IMPACT OF PROTECTION ON FOREST QUALITY AT PENCH TIGER RESERVE

by

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I. INTRODUCTION

India has a very high diversity of flora and fauna. It has about 45000 plant species, representing about 7% of the world's flora, including over 15000 flowering plants of which 4900 species are endemic to the country (MoEF, 1994). India's faunal wealth is estimated at 81000 species, representing about 6.4% of the world's fauna. But this immense biological diversity is threatened by a number of factors like habitat destruction, intensive agriculture, overgrazing, pollution, hydrological changes, changes in fire regime, overexploitation, introduced predator and competitor species. Though there are no firm statistics about the biodiversity loss in India, it is estimated by experts that approximately 10 percent of the flowering plants, 20 percent of the mammals and five percent of the birds are in various threatened stages. Solutions to this problem are habitat management measures, legislation, public awareness and the integration of developmental activities and conservation efforts (Sutherland, 2001).

Protected area management in India considers that a major threat to India's wildlife is due to the consumptive resource use by the human population living in and near forested areas. This is specially so in national parks where the annual firing of forests or grasslands, cattle grazing, cultivation, collection of non-timber products and any human residence are disallowed, unless they are a part of the management objectives. Other Indian conservationists, however, consider the policy of total exclusion to be ecologically unsound, practically unviable and socially unjust. They argue that disturbances and competition define the viability and functioning of natural systems, exclusion of competition destroys their dynamism. (Saberwal et al, 2001)

In order to assess the benefit of the exclusionist forest management approach to the forest ecology it is essential to evaluate the quality of forested areas enjoying different levels of protection and hence subject to various degrees of human interaction. This paper reports the results of a study undertaken by PSI in the autumn of 2002 to assess the impact of protection on the quality of the forest in the Pench Tiger Reserve in Madhya Pradesh. The objectives of the study were to :

(i) Develop a comprehensive methodology for (a) assessing the quality of the forest (including its ecological performance), and (b) estimating the degree of protection and the level of human interactions in the forest.

(ii) Assess the quality of the forests in areas receiving different levels of protection in the Pench Tiger Reserve (PTR) and correlate it with the nature and degree of human interactions.

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The Pench Tiger Reserve

The Pench Tiger Reserve (PTR) is named after the Pench river. It was formed in 1992 by merging the 293 sq. km. Pench National Park, the adjoining Pench Sanctuary (118 sq. km.) and an area of 347 sq. km. of reserve forest around it. The total area of the Tiger Reserve is about 758 sq. km. The Pench river, flowing north to south, bisects the Pench National Park into the western Gumtara Range (148 sq. km.) and the eastern Karmajhiri Range (145 sq. km.). The Park is located in the lower southern reaches of the Satpura hills, which constitute the catchment area of the Pench river and fall in the Deccan peninsula biogeographic zone. The southern boundary of the Reserve is contiguous with the Maharashtra state boundary. Although, the Pench river cuts right through the PTR, there are shortages of water inside the Reserve. Numerous streams flowing within the Reserve carry water only for 6 or 7 months in a year. The animals and plants have to bear the brunt of the severe dry months, when water shortages create havoc within and around the park.

At the time of the launching the Pench Tiger Reserve Project, the population of tigers within the park was 22. Their population had increased by 1999-2000 to around 49-51 according to the tiger census. This increase in population was accompanied by a rise in the populations of other wild animals.

II. METHODOLOGY

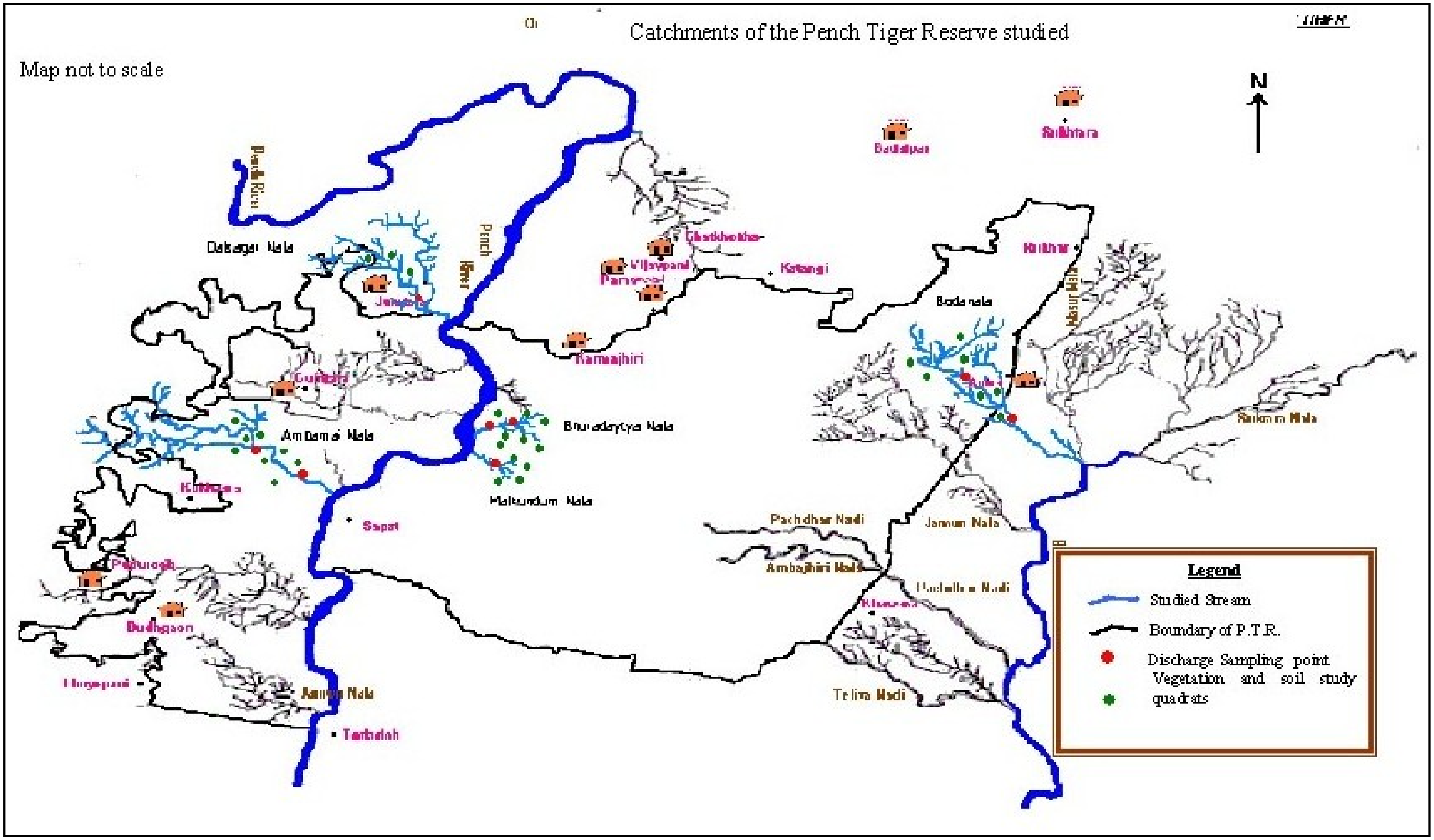
Study sites

To compare the impact of different levels of protection on the forest quality, the following areas were selected for the study (See map in Fig. 1)

Table 1. Study sites

Area	Location	Level of protection	Human intervention
Malakundam catchment area	National Park (Karmajhiri range)	High	Undisturbed
Bhuradaytya catchment area	National Park (Karmajhiri range)	High	Undisturbed
Ambamai catchment area	National Park (Gumtara range)	High	Slightly disturbed
Bodanala catchment area	Sanctuary and protected forest	Medium	Disturbed
Dalsagar catchment area	Reserved forest	Low	Highly disturbed

Bhuradaytya and Malkundam catchments located inside the Pench National Park receive a high level of protection and are considered as undisturbed areas. Ambamai catchment area is situated at the fringes of the National Park, with human settlements within a couple of kilometers. Hence it is considered as slightly disturbed area. A part of the Bodanala catchment falls under the Pench Tiger Sanctuary and the rest inside a protected forest. It receives less protection and human settlements are observed nearby. It is considered as a disturbed area. Dalsagar catchment area is located outside the PTR and receives the lowest level of protection. Villages are found within a kilometre at any point throughout this catchment. It is categorized as a highly disturbed area.


Catchments of the Pench Tiger Reserve studied
Map not to scale
N
Pench River
Pench River
Dalsagar Nala
Amlbamai Nala
Bhuradaytya Nala
Maltundum Nala
Sapat
Ramajhiri
Katangi
Badalpar
Sillitara
Kulthar
Boda nala
Salkam Nala
Pachdhar Nadi
Ambajhiri Nala
Jamun Nala
Teliya Nadi
Budhgaon
Turbaloh
Legend
Studied Stream
Boundary of P.T.R.
Discharge Sampling point
Vegetation and soil study quadrats

Forest Quality Attributes

In this study forest quality is defined in terms of :

a) Basic vegetation quality, a measure of the health of the vegetation in the PTR. It comprises of plant diversity, density, vegetative cover and its regeneration capacity.

b) Human use value, which indicates the availability of vegetation useful to human beings. It estimates the amount and species of vegetation like timber, non-wood forest products (NWFP), fodder, fuelwood, as well as the recreational value of the PTR forest calculated in terms of aesthetics.

c) Ecological performance, which is a measure of the nature and availability of specific natural resources in the PTR. These are (i) Water availability (in the main stream of a catchment) and soil quality, and (ii) faunal distribution.

In this paper the variation of these attributes as functions of human interventions or interactions has been studied.

a) Basic Vegetation Quality : To assess the basic quality of vegetation, 31.5 m x 31.5 m (0.1 ha) quadrats were laid in the selected catchments of PTR. The number of quadrats in each catchment depended on the size of the catchment area. The vegetation parameters recorded on site were: species name, height, approximate age, GBH, canopy diameter and human usage. In each quadrat, four 10m X10 m plots were laid to assess shrub cover, shrub diversity and density. Ten, 1m X 1m sub-plots were laid in each quadrat to measure ground cover and identify the predominant herb and grass species.

The species diversity of trees and shrubs were calculated using the Shannon-Weiner diversity index. The density of trees and shrubs, tree canopy cover and shrub cover were evaluated using standard formulae, whereas, the ground cover was visually estimated. The regeneration capacity of trees was determined by counting the number of emerging saplings in the quadrats.

b) Human use value : To determine the human use value of the forest resources at each study site, the number of NWFP species, fuelwood species and timber species tree species were counted in each quadrat and expressed in terms of one hectare of that catchment. Groundcover was used to represent fodder yield in the catchment. In addition, the potential of each catchment to attract tourists was qualitatively expressed as its recreational value.

c) Ecological performance : Water availability was estimated at specific sampling points on the main stream within each selected catchment. The water availability in each catchment area was calculated in terms of

$$Q = K \times A^n$$

where, Q = discharge, A = area of the catchment, K is constant for a particular catchment and n is a variable indicating the recharging capacity of a particular catchment (Subramanya 2000).

Field observations were made to measure a variety of soil quality parameters. Soil slope and depth were recorded on site. Soil texture was calculated in terms of the approximate sand, silt and clay content. Organic matter content and porosity were measured qualitatively. For soil erosion visual observations were made.

The faunal distribution of the forest was studied to evaluate the capacity of a certain forest area to support diverse animal wildlife populations. It was evaluated from direct and indirect evidence of wildlife distribution in the study areas. Direct evidence was gathered by counting the number of insect, fish, bird and animal species. In the case of birds and animals, the number of individuals sighted during the field measurements was also noted. Information was collected from forest officials and the forest guides (local people hired during the study to help the study team) about the likelihood of specific animals in the study area. Indirect information about the distribution of animals was obtained from footprints, scat and markings.

d) Human interactions: The following factors were monitored for assessing human interference :

(i) Proximity to habitation: Direct measurements were made of the distance of the study patch from the nearest village(s) and the forest beat office.

(ii) Forest passages**:** The number of forest trails 'pagdandis' passing through a study patch was counted. The nearness, (distance in kms.) of the forest main road from the study patch was also determined on site and cross-verified from the toposheet.

(iii) Loppings & fellings**:** The number of trees lopped and felled in the study quadrat was recorded on site.

(iv) Signs of grazing: Livestock grazing signs, e.g., hoof-marks, scat and/or direct sightings in and near the study quadrat were recorded.

(v) Signs of forest fires: Information was collected about occurrences of man-made fires in the study catchments. Visual observations of signs of forest fires on site were also made.

(vi) Water use: Water use information was collected from forest officials and visual observations.

(vii) Tourist influx: This data was collected from forest officials.

Attributes' Indices

Quantitative indices were developed for the three attributes of forest quality, viz, vegetation quality, human use value and ecological performance, as also for human interventions, the independent variable. Index values were calculated for each attribute in all the five study catchments. The index value for each attribute was determined by calculating scores for each parameters of the attribute. The score for each parameter of an attribute was based on a maximum score assigned to that parameter. Detailed calculations are given in the Appendix.

III. RESULTS AND DISCUSSION

This study has attempted to do a comprehensive assessment of the overall forest quality in PTR as a function of human interventions. As described in the above section, indices have been developed for all the three attributes of forest quality, i.e., vegetation quality, human use value and ecological performance – as well as, an index for human interactions. The Forest Quality Index (Q) is a assumed to be a simple summation of the Vegetation Quality Index (V), Human Use Value Index (H) and the Ecological Performance Index (E). Table 2 summarises the results of all the calculations given in the Appendix for all the different indices in the five PTR study catchments.

Table 2 : Comparison of all the attributes' indices for the 5 study catchments in the PTR

Catchment	Vegetation Quality Index V **(100)**	Ecological Performance Index E = W+F **(100)**		Human Use Value Index H **(100)**	Forest Quality Index Q = V+E+H **(out of 100)**	Human Interactions I **(out of 100)**
		Soil Quality & Water Availability Index W **(70)**	Faunal Distribution Index F **(30)**			
Malkundam	17	34	12	37	33	c
Bhuradaytya	18	39	14	34	35	34
Ambamai	26	47	16	37	42	50
Bodhanala	22	37	4	28	30	59
Dalsagar	17	31	4	23	25	66

Vegetation Quality

Fig 2a shows that vegetation quality is the highest in the Ambamai catchment, a slightly disturbed area, where the Human Intervention Index (I = 50) is mid-way between those for the undisturbed catchments (I ~ 35) and Dalsagar, the most disturbed one (I = 66). It is quite possible that the Ambamai catchment has the best vegetation quality because its Soil Quality and Water Availability Index (W = 47) is the highest for all the five catchments. Fig 2b shows that the Vegetative Quality Index has a strong positive (R = 0.87) and linear relationship with the Soil Quality and Water Availability Index.

The Vegetation Quality Index of Dalsagar (I = 17) is about a same as for the undisturbed Malkundam (I = 17) and Bhuradaytya (I = 18) catchments.

Fig 2a : Vegetation Quality Vs Human Interactions

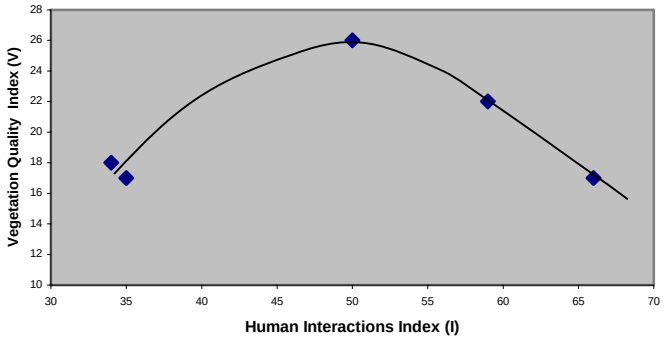
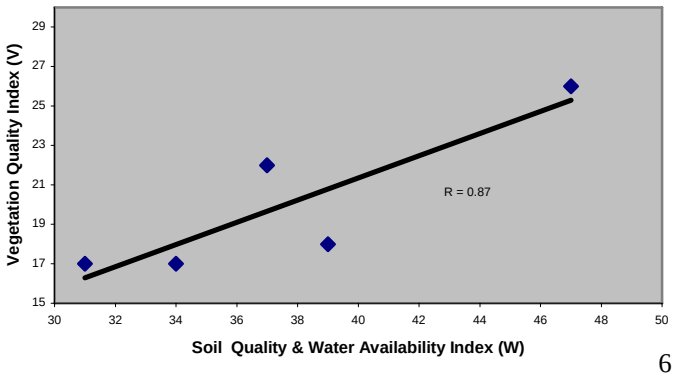


Fig 2b : Vegetation Quality Vs Soil Quality & Water Availability

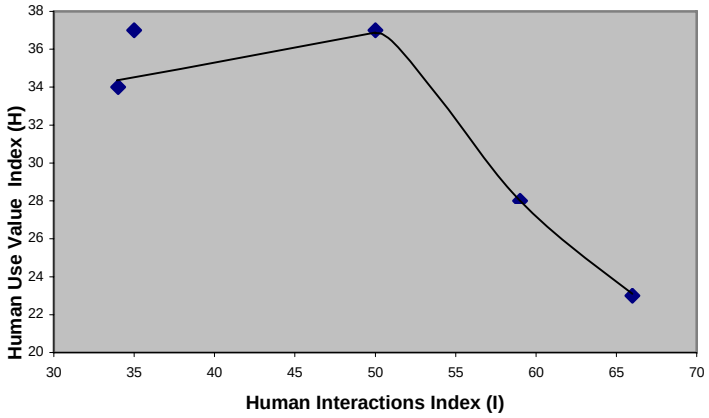


A likely explanation for this is that the vegetative diversities in the undisputed catchments are lower than those for the catchments with higher degrees of human intervention (See Table A1 in the Appendix). The overall conclusion from Fig 2a is that there is a threshold value of human interference beyond which the vegetative quality begins to deteriorate.

Human use value

The graph for the Human Use Value Index (H) as function of the Human Interactions Index (I), Fig 3, shows that the human use value of the study catchments rises slightly as the level of disturbance increases from undisturbed to slightly disturbed. But with increasing levels of human interventions, the human use value declines rapidly. The implication is that beyond a threshold level, human intervention leads to rapid denudation of vegetation that is useful to the local people. Data in Table A2 in the Appendix shows that fuelwood trees and fodder (ground cover) are more seriously affected by human intervention, as opposed to timber trees that are of commercial use.

Fig 3 : Human Use Value Vs Human Interactions



Ecological Performance

As in the case of the previous attributes, ecological performance also shows a threshold value for human interventions in the PTR. The slightly disturbed Ambamai catchment has the highest value of the Ecological Performance Index (E = 63). Fig 4b shows that faunal distribution drops rapidly once the level of human interactions exceeds the threshold level.

Fig 4a : Ecological Performance Vs Human Interactions

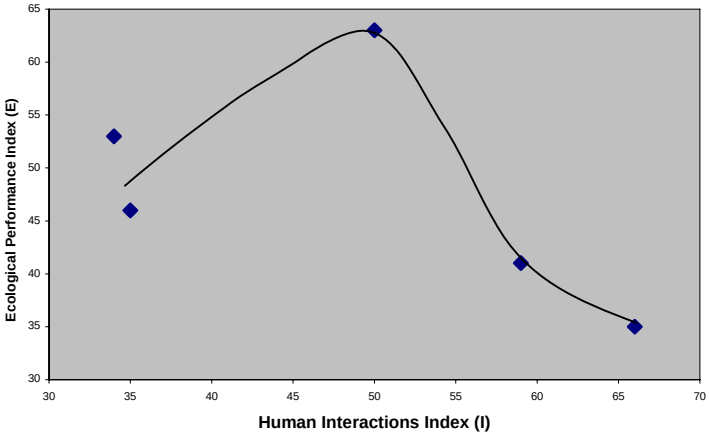
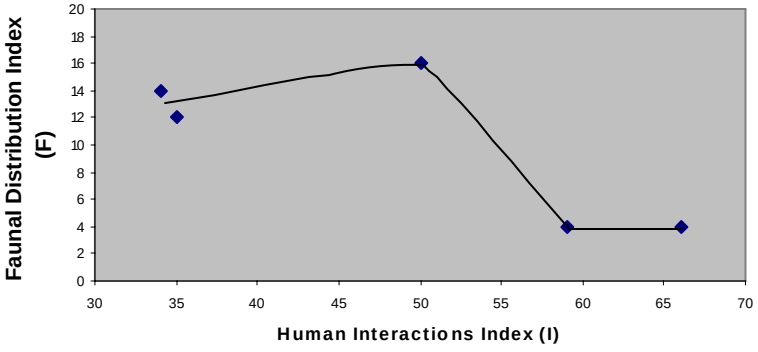


Fig 4b : Faunal Distribution Vs Human Interaction

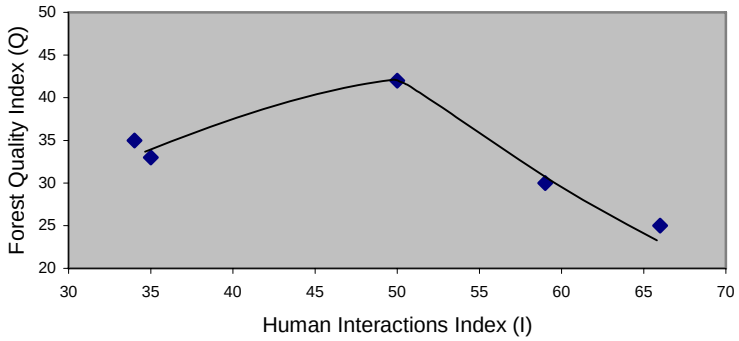


Forest Quality

A comprehensive Forest Quality Index (Q) has been developed in this paper based on measurement or observation of 28 parameters that are grouped under three attributes. The variation of Q

with the Human Intervention Index (I) is shown in Fig 5.

Fig 5 : Forest Quality Vs Human Interactions



It shows that the value of Q is greater for the slightly disturbed Ambamai catchment (Q = 42) than for the undisturbed Malkundam (Q = 33) and Bhuradaytya (Q = 35) catchments. This leads to the conclusion that catchments in the PTR have a threshold tolerance level for human interactions beyond which their overall forest quality begins to degrade. Thus forests in the PTR can tolerate, even prosper, under modest levels of human interference.

There is a negative and weak correlation (R = -0.52) between the Forest Quality Index and the Human Interactions Index. Since the correlation between the vegetation quality and the soil quality & water availability is positive and much higher (R = 0.87), it implies that in the PTR the impact of the soil and water quality regime on the vegetation quality, and the forest quality, overshadows the effects of human interventions.

Therefore, for the purpose of protected area management it becomes imperative to assess the level (degree) of human interactions and arrive at the threshold value of human interactions that forest ecosystems can tolerate. Appropriate measures should be adopted in areas, where the levels of interaction exceed this threshold. On the other hand, in areas where the level of interaction is below the threshold, the local community should be allowed to interact with the forest system (through a process of mutual agreement between the community and the protected area management).

IV. CONCLUSIONS

This study was designed to determine the effects of forest protection, or conversely human interference, on the quality of the forest ecosystem in the PTR. After quantitative measurement or qualitative observation of 28 different parameters that affect or indicate forest quality, it is seen that forests in the PTR have a threshold level of tolerance for human interventions. Upto this level, as represented by the slightly disturbed Ambamai catchment, forests can not only tolerate human interaction but even prosper. Beyond this level there is a rapid decline in the forest quality as a result of human interventions. Instead of the generalised exclusionist approach of forest management presently practiced in India, this study finds the necessity to evolve an area specific knowledge-based approach that appropriately establishes the usufruct rights of the forest communities.

V. ACKNOWLEDGEMENT

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APPENDIX

Calculation details for determining the parameters scores and the attributes' indices are given in this section. Two methods were followed by calculating the scores of the various parameters :

(1) For the Vegetation Quality Index and the Human Use Value Index, the parameter score for a particular catchment is the measured or observed value of that parameter expressed as a percentage of its aggregate value for all the five catchments and than noramlised for the maximum score assigned to that parameter. For example, the tree density for Malkundum catchment is 717 trees/ha, the aggregated tree densities for all the five catchments adds upto 3434 trees/ha and the maximum score assigned to tree density is 10, then the Tree Density score for Malkundum catchment is calculated as :

$$\frac{717}{3434} \times 100 = 21\% \times \frac{1}{10} = 2.1$$

(2) For the Ecological Performance Index (water availability, soil quality, and habitat support capacity) and Human Interaction Index the parameter scores were given on the basis of pre-defined classifications. The scoring for faunal distribution is shown below.

Sl. No.	No of species sighted	Predefined score (out of 10)	Total no. of individuals sighted	Predefined score (Out of 10)	No. of species likely	Predefined score (Out of 10)
1	$n < 2$	2	$n < 20$	1	$n < 2$	2
2	$2 \leq n < 5$	4	$20 \leq n < 50$	3	$2 \leq n < 5$	4
3	$5 \leq n < 8$	6	$50 \leq n < 80$	5	$5 \leq n < 8$	6
4	$n \geq 8$	8	$80 \leq n < 110$	7	$n \geq 8$	8

Table A1 : Vegetation Quality Index and parameter scores for five catchments in PTR.

Parameters	Max Score	Malkundum			Bhuradaytya			Ambamai			Bodanala			Dalsagar		
		Actual Value	%	Score	Actual Value	%	Score	Actual Value	%	Score	Actual Value	%	Score	Actual Value	%	Score
Tree diversity	**10**	2.2	18	**1.8**	1.98	16	**1.6**	2.96	24	**2.4**	2.52	21	**2.1**	2.46	20	**2**
Age diversity (tree)	**10**	1.93	20	**2**	1.91	19	**1.9**	1.81	18	**1.8**	2.05	21	**2.1**	2.14	22	**2.2**
Ht diversity (tree)	**10**	1.71	21	**2.1**	1.91	23	**2.3**	1.63	20	**2**	1.41	17	**1.7**	1.53	19	**1.9**
Shrub diversity	**10**	2.19	20	**2**	1.78	16	**1.6**	1.93	17	**1.7**	2.84	25	**2.5**	2.42	22	**2.2**
Tree density	**10**	717	21	**2.1**	650	19	**1.9**	852	25	**2.5**	722	21	**2.1**	493	14	**1.4**
Shrub density	**10**	808	10	**1**	1325	17	**1.7**	2033	26	**2.6**	2225	28	**2.8**	1447	18	**1.8**
Tree canopy cover (m^2/ha)	**10**	7415	16	**1.6**	7231	16	**1.6**	13356	30	**3**	11276	25	**2.5**	5970	13	**1.3**
Shrub cover (m^2/ha)	**10**	397	7	**0.7**	391	7	**0.7**	2883	48	**4.8**	1339	22	**2.2**	959	16	**1.6**
Ground cover (%)	**10**	55	25	**2.5**	54	25	**2.5**	46	21	**2.1**	30	14	**1.4**	32	15	**1.5**
Regeneration (saplings/ha)	**10**	126	16	**1.6**	136	17	**1.7**	261	33	**3.3**	195	24	**2.4**	79	10	**1**
Vegetation Quality Index	**100**			**17**			**18**			**26**			**22**			**17**

Table A2 : Human Use Value Index and parameter scores for five catchments in PTR.

Paramaters	Max score	Malkundum			Bhuradaytya			Ambamai			Bodanala (p.f.)			Dalsagar (r.f.)		
		Actual	%	Wt	Actual	%	Wt	Actual	%	Wt	Actual	%	Wt	Actual	%	Wt
Timber (trees/ha)	**20**	200	17	3.4	256	21	4.2	244	20	4	256	21	4.2	250	21	4.2
Fuel (trees/ha)	**20**	310	31	6.2	246	24	4.8	228	23	4.6	206	20	4	20	2	4
NWFP (plants/ha)	**20**	190	22	4.4	120	14	2.8	268	32	6.4	121	14	2.8	150	18	3.6
Fodder (% ground cover)	**20**	55	25	5	54	25	5	46	21	4.2	30	14	2.8	32	15	3
Aesthetic value	**20**			18			17			18			14			8
Human Use Value Index	**100**			**37**			**34**			**37**			**28**			**23**

Ecological Performance Index

Table A3 : Water and Soil Quality Indices and parameter scores for five catchments in PTR.

Parameters	Max score	Malkundum	Bhuradaytya	Ambamai	Bodanala	Dalsagar
Soil Quality						
1. Slope (angle in degrees)	**10**	3.4 ° (3)	1.7 ° (6)	1.7 ° (6)	1.7 ° (6)	1.2 ° (8)
2. Soil texture	**10**	Wt (6)	Wt (6)	Wt (8)	Wt (8)	Wt (4)
i. Sand (%)		50	45	35	35	40
ii. Silt(%)		50	45	35	30	20
iii. Clay(%)		0	10	30	35	40
3. Soil organic matter	**10**	Low (3)	Med to High (7.5)	Low to Med (4.5)	Low (3)	Low to Med (4.5)
4. Soil depth	**5**	40cm – 1 m (3)	30 cm – 80cm (2.5)	60 cm – 1m (4)	20 cm – 1m (3)	30 cm – 80 cm (2.5)
5. Soil porosity	**5**	Medium (3)	High (4)	Low to Medium (2.5)	Low (2)	Low (2)
6. Soil erosion	**10**	Low (8)	Low (8)	Low (8)	Medium (5)	High (2)
Soil Quality Index	**50**	**26**	**34**	**33**	**27**	**23**
Water Availability						
1. Discharge (stream-flow)		48 lpm	360 lpm	7560 lpm	2160 lpm	720 lpm
2. Recharging capacity (**n**)	**10**	n=3 (4)	n=0.2 (1)	n=5 (8)	n=4 (6)	n=3 (4)*
3. Catchment area		3.1325	7.185	65.013	62.688	10.763
4. Duration of flow	**10**	6 months (4)	6 months (4)	7.5 months (6)	5 months (4)	5 months (4)
Water Availability Index	**20**	**8**	**5**	**14**	**10**	**8**
Total Soil & Water Index	**70**	**34**	**39**	**47**	**37**	**31**

(NB: Scores for individual parameters are given in the parenthesis.)

Table A3b : Water availability classification

Sl. No.	Recharging capacity (10) (Value of n)	Score	Duration of flow	Score
1	$0 \leq n < 1$	1	$0 \leq n < 2$	1
2	$1 \leq n < 2$	2	$2 \leq n < 4$	2
3	$2 \leq n < 3$	4	$4 \leq n < 6$	4
4	$3 \leq n < 4$	6	$6 \leq n < 8$	6
5	$4 \leq n < 5$	8	$8 \leq n < 10$	8
6	$n \geq 5$	10	$10 \leq n < 12$	10

(Predefined Score)

Table A3c : Soil Quality Classification

Sl. No.	Soil Slope (degrees)	Score	Soil Depth (m)	Score	Soil Organic Matter	Score	Soil type	Score	Soil Porosity	Score	Soil Erosion	Score
1	< 0.5	10	< 0.5 m	2	Low	3	Sandy Silt	8	Low	2	Low	8
2	0.5 – 1.0	8	0.5 m – 1.0 m	3	Medium	6	Clayey Loam	5	Medium	3	Medium	5
3	1 – 2	6	> 1.0 m	4	High	9	Sandy Clay	2	High	4	High	2
4	Max Score	10		5		10		10		5		10

Table A4a : Faunal distribution in different catchments in PTR

Faunal Type	Malkundum	Bhuradaytya	Ambamai	Dalsagar	Bodanala
Direct Sightings					
a) Animals	Sp = 3	Sp = 2	Sp = 2	Nil	Nil
	TN = 92	TN = 30	TN = 88	Nil	Nil
b) Birds	Sp = 2	Sp = 3	Sp = 7	Sp = 2	Nil
	TN = 15	TN = 20	TN = 25	TN = 4	
c) Insects	Sp = 2	Sp = 5	Sp = 4	Sp = 2	Nil
d) Fishes	Nil	Nil	Sp = 4	Nil	Nil
Reportings/ Likelihood					
Animals	Sp = 3	Sp = 6	Sp = 5	Sp = 3	Sp = 4

Sp = Species number; TN = Total number of individuals

Table A4b : Ranking Faunal Distribution :

Sl. No.	No of species sighted	Predefined score	Total no. of individuals sighted	Predefined score	No. of species likely	Predefined score
1	$n < 2$	2	< 20	1	$n < 2$	2
2	$2 \leq n < 5$	4	$20 \leq n < 50$	3	$2 \leq n < 5$	4
3	$5 \leq n < 8$	6	$50 \leq n < 80$	5	$5 \leq n < 8$	6
4	$n \geq 8$	8	$80 \leq n < 110$	7	$n \geq 8$	8
5	**Max Score**	**10**		**10**		**10**

Table A4: **Faunal Distribution Index of the 5 catchments in PTR.**

Parameter	Max Score	Malkundum	Bhuradaytya	Ambamai	Bodanala	Dalsagar
Direct sighting (species)	**10**	(4+4+4)/3 = 4	(4+4+6)/3 = 5	(4+6+4+4)/4 = 5	0	0
Direct sighting (total no.)	**10**	(7+1)/2 = 4	(3+3)/2 = 3	(7+3)/2 = 5	0	0
Likelihood of species	**10**	4	6	6	4	4
HSC Index	**30**	**12**	**14**	**16**	**4**	**4**

Table A5a : Ranking of different parameters of human disturbance

Proximity to Villages (30)	Proximity to Forest beat office (10)	Nearness of forest main roads (20)	No of footpaths (20)	No of lopped trees (20)	No of felled trees (20)	Tourism (40)
<1 km = 25	<1 km = 8	<0.5 18	<2 = 3	None = 0	None = 0	Heavy = 35
1-2 km = 20	1-2 km = 7	0.5-1 = 13	2-4 = 7	Very few = 4	Very few = 4	Moderate = 25
2-3 km = 15	2-3 km = 5	1-2 = 8	4-6 = 11	Few = 8	Few = 8	Mild = 15
3-4 km = 10	3-4 km = 3	>2 = 3	6-8 = 15	Moderate =12	Moderate =12	None = 5
>4 km = 5	>4 km = 1		>8 = 19	Many =16	Many =16	

Note: Weightage is assigned to **signs of grazing (out of 30)** and **use of water** (out of 10) by qualitative estimation on the spot.

Table A5 : Human interference in different catchments in PTR

Sl. No	Paramaters	Malkundum	Score	Bhuradaytya	Score	Ambamai	Score	Bodanala	Score	Dalsagar	Score
1	Proximity to habitation										
	a) Forest beat office **(10)**	~ 1.5 km	7	~ 2-3 kms	5	2-3 kms	5	~ 1 km	8	Not seen	1
	b) Nearest village **(30)**	~ 6 kms (Karmajhiri)	5	~ 5 Kms (Karmajhiri)	5	~ 2-3 kms	15	~ 1.5 Km (Kurai and Hardoli)	20	~ 1 km (dawajhiri)	25
2	Passage										
	a) Nearness of forest main roads **(20)**	~ 1 km	8	~ 0.5 Km	18	~ 0.5 – 1 km	13	~ 1.5-2 Km from NH 7	8	~ 0.5 km	18
	b) No of footpaths **(20)**	6	15	5	11	8	19	5	11	8	19
3	No of lopped trees **(20)**	No	0	Very few	4	Few	8	Moderate	12	Many	16
	No of felled trees **(20)**	No	0	No	0	Few	8	Many	16	Many	16
5	Signs of Grazing **(30)**	No	0	No	0	Cattle hoof marks seen	15	A herd of about 20 goats	25	~ 30 cattle seen grazing	25
7	Use of water **(10)**	No	0	No	0	Used by livestock	6	Used by locals	7	Used by locals	7
8	Tourism **(40)**	Heavy influx	35	Moderate influx	25	Very Mild	10	Very Mild	10	Almost None	5
	Total Score for Human interactions **(200)**		**70**		**68**		**99**		**117**		**132**
	Human Interaction Index (100)		**35**		**34**		**50**		**59**		**66**

(N. B: NWFP collection, forest fire, agriculture and mining were not recorded in any of the catchment.)
Maximum scores are given in brackets