The Rufford Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Ayesha E. Prasad
Project title	Forest restoration meets community development - converting Lantana camara into fuel briquettes for indigenous communities -
RSG reference	11841-2
Reporting period	November 2014 – December 2016
Amount of grant	4958 GBP
Your email address	ayeshaprasad@gmail.com
Date of this report	13 February 2017

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
Removal of *Lantana* from restoration sites				Freshly cut *Lantana* is heavy and unwieldy, and difficult to haul off site. Therefore, cut above ground *Lantana* was left to dry for a period of at least 10 days, during which time its weight decreased considerably, and its structure wilted down as well. This dried *Lantana* was carried out of restorations plots, using pitchforks, and dumped in 5-10-m wide firelines that border forest management roads. Here it was burned under the supervision of park staff.
Monitoring of native plant recovery				Several delays in the completion of these objectives (see Section 2 for details) resulted in a large gap in our seasonal monitoring data (regeneration could not be monitored between November 2015 and October 2016). However, data on the structure and composition of both native and exotic plants within all 15 plots (Restoration, Invaded and Uninvaded) after 19 months since *Lantana* removal could be collected. These data also reflected the nature of plot recolonisation in the absence of regular weeding of germinating *Lantana*.
Monitoring of *Lantana* recolonisation				

Monitoring of tree growth				This is an ongoing component of the long-term monitoring programme, and will continue to be conducted as long as funds and the required government permits (to work inside a tiger reserve) can be obtained.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

Two major unforeseen setbacks were encountered during the project:

(i) Government permissions to conduct research within a tiger reserve: At the time that the Rufford Small Grant was received, we had valid permissions, issued by the Karnataka Forest Department (KFD) to conduct this work within Bandipur Tiger Reserve (BTR). However, when the time came to conduct the work, local KFD officials denied us entry into BTR, thus preventing us from initiating proposed project activities. Despite several attempts to meet and/or speak with the official(s) concerned, we were unable to discuss this unexpected move by the KFD. It was not until after the concerned official was transferred out of BTR, and replaced, that we were able to take the matter up, and convince the KFD to allow us to resume our work. This entire process took over year, and proposed project activities could be resumed only in November 2016.

Owing to this 12-month delay, important time-sensitive activities (i.e. removing germinating *Lantana* and other exotic plants from plots where they had been uprooted at the start of the experiment, in order to provide native vegetation with the space and resources required to recover) could not be carried out. As a result of not being able to conduct this weeding at 6-month intervals, large amounts of *Lantana* recolonisation occurred in the five restoration plots, and native vegetation recovery was suppressed. Furthermore, the cost (time and effort) associated with re-uprooting *Lantana* from restoration plots recolonised by it (owing to lack of weeding) was too great to re-start the experiment. Consequently, a key objective of this restoration experiment – to monitor native vegetation recovery rates and patterns after the uprooting and subsequent weeding of a major invasive plant – could not be determined. However, despite this failure, important findings vis-à-vis weeding, were made, and are discussed under Section 3 (below).

(ii) Field vehicle mechanical problems: The strict budgets of relatively small grants do not afford research projects the funds to purchase new vehicles. In August 2014, 3 months prior to the start of the Rufford Small Grant project period, a used all-wheel-

drive field vehicle was purchased with support from a previous grant (United States Fish & Wildlife Service – Asian Elephant Conservation Fund). As with any used vehicle purchase, there was a high probability of mechanical problems with the 'new' field vehicle, and within weeks of the purchase, a series of mechanical failures rendered the vehicle temporarily unusable. Furthermore, it resulted in over 22% of total project expenses being spent on vehicle repairs and ongoing maintenance.

3. Briefly describe the three most important outcomes of your project.

(i) The importance of weeding in landscape-scale restoration plans: A key objective of the proposed project was to clarify the role of multi-year follow-up weeding of germinating *Lantana*, in the success of long-term *Lantana* eradication efforts. Therefore, the proposed *Lantana* removal regime included initial uprooting of adult plants followed by biannual weeding of regenerating *Lantana* and other invasive exotic plants (including *Ageratum conyzoides*, *Chromalaena odorata*, and *Parthenium hysterophous*), until native plants had recolonised restoration plots. However, our being denied access to our experiment prevented us from carrying out two rounds of this weeding (November 2015 and May 2016), which was posited as being crucial to the long-term success of such invasive plant eradication and forest restoration programmes. Consequently, the (unplanned) outcome of the project was that all five restoration plots were rapidly overgrown by *Lantana* recolonising from the seed-bank, rendering them (at the end of 12 months of no weeding) almost indistinguishable from control plots, and from themselves at the start of the experiment, before *Lantana* was uprooted.

This failure to achieve an important project objective did, however, provide valuable data on the outcome of *Lantana* eradication programmes that do not include a multi-year weeding component. It provided evidence in support of our initial hypothesis that *Lantana* removal can succeed only when initial uprooting is followed by regular weeding, until such time as the native understory has re-established. Data from re-invaded restoration plots are currently being analysed to determine the exact structure and composition of understory vegetation (both native and exotic) that result from *Lantana* removal efforts that fail to weed for several years. The results of these analyses, together with any publications that may arise from them, will be submitted to The Rufford Foundation as soon as available.

(ii) The cost of restoring 1 ha of heavily-invaded tropical dry deciduous forest: A key objective of the initial landscape-scale restoration project (not funded by this RSG) was to determine the cost and logistics of landscape-scale *Lantana* eradication and forest restoration, in order to provide the relevant authorities (in this case, the KFD) with detailed recommendations on how to implement such a programme. Ongoing weeding and monitoring until the recovery of native understory species to

forests from where they had been displaced by *Lantana* would have provided valuable data on the shortcomings and successes of such a long-term, landscape-scale operation. Unfortunately, we were not able to see the proposed project through to this stage but had to, instead, conclude the experiment in November 2016, by which time restoration plots had been recolonised by *Lantana* and other secondary invasive species, instead of native plants.

Despite this, however, cost-effort data on initial *Lantana* uprooting together with two seasons of subsequent weeding at 6-monthly intervals (November 2014, May 2015) were documented, and should provide important details to be incorporated into the planning of BTR-wide *Lantana* removal and forest restoration protocols. These details will include per hectare costs of equipment and labour associated with uprooting and weeding, as well as potential setbacks and contingencies. Upon completion of the analysis of these data, the detailed final report to the KFD, which will include these details, will also be provided to The Rufford Foundation.

(iii) The impact of *Lantana* invasion on tree communities and carbon storage: The recolonisation of restoration plots by *Lantana* (due to lack of weeding) resulted in the discontinuation of the monitoring of native understory vegetation recovery, because it is known that native plant growth is significantly decreased by high densities of *Lantana*. What is not known, however, is the impact of *Lantana* on canopy vegetation communities (i.e., adult trees).

Another objective of the project was to determine whether *Lantana* invasion, forest fire, and precipitation influence adult tree growth, independently or interactively. In order to achieve this objective, a subset of 606 trees, distributed across the three dominant canopy species of this forest system – *Anogeissus latifolia*, *Tectona grandis*, and *Terminalia tomentosa*, was fitted with stainless steel dendrometer bands, which enable changes in tree girth (a measure of tree growth) to be monitored over time. Dendrobands could not be monitored during the 12-month delay that resulted from our permissions being unofficially revoked, except for once (in January 2016) when the KFD allowed us 10 days within which to collect these data. However, data from a total of five rounds of monitoring (August 2014, November 2014, February 2015, May 2015, August 2015, and January 2016) are currently available, and will be combined with data being collected from ongoing monitoring to provide us with a 'big picture' understanding of forest degradation resulting from major landscape-scale factors such as invasive species, climate-change-related fluctuations in rainfall, and fire.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

Local communities provided the manpower to conduct this project. All field assistants were youth from local indigenous communities, whose traditional ecological knowledge, forest skills, and knowledge of the local flora were critical to project success. They assisted in: (a) planning the logistics and layout of the overall restoration and monitoring project, (b) all subsequent data collection, (c) the creation and maintenance of experimental plots, and (d) weeding of germinating *Lantana* and other invasive exotic plants.

Although the project did not directly benefit any local communities, the employment provided by the project since 2014 (and ongoing) has benefited all local families involved. We also believe that the long-term outcomes of the project will include greater benefit to local communities by way of employment in BTR-wide *Lantana* eradication and forest restoration activities, if implemented correctly.

5. Are there any plans to continue this work?

Yes – there are two ways in which this work may be continued:

(i) Ongoing monitoring of tree growth — as long as the KFD allows us to continue monitoring, and we are able to raise the funding required to do so. This long-term monitoring will provide valuable information on rates and patterns of forest degradation and carbon storage in this tropical dry forest which is not only an endangered forest type but also a globally valued wildlife conservation landscape.

(ii) Landscape-scale forest restoration plan — as soon as the data from the first 3 years of the project (2014-16), particularly with respect to *Lantana* recolonisation and native species recovery, are analysed we will submit a detailed restoration plan to the government. We also plan to: (a) provide the KFD with the scientific expertise required to implement the plan, including ongoing consultancy, (b) contribute to the design and implementation of monitoring protocols, and (c) assist in the analysis of monitoring data to evaluate the restoration success.

6. How do you plan to share the results of your work with others?

Report to KFD — the primary deliverable of this project will be a detailed report submitted to the KFD describing the following:

- Priority sites for implementing forest restoration based on a variety of factors including level of *Lantana* invasion, proximity to a water source, proximity to

roads, fire history, and proximity to uninvaded forest from where seeds of native plants can disperse to recolonise restored areas.

- Intra- and inter-annual timelines for the implementation of various restoration activities including cutting *Lantana*, removing the rootstock, weeding regenerating exotic plants, maintaining firebreaks around restoration sites, and possibly seeding restoration sites with native seed.
- Cost and effort associated with carrying out various restoration activities
- Details of potential setbacks, failures, and contingencies.
- Options for the off-site disposal of cleared Lantana

Peer-reviewed publications — the results of the experiment thus far will also be published in peer-reviewed journals where lessons learned from this project can be made accessible to other forest restoration efforts, involving invasive plant eradication, globally.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

The actual length of the restoration project is variable and long-term, depending on the availability of funds, and support from the government, by way of permissions to conduct this work within a tiger Reserve. The funding provided by this grant supported this long-term project for a period of 23 months (November 2014 – December 2016), during which one aspect of the project (the effect of *Lantana* removal with/without weeding on native understory plant recovery) was concluded, and a second aspect (tree growth in response to landscape-scale factors) was monitored.

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Salaries & Wages	1897.96	3047.15	-1149.19	Vegetation recovery monitoring required teams of 4-5 field assistants spending 6-8 weeks in the field for each round of monitoring & plot

				maintenance
Per diem expenses for field team	0	125.94	-125.94	Food for research assistants stationed at the field station during rounds of field work
Local travel & transportation	0	189.84	-189.84	
Field vehicle maintenance	0	1065.77	-1065.77	See Section 2 (ii)
Field vehicle fuel	0	237.05	-237.05	
Field supplies & Utilities	0	86.89	-86.89	Electricity & household supplies for field station
Shredding machine	1530.61	0	1530.61	Not purchased
Briquetting machine	1530.61	0	1530.61	Not purchased
TOTAL	**4959.18**	**4752.64**	**206.54**	

Although the revised project proposal (The restoration and monitoring of important wildlife habitats in southern India impacted by *Lantana* camara invasion) was approved, the grant amount disbursed to us (£4,959) reflected the budget that accompanied the original proposal (Forest restoration meets community development - converting *Lantana camara* into fuel briquettes for indigenous communities). Therefore, the budgeted expenditure shown in the table below is that derived from the original approved budget of £4,959. Please note that, because the project itself was modified, the actual expenditure heads vary considerably from those provided in the proposed budget, but is in accordance with project activities as expected under the revised proposal. The amounts budgeted for purchase of briquetting and shredding machines, totalling £3061.22, were spent mainly on field vehicle maintenance, fuel, and per diem expenses for the field team.

9. Looking ahead, what do you feel are the important next steps?

We believe that the most important steps are the plans stated in Section 5, and described below:

The first major 'next step' is to use our monitoring data to 'convince' the KFD to implement *Lantana* eradication protocols that incorporate the following crucial considerations:

- Location of restoration sites: Prioritise both heavily- and lightly-invaded areas for *Lantana* eradication and forest restoration.

- Heavily-invaded forest — by restoring heavily-invaded sites, forests experiencing the greatest impact from *Lantana* invasion may recover their native plant and animal species. Heavily-invaded patches are also an important *Lantana* seed source from which surrounding forest may continuously be recolonised. Therefore, restoring these patches will also reduce the amount of *Lantana* seed-rain arising from them.
- Lightly-invaded patches — Owing to the low levels of *Lantana* present in these patches, the costs associated with restoring them are expected to be relatively low. Consequently, the invasion can be stopped and reversed before it reaches levels where the costs of eradicating *Lantana* and assisting native vegetation recovery are extremely high. Further, in lightly-invaded patches, the proportion of native plants to *Lantana* is relatively high, thus resulting in faster native species recovery following *Lantana* removal.

Also, prioritise invaded patches in the vicinity of water bodies in order to improve habitat quality for wildlife (such that both forage-rich habitat and water sources are available within close proximity).

- *Lantana* removal
  - Cut above-ground *Lantana* and leave to dry for 10-14 days in order to facilitate the removal of cut *Lantana* off site (fresh *Lantana* is over 5 times as heavy as dry *Lantana*).
  - Cut and dry *Lantana* on-site in such a way that the uprooting phase may be conducted at the onset of the rain (it is far easier to uproot *Lantana* from wet/damp soil than dry soil).

- Weeding: Uproot seedlings of *Lantana* and other invasive exotic plants every 4-6 months until the understory resembles that of uninvaded forest (in structure and composition).
- Restoration site maintenance: Clear and maintain firebreaks within and surrounding restoration sites until a few years after the native understory is re-established. Fires can damage the recovering understory enough to allow *Lantana* to re-invade.
- Monitoring: Quantify the abundance and composition of recovering vegetation twice a year for the first 3-5 years, and annually thereafter for the next 5 years.

Ongoing monitoring of tree growth

Continue to monitor tree growth using dendrometer bands for as long as possible, in order to better understand long-term trends in tropical forest carbon storage and

forest degradation under the influence of disturbances such as exotic plant invasion, fire, and climate change.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

No, we did not use The Rufford Foundation logo in any materials produced in relation to this project.

No, the RSGF did not receive any publicity during the course of our work. However, any reports or publications that might result from this project will acknowledge support from The Rufford Foundation.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

12. Any other comments?

None at this time.