

CEPF SMALL GRANT FINAL PROJECT COMPLETION REPORT

Organization Legal Name:	Nature Conservation Foundation
Project Title:	Identification of critical crossing points of animals along the road in and around Anamalai Tiger Reserve and to suggest relevant mitigation measures to minimize road mortality.
Date of Report:	
Report Author and Contact Information	Dr. Jeganathan. P

CEPF Region: Western Ghats (Anamalai Corridor)

Strategic Direction:

CEPF Strategic Directions 1 - Enable action by diverse communities and partnerships to ensure conservation of key biodiversity areas and enhance connectivity in the corridors.

Grant Amount: \$ 17,532

Project Dates: April 2011 to June 2012

Implementation Partners for this Project (please explain the level of involvement for each partner):

Tamil Nadu Forest Department (TNFD)

TNFD gave us necessary permission to conduct this study in Anamalai Tiger Reserve and in Valparai plateau. They have also implemented certain recommendations based on this study results through Tamil Nadu Highways Department such as construction of speed breakers in the Anamalai Tiger Reserve (ATR).

Tamil Nadu Highways Department (TNHD)

TNHD was a stakeholder for targeted outreach and discussions on issues related to wildlife, and maintenance. They also implemented some of the recommendations based on this study results.

Private Tea Plantation companies

Private Plantation companies in Valparai Plateau gave us necessary permissions to install canopy bridges in the rainforest fragments which falls under their property. They also facilitate us to sensitize their workers on the impact of the roads on the wildlife in ATR and surrounding region.

Conservation Impacts

Please explain/describe how your project has contributed to the implementation of the CEPF ecosystem profile.

This study contributed to the CEPF ecosystem profile mainly by two ways:

1. The results from this work enabled the Forest, highways and departments to focus their implementation on the priority sites for the protection of threatened fauna (eg Lion-tailed macaque *Macaca silenus*, Nilgiri langur *Trachypithecus johnii*, Sambar *Rusa unicolor*, and endemic amphibian and reptiles of the Western Ghats).

2. Collected scientific information has been shared with the Forest and Highways departments as well as private plantation owners by means of formal and informal interactions to implement the recommendations to minimize the road mortality of the threatened fauna in and around Anamalai Tiger Reserve.

Please summarize the overall results/impact of your project against the expected results detailed in the approved proposal.

Estimation of the road mortality in and around Anamalai Tiger Reserve

The survey of wildlife mortality due to roadkill was carried out in Anamalai Tiger Reserve and in parts of the Valparai Plateau where the roads has been improved in recent years to reach certain tourist points. Roadkills were surveyed along eleven road transects of 4 km to 13 km length (average = 7.2 km, total length 80.2 km, Table 1, Figure 1 in Annexure 1). Overall, 204 transect surveys were walked (including repeats). Each transect was walked between 9 – 13 times during each of two seasons: monsoon (June – December 2011) and summer (March – June 2012). Roadkills were identified up to the species level in the case of mammals and birds. For amphibians and reptiles, some of the kills were damaged especially during monsoon and it was difficult to ascertain even up to the genus. Such records were categorized as either up to the group level or categorised as unidentified. Invertebrates were recorded up to the Phylum level. Habitat on the either side of the roadkill location was also noted.

Total distance surveyed along the 11 road transects was 1473.4 km, including 838.5 km during June – December 2011 and 634.9 km during March – June 2012. The total number of roadkills recorded was 2969 (monsoon = 2217 and summer = 752). Apart from these 58 roadkills were also opportunistically recorded in different locations during field visits until May 2013. However, this data was not included for the analysis. In total there are 3027 roadkills were recorded (Table 2 in Annexure 1).

Roadkill rate on these roads averaged 20.1 kills/10 km. Amphibians were the dominant class of roadkills (8.8/10 km, n = 1307), followed by invertebrates and unidentified taxa (7.2/10 km, n = 1066), reptiles (2.9/10 km, n = 438), mammals (1.0/10 km, n = 148), and birds (0.06/10 km, n = 10).

Amphibians constitute a higher percentage among roadkills followed by invertebrates. Among amphibians, 93% (n = 1220) of the roadkills recorded were frogs and toads, followed by caecilians 7% (n = 87). In the case of reptiles, more than 80% were snakes, of which 33.6% (n = 147) were shieldtails (uropeltids). Among birds, Red-whiskered Bulbul *Pycnonotus jocosus* was represented by 40 % (n = 4) of the 10 bird roadkills recorded. Among mammals, of the roadkills recorded (n = 148), murids and insectivores comprised 81.1% which includes unidentified mice, rats, and shrews. Other significant mammal roadkills recorded during the transect survey were Western Ghats striped squirrel *Funambulus tristriatus* (n = 8), unidentified bat species (n = 7), Indian porcupine *Hystrix indica* (n = 5), black-naped hare *Lepus nigricollis* (n = 2), bonnet macaque *Macaca radiata* (n = 2) and brown palm civet *Paradoxurus jerdoni* (n = 1). Invertebrates and other unidentified organisms were 35.9% of the total roadkills recorded, of which molluscs (snails and slugs) were most frequent (34.1% n = 364), followed by diplopods (millipedes and pill millipedes) 25.9% (n = 276), and annelids (earthworms) 20.6% (n = 220). The remainder of the roadkills were insects 12.2%, centipedes 3.8%, arachnids (scorpions and spiders) 1.6%, crabs 1.5%, and other unidentified organisms 0.2%.

Other significant roadkills recorded during other field visits between June 2011 and May 2013 in this region were Indian Rock Python *Python molurus* (2), Barking Deer *Muntiacus muntjak* (1), Indian chevrotain (mouse deer) *Moschiola meminna* (1), Sambar

Rusa unicolor (1), Indian giant squirrel *Ratufa indica* (1), Common palm civet *Paradoxurus hermaphroditus* (2), Small Indian civet *Viverricula indica* (1), and Lion-tailed Macaque *Macaca silenus* (2).

Additional analyses to identify roadkill hotspots and spatial and seasonal patterns of roadkill mortality across transects were carried out and these will be presented in scientific and technical publications to be submitted to peer-reviewed journals. A short report with key results and recommendations was already submitted to Tamil Nadu Forest Department (Annexure 6).

Mapping the canopy contiguity & gaps along forest roads in and around Anamalai Tiger Reserve

Canopy contiguity is an important habitat attribute for endangered and endemic diurnal arboreal mammals such as the lion-tailed macaque and Nilgiri langur in Anamalai Tiger Reserve. Canopy contiguity and gaps were mapped to identify the critical crossing points available and to better understand status of the canopy connectivity and canopy architecture along the forest roads.

The presence and absence of canopy overhead was noted at every c. 25 m along the forest road transects. Gap width, canopy overlap, and vertical separation of the canopy were visually estimated. Ranks given for the canopy overlap and vertical separation are as follows: 0 – Open, 1 – Barely touching, 2 – Significant overlap, 3 – Considerable overlap with sky obscured. Habitat by the side of the road was also recorded.

Maps produced based on this information are in Annexure 2. These maps will be important as it will help the Forest Department and private plantation owners to concentrate their effort to implement the mitigation measure in critical crossing points of endemic and endangered fauna. It should be noted that the map produced based on the canopy contiguity is also a map for the critical crossing points for the arboreal mammals in this region. We are at the moment in the process of doing the analysis to figure out in which particular location the roadkills are clumped (which can be inferred as the critical crossing points for the terrestrial fauna). This will be published in our scientific papers which are under preparation.

Result dissemination, implementation and public awareness

Through formal meetings and informal interaction with Forest and Highways departments, private plantation owners and staff, and the general public, the results of this study has been disseminated. Blogs and newspaper articles on the impacts of the roads on the wildlife were published (see Annexure 3). As our team is permanently based in this region and conducting long term research on various aspects on rainforest wildlife and conservation issues it is intended to produce few more popular science write-ups, brochures in the future based on this study results both in English and vernacular Tamil. These outputs will be uploaded on our website and blogs as well as shared with Western Ghats Portal team. We are planning to submit two manuscripts in the open access scientific journals and it is under preparation.

Canopy bridges

One of the major outputs from this study is the installation of 5 canopy bridges for the arboreal mammals in two rainforest fragments in this region. It should be noted that there were already two bridges installed in Puthuthotam rainforest fragment on a trial basis. In addition to that four canopy bridges in Puthuthotam and one in Varattuparai fragments were installed at locations where Lion-tailed macaques, Nilgiri Langurs, and Indian Giant Squirrel were frequently observed crossing and where natural tree canopy connectivity was absent or low. It was observed that many of the bridges were used by these arboreal mammals soon after the installation (see photos in Annexure 4). These bridges were made up of fire hose and there were on average 15 – 20 m long. Locations of these bridges were selected after careful observation of critical crossing points of these arboreal mammals on the road stretch where the canopy connectivity was broken due to wider road. We are also planning to evaluate the efficacy of the canopy bridges soon.

As a part of the ongoing conservation education activities we conducted a public awareness campaign with National Green Corps students of Beula Matriculation School, Valparai. In this program (conducted on 7 March 2012), students walked from Valparai to Attakatti to raise awareness on various ecological and conservation issues in Anamalai Tiger Reserve, including importance of safe and responsible driving in forested roads, adverse effects of using plastic bags and bottles. During this 28 km walk, students stopped in many places on the way to interact with local people, tourists, and vehicle drivers to explain to them about the issues mentioned above (see photos in Annexure 4). Students were taught in the field about the importance of canopy contiguity for the arboreal mammals, adverse affects of feeding Bonnet Macaques and how to be a responsible tourist.

Please provide the following information where relevant:

Hectares Protected: Around 400-500 ha. This was calculated based on the length of transects surveyed (about 80 km and 25 meters either side) which gives around 400 ha. In additions to that approximate area of two rainforest fragments where the canopy bridges installed are about 100 ha.

Species Conserved: Several endangered and endemic flora and fauna occur in this region such as lion-tailed macaques, nilgiri langurs and Indian giant squirrel.

Corridors Created: As mentioned earlier there are 7 locations where we have installed canopy bridges for the arboreal mammal's movement (Two canopy bridges were installed earlier much before this project starts). Maps and location details were given in Annexure 5.

Describe the success or challenges of the project toward achieving its short-term and long-term impact objectives.

Prior to this study, we had conducted a meeting with Highways, Forest and Electricity departments in November 2009 mainly to discuss on the impacts of the linear intrusions in the forested areas. We followed up our discussion with the Highways and Forest Department thorough formal and informal meetings during this project period. This continued engagement resulted in change in their attitude (especially Highways Department) towards construction of the structures along the road. Prior to our

interactions, the Highways Department generally preferred to construct long, raised side walls (parapets) along the forest road without any gaps in-between, which therefore hindered the movements of the terrestrial fauna (such as small mammals, porcupine, ungulates, reptiles, and amphibians). However after our suggestion to consider using the crash-guards that allow the terrestrial fauna to pass through (see photo in Annexure 4), in recent times the Highways Department has implemented this in many places in and around Anamalai Tiger Reserve. As for the challenges, we are still unable to stop the indiscriminate slashing of the road side vegetation (including rainforest tree saplings). This we are hoping that will with continuous sensitization in a longer run.

In March 2013, Highways Department has constructed 12 speed breakers in about 3 km road stretch passing through the Anamalai Tiger Reserve (from Monkey Falls to Azhiyar check post, see Annexure 6). Species such as Slender Loris, Elephants, Sambar Deer were seen frequently crossing this particular stretch. On one occasion (end of December 2011) a Sambar and a Common Palm Civet were killed on this road and we alerted the Highways and the Forest Departments on this and requested them to construct speed-calming measures in this stretch. Tamil Nadu Forest Department asked the Highways Department to construct speed breakers and 12 were installed in 2013.

However, in May 2013 prior to the summer festival in Valparai, local stakeholders felt there were too many speed breakers in a short stretch and therefore 5 of them were removed. We could consider deployment of the speed breakers in this stretch as a positive outcome or an impact. However, the removal of a few shows the need for better planning and engagement with the concerned officials to implement various mitigation measures.

We were unable to conduct the rapid assessment of the vehicular traffic in this region as planned. This work was started and we did conduct this survey for few days but unable to continue do due to lack of man power and other field logistic constrains. However, Anamalai Tiger Reserve authorities are maintaining the register (from three check posts) of the number of vehicles passing through the protected area. This will give us an idea of amount of vehicular traffic in this region. We intended to use this information for our papers and reports we publish.

Were there any unexpected impacts (positive or negative)?

There were no unexpected positive or negative impact.

Lessons Learned

Describe any lessons learned during the design and implementation of the project, as well as any related to organizational development and capacity building. Consider lessons that would inform projects designed or implemented by your organization or others, as well as lessons that might be considered by the global conservation community.

While certain studies on roadkills in this region and elsewhere suggested several measures, very few have implemented them on the ground, whereas, this project initiated and implemented certain mitigation measures. One limitation was that we could only suggest measures, as only government departments are authorised in implementing the measures. To achieve this it is essential to engage the stakeholders (Forest Department, Highways Department) though long-term advocacy and sensitization. Implementing every identified measure is not possible in short-term period as this involves greater coordination between several government departments, private land owners in this region and hence it is a time consuming process. The knowledge

gained from the study, once it is passed on to appropriate stakeholder would certainly takes time to percolate into the system. However, with the continuous engagement it is possible to change the attitude of the stakeholders towards making the wildlife friendly roads in forested region.

Project Design Process: (aspects of the project design that contributed to its success/shortcomings)

One major shortcoming of this study was delay in getting necessary research permission to conduct study in various parts of the Anamalai Tiger Reserve. It was originally planned to conduct the survey on roads that go through Topslip and Udumalpet region within Anamalai Tiger Reserve, but it was not possible during this study period due to lack of the necessary permission. Although we informally met and discussed to implement certain mitigation measures to the Highways Department officials, it was not possible to bring all the major stakeholders (Tamil Nadu Forest Department and Plantation owners) into a common meeting during the project period to have a dialogue on the road-related issues in this region.

Project Implementation: (aspects of the project execution that contributed to its success/shortcomings)

The long-term research conducted and the continuous presence in this region by the team was an advantage in implementation of some of the mitigation measures based on this project results. For instance, the knowledge of the critical movement of various fauna was gained over the time was useful in suggesting and implementing certain measures (such as speed breakers and canopy bridges). Our ongoing conservation education program and the long term engagement with the private plantation companies were helpful in disseminating the project results to various stakeholders in this region.

Other lessons learned relevant to conservation community:

It is essential to have long term engagement with the stakeholders especially with the Highways Department to achieve wildlife friendly roads in forested region. In this project, we have identified certain critical crossing points of arboreal mammals and constructed canopy bridges. We have also seen certain change in making roadside structures (from continuous parapets walls to crash-guards) by the Highways Department. However, it should be noted that having canopy bridges is only an engineering solution and this is not an ecological solution. It is essential to for the conservation community to push for sustainable ecological solutions (such as suggesting not to cut the trees while road widening, not to slash the natural vegetation – ferns and impatiens – by the side of the road) than the engineering solutions.

ADDITIONAL FUNDING

Provide details of any additional donors who supported this project and any funding secured for the project as a result of the CEPF grant or success of the project.

Donor	Type of Funding*	Amount	Notes
Nature Conservation Foundation	A	INR 180000	Partial salary support for project scientist.

***Additional funding should be reported using the following categories:**

- A** *Project co-financing (Other donors contribute to the direct costs of this CEPF project)*
- B** *Grantee and Partner leveraging (Other donors contribute to your organization or a partner organization as a direct result of successes with this CEPF project.)*
- C** *Regional/Portfolio leveraging (Other donors make large investments in a region because of CEPF investment or successes related to this project.)*

Sustainability/Replicability

Summarize the success or challenge in achieving planned sustainability or replicability of project components or results.

This project was carried out by NCF rainforest research station permanently based at Valparai, Anamalai Tiger Reserve. The research team will be and are following it up regularly through formal and informal meetings with the local stakeholders in implementing the mitigation measure based on this project finding. The project team members are intend to continue to work on impact of linear intrusions on the forested region. Based on our observation and from this study results we have recommended several measure to the Tamil Nadu Forest Department and to the Tamil Nadu Highways Department (Annexure 6). These suggestions were included in the Anamalai Tiger Reserve management plan. In addition, the canopy bridges installed here can be easily replicated in other locations in the Western Ghats, if required.

Summarize any unplanned sustainability or replicability achieved.

No unplanned achievement to note here

Safeguard Policy Assessment

Provide a summary of the implementation of any required action toward the environmental and social safeguard policies within the project.

No action required towards the environmental and social safeguard policies

Performance Tracking Report Addendum

CEPF Global Targets

(Enter Grant Term)

Provide a numerical amount and brief description of the results achieved by your grant.
Please respond to only those questions that are relevant to your project.

Project Results	Is this question relevant?	If yes, provide your numerical response for results achieved during the annual period.	Provide your numerical response for project from inception of CEPF support to date.	Describe the principal results achieved from July 1, 2007 to June 30, 2008. (Attach annexes if necessary)
1. Did your project strengthen management of a protected area guided by a sustainable management plan? Please indicate number of hectares improved.	Yes	About 200 to 300 ha		Please also include name of the protected area(s). If more than one, please include the number of hectares strengthened for each one. Anamalai Tiger Reserve
2. How many hectares of new and/or expanded protected areas did your project help establish through a legal declaration or community agreement?	Yes	About 200 to 300 ha		Please also include name of the protected area. If more than one, please include the number of hectares strengthened for each one. Anamalai Tiger Reserve
3. Did your project strengthen biodiversity conservation and/or natural resources management inside a key biodiversity area identified in the CEPF ecosystem profile? If so, please indicate how many hectares.	Yes	100 to 200 ha		Valparai plateau
4. Did your project effectively introduce or strengthen biodiversity conservation in management practices outside protected areas? If so, please indicate how many hectares.	No			
5. If your project promotes the sustainable use of natural resources, how many local communities accrued tangible socioeconomic benefits? Please complete Table 1 below.	No			

If you answered yes to question 5, please complete the following table.

Table 1. Socioeconomic Benefits to Target Communities

Please complete this table if your project provided concrete socioeconomic benefits to local communities. List the name of each community in column one. In the subsequent columns under **Community Characteristics** and **Nature of Socioeconomic Benefit**, place an X in all relevant boxes. In the bottom row, provide the totals of the Xs for each column.

Name of Community	Community Characteristics							Nature of Socioeconomic Benefit												
	Small landowners	Subsistence economy	Indigenous/ ethnic peoples	Pastoralists/nomadic peoples	Recent migrants	Urban communities	Communities falling below the poverty rate	Other	Increased Income due to:			Increased food security due to the adoption of sustainable fishing, hunting, or agricultural practices	More secure access to water resources	Improved tenure in land or other natural resource due to titling, reduction of colonization, etc.	Reduced risk of natural disasters (fires, landslides, flooding, etc)	More secure sources of energy	Increased access to public services, such as education, health, or credit	Improved use of traditional knowledge for environmental management	More participatory decision-making due to strengthened civil society and governance.	Other
									Adoption of sustainable natural resources management practices	Ecotourism revenues	Park management activities									
Total																				

If you marked "Other", please provide detail on the nature of the Community Characteristic and Socioeconomic Benefit:

Additional Comments/Recommendations

No additional comments

Information Sharing and CEPF Policy

CEPF is committed to transparent operations and to helping civil society groups share experiences, lessons learned, and results. Final project completion reports are made available on our Web site, www.cepf.net, and publicized in our newsletter and other communications.

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Annexure details

Annexure 1

Table 1 Details of sampling sites and efforts of roadkill survey conducted in and around Anamalai Tiger Reserve in 2011 and 2012.

Figure 1 Map showing the transect locations in and around Anamalai Tiger Reserve and Valparai plateau (light green) with rainforest fragments (dark green). Numbers given beside transects corresponds to the names given in Table 1.

Table 2 List of fauna recorded as a roadkill during June 2011 to June 2013. Numbers given within brackets indicates roadkills recorded during non survey period.

Annexure 2

Maps of canopy overhead recorded along 11 transects in and around Anamalai Tiger Reserve shown. Details of transects are given in Table 1 (Annexure 1).

Annexure 3

List of newspaper articles, blog post published and talks given on road related issues.

Annexure 4

Photographs showing various activities and results from this project.

Annexure 5

Map 1 showing the canopy bridge locations in Puthuthotam Rainforest fragment.

Map 2 showing the canopy bridge location in Varatuparai Rainforest fragment.

Annexure 6

List of recommendations given for the Anamalai Tiger Reserve Management plan

Annexure 1. Table.1 Details of sampling sites and efforts of roadkill survey conducted in and around Anamalai Tiger Reserve in 2011 and 2012.

Name of the Transect	Length (Km)	Monsoon				Summer			
		Start date	Finished	Total walks	Total km walked	Start date	Finished	Total walks	Total km walked
1 - Aziyar	5.1	04-11-2011	15-12-2011	10	51	23-05-2012	20-06-2012	8	40.8
2 - Attakatti	6.7	03-11-2011	17-12-2011	11	73.7	22-05-2012	13-06-2012	8	53.6
3 - Waterfalls	5.2	02-11-2011	16-12-2011	11	57.2	21-05-2012	18-06-2012	8	41.6
4 - Waverly	8.5	16-08-2011	31-10-2011	10	85	19-05-2012	30-06-2012	8	68
5 - Balaji Temple	6.7	15-06-2011	22-10-2011	12	80.4	20-03-2012	10-05-2012	7	46.9
6 - Puthuthotam	3.7	13-06-2011	12-10-2011	13	48.1	06-03-2012	20-05-2012	8	29.6
7 - Tatafinley	6.1	12-08-2011	30-10-2011	10	61	10-03-2012	14-05-2012	8	48.8
8 - Sholayar	12.9	19-08-2011	29-10-2011	10	129	09-03-2012	23-05-2012	8	103.2
9 - Nallamudi Poonjolai	9.3	16-06-2011	23-10-2011	11	102.3	18-03-2012	22-05-2012	8	74.4
10 - Neerar Dam	9.2	17-08-2011	25-09-2011	9	82.8	17-03-2012	24-05-2012	8	73.6
11 - Chinnakallar	6.8	15-08-2011	01-11-2011	10	68	16-03-2012	24-05-2012	8	54.4
Total	80.2			117	838.5			87	634.9

Figure 1 Map showing the transect locations in and around Anamalai Tiger Reserve and Valparai plateau (light green) with rainforest fragments (dark green). Numbers given beside transects corresponds to the names given in Table 1.

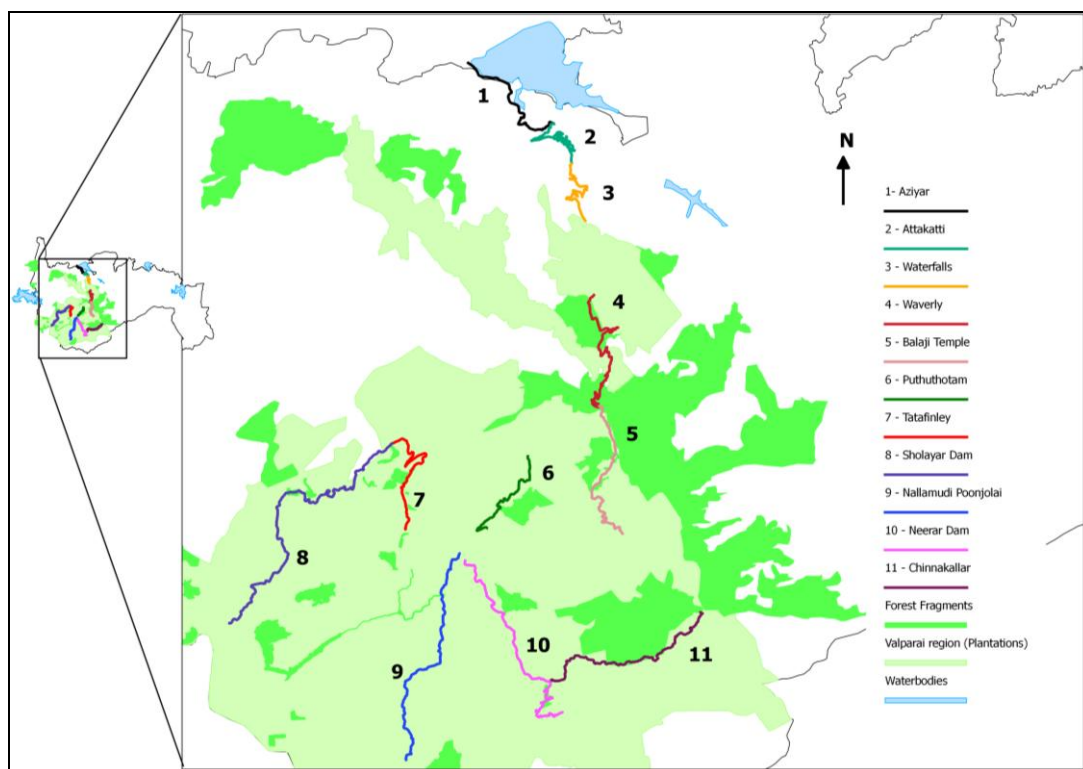
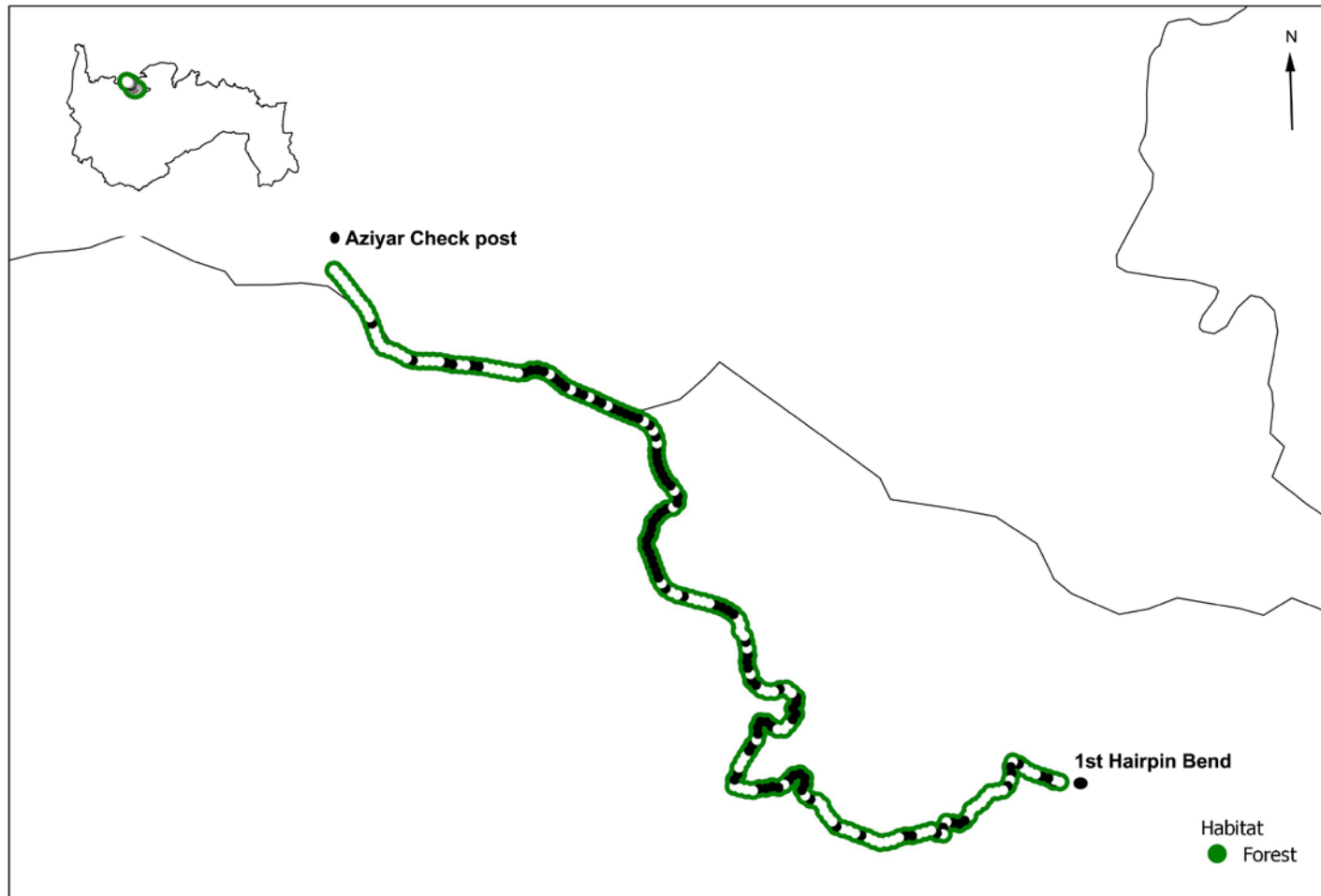


Table 2. List of fauna recorded as a roadkill during June 2011 to June 2013. Numbers given within brackets indicates roadkills recorded during non survey period.

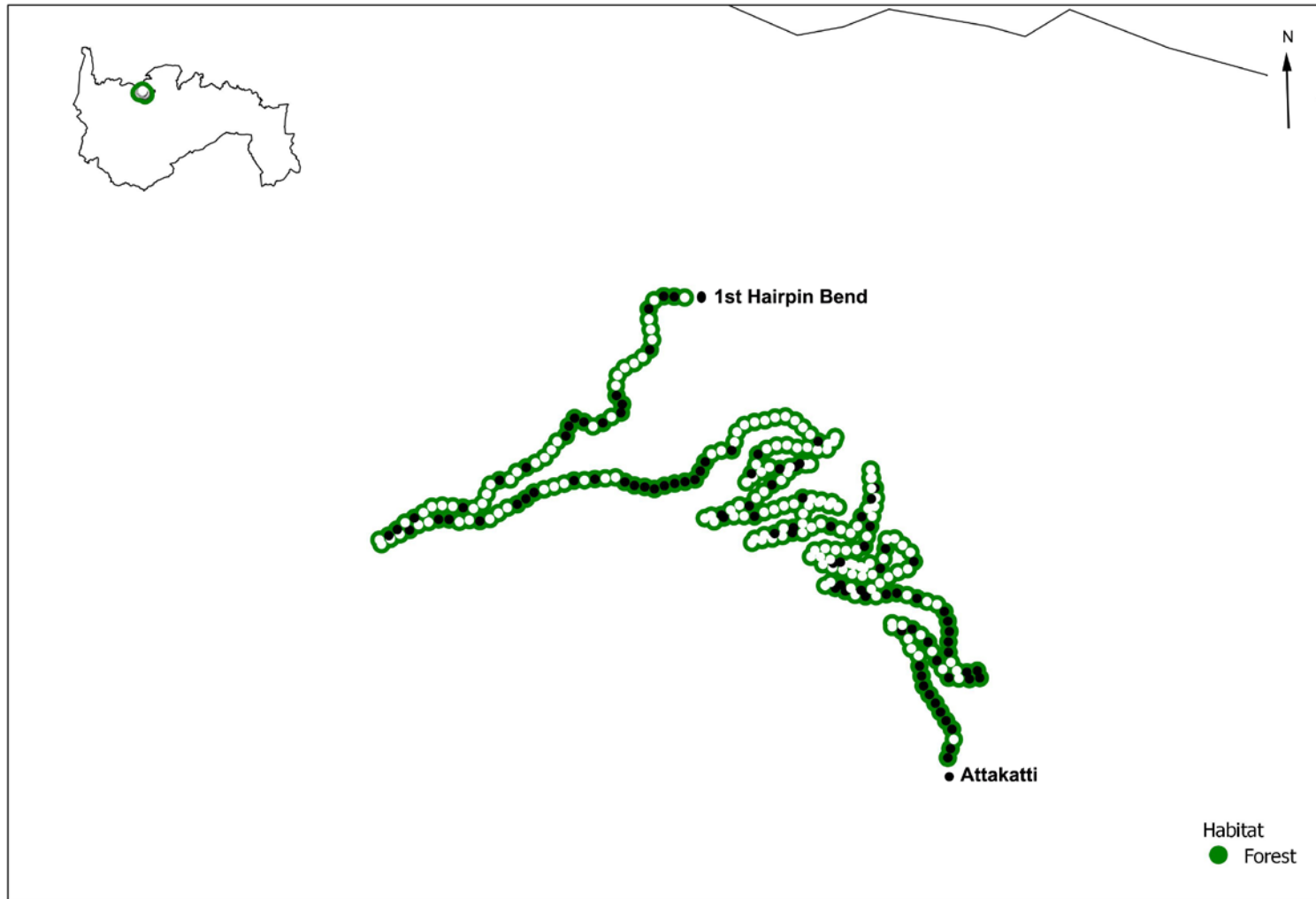
Group	Group/Species	Individuals from transect (others)
Annelids		
	Earthworms	220
Arthropods		
	Scorpions	9
	Spiders	8
	Centipedes	41
	Millipedes	225
	Pill millipedes	51
	Crabs	16
	Beetles	7
	Butterflies	13
	Caterpillars	13
	Cockroaches	6(1)
	Crickets	2
	Damselfly	1
	Glow worms	24
	Grasshoppers	31
	Unidentified insects	15
	Moths	4
	Praying mantis	9
	Stick insects	4
	Wasp	1
	Cicada	0(1)
Molluscs		
	Slugs	28
	Snails	336(7)
Amphibians		
	Caecilians	87(2)
	Frogs	744(5)
	Frog/Toad	10
	Toads	466(8)
Reptiles		
	Agamids	1
	Calotes spp.	38(2)
	Geckos	3
	Shieldtails	147(2)
	Skinks	39(4)

	Snakes	210(4)
	Indian Rock python	0(1)
Birds		
	Red-vented Bulbul	1
	Red-whiskered Bulbul	4
	Indian Scimitar Babbler	1
	Unidentified birds	3
	White-throated Kingfisher	1
	Greater Coucal	0(1)
	Nightjar sp.	0(1)
	Spotted Dove	0(1)
Mammals		
	Bat spp.	7
	Black-naped Hare	2
	Mouse	102
	Rat	11(2)
	Shrew	7
	Indian Porcupine	5(1)
	Barking Deer	0(1)
	Sambar deer	0(1)
	Mouse Deer	0(1)
	Indian Palm Squirrel	3
	Western Ghats Squirrel	8(5)
	Indian Giant Squirrel	0(1)
	Small Indian Civet	0(1)
	Common Palm Civet	0(2)
	Brown Palm Civet	1
	Bonnet Macaque	2(1)
	Lion-tailed Macaque	0(2)
Unidentified		
	Unidentified	2
Total		2969 (58)

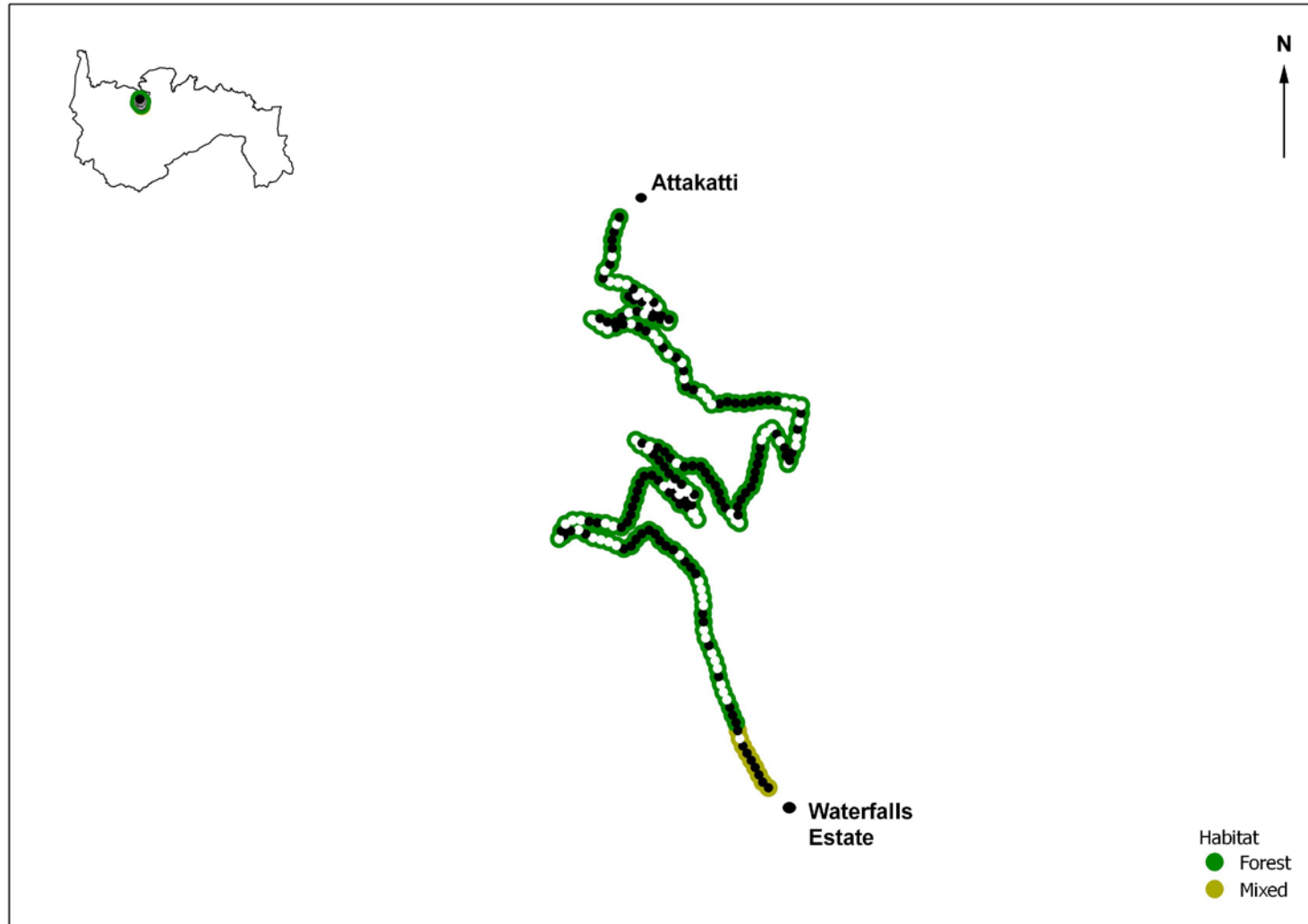
Annexure 2: Maps of canopy overhead recorded along 11 transects in and around Anamalai Tiger Reserve shown. These are also the maps for the critical crossing points for the arboreal mammals of this region. Details of transects are given in Table 1 (Annexure 1). Note that Transects No. 8 & 9 were not given here as they pass through Tea where there are no canopy overhead.



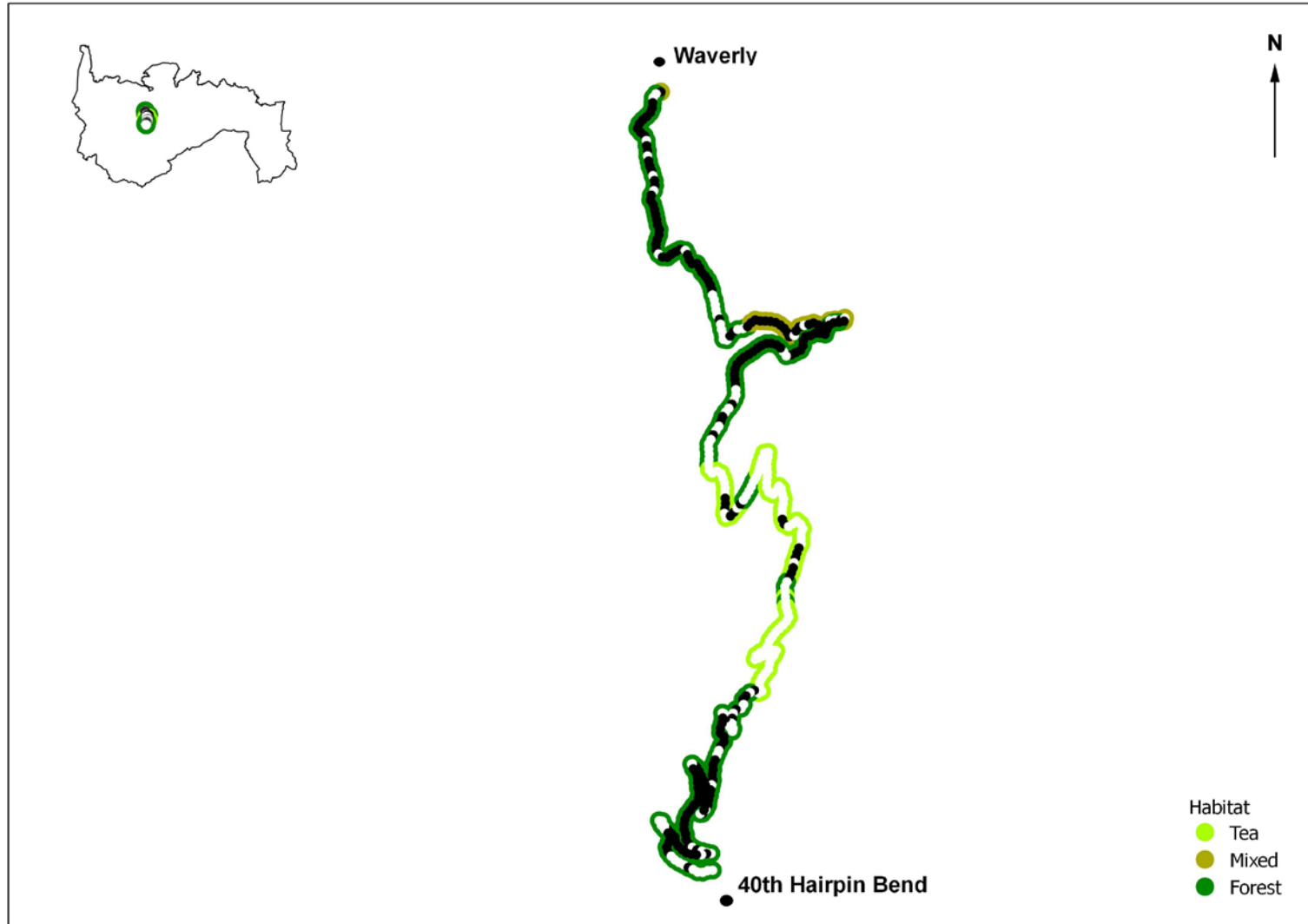
Map 1 showing the presence (filled in black) and absence (filled in white) of the canopy over 1-Aziyar transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (Map not to scale).



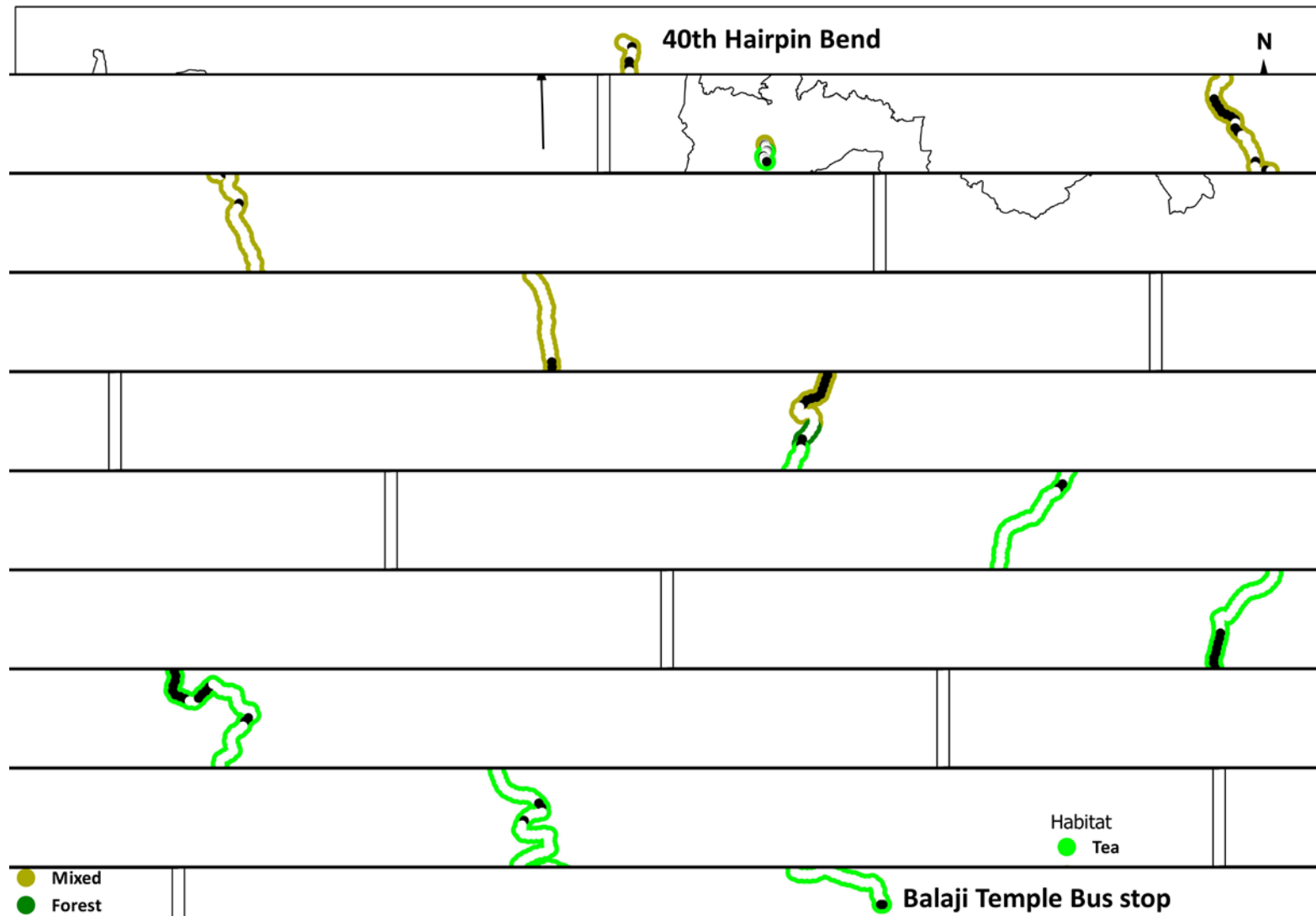
Map 2 showing the presence (filled in black) and absence (filled in white) of the canopy over 2-Attakatti transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (Map not to scale).



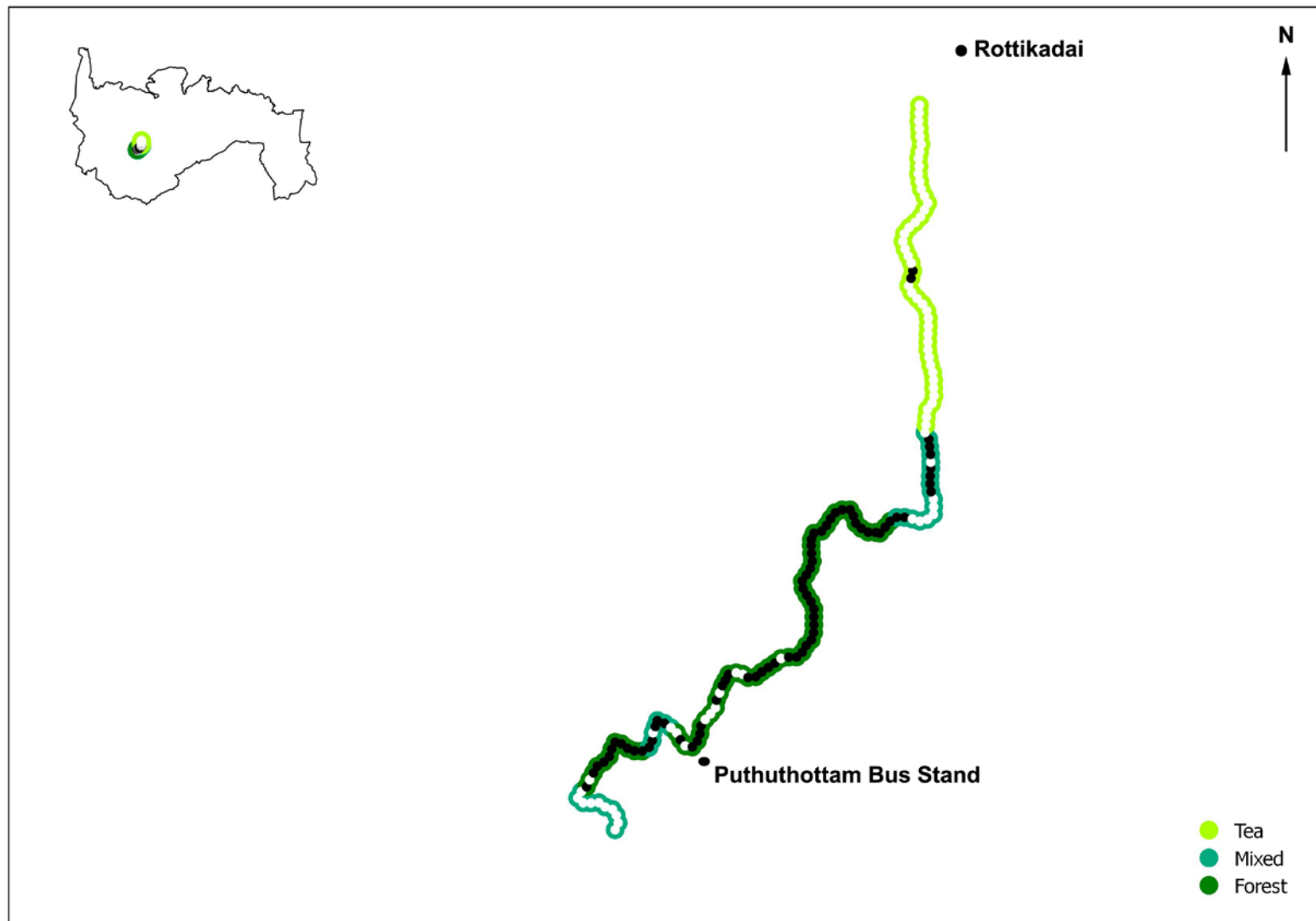
Map 3 showing the presence (filled in black) and absence (filled in white) of the canopy over 3-Waterfalls transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (*Map not to scale*).



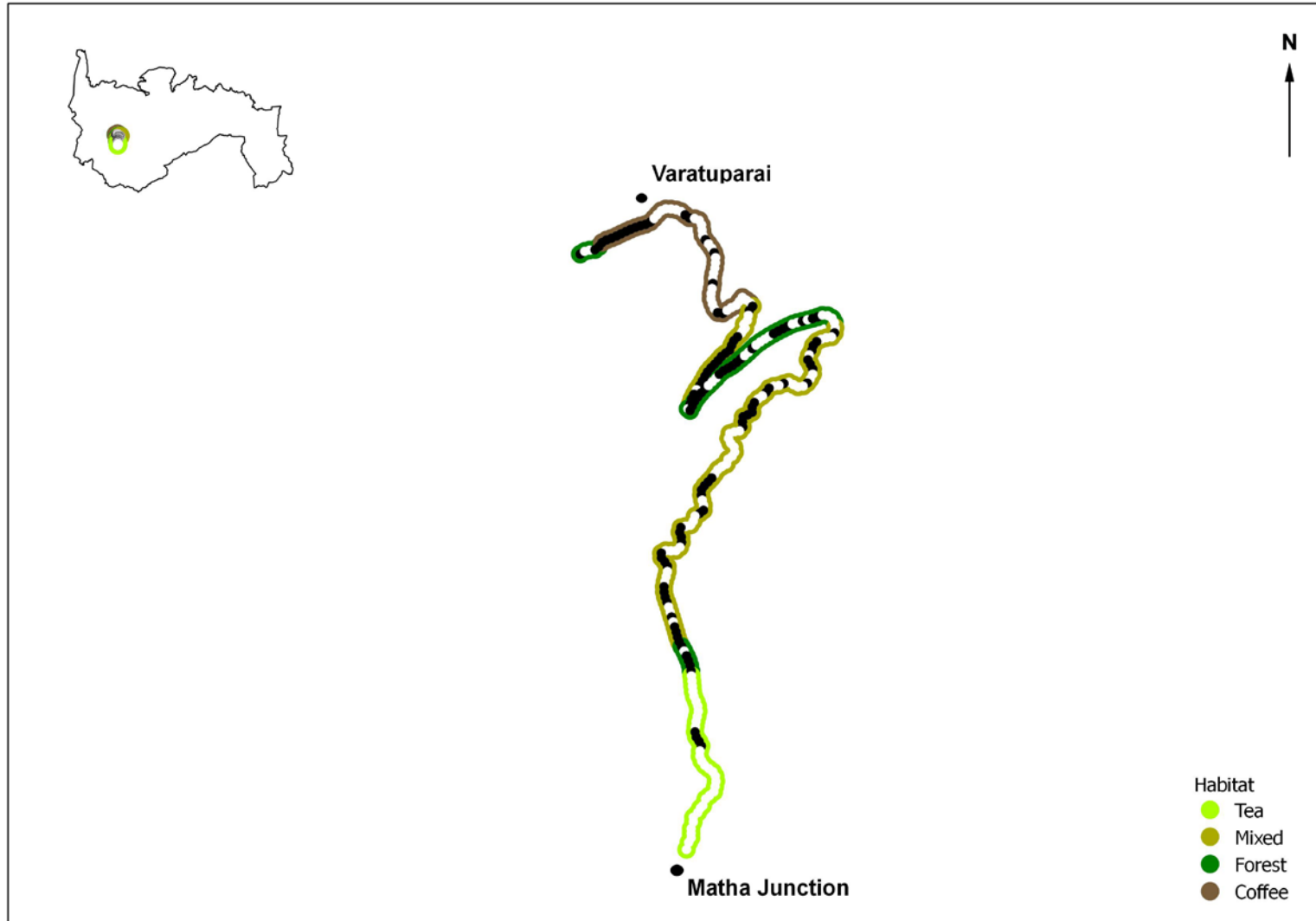
Map 4 showing the presence (filled in black) and absence (filled in white) of the canopy over 4-Waverly transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (Map not to scale).



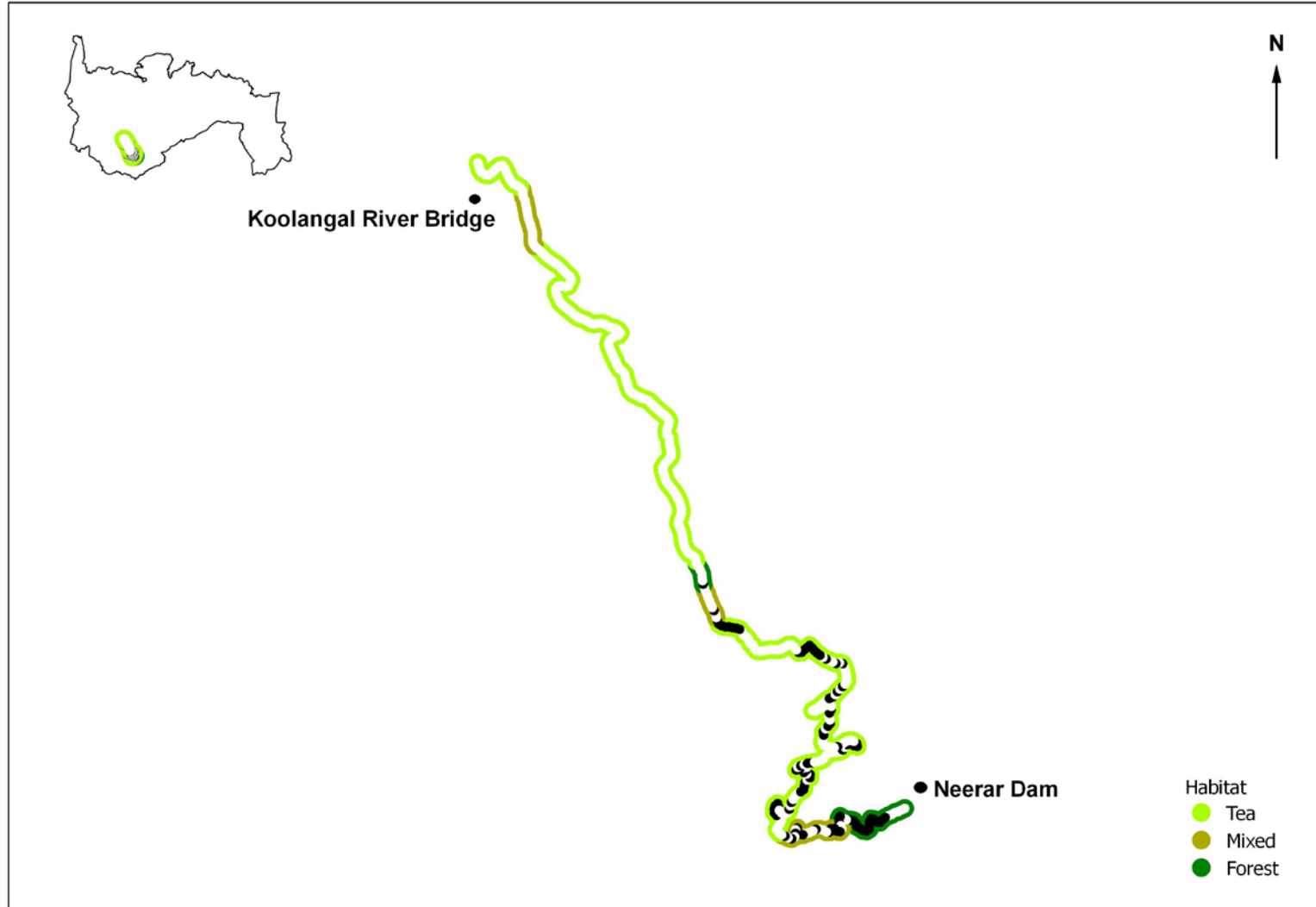
Map 5 showing the presence (filled in black) and absence (filled in white) of the canopy over 5-Balaji Temple transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (*Map not to scale*).



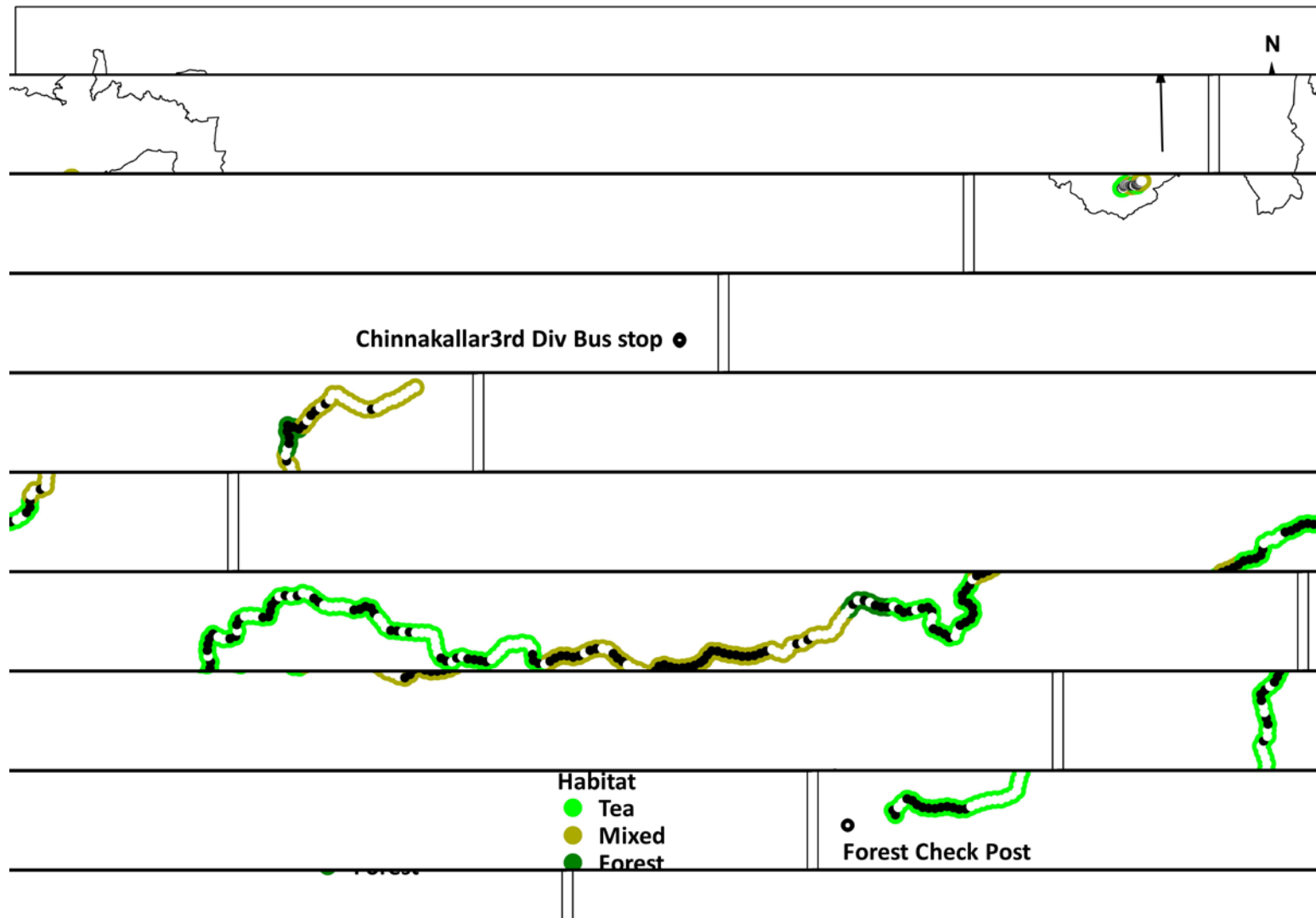
Map 6 showing the presence (filled in black) and absence (filled in white) of the canopy over 6-Puthuthottam transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (*Map not to scale*).



Map 7 showing the presence (filled in black) and absence (filled in white) of the canopy over 7-Tatafinley transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (*Map not to scale*).



Map 8 showing the presence (filled in black) and absence (filled in white) of the canopy over 10-Neerar Dam transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (Map not to scale).



Map 9 showing the presence (filled in black) and absence (filled in white) of the canopy over 11-Chinnakallar transect. Location of transect in Anamalai Tiger Reserve shown at the top left. (Map not to scale).

Appendix: 3 List of newspaper articles, blog post published and talks given on road related issues.

Jeganathan, P. (2013). Out of sight, but not out of mind. Blog post.
<http://ncf-india.org/restoration/blog/2013/03/out-of-sight-but-not-out-of-mind/>

முந்தோன்றி மூத்தவரே. காக்கைக் குருவி எங்கள் ஜாதி தொடர்-6. புதிய தலைமுறை. 16ஆகஸ்டு 2012. [Jeganathan, P. 2012].Munthondri Moothavare. Kakkai Kuruvi Engal Jathi-Series, Article No.6 Puthiya Thalaimurai. 16th August 2012. (***On South Indian Primates and impact of feeding monkeys***)

தேசாந்திரியின் தோற்றப்பிழை. காக்கைக் குருவி எங்கள் ஜாதி தொடர்-7. புதிய தலைமுறை. 23ஆகஸ்டு 2012. [Jeganathan, P. (2012). Desandiriyin Thotrapizai. Kakkai Kuruvi Engal Jathi-Series, Article No.7 Puthiya Thalaimurai. 23rd August 2012. (***On the impact of tarmac and polarized light on the road on Wandering Gliders***)]

காணாமல் போகும் சாலையோர உலகம். காக்கைக் குருவி எங்கள் ஜாதி தொடர்-8. புதிய தலைமுறை. 30ஆகஸ்டு 2012. [Jeganathan, P. (2012).Kanamal Pogum Salaiyora Ulagam. Kakkai Kuruvi Engal Jathi-Series, Article No.8 Puthiya Thalaimurai. 30th August 2012. (***On disappearing roadside trees***)]

களைகள் ஓய்வதில்லை. காக்கைக் குருவி எங்கள் ஜாதி தொடர்-12. புதிய தலைமுறை. 27 செப்டம்பர் 2012. [Jeganathan, P. (2012).Kalaigal Oivathillai. Kakkai Kuruvi Engal Jathi-Series, Article No. 12 Puthiya Thalaimurai. 27th September 2012. (***On Invasive Alien Plants and impact of roadside vegetation clearing***)]

Jeganathan, P. (2012). Idaiveliyum Idayoorum. Dinamani- Tamil Newspaper. (Gaps and obstacles: Canopy gaps above the forest roads and their impact on arboreal mammals of Western Ghats) Date: 29 th January

T. R. Shankar Raman (2012). Of tamarind and tolerance.
Blog post: <http://ncf-india.org/restoration/blog/2012/06/of-tamarind-and-tolerance/>

Divya Mudappa & T. R. Shankar Raman (2011). Roads, revetments and restoration.
Blog post: <http://ncf-india.org/restoration/blog/2011/03/roads-revetments-and-restoration/>

Divya Mudappa (2011). Bridging the canopy gaps.
Blog post: <http://ncf-india.org/restoration/blog/2011/02/bridging-the-canopy-gaps/>

Jeganathan, P. (2010). ...Tik..Tik..Tik...Tuk Tuk...Krok...Krok...Krok..
Blog post: <http://ncf-india.org/restoration/blog/2010/06/tik-tik-tik%E2%80%A6tuk-tuk%E2%80%A6krok%E2%80%A6krok%E2%80%A6krok/>

Presentations

Presentation on "Tourism and its impact on wildlife in Anamalai Tiger Reserve" was made in the workshop on making tourism responsible in the Western Ghats, Sirsi, Karnataka on 3rd November 2011

Presentation on "Impact of roads on wildlife in Anamalai Tiger Reserve " was made for Parry Agro staff at Valparai on 20th March 2012.

Presentation on "Impact of roads on wildlife and suggestions of mitigation measures in the Anamalai Hills, Western Ghats, India" at a workshop on *Road Ecology in Asia: State of the science and future directions to achieve a sustainable transportation system* in SCB-Asia, Bangalore, 8th August 2012

Presentation on "Impact of roads on wildlife in Anamalai Tiger Reserve and suggested mitigation measures" was made for Tamil Nadu Forest Department staff at Coimbatore Forest College, Coimbatore on 12th February 2013.

Presentation on "Wildlife of Anamalai Tiger Reserve and roadkill issue" was made for Anamalai Tiger Reserve Forest Department staff at Attakatti on 8th & 9th March 2013.

Presentation on "Wildlife of Anamalai Tiger Reserve and roadkill issue" was made for Parry Agro Tea plantation company workers at Valparai on 23rd April 2013.

Presentation on "Wildlife of Anamalai Tiger Reserve and roadkill issue" was made for TATA Tea plantation company workers on 5th June 2013.

Presentation on "Impact of roads on wildlife" was made for FERAL and Kerala Forest Department at Thiruvananthapuram, Kerala on 8th August 2013.

Annexure 4 Photographs showing various activities and results from this project. (Photos NCF)



Parapet wall with gaps to facilitate animal movement.



Crash-guards used in forested region allows terrestrial animals movements



Lion-tailed Macaque using the canopy bridge in one of the critical crossing points in Puthuthotam Rainforest Fragment.



Valparai School students (also members of National Green Corps) participating in awareness campaign on various conservation issues including wildlife friendly roads in Anamalai Tiger Reserve.

Appendix 5:

**Map 1 showing the canopy bridge locations in Puthuthotam Rainforest fragment
(Image courtesy: Google Earth)**



Puthuthotam

Canopy Bridge 1-10.339394° 76.966401°, Canopy Bridge 2-10.340485° 76.967535°
Canopy Bridge 3-10.340955° 76.968419°, Canopy Bridge 4-10.341999° 76.969431°
Canopy Bridge 5-10.343524° 76.969247°, Canopy Bridge 6-10.345118° 76.970587°

Map 2 showing the canopy bridge location in Varatuparai Rainforest fragment (Image courtesy: Google Earth)



Varatuparai - Canopy Bridge 7 10.352442° 76.936984°

Annexure 6

HABITAT MANAGEMENT: Maintenance of roads

Issue: Roadkills An important issue in protected areas where roads with vehicular traffic are present is the problem of wildlife mortality due to roadkills.

Suggestions:

- Tourist traffic can be better regulated and minimized along the roads during rainy season, using measures such as speed-limitations, rerouting to avoid sensitive stretches, and restrictions against night time driving. Commercial vehicles carrying perishable items (plantation produce, vegetables, milk), public transport vehicles, medical emergency vehicles, and vehicles belonging to local residents (e.g., Valparai) may be permitted along roads following speed guidelines. Movement of other commercial and tourist vehicles could be restricted during the day and prohibited on sensitive stretches of forest roads between 10 p.m. and 5 a.m.
- Speed controls through erection of road humps/speed breakers and/or rumble strips, at designated points should be enforced in all stretches of road passing through the forest area.
- Along with the Highways Department, the Forest department should ensure that trees along the roads are not cleared. There should be canopy connectivity with overlapping branches of trees growing along the road at regular intervals of at least 100 m. These have to be at least 15 m wide.
- Having underground passages beneath the roads, at culverts and other defined points might reduce the risk of small animals having to cross the road.
- Also, having narrow canals on the road-sides can help rain water to flow away from the road, reducing damage to the roads and providing a possible option for small animals such as reptiles, amphibians, rodents to move.
- Parapets with low walls (maximum 2 feet) with sufficient gaps (minimum 3 feet) at regular intervals will not only serve as indicators for drivers on these roads to avoid accidents but also help to save wildlife from road accidents as these breaks/gaps will be an opportunity for wild animals to escape in case a vehicle approaches. Railings (crash-guards) as used along the roads in other hill areas (see pictures) also could be an alternative.

Issue: Removal or destruction of natural vegetation

Removal or destruction of natural vegetation, particularly on slopes, along roads passing through forests is neither useful for drivers nor for roads and is detrimental for wildlife for the following reasons.

- Clearing up of all vegetation by slashing along main roads, creates open conditions and exposed soil, which allows opportunistic weed species such as lantana (*Lantana camara*), *Eupatorium*, and *Parthenium* to grow rapidly. Besides being undesirable and noxious species, these again grow rapidly and hinder visibility for motorists. Native plants along roadsides seldom grow like this and many native grasses, ferns, and herbs, hold the soil and provide a low ground cover that protects the soil from erosion and a more attractive roadside.
- Roads and clearings act as sources of weed-entry into an already vulnerable and fragmented patch of forest that affect the natural regeneration and native species plant diversity. There is also increased risk of fire due to proliferation of weed species.
- On the other hand, removal of natural vegetation leads to landslides and soil erosion which damages the roads and increases public expenditure.
- Many arboreal species such as giant squirrel, lion-tailed macaque, Nilgiri langur, bonnet macaque require connectivity in the canopy. When canopy connectivity is lost due to cutting of tree branches to maintain roads, animals are forced to come on ground to cross roads. This will result in mortality of wildlife due to road accidents. In the case of some larger wildlife such as deer, there is also risk of injury to motorists, particularly people on two-wheelers.

Suggestions:

Hence, we suggest the following points to be considered for mutual benefit of roads, road users, and wildlife.

- Presence of rainforest plant species along roads suppresses weed growth and facilitates visibility for drivers
- Maintenance and protection of natural vegetation along road sides and if possible, planting native tree species will help avoid landslides and prevents soil erosion.
- Slashing of vegetation along roadside must be restricted to targetted removal of weedy plants such as Lantana, eupatorium, and Parthenium, and avoid cutting of native vegetation or scraping of earth.

- Highways and Forest Departments may collaborate with local NGOs to install appropriate signposts to inform road users of wildlife crossings, and also the aesthetic and beneficial uses of native roadside natural vegetation.