Assessing Ecosystem recovery of invaded dry forests | Kanha Tiger Reserve

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Funding: **Rufford Small Grant** & UFZ department funds
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   - Wildlife Institute of India, Dehradun
   - MP forest Department
2. **Europe**:
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   - Helmholtz Centre for Environmental Research (UFZ), Leipzig, Germany
   - Martin Luther University, Halle-Wittenberg, Leipzig, Germany
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Field Sampling Protocol for Assessing Vegetation Composition, Habitat Recovery, and Herbivory by Ungulates

Contents:

1. PLOT SELECTION

1.1 Reconnaissance data collection and site selection

i. Obtain data on invasive plant removal and mopping (or other management activities) from the respective Forest Department Range Offices.
ii. Compile a matrix based on this data and integrate it with the administrative records of the Protected Area (PA).
iii. Develop a spatial map to visualize restoration efforts across different years.
iv. Select sampling sites based on the map, considering the following factors:
   a. **Time Since Removal** – Determine the first instance of invasive plant removal in the compartment or the finest administrative unit (2024, 2023, 2022, 2021, 2020, or earlier).
   b. **Removal Procedure** – Assess whether the removal was a single event or followed up with additional mopping efforts in the consecutive seasons or years.

c. Management Zone – Identify whether the removal occurred in the Core (the inviolate area) or Buffer zone (the multi-use area) and whether it was near a road, grassland, or inside a forested patch.
d. Habitat Type – Determine the habitat where removal was conducted (Sal, Mixed, or Bamboo forests).

v. Once a sampling site is selected, locate the specific area where removal has taken place.
vi. Identify an area near the boundary between invaded and managed sites for further assessment.

2. PLOT ESTABLISHMENT

2.1 Plot selection and setup

i. Establish plots at a minimum distance of approximately 15–20 meters from the road/canopy opening and the invasion boundary.
ii. At each site, sample two plots:
- One within the managed area.
- One within the invaded area.

iii. Ensure a minimum distance of 300 meters between successive pairs of plots to align with MODIS fire data resolution (250m scale).

2.2 Plot establishment procedure

i. In the selected area, remove any dead or decaying invasive biomass.
ii. Unroll a 40m rope or open the measuring tapes to visualize and demarcate a 10m × 10m plot.
iii. Marking the Plot:
a. Mark the edges of the plot and place four iron rods and wooden stumps at the corners.
b. Paint two circles on the top of each wooden stump for easy identification.

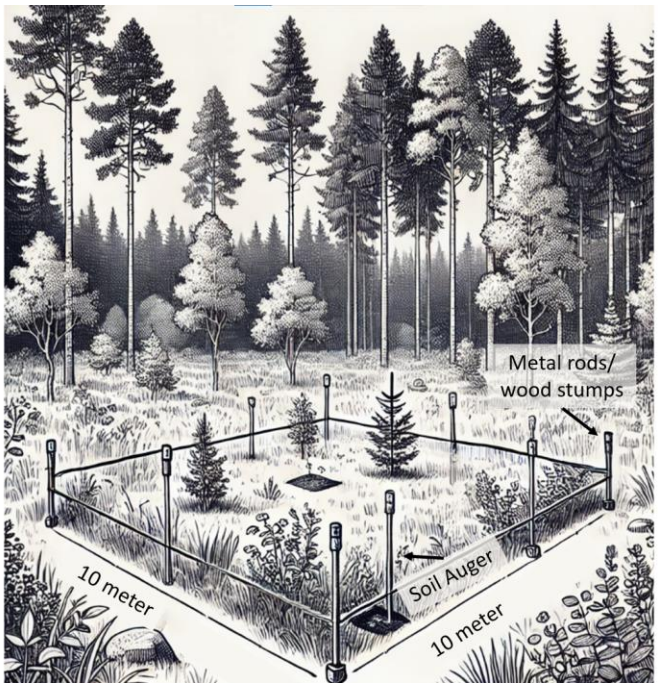

Figure 1: Schematic diagram of a 10X10 m^2 sampling plot. The image is generated using AI.

3. DATA COLLECTION

3.1 Vegetation assessment

i. Record the identity and abundance of all plant species present (shrubs, trees, tree regeneration, and invasive plant recurrence).
ii. Measure and record height of trees, shrubs and tree saplings.
iii. Establish three 1m × 1m subplots within each 10m × 10m plot to record herbs and grasses.
iv. Measure grass and herb cover within each subplot. Record their identity.
v. Assess and record the palatability of species based on available knowledge.
vi. Document whether any fire events have occurred in the area in the past three years.

3.2 Habitat assessment

i. Record the geographical coordinates and names of the forest department staff.
ii. Record the habitat type (Sal, Mixed, Bamboo, etc.).
iii. Document the terrain type of the sampling area.
iv. Note the soil type.
v. Assess canopy cover.
vi. Record litter cover and percentage of bare ground.

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				TREES (in 10m x10m) - 2025-26					SHRUBS (in 10m x 10m) - 2024-25			
Recorder -				Plot ID	Species	Number	height		Plot ID	Species	Number	height
Date	Core	Buffer										
Range	Beat											
camp				GPS WP					GPS WP			
Management unit	RES	INV										
Lat												
Long				Canopy					Canopy			
inv %	inv ht											
oth. Inv.												
terrain												
flat												
gentle slope												
moderate slope												
steep												
undulating/rugged												
forest type												

		Litter		Grass						herbs							
PLOTS	Sub plots				Sp (abundance)						Sp (abundance + phenology)						
		% cover	Depth	Grass %	1	2	3	4	5	% cover	1	2	3	4	5	Bare ground%	Light ground
	a																
	b																
	c																

Figure2: Sampling datasheet for vegetation and habitat sampling

3.3 Herbivory assessment

i. Select three plant species from each plot, ensuring that the same species are sampled in both invaded and managed plots.
ii. From each selected plant, choose one branch and record the following:

- Total number of leaves
- Number of leaves eaten
- Percentage of leaves consumed
- Percentage of plant biomass eaten
- Other plant parts consumed, if any

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Range	Beat	Plot	Core	Recorder	
			Buffer	Forest Staff	

Species	no. leaves	fed leaves	no. branch	fed branch	feeding prop	animal

Figure3: Datasheet to record and assess herbivory by ungulates in the sampling area.

3.4 Soil sampling

i. Collect three soil samples from each 10m × 10m plot, using a soil auger.
ii. Store samples in labeled zip-lock bags.

3.5 Animal signs and presence survey

i. Within the 10m × 10m plot, identify and count animal signs, including all types of faeces.
ii. Record species-specific details for each plot.
iii. Remove all animal pellets from the restored plot for resampling in subsequent assessments.

Animal presence data sheet -
Observer: .....Range: .....Beat: .....date: .....

Plot	Chital	Sambhar	Barasingha	Barking deer	Chausingha	Gaur	Wild pig	Hare	Elephant	Langur	Peafowl	Vulture	Owl	Leopard	Tiger	Jackal	Sloth bear		Cattle		others
RES																					
INV																					

Figure 4: Datasheet to sample animal signs and occurrence

3.6 Human activity signs

i. Document any signs of human and livestock activity in the sampling area.

- Number of trees cut
- Number of branches lopped
- Livestock signs or dung
- Live livestock or humans seen
- Livestock trails
- Number of villages in the administrative unit
- Human and livestock population in the administrative unit

Human disturbance

PLOT	No. of tree cutting	No. of lopped branches	No. of livestock	People seen	Livestock seen	grass/bamboo cutting
A						
B						
C						

Human settlements in the beat (YES/NO). If yes, How many?..... Human population.....livestock pop.....
NTFP Collection (yes/no).....
Fire incident.....extent (0-4),no to very high.....

Figure 5: Datasheet to sample human disturbances in the sampling area. Adopted from Qureshi et al. 2023 (Field guide, Tiger Project).

3.7 Additional Sampling in Future (2025–26)

- Biomass assessment
- Plant Functional traits
- Bird community and acoustics
- Camera Trapping for ungulate interactions
- Plant phenology monitoring

4. FIELD GEAR CHECKLIST

1. 40m rope
2. 4 measuring tapes (10m each)
3. Datasheets or mobile application for data entry
4. Writing pad
5. Folder for organizing datasheets
6. Folder for permission letters and other documents
7. Pen/Pencil
8. Metal spokes for plot marking
9. Kudaal/Faavda/Khurpi (digging tools)
10. Kulhadi (axe)
11. Red and/or white paint
12. Paintbrushes
13. Bag for storing ropes and field gear
14. Soil auger
15. Zip-lock bags for soil storage
16. Vernier calipers
17. 12-inch ruler
18. Permanent marker for labeling soil samples
19. First-aid kit with bandages, anti-septic wash, cotton, tick tweezers, etc.
20. Snacks and food items

Affiliations and Funding: