

**Mapping the Distribution of Lantana Camara
in the Hasanur Division, Sathyamangalam Tiger Reserve
Tamilnadu**



**Report submitted to WWF-India and the Tamilnadu Forest
Department, November 2015**

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Introduction

Lantana camara L. (referred to as Lantana from here on), a shrub native to South America, has become one of the worst weeds in recorded history. It was first introduced in India in 1807 (Thakur et al., 1992). Lantana has now spread to become a pan-global weed, reported as invasive in more than 60 countries (Parsons and Cuthbertson, 2001; Day et al., 2003), and identified as one of the top ten invasive species in the world (GISIN, 2011).

Lantana as an Invasive Species

- It exhibits allelopathic properties - puts out chemicals which hinder seedling recruitment and growth of native plants in its vicinity (Achhireddy & Singh 1984)
- When mechanically cut, it quickly produces many new shoots that can grow upto six times faster than the mother plant, producing dense and impenetrable thickets (Sharma et al. 2005).
- It has a vibrant seed bank (each adult plant can produce upto 12,000 seeds, which remain viable for up to 11 years) that is dispersed widely by birds, rodents and other animals, and propagates very well vegetatively (Swarbrick et al. 1998).
- It benefits from soil disturbances associated with destructive foraging activity of mammals such as pigs, cattle, goats and deer, which enhance both germination and vegetative propagation (Thaman 1974).
- It possesses a strong root system, and can regenerate from basal shoots even after moderately intense fires (Day et al. 2003) and seeds also tend to germinate faster if exposed to smoke.
- The leaves and young stems contain lantadene A and B, which are toxic (sometimes fatal) if/when browsed by herbivores (Sharma et al. 1981).

All these characteristics together make Lantana highly suited to invading novel environments as has happened across most of India, reviewed by Sharma et al., (2005).

Understanding the extent of the Lantana invasion is essential to plan any management interventions relating to the plant. Following from discussions with the Tamilnadu forest department and as per the letter (Ref. No.4325/2014/D, dated 26/06/2015) this mapping exercise was implemented. The field work was undertaken from September to November 2015, in collaboration with WWF-India.

Methodology

The methodology used for mapping purposes was as described below.

1. Preliminary maps were obtained from WWF-India, and the beat boundary polygons were edited using Quantum GIS (v 2.8) based on discussions with field staff, to match on ground boundaries.
2. Digital copies of 1:25000 topographic sheets were obtained from WWF India to be used as a field reference to plan the survey on the ground.
3. An approximately 0.01 degree square grid (approx. 1.1 km) was created and overlaid onto each beat boundary. These were used as field reference. A sample gridded beat map is attached as Appendix 1.
4. Each beat was travelled through by either foot or vehicle, attempting to cover every grid.
5. Every 500m, a GPS (Garmin etrex 10 and etrex 30) waypoint was marked, and a qualitative visual assessment of the level of Lantana infestation was made as follows:
 - (a) 0 – No Lantana
 - (b) 1 – Few scattered plants
 - (c) 2 – Many plants
 - (d) 3 – Dominated by Lantana
 - (e) 4 – Impenetrable

Areas that were recently cleared of Lantana were ignored in the assessment. Each such waypoint was also plotted on the gridded beat map mentioned above to ensure full coverage of the area.

6. Presence or Absence of some other common invasive species were also noted, namely *Chromolaena odorata*, *Parthenium hysterophorus*, and *Opuntia spp.* Any other interesting/relevant information was also noted.
7. These waypoints and corresponding data were entered into a spreadsheet (Libre Office v 3.5), as well as saved in ESRI shapefile using Quantum GIS (v 2.8). Appendix 2 shows the map of all the points taken during the course of the research.
8. Inverse Distance Weighted Interpolation was then carried out in the same software using Level of Lantana Infestation as the input. A distance coefficient (p) of 6 was used and a cell size of about 50m (0.0005 degrees). The resulting raster layer was converted into vector and cropped to the range boundaries. A map was generated to visualise the spread of Lantana through the Reserve, attached as Appendix 3.

9. Areas of each of the levels of Lantana infestation were calculated for each range, and corresponding graphs prepared (Appendices 4, 5 and 6).
10. The presence/absence of *Chromolaena odorata*, *Parthenium hysterophorus*, and *Opuntia spp.* at each of the data points is also shown in the Appendices 7, 8 and 9.

Possible shortcomings

1. The qualitative assessment of the level of Lantana infestation may not be uniform ie if two different people walk the same paths, they may give different scores from 0-4. We tried this in some areas, and found some small variation did happen in about 20% of the points, but the score was only off by 1. That is 'impenetrable (4)' may be exchanged with 'dominated by Lantana (3)' or 'few scattered plants (1)' with 'many plants (2)'. But 'few scattered plants (1)' was never scored as 'dominated by Lantana (3)', so we think it is not too serious a problem.
2. For best results in interpolation, the sampling points have to be uniformly spaced out. This is not really possible in the forests that are dominated by Lantana or other thick undergrowth, and we have let the field staff guide us as best possible, ensuring maximum/even coverage.
3. Interpolation is also not ideal with non parametric/qualitative variables, but we are reasonably confident about the results given the extensive coverage, and believe this is the best that can be achieved. A quantitative assessment (like stem counts/percentage cover in quadrats) is not a feasible undertaking if you want such extensive coverage/sampling.
4. The selection of distance coefficient (p) of 6 is somewhat arbitrary, but a higher value was chosen since Lantana level at a point is very strongly influenced by neighbouring points, and almost independent of points further away.
5. Two areas – Geddesal beat in the Germalam Range and Neydalpuram North in the Talavadi Range – were not adequately covered. This was due to a high number of elephants in the areas that made it hard to walk through the area as planned, and also unusually high rainfall. We hope to complete this in early December, but in an effort to complete report in a timely fashion we have proceeded without it. We don't believe it will make a difference of more than 5% in the overall assessment of the areas infested by Lantana.
6. Area calculation may vary slightly based on the Projection and Coordinate Reference System used in the GIS software. We have used WGS 84 (EPSG:4326) for the GPS units and maps, and WGS 84/World Mercator (EPSG:3395) to compute areas of polygons. We have also noted the full areas of each Range and percentages infested to overcome this issue.

Despite these shortcomings, we are confident that is the most accurate and appropriate methodology for mapping lantana.

Results

The following sampling effort was undertaken:

<i>Range</i>	<i>Total Area (ha)</i>	<i>Sample points</i>	<i>Dist. on Foot (km)</i>	<i>Dist. in Vehicle (km)</i>	<i>Notes</i>
Germalam	17612	365	125	55	Reasonably well covered except for Geddesal Beat.
Hasanur	15550	463	180	60	Well covered.
Talavadi	20420	437	160	35	Reasonably well covered except for Neydalpuram North Beat.
Entire Division	53582	1265	465	150	

This was the total sampling effort in the reserve. The total effort including pick up/drops, repeat walks and travel to field site about 550 km on foot 2800 km in the Jeep.

From these 1265 points, based on the interpolation the following results were obtained:

<i>Lantana Level/Range</i>	<i>Germalam</i>		<i>Hasanur</i>		<i>Talavadi</i>		<i>Entire Division</i>	
	<i>Area (ha)</i>	<i>%</i>	<i>Area (ha)</i>	<i>%</i>	<i>Area (ha)</i>	<i>%</i>	<i>Area (ha)</i>	<i>%</i>
No Lantana	907	5	292	2	2259	11	3457	6
Few Scattered Plants	2732	16	2495	16	12188	60	17415	33
Many Plants	4963	28	6494	42	5206	26	16664	31
Dominated by Lantana	5481	31	4277	28	690	3	10448	19
Impenetrable	3530	20	1992	13	77	0	5598	10

Note: Area calculations are only approximate, and may vary on the coordinate-reference system used in the GIS software. Graphs showing Lantana spread attached.

Further visual results are enclosed in the appendix 10.

Other Observations

1. Overall, though the Lantana infestation seems very high, the percentage wise, the spread is slightly less than Mudumalai of Bandipur (Appendices 10 and 11). This is an interesting result, and something that we hope to understand better in further analysis. What we also felt, based on preliminary observations, was that the Lantana seemed to be older/better established than in Mudumalai or Bandipur.
2. Being a relatively new Tiger Reserve, the road network in the PA was very limited compared to Bandipur and Mudumalai. This could have a significant effect on the Lantana spread, as anecdotal evidence and casual observation in the previous two PAs has shown that Lantana infestation is higher near the roads. And as per our preliminary impressions, the spread of Lantana in STR does not seem to correlate as closely with roads as in Bandipur or Mudumalai. More analysis will bring more clarity to this point. The downside of this was that fieldwork was considerably more challenging, and 'managing' the PA also seems much more challenging for the forest department staff, with many areas being quite inaccessible.
3. Like in the other PAs, we noticed the hill slopes are largely free of Lantana and dominated by grasses, but many of the valleys are taken over by Lantana. But we also noticed one instance in Geddesal beat (Germalam Range), where there were small Lantana bushes (two feet or so tall) that seemed well established among the grasses on the slopes. We have never seen this before, and it was the first instance we found of Lantana present in the slopes among the grasses. More monitoring of this area will be useful, to understand if Lantana is invading the grasslands.
4. Talavadi range is mostly Lantana free, except near the edges of the PA, along the boundaries of the park, bordering farm lands. There is almost a wall of Lantana along the edges in many places. It may be worth prioritising these areas, so there is not much scope for Lantana to invade into the other areas.
5. We also noticed some new growth of Lantana in the Kottadi beat of Hasanur Range. This is perhaps the best time to target it for any removal efforts - before it is well established.
6. In Germalam range there are some Eucalyptus plantations, and the under-storey of these is completely taken over by Lantana. This is an interesting case of two non-native species being able to co-exist, as very little is usually able to grow under the Eucalyptus canopy.

7. On the whole, human presence in the park is much higher than in either of the other parks. There are numerous settlement through the reserve, and local people seem to collect a variety of forest produce. They also seem highly knowledgeable about the forests and Lantana, so it will be useful to interview elders from the indigenous communities and record their perceptions of Lantana and how it has spread.

Conclusion and Management Interventions

Overall, about 30% of the Hasanur Division, or 160 sq km (16046 hectares), is either 'dominated by Lantana' or 'Impenetrable', and about 39% or 209 sq km is either with 'few scattered plants' or 'many plants'. Only about 6.5% or 35 sq km is completely free of Lantana. But despite this, the Lantana seems to be mostly stable, and not spreading into newer areas. This would be to a large extent due to the drier nature of the park compared to parts of Mudumalai and Bandipur.

The complete results with range-wise information about the Lantana spread along with maps and graphs are included in the appendices.

We find it quite hard to make concrete suggestions about the management of Lantana, since almost all interventions aimed at 'eradicating' the plant over the last 100 years have failed. The only specific suggestion we can give is that is to target the areas mentioned in the Talavadi and Hasanur Ranges in the above 'Observations' for the removal of Lantana.

However, some general observations about management are worth discussing:

- The current 'eradication' effort is based on uprooting Lantana in area that are heavily infested, at a rough cost of between Rs.25,000 to Rs. 40,000 per hectare. The cost of removing Lantana from all the heavily infested areas in the Hasanur Division alone will therefore be between 40 and 64 crore rupees. This is clearly not a realistic sum of money that can be spent. Further, any large scale disturbance in a forest could have cascading, unforeseen effects on the native flora and fauna, and is not advisable.
- Clearing of Lantana is done in small patches based on availability of funds, where the patches are selected mostly based on convenience of field staff. This is perhaps a futile effort, as Lantana will surely come back if removed in a small patch in a landscape that is otherwise full of Lantana. We suggest that a rationale is clearly put down as to why Lantana is going to be cleared in a particular area. There could be many reasons for targeted clearing – like around water bodies, or in tourism areas for better wildlife viewing, or in areas where Lantana is starting to spread etc. These areas should be identified for each range independent of the funding, and then should be targeted year after year on an ongoing basis.
- Follow weeding/clearing is essential, and all new clearing should be perhaps be undertaken only after it is established that previous cleared areas are Lantana free.

- Yearly monitoring of Lantana is essential to ensure the plant is not spreading further. Long term data on the spread of Lantana will be very useful for management.
- Other options that involve local communities using Lantana could also possibly be looked into if the forest department has the manpower. This will give employment to the local tribals, and make the removal of Lantana a financially self sustaining process. Other NGOs could also be potentially involved. Numerous such uses for Lantana have already been experimented with - to make furniture, or shredded Lantana to be made into briquettes/sold to plywood industries, or the extraction of essential oils/amino acids. All of these have significant potential.

In conclusion, we believe the best way forward is to have a one day workshop with key field staff, officers and NGOs/Researchers involved with Lantana, to come up with site specific Lantana management plans for each range in the Hasanur Division of the Sathyamangalam Tiger Reserve.

Acknowledgements

We are grateful to a large number of people who helped with this work.

Firstly Thiru. I Anwardeen, the Field Director of Sathyamangalam Tiger Reserve for inviting us to work in the Sathyamangalam Tiger Reserve. Tmt. R. Padmawathe, The DFO of Hasanur Division for her cooperation and logistical help. All the Range Officers, Thiru. Amalraj, Thiru. Palaniswamy and Thiru. Udaykumar. We are also extremely grateful to a large number of field staff who accompanied us while walking through the forests.

Report compiled by Tarsh Thekaekara, 15 November 2015, updated February 2016.

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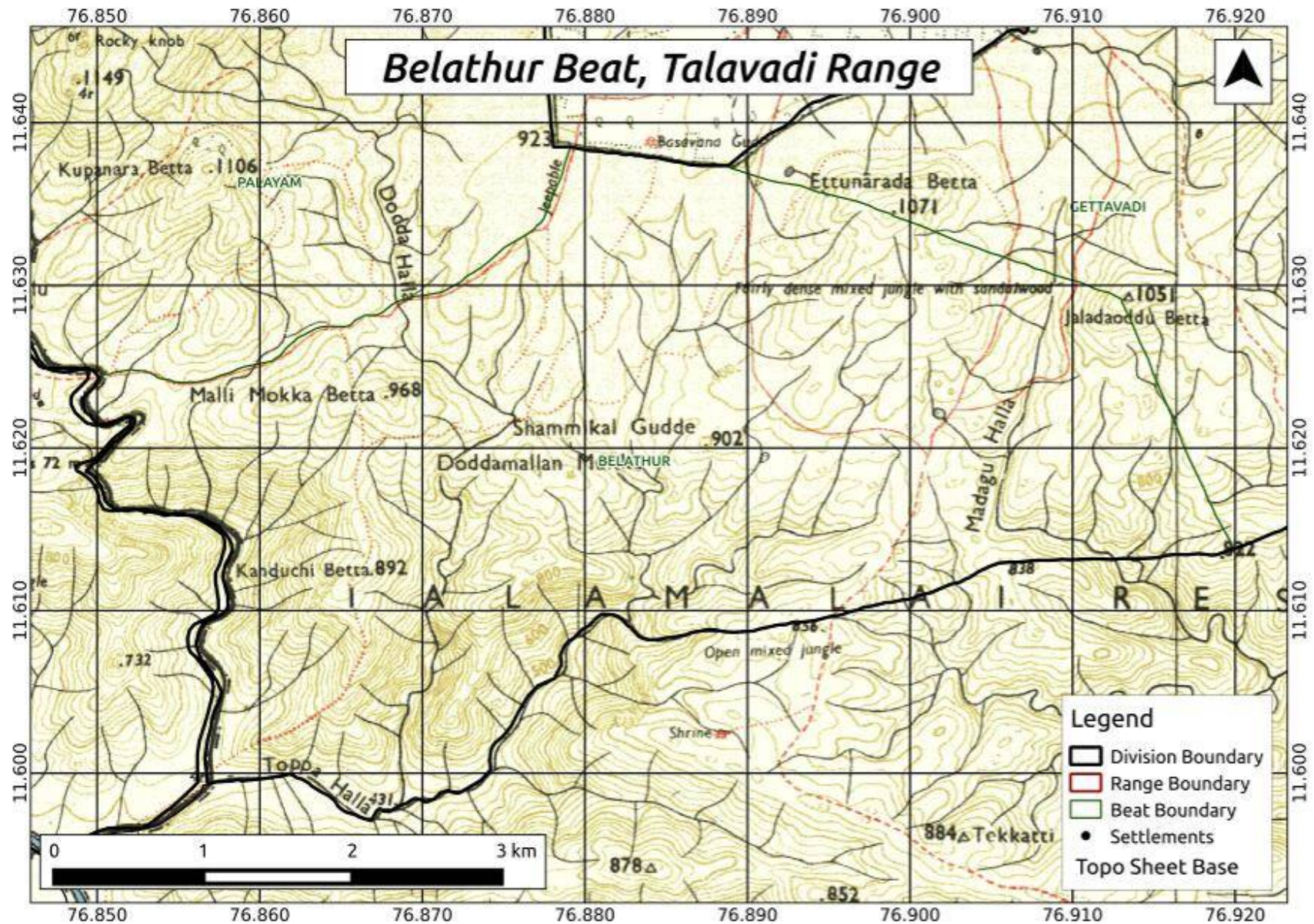
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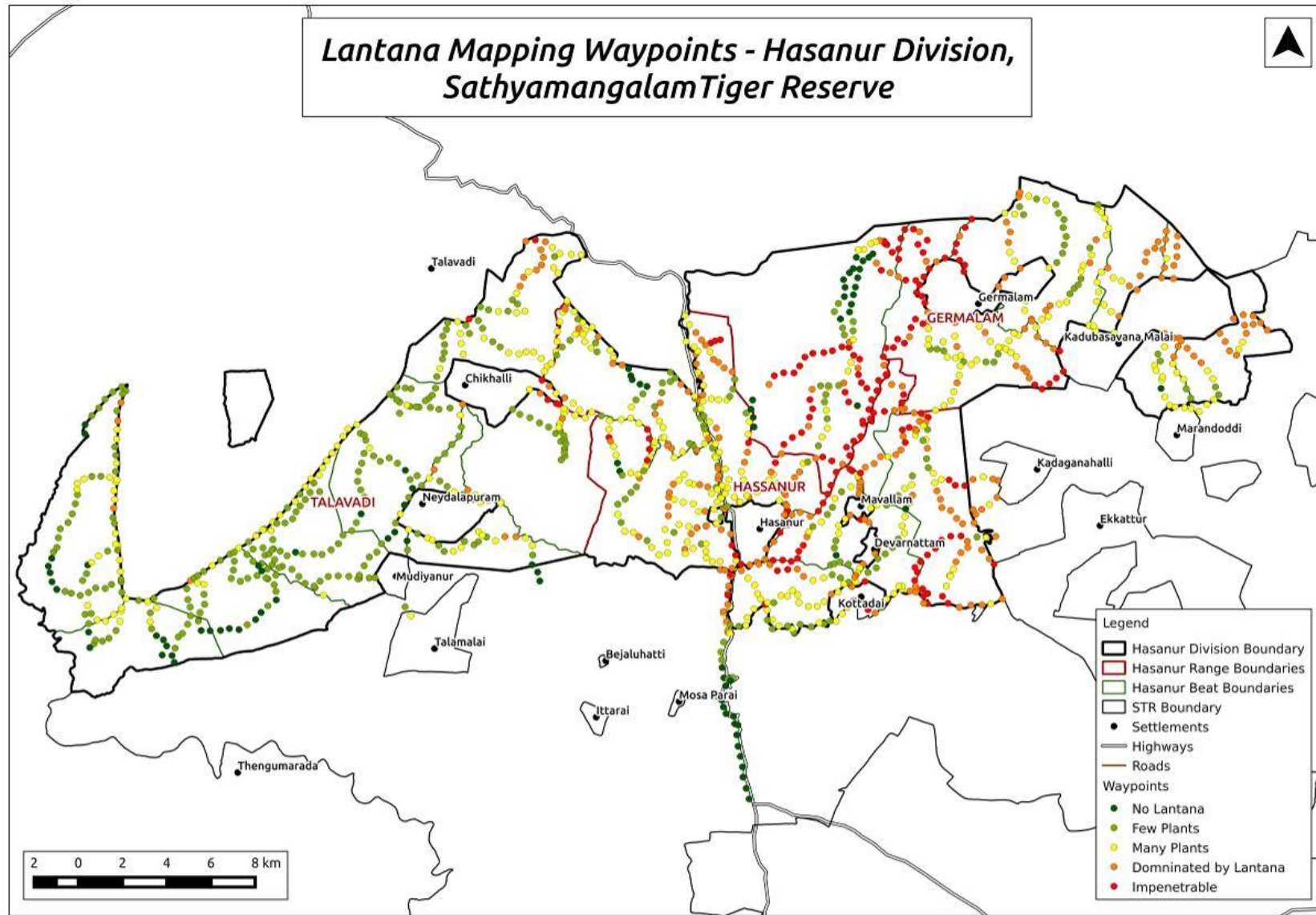
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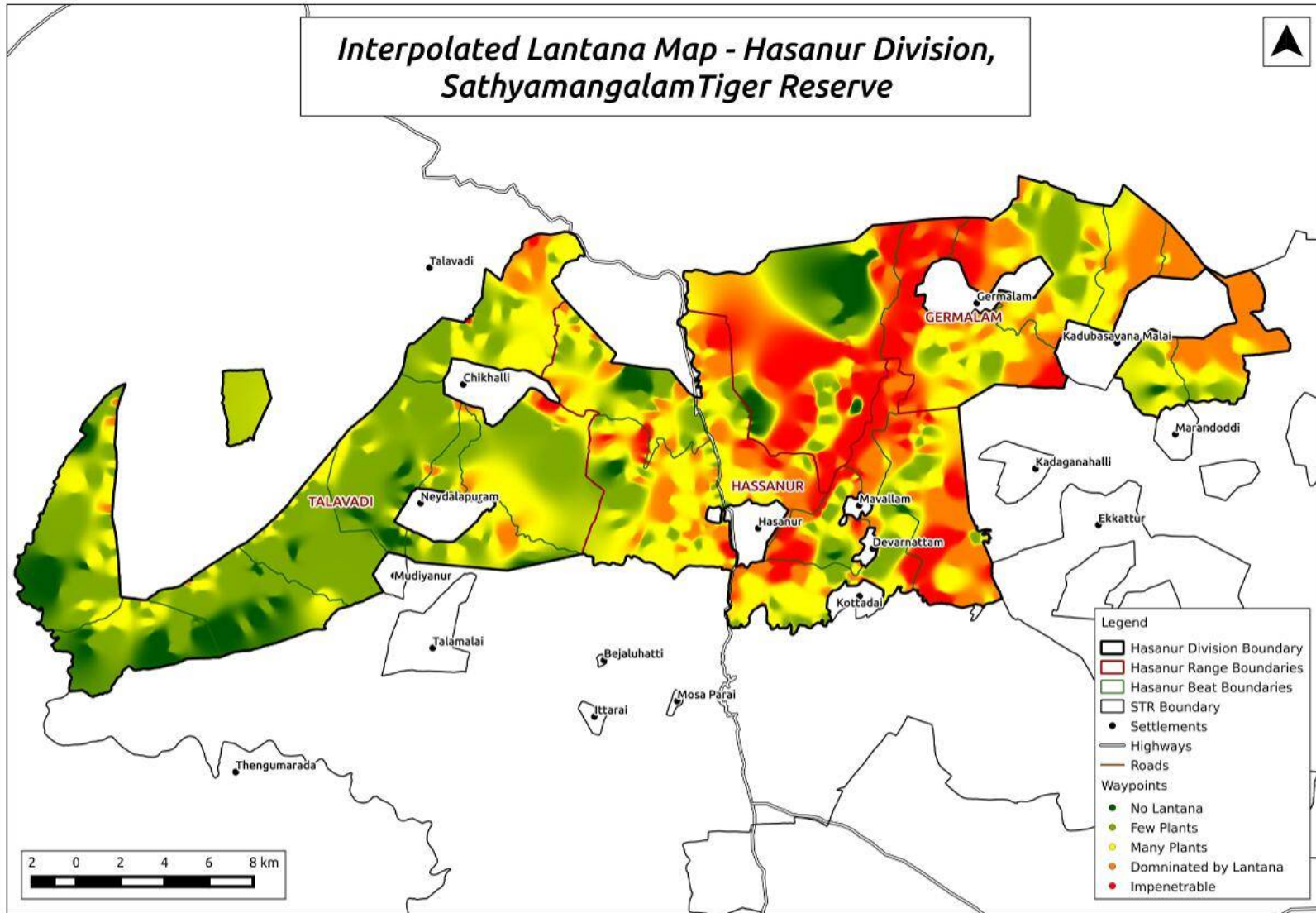
Appendix 1: Sample Beat Map



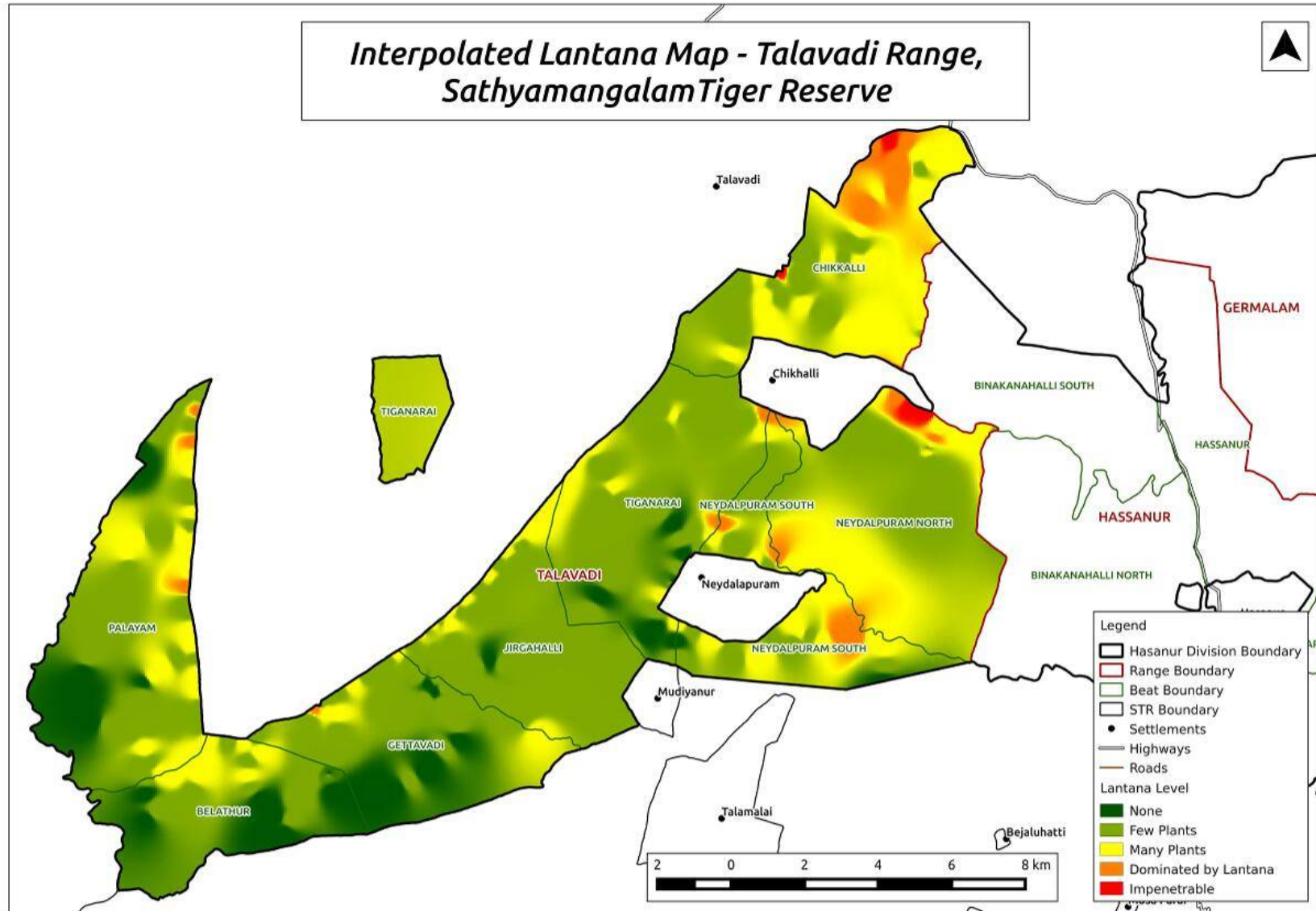
Appendix 2: Distribution of Waypoints



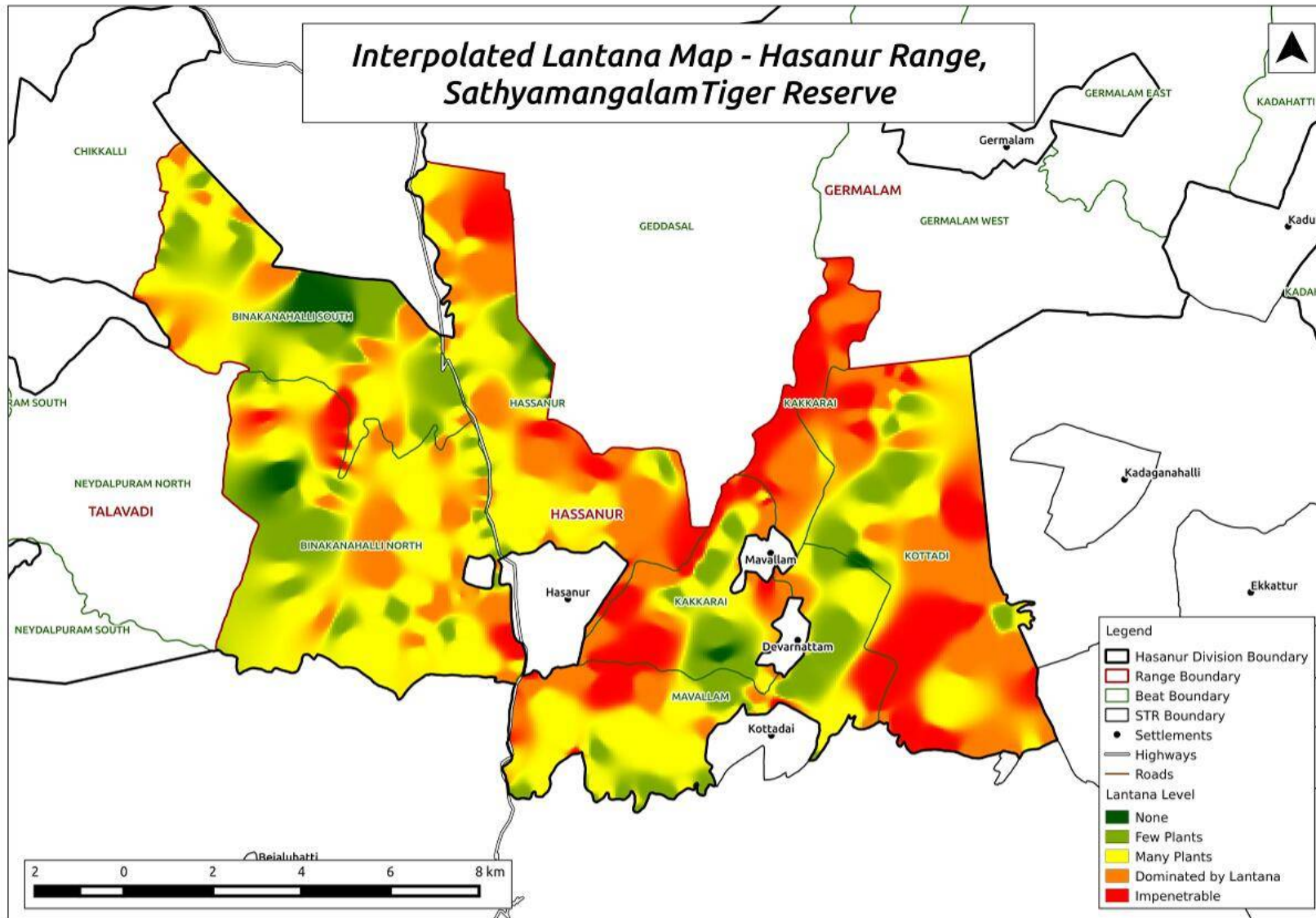
Appendix 3: Interpolated Lantana Map



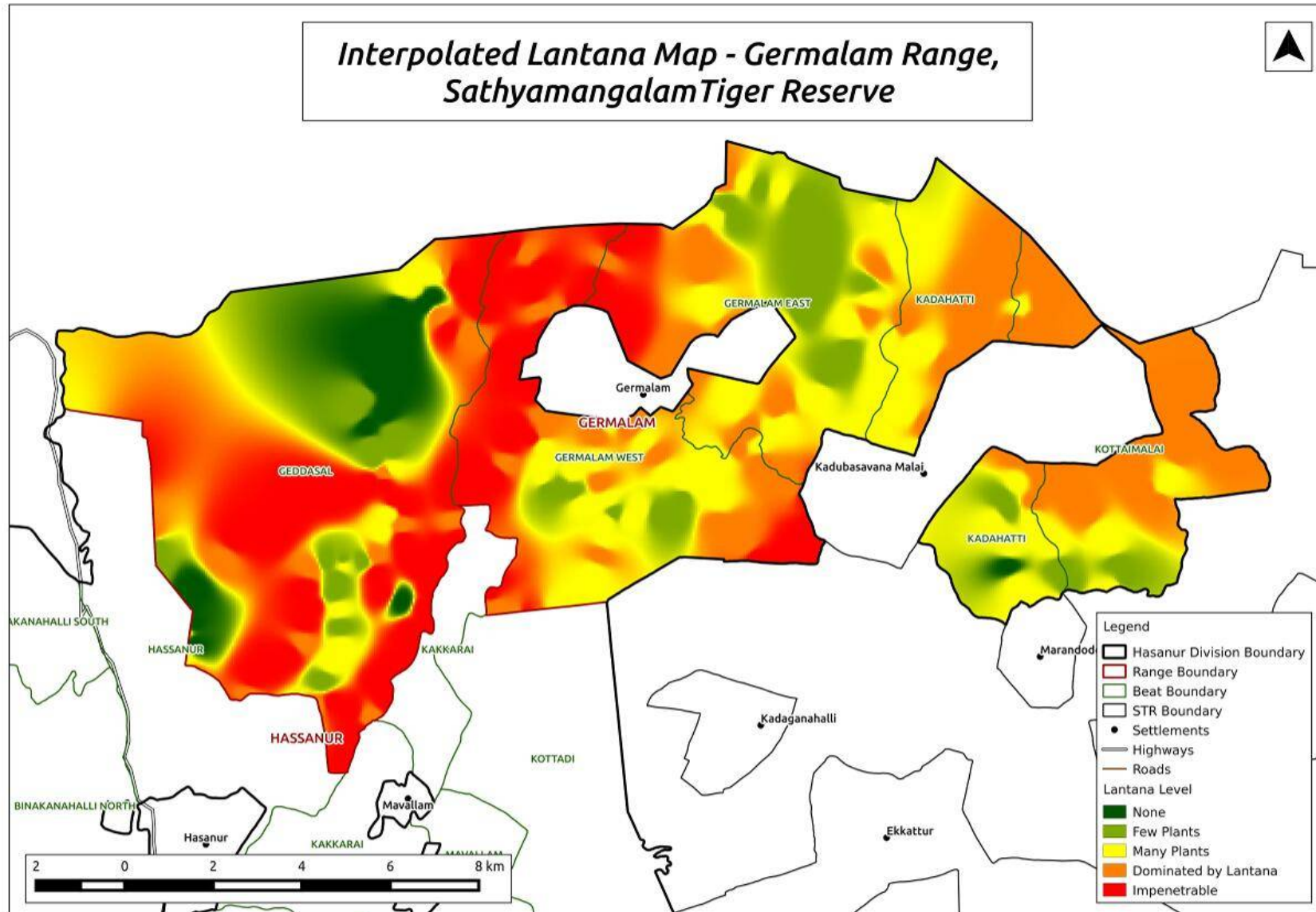
Appendix 4: Interpolated Lantana Map of Talavadi Range



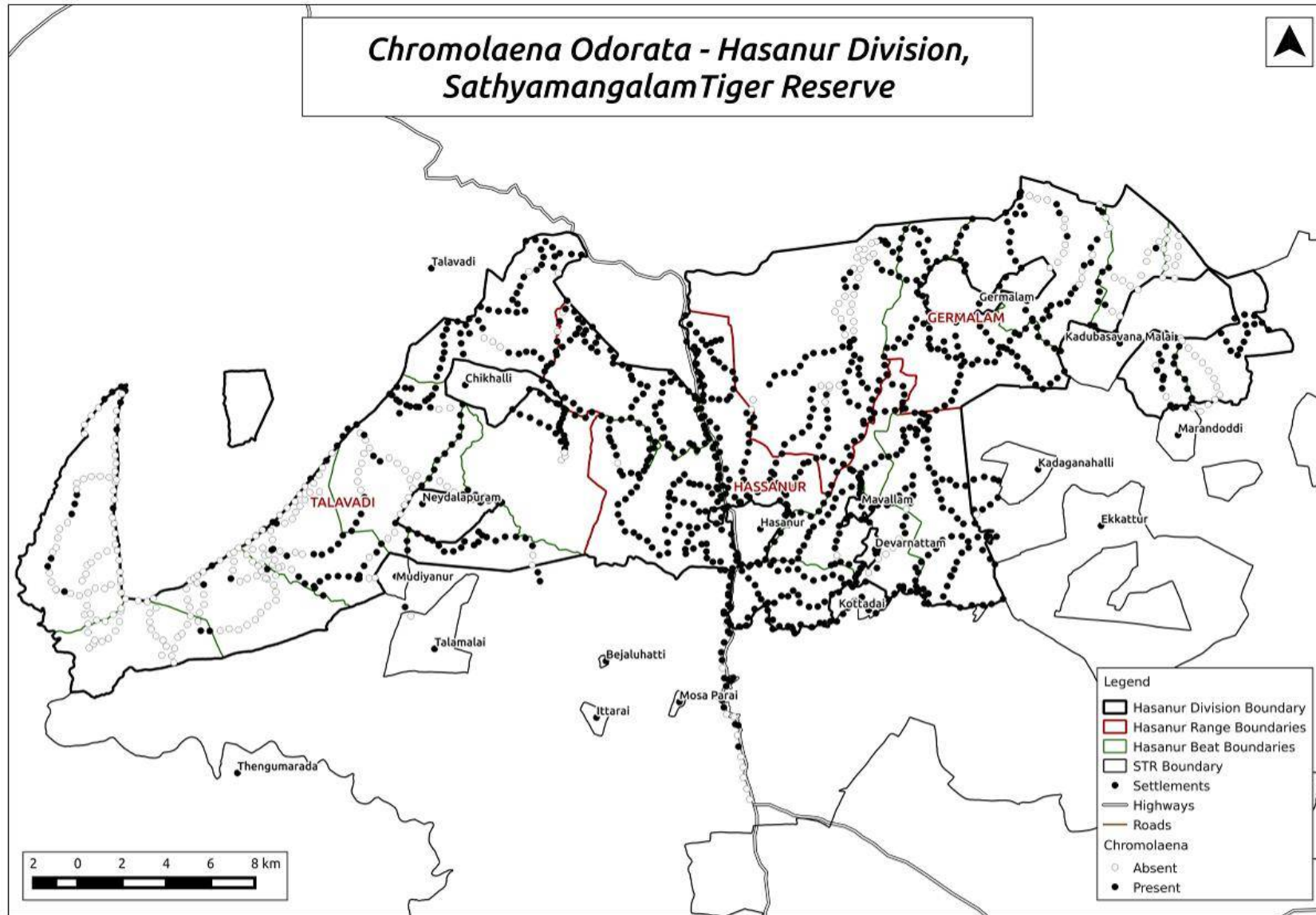
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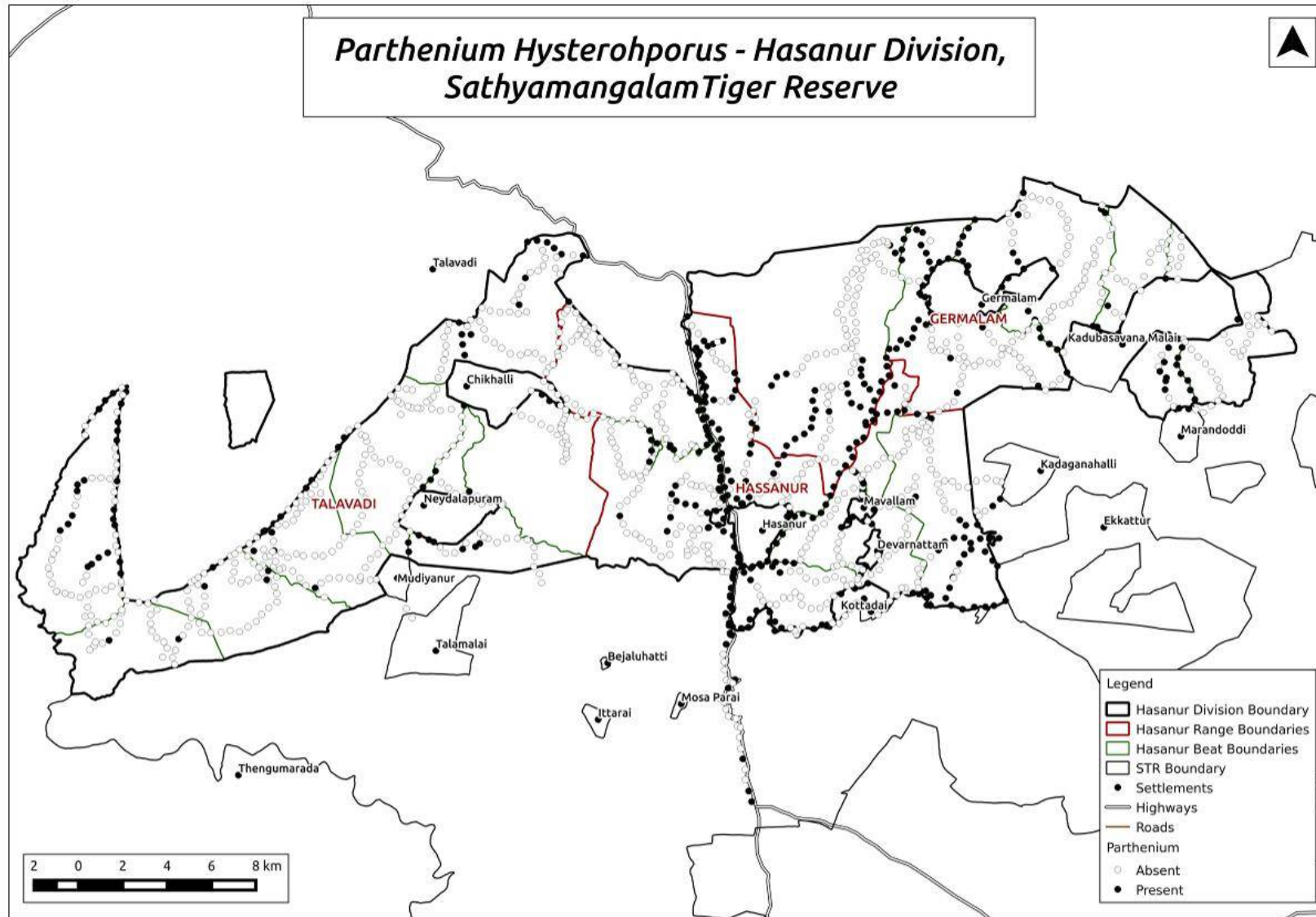
Appendix 6: Interpolated Lantana Map of Germalam Range



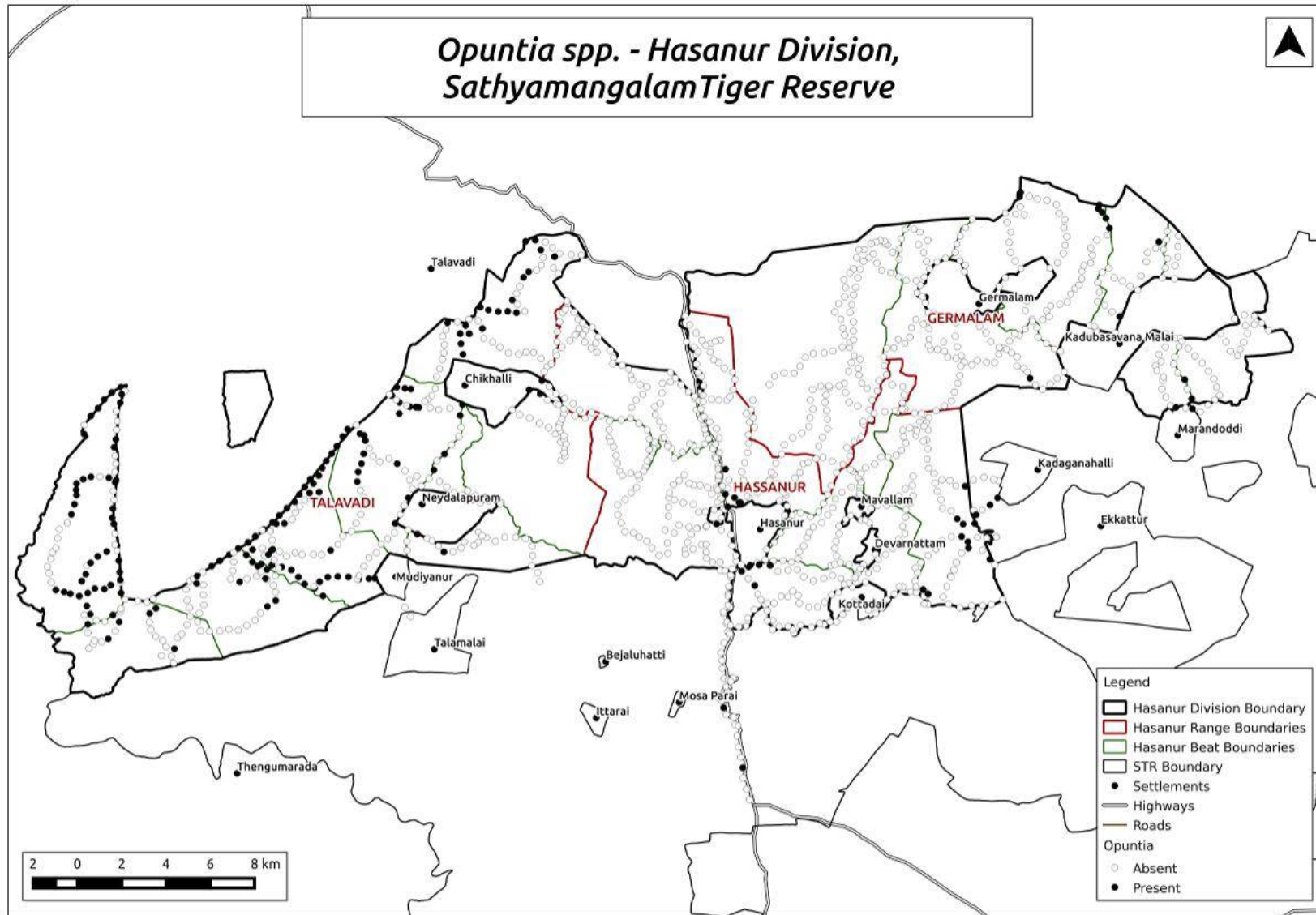
Appendix 7: Distribution of *Chromolaena odorata*



Appendix 8: Distribution of *Parthenium hysterophorus*

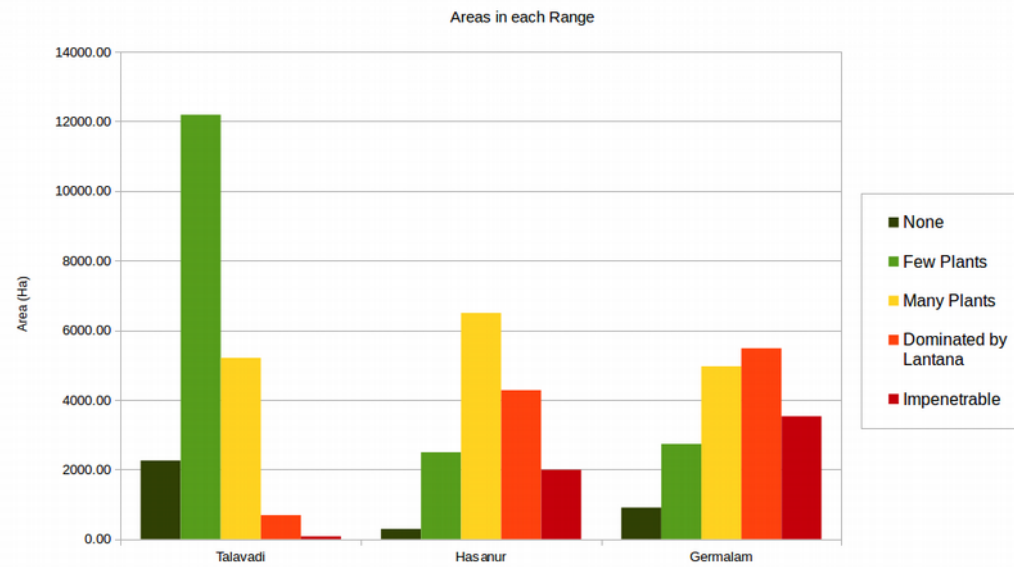


Appendix 9: Distribution of *Opuntia* spp.

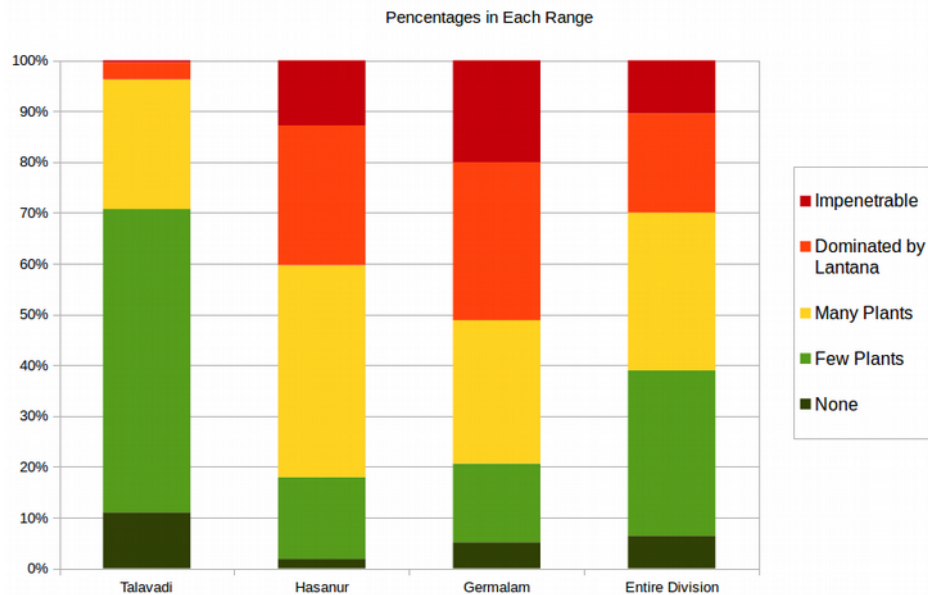


Appendix 10: Graphs of Lantana Distribution

Lantana Infestation in Hasanur Division, Sathymangalam Tiger Reserve

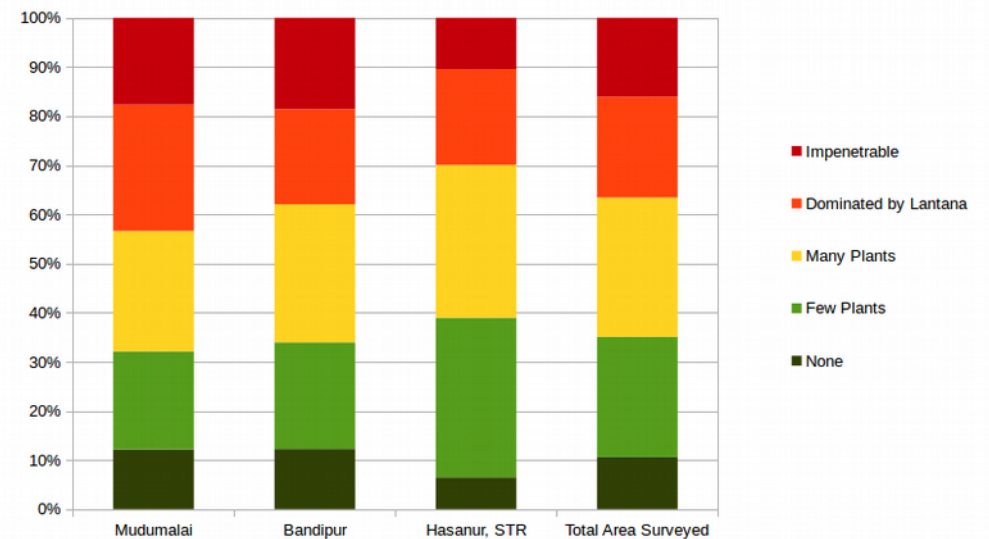


Lantana Infestation in Hasanur Division, Sathymangalam Tiger Reserve



Comparison of Lantana Invasion Between Parks

Mudumalai, Bandipur and Hasanur Division, Sathyamangalam



Appendix 11: Comparison of Lantana Spread between Parks

