Examining large carnivore connectivity and creating conservation networks in the Sahyadri-Konkan corridor

Final report

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Wildlife Research and Conservation Society (WRCS)

The Nityata Foundation

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Introduction

The tiger (*Panthera tigris*), Asiatic wild dog (*Cuon alpinus*), sloth bear (*Melursus ursinus*), and leopard (*Panthera pardus*) are sympatric large carnivores occurring in the Western Ghats. Both, the tiger and Asiatic wild dog are considered Endangered (Chundawat et al. 2011, Durbin et al. 2008), and the Sahyadri-Konkan corridor, as defined in Bawa et al. (2007), forms the northern range limit for the distribution of the tiger and Asiatic wild dog in the Western Ghats. The sloth bear is considered Vulnerable (Garshelis et al. 2008), while the leopard is a Near Threatened carnivore (Henschel et al. 2008). A previous study in this corridor funded by CEPF-ATREE\(^1\) indicated that occupancy (proportion of area occupied) in this corridor for tigers is low (< 0.4), while it is moderate (c. 0.70) for Asiatic wild dogs (Edgaonkar 2014). As the Sahyadri-Konkan corridor forms the northern range limit for two endangered large carnivores, it makes these species highly susceptible to local extinction owing to a loss in landscape connectivity. Large carnivores being wide-ranging require a functionally connected landscape for movement, dispersal, and population viability. Therefore, it is crucial to understand and retain functional connectivity for large carnivores in this corridor.

There are three Protected Areas (PAs henceforth) in the Sahyadri-Konkan corridor in the state of Maharashtra. These are the Koyna Wildlife Sanctuary (423.6 km\(^2\)), Chandoli National Park (317.7 km\(^2\)), and Radhanagari Wildlife Sanctuary (351.2 km\(^2\)), in order from North to South. All three PAs have been designated as UNESCO World Heritage sites. These sites are structurally connected, either by forests or plantations to PAs in the states of Karnataka (Bhimgad Wildlife Sanctuary and further to Dandeli-Anshi tiger reserve) and Goa (Mhadei Wildlife Sanctuary and adjoining PAs along the Goa-Karnataka state border). However, a major portion of areas outside PAs in the state of Maharashtra of this corridor is privately-owned (Kulkarni & Mehta 2013), which has a high vulnerability of changing to land-uses which are non-conducive to animal movement. This will further constrict this corridor for large carnivores, which is already much fragmented. In the absence of any clear understanding of connectivity for large carnivores in this landscape, this project was designed to assess functional connectivity and threats to corridors and enable the conservation of corridors in the long-term through stakeholder participation.

\(^1\) Critical Ecosystem Partnership Fund and Ashoka Trust for Research in Ecology & the Environment
Given this background, the specific objectives of the project were to:

a) **Identify critical links in connectivity for large carnivores in the Sahyadri-Konkan corridor.** This objective aimed at assessing connectivity for carnivores using modelling approaches by understanding how much resistance to movement carnivores face when moving between PAs. Through this exercise we also aimed to identify pinch-points, areas where movement is high but connectivity is tenuous and the corridor can easily break apart.

b) **Create a conservation ‘network’ with stakeholders.** Stakeholders included members of civil-society (grassroots NGOs, social activists, naturalists) as well as the government bodies such as Forest Department. The project aimed to involve a small but focussed group of local stakeholders as part of a ‘conservation network’, which can discuss issues and opportunities to maintain and enhance functional connectivity for large carnivores in the future. We also aimed to link this conservation network with environmental watchdogs, which are organisations that monitor environmentally damaging projects.

c) **Incorporate the importance of landscape connectivity in regional policy and PA management to ensure large carnivore persistence.** This objective aimed to create awareness on large carnivore corridors through outreach activities for the forest department. This included extensive training of Maharashtra Forest department frontline staff in large carnivore and herbivore monitoring, publishing articles in the media, attending public hearings of projects planned in important regions of the corridor with the civil-society stakeholder group, and helping management agencies better protect corridors through ecological surveys and scientific inputs.

The first objective was short-term and was achieved in the duration of the project. The second objective was successful through this project as we were able to create a focussed and active group of stakeholders. The third objective of incorporating the importance of corridors in regional policy is allied to the nation-wide efforts for management of PAs and corridors as larger landscapes for large carnivores, mainly tigers (Harihar & Pandav 2012, Sharma et al. 2012, Joshi et al. 2013, Yumnam et al. 2014) and is still in progress. To give a sense of the breadth of work taken up throughout the project, the activities in this project have been detailed in different chapters in this report, specifically a) **Assessment of corridors in Circuitscape**, b) **Ecological surveys and camera-trapping**, c) **Stakeholder meetings, field**
visits, and workshops, d) Capacity-building and training, and e) Outreach material and publications.

The chapter on Assessment of corridors in Circuitscape outlines key results from connectivity modelling, while the following three chapters chronologically detail the activities that were conducted during the project to realize the second and third objective. The last chapter on Outreach material and publications presents the material created, and lists some articles and publications that have resulted from the project till date. A conclusion section called Recommendations for management highlights important areas and gives future directions for protection of this large carnivore corridor.
Study area

The project site is part of the Western Ghats & Sri Lanka biodiversity hotspot. The extent of the study site is from 17.78°N, 73.60°E up to 15.63°N, 74.10°E in the state of Maharashtra within the Sahyadri-Konkan corridor (10,489 km²) and includes three protected areas- Koyna and Radhanagari Wildlife Sanctuaries and Chandoli National park, which are designated UNESCO World Heritage sites and one wholly irreplaceable site- Amboli Reserved Forest (Figure 1, Bawa et al. 2007). The Koyna Wildlife Sanctuary and Chandoli National Park have been designated as the Sahyadri Tiger Reserve in the year 2010 and are also CEPF priority sites. Reserved Forests in the corridor, outside of PAs, are under the management of the Territorial division of the Maharashtra Forest Department and play a crucial role in structurally connecting PAs. In Ratnagiri and Sindhudurg districts, much land in the Sahyadri-Konkan corridor is under private ownership, but is still forested to a large extent.

Figure 1: Map showing the Sahyadri-Konkan corridor with protected areas in Maharashtra, Goa and Karnataka

The vegetation type is broadly composed of Tropical Semi-Evergreen and Moist Deciduous forests (Champion & Seth 1968), interspersed by forestry plantations (Australian acacia,
eucalyptus), horticultural plantations (cashew, mango, rubber) in private land-holdings, and rock outcrops dominated by grasses and forbs. Characteristic tree species of Semi-Evergreen forests include *Olea dioica*, *Mallotus philippensis*, *Macaranga peltata* and *Terminalia paniculata* (Ghate et al. 1998; Pascal 1988). Some characteristic tree species of stunted evergreen forests are *Actinodaphne angustifolia*, *Memecylon umbellatum* and *Syzygium cumini*, while *Terminalia crenulata*, *Lagerstroemia lanceolata*, *Grewia tiliaefolia*, *Dillenia pentagyna*, *Careya arborea* and *Xyli xylocarpa* are typical of moist deciduous forests of the northern Western Ghats (Ghate et al. 1998). *Memecylon-Syzgium-Olea* and *Memecylon-Syzgium-Actinodaphne* floristic series are typical of the higher elevation regions of the study area (Pascal 1988; Kanade at al. 2008). A number of lateritic rock outcrops, dominated by grasses and forbs, occur throughout the study area.

The area witnesses distinct seasonal shifts from the hot season (March to May), to the monsoon season (June to October) and the cold season (November to February). Temperatures vary from about 10 °C in the cold season to about 38 °C in the hot season. Average rainfall during the monsoon season in the study area varies from 1500 mm (Satara district) to about 3200 mm (Ratnagiri and Sindhudurg districts), and some areas record rainfall as high as 5000 mm as well (Gaganbawda, Kolhapur district).

A number of villages occur in the four districts of Sahyadri-Konkan corridor region in Maharashtra. The rural density of people in Kolhapur district is around 360 people/km², 144 people/km² in Sindhudurg district, 242 people/km² in Satara district, and 167 people/ km² in Ratnagiri district.
a) Assessment of corridors in Circuitscape

Circuitscape uses the theory of current flow and resistances to assess functional connectivity and pinch points in species movement (McRae et al. 2008, McRae and Shah 2011). Pinch points are areas where connectivity for an organism is severely limited or tenuous, and that area needs urgent conservation to retain functional connectivity for the species. We did this analysis to mainly understand resistance to movement between PAs and ascertain pinch-points, where connectivity is severely threatened for large carnivores.

To assess connectivity, we used results of probability of occupancy from a previous CEPF-ATREE funded project on large carnivore occupancy in the region (Edgaonkar 2014). The probability of occupancy values were used as a conductance layer for the analysis. This means that the probability of species occupying/using an area was also treated as the probability of the species moving through an area. This may not strictly hold true, as many species may occupy suitable habitats, but may move and disperse through unsuitable habitats. However, in the absence of data on species movement and dispersal, this was the most suitable option available for this study.

For tigers and dholes, probability of occupancy values was initially calculated for grids 188 km² in size. For the sake of analysis, we split each 188 km² grid to 1 km² cells and assigned the same probability of occupancy value to each cell, as that of the larger grid. For sloth bears and leopards, probability of occupancy values were originally calculated for grids 47 km² in size and these were also similarly split to cells of 1 km² and assigned the same probability as that of the original grid. This was necessary to understand movement at a much finer scale than that used for assessing occupancy of these species.

The nodes were designated protected areas in order from north to south, namely Koyna Wildlife Sanctuary, Chandoli National Park, Radhanagari Wildlife Sanctuary in Maharashtra and Mhadei Wildlife Sanctuary in Goa. Mhadei was chosen as a node for the analysis as the PA is bordering the state of Maharashtra, and is contiguous to other PAs in Goa and Karnataka. Pair-wise resistances to movement, between each pair of nodes, were calculated using the pair-wise mode in Circuitscape.
Key results from connectivity analysis

The results from pair-wise connectivity analysis for each carnivore have been presented in Tables 1 - 4 and maps of areas with high current density (animal movement) have been shown in Figures 2 to 5. Pinch-points are circled in yellow in the maps. Based on the results, resistance to movement is highest for tigers when moving from Koyna to Mhadei (PAs that are furthest away) and decrease relatively from Koyna to Radhanagari and Koyna to Chandoli (Table 1). Resistance to movement is relatively low for tigers when moving from Radhanagari to Mhadei (Table 1). Important pinch points are the corridor regions between Koyna and Chandoli, south of Chandoli (near Amba reserved forest), and between Tillari Reserved Forest and Mhadei Sanctuary at the border of Maharashtra, Goa, and Karnataka states.

Similarly, resistances to movement for dholes, sloth bear and leopard have been shown in Tables 2 - 4. Dholes showed relatively low resistance to movement between all PAs as compared to tigers. Sloth bears, however, showed high resistance to movement between PAs, especially between Chandoli to Radhanagari, and Chandoli to Mhadei, indicating that further loss of habitat in these corridor areas may affect sloth bears adversely. Leopards showed relatively low resistance to movement, similar to dholes, but it is interesting to note that these were slightly higher than those for dholes. But this may be due to the different scales at which probability of occupancy values were initially calculated.

Table 1: The tables below indicate ‘Resistance to movement’ for tigers between protected areas.

<table>
<thead>
<tr>
<th>Tiger- Resistances to movement (Ohms)</th>
<th>Koyna</th>
<th>Chandoli</th>
<th>Radhanagari</th>
<th>Mhadei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koyna</td>
<td>0.00</td>
<td>16.78</td>
<td>27.70</td>
<td>29.73</td>
</tr>
<tr>
<td>Chandoli</td>
<td>16.78</td>
<td>0.00</td>
<td>12.50</td>
<td>14.53</td>
</tr>
<tr>
<td>Radhanagari</td>
<td>27.70</td>
<td>12.50</td>
<td>0.00</td>
<td>2.59</td>
</tr>
<tr>
<td>Mhadei</td>
<td>29.73</td>
<td>14.53</td>
<td>2.59</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 2: The tables below indicate ‘Resistance to movement’ for dholes between protected areas.
Table 3: The tables below indicate ‘Resistance to movement’ for sloth bears between protected areas.

Dhole- Resistances to movement (Ohms)

<table>
<thead>
<tr>
<th></th>
<th>Koyna</th>
<th>Chandoli</th>
<th>Radhanagari</th>
<th>Mhadei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koyna</td>
<td>0.00</td>
<td>2.23</td>
<td>4.34</td>
<td>6.24</td>
</tr>
<tr>
<td>Chandoli</td>
<td>2.23</td>
<td>0.00</td>
<td>2.64</td>
<td>4.53</td>
</tr>
<tr>
<td>Radhanagari</td>
<td>4.34</td>
<td>2.64</td>
<td>0.00</td>
<td>2.48</td>
</tr>
<tr>
<td>Mhadei</td>
<td>6.24</td>
<td>4.53</td>
<td>2.48</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 4: The tables below indicate ‘Resistance to movement’ for leopards between protected areas.

Sloth bear- Resistances to movement (Ohms)

<table>
<thead>
<tr>
<th></th>
<th>Koyna</th>
<th>Chandoli</th>
<th>Radhanagari</th>
<th>Mhadei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koyna</td>
<td>0.00</td>
<td>3.35</td>
<td>17.93</td>
<td>25.97</td>
</tr>
<tr>
<td>Chandoli</td>
<td>3.35</td>
<td>0.00</td>
<td>15.03</td>
<td>23.08</td>
</tr>
<tr>
<td>Radhanagari</td>
<td>17.93</td>
<td>15.03</td>
<td>0.00</td>
<td>8.86</td>
</tr>
<tr>
<td>Mhadei</td>
<td>25.97</td>
<td>23.08</td>
<td>8.86</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Leopard- Resistances to movement (Ohms)

<table>
<thead>
<tr>
<th></th>
<th>Koyna</th>
<th>Chandoli</th>
<th>Radhanagari</th>
<th>Mhadei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koyna</td>
<td>0.00</td>
<td>2.98</td>
<td>7.48</td>
<td>9.65</td>
</tr>
<tr>
<td>Chandoli</td>
<td>2.98</td>
<td>0.00</td>
<td>4.91</td>
<td>7.08</td>
</tr>
<tr>
<td>Radhanagari</td>
<td>7.48</td>
<td>4.91</td>
<td>0.00</td>
<td>2.91</td>
</tr>
<tr>
<td>Mhadei</td>
<td>9.65</td>
<td>7.08</td>
<td>2.91</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Figures

Figure 2: Results from the current density map produced in Circuitscape for functional connectivity for tigers in the Sahyadri-Konkan corridor. Pinch points are circled in yellow, areas where current density is high therefore connectivity is very tenuous.
Figure 3: Results from the current density map produced in Circuitscape for functional connectivity for dholes in the Sahyadri-Konkan corridor. Pinch points are circled in yellow, areas where current density is high therefore connectivity is very tenuous.
Figure 4: Results from the current density map produced in Circuitscape for functional connectivity for sloth bears in the Sahyadri-Konkan corridor. Pinch points are circled in yellow, areas where current density is high therefore connectivity is very tenuous.
Figure 5: Results from the current density map produced in Circuitscape for functional connectivity for leopards in the Sahyadri-Konkan corridor. Pinch points are circled in yellow, areas where current density is high therefore connectivity is very tenuous.
b) **Ecological surveys and camera-trapping**

As part of the project, surveys (sign-surveys and camera-trapping) were conducted in the different parts of the corridor as well as in pinch-points identified by corridor modelling. The details and findings of these surveys are summarized:

- From the 9th to 14th November 2013, Girish Punjabi as part of a team comprising of different stakeholders working in the Sahyadri-Konkan region surveyed 25 villages in the Sawantwadi and Dodamarg tehsils in Sindhudurg district. The Honourable Bombay High Court directed the Maharashtra State Government to forward a proposal based on ground-level information for declaration of Sawantwadi and Dodamarg region as an ecologically sensitive region in response to a Public Interest Litigation (PIL no. 179) filed by Awaaz Foundation. This rapid survey was conducted on the request of the Chief Conservator of Forests (Territorial) of Kolhapur Circle, Maharashtra State Forest Department for want of ground-level information. A copy of the report submitted by the team can be found at [http://thesahyadricorridor.weebly.com/blog/report-on-rapid-assessment-of-biodiversity-in-25-villages-of-sawantwadi-dodamarg-corridor](http://thesahyadricorridor.weebly.com/blog/report-on-rapid-assessment-of-biodiversity-in-25-villages-of-sawantwadi-dodamarg-corridor)

- From the 9th to 15th of December 2013, Girish Punjabi along with a team of volunteers surveyed areas for large carnivores in Changad and Patne Ranges, part of an important pinch point (**Figure 6**). The objective was to assess the area to understand use by large carnivores as well as examine habitat contiguity and anthropogenic activities in this critical linkage connecting forests of Maharashtra with those of Karnataka and Goa. Surveys were conducted by walking on forest trails, along rivers, streams or other water bodies and looking for signs (tracks, scrapes, scats or droppings, claw marks) of tigers, leopards, dholes, and sloth bears. Villages covered during this survey were Vijghar (Tillari ghat), Kodali, Mahalunge Inam, Kolik, Gudawale Khalsa in the Chandgad and Patne forest ranges of Kolhapur district (**Table 5 for village details**). We also collated data on number of households and human population in these villages to better understand the dependence of villagers on forest resources and how the area can be better managed through village participation. During the surveys, tiger signs were recorded in Kodali (Vijghar) area of Patne Range. These areas are connected to those in Dodamarg tehsil in neighbouring
Sindhudurg district and form a very important linkage for tigers in the Sahyadri-Konkan corridor.

![Map of Sindhudurg district and surrounding areas](image)

**Figure 6**: Survey effort and waypoints recorded in December 2013 during the survey of an important pinch-point in Chandgad tehsil of Kolhapur district bordering the state of Karnataka.

<table>
<thead>
<tr>
<th>Village</th>
<th>Total no. of households</th>
<th>Total population</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kodali</td>
<td>350</td>
<td>1490</td>
<td>765</td>
<td>725</td>
</tr>
<tr>
<td>Kolik</td>
<td>218</td>
<td>1134</td>
<td>559</td>
<td>575</td>
</tr>
<tr>
<td>Mahalunge Inam</td>
<td>121</td>
<td>623</td>
<td>293</td>
<td>330</td>
</tr>
<tr>
<td>Gudawale Khalsa</td>
<td>207</td>
<td>898</td>
<td>411</td>
<td>487</td>
</tr>
<tr>
<td>Waghotre</td>
<td>83</td>
<td>265</td>
<td>120</td>
<td>145</td>
</tr>
<tr>
<td>Kalasgade</td>
<td>222</td>
<td>1197</td>
<td>567</td>
<td>630</td>
</tr>
<tr>
<td>Gulamb</td>
<td>94</td>
<td>433</td>
<td>218</td>
<td>215</td>
</tr>
<tr>
<td>Isapur</td>
<td>102</td>
<td>376</td>
<td>164</td>
<td>212</td>
</tr>
<tr>
<td>Kitvade</td>
<td>60</td>
<td>274</td>
<td>138</td>
<td>136</td>
</tr>
</tbody>
</table>

**Table 5**: Population of villages in the pinch point of the Tillari-Chandgad region in Maharashtra bordering Karnataka state (Source: Census of India, 2011).

- In February 2014, a visit was made to Amba village in Kolhapur district, which is located at south of Chandoli National Park and was identified as a crucial pinch-point
during the corridor analysis. Surveys were conducted to understand structural connectivity for large carnivores between Chandoli National Park and reserved forests of Amba, which further connects to Radhanagari Wildlife Sanctuary. It was found that one crucial passage point existed in a small patch of reserved forest on either side of the State Highway 202. Signs of gaur, leopard and sambar were found in that patch signifying the region to be important for species that were using it for crossing over from one side of the road to the other. Local villagers explained that species such as gaur, muntjac, and sambar were regularly seen crossing over during the summer and monsoon (See Figure 7 & 8). This visit helped make important networks with local villagers and naturalists in this crucial area of the corridor.

Figure 7: Local residents of Amba region showing the pinch-point where wildlife crosses over from one side of the State highway 202.
Figure 8: Map showing the survey of the pinch-point connecting Chandoli National Park with reserved forest areas of Amba.

- From 17th to 19th February 2014, Girish Punjabi and his team visited Mahabaleshwar to survey the reserved forest areas structurally connected to northern parts of Koyna wildlife sanctuary. The team sighted a leopard cat *Prionailurus bengalensis* during the early hours of 19th February in Kshetra Mahabaleshwar and this seems to be the first confirmed record of the species from the region. This important record has been published as a short communication to CATNEWS, an international scientific journal Link: [http://thesahyadricorridor.weebly.com/blog/short-note-on-leopard-cats-in-the-north-western-ghats-published-in-catnews](http://thesahyadricorridor.weebly.com/blog/short-note-on-leopard-cats-in-the-north-western-ghats-published-in-catnews)

- From 13th to 16th May 2014, an area near Mogalgad was surveyed to understand the implications of a proposed bauxite mine to the Sahyadri-Konkan corridor, which got an environmental clearance by the MOEF on 6th January 2014. Even though the mine lease area is less than 10 ha, the area was found to be good habitat for wildlife such as leopards, gaur, sloth bears, and dholes, among other species. From the survey, it was found that some of the area around the proposed mine is dominated by Australian acacia plantations. The area is part of an elephant route as found in the EIA study and
a study by Wildlife Trust of India (Sarma and Easa 2006). The proposed mine has a life of 10 years and it would cause immense disturbances to a wildlife corridor. There is also immense opposition to this project from local villagers and organisations. In this regard, a letter was written to the Chief Conservator of Forests (Territorial), Kolhapur.

- In the month of May –June 2014, Girish Punjabi and his team travelled to different parts of the corridor and conducted a large scale camera-trapping activity in collaboration with the Maharashtra forest department staff in 6 ranges of Kolhapur circle of the Territorial wing (Figure 9). A total of 48 camera traps were deployed in the Dodamarg (8 camera points), Patne (8 camera points), Chandgad (10 camera points), Amboli (10 camera points), Aajra (2 camera points), and Mahabaleshwar (10 camera points). A lot of species were captured on camera-traps including tiger, elephant, dhole, leopard, sloth bear, sambar, gaur, muntjac among others (See Appendices). This was the first-ever large-scale camera-trapping survey in these Ranges which are part of the corridor.

Figure 9: Deploying a camera trap in Dodamarg Range of Sawantwadi Division, Kolhapur Circle with Maharashtra Forest department staff
c) **Stakeholder meetings, field visits, and workshops**

During the course of the project, a number of meetings took place with various stakeholders from the government and civil society. The aim of these meetings and workshops was to network with stakeholders from civil-society and the forest department to create public opinion to conserve this important large carnivore corridor. Some of these important events have been summarized below:

- The project started in July 2013 with a brief visit to project sites in parts of Satara, Ratnagiri, Amboli and Kolhapur to meet various stakeholders. In Amboli, there was news of a tiger being sighted, thus the visit also involved looking for fresh signs of the carnivore. There was also a short meeting with some members of Malabar Nature Conservation Club in Amboli. In Kolhapur, Girish Punjabi gave a short presentation to the Chief Conservator of Forests, Wildlife (Kolhapur), Divisional Forest Officers (Wildlife), Assistant Conservator of Forests and Range forest offices of Koyna, Chandoli and Radhanagari about the project and had interesting discussions regarding protection of corridors and monitoring of wildlife.

- In July 2013, Girish Punjabi also got in touch with Mr. Ravikiran Govekar, AIG at the National Tiger Conservation Authority (NTCA) in Nagpur, and issues about conservation of corridors was discussed with special reference to that from Radhanagari wildlife sanctuary to Mhadei sanctuary in Goa. Data from the previous project and maps of tiger occupancy in the region and a small-write-up was also provided to the NTCA.

- In August 2013, a visit was made to the reserve forests of Wai region (Satara district), adjoining Koyna wildlife sanctuary. A small meeting was taken up with the Range Forest Officer at Wai and the Gram Panchayat at Jambli village, with the help of Mr. Shrikar Ashtaputre and Mr. Sunil Kale who have been working in the region. The objective of the meeting was to start a tourism program for the community to benefit from, in order to conserve the forest area in Wai Tehsil for large carnivores and herbivores. Both have been documenting the regions wildlife using camera-traps.
On the 20\textsuperscript{th} to 22\textsuperscript{th} of November 2013, Girish Punjabi made field visits to Koyna Wildlife Sanctuary, Chandoli National Park, and Radhanagari Wildlife Sanctuary along with Mr. S.M. Gujar, DFO Wildlife and Mr. M.M. Panditrao, DFO Wildlife. These field visits were to understand issues related to monitoring of large carnivores and management of the protected areas in the Sahyadri-Konkan corridor (Figure 10). In the meeting with DFO Mr. M.M. Panditrao, the need for a corridor plan for the area between Radhanagari wildlife sanctuary in Maharashtra to Mhadei Wildlife Sanctuary in Goa and Bhimgad wildlife sanctuary in Karnataka was also discussed. It was decided that this plan would be prepared early in 2014 using inputs provided by an earlier CEPF-ATREE funded project on large carnivores. Girish Punjabi shared this data with the forest department.

![Figure 10: A meeting with officials in Chandoli National Park in November 2013 to discuss management and monitoring of large carnivores](image)

From the 23\textsuperscript{th} to 25\textsuperscript{th} of November 2013, field visits were made to areas in Sawantwadi and Dodamarg tehsils with Mr. M.K. Rao, Chief Conservator of Forests (Territorial) (Figure 11). On one visit the forest area in the catchment area of Tillari
reservoir was visited where fresh signs of a tiger were observed. Girish Punjabi also highlighted the importance of the area as a crucial pinch-point for movement of large carnivores in the northern Western Ghats from the states of Maharashtra, Goa, and Karnataka. Important points that were presented during the visit included regular monitoring in the region for large carnivore activity and possibility of increasing the level of protection of the region by declaring it as a conservation reserve after local consultation. Kendre, Shirange, Dabhil, Sarambale, Ker, Bhekurli, and Kumbhavde were the villages visited in the corridor during the period.

Figure 11: A site visit to Kendre in the catchment of Tillari reservoir in November 2013 with Mr. M.K. Rao, Chief Conservator of Forests (Territorial) and forest department staff. Fresh tiger pugmarks were found during the visit.

- On the 18th of December 2013, Girish Punjabi visited Mumbai for a meeting organized by South Asia Network on Dams, Rivers and People (SANDRP) to discuss issues regarding dams in the Western Ghats. Though the agenda was to discuss upcoming dams around Mumbai, some useful networks were created and issues on dams causing a loss of forests and livelihoods were discussed. The issue of
the Dabhil-Sarambale dam in Sindhudurg district (part of the study area) was also discussed briefly during the meeting by members of Vanshakti, an NGO. It was decided that another such meeting would likely be organized in 2014 to discuss dams in the Konkan regions of Maharashtra. Girish promised GIS support for activities of SANDRP.

- In March 2014, a meeting was held with the Satara forest department in Mahabaleshwar Range regarding camera-trapping in reserved forest areas with good potential for preserving wildlife. It was decided that areas in Kshetra Mahabaleshwar would be a good starting point for deploying camera traps in the months of April-May 2014.

- On March 21st, Girish Punjabi was invited by the Satara Forest Department to discuss a tourism plan for Kas plateau (UNESCO World heritage site) in consultation with other experts. It was decided in the meeting that tourism would be regulated from this year. Tourists would be restricted to a path, unlike the previous years where an entire area would be open resulting in excessive trampling of vegetation and disturbance to local wildlife.

- A meeting was held with Mr. M.M. Panditrao, DFO Wildlife at Karad on the 10th of April 2014 to discuss new protocols for monitoring wildlife in the Sahyadri tiger reserve and Radhanagari wildlife sanctuary. A capacity-building session was also taken up with staff of the DFOs office on how to enter herbivore detection data for distance sampling.

- On the 8th of June, then Principal Secretary, Revenue and Forests (Maharashtra State) Mr. Praveen Pardeshi and present Director of Wildlife Conservation Trust, Mr. Anish Andheria visited the area around Tillari. The visit was extremely positive, with Mr. Pardeshi and Mr. Anish Andheria showing keen interest in improved protection of the area with help from local communities (Figure 12).
A civil society stakeholder workshop was held in Amboli on the 18th of July 2014, where 16 participants from various backgrounds (NGOs, social activists, researchers) participated (Figure 13). Everyone had an invigorating discussion and the future course of action for conservation activities in parts of the Sahyadri-Konkan corridor was chalked out. Two presentations were given during the workshop, first by Girish Punjabi on the activities of the Sahyadri corridor project and what is known about large carnivores in the Sahyadri-Konkan corridor. The second presentation was given by Terence Jorge of eRc India on how the process of forest and environment clearance works and the role of eRc India cell. A closed facebook group was found after this workshop, which constantly discusses issues related to conservation of the Sahyadri corridor. More details can be found on this
On the 31st of July 2014, some members from this newly formed group attended a public hearing on Tillari Hydro-electric project Phase II. Many objections were raised and representations were given in writing during this hearing as this project would affect the large carnivore corridor. Representations in writing were given by Girish Punjabi, Jayant Kulkarni (WRCS), Terence Jorge (ERC), Kedar Munishwar (Enviro-legal forum), Saili Datar (Malabar Nature Conservation Club). Objections were also raised verbally by Raman Kulkarni (Honorary wildlife warden, Kolhapur), and Varad Giri (Post-doctoral researcher at NCBS, earlier Scientist at BNHS). A few important contacts were made with local people from affected villages that were opposed to the project on many valid grounds.

In September 2014, Girish Punjabi personally met the Mr. Pardershi, then Principal Secretary of Forests in Satara and gave him a presentation of the activities from the Sahyadri corridor project. The CCF (Territorial) Kolhapur, DCF (Territorial) Satara, and the honorary warden of Satara were among others present during this presentation. The results of the corridor modelling and the need for pinch-points to be prioritized for conservation were discussed. The Secretary expressed that the results of the project were very useful, as he was not aware of the issues outside protected areas in the Western Ghats. It was decided that camera-trapping activities would be continued and even expanded to other important areas in the corridor, along with programs for community involvement.
On 20th September, Girish Punjabi gave a brief presentation about activities of the Sahyadri corridor project during a research seminar held by WRCS in Pune. This was attended by Mr. V.B. Sawarkar ex-director Wildlife Institute of India (Trustee of WRCS), former PCCF (Wildlife) Mr. M.G. Gogate (Trustee of WRCS), many Maharashtra forest department officers including APCCF Pune (Social Forestry directorate) Dr. A.K. Jha, APCCF Borivali (Wildlife) Mr. S.A. Thorat, APCCF (Monitoring and Evaluation) Mr. Devendra Kumar, CCF Kolhapur (Wildlife) Mr. G. Saiprakash, CCF Kolhapur (Territorial) Mr. M.K. Rao, CCF Pune (Education and Training) Mr. N.H. Kakodkar, CCF Pune (Wildlife) Mr. S.B. Limaye, DCF Pune (Territorial) Mr. S.M. Gujar, DFO Kolhapur (Wildlife) Mr. M.M. Panditrao, DFO Kolhapur (Wildlife) Mr. S.L. Zure, ACF Pune (Wildlife) Mr. R.N. Nale. Other Trustees of WRCS that attended the seminar were Mr. Raghunath Ayer, Mr. Ashok Sreenivas, and Mr. C.P. Mammen. Some prominent civil-society members were also present during the seminar. WRCS members made presentations on the current work going on in different parts of Maharashtra, Madhya Pradesh, and Karnataka.

On October 28 and 29th Girish Punjabi attended a meeting at Wildernest resort in Chorla Ghats organized by People for Western Ghats (P4WG) (Figure 14). The meeting helped network with like-minded grassroots activists and brain-storm on creating solutions to the current impasse on implementation of the Western Ghats reports.

Figure 14: Girish Punjabi during a meeting organized by People for Western Ghats (P4WG) in Wildernest resort, Chorla Ghats.
d) **Capacity-building and training**

Since one of the aims of the project was to enhance protection and monitoring in the corridor region, a number of trainings and capacity-building sessions were taken up for officers and ground staff in Territorial (outside PAs) as well as Wildlife circles (PAs) of the corridor.

- In September 2013, a training session for staff of Sahyadri Tiger Reserve was organised by the Maharashtra Forest Department, which included staff of Koyna Wildlife Sanctuary and Chandoli National Park. This was organized on the 6\textsuperscript{th} and 7\textsuperscript{th} September in Mandur near Chandoli National Park. Girish Punjabi imparted training to staff about using equipment (GPS, range-finders, compasses) and monitoring of herbivores using line-transects and deploying camera-traps for large carnivores.

- A similar training session was organized in Radhanagari Wildlife Sanctuary on the 19\textsuperscript{th} and 20\textsuperscript{th} of September 2013.

- From the 19\textsuperscript{th} to 25\textsuperscript{th} of October, Girish Punjabi along with Hemant Kenjale of Creative Nature Friends (Karad) took up training sessions for forest department staff of Territorial forest divisions in Satara, Ratnagiri (Chiplun), Sangli, Kolhapur, and Sawantwadi on the use of GPS units and Android phones for monitoring. These capacity-building sessions proved to be excellent opportunities to create networks with senior officials and staff in the Territorial wing of the Maharashtra Forest Department.

- Two separate visits (20\textsuperscript{th} - 21\textsuperscript{st} and 23\textsuperscript{rd} - 24\textsuperscript{th} December) were then made to different areas in the corridor to interact with forest department staff and organise training on line-transect sampling for monitoring areas outside protected areas in the corridor. The first visit was to Mahabaleshwar and Patan forest ranges; both areas are situated to the north and south, respectively, of the Koyna Wildlife Sanctuary. In Patan, a brief visit was also made to the corridor linking Koyna and Chandoli protected areas. The second visit was made to Amboli to take capacity-building sessions for forest staff in Amboli and Sawantwadi Ranges.
In January 2014 (Quarter 3), the project began with meetings with territorial division officers in Satara, Kolhapur, and Sawantwadi about monitoring of areas for large carnivores and herbivores outside protected parks using line transects and camera traps. In this regard, Girish Punjabi urged the Chief Conservator of Forests (Territorial) Mr. M.K. Rao to order camera-traps for monitoring important forest areas in the corridor. From the 2nd to the 6th of January 2014, Girish Punjabi took hands-on training sessions for Range forest officers and forest guards of Amboli and Sawantwadi ranges Kolhapur Territorial circle in marking line transects and monitoring wildlife (Figure 15 and 16).

Figure 15: Girish Punjabi interacting with forest department staff from Kolhapur division in Amboli and explaining the use of equipment in line-transect monitoring.
A visit was made to Dapoli in Ratnagiri on the 7th to 10th January 2014 to train forest guards and then to Wai on the 11th to build local capacity in Jambli village for a proposed ecotourism venture through the Joint forest management committee. Girish Punjabi visited Satara on the 14th January 2014 to discuss Phase I monitoring protocols in the corridor with forest officials. Capacity-building sessions and training was taken for Assistant Conservator of Forests, Range Forest officers, and over a hundred forest guards of Satara forest division in the Kolhapur circle (Figure 17). During these sessions, Girish Punjabi stressed on the importance wildlife monitoring in crucial areas in the corridor outside of protected areas. Hands-on sessions on using free tools such as Google Earth were taken for the forest guards of Satara division.
Figure 17: Capacity-building sessions and training for Assistant Conservator of Forests (ACFs), Range Forest officers (RFOs), and over a hundred forest guards of Satara forest division in the Kolhapur circle.
e) Outreach material and publications

For outreach we designed a brochure explaining the various activities of the project. This was designed by Project Associate Akhila Paranjape with useful inputs by Mr. Jayant Kulkarni and Mr. Mayuresh Gangal (Nature Conservation Foundation) which helped in further improving the content of the brochure. We also designed posters, which were put up in Mahabaleshwar, Amboli, and Tillari areas to explain stakeholders the project objectives and importance of large carnivores and corridors and report grievances.

A copy of the brochure created for the project

Website: On February 20th 2014, the project website [http://thesahyadricorridor.weebly.com/](http://thesahyadricorridor.weebly.com/) was launched. This website is constantly updated using a blog about project activities, articles, and publications.
Articles in Magazines and newsletters: Some articles were published in popular media to create awareness about carnivores and threats to wildlife in this corridor.

1) Down to Earth. Tigers fall prey to development. 15th November, 2013. [http://www.downtoearth.org.in/content/tigers-fall-prey-development](http://www.downtoearth.org.in/content/tigers-fall-prey-development)

2) ‘Aaple Paryavaran’ (Our environment). Article on tigers threatened by development activities in the Western Ghats was published in a Marathi magazine. This article was translated by Mr. Parikshit Suryawanshi. The article can be accessed through this link [http://www.paryavaran.org/april14/index.html#28](http://www.paryavaran.org/april14/index.html#28)


Articles in Newspapers

1) Pune Mirror. Forging a path for the Ghats’ wildlife. 2nd November 2013
2) **Pudhari** (Marathi daily). A news article on the poachers caught on camera-traps

3) **Times of India.** Three tigers caught in Tillari region. 17th June 2014
4) DNA India. Cameras trap poachers with sambar meat in Tillari forest. 16th June 2014

Journal articles


f) Recommendations for management

> For tigers, resistance to movement is least when moving between Radhanagari Wildlife Sanctuary in Maharashtra and Mhadei Wildlife Sanctuary in Goa, and most between Mhadei and Koyna Wildlife Sanctuary. Resistance to movement for tigers is relatively high when moving between Chandoli National Park and Radhanagari Wildlife Sanctuary. Based on these results, we recommend that the tiger corridor between Radhanagari and Mhadei be protected as a priority, as this corridor still shows evidence of tiger movement. This will give most dividends at this point of time, in terms of viability of a tiger metapopulation in the north Western Ghats landscape.

> We recommend that the region around Tillari dam, which comprises of Reserved Forest and Private Forest in Dodamarg and Patne Ranges be protected as a conservation or community reserve. During the project we found evidence of tigers, wild dogs, sloth bears, and leopards and good evidence of large herbivores which are important prey for tigers and wild dogs. This region comprises of a mix of bamboo-rich moist tropical forest and grassland habitats in the valleys and plateau tops. There are almost no human settlements in a large part of the region, because of relocation after the Tillari dam project. These lands, which are no more cultivated, can be acquired by project proponents under compensatory afforestation schemes by paying the land-owners appropriate market value of the land. This acquisition process needs to be just and fair, so that there is support towards wildlife conservation activities in the region. The Forest Department could also present a certificate of recognition towards land-owners who have contributed to the cause of conservation by agreeing to sell their uncultivated land under compensatory afforestation schemes.

> There is a need to protect the corridor between Radhanagari and Koyna for tigers and sloth bears. Similar to tigers, sloth bears also showed high resistance to movement when the habitat gets fragmented, as is the case between Radhanagari and Koyna. Recent surveys during this project from Amba Reserved Forest, which has experienced a large amount of fragmentation, have rarely recorded signs of sloth bears indicating that fragmentation is having a negative effect on this species.

> Camera-trapping activities in the corridor have revealed presence of wild herbivores in some parts, but at the same time also gathered evidence of hunting. We recommend that regular camera-trapping activities be taken up in a more systematic and scientific frame-work in important ranges of the Territorial Wing in Kolhapur Circle. These include Dodamarg,
Sawantwadi, and Amboli Ranges in Sawantwadi Division; Patne, Chandgad, Ajara, Kadgaon, and Gargoti Ranges in Kolhapur Division, and Mahabaleshwar and Patan Ranges in Satara Division. This will help monitor wildlife presence regularly and serve as an important deterrent to poachers, since camera-traps act as eyes in the forest where regular patrolling is not taken up either due to shortage of staff or logistical difficulties.

Based on the results of this project, and recommendations from Wildlife Conservation Trust regarding delineation of corridors, we recommend the Maharashtra Forest Department’s Wildlife and Territorial Wings themselves delineate important beats which form part of the large carnivore corridor. This corridor should then be protected and no permission should be granted to any large-scale projects which will further fragment this corridor for wildlife movement. This includes any new highway, wind farm, and medium and large dam projects, as all these projects will further open up intact forest areas, which are important refugia for wildlife, especially for tigers, wild dogs, and sloth bears.

As an allied management strategy, large-scale awareness activities on crop protection, compensation and insurance schemes can be taken up in villages from those Ranges which have been identified as having high incidence of crop depredation by herbivores such as gaur, sambar, and wild pig (and in some cases elephants). Compensation schemes, even though necessary in the short-term, are not a solution to solve crop depredation problems in the long-run. Changing the cropping pattern in some cases may help reduce depredation problems. Insurance schemes could be tried out initially in some representative areas to ease financial losses due to crop damage. Successful implementation of these schemes in some areas may lead to a larger demand in the long-run and ease the inconvenience to farmers due to procedural delays in compensation from the Forest department’s side. In such areas, the recovery of large carnivores may help ease some problems with crop-raiding herbivores. However, hunting of herbivores as a retaliatory measure needs to be prevented at all costs.
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Literature cited


A sloth bear *Melursus ursinus* in Amboli. Picture courtesy: Maharashtra Forest Dept.

A small clawed otter *Aonyx cinerea* (right corner) in Umgao area of Chandgad. Picture courtesy: Maharashtra Forest Dept.
A tusker *Elephas maximus* in Kendre area of Tillari dam. Picture courtesy: Maharashtra Forest Dept.

A gaur *Bos gaurus* bull in Kendre, Tillari. Picture courtesy: Maharashtra Forest Dept.
A wild dog *Cuon alpinus* with a sub-adult in Ratoba, Tillari nagar. Picture courtesy: Maharashtra Forest Dept.

A leopard in Kendre, Tillari. Picture courtesy: Maharashtra Forest Dept.
The three individual tigers photographed in Tillari region. Picture courtesy: Maharashtra Forest Dept.

A melanistic leopard on the camera trap in Ajara range. Picture courtesy: Maharashtra Forest Dept.