A Resource Allocation Model for Tiger Habitat Protection

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June 2013

Abstract

Habitat conservation is critical to the survival of endangered tigers. This paper develops a resource-allocation model for the protection of tiger habitats, using information on threats to particular tiger subspecies, the quality of remaining habitat areas, the observed effectiveness of habitat protection by country, and the potential costs of protection projects in 74 habitats in Asia. This model will be implemented in two stages. The first stage involves using user-specified weights to combine numerous sub-indices into composite indices, covering threats to species, habitat quality, potential project costs and the effectiveness of protections. At the

second stage, additional user-specified weights are used to combine the composite indices into priority scores and potential project budget shares for all 74 habitat areas. Results suggest that changes in user-specified weights can have very a significant impact on habitat priority scores. Illustrative scenarios indicate that the model can make a useful contribution by identifying priority orderings that are consistent with different sets of preferences. It will also provide feedback to decision makers regarding the implicit preferences associated with their resource allocation decisions.

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Keywords: Biodiversity Conservation; Tiger Habitat: Resource Allocation

JEL Classification: Q23, Q57

World Bank Sector: ENV

This research was funded by the Knowledge for Change Program.

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1. Introduction

The International Union for Conservation of Nature has classified tiger as *endangered* in its Red list of Threatened Species of (<http://www.iucnredlist.org/details/15955/0>). The wild tiger population of tropical Asia dropped from about 100,000 to 3,500 in the past century. The Bali, Javan and South China subspecies are believed to be extinct in the wild. An estimated 2,380 Bengal tigers survive, along with 340 Indochinese, 500 Malayan and 325 Sumatran tigers. The surviving wild tiger population of tropical Asia inhabits a scattered arc from southwest India to northwest Indonesia, much of it in upland areas. Bengal tigers survive in India, Nepal, Bhutan, Bangladesh and northern Myanmar, while the remaining Indochinese tigers are found in western and southeastern Myanmar¹, Lao PDR, Vietnam, Cambodia and Thailand. In contrasting geographic concentration, Sumatran tigers are confined to one Indonesian island and Malayan tigers exist only in Peninsular Malaysia and one small area in southern Thailand. Long term survival of the tiger is dependent on conservation of tiger habitats.²

The global community has mobilized to conserve the tiger's remaining habitat through the Global Tiger Initiative, which is supported by all countries with known tiger populations, the World Bank, and over 40 civil society organizations.³ Participating countries and institutions have endorsed the Global Tiger Recovery Program (GTRP), which aims to double the number of wild tigers by 2022 through habitat conservation programs and cooperation across national boundaries to stop poaching and illegal trade in tiger parts.

Operating under tight budget constraints, the GTRP confronts several complicating factors, including the need to conserve specific habitats large enough to accommodate this keystone

¹ The ranges of the Bengal and Indochinese tigers may overlap in Myanmar.

² This paper focuses on forest habitat loss, but we recognize that poaching and illegal trade in tiger parts can devastate remaining tiger populations, even when forest habitat is intact.

³ For more complete information, see <http://www.globaltigerinitiative.org/html/participants.php>

predator; differential threats to important regional subspecies that must be preserved (Bengal, Indochinese, Malayan and Sumatran tigers); divided national jurisdictions; differences in countries' institutional capabilities, conservation management costs, and willingness to pay for conservation; and, not least, widely-differing and rapidly-changing opportunities for commercial exploitation of remaining habitat areas.

Cost-effective resource allocation under these dynamic conditions involves frequent reassessment of threats and opportunities in many habitat areas scattered across the tiger range countries. Timely analysis requires near-real-time forest monitoring information, which is now available from FORMA (Forest Monitoring for Action), a new database developed by a research consortium that includes the Center for Global Development (<http://www.cgdev.org/forma>), the World Resources Institute, the University of Maryland, and Resources for the Future, in consultation with World Bank staff, Conservation International, the Nature Conservancy and WWF. Drawing on data from NASA's MODIS system, FORMA provides monthly updates on forest clearing at high spatial resolution for tropical Asian countries with tiger habitat.

From a formal analytical perspective, saving the tiger involves optimal spatial resource allocation with a limited budget, a short time horizon (to prevent extinction), a complex, constantly-changing spatial distribution of potential conservation benefits and costs, and the prospect of rapid, irreversible losses in areas where conservation is weak. Combining the FORMA information with a spatially-disaggregated database of economic, demographic and geographic information, previous papers in this series have focused on identifying area-specific drivers of habitat destruction (Dasgupta, et al. 2012a), and testing the effects of interventions intended to protect habitat (Dasgupta, et al., 2012b).

In this paper, we draw on information and insights from the previous papers to develop a model that can inform the allocation of GTRP resources for tiger habitat conservation. Designed for frequent updates as new information becomes available, the model estimates priorities and potential program budget shares for 74 tiger habitat areas in 9 countries: Cambodia, India, Indonesia, Lao PDR, Myanmar, Malaysia, Nepal, Thailand and Vietnam.⁴ It incorporates four key factors for resource allocation: Differential threats to tiger subspecies, habitat quality, potential project implementation costs, and recent evidence on the effectiveness of countries' protection policies.

The remainder of the paper is organized as follows. Section 2 develops the modeling framework, while Section 3 introduces the data that drive the model. Section 4 describes the operation of the model. Section 5 illustrates its operation in three different scenarios, and Section 6 summarizes and concludes the paper.

2. Allocating Resources for Tiger Habitat Protection

To provide a consistent modeling framework, we adopt an approach to optimal allocation that draws on prior theoretical and empirical work by Behrman, Pollak and Taubman (1982), Bolt, et al. (2003), Buys, et al. (2004), Pandey, et al. (2005) and Wheeler (2011). In this model, the welfare impact of conservation project expenditures is a function of their levels and distributions across tiger habitat areas. Resource allocation decisions by the Global Tiger Recovery Program must incorporate and balance three factors: tiger subspecies preservation; representation for all participating countries; and overall welfare maximization. We cannot realistically characterize the program's objective function as linear (infinite elasticity of substitution across habitat areas), because sole allocation to one area is infeasible, whatever the

⁴ Bangladesh and Bhutan are not included in this exercise because FORMA data are not yet available for their tiger habitat areas. They will be included in future updates as the data become available.

relative scale of its protection problem. Broader geographic coverage is implied by the program's charter. At the same time, the objective function is not purely fixed-coefficient (zero elasticity of substitution across areas), because nothing forces it to maintain cross-country parity in allocation. This is good, since the distribution of habitat protection problems is likely to be far from even across areas.

We adopt an intermediate assumption: that the objective function is characterized by unit-elastic substitution across areas. A unit-elastic (Cobb-Douglas) welfare function permits tailoring of programs to area-specific conditions, while encouraging portfolio diversification through the operation of diminishing returns. Expected welfare gains from expenditures are related to both the scale of habitat protection problems and the cost of successful protection under local conditions.

Formally, we specify the resource allocation problem as follows:

Welfare Function: (1) $W = \prod_{ijk} T_{ijk}^{\rho_i}$

where T_{ijk} = Expected number of surviving tigers of subspecies i in habitat j, country k

ρ_i = Exogenous extinction risk for tigers of subspecies i.

Extinction risk is a function of overall deterioration of the subspecies' habitat in the region (D), the number of surviving tigers in the subspecies (T), and the number of countries (N) that still harbor them:

(2) $\rho_i = \gamma_0 D_i^{\gamma_1} T_i^{\gamma_2} N_i^{\gamma_3}$

The expected number of surviving tigers is a function of habitat quality and the effectiveness of habitat protection in country k.

(3) $T_{ijk} = \alpha_0 G_{jk}^{\alpha_1} Q_{jk}^{\alpha_2} P_k^{\alpha_3}$

where G_{jk} = Scale of GTRP activity in habitat j, country k

Q_{jk} = Quality of habitat j, country k

P_k = Effectiveness of habitat protection in country k

Habitat quality is a function of habitat size (H) and fragmentation (F):

$$(4) Q_{jk} = \delta_0 H_{jk}^{\delta_1} F_{jk}^{\delta_2}$$

Resource allocation is limited by an overall budget constraint:

$$(5) \bar{B} = \sum_{jk} C_{jk} G_{jk}$$

where B = Available budget

C_{jk} = Unit cost of protection for habitat jk

Unit protection costs reflect a combination of economic incentives for local conservation and the direct cost of habitat protection, which is principally a function of local labor cost.

$$(6) C_{jk} = \beta_0 L_{jk}^{\beta_1} W_k^{\beta_2}$$

where L = Opportunity cost of land in habitat jk

W = Labor cost in country k

Substituting (3) into (1) yields the following welfare function:

$$(7) W = \omega \prod_{ijk} G_{ijk}^{\alpha_1} Q_{jk}^{\alpha_1} P_k^{\alpha_2}$$

Maximization of W subject to the overall budget constraint yields the following ratio of optimal GTRP resource allocations for protection of arbitrarily-chosen habitat areas 1 and 2 with tiger subspecies m and n:

$$(8) \frac{C_1 G_1^*}{C_2 G_2^*} = \frac{\rho_m^{\alpha_1} Q_1^{\alpha_2} P_1^{\alpha_3}}{\rho_n^{\alpha_1} Q_2^{\alpha_2} P_2^{\alpha_3}}$$

Substituting and re-arranging, we obtain:

$$(9) \frac{G_1^*}{G_2^*} = \frac{\hat{\rho}_m^{\alpha_1} \hat{Q}_1^{\alpha_2} P_1^{\alpha_3} \hat{C}_1^{\alpha_4}}{\hat{\rho}_n^{\alpha_1} \hat{Q}_2^{\alpha_2} P_2^{\alpha_3} \hat{C}_2^{\alpha_4}}$$

The program priority score of habitat area 1 is the numerator of (9), where $\hat{\rho}$, $\hat{Q}$ and $\hat{C}$ are calculated from (2), (4) and (6), respectively. Its share of the program budget is

$$(10) \quad s_1 = \frac{S_1}{\sum_{j=1}^N S_j}$$

3. Quantifying Habitat Protection Factors

To implement the model, we quantify the allocation factors using the database developed in Dasgupta, et al. (2012a). For each tiger habitat area, we develop composite measures as follows. Variables are denoted by letters from the previous equations.

(1) Subspecies extinction risk (ρ). Our measure has three components:

- a. Species numbers (T): Table 1 provides recent estimates of surviving tiger populations, by subspecies and country. Our measure for each subspecies is its share of the total tiger population.
- b. Overall habitat loss (D): For each habitat area, we compute natural forest cover remaining by August, 2011. This combines measures from Hansen, et al. (2006) for 2000, Hansen, et al. (2008) for 2000 – 2005, and FORMA data for January, 2006 to August, 2011. Across all areas, we total original and remaining forest cover by subspecies⁵, and compute the overall percentage of original forest that has been subject to clearing.
- c. Species distribution across countries (N): In standard portfolio terms, spreading the remaining tigers across polities should reduce aggregate risk. Our index of “portfolio risk” is the intercountry entropy measure (E) for each subspecies, where

$$E_i = -\sum_{k=1}^K s_{ik} \ln s_{ik}$$

and s_k = country k 's share of surviving tigers of subspecies i .

⁵ See the Introduction, para. 1, for the geographic ranges of Bengal, Indochinese, Malayan and Sumatran tigers.

Table 1: Surviving Wild Tiger Populations*

<u>Bengal^a</u>		<u>Indochinese</u>		<u>Malayan</u>		<u>Sumatran</u>	
India	1,706	Thailand	200	Malaysia	500	Indonesia	325
Bangladesh	440	Myanmar	85	(Peninsular)		(Sumatra)	
Nepal	155	Vietnam	20				
Bhutan	75	Cambodia	20				
		Lao PDR	17				
Total	2,376		342		500		325

* Midrange estimates

^a No current estimate for Myanmar

Source: Dasgupta, et al. (2012a)

(2) Habitat Quality (Q). This includes two components: Habitat area (H) and the degree of fragmentation (F). For the latter, we use the percentage of habitat area not subject to clearing by August, 2011.

(3) Effectiveness of protection (P): For all tiger habitat areas within a country, we total original and remaining forest area and compute the shares of original forest that were subjected to clearing by 2000 and August, 2011, respectively. The increase in share from 2000 to 2011 is a proxy for the risk of protection failure during the period.

(4) Protection project Cost (C). This includes two components:

- a. Habitat land opportunity cost (L): In Dasgupta, et al. (2012a), we specify a model that relates local forest clearing to the profitability of alternative uses for the land. By implication, the best single measure of the opportunity cost of forested land in a locality is the intensity of recent clearing. Accordingly, our proxy for opportunity cost in each habitat is the increase in the percent of its area cleared from 2000 to August, 2011.
- b. Labor cost (W): We incorporate relative protection project costs using differential wages, with income per capita as the proxy and an exponential weight

(0.6) that reflects the findings of Harrison (2002) on the labor share of income in low- and middle-income countries.⁶

4. Model Implementation

We transform all model variables to ranks for ease of use and interpretation, and to ensure robustness against outlier effects. To facilitate the nested procedure that we describe below, our rank-ordering for each variable ensures a positive relationship to the priority scores in (9). Accordingly, higher numerical ranks are assigned to lower values for subspecies numbers (T), subspecies distribution (E), land opportunity cost (L) and labor cost (W). Higher numerical ranks are assigned to higher values for subspecies' overall habitat loss (D), habitat area (H), the percent of habitat remaining (F), and the effectiveness of country protection (P).

Our model incorporates equations (1) – (10) in a two-stage exercise. In the first stage, the user specifies relative weights for the determinants of ρ , Q and C in (2), (4) and (6) above.⁷ The model allows the user to specify the parameters for each equation in arbitrary units. After the parameters are specified, the model standardizes to Cobb-Douglas (CD) parameters by dividing each parameter by the sum of parameters for that equation. Then it forms the product of the relevant rank-transformed variables, each weighted by its exponential CD parameter.

At the completion of the first stage, the model has created indices for ρ , Q and C . P (protection effectiveness) has only one component, so that is the second-stage index for this variable. At the beginning of the second stage, the user specifies relative weights for species risk (ρ), habitat quality (Q), protection effectiveness (P) and project cost (C). As before, the model allows the user to specify the weighting parameters in arbitrary units. Then it standardizes to CD

⁶ Formally, this index assumes a Cobb-Douglas (unit-elastic) cost function, internationally-traded capital and non-traded labor. The cost elasticity of the average wage (proxied by income per capita) in this function is the labor share of national income.

⁷ There is no need to specify the constants ($\gamma_0 \delta_0 \beta_0$), since they do not affect the relative values that determine priority scores.

parameters and forms the product of the four indices, each weighted by its exponential CD parameter.

The most critical question for our modeling exercise relates to the potential variation in outcomes for different user settings of model parameters. To address this question, Table 2 provides rank correlations for the 8 variables incorporated in the model. The results are almost evenly divided between positive and negative correlations; some are strong but most are relatively weak. Overall, these results indicate that the habitat priorities and implicit budget shares calculated by the model are highly dependent on user-specified weights.

Table 2: Rank Correlations for Model Variables

Obs = 74	Subspecies Numbers	Subspecies Distribution	Subspecies Habitat Threat	Habitat Size	Habitat Percent Remaining	Habitat Land Opp. Cost	Habitat Labor Cost
Subspecies Numbers	1.00						
Subspecies Distribution	0.06	1.00					
Subspecies Habitat Threat	-0.75	-0.43	1.00				
Habitat Size	0.22	-0.18	-0.21	1.00			
Habitat Percent Remaining	0.41	0.20	-0.46	0.16	1.00		
Habitat Land Opp. Cost	-0.57	-0.13	0.62	-0.43	-0.30	1.00	
Habitat Labor Cost	-0.28	-0.35	0.51	0.13	-0.03	0.16	1.00
Country Protection Effectiveness	-0.78	-0.44	0.87	-0.23	-0.43	0.66	0.41

5. Three Illustrations

To illustrate the possible range of variation, we implement the model for three sets of parameter weights. The first two give extra weight to subspecies threats and project cost elements, while the third assigns equal weight to all variables.

The subspecies threat scenario assigns unit weights to first-stage variables except for subspecies numbers (T) and distributions across countries (N), which are assigned weights of 5. In the second stage, we assign a weight of 3 to subspecies threat and unit weights to the other

three indices. The cost scenario assigns a weight of 3 to the cost index in the second stage, leaving all other weights at unit values. The equal-weights scenario assigns unit weights to all variables in both stages.

Table 3 shows that these weighting changes have very significant consequences for the priority rankings of the 74 tiger habitat areas in the model: The rank correlations of Species Threat with Cost and Equal Weights are .41 and .64 respectively, while the correlation between Equal Weights and Cost is .82.

Table 3: Habitat Rank Correlations		
	Species Threat	Cost
Species Threat	1.00	
Cost	0.41	1.00
Equal Weights	0.64	0.82

Table 4 presents results for all 74 habitat areas, sorted by rank in the Species Threat Scenario. Inspection of the top entries indicates that the major beneficiaries of extra weighting for species threat are habitat areas in Indonesian Sumatra, the sole locale of the Sumatran tiger, which rank much higher than in the Cost and Equal Weighting scenarios. This applies particularly to Bukit Balai Rejang-Selatan and Gunug Leuser, which move to first and second in the priority ordering. Subspecies scores for the critically-threatened Indochinese Tiger are also high, which produces high ranks for several Vietnamese, Laotian and Thai habitat areas (e.g., Northern and Southern Annamites, Phu Miang – Phu Thong, Taman Negara-Belum) .

The Cost scenario shifts habitat scores toward areas that have low labor costs, low land opportunity cost indices, or both. As a result, the highest priorities are assigned to some habitat areas in Nepal (Corbett-Sonanadi, Royal Bardia, Royal Chitwan, Royal Suklaphanta), Myanmar (Northern Forest Complex - Namdapha - Royal Manas), and India (Dandeli – Anshi, Royal

Chitwan, Kanha û Phen, Western Ghats: Bandipur - Khudrenukh û Bhadra, Simlipal, Kaziranga – Garampani). At the same time, cost advantages in Vietnam and Lao PDR maintain high rankings for several areas with high priorities in the Species Threat scenario (particularly the Northern and Southern Annamites). The Equal Weights scenario favors many of the same protected areas in Nepal, Vietnam, Lao PDR and India.

The three illustrative cases suggest that the priority rankings of some habitat areas are highly sensitive to variable weighting, while others are not. However, these are only three of many possible scenarios, and the correlations in Table 2 suggest that most habitat areas would change priority ordering substantially for some values of the 8 weighting parameters. We conclude that the principal value of our modeling system is educational rather than prescriptive. Undertaking numerous weighting experiments can provide a useful sense of the relationship between decision-makers' preferences and habitat assistance priorities. In the same vein, the model can be used to reveal the preferences of decision-makers who have assigned priorities to different habitats in resource allocation.

6. Summary and Conclusions

In this paper, we have developed and implemented a model that translates detailed information about 74 tiger habitat areas into consistently-derived priority scores and potential project budget shares for those areas. Drawing on the database constructed by Dasgupta, et al. (2012a), the model incorporates information about threats to particular tiger subspecies, the quality of remaining habitat areas, the observed effectiveness of habitat protection by country, and the potential costs of protection projects for different habitats. Implementation of the model moves through two stages. In the first, user-specified weights are employed to combine subindices into composite indices of species threat, habitat quality, cost and protection

effectiveness. In the second stage, user-specified weights are employed to combine the composite indices into priority scores and potential project budget shares for all 74 habitat areas.

Our investigation of inter-variable correlations suggests that changes in user-specified weights can have very significant consequences for habitat priority scores. In three illustrative scenarios, we investigate the implications of equal weights for all model variables, higher weights for species threats, and higher weights for potential project costs. We find very substantial differences in high-priority habitats across the three scenarios, although habitats in some countries retain high positions in all three.

In summary, we find that great habitat diversity is revealed by the introduction of eight critical variables for priority-setting. No single priority ordering can be prescribed in such a diverse setting, and actual priorities will depend on the preferences of decision-makers, as revealed in the weights assigned to species threats, habitat quality, cost elements, and effective protection. At the same time, we believe that our model can make a useful contribution by identifying priority orderings that are consistent with different sets of preferences. And it can inform policy discussions by allowing for extended exploration of alternative strategies, along with feedback to decision makers about the implicit preferences associated with their resource allocation decisions.

Table 4: Results for Three Weighting Scenarios

		Habitat Ranks ⁸			Habitat Scores			Variable Ranks ⁹							
Country	Habitat Name (Tiger Landscape)	Species Threat	Cost	Equal Weights	Species Threat	Cost	Equal Weights	Subspecies Numbers	Subspecies Distribution	Subspecies Habitat	Habitat Size	Habitat Percent	Land Cost	Labor Cost	Effective Protection
Indonesia	Bukit Balai Rejang - Selatan	1	39	45	100.00	63.31	70.08	4	3	2	35	71	42	3	2
Indonesia	Gunug Leuser	2	54	48	98.44	56.77	68.44	4	3	2	59	61	24	3	2
Vietnam	Northern Annamites	3	14	2	97.78	82.07	97.43	3	1	3	64	67	32	5	7
Vietnam	Southern Annamites	4	15	6	97.15	81.22	95.18	3	1	3	69	50	33	5	7
Laos	Southern Annamites	5	8	4	96.27	85.73	96.49	3	1	3	69	58	36	6	6
Laos	Phu Miang - Phu Thong	6	4	7	95.99	93.71	94.77	3	1	3	54	35	66	6	6
Indonesia	Bukit Barisan Selatan South	7	46	52	94.73	59.74	64.62	4	3	2	19	70	41	3	2
Indonesia	Kerinci Seblat	8	61	53	94.50	50.40	64.37	4	3	2	63	56	15	3	2
Thailand	Taman Negara - Belum	9	51	31	94.20	58.28	75.79	2	3	1	67	63	28	2	5
Indonesia	Rimbo Panti-Batang Gadis West	10	43	54	94.17	60.75	64.04	4	3	2	15	72	47	3	2
Vietnam	Kon Ka Kinh	11	17	14	92.88	79.13	90.20	3	1	3	46	46	35	5	7
Nepal	Royal Bardia	12	2	1	92.53	96.63	100.00	1	2	4	48	30	48	8	9
Laos	Nam Et Phou Loey	13	25	33	92.24	75.54	75.12	3	1	3	56	60	23	6	6
Indonesia	Sibologa	14	55	56	91.46	56.69	61.29	4	3	2	14	69	37	3	2
Thailand	Khlong Saeng	15	52	39	91.24	57.41	72.25	2	3	1	40	65	31	2	5
Nepal	Corbett - Sonanadi	16	1	3	90.81	100.00	97.22	1	2	4	44	19	66	8	9
Laos	Nam Ha	17	19	19	90.47	77.00	86.71	3	1	3	33	64	29	6	6
India	Royal Chitwan	18	9	12	90.00	85.12	90.79	1	2	4	36	34	66	4	8
India	Western Ghats:	19	11	8	89.03	83.40	94.39	1	2	4	58	38	50	4	8

⁸ All three ranks in descending order from 1 to 74⁹ See Section 4 for an explanation of rank calculations for these variables.

	Bandipur - Khudrenukh û Bhadra														
India	Kaziranga - Garampani	20	13	9	88.49	82.62	93.53	1	2	4	51	41	49	4	8
India	Dandeli - Anshi	21	7	10	88.40	86.06	93.38	1	2	4	22	73	63	4	8
Laos	Northern Annamites	22	35	23	88.16	65.65	83.41	3	1	3	64	54	13	6	6
India	Northern Forest Complex - Namdapha - Royal Manas	23	37	11	87.93	64.09	92.64	1	2	4	73	20	20	4	8
Indonesia	Bukit Rimbang Baling	24	67	58	87.88	44.51	57.74	4	3	2	38	53	11	3	2
Indonesia	Bukit Barisan South	25	66	60	87.68	46.23	57.54	4	3	2	28	55	14	3	2
Nepal	Royal Chitwan	26	3	5	86.76	94.94	95.93	1	2	4	36	27	51	8	9
India	Periyar - Megamala	27	16	13	86.45	79.57	90.31	1	2	4	43	40	45	4	8
India	Kanha û Phen	28	10	15	86.07	84.45	89.72	1	2	4	53	21	66	4	8
India	Simlipal	29	12	17	85.25	82.77	88.44	1	2	4	24	44	62	4	8
India	Indravati	30	22	18	84.54	75.98	87.33	1	2	4	66	23	39	4	8
India	Royal Bardia	31	24	20	83.86	75.69	86.29	1	2	4	48	28	40	4	8
Laos	Hin Nam Ho	32	36	27	83.85	64.64	77.37	3	1	3	27	57	16	6	6
Indonesia	Bukit Tigapuluh Landscape	33	69	63	82.78	37.89	52.78	4	3	2	50	36	6	3	2
Vietnam	Bi Dup-Nui Ba	34	38	32	82.53	63.51	75.55	3	1	3	16	59	19	5	7
India	Royal Suklaphanta	35	59	21	82.49	53.89	84.18	1	2	4	11	1	51	4	8
Vietnam	Nam Et Phou Loey	36	41	16	82.21	62.70	89.26	3	1	3	56	17	18	5	7
India	Anamalai-Parambikulam	37	29	22	82.13	70.65	83.63	1	2	4	31	45	30	4	8
Indonesia	Berbak	38	68	66	81.20	38.14	51.28	4	3	2	25	49	7	3	2
India	Corbett - Sonanadi	39	20	24	81.09	76.21	82.04	1	2	4	44	16	51	4	8
Thailand	Phu Khieo	40	50	37	80.19	59.45	72.36	3	1	3	42	39	38	2	5
Myanmar	Northern Forest Complex -	41	6	25	79.71	88.42	79.95	1	2	4	73	68	34	9	4

	Namdapha - Royal Manas														
India	Dandeli North	42	18	26	78.87	77.18	78.70	1	2	4	6	66	65	4	8
Vietnam	Cat Tien	43	47	42	78.87	59.57	70.58	3	1	3	34	18	17	5	7
Cambodia	Cardamom's	44	56	51	78.67	54.97	67.43	3	1	3	60	52	9	7	3
India	Rajaji Minor	45	21	28	77.58	76.11	76.77	1	2	4	10	32	66	4	8
India	Pachmarhi - Satpura - Bori	46	26	29	77.52	72.85	76.68	1	2	4	41	10	51	4	8
India	Radhanagari	47	27	30	77.45	71.55	76.58	1	2	4	30	15	46	4	8
Thailand	Phu Miang - Phu Thong	48	60	49	76.76	51.96	67.77	3	1	3	54	31	22	2	5
Myanmar	Tenasserims	49	45	34	76.57	59.98	74.33	1	2	4	71	51	8	9	4
Thailand	Cardamom's	50	57	44	76.50	54.40	70.32	3	1	3	60	33	25	2	5
Thailand	Tenasserims	51	65	50	75.92	46.85	67.52	3	1	3	71	42	12	2	5
India	Pench	52	28	35	75.91	71.34	74.31	1	2	4	29	11	51	4	8
India	Satkosia-Gorge	53	44	36	74.81	60.64	72.70	1	2	4	26	25	21	4	8
India	Palamau	54	31	38	74.53	70.05	72.30	1	2	4	32	8	51	4	8
Indonesia	Kualar Kampar- Kerumutan	55	70	70	74.43	28.37	45.00	4	3	2	52	29	2	3	2
Nepal	Royal Bardia South	56	23	40	74.00	75.87	71.52	1	2	4	5	22	43	8	9
India	Shendurney	57	42	41	73.63	61.85	70.99	1	2	4	7	62	26	4	8
India	Chandoli	58	33	43	73.18	67.10	70.33	1	2	4	17	14	44	4	8
India	Sunabeda- Udanti	59	32	46	72.67	68.30	69.60	1	2	4	21	9	51	4	8
India	Western Ghats - Sharavathi Valley	60	30	47	72.39	70.47	69.20	1	2	4	2	73	63	4	8
Thailand	Khao Yai	61	53	59	68.90	56.83	57.63	3	1	3	20	7	72	2	5
Thailand	Salak-Phra	62	62	62	67.58	47.33	55.98	3	1	3	8	37	27	2	5
India	Bandhavgarh - Panpatha	63	40	55	67.06	63.02	61.69	1	2	4	18	4	51	4	8
India	Purna	64	34	57	66.36	66.06	60.74	1	2	4	9	5	72	4	8
Indonesia	Tesso Nilo Landscape	65	72	71	65.04	22.09	36.76	4	3	2	23	26	1	3	2
Cambodia	Cambodian Northern Plains	66	63	64	64.64	47.28	52.37	3	1	3	62	6	10	7	3

India	Rajaji Major	67	49	61	63.29	59.48	56.57	1	2	4	3	12	51	4	8
Thailand	Thap Lan - Pang Sida	68	64	69	60.19	46.87	47.05	3	1	3	39	1	51	2	5
India	Biligiri Range	69	48	65	59.84	59.56	52.00	1	2	4	1	13	72	4	8
India	Mahabaleshwar Landscape - South	70	58	67	57.76	54.28	49.31	1	2	4	4	3	51	4	8
Nepal	Royal Suklaphanta	71	5	68	57.34	90.84	48.78	1	2	4	11	24	66	8	9
Malaysia	Taman Negara - Belum	72	71	72	56.42	22.48	35.13	2	3	1	67	47	4	1	1
Malaysia	Endau Rompin	73	74	73	53.09	20.16	32.06	2	3	1	47	43	3	1	1
Malaysia	Krau	74	73	74	50.23	20.77	29.51	2	3	1	13	48	5	1	1

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