OPPORTUNITIES AND CHALLENGES FOR TIGER (*PANTHERA TIGRIS*) CONSERVATION IN THE SOUTHERN WESTERN GHATS, INDIA

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Abstract

The southern Western Ghats (c. 13,000 km²) is an important ecological subunit of the Western Ghats biodiversity hotspot. Dominated by moist forests, including tropical wet evergreen forests, it has higher levels of biodiversity and endemism than the rest of the Western Ghats. There are 19 Protected Areas in the southern Western Ghats that cover 36% of its total area, among which Parambikulam, Anamalai and Periyar Tiger Reserves stand out as primary source habitats for tigers. A contiguous forested landscape until the beginning of the last century, the region is now fragmented from north to south into the Anamalai (which in our definition includes Munnar and Kodaikanal Forest Divisions and Palani Range of Dindigul Forest Division), Periyar and Agasthyamalai landscapes. Given the crucial need for large, contiguous areas to ensure the persistence of wide-ranging large predators such as the tiger *Panthera tigris* and its prey, it is important to establish and maintain habitat connectivity within and between these landscapes, whereas conservation efforts today are focused on small, insular protected areas. Possibilities for forging connectivity between the Anamalai and Periyar landscapes along Kerala state are nonexistent owing to the loss of Devikulam Range in Munnar Forest Division to cardamom cultivation and developments related to tourism and Kumily Range in Kottayam Forest Division to encroachment. The link on the Tamil Nadu side, along the steep eastern slopes of Theni Forest Division, is extremely narrow and consequently unsuitable for large mammal movement at present. However, this tenuous corridor link and the isolated patches of forests within it should be protected and strengthened as much as possible. Further south, there may be a possible break in the habitat for tigers between the Periyar and Agasthyamalai landscapes at the Ariankavu Pass. Our surveys, however, point to the possibility of bridging this gap through a corridor at Kottavasal. Recent camera-trapping studies by the Wildlife Institute of India, Dohradun have highlighted the precarious situation of tigers in Kalakad-Mundanthurai Tiger Reserve in the Agasthyamalai landscape. Therefore, establishment of the Kottavasal corridor and the c. 500 km² Kulathupuzha Conservation Reserve are a must to secure the future of tiger in the Agasthyamalai landscape. While the southern Western Ghats as a contiguous landscape could potentially sustain a population of 200 adult tigers, it may now be difficult albeit not impossible, for any one of the three landscapes to sustain large tiger populations in isolation. Therefore, it is important that all endeavours now be made to enable the Anamalai and Periyar-Agasthyamalai landscapes to each sustain a minimum population of 100 adult tigers. Controlling poaching of prey species especially sambar *Cervus unicolor*, ecologically and behaviorally the most suitable prey for the tiger, establishment of protected areas such as Kodaikanal, Megamalai and Kulathupuzha, acquisition of failed private estates to facilitate large mammal recolonization and restoration of native vegetation in exotic species plantations are priority tasks that need immediate attention in order to realize the huge opportunities for tiger conservation in the southern western Ghats.
Introduction

The Western Ghats are recognized as one of the world’s eight ‘hottest hotspots’ of biological diversity along with Sri Lanka (Myers et al. 2000). Approximately 137 mammal species (48 of them bats) have been recorded in the Western Ghats, with 17 endemic species (CEPF 2007). Large mammals (defined here as diurnal mammals of body mass ≥ 3 kg) of the Western Ghats include among others, carnivores such as the tiger *Panthera tigris*, leopard *P. pardus*, dhole *Cuon alpinus*, golden jackal *Canis aureus* and sloth bear *Melursus ursinus*, ungulates such as the gaur *Bos gaurus*, sambar *Cervus unicolor*, chital *Axis axis*, barking deer *Muntiacus muntjak*, mouse deer *Moschiola meminna*, wild pig *Sus scrofa* and Nilgiri tahr *Hemitragus hylocrius* and primates such as the lion-tailed macaque *Macaca silenus*, bonnet macaque *M. radiata*, common langur *Semnopithecus entellus* and Nilgiri langur *Trachypithecus johnii*. The Indian giant squirrel *Ratufa indica* and grizzled giant squirrel *R. macroura* are the two large arboreal diurnal squirrels found in this region. The Western Ghats is also home to the largest population of the endangered Asian elephant *Elephas maximus*, believed to exceed 12,000 individuals (Bist 2002). The Protected Area (PA) network in the Western Ghats includes 14 National Parks (NP) and 44 Wildlife Sanctuaries (WLS), covering a mere 9% of its land area, with a majority of forest types in this landscape falling outside PAs. Over two-thirds of these PAs are small (<500 km²) and isolated and hence, occur as fragments in the landscape.

Habitat fragmentation threatens the survival of wildlife throughout the world. As large forest tracts are converted to small islands marooned in a sea of human-modified and developed areas, the survival of many species hinges upon their ability to persist in human-modified landscapes and on our efforts to manage these landscapes for the conservation of habitats and species. Unlike true islands, most forest fragments are not surrounded by a sea of totally inhospitable or ecologically neutral environments (Wiens 1994). The altered habitats in the surrounding landscape matrix allow animals to move through to varying degrees, act as habitat sinks for dispersing individuals and are also suitable for colonization by species that can persist in such habitats. The Western Ghats hill ranges of India typify many of these conservation challenges, and indeed opportunities, as well. The Western Ghats has weathered the assault from anthropogenic factors ranging from large scale commercial and developmental activities as well as chronic habitat fragmentation and degradation due to an array of anthropogenic resource-use regimes. Between 1920 and 1990, forest cover in the Western Ghats declined by 40%, resulting in a fourfold increase in the number of fragments, and an 83% reduction in size of forest patches (Menon & Bawa 1997). This is not surprising given that at over 350 people per sq. km., this region is one of the most densely populated biodiversity hotspots (Cincotta et al. 2000). The resultant effects of such widespread fragmentation and habitat degradation are likely to be disproportionately heavy on the region’s large mammal fauna. Many of the large mammal species in the Western Ghats are ‘landscape’ species whose conservation cannot depend upon PA-centric approaches alone but require the consolidation and protection of larger landscapes.

The southern Western Ghats (Fig. 1), lying between 8 and 11 °N, harbours predominantly moist forests and is home to higher levels of biodiversity and endemism than the rest of the Western Ghats. This greater diversity can be attributed to the wide variation in rainfall and complex geography that leads to a diversity of vegetation types. Moist forests including tropical moist deciduous and wet evergreen
forests dominate up to about 1,500 m on the windward side (Champion & Seth 1968). These forests include some of the best representatives of non-equatorial tropical evergreen forests in the world. High elevation montane or shola forests and rolling grasslands above 1,500 m contribute to the diversity of habitats. Extending south of the Palghat gap and straddling the southernmost states of Kerala and Tamil Nadu, the southern Western Ghats is home to a number of indigenous tribes including the Kadar, Mannar, Malayar/Malasar, Malai Malasar, Muthuvan, Malai Aryan, Kani, Ulladan, Urali, Hill Pulayar and Paliyar among others, which are primarily dependent on the forest. However, the massive influx of non-tribal settlers over the last century has had a far greater impact on the forests and wildlife of the region than the tribal population. Hunting, habitat loss, degradation and fragmentation due to monoculture plantations, agriculture, dams, roads and railway links are the principal threats to biodiversity in the region. A contiguous forested landscape until the beginning of the 20th century, the southern Western Ghats is now fragmented from north to south into the Anamalai, Periyar and Agasthyamalai landscapes (Nair 1991) (Fig. 1).

Fig.1: Existing and suggested Protected Areas and the recommended corridor in the southern Western Ghats.
Study Area

Anamalai-Kodaikanal-Palani Hills landscape

The Anamalai hills (Fig. 1) are a major conservation unit in the southern Western Ghats, occurring just south of the Palghat gap. A number of PAs span this region, among which the Anamalai Tiger Reserve (TR) (987 km²), Eravikulam NP (97 km²), Chinnar (90 km²) and Parambikulam WLS (274 km²) are important. In addition, there are large tracts of reserved forests under Mankulam, Malayattur, Vazhachal, Chalakudy and Nemmara Forest Divisions (FDs). Parambikulam WLS together with parts of Vazhachal, Malayattur and Mankulam FDs is in the process of getting notified as a Tiger Reserve. The Anamalai hills are contiguous with the reserved forests and PAs further to the south and east, comprising Munnar (694 km²) and Kodaikanal FDs (441 km²) and Palani Range (184 km²) of Dindigul FD, thus forming vast conservation landscape of c. 5,000 km². Several rivers such as the Chalakudy, Kellar, Pambar, Kudrayar, Aliyar, Sholayar and Porandalar arise from this landscape. The Anamalai region is the most important area in the Western Ghats for the conservation of the endemic and endangered mountain ungulate, the Nilgiri tahr. It contains around 1,500 animals (560 to 680 in the Anamalai hills and around 800 in Eravikulam NP) (IUCN 2008) out of the global population of a little over 2,000 animals (Daniels et al. 2008). With around 1,500 elephants (Bist 2002), it also has the Anamalai and Anamudi Elephant Reserves (ER) in Tamil Nadu and Kerala respectively. In addition, it is an important site in the Western Ghats for the conservation of the endangered lion-tailed macaque and grizzled giant squirrel, the latter also occurring in Varunshanan Range of Theni FD and in Srivilliputtur WLS (also known as Grizzled Giant Squirrel WLS) within the Periyar landscape further to the south.

Periyar-Srivilliputtur landscape

The Periyar landscape (Fig. 1) extends from the north of the Ariankavu Pass (at 9° N) over the region known as the Cardamom Hills, encompassing Kottayam FD, Theni FD and Srivilliputtur WLS. To the south of Periyar TR are the forests of the Ranni, Konni and Achenkoil FDs. On the eastern side, lying largely in the rain-shadow area of the Western Ghats with mostly dry forests, are Srivilliputtur WLS and the reserved forests of Tirunelveli FD. The region spans a mostly forested tract of around 3,000 km². Periyar, Vaigai and Pambar are the important rivers that flow through this area. The presence of a significant population of nearly 1,500 Asian elephants in this region (Bist 2002) has led to the notification of Periyar and Srivilliputtur ERs in Kerala and Tamil Nadu respectively. A highly skewed adult elephant sex ratio (<1 male per 100 females), a consequence of historical poaching pressures, remains a matter of conservation concern being addressed by the management with active participation of the local people.

Agasthyamalai landscape

The Agasthyamalai landscape (Fig. 1) constitutes an extensive and compact tract of mountains called the Ashambu or Agasthyamalai hills distributed from just south of the Ariankavu Pass to the Mahendragiri peak near Kanyakumari. The potential habitat for tigers here could be approximately 2000 km² with a maximum population about 200 elephants (Sukumar 1986). The region receives precipitation from both the southwest and northeast monsoons and has a very short dry season of less
than 2-3 months. Thus, much of it is covered in tropical moist forests, with drier forests occurring chiefly in the rain-shadow regions along the eastern foothills. On the eastern side, Kalakad-Mundanthurai TR (KMTR), the second largest protected area in Tamil Nadu State, spans an altitude ranging between 50 and 1,700 m, with tropical wet evergreen forests occurring chiefly above 500 m. On the western flank, three PAs (Neyyar, Peppara and Shendurney WLS) along with the Kulathupuzha and Palode reserved forests form an almost equally extensive and contiguous tract of forest in Kerala. These wildlife sanctuaries include catchment areas upstream of three dams (Neyyar on the Neyyar river, Peppara on the Karamana river and Parappar on the Kallada river in Shendurney). Other rivers and perennial streams that arise in this area are the Kaluthurittty, Kulathupuzha, Ramanadhi, Kadanadhi, Servalar, Tambiraparani, Manimuthar, Pachaiyar, Nambiar and Kudumudiyar. The Agasthyamalai region is also important for the conservation of the lion-tailed macaque (Molur et al. 2003) since it contains relatively large tracts of unfragmented rainforests, vital for the survival of this endangered species whose global population has dwindled to around 3,000-3,500 individuals (Singh et al. 2009).

**Ariankavu Pass corridor**

The Ariankavu Pass region (Fig. 1) of c. 80 km² is extremely critical to establish vital connectivity between the Periyar-Srivilliputtur hills (c. 3,000 km²) and the Agasthyamalai hills (c. 2000 km²) and this entire landscape is identified as the Megamalai-Periyar-Kalakkad Tiger Conservation Unit (Johnsingh 2001). The low elevation valley of the Ariankavu Pass is a major channel for trade and commerce between southern Tamil Nadu and Kerala. The Madurai-Kollam National Highway (NH-208) and the century-old Shencottah-Punalur metre-gauge railway, now a heritage railway, traverse the pass. It may be said that this railway link initiated the process of habitat fragmentation in the southern Western Ghats (Johnsingh et al. 1991). The conducive climate and topography of the Ariankavu Pass has made it a suitable location for plantations and settlements along the Shencottah-Punalur railway and NH-208 for well over a century, resulting in the loss and transformation of almost all the native vegetation. The remaining forest cover is restricted to the top and the eastern slopes along the main ridge-line of the Western Ghats, which forms the border between Kerala and Tamil Nadu. This seems to be the only major wildlife area in the Pass. The plantations in the Ariankavu Pass range from private or company-owned rubber Hevea brasiliensis, tea Camellia sinensis and pineapple Ananas comosus plantations to government-owned teak Tectona grandis plantations. Although the rubber and teak plantations by themselves may not impede the movement of animals, the presence of high population density human settlements such as Ariankavu, Murugappanchal, Edapalayam and Kaluthurittty and several other smaller settlements have greatly reduced the suitability of the habitat for wildlife away the main ridge-line of the Western Ghats. NH-208 is intensively used, particularly by heavy vehicles. Traffic jams are frequent at locations such as the narrow 'S-bend' where the road enters the Ghats from the plains of Tamil Nadu. Besides heavy traffic, human settlements and steep embankments in most places make it difficult for any large terrestrial wild mammal to cross the road.

**Objectives**

The main objective of this study was to identify and map important habitat corridors for tigers, prey species and other large mammals in the southern Western Ghats based on assessments of habitat status, anthropogenic pressures, fragmentation
extent and ecological needs. In order to achieve this objective, the following activities were carried out:

i. Development of a detailed GIS database for the southern Western Ghats in order to integrate secondary data pertaining to administrative boundaries and land cover maps with primary data on land use and species distributions.

ii. Utilization of secondary information to identify conservation units such as the Anamalai, Periyar and Agasthyamalai landscapes and the issues critical to habitat quality and connectivity therein.

iii. Undertaking of field surveys within and between each conservation landscape to document the presence and movement of tigers, prey species and other large mammals in varying human land-use and forest administration categories.

iv. Integrated identification of threats, impediments as well as opportunities for tiger conservation across the southern Western Ghats. v. Interaction with local stakeholders including the Forest Department and putting forth conservation recommendations to improve habitat quality and connectivity.

Methods

In order to obtain a clear picture of habitat connectivity and the extent of landscapes available for large mammals across the southern Western Ghats, Survey of India 1:50000 topographic maps, forest administration maps, and satellite imagery were studied before commencing field surveys. Discussions were held with officials from the Tamil Nadu and Kerala Forest Departments to forge a better understanding of the landscapes being surveyed.

A series of seven rapid surveys were carried out during the period from June 2007 to December 2008. These surveys covered (i) Anamalai-Kodaikanal-Palani landscape (June 2007), (ii) KMTR-Srivilliputtur WLS in the Agasthyamalai landscape (July 2007), (iii) Ariankavu Pass (October 2007), (iv) Parambikulam-Vazhachal region in the Anamalai hills (February 2008), (v) Malayattur-Mankulum-Munnar region in the Anamalai hills (March 2008) and (vi & vii) Two surveys to assess connectivity between the Anamalai and Periyar landscape complexes (September and December 2008). Aside from these rapid surveys, an extensive survey involving visits to each of the 119 forest ranges of the southern Western Ghats was carried out from April to June 2009 as part of a larger study to assess large mammal distributions. The total effort during fieldwork involved 100 field days, covering 6,900 km in forest areas by vehicle and 105 km on foot. The data collected during these surveys included:

- Occurrence of large mammal species - Direct (actual sightings) and indirect (e.g., droppings, tracks and vocalizations) evidences were collected and the geographic location of such evidence of species were recorded.
- Vegetation cover and land use - A description was compiled on the dominant vegetation cover and land use along the survey route.

Based on discussions with officials from the Tamil Nadu and Kerala Forest Departments and visual examination along the survey routes, descriptions were compiled on the location and contiguity of natural habitat across the landscapes surveyed.
Results and Discussion

In this section we present the results of our findings on the status of habitats within and between the three conservation landscapes and come up with conservation recommendations specifically for each conservation landscape as well as for the southern Western Ghats as a whole.

Anamalai landscape

The presence of a high density human population has besieged this landscape with numerous conservation problems such as (i) the large number of existing irrigation and hydel projects and proposed ones such as the Athirapally project which will pose a serious conservation threat, (ii) incessant proposals to build new roads and develop existing forest roads as all weather highways, (iii) the lack of speed breakers and the needless construction of side walls on forest roads allowing vehicles to speed through while impeding animals from crossing, (iv) the presence of numerous failed estates, particularly in Nemmara FD, which the local people desire to convert into tourist resorts, (v) ill-conceived concepts such as gap planting of non-native species (e.g. Dendrocalamus seedlings from northern India) and dry deciduous species such as amla Emblica officinalis and tamarind Tamarindus indica in wet evergreen habitats, (vi) uncontrolled vehicle-based tourism even to some of the last Nilgiri tahr habitats such as Mampara in Nemmara FD, (vii) apparently trivial issues that nevertheless adversely affect wildlife, two of which are: a 20 km powerline from Ambalapara to Malakipara breaking rainforest canopy connectivity to provide power to Malakipara settlement on the interstate border when power can alternatively be obtained from Tamil Nadu, as done for settlements in Parambikulam WLS, without disrupting canopy connectivity and, regular clearing of the damp under storey on either side of roads in evergreen forests for fire protection (given that fire is not really a serious threat in evergreen forests), further disrupting canopy continuity and forcing arboreal mammals like the lion-tailed macaque to cross on the ground, thereby making them vulnerable to road accidents, (ix) unregulated collection of reeds in Vazhchal FD, (x) encroachments in Kerala State Electricity Board and PWD enclaves such as in Perringalkutty, or the Servalar damsite in KMTR (Agasthyamalai landscape); (xi) unchecked poaching especially by people from certain settlements in Chalakudy FD that has led to not only a near lack of large mammals in Malayattur and Mankulam FDs but also to several incidents of poaching in the adjacent areas of the Western Ghats; (xii) a 30 km long canal from Bhoothathankettu dam to Angamaly that runs parallel to the Periyar river impeding animals from going to the water and has caused enormous disturbance to the landscape over several decades, (xiii) growing disturbance to the elephants which are regular visitors to a mineral spring in the Ethasholayar river at Anakulam village in Mankulam FD; (xiv) building of tourist infrastructure in the heart of Chimmony WLS when there are numerous vacant buildings abandoned by the PWD near the Chimmony damsite; (xv) inordinate delay in bringing 72.5 km² of revenue land in the Kannan Devan Hills under the custody of the Forest Department which, regrettably, has not extended Eravikulam NP by another 35 km² although recommendations to this effect were made by Kerala State Wildlife Board as early as 1984 and reiterated in 2002.

Periyar-Agasthyamalai landscape

Establishing Megamalai WLS

There is a long-pending proposal with the Government of Tamil Nadu to establish the Megamalai WLS (c. 600 km²), which will protect the watershed of river Vaigai (an important river for the dry districts of Madurai, Ramnad and Sivagangai) while being
an excellent buffer to Periyar TR on its northern and eastern side. Establishment of
this PA would significantly improve the conservation status of tiger, elephant and
other species in this landscape. The Varushand valley, located between Varushanad
and Megamalai ranges, is a horseshoe-shaped valley surrounded by high mountains
(1000-1800m) and is extremely fertile. This fertility and the cool climate led to large-
scale encroachments (36 settlements, 11 to the south and 26 to the north of
Manjanoothu village) in the late 1960s and 1970s with blatant political support and
the establishment of numerous cardamom and coffee plantations. Repeated genuine
efforts by the Forest Department have failed to evict the encroachers who have
always enjoyed staunch political support.

Protecting Ranni, Konni and Achenkoil FDs from further development

The forested landscape between Periyar TR and Ariankavu is one of the vital and
large tracts of contiguous fairly undisturbed wildlife habitats in the Western Ghats.
This total area of nearly 1,200 km² is formed by Goodrickal Range (654 km²) of
Ranni FD, Mannarapara and Naduvattamuzhi Ranges (130 km² and 140 km²
respectively) of Konni FD and Kanayar, Kallar, and Achenkoil Ranges (107 km²,
78 km² and 84 km² respectively) of Achenkoil FD. Realizing the vision of a contiguous
landscape, however, can easily be derailed by projects such as the proposed
conversion of the infrequently-used Achenkoil-Kalleil-Koni-Pamba forest road into a
State Highway to cater to the needs of the growing number of pilgrims visiting the
Lord Ayyappa shrine at Sabarimala. It is well known that roads and the settlements
that arise along them accelerate the threats to wildlife and natural habitat. If they are
serious about conservation, the Government of Kerala and the Union Government
should never clear such proposals. If executed, they would pave the way for the rapid
destruction of the fine tiger and elephant habitat between Periyar TR and the
Ariankavu Pass.

Establishing the c. 500 km² Kulathupuzha Conservation Reserve/National Park

There is enough data from India to show that pristine habitats, undisturbed by
people, are strongly favoured by fragile large mammalian species such as the
elephant (particularly herds), gaur, sambar and tiger. By including Kulathupuzha and
Palode Ranges (220 km² and 108 km² respectively) with the existing Shendurney
WLS (170 km²), there is an opportunity to establish a nearly 500 km² Conservation
Reserve or National Park provided the people of this area, residing far away from
basic amenities such as schools and hospitals, volunteer to be resettled.
Our enquiries with a few residents of Rosarmala Estate in Shendurney WLS, located
8 km from Ariankavu which has such facilities, indicate that sincere efforts to provide
better healthcare, education and employment opportunities would persuade them to
consider such a resettlement. We suggest that the Government should not hesitate
to “sacrifice” land currently under plantation forests near townships for relocated
people to settle in and benefit from improved infrastructure and opportunities, in lieu
of consolidating a large tract of priceless wildlife habitat, which once gone is
irreplaceable.

Acquisition of defunct private estates

There is an urgency to acquire ailing coffee, tea and cardamom estates such as
Downton (2.1 km², on the border of Ranni FD and Periyar TR), Priya (0.72 km², in
Achenkoil FD), Kattamalai (13 km², in KMTR) and Bonaccord (5 km², in Pepppara
WLS) and restore them as large mammal habitats. If not acquired these estates may
soon be developed into tourist resorts, creating perpetual, ever-increasing problems for the surrounding wildlife habitats. Several other smaller defunct estates in this landscape should also be acquired at the earliest. This needs the urgent attention of the Government.

**Ariankavu Pass**

*Establishing a large mammal corridor across the Ariankavu Pass along*

Kottavasal (Achenkoil) – Pulliyarai Beat of Kadayanallur Range – Kottavasal (Ariankavu) – Karkudi Beat of Courtalam Range – Shendurney WLS (Fig. 1). This corridor will link the large mammal population of the Periyar landscape with that of the Agasthyamalai landscape.

There is also a suggestion from other quarters to establish the nearby Murugapanchal corridor (along Achenkoil – Priya Estate – Ambanad Tea Estate – Suvarnagiri Estate – Murugapanchal – Bedford Estate – Shendurney WLS) for elephants. This proposal suggests relocation of people from the Murugapanchal area and the creation of a 100 m wide corridor. The presumption is that once the Murugapanchal area is freed of settlements, elephant populations; now 10-12 km apart owing to extensive settlements such as Bedford Estate (in the south) and Priya, Suvarnagiri, Senagiri, Kuzhirkadu, Pandianpara and Kadamanpara estates (in the north); may begin using this corridor. However, we believe this to be a difficult prospect. In such fragmented landscapes elephant bulls link isolated habitats by moving through the disturbed habitats. In the heavily disturbed Murugapanchal area such bull elephants may be absent altogether. Even if present, they may find it impossible to span the habitat north of Achenkoil with Shendurney WLS since it involves traversing through a highly disturbed habitat for a very long distance. In comparison, the Kottavasal corridor, which runs along the main ridge of the Western Ghats, appears to be much more promising for the travel of large mammals including tiger and elephant. The slopes along the main Western Ghats ridgeline harbour most of the remnant forests across the gap (sambhar tracks are common here), and thus wildlife habitats on either side of the corridor are much closer in the suggested Kottavasal corridor (3-4 km) than in the Murugapanchal corridor (10-12 km). There is also more forest cover within the Kottavasal corridor. The fact that comparatively fewer households (approximately 60 in Kottavasal, compared to over 200 at Murugapanchal) would be affected by the creation of the Kottavasal corridor suggests that resources and efforts to conserve connectivity in this landscape should first be directed at this corridor. A 600-800 m long flyover for the vehicular traffic over the 'S-bend' is a must. Efforts should also be made to remove the encroachments from Pulliyarai (Kadayanallur Range) and Karkudi (Courtalam Range) beats (both in Tirunelveli FD) in the foothills, which will strengthen the proposed corridor immensely. The mountains on either side of the Kottavasal Karuppaswamy temple in this corridor are only 40 m apart where an overpass over the NH-208 for the movement of species such as sambhar and leopard could be easily built. If such effective protection is sustained in the Periyar-Agasthyamalai landscape, even tigers may eventually begin using this overpass.

**Cross-cutting priorities and recommendations**

We summarize six cross-cutting points that conservation initiatives in the landscapes of the southern Western Ghats urgently need to prioritize.

1. *Consolidation of wildlife habitat* In order to implement landscape-level conservation strategies, there is a need to improve habitat quality and
connectivity by: (i) establishing PAs in currently unprotected high-quality wildlife areas (such as the proposed Kodaiakanal and Megamalai WLSs and Kulathupuzha Conservation Reserve), (ii) acquiring private estates in prime wildlife habitat whose leases have expired and/or are ailing (e.g. Thuthampara in Nemmara FD, private plantations in the Cardamom Hills, Ranni and Achenkoli FDs and Puthuthottam Estate in Anamalai TR) and (iii) striving for greater field-level coordination in management between the wildlife and territorial divisions of the Forest Departments.

2. Identification and securing of wildlife corridors Corridors are crucial to increase the effective size of conservation units and to ensure long-term viability of wide-ranging large mammal populations. Once identified in an objective and rigorous manner, priority must be given to secure these corridors, such as the Kottavasal corridor at Ariankavu. This could include the design of financially attractive offers for the acquisition of small but key sites that connect large habitat tracts but are currently compromised by human presence and activity.

3. Restriction of large-scale development in important wildlife areas
The vast forested landscapes of the southern Western Ghats are among India’s last wilderness areas. Yet, they are constantly faced with serious threats resulting from developmental projects, such as the proposed construction of highways in Kodaiakanal and Achenkoli FDs and several hydroelectric projects including the potentially devastating Athirapally project in Vazhachal FD. We also believe that in some of the best and most critical remaining wildlife habitats, it may be unwise for the Forest Department to prioritize revenue generation (e.g. raising teak plantations on clear-felled areas in Konni and Achenkoli FDs) over biodiversity values.

4. Improvement of habitat quality on non-forest lands in important wildlife areas
This may be achieved by designing and implementing activities that improve habitat quality in wildlife habitats that have historically undergone degradation or land-use conversion. We believe that in regions such as the Kodaiakanal-Palani Hills, where thousands of hectares of prime shola-grassland habitat have been destroyed by planting exotic coniferous trees such as wattle Acacia mearnsii, blue gum Eucalyptus globulus, and pine Pinus patula, proactive efforts must be initiated to restore native vegetation. In other areas, many man-made obstacles (barbed wire fences between tea gardens in Eravikulam NP and Kodaiakanal FD, high retaining walls along roads in Anamalai TR, fast-flowing canals, power pylons, and penstock pipes in various areas) have been constructed which impede animal movement and effectively fragment wildlife populations without the visible alteration of habitats. Urgent efforts are needed to provide movement pathways across these barriers by simple actions such as breaking walls bordering forest roads which are used as large mammal crossings and building underpasses beneath canals and penstock pipes.

5. Strengthening of anti-poaching measures
Poaching of wildlife, particularly of critical tiger prey species such as gaur, sambar, chital and wild pig remains an issue of concern across the Western Ghats, especially in otherwise-excellent habitats outside PAs. A reliable indicator of the occurrence of poaching is the low density of ungulates and primates in otherwise good habitats outside PAs in several parts of the southern Western Ghats, a fact borne out by low encounter rates of these
species. As a preferred prey for the tiger we place greater emphasis on the sambar since, unlike the chital, it is widely distributed in southern Western Ghats. Sambar are usually solitary or occur in small herds, and are therefore an ideal prey for a solitary predator like the tiger to stalk and kill. Both the tiger and the sambar prefer forest and are crepuscular and nocturnal. Unlike the gaur and wild pig, no records exist of sambar retaliating against tigers. Consequently, the sambar stands out as the most suitable prey for tiger ecologically and behaviourally (Khan & Johnsingh in press). Across the two states, there is still great reluctance among Forest Department staff to officially acknowledge the occurrence of poaching, making this one of the most critical impediments to addressing the problem constructively. Often, frontline forest personnel need better resources and greater motivation to take up anti-poaching measures. There is an urgent need to identify and take punitive action against hard-core poachers while simultaneously attempting to reform communities which have taken to poaching as a livelihood, on similar lines to the successful endeavour in Periyar TR.

6. Long-term ecological monitoring

There is no better way than systematic and scientific study to monitor the status of wildlife populations and habitats. Efforts should be made to put in place long-term projects dedicated to monitoring of ecosystems, wildlife populations and communities in the Western Ghats in the face of growing threats and pressures.

Conclusion

As the possibilities for establishing connectivity between the Anamalai and Periyar landscapes along Kerala State are bleak and as there is a feasibility to establish the Kottavasal corridor, we are now left with the only option of managing the Anamalai and Periyar-Agasthyamalai landscapes as two separate units. Nevertheless we should remember the presence of a fragile link on the Tamil Nadu side of the Anamalai and Periyar complexes, along the steep eastern slopes of Theni FD and isolated pockets of forests such as Cumbummettu and Mathikettan Shola NP. If habitat restoration efforts are made, these pockets of forest and the narrow strip of habitat may potentially be used as stepping stones (Bennett 2003) in the future provided large mammal populations increase to the extent that surplus individuals look for opportunities to disperse between the Anamalai and Periyar landscapes.

The Anamalai landscape, although one of the most human-dominated landscapes in India, is arguably one of the ecologically richest landscapes in Asia with stretches of habitats that are still surpassingly grand and incomparably beautiful. Sadly, the extent of habitat fragmentation and depletion of wildlife from the once-teeming forests were all too apparent during our surveys. The status of tigers in Parambikulam WLS and Anamalai TR may not be too healthy with a combined tiger population estimated to range between 13-16 individuals (Jhala et al. 2008). However, areas like Vazhachal, Eravikulam and Chinnar are likely to harbour more tigers and population of the entire Anamalai landscape may come to around 50 individuals. The status of wildlife in Malayattur and Mankulam FDs is appalling with almost the entire large mammalian assemblage other than elephants apparently exterminated except may be in the most inaccessible places. The presence of innumerable human settlements within these areas offers little prospect for the revival of large mammal populations. However, the advantage of bringing Mankulam under the umbrella of the National Tiger Conservation Authority is the connectivity it offers between Eravikulam NP and
the proposed Parambikulam TR. If this were to materialize, simultaneous efforts have to be made to transform hard-core poachers in Mankulam into conservation supporters through similar ecodesvelopment and ecotourism programmes which were successfully deployed in Periyar TR. Such a change may be more difficult if Mankulam remains a territorial division with priorities not directly focused on wildlife. In the Anamalai hills, only the Grass Hills-Eravikulam stretch appears somewhat free of human intrusion at present. However, habitats like Vazhchal FD, which still has large swathes of wildlife habitat harbouring large mammals and is connected to Parambikulam, offer the possibility of strengthening conservation in this landscape. The long-pending extension of Eravikulam NP should be accomplished immediately and the much-awaited Kodalkanal WLS (756 km²) should be established at the earliest. There could be a large number of habitats which can offer potential sites for the protection and reintroduction of Nilgiri tahr. Fortunately the string of PAs in the Anamalai hills stretching from Peechi-Vazhani to Eravikulam is still connected. The challenge is to retain this connectivity while trying to reduce the levels of threat that arise from the surrounding landscapes. With the combined tiger population of Periyar TR and KMTR estimated to range between 28-38 individuals (Jhala et al. 2008), the priority tasks for the Periyar-Agasthyamalai landscape are the establishment of Megamalai WLS, Kulathupuzha NP and the Kottavasal corridor. Like the Anamalai landscape, we think that the Periyar-Agasthyamalai landscape may harbour around 50 tigers at present with areas like Ranni, Konni, Achenkoll, Kulathupuzha, Palode, Shendumey, Neyyar and Peppara contributing to the tally. The most important task for both the landscapes is the control of poaching of ungulate prey species and elephant tuskers since this will boost prey availability for large carnivores while improving the elephant tusker: female ratio, reportedly abysmally low in the southern Western Ghats.

Acknowledgements

We are grateful to the Ministry of Environment and Forest, Government of India for supporting the project financially and logistically and the Kerala and Tamil Nadu Forest Departments for permission, cooperation and invaluable logistical support. We acknowledge additional programmatic and institutional support from the National Fish and Wildlife Foundation (Save the Tiger Fund) U.S.A. and WWF International. We are grateful to the Wildlife Association of Rajapalayam (WAR), WWF India, Foundation for Ecological Research, Advocacy and Learning (FERAL), Asian Nature Conservation Foundation (ANCF) and National Centre for Biological Sciences (NCBS) for sharing information and resources. We are particularly grateful to all the field staff in the Forest Departments of Kerala and Tamil Nadu who provided us valuable support, information and hospitality. We thank the following individuals who supported and encouraged our work in various capacities: R.B. Lal, Anmol Kumar, Rashid Hasan, C.K. Sreedharan, T.M. Manoharan, Dr. Sukhdev Thakur, R.K. Upadhyaya, A.R. Ramkumar, P.C. Tyagi, Sanjay Srivastava, K.R. Varadarajan, V.K. Uniyal, J. Zacharias, O.P. Kaler, Roy Thomas, P. Radhakrishna Pillai, P. Pugazhendhi, Sanjay Kumar, Padma Mohanty, D. Venkatesh, C. Bhdrasamy, S. Srinivas Reddy, Sheik Hyder Hussain, Pillai Vinayagam, K.M. Sreekumar, V. Raghavan, P. Vinod, V. Chelladurai, Dharmakrishna Raja, Ramasubramania Raja, Ramchandra Raja, A.K.D. Krishnamurthy, S. Elamon, S. Babu, A. Ali, J. Ambrose, Drs. Induchudan, A. Rajendran, K. Neelakantan, N. Manjrekar, Rauf Ali, T.R. Shankar Raman and D. Mudappa.
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