 Improve national capacity in forest biodiversity surveys in terms of technician skills, trained students and reference material	Expertise in forest biodiversity surveys increased	5 MScs completed by EoP 3 Technicians fully competent in agreed standard field procedures by EoP 2 candidates improve eligibility for Doctoral studies before EoP	Students awarded stipend Technicians maintain interest and have right aptitude
	Curated specimens and equipment handed over to MPEG/IMPA	Equipment in place and being used	Museum makes use of material
4 Pilot study of socio-economic and livelihood values derivable from the 3 forest types	Sample areas identified by month 18 and effective sampling undertaken by month 30	Maps and validated data	Village health assistants willing to undertake data recording

	Comprehensive analysis undertaken	Peer reviewed reports and scientific papers	
5 Pilot study to understand phenology and rates of litter turnover in three forest types.	Leaf, flower and fruit phenology assessed on a month-by-month basis at 15 sites Litter decomposition bags placed at 15 sites and examined every 3 months	Peer reviewed reports and scientific papers Data to help explain seasonal change in the abundance of taxa surveyed many times over the year (butterflies, large vertebrates)	Litter fall and litter decomposition experiment would yield useful results Investigators have sufficient time to enter and analyse data

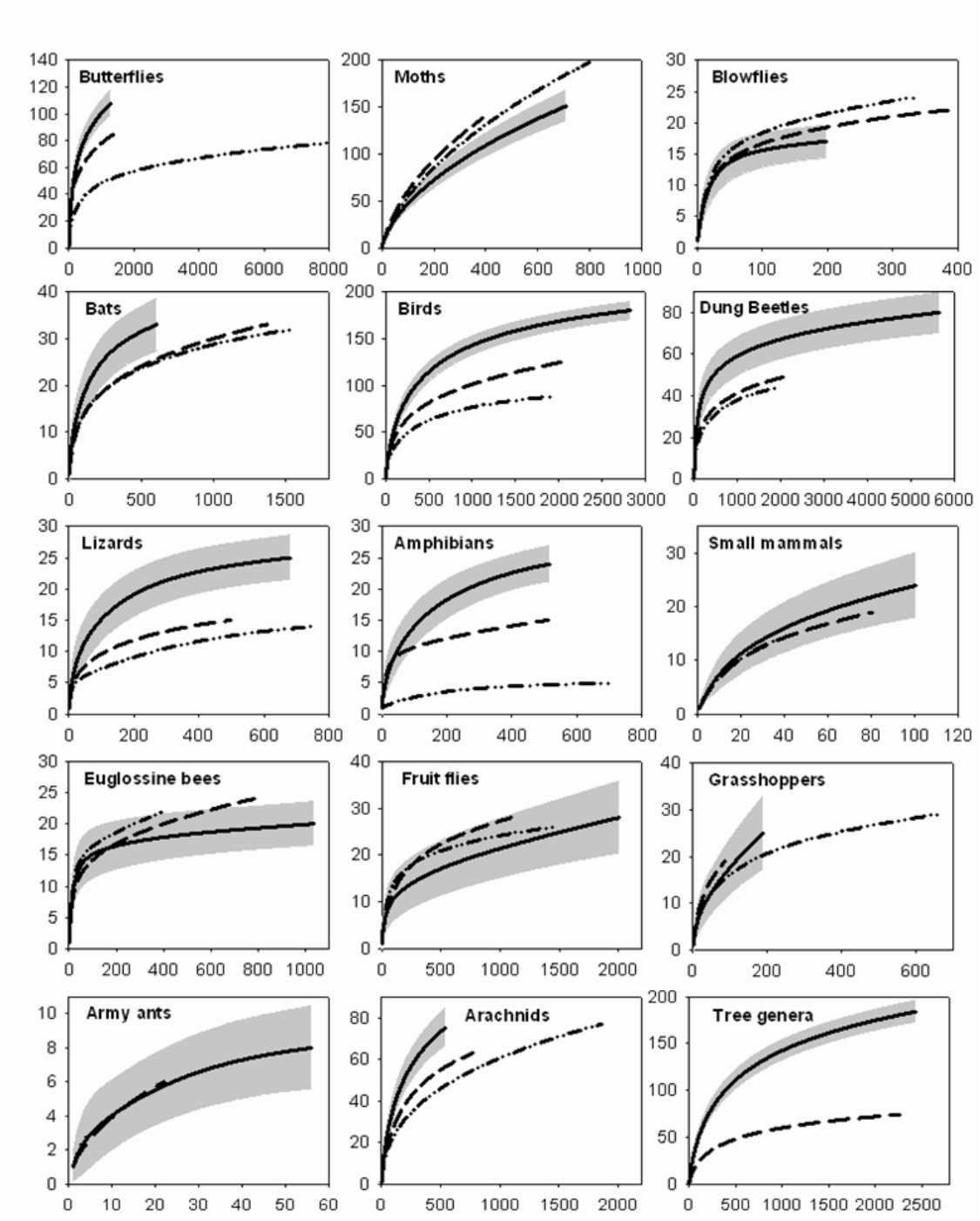

Figure 1. Individual-based species accumulation curves for 15 taxa in primary (smooth lines), secondary (dashed lines) and plantation forests (dash-dotted lines). Grey area shows 95% confidence interval for primary forest.