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Caption: Front cover—The Dudhsagar waterfall in full spate beside the existing Castlerock-Kulem railway track inside Bhagwan Mahavir (Mollem) National Park. © Parag Rangnekar. Back cover—The landscape of Bhagwan Mahavir Wildlife Sanctuary & National Park supports high biodiversity due to the diversity of habitats, including grasslands, as seen in this image. © Omkar Dharwadkar

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On the inadequacy of environment impact assessments for projects in Bhagwan Mahavir Wildlife Sanctuary and National Park of Goa, India: a peer review

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Abstract: The Environment Impact Assessment (EIA) is a regulatory framework adopted since 1994 in India to evaluate the impact and mitigation measures of projects, however, even after 25 years of adoption, EIAs continue to be of inferior quality with respect to biodiversity documentation and assessment of impacts and their mitigation measures. This questions the credibility of the exercise, as deficient EIAs are habitually used as a basis for project clearances in ecologically sensitive and irreplaceable regions. The authors reiterate this point by analysing impact assessment documents for three projects: the doubling of the National Highway-4A, doubling of the railway-line from Castlerock to Kulem, and laying of a 400-kV transmission line through the Bhagwan Mahavir Wildlife Sanctuary and National Park in the state of Goa. Two of these projects were recently granted 'Wildlife Clearance' during a virtual meeting of the Standing Committee of the National Board of Wildlife (NBWL) without a thorough assessment of the project impacts. Assessment reports for the road and railway expansion were found to be deficient on multiple fronts regarding biodiversity assessment and projected impacts, whereas no impact assessment report was available in the public domain for the 400-kV transmission line project. This paper highlights the biodiversity significance of this protected area complex in the Western Ghats, and highlights the lacunae in biodiversity documentation and inadequacy of mitigation measures in assessment documents for all three diversion projects. The EIA process needs to improve substantially if India is to protect its natural resources and adhere to environmental protection policies and regulations nationally and globally.

Keywords: Biodiversity, development, highway, National Board for Wildlife, protected area, railway, transmission line, Western Ghats.

Abbreviations: Bhagwan Mahavir Wildlife Sanctuary and National Park—BMWS & NP | EC—Environmental Clearance | EIA—Environment Impact Assessment | FC—Forest Clearance | IUCN—International Union for Conservation of Nature and Natural Resources | NP—National Park | PAs—Protected Areas | WC—Wildlife Clearance | WPA—Wildlife (Protection) Act | WS—Wildlife Sanctuary | MoEFCC—Ministry of Environment, Forests and Climate Change, Government of India | UNESCO—United Nations Educational, Scientific & Cultural Organization.

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1. BACKGROUND

The Environment Impact Assessment (EIA) process is a standard framework for appraisal and evaluation of development projects. The first EIA notification in India was published in 1994 by the Ministry of Environment and Forests. This was followed by a new EIA notification in 2006 that made it mandatory for most projects in the mining, power, infrastructure, and industrial sectors to seek Environmental Clearance (EC) prior to new developments or the expansion of existing ones. If a project is sited in a protected area or passing through a notified forest it may additionally require a Forest Clearance (FC) and/ or Wildlife Clearance (WC). While India has been following the EIA process for over 25 years, studies have frequently highlighted sub-standard and deficient EIA and other assessment reports used by proponents to obtain these clearances by diluting the spirit of the exercise (Comely 2018; Datar et al. 2019; Sheth et al. 2020).

EIA and other assessment reports have often been found deficient in documenting biodiversity, assessing direct, indirect, and cumulative impacts, and proposing mitigation measures (Datar et al. 2019; Khera & Kumar 2010; Sheth et al. 2020). In this Review, the authors present an analysis on three projects that will cumulatively affect Bhagwan Mahavir Wildlife Sanctuary and National Park (BMWS & NP), formerly known as Mollem, in the state of Goa (Figure 1, Image 1–3). These forests are an important part of a larger landscape that affords connectivity not only to other forests in Goa but also across the border to Kali (Dandeli-Anshi) Tiger Reserve in Karnataka. The three projects are as follows:

a. Road: The four-laning of the National Highway 4A (153km in total length, of which 70.07km falls within Goa, with 13km bisecting the BMWS & NP, now redesignated as National Highway 748), that is being carried out by the National Highways Authority of India and by the Public Works Department in Goa. The proposal involves the diversion of about 31.015ha of protected forest area (24.265ha in the NP and 6.75ha in the WS). At present, the road passing through the protected area has a 7m wide two-lane carriageway. The proposal involves widening specific sections of the road, thus creating new intrusions into the forest that have not yet faced the direct and indirect impacts of fragmentation. On the other side of the border in Karnataka, the highway expansion passing through the protected area (PA) has been halted by the Karnataka High Court. The total forest land required is 63.615ha and the total number of trees to be felled are 20,340, of which 12,097 trees will be felled from the PA.

b. Railway: The second project is the doubling of the Castlerock–Kulem railway line, which is part of the larger Hospet–Tinaighat–Castlerock–Kulem–Madgaon–Vasco line. The total length of this railway line is 345km, of which 26km passes through the BMWS & NP, that is being undertaken by MS Rail Vikas Nigam Ltd. The total forest land required is 138.37ha and the total number of trees to be felled are 22,882; of which 20,758 will be felled from the PA. Four underpasses measuring 12m in width and 5.65m in height have been proposed as mitigation measures along the railway line. The existing railway line from Hospet to Vasco was laid in 1900 and presently connects iron ore mining and industrial areas in Hospet to Mormugao Port in Vasco. The alignment of the second proposed railway line runs parallel to the existing line and passes through forest tracts in and around Kali Tiger Reserve and in the BMWS & NP.

c. Transmission line: The third project is the laying of a 3.15km transmission line through BMWS & NP. The line will be set between Narendra, Karnataka and terminating with a 400 kV substation at Xeldem, Goa. This project is being undertaken by M/s Goa – Tamnar Transmission Project Ltd (Sterlite Power) with 12,097 trees that will be felled and 11.54ha of forests being diverted, with the power line being 46m in width. The project also requires diversion of 30.412ha of protected forests of Kali Tiger Reserve in Karnataka. In reality, there are five forest diversion proposals for one single project involving diversion of total 323.596ha of forest land through the state of Goa (146.505ha) and the state of Karnataka (177.091ha). The entire project in the state of Goa would require felling of 43,456 trees and felling of another 62,289 trees in the state of Karnataka. The total trees enumerated to be felled for implementing the entire inter-state project is 1,05,745 trees.

The Indian Ministry of Environment, Forests and Climate Change (MoEFCC) has a web portal, Parivesh, which makes public all project documents required for clearances sought by project proponents. The Parivesh website does not have the Biodiversity Impact Assessment Report of the transmission line project uploaded (as on 1 July 2020), despite in-principle approval being afforded at the 57th National Board for Wildlife meeting held on 7 April 2020.

In this Review, we first present the biodiversity significance of BMWS & NP by reviewing published literature on taxonomic groups, and referring to

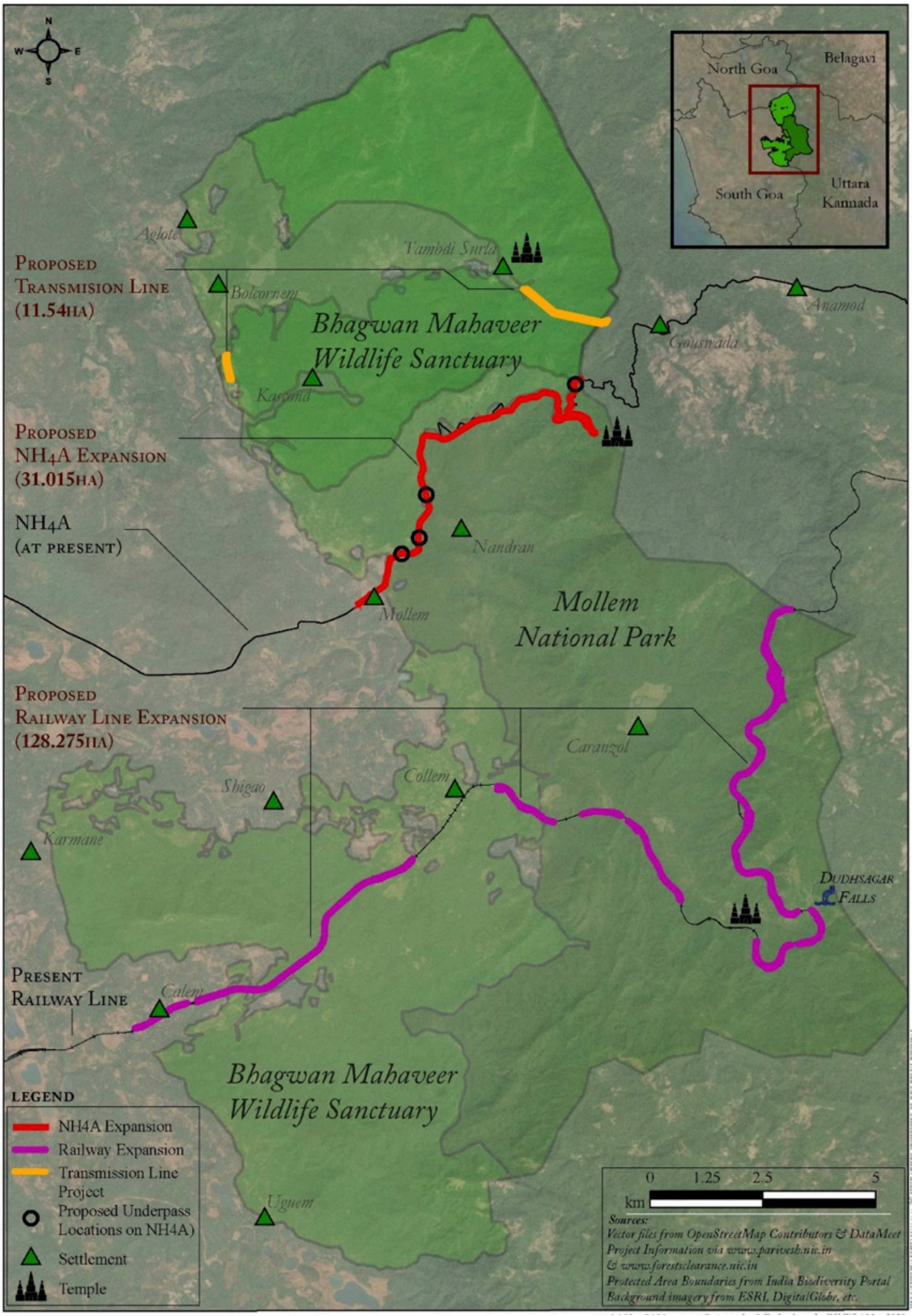

Figure 1. Bhagwan Mahavir Wildlife Sanctuary and National Park (Mollem) alongwith the three linear projects (400Kv transmission line, NH 4A Expansion, Castlerock-Kulem-Madgaon Railway line expansion) planned in the protected area complex. Map credit: Nandini Mehrotra and Shashank Srinivasan, Technology for Wildlife.

Image 1. Actual tree felling for transmission line Xeldem. © Anonymous

Image 2. Castlerock - Kulem Railway line at Dudhsagar. © Omkar Dharwadkar

Image 3. A representative photo of perceived impacts on wildlife by roadkills due to the NH4A expansion inside Bhagwan Mahavir WS & NP. © Ninad Bhosale

unpublished sources such as dissertations, reports, and checklists that have been at least peer-reviewed among expert groups, where published information is scarce. We then present a critique of the two assessment studies (the railway study prepared by the Indian Institute of Science, Bengaluru and the highway study prepared by Aarvee Associates, Hyderabad) and a summary on the impact of the transmission line given that the project report is not available in public domain.

2. ABOUT BHAGWAN MAHAVIR WILDLIFE SANCTUARY AND NATIONAL PARK

Bhagwan Mahavir Wildlife Sanctuary and National Park comprises wet evergreen, semi-evergreen, and moist deciduous forests in the Western Ghats. Both PAs are contiguous and span an area of 240km^2, with 133km^2 as WS and 107km^2 as NP.

Both PAs are classified as Important Bird and Biodiversity Area by the Bombay Natural History Society and Birdlife International, UK (Rahmani et al. 2016).

A summary of the known status of taxonomic groups is provided here to enable a reliable assessment of the ecological value of the PA complex (Image 4).

2.1 Plants and Fungi

BMWS & NP comprise more than 700 plant species (Datar & Lakshminarasimhan 2013; See Appendix II). Of these, at least 127 species are endemic, making about 18% of the total flora (Datar & Lakshminarasimhan 2011).

The region is a hotspot for fungal diversity in the Western Ghats. Nearly 1,200 fungi species are known from Goa, of which at least 500 mushroom species have been identified and many are yet to be described (Nandkumar Kamat in litt. 27.xii.2020). A total of 18 lichen species are known from the PA, although the overall diversity is likely to be higher.

2.2 Insects and Arachnids

Both PAs together support 219 butterfly species (Appendix V) and 80 species of odonates (Appendix VI), of which 14 species of butterflies and 18 species of odonates are endemic to the Western Ghats. Two odonate species *Idionyx gomantakensis* (Subramanian et al. 2013) and *Cyclogomphus flavoannulatus* (Rangnekar et al. 2019) have been described from within and immediate outskirts of the PA. A few butterfly species found in the BWWS & NP such as the Danaid Eggfly *Hypolimnas misippus*, Common Mime *Papilio clytia*, Common Pierrot *Castalius rosimon*, Blue Nawab *Polyura schreiberi*, Kanara Oakblue *Arhopala alea*, Orchid Tit *Hypolycaena othona*, Short-banded Sailor *Neptis columella*, and Crimson Rose *Pachliopta hector* are protected under Schedule I of the Wild Life (Protection) Act, 1972 (henceforth WPA 1972). Two endemic butterfly species found here are the Malabar Rose *Pachliopta pandiyana* and the Southern Birdwing *Troides minos*. A 2011 report on moth diversity from the northern Western Ghats reports at least 418 moth species out of which 116 species were unidentified, and potentially new to science (Shubhalaxmi et al. 2011). A total of 75 ant species are recorded from the WLS of which seven are endemic (See Appendix IX). Six scorpion species, 16 spider species, and one species each of Whip Scorpion and Whip Spider have been recorded from both the PAs (Bastawade & Borkar 2008). An isolated population of Whip Spider *Phrynichus phipsoni* and Whip Scorpion *Labochirus tauricornis* occurs in the proximity of this PA (Borkar et al. 2006; Borkar 2018).

2.3 Fish

The Western Ghats supports over 300 fish species of which more than 65% are endemic (Kumar & Devi 2013). New fish species and range extensions are being described from this region as yet, suggesting that fish species assessments and distribution patterns remain incomplete (Molur et al. 2011). A comprehensive study in the Mhadei sub-basin (which includes BMWS & NP) has the presence of 49 fish species, of which 18 species are endemic to the Western Ghats (Atkore 2017; See Appendix IV).

2.4 Herpetofauna

The reptilian diversity of the region is represented by 52 species from Crocodylidae (Crocodiles), testudines (freshwater turtles & tortoises), and squamates which includes Sauria (Lizards) and Ophidia (Snakes) (See Appendix VII). Amongst the diversity of reptiles, the Indian Rock Python *Python molurus*, Indian Monitor Lizard *Varanus bengalensis*, and King Cobra *Ophiophagus hannah* are some species in the Schedule I and II of WPA, 1972. Other endemics such as the Malabar Pit Viper *Trimeresurus malabaricus* and the Large-Scaled Shieldtail *Uropeltis macrolepis* are also reported from the region.

In the past 15 years, 112 new amphibian species have been discovered from the Western Ghats, indicating high species richness and a need for more systematic studies in the landscape. Among the 218 known species of amphibians, 87.8% (158 species) are endemic to the

Image 4. Some representative taxa which would be affected due to the direct and indirect impacts of the three linear projects in the Bhagwan Mahavir Wildlife Sanctuary and National Park in Goa (from top left): South Indian Gliding Lizard *Draco dussumieri*, Malabar Tree Toad *Pedostibes tuberculosus*, Indian Giant Gliding Squirrel *Petaurista philippensis*, Black Rajah *Charaxes solon*, Flame-throated Bulbul *Rubigula gularis*, & the dragonfly *Cyclogomphus flavoannulatus*.

Western Ghats (Nirmal Kulkarni pers. obs. 01.vii.2020). The two PAs together contain at least 36 amphibian species (See Appendix VIII). Castlerock is the type locality of *Nyctibatrachus petraeus* (Das & Kunte 2005) and *Raorchestes bombayensis* (Annandale 1919). Biju et al. (2014a) described 14 new dancing frogs, of which one species *Micrixalus uttaraghati* is found in the streams that cut across the existing Castlerock-Kulem railway line. Similarly, these streams are home to *Indosylvirana caesari* and *Indirana chiravasi*, two new frog species that were described recently (Biju et al. 2014b; Padhye et al. 2014). Seven new amphibian species have been discovered in the past two decades from Goa.

2.5 Birds

The first ornithological study in Goa was conducted by Grubh & Ali (1976). During their 16-day survey that included Mollem, the team recorded a total of 97 bird species. Presently, 286 species have been recorded from the BMWS & NP (Rahmani et al. 2016; see Appendix I). The list includes species such as the Critically Endangered Indian Vulture *Gyps indicus*, Endangered Egyptian Vulture *Neophron percnopterus* and other globally threatened species such as the Lesser Adjutant *Leptoptilos javanicus*, Woolly-necked Stork *Ciconia episcopus*, Nilgiri Wood Pigeon *Columba elphinstonii*, and Malabar Pied Hornbill *Anthracoceros coronatus*. A total of 14 bird species recorded from BMWS & NP are endemic to the Western Ghats and 32 of the recorded species are listed in the Schedule I (Part III) of the WPA, 1972. Six bird species are classified as Near Threatened by International Union for Conservation of Nature and Natural Resources (IUCN).

2.6 Mammals

BMWS & NP, along with the Kali Tiger Reserve and surrounding reserved and protected forests cover an area of at least 2,000km^2 and form an important Bengal Tiger *Panthera tigris* habitat (Gubbi et al. 2016). The National Tiger Conservation Authority has recommended bringing together the protected areas of Goa and Karnataka for Tiger conservation and improved management. In a document released by the MoEFCC titled "Connecting Tiger Populations for Long-term Conservation" the forests of Goa are mentioned as one (Sahyadri-Radhanagari-Goa) of 32 major Tiger corridors in India. A breeding population of Tigers has been recorded from the tri-junction of Goa–Karnataka–Maharashtra (Girish Punjabi pers. obs. 19.iii.2019; Jhala et al. 2020). In May 2019, the Forest Department of Goa photographed an individual Tiger using trail cameras in the BMWS & NP, and expect more individuals to be present (The Goan Everyday 2019). On the 5 January 2020, carcasses of four Tigers – a female and her three cubs were found in the neighbouring Mhadei Wildlife Sanctuary (Kerkar 2020). The four tigers were poisoned in retaliation for depredating livestock (Kerkar 2020).

More than 60 mammal species are likely to occur in the PAs, of which 11 species belong to Schedule I of the WPA 1972 (See Appendix III). Gad & Shyama (2009) found that Gaur *Bos gaurus* was widespread and fed on 32 plant species belonging to 17 plant families in the PA. Sengupta & Radhakrishna (2013) encountered a higher number of Bonnet Macaques *Macaca radiata* in BMWS & NP as compared to other parts of Goa. Krupa et al. (2017) reported two sympatric otter species, the Asian Small-clawed Otter *Aonyx cinereus* and Smooth-coated Otter *Lutrogale perspicillata* in the buffer region of Mhadei WS, which adjoins BMWS & NP.

3. REVIEW OF EIA FOR THE NH-4A HIGHWAY EXPANSION PROJECT

After compiling lists of taxonomic groups known from the PAs, the authors reviewed the EIA for NH-4A Highway Expansion (henceforth Road Report) for information provided on taxonomic groups, environmental and social impacts of the project. We found inadequacies in most aspects and as such the Road Report was observed to be of poor quality. The relevant issues are discussed here.

3.1 Plants

i) Several issues were found with the reported methodology for the baseline survey on plant species in the Road Report. The sampling strategy was not clearly indicated. The Report says that the number of quadrats in each habitat type was proportionate to the land in the habitat type, but no further information is provided whether a randomized or systematic sampling protocol was used. In the absence of a protocol, sampling locations would be biased and not fully representative of the habitat type.

ii) Resultantly, the list on floral species in the Road Report is inadequate when compared to existing species list of the area (Datar & Lakshminarasimhan 2011).

iii) The sampling methodology outlined was likely not followed. The data were finally compiled and based on a reconnaissance trip and secondary literature (Section 5.8.2, Page 79). No analysis of species diversity or dominance were performed, and the findings are only provided in the form of a brief species list (Table 5.15, Page 79). This list excludes understory species, herbs, and lianas. No data are presented on tree girths, size classes or age structure, which could help in an assessment of the damage to the forest.

iv) The Road Report is not clear about which agency will plant trees as part of the project and the figures provided are inconsistent. It states that the intention is to plant 20,000 avenue trees next to roadside parking areas, toll gates, bus bays, and truck lay-bys (page 82). The Report later revises this number to 50,000 trees (Page 96), then to ~27,000 trees (based on planting 333 trees per km^2 in wildlife sanctuary and 666 trees per km^2 elsewhere) and finally back to 20,000 trees (Page 137).

v) The Road Report has also not specifically identified plant species that will provide appropriate and compensatory ecosystem services for the tree plantation. The species to be planted on the edge of the highway are Mahua *Madhuca longifolia* and Khair *Acacia catechu*, which are not typical of the Western Ghats and *Bougainvillea* sp., an ornamental that is not native to India, but is to be planted in the median.

3.2 Insects and Arachnids

i) The Road Report has no impact assessment of linear intrusions on insect and arachnid diversity, with no details on species richness in the area. No attempt has been made to compile secondary information from published and unpublished sources.

ii) There are many studies from India and the world which have examined the impact of roads on insects. Insects suffer a high mortality while crossing roads or may avoid crossing roads altogether (Muñoz et al. 2015). Studies report that vehicle lights attract many insects, causing mortality during the night (Seshadri & Ganesh 2011). The barrier effect of roads is higher for slow-moving insects (Muñoz et al. 2015), but even flying insects such as butterflies are affected by fragmentation created by roads, as the nature of patch-edge affects their dispersal ability (Ries & Debinski 2001; Dover & Settele 2009). Studies on grasshoppers have demonstrated that males increase their call frequency in response to road noise, which may have population-level consequences (Lampe et al. 2014).

iii) Despite evidence of high levels of diversity and endemism in the BMWS & NP, odonates have not been surveyed. Species of hill streams are more narrowly-distributed and are indicators of water quality (Simaika et al. 2016). A new dragonfly species *Idionyx gomantakensis* (Subramanian et al. 2013) was reported in 2013 from the PAs, a fact that has been overlooked in the Road Report. This raises doubts whether secondary data has been reviewed while compiling the faunal list for the project area.

iv) No details are provided for Arachnids in the Road Report. In so far as the amblipygid, urropygid, and theraphosid spiders of these areas are concerned, given their fidelity to their habitat type and their rather restricted movement, any alteration of the habitat, due to road construction and widening, shall decimate these small and isolated populations beyond recuperation and renewal**,** even leading to local extinctions (Maelfait & Hendrickx 1998).

3.3 Fish

i) No fish species or impacts of road expansion have been described in the Road Report. It states that "since most of the water bodies remain dry during the non-monsoon months, this [sediment] impact will be negligible" (Page 98). This statement is inaccurate, as several perennial streams and pool habitats contain water and act as refuges for various fish species in the non-monsoon months. A study cautions against the effects of sedimentation and run-off on the fish communities due to rampant vehicular traffic in the neighbouring Mhadei Sanctuary (Atkore 2017).

ii) Many other impacts are envisioned which the Road Report has not assessed. Soil erosion due to the removal of riparian vegetation would have short-term as well as long-term impacts on stream dwelling communities. Riparian vegetation plays an important role in maintaining ambient temperature in the headwater catchment (region from numerous streams originates) enabling persistence of diverse, endemic and habitat specialist fish species such as *Balitora* sp., *Glyptothorax* sp., *Schistura* sp., *Bhavania* sp., and *Garra* sp. (Sreekantha et al. 2007).

iii) Increased soil erosion due to the road expansion is likely to multiply the sedimentation load, which may impair water quality greatly due to high turbidity. Sediment deposition is likely to reduce food availability to aquatic communities. Bottom-dwelling fish such as *Balitora* sp., *Glyptothorax* sp., and *Schistura* sp. feed on benthic insects (Daniels 2002), and have a very narrow range of distribution and tolerance level to certain water quality variables.

iv) Higher suspended solids and silt deposition can also affect spawning grounds and various life stages of fish. A few highly sensitive fish species such as Deccan Mahseer *Tor khudree* and *Hypselobarbus* sp. are known to migrate upstream for feeding and breeding, either once or twice a year. Mahseer, in particular, are known to choose definite and special spawning grounds which usually are rich in dissolved oxygen content, neutral pH, and cool water temperature. Eggs, fry and fingerlings stages of this fish are highly sensitive to the slight alterations in their environment and spawning habitats (Daniels 2002). Soil erosion and high deposition of silt along with stream flow are expected to destroy their habitat, and could reduce their population in Dudhsagar and other adjoining waterbodies.

v) Surface dwelling fish such as *Devario* sp., *Barilius* sp., and *Salmostoma* sp. feed largely on insects falling from the canopy (Johnson & Arunachalam 2010). Higher turbidity due to sediment load would reduce their ability to forage and may restrict these fishes to downstream habitats, affecting their survival.

3.4 Herpetofauna

i) Details on herpetofaunal diversity in the PAs is not mentioned in the Road Report. Section 5.8 (Page 74) mentions that Goa has a high snake population. While this may be a general statement, it is not backed by any references.

ii) Further, data from exsiting literature points to an increase in the number of snake and amphibian road-kills with existence of roads (Garriga et al. 2012; Santhoshkumar et al. 2017). There is, however, no mention of the impact of road expansion on herpetofaunal diversity of the PA in the Road Report.

3.5 Birds

i) Although the Road Report mentions that a field survey has been carried out (Section 5.8.2 (v), Page 78), there is no bird checklist provided, except for one mention of the Indian Robin *Copsychus fulicatus* along with other fauna (Table 5.16, Page 82). Bird species richness and abundance were not quantified in the project area that may be affected due to the project construction. This is a serious shortcoming given that 286 bird species have been recorded in the BMWS & NP (Rahmani et al. 2016, See Appendix I).

ii) A section (Page 74) of the Road Report matches the Wikipedia page "Flora and Fauna of Goa" (Wikipedia contributors 2020), which mentions that the state bird of Goa is "the Ruby-throated Yellow Bulbul, which is a variation of Black-crested Bulbul". This is inaccurate, as the state bird of Goa is the Flame-throated Bulbul *Pycnonotus gularis*, which recent studies have elevated to a full species (Rasmussen & Anderton 2012).

iii) There is further confusion about the state bird of Goa; section 5.8.1 of Page 78 of the Road Report refers to the Yellow-throated Bulbul *Pycnonotus xantholaemus* as the state bird. The Yellow-throated Bulbul is endemic to peninsular India and has no known distribution in Goa. The faunal statistics presented in section 5.8.1 have been taken from Kumar & Somashekar (2008) with no attribution to the original source. The absence of any data on birds, either quantitative or qualitative, from an area that has been classified as an Important Bird and Biodiversity Area (IBBA), undermines the purpose of the EIA.

3.6 Mammals

i) To assess faunal diversity, field surveys and a local consultation were conducted in the Road Report, however, it does not contain any methodological specifications or sampling strategy. Sampling methods for different taxa are also not clearly differentiated. The species list is limited with only 16 species recorded. This is a clear underestimate as more than 60 mammal species are known to inhabit this region (See Appendix III).

ii) The presence of the Bengal Tiger in the area is also not mentioned. The report states that no endangered species are found in the area which is clearly misleading considering three Endangered mammal species occur, including the Tiger, Dhole, and Indian Pangolin. One of the species mentioned in the Road Report, the Red Giant Flying Squirrel *Petaurista petaurista* is not found in the Western Ghats. Common species such as the Bonnet Macaque and Chital *Axis axis*, are also not reported.

iii) The Road Report states that the road expansion will not affect faunal species, and instead claims that species "may increase in number because of the road structures as the project will not obstruct their movement rather can create new habitats for them" (Section 5.8.1, v, Page 82). This statement is misleading as wide roads are known to create an obstruction to movement for a wide variety of species, including mammals (Bennett 2017). Roads also create forest edges that can harmfully affect native vegetation and rare wildlife due to edge effects, which extend far beyond the area of the road (Gubbi et al. 2012; Poor et al. 2019). Small mammal communities near roads have also been found to differ from those away from roads (Goosem 2002).

iv) Section 5.8.1 (Page 78) of the Road Report mentions the Leopard and Black Panther as two separate species, however, these are colour morphs of the same species *Panthera pardus*. The Gaur *Bos gaurus*, which is the State Animal of Goa, does not find mention in the checklist. Section 5.8.1, (v) also states that none of the faunal species found here are "endangered or extinct". This is unsound as endangered species such as the Bengal Tiger, Dhole, and Indian Pangolin are found in the region, while extinct species are found nowhere in the wild.

3.7 Land-use

i) A land-cover map for this project was acquired as a secondary data source, without clarity on how it was prepared. The map presented is for the entire state of Goa (Figure 5.23, Page 75), and not specific to the project site. The impacts on the land-use and land-cover specific to the project area have not been assessed in the EIA. The land-use table (Table 5.14, Page 73) has an error in summation of all land-use types. Further, the land-cover classes in the table do not match the ones in the map. These errors create confusion about which land-cover types will be affected by the project.

3.8 Water

i) The Road Report mentions that there are declining water level pockets in South Goa, indicating the need to strictly regulate groundwater extraction in these pockets, however, Section 5.1.4. (Page 40) of the Report has insufficient information on the river basins in the region. Only water depths are provided, without any data on the coverage area, volumes, or a reasonable level of water extraction that is possible from rivers during road expansion.

ii) Section 5.5.1. (Page 51) states that chloride concentrations are "well within the desirable and permissible limits". This statement is misleading. Samples GW-02 and -06 both had detected values above the desirable limit range and are at risk of exceeding the Bureau of Indian Standards' drinking water standards. Thus, there is insufficient evidence to support the statement that there is 'good' scope for groundwater exploitation in all the five affected taluks in the South Goa District.

iii) There is inadequate information on the water assessment sampling procedure in the region. Section 5.5.1 (Page 51) suggests that single samples were collected from five separate surface water sites and eight separate groundwater sites, during one sampling visit. No indication of the season or sampling date is provided, nor of repeated sampling to ensure accuracy or reliability. The statement that "total hardness observed to be constant in all samples" is flawed, as notable variation was observed between hardness in the different sample locations of the Road Report.

3.9 Air

i) Air quality would be negatively affected after the road expansion, but there is scarce attention paid to any robust evaluation in the Road Report. The statement that with the "proposed four-laning project, traffic may further come down and ease the vehicles movement and traffic congestion, which may lead to reduce the pollution levels" lacks substantial evidence and cannot be a justification for road expansion within a PA and ecologically-sensitive area.

ii) Table 6.5 (Page 102) proposes that greenhouse gases and other pollutant emissions may be significantly reduced based on the assumption of a small increase in traffic burden along with the avoidance of stopping, idling and congestion, however, traffic projections in the report show that total traffic is projected to only increase over the years, at all the three points where present traffic was surveyed (Table 2.15, Page 20). It is doubtful that vehicular emissions will be reduced with increased number of lanes, when scientific literature indicates that road widening leads to increased emissions which negatively affect air quality (Roberts et al. 2010; Font et al. 2014)

3.10 Soil

i) According to Table 5.13. (Page 72) of the Road Report, among the trace metals likely to contaminate soils due to large-scale construction and traffic pollution, only Lead (Pb) and Iron (Fe) are noted, however, this is this is insufficient, as several heavy metals such as Cadmium (Cd), Copper (Cu), Zinc (Zn), and Manganese (Mn) originate from material abrasion, fuel combustion and road dust (Chen et al. 2010; Abdel-Latif & Saleh 2012; Świetlik et al. 2013). Heavy metals have been associated with high levels of genotoxicity and mutagenicity in soils contaminated with heavy metals (Husejnovic et al. 2018) and their concentrations should be monitored and potentially reduced in PAs, particularly in view of the risk of trophic transfer, migration, and bioaccumulation (Zhang et al. 2018; Chouvelon et al. 2019).

3.11 Social Impacts

i) Datar & Lakshminarasimhan (2011) documented around 90 floral species to be important for local consumption and livelihood. While the Road Report lists flora of the affected area and people's reliance on non-timber forest produce (NTFP), it does not mention the potential impacts on the floral community that can hamper NTFP-based livelihoods of the local community around BMWS & NP.

ii) The Road Report mentions that apart from forest land, almost 70.42ha of non-forest land would be acquired affecting 377 civilian and governmental structures (Table 5.17, Page 85). It is not clear what the extent of damage to these structures would be. Further, the assessment does not delve deeper into the livelihood impacts and possible mitigation plans for families affected by the project. It mentions that a separate land acquisition plan would be devised for these aspects and has no concrete mitigation plans for social impacts.

4. REVIEW OF ASSESSMENT STUDY FOR THE RAILWAY EXPANSION PROJECT

While the assessment study (hereafter Railway Report) for railway expansion was informative and detailed, it suffered from several shortcomings as well. The authors reviewed it for information on the same parameters – assessment of taxonomic groups, environmental, and social impacts. It is noteworthy that the railway expansion will affect not only the BMWS & NP but also the neighbouring Kali Tiger Reserve in Karnataka State. Therefore, a project which will fragment the only intact tiger and elephant population in the north-central Western Ghats will have severe ramifications for wildlife and biodiversity. The Railway Report, however, does not stress on the ecological impacts of railway expansion and instead presents a neutral portrait of the project impacts by emphasizing uncertain mitigation measures.

4.1 Plants

i) In the section on vegetation characteristics, it is mentioned that 255 species of flowering plants were recorded (Page 64), but Appendix 2.1.a. of the Railway Report lists 224 woody trees. The IUCN Red List status is not provided, and a few common endemic species that occur in the region are not mentioned in the tree species list.

ii) The floristic survey results (Page 83) only records seedlings of woody trees but not herbs and orchids, some of which are rare with restricted distribution in the Western Ghats (Joshi & Janarthanam 2004).

iii) Plant species are misspelled or outright erroneous in the Appendix which makes it difficult to identify the plants that will be impacted. For example, *Euonymus undulatus* is misspelled (correct name: *Euonymus angulatus*), while *Lapisanthes microphylla* is an invalid scientific name as per our knowledge.

iv) Appendix 2.1.a of the Railway Report mentions 13 plant species (including vulnerable and endemic species) which are yet to be recorded from Goa. Three of those species may not occur in the BMWS & NP and need further scrutiny as to the validity of their inclusion, however, even if they do occur, it only reveals the importance of the region for plant diversity, and therefore the region should not be diverted for the railway expansion.

4.2 Insects

i) The Railway Report follows standardized protocols to document butterfly diversity of the region but covers a very small area which might not represent all the habitats affected by the project, a fact acknowledged in the study (Page 87).

ii) The survey was carried out from April (2013) to May (2014), however, there is no mention of the duration of data collection, including details on whether surveys were undertaken every month or a few days every season. This would have a bearing on the findings.

iii) There is no mention of whether sampling effort was replicated. This precludes an understanding of how many times a transect was sampled, and whether the same transects were sampled repeatedly in subsequent seasons. Quantitative analysis of data collected with inadequate sampling protocols may lead to incorrect estimates of insect diversity.

iv) The Railway Report mentions that the Family Lycaenidae and Hesperiidae were represented by 33 and 18 species, respectively. The number of species, however, might be under-represented given the difficulty in visual identification of species belonging to these Families. No effort was made to account for detection issues in the Railway Report.

v) The Railway Report also does not provide an assessment on moth diversity. Moths are ecologically important and even more diverse than butterflies and dragonflies. At least 418 species of moths of which 116 species are unidentified, were reported from the north Western Ghats (Shubhalaxmi et al. 2011). Given that the study site is a PA in the Western Ghats, it is likely to have high moth diversity.

vi) There are discrepancies in the listing of species in the Railway Report. For example, butterfly species such as *Neptis columella, Doleschallia bisaltide*, *Actolepis puspa*, and *Castalius rosimon* which are Schedule I species are left out of the scheduled species list and the text, with only a passing mention in the Appendix of the Railway Report (Appendix 2, Page 89).

4.3 Fish

i) The Railway Report records the presence of 23 fish species, however, a comprehensive study in the Mhadei sub-basin (which includes BMWS & NP) reported 49 fish species with 18 endemics from the Western Ghats (Atkore 2017; see Appendix IV).

ii) The Railway Report does not assess potential impacts of the project on fish community structure, even though studies have found that alteration of stream environment (changes in water quality and flow alteration) by anthropogenic pressures have negative influences on fish guild composition (Atkore 2017; Atkore et al. 2020).

4.4 Herpetofauna

i) The Railway Report has a fairly comprehensive assessment of amphibians and reptiles. It reports key details about the diversity of herpetofauna, including endemics, however, it only mentions the impact of the railway-line in causing mortality of reptiles (Page 140), and remains inconclusive of impacts on amphibians (Page 135).

ii) The survey on amphibians clearly finds that 13% of endemic Western Ghats species (14 species out of 24) were found in the project area. This number is likely higher and points to the sensitivity of the region for anurans (See Appendix VIII of this paper).

iii) For reptiles, the Railway Report finds 27 species, which is an underestimate (See Appendix VII of this paper). The report does not have an exhaustive assessment of impacts due to the railway expansion on herpetofauna, reasoning that the study was carried out "during the inactive period of reptiles (winter) where the intensity of the impact could not be assessed properly due to their high seasonal activity, secretiveness and less conspicuousness" (Page 140).

4.5 Birds

i) The Railway Report mentions that a two-day survey for birds was carried out in September 2014 and May 2015. It is not clear why a short survey effort was employed to compile the checklist. The survey enumerates only 35 species, of which nine were endemic species. This is an underestimate, compared to the 286 bird species recorded in the BMWS & NP in a comprehensive checklist (Rahmani et al. 2016; eBird 2017).

ii) Data is collected only for cavity-nesting birds. This omits species that do not nest in cavities, but are dependent on trees and vegetation for nesting and feeding. The reason for surveying only cavity-nesting birds is not provided. Further, migratory birds are under-represented in the survey, given that the survey was not carried out during the migratory season between October–March.

iii) The Railway Report mentions, "The loss of tree specially >10 and >60cm dbh would impact the nesting of birds in the proposed project area" (Page 145). Again, this focuses only on cavity-nesting birds, and undermines the importance of shrubs and undergrowth for passerines and understorey insectivores, which will also be impacted. Such impacts of the loss and fragmentation of the forest cannot be mitigated or compensated for, with respect to ground-nesting and understorey insectivorous birds (Lampila et al. 2005).

iv) The project area description (Page 19) mentions the state bird of Goa as the Ruby-throated Yellow Bulbul *Pycnonotus dispar*. This is an error. The state bird of Goa is the Flame-throated Bulbul *Pycnonotus gularis*, while *P. dispar* is a bird found in the forests of Java and Sumatra.

4.6 Mammals

i) The Railway Report suffers from multiple lacunae such as inadequate sampling effort. Species accumulation curves, which could have accounted for this limitation, were not generated.

ii) The sampling methods also do not account for detection issues (i.e., false negatives; Sollmann et al. 2013). This is especially pertinent given that a much higher number of mammal species occur in the region, which find either inconsistent, or no mention in the Railway Report (See Appendix III of this paper). For example, the Executive Summary (Page 5–6) mentions 42 mammal species were found using a literature survey, but the presence of the Bengal Tiger (India's National animal) is not explicitly stated. Appendix 2 of the Railway Report (Page 166) mentions 23 species of mammals, but does not mention which of those are Schedule I species, even though the region has 11 Schedule I mammal species. The ecological value of the region may have been underemphasized due to these inadequate methods as many more mammal species that occur in the region are likely to have been missed as they were not accounted for (Hayward et al. 2015).

iii) The description of the methods is very sparse and limits clear understanding (Page 153). The sampling unit was undefined — signs were recorded both inside and outside of belt transects. The study description lacks any detail about statistical methods used to assess species richness or percentage occurrence or relative abundance, using indirect signs or direct sightings.

iv) Randomly placed belt-transects used in the Railway Report are not a suitable choice to assess large and small carnivore species richness and occurrence (Barea-Azcón et al. 2007). Further, signs were recorded opportunistically from outside of belt transects (Results, Page 153–154), but no clear analytical framework is provided for this data. Carnivores often tend to move on forest trails, roads, dry streams therefore a non-random or systematic sampling approach (within beats or grid cells) would be more appropriate to specifically assess carnivore occurrence in the study region (Karanth et al. 2011).

v) Camera-traps are one of the best tools available to assess the occurrence, density, and abundance of mammals (O'Connell et al. 2011). But, the Railway Report uses a sparse sampling effort by surveying only 16 sites (camera-traps malfunctioned in nine of the 25 sites surveyed). In addition, the cameras were placed for less than six days in most sites. Studies have found a minimum of 20 to 30 error-free days of camera-deployment are required for stable estimates of species occurrence (Hamel et al. 2013). The standard duration for density assessment of large cats in Tiger Reserves and PAs of India is 25 days (with a closure period of 45–60 days). Therefore, a sampling duration of less than six days used in the Railway Report translates to poor data collection, which eventually affects any ecological inferences derived from such studies (Burton et al. 2015).

vi) The camera-trapping protocols lacks any detail about the camera models used, mode of deployment, camera-settings, and study design (Meek et al. 2014).

vii) Table 2.8.1 (Page 154) reports the species *Viverra zibetha* (Large Indian civet) which is not found in the Western Ghats, but in northeastern India. The table also mentions the occurrence of an otter species, *Lutra lutra,* the Eurasian Otter, which has not been recorded from the region. The Railway Report provides no evidence of its presence in the form of photographs. Two other species of otters which have been recorded and photographed in the region, the Asian Small-clawed Otter and the Smooth-coated Otter are not mentioned (Punjabi et al. 2014; Krupa et al. 2017). Page 161 of the Railway Report has erroneously labelled Wild Pig *Sus scrofa* as Indian Porcupine *Hystrix indica*.

viii) Appendix 2 in the Railway Report (Page 166) has incorrect coding for species: Langur and Bonnet Macaque are listed as herbivores (when they are actually primates); Asian Palm Civet is coded as a carnivore, but the Small Indian Civet, Brown Palm Civet, and Stripe-necked Mongoose are incorrectly coded as herbivores; the otter and Indian Pangolin are coded as large mammals, but the Asiatic Wild Dog, which is larger in size is coded as a small mammal. This reveals a naive understanding of mammals and the impacts that railway expansion could have on low-density species such as carnivores.

4.7 Land-use

i) The land-use land-cover map was derived from classification of single date satellite data, acquired in April 2013. Since the project area supports different types of vegetation which have variation in spectral signatures during different seasons, an ideal mapping exercise should have considered seasonal data, for at least two different seasons within one year.

ii) Out of six effective bands of Landsat and eight for vegetation discrimination, only four bands have been used for classification. This essentially leaves out the details of land-cover class categories that are clearly identified by the other two short-wave infra-red bands. These two short-wave IR bands demarcate the response of vegetation to moisture stress, and thus improve the classification of the forest types (Ferreira et al. 2016).

iii) The reasoning behind the number of sampling points used for each land-cover category is not clear. It is stated that unsupervised classification, which yielded 15 classes, was used as a basis for ordering the landscape into distinct units. It is unclear, however, if these 'distinct units' were further assigned land-cover classes on the basis of any reference map. A reference map could have informed the locations where ground truth data was necessary for ascertaining land-use types.

iv) The exact methodology for land-cover classification, parametric (maximum likelihood, minimum distance to means), or non-parametric (support vector machines or any other) has not been mentioned. This prohibits a nuanced understanding of the method of classification for a forest complex.

v) Ancillary data such as topographical information from an elevation model have not been utilized for assessments. A simple elevation profile of the proposed railway route indicates an elevation range of 80–500 m. In a high elevation area with varying gradients, the topography of the land determines much of the vegetation assemblages, and this could be important information to include in the classification process. The importance of topographic information for vegetation mapping is a widely accepted methodology (Das et al. 2015; Roy et al. 2015) and earlier work in the Eastern Ghats region has used topographic information effectively to this end (Balaguru et al. 2003).

vi) The basis for accuracy assessment has not been mentioned. An overall accuracy of 88% is indicated, but no reference map seems to have been used for calculation. The report also does not mention the percentage of samples used for training and testing the classification, which is a standard accuracy assessment procedure.

4.8 Water

i) Water pollution is a major concern during the construction as well as during the operation phase. Water pollution analysis, however, was minimal with no monitoring of pollutants done for polycyclic aromatic hydrocarbons (PAHs) and heavy metals because of the existing railway-line, despite high concentrations being often reported in waterways bisected, or bordered by railways (Wiłkomirski et al. 2011; Wiłkomirski et al. 2012; Levengood et al. 2015).

ii) Furthermore, *Escherichia coli* bacterial contamination was reported in all sampled streams, indicating faecal contamination, which may be attributed to waste disposal from passing trains. The total coliform count ranged from 221/100mL to 542/100mL, while the safe threshold value is 100 count/100mL. The increased risk of coliform contamination resulting from the railway expansion is a severe threat, as many streams that cross the tracks harbour sensitive wildlife, and also supply water to villages downstream for drinking and farming.

4.9 Air

i) No air quality monitoring was performed to provide baseline levels or to establish the risk of railway expansion in this region. The Railway Report assumes that engines will be electrified; however, if existing diesel engines are used then the doubling would increase the amount of pollutants associated with combustion and diesel emissions.

ii) The main constituents of diesel engine exhaust emissions are Carbon (CO, CO_2), Nitrogen (N), Nitrogen Oxides (NOx), Sulphur Oxides (SOx), Hydrocarbons (HC), Methane (CH4), Non-Methane Volatile Organic Compounds (NMVOC), PAHs, and particulate matter (PM) (Borda-de-Água et al. 2017). Monitoring of the current pollutant levels should have been performed at least twice a year to avoid data bias due to seasonal variation, although quarterly (or even monthly) sampling events could have been employed (Jayamurugan et al. 2013; Manju et al. 2018).

4.10 Soil

i) Chemical properties of soil and baseline levels of soil pollution were not established during sampling and analysis. Soil and plants surrounding the railway lines should be monitored for organic and inorganic compound contamination, resulting mostly from used lubricant oils and condenser fluids, the transportation of oil derivatives, metal ores and other chemicals, as well as from application of herbicides and other treatments to the train vehicles. These pollutants, however, were not considered in this assessment.

ii) PAHs, heavy metals, oil-derived HC, and to some extent, polychlorinated biphenyls (PCBs) should be monitored in soils, with risks comprehensively assessed as they exhibit toxicity, long-term stability and a cumulative effect in the environment (Wiłkomirski et al. 2011; Wiłkomirski et al. 2012; Levengood et al. 2015; Pereira et al. 2015). PAHs are carcinogenic and mutagenic to living organisms (IARC 1989). The main source of PAHs in railway areas are machine grease, fuel oils and transformers oils. Heavy metals (such as Pb, Cd, Cu, Zn, Hg, Fe, Co, Cr, Mo) originate mainly from material abrasion and fuel combustion in diesel and electric locomotives, therefore the railway expansion will lead to further heavy metal contamination in soils.

4.11 Social Impacts

i) The Railway Report's socio-economic survey of 60 families conducted in four villages does not report the total number of affected families, demography and livelihood patterns of concerned villages. The sampling strategy and the criteria for selection of households is unclear. The questionnaire was focussed on the perception of transport models by local communities. The questionnaire did not have open-ended, non-leading questions to bring out local concerns towards the project, and possible impacts on their livelihood and environment. Instead, it addressed questions such as preferred mode of transport, where 90% of the respondents listed trains.

ii) The Railway Report mentions a public consultation meeting regarding the railway expansion project that occurred in June 2016 at Kulem Panchayat (Hindi: Village Council) office (Page 190). The Kulem Panchayat raised concerns about the impact of the project on the Dudhsagar waterfall which contributes revenue from tourists to the local economy, availability of medicinal plants and disturbance to the temple close to Sonalium Station (Page 191). The consultation meeting was attended by only 14 members, most of whom were panchayat office bearers and members of the biodiversity committee, but not by the general public who would be affected by such developmental projects. As this meeting took place in 2016, before the Railway Report was published (in 2017), it is unclear whether a public hearing took place after the report was published. This suggests that the affected public is unaware of the damage the expansion may bring to their livelihoods.

iii) The Railway Report mentions that NTFPs and medicinal plants from the forest area were important for local use (Pages 169–171), but the specific impacts of the railway expansion on such NTFP and medicinal plant species were not assessed. Datar & Lakshminarasimhan (2011) reported that local communities around BMWS were dependent on the forest for wild edible mushrooms, fruits, herbal medicinal plants, and specific plants for cultural use. This indicates that it is important to assess the impact of the proposed project on NTFP collection.

iv) The Railway Report finds that existing faecal contamination in the streams near to the railway tracks and the level of contamination is already 2–5 times the prescribed limit. Waste generation due to construction debris within the forest can further pollute soil and water resources in this sensitive region, thereby also affecting human communities. Increased waste dumping by railway passengers near villages can attract wildlife to these villages, which can result in human-wildlife conflict scenarios.

5. REVIEW OF THE 400kV TRANSMISSION LINE

The transmission line project did not have the assessment study in the public domain and therefore this limited our review to aspects of this project for which information was available in the public domain on the Parivesh portal. The key concerns with the transmission line project are discussed here.

i) The construction of new power lines in forest areas of high conservation value should be avoided (Eldegard et al. 2015). The transmission line project passes through a PA (11.54 ha inside PA) and the total forest land required for the project is 48.3 ha (almost 50 ha, for which an EIA is necessary from a socio-ecological point of view). The minutes of the meeting of the Goa State Board for Wildlife held on 02 December 2019 mentions that "the Biodiversity Impact Assessment studies and Biodiversity Management Plan has been prepared by ERM India Pvt. Ltd, Gurgaon has been submitted". The same, however, is not available in the public domain to allow a clear assessment of projected impacts.

ii) The detailed project report that is available for the transmission line makes contradictory statements about the location of the transmission line in the BMWS & NP. It first states that 2.51km of the transmission line is within the NP, clearing an area of 11.54ha (Table 1, Page 2, Detailed Project Report). Subsequently, when justifying the reason for choosing between alternative routes of the transmission line, it states that the chosen route fully avoids the NP. These statements severely weaken the report and hinder an effective assessment of the impacts of the transmission line, which already lacks sufficient public scrutiny. An inspection report by the forest department indicates that over 4,146 trees and 985 cane clumps in the PA are to be cut for the project.

iii) The project proponent claims that "transmission line projects are environment friendly and do not involve any disposal of solid effluents and hazardous substances in land, air and water. Moreover, forest area trees are felled below each conductor to facilitate stringing. On completion of construction only one strip is maintained for O & M purpose. Therefore, the actual loss of forest is restricted to some selected areas only." These statements do not recognize the larger effects of the transmission line on birds and volant mammals such as bats and gliding squirrels, or on arboreal species such as the Slender Loris, Giant Squirrel, Bonnet Macaque, and Grey Langur. For example, due to the absence of tree cover along transmission lines, arboreal mammals such as Lorises are forced to use electric wires of power lines to cross, causing mortality due to electrocution (Raman 2011).

iv) The project requires a clearance for 35 years, during which there will be regular cutting below the transmission line. This is especially concerning given that the project cuts through the PA, so the effects of this project are long-term.

v) The statement "the actual loss of forest is restricted to some selected areas only" fails to take into account existing evidence that power lines are linear intrusions that prevent animal movement, fragment communities of small mammals (Goosem & Marsh 1997), and cause mortality due to electrocution and collision (Jenkins et al. 2011; Rioux et al. 2013; Loss et al. 2014; Uddin 2017). Large mammals have also been electocuted due to sagging power lines (Raman 2011). The area underlying the proposed transmission line currently (i.e., without the construction of the power line) offers low resistance to large mammal movement, indicating that the area is important for animal movement (Jayadevan et al. 2020; https://indiaunderconstruction.com). In their paper, Jayadevan et al. (2020) recommend avoidance of new infrastructure in areas that currently pose a low resistance to movement.

vi) Transmission lines have several impacts on birds. Studies have shown that birds avoid areas between 0.25 and 0.6 km of transmission lines (Dunkin et al. 2009; Gillan et al. 2013). Transmission lines cause bird mortality due to electrocution and collision (Uddin 2017; Biasotto & Kindel 2018). For example, many birds use structures of transmission lines as a perch, which often leads to electrocution (Biasotto & Kindel 2018). The clearing of trees for the transmission line affects the movement and nesting success of birds (Biasotto & Kindel 2018).

vii) The conservation value document uploaded by the wildlife warden details the damaging effects of the project. The document, however, concludes that the movement of faunal species will not be affected by the project, and the loss of trees can be compensated via afforestation. This is inaccurate, as transmission lines would impact movement of fauna, in addition to other deleterious impacts including mortality, as we detail above. Further, compensatory afforestation at a different site does not ameliorate any of the ecological impacts within the PA, as mentioned in the document.

6. DISCUSSION

We argue that mitigation measures proposed in the Road Report, Railway Report, and documents for the transmission line are inadequate and will not alleviate serious damage to the BMWS & NP or ecologically-sensitive regions around the PAs. We have explained this in detail in the following sections.

6.1 INADEQUACY OF MITIGATION MEASURES FOR NH-4A

i) For the mitigation measures, the Road Report merely notes that "Mitigation of man versus animal conflict is going to be the important issue that will threaten wildlife in Sanctuary area" (Page 97, Section 6.3.9 (i)). There are, however, no mitigation measures recommended to reduce the conflict created by road expansion. An acknowledgement of an important socio-economic and environmental problem will not equip the Goa Forest Department, National Highways Authority of India, or the Public Works Department of Goa to effectively manage the problem created by road expansion without detailed mitigation plans.

ii) For terrestrial fauna, the Road Report states that no impact on the wildlife is anticipated and hence does not outline any mitigation measures (Page 97, Section 6.3.9 (II)). Given that nearly 32ha of forest land will be diverted for the project, there is likely to be an impact on wildlife. There is growing scientific evidence demonstrating that building new roads and their upgradation or expansion has serious impacts on wildlife in protected areas. For example, Garriga et al. (2012) found a total of 2,013 wildlife mortalities on roads within protected areas of Catalonia, of which 267 were mammals (13.3%), 253 birds (12.6%), 245 reptiles (12.2%), and 1,248 amphibians (62.0%). A total of 85 different species were affected across all taxa due to roads within PAs over just two seasons, Spring and Autumn, in one year.

iii) As a measure to mitigate vegetation and habitat loss, the Road Report mentions that "an avenue plantation programme shall be promptly adopted to restore and further enrich the loss of vegetation" (Page 96, Section 6.3.9 (i)). Such measures may increase green cover, but they do not mitigate the impacts of road construction on vegetation or wildlife. Instead, it also puts people at risk due to the increased likelihood of vehicular collision with mammals (Case 1978; Jaren et al. 1991; Putman 1997; Cain et al. 2003).

iv) The Road Report proposes "periodic maintenance of drains to check scouring of soil" to decrease soil erosion (Page 92, Section 6.3.5). Soil erosion is expected to be higher in tropical forests, such as BMWS & NP, due to its wet climatic conditions and steep terrain (Sidle et al. 2006; Sidle & Zeigler 2012). Deposition of eroded soil into rivers at an increased rate is responsible for increasing turbidity and temperature of the water, reducing the amount of dissolved oxygen and changing existing flow regimes, while accelerating eutrophication (Beevers et al. 2012; Douven & Buurman 2013). The proposed clearing of land for the development of the road is likely to make cut sections highly susceptible to soil erosion. Drainage structures and culverts are essential to allow better above-ground water drainage, and prevent drastic changes to the hydrology of the landscape and decrease flooding along the road during monsoon seasons (Sidle et al. 2006; Laurance et al. 2009). No site-specific hydrological survey has been carried out to arrive at the optimal number of culverts and bridges, and their spatial placement.

v) Although the Road Report aims to reduce the impact of the developmental project in the "direct path" of the roadworks, it is pertinent to understand that the impacts of road construction are rarely limited to the direct path. Environmental impacts of roads extend beyond the direct impacts of construction and tree clearing, to indirect impacts because of increased human access and vehicular traffic. This includes, but is not limited to, air, water, and noise pollution, disturbance effects, fragmentation due to edge effects, and hindrances to migratory corridors (Alamgir et al. 2017).

6.2 THE IMPACT OF ROADS

We further expand on biotic and abiotic impacts of roads here, for which no mitigation measures have been suggested.

i) Roads compound the impacts of natural disasters

Constructing roads in hilly and mountainous terrain increases the risk of natural disasters such as landslides and flooding (Sidle et al. 2006; Larsen & Torres-Sánchez 1997; Larsen & Parks 1998). There is no information on the susceptibility of the proposed site to extreme weather events in the EIA. Such dissemination of information regarding the socio-economic and environmental risks involved in the project is critical to the decision of investors, decision-makers and taxpayers, whose money is being utilized for the project. Road projects that pass through forested areas and lack proper planning can lead to major cost overruns, corruption, and damage to the environment (Trombulak & Frissell 2000; Alamgir et al. 2017)

ii) Roads are a cause for wildlife mortality (roadkills)

Enabled by the expansion of the highway, an increase in vehicular traffic in the area can be expected. This will likely increase the rates of wildlife-vehicle collisions, impacting species of most terrestrial fauna. A study from Mudumalai Tiger Reserve found road mortality of 40 animal species, including amphibians, reptiles, birds, and mammals (Baskaran & Boominathan 2010). Additionally, animals that are slow-moving or burrowing, such as freshwater turtles, amphibians, snakes, and soil-living fauna, get killed during road construction. The impacts of earthwork and annual maintenance operations on terrestrial fauna are usually overlooked (Clevenger et al. 2003; Fahrig et al. 1995; Trombulak & Frissell 2000; Goosem et al. 2010).

iii) Roads are barriers to wildlife movement, and cause habitat fragmentation

For many species, particularly in the Western Ghats, the expansion of the NH-4A is an additional fragmentation of an already fragmented habitat (Nayak et al. 2020). The resistance to potential large mammal movement posed by the existing NH-4A is higher than the median resistance to mammal movement in the Western Ghats (Jayadevan et al. 2020; https://indiaunderconstruction.com). Expansion of the road can, thus, lead to an increase in the resistance posed to movement, and lead to increased isolation between forest patches on either side of the road.

Subdivision of remnant forest patches due to various linear intrusions such as highways and roads causes "internal fragmentation" (Goosem 1997; Goosem 2007). Such internal fragmentation with wide, cleared roads and their edges, physical barriers such as fences and crash barriers, cuttings, fill batters, and culverts with drop structures, could be a serious threat to movement of wildlife and lead to increased negative human-wildlife interactions (Goosem et al. 2010). For example, many animals in tropical forests avoid even narrow linear clearings (< 30m wide; Holderegger & Di Giulio 2010; Laurance et al. 2009). Increased traffic and continuous vehicular movement can stress the animals or make species alter their behaviour in the vicinity of roads (Trombulak & Frissell 2000). While certain species such as macaques are attracted to roads for scrap food from travellers (a potential ecological trap), species such as Elephants have been observed to avoid roads and highways due to associated risks, or suffer mortality from collisions (Blake et al. 2008). Behavioural avoidance of the road may also be exhibited by animals that can fly over the width of the road (e.g., birds and bats), due to the noise, pollution, and risk of crossing (Laurance et al. 2009).

The problem of fragmentation by roads is particularly acute for canopy dwelling species that use closed-canopy structures to move and do not generally use the ground to cross. In the absence of tree cover, tree-dwelling animals are forced to either use the ground or cross using power lines, which can lead to mortality due to vehicular collisions or electrocution. This is especially the case for primates, arboreal rodents, and some carnivores (Radhakrishna & Singh 2002; Raman 2011).

iv) Roads affect the genetic diversity of animals

Decreased movement of animals across roads leads to decreased genetic variation, due to reduced genetic exchange between populations. For example, studies from India show that roads negatively affect tiger connectivity (Joshi et al. 2013; Dutta et al. 2018; Thatte et al. 2018). Such impacts can be seen after just a few generations in populations of large mammals that have been separated by newly built roads and highways (Holderegger & Di Giulio 2010).

v) Roads affect biodiversity due to increased noise pollution

Although monitoring of noise quality levels created by the existing highway was carried out at eight sites designated as commercial, industrial and residential, there was no monitoring carried out on existing highway stretches within the protected area. Noise quality levels were found to be "within the limits" for commercial and industrial categories but "exceed the limits" in the residential category. Noise pollution associated with roads has been shown to decrease reproductive capacity in bird and amphibian species, as well as in mammals such as Tigers (Kerley et al. 2002; Hoskin & Goosem 2010; Qin et al. 2014; Laurance 2015), with impacts seen at the community level as well (Francis et al. 2009; Slabbekoorn & Halfwerk 2009).

vi) Roads lead to increased human accessibility

Roads passing through forested areas increase human accessibility and can increase movement, settlement and human activity in frontier forest areas. This has manifold repercussions including forest fires, waste disposal and pollution, illegal timber harvest, poaching and hunting (Alamgir et al. 2017). Studies from protected areas in developing economies show that road expansion and improved accessibility to the market can result in expansion of agricultural and livestock frontiers with reduction in nearby forest areas of the protected area (Ratner et al. 2007; Lama & Job 2014; Phaipasith & Castella 2017; Walelign et al. 2019). Conversion from subsistence agriculture to cash crops, emergence of commercial service economies such as mass tourism resulted in transition from a low-impact economy to a high-impact one (Walelign et al. 2019). Local socio-economic inequality also increased after road-expansion (Ratner et al. 2007). In the long run, the negative impact on the forest, waste generation and excessive use of agro-chemicals resulted in lesser availability of clean water, reduced soil fertility and local extinction of NTFP species (Phaipasith & Castella 2017). This also affected local governance systems negatively and people often could not revert to their subsistence economies which were relatively sustainable (Lama & Job 2014).

vii) Roads as a cause for habitat loss and degradation

During the construction and maintenance of roads and highways, habitat loss and degradation is observed due to direct clearing of vegetation, dumping of excavated earth and materials, regular usage of access roads by heavy machinery, and construction of labour camps. Within tropical forests, disturbance from roads due to fluctuations in light, temperature and humidity, increased mortality of trees beside roads, and spread of exotic species to a width of least 100m from the road (Laurance et al. 2009). Thus, “each kilometre of road directly and detrimentally affects at least 10 ha of habitat”, and the impacts may persist for decades (Laurance et al. 2009; Raman 2011).

viii) Roads as corridors for invasive species

Roads have been found to be a major factor in the spread of invasive flora and fauna into forests (Mortensen et al. 2009; Meunier & Lavoie 2012). These invasive species can use the edge habitats along the road and invade forests by secondary wind dispersal, that would have otherwise been inaccessible (Kowarik & von der Lippe 2011).

6.3 THE IMPACT OF RAILWAY-LINE DOUBLING AND INADEQUACY OF MITIGATION

i) Air quality

No potential impacts on air quality were studied, as the railway line between Castlerock and Kulem was assumed to be electric. If the trains in the proposed stretches run on traditional diesel engines, increased locomotive traffic due to the doubling of the railway line will lead to an increase in harmful exhaust components. The main pollutants from diesel locomotives are Carbon Dioxide (CO_2), Carbon Monoxide (CO), Sulphur Dioxide (SO_2), Nitrous Oxide (N_2O), particulate matter (PM), hydrocarbons (HC), among others. Many of these pollutants are carcinogenic and responsible for health and environmental impacts (Lucas et al. 2017).

The report suggests monitoring of air quality and minimizing air pollution due to dust particles, vehicular and locomotive emissions, during the construction and operational phase. Although necessary, such general recommendations on controlling impacts on air quality during the construction phase will minimally help in reducing pollution as the project will take three years to construct and the operational impacts will be near permanent. Abrasion of brakes, wheels, dust, mineral transport will all still produce PM emissions even if electric locomotives are used (Levengood et al. 2015). No amount of mitigation will compensate for the long-term impacts of air pollution due to the proposed expansion.

ii) Sound (Noise pollution)

The noise levels at various regions within the areas of the proposed project were already noted to be above the permissible level of 91dB, posing a serious threat from noise pollution. Anthropogenic noise can affect acoustic communication among bird species that use calls and songs for a variety of functions such as attracting mates and defending territories (Collins 2004; Marler 2004). Noise emission from railways has also been documented to reduce the density and nesting behaviour of birds, with nests that are farther away from railway lines being more successful (Mundahl et al. 2013).

To reduce noise pollution, the Railway Report recommends switching to electric engines, planting native tree species along the railway line and building sound barriers on both sides of the track, particularly within the biodiversity-rich Kali Tiger Reserve (from Castlerock station – Goa border) and BMWS & NP. All of these three recommendations, however, have serious drawbacks which the report has overlooked.

a. Switching to electric engines will not greatly reduce noise pollution. This is because, at a speed of 30–200 km/h (the speed at which most trains will be travelling between stations), all trains, including the electric trains, produce a "rolling noise" which is the dominant source of noise pollution (Clausen et al. 2012).

b. Recovering vegetation beside roads and railways is known to attract wildlife and increase their vulnerability to get killed by moving vehicles (Case 1978; Jaren et al. 1991; Putman 1997; Cain et al. 2003).

c. Sound barriers will further intensify the impacts of forest fragmentation caused due to railways. While the size and structure of sound barriers are not mentioned in the report, they are usually artificially built, vertical walls of a solid structure, which blocks the noise created by moving trains. While this could be a reasonable mitigation measure for railway lines that pass through human habitat, it will have detrimental ecological impacts inside a forest ecosystem. Sound barriers can cause various negative impacts on wildlife, particularly through isolation of populations (Bank et al. 2002). Given that the minimum height of such barriers is as high as the train, and with electric lines proposed to be running on top of the railway, it would make it impossible for any terrestrial species to freely move to the other side of the track and will be a death trap for wildlife trapped between the barriers.

iii) Water quality

The Railway Report states that the current water quality in streams along existing railway track is pristine (Bureau of Indian Standards 2012), but with harmful levels of bacteria *Escherichia coli* in all streams (221 to 542 per 100mL), it indicates widespread faecal contamination of waterbodies mostly due to exisiting train traffic (threshold is 100 per 100mL). Creation of new railway embankments for the proposed double gauging will further lead to vegetation loss, soil compression and changes in water drainage, thus increasing runoff, promoting erosion of topsoil and increasing water turbidity (Ferrell & Lautala 2010; Chen et al. 2015). Turbid water has been found to affect the diversity and abundance of aquatic wildlife communities such as odonates and freshwater fish (Luce & Mountain 2002).

The Railway Report mentions that the new railway coaches will be fitted with bio-toilets, hence reducing the likelihood of *E. coli* infiltrating streams along the railway route. Construction of dykes and retaining walls along the railway line to restrict the movement of sediments during the construction phase has been recommended. While this may address sediment runoff, it may indirectly inhibit animal movement, adding to the effects of tree clearing, noise, and train movement.

iv) Biodiversity

The major focus of the studies appears to be to create baseline information on species diversity and abundance, rather than to explicitly study the impact of the proposed expansion on biodiversity. The Railway Report only cursorily mentions that animal movement will be impacted by the doubling of the railway line (Chapter 18, Page 207) and does not address long-term impacts to landscape connectivity that all the taxa under study face from the proposed expansion of the railway line. There is strong evidence of the negative impacts of railway lines on biodiversity.

Railway lines have been shown to be barriers to movement for large mammals such as the tiger (Dutta et al. 2018). The current railway line between Kulem and Castlerock poses a high degree of resistance to large mammal movement (Jayadevan et al. 2020). Doubling of the railway track will lead to a higher frequency of trains, and further increase resistance to movement. This can isolate the forest patches on either side of the railway line. In addition to its impacts on movement, noise and vibrations from railways affect insects, amphibians, and birds. Further, the availability of food (solid food waste; carcases of dead animals) and vegetation along the railway edges attracts reptiles, few species of birds, and several mammals acting as an ecological trap and leading to higher mortality due to collision with trains (Lucas et al. 2017).

The mitigation measures suggested in the Railway Report are very general. The suggestion of the creation of 'biodiversity parks' for conserving birds and mammals is not compensatory, when the protected area, which is a biodiversity-rich region, will be fragmented. For aquatic life, it is suggested that railways should adopt the 'best construction procedures' to reduce turbidity, siltation, etc., but what these procedures comprise of is unexplained.

The Railway Report highlights cases of Gaur and Sambar being hit by trains on the existing single track, reaffirming that the doubling of the railway line will lead to increased risk of accidental collisions with wildlife.

Although the report identifies 42 animal-crossing points for mammals, a bare minimum of four animal underpasses are finalized at Ch 32/200, Ch 41/100, Ch 45/500, Ch 49/500 (RVNL Letter No.PlU/UBLllLN654 dated 06.10.2018 to deputy forest officer). The report suggests many other mitigation measures to be followed (Pages 207–208), but such mitigation measures are undetailed, and without strong supervision during implementation have poor application in practice.

6.4 INADEQUATE MITIGATION MEASURES FOR THE TRANSMISSION LINE

i) On the subject of mitigation measures for the transmission line, the inspection report of the transmission line mentions only that “the user agency has agreed to cut minimum trees requirements and to adopt wildlife-friendly mitigation measures.” It adds that “trees listed for felling under this project will be compensated in the long term through the proposed compensatory afforestation programme covering double the degraded forest land.” It is not clear how ‘minimum tree cutting’ will be calculated or enforced. No details are provided on where and when the compensatory afforestation will be executed. Further, without an impact assessment of the transmission line, it is not clear what ‘wildlife-friendly mitigation measures’ will be implemented.

ii) The inspection report fails to take into account the ecological impacts of the transmission line as we have detailed in this paper (Section 5). A background paper for the National Board for Wildlife (Raman 2011) recommends that the first priority for power lines in forests should be prevention, followed by re-alignment. The third option of a mitigation measure is suggested only where the first two have been comprehensively considered and ruled out with sufficient justification (Raman 2011). In case a transmission line passes through a biodiverse region, recommended mitigation measures for transmission lines include insulators on wires to avoid bird electrocution, placing of perch deterrents on cross-arms and poles and using large line-markers on earth wires to increase their visibility during the day and night, thus avoiding collisions by birds and volant mammals (WII 2016). But neither of these are considered as mitigation measures for this project.

7. CONCLUSION

Any major infrastructure projects should be avoided within PAs, unless there are exceptional circumstances that will clearly show forest diversion will benefit wildlife (as per the WPA, 1972). Utmost importance should be given to all environmental and ecological impacts of any project, and as per the background paper of the National Board for Wildlife itself, ecologically-harmful projects should be avoided. In the present case, there is not one, but three large projects which are planned in this ecologically-sensitive region. It is noteworthy that the Western Ghats is a designated Natural World Heritage Site by UNESCO. The cumulative impacts of these three projects may change the entire ecology of the BWWS & NP, as well as the neighbouring Kali Tiger Reserve, and will result in irreparable damage to its fragile environment. Further, such damage will impact the quality of human life within and near the PA. Multiple projects also call for an in-depth investigation into cumulative impacts on the PA. Cumulative impact studies have been considered mandatory in many countries (Braid et al. 1985), and are implemented rigorously for their added value in understanding irreversible changes to existing natural systems (Xue et al. 2004).

It is pertinent to note that two of these projects (NH-4A and transmission line) were awarded wildlife clearances in the 57th meeting of the Standing Committee of the NBWL, held on 7 April 2020 through a video conference, which is unlikely to have had critical evaluation. Our review details how the EIAs and assessments for these projects are considerably weak, and evidently overlooked by the highest statutory authority that is mandated to protect wildlife in the country. Socially- and environmentally-just development is important, but none of these projects provide any benefit to wildlife or the environment in the BMWS & NP. Environmental costs and mitigation measures are not comprehensively assessed in the EIAs and assessment studies. Information on the land area for compensation, overseeing agencies for mitigation measures, monitoring and penalties for non-compliance are also not laid out in detail.

Faulty EIAs and other assessment studies continue to be condoned by successive appraisal boards and governments, with a lack of due process. Such practices consider environmental concerns as a burden on development, rather than a process that guides sustainable development, which should, therefore, be strengthened. This further weakens socio-ecological governance in a country which is ranked a 168 (out of 180 countries) in the Environmental Performance Index

(Wendling et al. 2020). Considerable opportunities exist to improve the EIA and assessment process in India (Paliwal 2006). Incentivising post-clearance monitoring and evaluation is vital (Duflo et al. 2013); however, a rational screening process which fortifies existing legislation and avoids forest diversion proposals in protected areas at the outset itself is most necessary (Rajaram & Das 2011).

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Appendix I. Checklist of birds in Bhagwan Mahavir Sanctuary and National Park.
The List is compiled from data available on eBird (2017) from multiple hotspots and checklist locations within BMWS NP and Rahmani et al. (2016).
ENDEMISM TO WG (WESTERN GHATS): Species, whose global distribution range is restricted to within the biogeographical boundaries of the Western Ghats. In other words, they are unique to Western Ghats, and are not found anywhere else in the world.
IUCN: Evaluation of species as per IUCN Redlist 2020-1 CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened
WPA (1972): Species listed and protected under five different categories (Schedule I to IV, and VI) in accordance to the Wildlife Protection Act of 1972
STATUS: Evaluation of migratory status of a species. R: Resident; M: Migrant; LM: Local Migrant, making short movements out of the political boundaries of Goa; R/M: Resident population supplemented by a migratory population; VG: Vagrant migrants recorded away from their known migratory range; S: Residents of the Indian Subcontinent with no known resident populations in Goa attributed to as stray; UC: Unclear
RARITY: A species that has less than ten independently confirmed records form within the political boundaries of Goa, post 2000.

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
	I. Anseriformes					
	1. Anatidae (Ducks, geese, swans)					
1	Lesser Whistling Duck *Dendrocygna javanica*			4	R	
	II.Galliformes					
	2. Phasianidae (partridges, pheasants, grouse)					
2	Indian Peafowl *Pavo cristatus*			1	R	
3	Jungle Bush Quail *Perdicula asiatica*			4	R	
4	Grey Junglefowl *Gallus sonneratii*			2	R	
5	Red Spurfowl *Galloperdix spadicea*			4	R	
	III. Columbiformes					
	3. Columbidae (pigeons)					
6	Rock Pigeon *Columba livia*			4	R	
7	Nilgiri Wood Pigeon *Columba elphinstonii*		VU	4	R	
8	Oriental Turtle Dove *Streptopelia orientalis*			4	R	
9	(Western) Spotted Dove *Streptopelia chinensis suratensis*			4	R	
10	Orange-breasted Green Pigeon *Treron bicinctus*			4	R	
11	Grey-fronted Green Pigeon *Treron affinis*			4	R	
12	Asian Emerald Dove *Chalcophaps indica*			4	R	
13	Green Imperial Pigeon *Ducula aenea*			4	R	
14	Mountain Imperial Pigeon (Nilgiri Imperial Pigeon) *Ducula badia cuprea*			4	R	
	IV. Caprimulgiformes					
	4. Podargidae (frogmouths)					
15	Sri Lanka Frogmouth *Batrachostomus moniliger*			1	R	
	5. Caprimulgidae (nightjars)					
16	Jungle Nightjar *Caprimulgus indicus*			4	R	
17	Jerdon's Nightjar *Caprimulgus atripennis*			4	R	
18	Indian Nightjar *Caprimulgus asiaticus*			4	R	X
19	Savanna Nightjar *Caprimulgus affinis*			4	R	
	6. Hemiprocnidae (Treeswifts)					
20	Crested Treeswift *Hemiprocne coronata*				R	
	7. Apodidae (swifts)					
21	White-rumped Spinetail *Zoonavena sylvatica*				R	
22	Brown-backed Needletail *Hirundapus giganteus*				R	
23	Indian Swiftlet *Aerodramus unicolor*			1	R	
24	Asian Palm Swift *Cypsiurus balasiensis*				LM	
25	Alpine Swift *Tachymarptis melba*				R	
26	Indian House Swift *Apus affinis*				R	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
27	Common Swift *Apus apus*				M	X
	V. Cuculiformes					
	8. Cuculidae (cuckoos)					
28	Greater Coucal *Centropus sinensis*			4	R	
29	Blue-faced Malkoha *Phaenicophaeus viridirostris*			4	R	
30	Pied Cuckoo *Clamator jacobinus*			4	R/M	
31	Asian Koel *Eudynamys scolopaceus*			4	R	
32	Banded Bay Cuckoo *Cacomantis sonneratii*			4	R	
33	Grey-bellied Cuckoo *Cacomantis passerinus*			4	R	
34	Fork-tailed Drongo Cuckoo *Surniculus dicruroides*			4	R	
35	Large Hawk Cuckoo *Hierococcyx sparverioides*			4	M	X
36	Common Hawk Cuckoo *Hierococcyx varius*			4	R	
37	Indian Cuckoo *Cuculus micropterus*			4	M	X
38	Common Cuckoo *Cuculus canorus*			4	M	
	VI. Gruiformes					
	9. Rallidae (rails and coots)					
39	Slaty-legged Crake *Rallina eurizonoides*			4	M	
40	White-breasted Waterhen *Amaurornis phoenicurus*			4	R	
41	Purple Swamphen *Porphyrio porphyrio*			4	R	
	VII. Ciconiiformes					
	10. Ciconiidae (storks)					
42	Lesser Adjutant *Leptoptilos javanicus*		VU	4	R	
43	Asian Openbill *Anastomus oscitans*			4	R	
44	Black Stork *Ciconia nigra*			4	M	X
45	Woolly-necked Stork *Ciconia episcopus*		VU	4	R	
	11. Ardeidae (herons)					
46	Malayan Night Heron *Gorsachius melanolophus*			4	R	
47	Striated Heron *Butorides striata*			4	R	
48	Indian Pond Heron *Ardeola grayii*			4	R	
49	(Eastern) Cattle Egret *Bubulcus ibis coromandus*			4	R	
50	Grey Heron *Ardea cinerea*			4	R/M	
51	Purple Heron *Ardea purpurea*			4	R	
52	(Eastern) Great Egret *Ardea alba modesta*			4	R	
53	Intermediate Egret *Ardea intermedia*			4	R	
54	Little Egret *Egretta garzetta*			4	R	
55	Western Reef Egret *Egretta gularis*			4	R	
	12. Threskiornithidae (ibises)					
56	Black-headed Ibis *Threskiornis melanocephalus*		NT	4	R/M	
	VIII. Suliformes					
	13. Phalacrocoracidae (cormorants)					
57	Little Cormorant *Microcarbo niger*			4	R	
58	Indian Cormorant *Phalacrocorax fuscicollis*			4	R	
	14. Anhingidae (darters)					
59	Oriental Darter *Anhinga melanogaster*		NT	4	R	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
	IX. Charadriiformes					
	15. Recurvirostridae (stilts and avocets)					
60	Black-winged Stilt *Himantopus himantopus*			4	M	
	16. Charadriidae (plovers & lapwings)					
61	Little Ringed Plover *Charadrius dubius*			4	R	
62	Yellow-wattled Lapwing *Vanellus malabaricus*			4	R	
63	Red-wattled Lapwing *Vanellus indicus*			4	R	
	17. Jacanidae (jacanas)					
64	Bronze-winged Jacana *Metopidius indicus*			4	R	
	18. Scolopacidae (sandpipers)					
65	Common Snipe *Gallinago gallinago*			4	M	
66	Common Sandpiper *Actitis hypoleucos*			4	LM	
67	Green Sandpiper *Tringa ochropus*			4	M	
	19. Turnicidae (buttonquails)					
68	Barred Buttonquail *Turnix suscitator*			4	R	
	20. Glareolidae (coursers and pratincoles)					
69	Little Pratincole *Glareola lactea*				M	
	21. Laridae (gulls and terns)					
70	Gull-billed Tern *Gelochelidon nilotica*			4	R	
71	River Tern *Sterna aurantia*		NT	4	R	
	X. Accipitriformes					
	22. Accipitridae (kites, hawks and eagles)					
72	Black-winged Kite *Elanus caeruleus*			1	M	
73	Oriental Honey Buzzard *Pernis ptilorhynchus*			1	R	
74	Egyptian Vulture *Neophron percnopterus* §		EN	1	S	X
75	Crested Serpent Eagle *Spilornis cheela*			1	R	
76	Short-toed Snake Eagle *Circaetus gallicus*			1	S	
77	White-rumped Vulture *Gyps bengalensis*		CR	1	S	X
78	Indian Vulture *Gyps indicus*		CR	1	S	X
79	Mountain Hawk Eagle (Legge's Hawk Eagle) *Nisaetus nipalensis kelaarti*			1	R	X
80	Changeable Hawk Eagle (Crested Hawk Eagle) *Nisaetus cirrhatus cirrhatus*			1	R	
81	Rufous-bellied Eagle *Lophotriorchis kienerii*			1	R	
82	Black Eagle *Ictinaetus malaiensis*			1	R	
83	Bonelli's Eagle *Aquila fasciata*			1	R	
84	Booted Eagle *Hieraaetus pennatus*			1	M	
85	Western Marsh Harrier *Circus aeruginosus*			1	M	
86	Crested Goshawk *Accipiter trivirgatus*			1	R	
87	Shikra *Accipiter badius*			1	R	
88	Besra *Accipiter virgatus*			1	R	
89	Eurasian Sparrowhawk *Accipiter nisus*			1	M	
90	White-bellied Sea Eagle *Haliaeetus leucogaster*			1	R	
91	Grey-headed Fish Eagle *Icthyophaga ichthyaetus*		NT	1	M	X
92	Brahminy Kite *Haliastur indus*			1	R	
93	Black Kite *Milvus migrans*			1	R/M	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
94	White-eyed Buzzard *Butastur teesa*			1	R	
	XI. Strigiformes					
	22. Tytonidae (barn owls)					
95	Sri Lanka Bay Owl *Phodilus assimilis*			4	R	X
96	Common Barn Owl *Tyto alba*			4	R	
	23. Strigidae (owls)					
97	Brown Hawk Owl Ninox scutulata			4	R	
98	Jungle Owlet *Glaucidium radiatum*			4	R	
99	Spotted Owlet *Athene brama*			4	R	
100	Oriental Scops Owl *Otus sunia*			4	R	
101	Indian Scops Owl *Otus bakkamoena*			4	R	
102	Brown Wood Owl *Strix leptogrammica*			4	R	
103	Spot-bellied Eagle Owl *Bubo nipalensis*			4	R	
104	Brown Fish Owl *Ketupa zeylonensis*			4	R	
	XII. Trogoniformes					
	24. Trogonidae (trogons)					
105	Malabar Trogon *Harpactes fasciatus*			4	R	
	XIII. Bucerotiformes					
	25. Bucerotidae (hornbills)					
106	Great Hornbill *Buceros bicornis*		NT	1	R	
107	Malabar Pied Hornbill *Anthracoceros coronatus*		NT	1	R	
108	Malabar Grey Hornbill *Ocyceros griseus*	WG		1	R	
109	Indian Grey Hornbill *Ocyceros birostris*			1	R	
	26. Upupidae (hoopoes)					
110	Common Hoopoe *Upupa epops*				R	
	XIV. Piciformes					
	27. Picidae (woodpeckers)					
111	Speckled Piculet *Picumnus innominatus*			4	R	
112	Heart-spotted Woodpecker *Hemicircus canente*			4	R	
113	Common Golden-backed Woodpecker *Dinopium javanense*			4	R	
114	Lesser Golden-backed Woodpecker *Dinopium benghalense*			4	R	
115	Rufous Woodpecker *Micropternus brachyurus*			4	R	
116	Lesser Yellow-naped Woodpecker *Picus chlorolophus*			4	R	
117	White-bellied Woodpecker *Dryocopus javensis*			4	R	
118	Greater Golden-backed Woodpecker *Chrysocolaptes guttacristatus*			4	R	
119	White-naped Woodpecker *Chrysocolaptes festivus*			4	R	
120	Brown-capped Pygmy Woodpecker *Dendrocopos nanus*			4	R	
121	Yellow-fronted Pied Woodpecker *Dendrocopos mahrattensis*			4	R	
	28. Megalaimidae (barbets)					
122	Brown-headed Barbet *Psilopogon zeylanicus*			4	R	
123	White-cheeked Barbet *Psilopogon viridis*			4	R	
124	Malabar Barbet *Psilopogon malabaricus*	WG		4	R	
125	Coppersmith Barbet *Psilopogon haemacephalus*			4	R	
	XV. Coraciiformes					
	29. Meropidae (bee-eaters)					

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
126	Blue-bearded Bee-eater *Nyctyornis athertoni*				R	
127	Green Bee-eater *Merops orientalis*				R	
128	Chestnut-headed Bee-eater *Merops leschenaulti*				R	
129	Blue-tailed Bee-eater *Merops philippinus*				M	
130	Indian Roller *Coracias benghalensis*			4	LM	
131	European Roller *Coracias garrulus*			4	M	
	30. Alcedinidae (kingfisher)					
132	Oriental Dwarf Kingfisher *Ceyx erithaca*			4	R	
133	Blue-eared Kingfisher *Alcedo meninting*			4	R	
134	Common Kingfisher *Alcedo atthis*			4	R	
135	Pied Kingfisher *Ceryle rudis*			4	R	
136	Stork-billed Kingfisher *Pelargopsis capensis*			4	R	
137	White-throated Kingfisher *Halcyon smyrnensis*			4	R	
138	Black-capped Kingfisher *Halcyon pileata*			4	R	
	XVI. Falconiformes					
	31. Falconidae (falcons and caracaras)					
139	Common Kestrel *Falco tinnunculus*			4	M	
140	Amur Falcon *Falco amurensis*			4	M	
141	Eurasian Hobby *Falco subbuteo*			4	M	
142	Peregrine Falcon *Falco peregrinus*			1		
	XVII. Psittaciformes					
	32. Psittaculidae (Old World parrots)					
143	Plum-headed Parakeet *Psittacula cyanocephala*			4	R	
144	Malabar Parakeet *Psittacula columboides*	WG		4	R	
145	Rose-ringed Parakeet *Psittacula krameri*			4	R	
146	Vernal Hanging Parrot *Loriculus vernalis*			4	R	
	XVIII. Passeriformes					
	33. Pittidae (pittas)					
147	Indian Pitta *Pitta brachyura*			4	R	
	34. Campephagidae (minivets and cuckooshrikes)					
148	Small Minivet *Pericrocotus cinnamomeus*			4	R	
149	Scarlet Minivet (Orange Minivet) *Pericrocotus flammeus*			4	R	
150	Large (Indian) Cuckooshrike *Coracina javensis macei*			4	R	
151	Black-winged Cuckooshrike *Lalage melaschistos*			4	M	X
152	Black-headed Cuckooshrike *Lalage melanoptera*			4	R	
	35. Oriolidae (orioles, figbirds and allies)					
153	Black-hooded Oriole *Oriolus xanthornus*			4	R	
154	Indian Golden Oriole *Oriolus kundoo*			4	LM	
155	Black-naped Oriole *Oriolus chinensis*			4	M	
	36. Artamidae (woodswallows, Australian magpies and allies)					
156	Ashy Woodswallow *Artamus fuscus*				R	
	37. Vangidae (vangas and helmet-shrikes)					
157	Bar-winged Flycatcher-shrike *Hemipus picatus*			4	R	
158	Malabar Woodshrike *Tephrodornis sylvicola*	WG		4	R	
159	Common Woodshrike *Tephrodornis pondicerianus*			4	R	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
	38. Aegithinidae (ioras)					
160	Common Iora *Aegithina tiphia*			4	R	
	39. Dicruridae (drongos)					
161	Black Drongo *Dicrurus macrocercus*			4	R	
162	Ashy Drongo *Dicrurus leucophaeus*			4	M	
163	White-bellied Drongo *Dicrurus caerulescens*			4	R	
164	Bronzed Drongo *Dicrurus aeneus*			4	R	
165	Hair-crested Drongo *Dicrurus hottentottus*			4	R	
166	Greater Racket-tailed Drongo *Dicrurus paradiseus*			4	R	
	40. Rhipiduridae (fantails)					
167	White-spotted Fantail *Rhipidura albogularis*			4	R	
	41. Laniidae (shrikes)					
168	Brown Shrike *Lanius cristatus cristatus*				M	
169	Isabelline Shrike *Lanius isabellinus*				M	
170	Long-tailed Shrike *Lanius schach*				M	
	42. Corvidae (crows and jays)					
171	Rufous Treepie *Dendrocitta vagabunda*			4	R	
172	House Crow *Corvus splendens*			5	R	
173	Large-billed Crow (Indian Jungle Crow) *Corvus macrorhynchos culminatus*			4	R	
	43. Monarchidae (monarchs and paradise-flycatchers)					
174	Black-naped Monarch *Hypothymis azurea*			4	R	
175	Indian Paradise-flycatcher *Terpsiphone paradisi*			4	LM	
	44. Dicaeidae (flowerpeckers)					
176	Thick-billed Flowerpecker *Dicaeum agile*			4	R	
177	Pale-billed Flowerpecker *Dicaeum erythrorhynchos*			4	R	
178	Nilgiri Flowerpecker *Dicaeum concolor*	WG		4	R	
	45. Nectariniidae (sunbirds)					
179	Little Spiderhunter *Arachnothera longirostra*			4	R	
180	Purple-rumped Sunbird *Leptocoma zeylonica*			4	R	
181	Crimson-backed Sunbird *Leptocoma minima*	WG		4	R	
182	Purple Sunbird *Cinnyris asiaticus*			4	R	
183	Loten's Sunbird *Cinnyris lotenius*			4	R	
184	Vigors's Sunbird *Aethopyga vigorsii*	WG		4	R	
	46. Irenidae (fairy-bluebirds)					
185	Asian Fairy-bluebird *Irena puella*			4	R	
	47. Chloropseidae (leafbirds)					
186	Golden-fronted Leafbird *Chloropsis aurifrons*			4	R	
187	Jerdon's Leafbird *Chloropsis jerdoni*			4	R	
	48. Ploceidae (weavers)					
188	Baya Weaver *Ploceus philippinus*			4	R	
	49. Estrildidae (waxbills)					
189	Red Munia *Amandava amandava*			4	R	
190	White-rumped Munia *Lonchura striata*			4	R	
191	Scaly-breasted Munia *Lonchura punctulata*			4	R	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
192	Black-throated Munia *Lonchura kelaarti*			4	R	
193	Tricoloured Munia *Lonchura malacca*			4	R	
	50. Passeridae (sparrows, snowfinches and allies)					
194	House Sparrow *Passer domesticus*			4	R	
195	Yellow-throated Sparrow *Gymnoris xanthocollis*			4	R	
	51. Motacillidae (wagtails and pipits)					
196	Forest Wagtail *Dendronanthus indicus*			4	M	
197	Tree Pipit *Anthus trivialis*			4	M	
198	Olive-backed Pipit *Anthus hodgsoni*			4	M	X
199	Paddyfield Pipit *Anthus rufulus*			4	R/M	
200	Tawny Pipit *Anthus campestris*			4	M	
201	Western Yellow Wagtail *Motacilla flava*			4		
202	Grey Wagtail *Motacilla cinerea*			4	M	
203	White-browed Wagtail *Motacilla maderaspatensis*			4	R/M	
204	White Wagtail *Motacilla alba*			4	M	
	52. Fringillidae (finches, euphonias and Hawaiian honeycreepers)					
205	Common Rosefinch *Erythrina erythrina*			4	M	
	53. Emberizidae (Old World buntings)					
206	Red-headed Bunting *Emberiza bruniceps*			4	M	
207	Black-headed Bunting *Emberiza melanocephala*			4	M	
208	Grey-necked Bunting *Emberiza buchanani*			4	M	
	54. Stenostiridae (fairy-flycatcher and crested flycatchers)					
209	Grey-headed Canary-flycatcher *Culicicapa ceylonensis*			4	M	
	55. Paridae (tits, chickadees)					
210	Black-lored Tit *Machlolophus xanthogenys*			4	R	
	56. Alaudidae (larks)					
211	Sykes's Short-toed Lark *Calandrella dukhunensis*			4	M	
212	Malabar Lark *Galerida malabarica*			4	R	
	57. Cisticolidae (cisticolas)					
213	Zitting Cisticola *Cisticola juncidis*			4	R	
214	Grey-breasted Prinia *Prinia hodgsonii*			4	R	
215	Ashy Prinia *Prinia socialis*			4	R	
216	Plain Prinia *Prinia inornata*			4	R	
217	Common Tailorbird *Orthotomus sutorius*			4	R	
	58. Locustellidae (bush warblers)					
218	Grasshopper Warbler *Locustella naevia*			4	M	
	59. Acrocephalidae (brush, reed and swamp warblers)					
219	Booted Warbler *Iduna caligata*			4	M	
220	Sykes's Warbler *Iduna rama*			4	M	X
221	Blyth's Reed Warbler *Acrocephalus dumetorum*			4	M	
222	Paddyfield Warbler *Acrocephalus agricola*			4	M	
223	Clamorous Reed Warbler *Acrocephalus stentoreus*			4	R/M	
	60. Hirundinidae (swallows)					
224	Northern House Martin *Delichon urbicum*				M	X
225	Streak-throated Swallow *Petrochelidon fluvicola*				M	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
226	Red-rumped Swallow *Cecropis daurica*				R	
227	Wire-tailed Swallow *Hirundo smithii*				R	
228	Barn Swallow *Hirundo rustica*				M	
229	Eurasian Crag Martin *Ptyonoprogne rupestris*				M	
230	Dusky Crag Martin *Ptyonoprogne concolor*				R	
	61. Pycnonotidae (bulbuls)					
231	Square-tailed Bulbul *Hypsipetes ganeesa*			4	R	
232	Flame-throated Bulbul *Pycnonotus melanicterus gularis*	WG		4	R	
233	Red-whiskered Bulbul *Pycnonotus jocosus*			4	R	
234	Red-vented Bulbul *Pycnonotus cafer*			4	R	
235	White-browed Bulbul *Pycnonotus luteolus*			4	R	
236	Grey-headed Bulbul *Brachypodius priocephalus*	WG	NT	4	R	
237	Yellow-browed Bulbul *Acritillas indica*			4	R	
	62. Phylloscopidae (Old World leaf warblers)					
238	Yellow-browed Warbler *Abrornis inornatus*			4	M	X
239	Sulphur-bellied Warbler *Phylloscopus griseolus*			4	M	
240	Tickell's Leaf Warbler *Phylloscopus affinis*			4	M	
241	Green Leaf Warbler *Seicercus nitidus*			4	M	
242	Greenish Leaf Warbler *Seicercus trochiloides*			4	M	
243	Large-billed Leaf Warbler *Seicercus magnirostris*			4	M	
244	Western Crowned Leaf Warbler *Seicercus occipitalis*			4	M	
	63. Sylviidae (Sylvia warblers, parrotbills and allies)					
245	Yellow-eyed Babbler *Chrysomma sinense*			4	R	
	64. Zosteropidae (white-eyes and yuhinas)					
246	Oriental White-eye *Zosterops palpebrosus*			4	R	
	65. Timaliidae (scimitar babblers and allies)					
247	Indian Scimitar Babbler *Pomatorhinus horsfieldii*			4	R	
248	Tawny-bellied Babbler *Dumetia hyperythra albogularis*			4	R	
249	Dark-fronted Babbler *Rhopocichla atriceps*			4	R	
250	Puff-throated Babbler *Pellorneum ruficeps*			4	R	
	66. Pellorneidae (smaller babblers)					
251	Quaker Tit Babbler *Alcippe poioicephala*			4	R	
	67. Leiothrichidae (babblers, laughingthrushes and allies)					
252	Rufous Babbler *Argya subrufa*	WG		4	R	
253	Jungle (Black-winged) Babbler *Turdoides striata somervillei*	WG		4	R	
254	Yellow-billed Babbler *Turdoides affinis*			4	S	X
255	Waynaad Laughingthrush *Garrulax delesserti*	WG		4	R	
	68. Sittidae (nuthatches, spotted creepers and wallcreeper)					
256	Velvet-fronted Nuthatch *Sitta frontalis*				R	
	69. Sturnidae (starlings)					
257	Rosy Starling *Pastor roseus*			4	M	
258	Brahminy Starling *Sturnia pagodarum*			4	R	
259	Chestnut-tailed Starling *Sturnia malabarica*			4	R	
260	Malabar Starling *Sturnia malabarica blythii*	WG		4	R	
261	Common Myna *Acridotheres tristis*			4	R	

	Species	Endemism to WG	IUCN	WLPA (1972)	Status	Rarity
262	Jungle Myna *Acridotheres fuscus*			4	R	
263	Southern Hill Myna *Gracula indica*			1	R	
	70. Muscicapidae (chats ad flycatchers)					
264	Indian Robin Saxicoloides fulicatus			4	R	
265	Oriental Magpie Robin *Copsychus saularis*			4	R	
266	White-rumped Shama *Kittacincla malabarica*			4	R	
267	Dark-sided Flycatcher *Muscicapa sibirica §*			4	VG	X
268	Asian Brown Flycatcher *Muscicapa dauurica*			4	M	
269	Brown-breasted Flycatcher *Muscicapa muttui*			4	M	
270	Rusty-tailed Flycatcher *Muscicapa ruficauda*			4	M	
271	White-bellied Blue Flycatcher *Cyornis pallidipes*	WG		4	R	
272	Tickell's Blue Flycatcher *Cyornis tickelliae*			4	R	
273	Verditer Flycatcher *Eumyias thalassinus*			4	M	
274	Indian Blue Robin *Larvivora brunnea*			4	M	
275	Malabar Whistling Thrush *Myophonus horsfieldii*			4	R	
276	Red-breasted Flycatcher *Ficedula parva*			4	M	
277	Taiga Flycatcher *Ficedula albicilla*			4	M	
278	Ultramarine Flycatcher *Ficedula superciliaris*			4	M	X
279	Black Redstart *Phoenicurus ochruros*			4	M	X
280	Blue-capped Rock Thrush *Monticola cinclorhyncha*			4	M	
281	Blue Rock Thrush *Monticola solitarius*			4	M	
282	Siberian Stonechat Saxicola maurus			4	M	
283	Pied Bushchat Saxicola caprata			4	R	
	71. Turdidae (thrushes)					
284	Orange-headed Thrush *Geokichla citrina*			4		
285	Indian Blackbird *Turdus simillimus*			4	R	
286	Tickell's Thrush *Turdus unicolor*			4	M	X

Appendix II. Wild Angiosperms of Bhagwan Mahavir National Park, Goa, India (adapted from Datar & Lakshminarasimhan 2013).
Abbreviations used for endemism: WG—Western Ghats | PI—peninsular India | AN—Andaman & Nicobar Islands | IND—India | SWI—southwestern India | NWG—northern Western Ghats | WI—western India | WSI—western and southern India | PCI—peninsular and central India | WPI—western peninsular India | Goa—Goa state.
Abbreviations used for Red Listed Species: CR—Critically Endangered | EN—Endangered | VU—Vulnerable

Species / Family	Local name	Endemism	IUCN
ACANTHACEAE			
Andrographis paniculata (Burm.f.) Wall. ex Nees	Chirayat		
Asystasia dalzelliana Santapau		Endemic WG	
Barleria prattensis Santapau			
Barleria prionitis L.			
Barleria terminalis Nees			
Cynarospermum asperrimum (Nees) Vollesen		Endemic PCI	
Dicliptera foetida (Forssk.) Blatt.			
Ecbolium ligustrinum (Vahl) Vollesen			
Eranthemum capense L. var. *concanensis* (T.Anderson ex C. B. Clarke) Santapau		Endemic WG	VU
Eranthemum roseum (Vahl) R.Br.		Endemic WG	
Gymnostachyum glabrum (Dalzell) T.Anderson			
Haplanthodes tentaculatus (L.) R.B.Majumdar			
Hemigraphis latebrosa (B.Heyne ex Roth) Nees			
Hygrophila pinnatifida (Dalzell) Sreem.			
Hygrophila ringens (L.) R.Br. ex Steud.			
Hygrophila schulli (Buch.-Ham.) M.R.Almeida & S.M.Almeida			
Justicia adhatoda L.	Adulsa		
Justicia procumbens L.			
Justicia simplex D.Don			
Justicia wynaadensis (Nees) Heyne ex T.Anderson		Endemic WG	
Lepidagathis cuspidata Nees			
Lepidagathis incurva Buch.-Ham. ex D.Don var. *mucronata* (Nees) C.B.Clarke ex T.Cooke			
Lepidagathis lutea Dalzell	Koche		
Lepidagathis prostrata Dalzell			
Nelsonia canescens (Lam.) Spreng.			
Phaulopsis imbricata (Forssk.) Sweet			
Pseuderanthemum malabaricum (C.B.Clarke) Gamble			
Rostellularia japonica (Thunb.) Ellis			
Rungia parviflora (Retz.) Nees ssp. *pectinata* (L.) L.H.Cramer			
Strobilanthes callosus Nees	Karaw	Endemic WI	
Strobilanthes ciliata Nees		Endemic WG	EN
Strobilanthes heyneanus Nees	Karaw	Endemic PI	
Strobilanthes integrifolia (Dalzell) Kuntze		Endemic WG	
Strobilanthes ixiocephalus Benth.	Kaarw	Endemic WG	
ALISMATACEAE			
Wiesneria triandra (Dalzell) Micheli			EN
AMARANTHACEAE			
Achyranthes aspera L.			
Alternanthera sessilis (L.) R.Br. ex DC.			
Amaranthus spinosus L.			

Species / Family	Local name	Endemism	IUCN
Celosia argentea L.			
Cyathula prostrata (L.) Blume			
AMARYLLIDACEAE			
Crinum lorifolium Roxb. ex Ker Gawl.			
Crinum viviparum (Lam.) R.Ansari & V.J.Nair			
Pancratium triflorum Roxb.			
ANACARDIACEAE			
Anacardium occidentale L.	Kaju		
Buchanania lanzan Spreng.	Char		
Holigarna arnottiana Hook.f.	Bibba	Endemic WG	
Holigarna grahamii (Wight) Kurz		Endemic WG	
Lannea coromandelica (Houtt.) Merr.			
Mangifera indica L.	Amba		
Nothopegia beddomei Gamble		Endemic WG	
Nothopegia castaneifolia (Roth) Ding Hou		Endemic WG	
ANCISTROCLADACEAE			
Ancistrocladus heyneanus Wall. ex J.Graham		Endemic WG	
ANNONACEAE			
Miliusa tomentosa (Roxb.) Finet and Gagnep.			
Orophea zeylanica Hook.f. & Thomson			
Polyalthia fragrans (Dalzell) Bedd.		Endemic WG	
Sageraea laurina Dalzell	Sadni	Endemic WG	
Uvaria narnum (Dunal) Blume			
ANTHERICACEAE			
Chlorophytum heynei Rottl. ex Baker			
APIACEAE			
Centella asiatica (L.) Urb.			
Pimpinella wallichiana (Miq. ex Hohen.) Gandhi			
APOCYNACEAE: SUBFAMILY ASCLEPIADOIDEAE			
Asclepias curassavica L.			
Calotropis gigantea (L.) R.Br.			
Cynanchum callialata Buch.-Ham. ex Wight			
Dregea volubilis (L. *f.*) Benth. ex Hook.f.			
Genianthus laurifolius (Roxb.) Hook.f.			
Gymnema sylvestre (Retz.) R.Br. ex Schult.			
Holostemma annulare (Roxb.) K.Schum.			
Hoya wightii Hook.f.		Endemic PI	
Tylophora fasciculata Buch.-Ham. ex Wight & Arn.			
APOCYNACEAE: SUBFAMILY APOCYNOIDEAE			
Aganosma cymosa (Roxb.) G.Don			
Anodendron paniculatum (Roxb.) A.DC.			
Chonemorpha fragrans (Moon) Alston			
Holarrhena pubescens (Buch.- Ham) Wall. ex G.Don			
Ichnocarpus frutescens (L.) W.T.Aiton			
Parsonsia alboflavescens (Dennst.) Mabb.			

Species / Family	Local name	Endemism	IUCN
Wrightia arborea (Dennst.) Mabb.			
Wrightia tinctoria (Roxb.) R.Br.			
APOCYNACEAE: SUBFAMILY- RAUVOLFIOIDEAE			
Alstonia scholaris (L.) R.Br.			
Carissa spinarum L.			
Rauvolfia serpentina (L.) Benth. ex Kurz			
Tabernaemontana alternifolia L.		Endemic WSI	
APOCYNACEAE: SUBFAMILY PERIPLOCOIDEAE			
Cryptolepis buchananii R.Br. ex Roem. & Schult.			
Hemidesmus indicus (L.) R.Br.			
ARACEAE			
Amorphophallus bulbifer (Roxb.) Blume			
Amorphophallus commutatus (Schott) Engl. var. *commutatus*		Endemic PI	
Amorphophallus commutatus var. *anmodensis* Sivad. & Jaleel		Endemic Goa	EN
Amorphophallus paeoniifolius (Dennst.) Nicolson			
Ariopsis peltata Nimmo			
Arisaema sivadasanii S.R.Yadav, K.S.Patil & Janarth.		Endemic WG	CR
Arisaema tortuosum (Wall.) Schott			
Cryptocoryne retrospiralis (Roxb.) Kunth			
Lagenandra ovata (L.) Thwaites			
Pothos scandens L.			
Theriophonum dalzelli Schott.		Endemic WG	
ARALIACEAE			
Schefflera elliptica (Blume) Harms			
ARECACEAE			
Arenga wightii Griff		Endemic WG	
Calamus pseudotenuis Becc.	Wet		
Calamus thwaitesii Becc.	Wet		
Caryota urens L.	Bherli mad		
ARISTROLOCHIACEAE			
Thottea siliquosa (Lam.) Ding Hou			
ASPARAGACEAE			
Asparagus racemosus Willd.			
ASTERACEAE			
Acanthospermum hispidum DC.			
Ageratum conyzoides L.			
Bidens biternata (Lour.) Merr. & Sherff			
Blumea belangeriana DC.		Endemic PI	
Blumea membranacea DC.			
Blumea oxyodonta DC.			
Blumea virens DC.			
Cyathocline purpurea (Buch.-Ham. ex D.Don) Kuntze			
Dichrocephala integrifolia (L.f.) Kuntze			
Eclipta prostrata (L.) L.			
Elephantopus scaber L.			

Species / Family	Local name	Endemism	IUCN
Emilia sonchifolia (L.) DC.			
Erigeron sublyratus DC.			
Eupatorium odoratum L.			
Gnaphalium polycaulon Pers.			
Grangea maderaspatana (L.) Poir.			
Gynura nitida DC.			
Phyllocephalum phyllolaenum (DC.) Narayana			
Phyllocephalum ritchiei (Hook.f.) Narayana		Endemic PI	
Senecio belgaumensis (Wight) C.B.Clarke			
Senecio gibsonii Hook.f.		Endemic WG	
Spilanthes paniculata Wall. ex DC.			
Synedrella nodiflora (L.) Gaertn.			
Tricholepis glaberrima DC.			
Tridax procumbens L.			
Vernonia cinerea (L.) Less.			
BALSAMINACEAE			
Impatiens acaulis Arn.			
Impatiens balsamina L.	Terda		
Impatiens lawii Hook.f. & Thomson			
Impatiens minor (DC.) Bennet		Endemic WG	
Impatiens oppositifolia L.			
Impatiens pulcherrima Dalzell		Endemic WG	
BEGONIACEAE			
Begonia crenata Drynad.			
Begonia trichocarpa Dalzell		Endemic NWG	EN
BIGNONIACEAE			
Heterophragma quadriloculare (Roxb.) K.Schum.	Kuski		
Oroxylum indicum (L.) Benth. ex Kurz			
Pajanelia longifolia (Willd.) K.Schum.	Padwal		
Stereospermum colais (Buch.-Ham. ex Dillw.) Mabb.			
BOMBACACEAE			
Bombax ceiba L.	Sawar		
Bombax insigne Wall.			
BORAGINACEAE			
Coldenia procumbens L.			
Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. ex Lehm.			
Ehretia canarensis (C.B.Clarke) Gamble			
Paracaryopsis coelestina (Lindl.) R.R.Mill			VU
Rotula aquatica Lour.			
BUDDLEJACEAE			
Buddleja asiatica Lour.			
BURMANNIACEAE			
Burmannia pusilla (Wall. ex Miers) Thwaites			
BURSERACEAE			
Canarium strictum Roxb.	Dhup		

Species / Family	Local name	Endemism	IUCN
CAMPANULACEAE			
Lobelia alsinoides Lam.			
Lobelia nicotianaefolia Roth ex Roem. & Schult.	Rantambaku		
CAPPARACEAE			
Capparis rheedei DC.		Endemic WG	
Cleome viscosa L.			
CARYOPHYLLACEAE			
Polycarpon prostratum (Forssk.) Asch. & Schweinf.			
CELASTRACEAE			
Celastrus paniculata Willd			
Euonymus indicus B. Heyne ex Wall.		Endemic PI & AN	
Hippocratea grahamii Wight			
Hippocratea indica Willd.			
Hippocratea obtusifolia Roxb.			
Lophopetalum wigtianum Arn.			
Maytenus rothiana (Walp.) Lobreau-Callen			
Salacia chinensis L.	Narbundi		
Salacia oblonga Wall ex Wight & Arn.			
CLEOMACEAE			
Crateva magna (Lour.) DC.			
CLUSIACEAE			
Calophyllum calaba L.	Wiray	Endemic WG	
Calophyllum polyanthum Wall. ex Choisy			
Garcinia gummi-gutta (L.) N.Robson		Endemic WG	
Garcinia indica (Thouars) Choisy	Bhirand, Kokam, Aamsul	Endemic WG	
Garcinia morella (Gaertn.) Desr.			
Mammea suriga (Buch.-Ham. ex Roxb.) Kosterm.	Surangi		
Mesua ferrea L.	Nag-Chapha		
COLCHICACEAE			
Gloriosa superba L.			
Iphiginea indica (L.) A. Grey ex Kunth			
COMBRETACEAE			
Combretum latifolium Blume			
Getonia floribunda Roxb.	Uski		
Terminalia bellirica (Gaertn.) Roxb.			
Terminalia chebula Retz.			
Terminalia elliptica Willd.	Matti, Madat		
Terminalia paniculata Roth	Kindal	Endemic PI	
COMMELINACEAE			
Commelina benghalensis L.			
Commelina forsskalaei Vahl			
Cyanotis fasciculata (B.Heyne ex Roth) Schult. & Schult.f.			
Cynotis cristata (L.) D.Don			
Floscopa scandens Lour.			
Murdannia dimorpha (Dalzell) G.Brückn.			

Species / Family	Local name	Endemism	IUCN
Murdannia japonica (Thunb.) Faden			
Murdannia semiteres (Dalzell) Santapau			
Murdannia simplex (Vahl) Brenan			
Murdannia spirata (L.) G.Brückn.			
Murdannia versicolor (Dalzell) G.Brückn.			
CONNARACEAE			
Connarus monocarpus L.	Ghagrya		
CONVALLARIACEAE			
Ophiopogon intermedius D.Don			
CONVOLVULACEAE			
Argyreia elliptica (Roth) Choisy			
Argyreia involucrata C.B.Clarke			
Erycibe paniculata Roxb.			
Evolvulus nummularius (L.) L.			
Ipomoea campanulata L.			
Ipomoea nil (L.) Roth			
Ipomoea obscura (L.) Ker Gawl.			
Ipomoea sinensis (Desv.) Choisy			
Ipomoea violacea L.			
Merremia umbellata (L.) Hall f.	Washel		
Merremia vitifolia (Burm.f.) Hall f.			
CORNACEAE			
Mastixia arborea (Wight.) Bedd.			
COSTACEAE			
Costus speciosus (J.J.König) J.E.Sm.			
CRASSULACEAE			
Kalanchoe pinnata (Lam.) Pers.			
CUCURBITACEAE			
Coccinia grandis (L.) Voigt	Tendli		
Cucumis melo L.			
Momordica dioica Roxb. ex Willd.			
Mukia maderaspatana (L.) M.Roem.			
Solena amplexicaulis (Lam.) Gandhi			
Trichosanthes cucumerina L.	Kondal, Fagal		
Zanonia indica L.			
CYPERACEAE			
Carex caricina (D.Don) Ghildyal & U.C.Bhattach. var. *caricina*.			
Carex caricina (D.Don) Ghildyal & U.C.Bhattach. var. *glaucina* (Boeck.) Ghildyal & U.C.Bhattach.		Endemic PI	
Cyperus haspan L. ssp. *haspan*.			
Cyperus haspan L. ssp. *juncoides* (Lam.) Kuk.			
Cyperus iria L.			
Diplacrum caricinum R.Br.			
Eleocharis acutangula (Roxb.) Schult.			
Fimbristylis dichotoma (L.) Vahl			
Fimbristylis lawiana (Boeck.) J.Kern			

Species / Family	Local name	Endemism	IUCN
Fimbristylis ovata (Burm.f.) J.Kern			
Fimbristylis woodrowii C.B.Clarke		Endemic WPI	
Hypolytrum nemorum (Vahl) Spreng.			
Kyllinga brevifolia Rottb.			
Lipocarpha squarrosa (L.) Goetgh.			
Mariscus compactus (Retz.) Bold.			
Mariscus paniceus (Rottb.) Vahl			
Pycreus flavidus (Retz.) T.Koyma			
Pycreus malabaricus C.BClarke			
Pycreus pumilus (L.) Nees			
Pycreus sanguinolentus (Vahl) Nees			
Rhynchospora wightiana (Nees) Steud.			
Scleria terrestris (L.) Fassett			
DATISCACEAE			
Tetrameles nudiflora R. Br.			
DILLENIACEAE			
Dillenia pentagyna Roxb.	Karmal		
DIOSCOREACEAE			
Dioscorea bulbifera L.			
Dioscorea hispida Dennst.			
Dioscorea pentaphylla L.			
DIPTEROCARPACEAE			
Hopea ponga (Dennst.) Mabb.		Endemic WG	
DRACAENACEAE			
Dracaena terniflora Roxb.			
DROSERACEAE			
Drosera indica L.			
EBENACEAE			
Diospyros buxifolia (Blume) Hiern			
Diospyros candolleana Wight			
Diospyros crumenata Thwaites			
Diospyros montana Roxb.	Kalakonda		
Diospyros neilgerrensis (Wight) Kosterm.		Endemic PI	
Diospyros oocarpa Thw.			
Diospyros paniculata Dalzell		Endemic IND	
Diospyros pruriens Dalzell			
ELAEAGNACEAE			
Elaeagnus conferta Roxb.			
ERIOCAULACEAE			
Eriocaulon dalzellii Koern.		Endemic WG	
Eriocaulon eurypeplon Koern.		Endemic WG	
Eriocaulon heterolepis Steud.		Endemic WI	
Eriocaulon lanceolatum Miq. ex Koern.		Endemic WG	
Eriocaulon robusto-brownianum Ruhland			
Eriocaulon sexangulare L.			

Species / Family	Local name	Endemism	IUCN
Eriocaulon stellulatum Koern.		Endemic WG	
Eriocaulon xeranthemum Mart.			
Eroicaulon palghatense R.Ansari & N.P.Balakr.		Endemic WG	
EUPHORBIACEAE *s.l.*			
Actephila excelsa (Dalzell) Mull. Arg.			
Agrostistachys indica Dalzell			
Antidesma acidum Retz.			
Antidesma menasu (Tul.) Mull. Arg.			
Aporusa cardiosperma (Gaertn.) Merr.			
Baliospermum montanum (Willd.) Mull. Arg.			
Blachia andamanica (Kurz) Hook.f. ssp. *denudata* (Benth.) N.P.Balakr. & Chakrab.		Endemic WG	
Breynia retusa (Dennst.) Alston			
Bridelia retusa (L.) A.Juss.			
Bridelia stipularis Blume			
Croton persimilis Mull. Arg.			
Dimorphocalyx glabellus Thwaites var. *lawianus* (Mull. Arg.) Chakrab. & N.P.Balakr.		Endemic WG	
Drypetes venusta (Wight) Pax & K.Hoffm.			
Euphorbia erythroclada Boiss		Endemic PCI	
Euphorbia hirta L.			
Euphorbia ligularia Roxb.			
Euphorbia notoptera Boiss.		Endemic WG	
Falconeria insignis Royle			
Glochidion hohenackeri (Mull.-Arg.) Bedd.		Endemic NWG	
Glochidion zeylanicum (Gaertn.) A.Juss.			
Homonoia riparia Lour.			
Jatropha curcas L.			
Macaranga peltata (Roxb.) Mull. Arg.	Chanda		
Mallotus ferrugineus (Roxb.) Mull. Arg.			
Mallotus philippensis (Lam.) Mull. Arg.			
Mallotus resinous (Blanco) Merr. var. *stenanthus* (Mull. Arg.) Susila & N.P.Balakr.		Endemic WG	
Margaritaria indica (Dalzell) Airy Shaw			
Microstachys chamaelea (L.) Mull. Arg.			
Phyllanthus amarus Schumach. & Thonn.			
Phyllanthus emblica L.	Awla		
Phyllanthus juniperinus Mull. Arg.			
Phyllanthus simplex Retz.			
Phyllanthus urinaria L.			
Tragia praetervis Chakrab. & N.P.Balakr.			
FLACOURTIACEAE			
Casearia ovata (Lam.) Willd.			
Flacourtia montana J.Graham	Chaper	Endemic WG	
Homalium ceylanicum (Gardn.) Benth.			
Hydnocarpus pentandrus (Buch.-Ham.) Oken	Kastal	Endemic WG	
GENTIANACEAE			
Canscora diffusa (Vahl) R.Br. ex Roem & Schult.			

Species / Family	Local name	Endemism	IUCN
Canscora perfoliata Lam.		Endemic WG	
Exacum pumilum Griseb.			
Exacum tetragonum Roxb.			
Hoppea fastigiata (Griseb.) C.B.Clarke			
GESNERIACEAE			
Rhynchoglossum notonianum (Wall.) Burtt			
Rhynchoglossum obliquum Blume var. *parviflorum* C.B.Clarke			
HYCINTHACEAE			
Ledebouria revoluta (L.f.) Jessop			
HYDROCHARITACEAE			
Blyxa aubertii Rich.			
Vallisneria spiralis L.			
HYACINTHACEAE			
Curculigo orchioides Gaertn.			
ICACINACEAE			
Gomphandra tetrandra (Wall.) Sleumer			
Nothapodytes nimmoniana (J. Graham) Mabb.			
Sarcostigma kleinii Wight & Arn.			
LAMIACEAE			
Anisomeles indica (L.) Kuntze		Endemic WG	
Callicarpa tomentosa (L.) L.			
Clerodendrum infortunatum L.			
Colebrookea oppositifolia Sm.			
Gmelina arborea Roxb.	Shiwan		
Hyptis capitata Jacq.			
Hyptis suaveolens (L.) Poit.			
Leucas biflora (Vahl) R. Br. ex Sm.			
Leucas ciliata Benth.			
Leucas lavendulifolia Sm.			
Leucas stelligera Wall.			
Platostoma hispidum (L.) A.J.Paton			
Pogostemon paniculatus (Willd.) Benth			
Pogostemon purpurascens Dalzell			
Premna coriacea C.B.Clarke			
Rotheca serrata (L.) D.A.Steane & Mabb.			
Scutellaria discolor Colebr.			
Tectona grandis L.f.	Sagon		
Vitex altissima L.f.	Bailado		
Vitex leucoxylon L.f.			
Vitex negundo L.			
LAURACEAE			
Actinodaphne angustifolia (Blume) Nees			
Beilschmiedia dalzellii (Meisn.) Kosterm.	Miryo		
Cinnamomum nitidum (Roxb.) Hook.			
Cinnamomum sulphuratum Nees	Tikki		

Species / Family	Local name	Endemism	IUCN
Cinnamomum verum J.Presl	Tikki		
Cryptocarya lawsonii Gamble		Endemic WG	
Litsea coriacea (Heyne ex Meisn.) Hook.f.		Endemic WG	
Litsea ghatica C.J.Saldanha		Endemic WG	
Persea macrantha (Nees) Kosterm.	Olamb		
LECYTHIDACEAE			
Careya arborea Roxb.	Kumyo		
LEEACEAE			
Leea asiatica (L.) Ridsdale			
Leea indica (Burm.f.) Merr.	Dino		
LEGUMINOSAE: SUBFAMILY CAESALPINIOIDEAE			
Bauhinia malabarica Roxb.			
Bauhinia racemosa Lam.	Apto		
Caesalpinia mimosoides Lam.	Pansi		
Cassia fistula L.	Bayo		
Chamaecrista absus (L.) H.S.Irwin & Barneby			
Moullava spicata (Dalzell) Nicolson	Shamachi Wal	Endemic PI	
Saraca asoca (Roxb.) W.J.de Wilde	Ashok		
Senna hirsuta (L.) H.S.Irwin & Barneby	Taykolo		
Senna obtusifolia (L.) H.S.Irwin & Barneby			
Senna tora (L.) Roxb.			
LEGUMINOSAE: SUBFAMILY MIMOSOIDEAE			
Acacia caesia (L.) Willd.			
Acacia chundra (Roxb. & Rottl.) Willd.			
Acacia concinna (Willd.) DC.	Shikekai		
Acacia pennata (L.) Willd.			
Acacia torta (Roxb.) Craib.			
Albizia chinensis (Osbeck.) Merr.			
Albizia odoratissima (L.f.) Benth.			
Entada rheedei Spreng.	Garmbi		
Mimosa pudica L.			
Xylia xylocarpa (Roxb.) Taub.	Jambha		
LEGUMINOSAE: SUBFAMILY PAPILIONOIDEAE			
Abrus pulchellus Wall. ex Thwaites	Gunj		
Aeschynomene indica L.			
Alysicarpus bupleurifolius (L.) DC.			
Alysicarpus glumaceus (Vahl.) DC.			
Butea monosperma (Lam.) Taub.	Palas		
Cajanus lineatus (Wight & Arn.) Maesen			
Crotalaria filipes Benth.		Endemic WG	
Crotalaria lutescens Dalzell		Endemic WG	
Crotalaria pallida Aiton			
Crotalaria prostrata Rottl.			
Crotalaria retusa L.			
Dalbergia horrida (Dennst.) Mabb.		Endemic WG	

Species / Family	Local name	Endemism	IUCN
Dalbergia latifolia Roxb.	Sisam		
Dalbergia rubiginosa Roxb.		Endemic PI	
Dendrolobium triangulare (Retz.) Schindl.			
Derris heyneana (Wight an&d Arn.) Benth.		Endemic PI	
Desmodium heterocarpon (L.) DC.			
Desmodium *laxiflorum* DC.			
Desmodium motorium (Houtt.) Merr.			
Desmodium triflorum (L.) DC.			
Erithrina stricta Roxb.	Pangaro		
Flemingia macrophylla (Willd.) Kuntze ex Merr.			
Flemingia strobilifera (L.) R.Br. ex W.T.Aiton			
Flemingia tuberosa Dalzell		Endemic PI	
Geissaspis cristata Wight & Arn.			
Geissaspis tenella Benth.		Endemic PI	
Indigofera dalzelli T.Cooke		Endemic WG	
Indigofera prostrata Willd.		Endemic PI	
Mucuna monosperma DC.			
Paraderris canarensis (Dalzell) Adema			
Pongamia pinnata (L.) Pierre	Karanji		
Sesbania bispinosa (Jacq.) W.Wight			
Smithia bigemina Dalzell			
Smithia conferta J.E.Sm			
Smithia salsuginea Hance		Endemic PI	
Spatholobus parviflorus (Roxb. ex DC.) Kuntze			
Spatholobus purpureus Benth. ex Prain			
Tadehagi triquetrum (L.) H.Ohashi			
Tephrosia candida (Roxb.) DC.			
Tephrosia coccinea Wall.		Endemic PI	
Teramnus labialis (L.f.) Spreng.			
Uraria rufescens (DC) Schindl.			
Vigna vexillata (L.) A.Rich.			
LENTIBULARIACEAE			
Utricularia caerulea L.			
Utricularia graminifolia Vahl			
Utricularia lazulina P.Taylor			
Utricularia purpurascens J.Graham			
Utricularia reticulata Sm.			
Utricularia striatula Sm.			
Utricularia uliginosa Vahl.			
LOGANIACEAE			
Strychnos nux-vomica L.	Kajro		
Strychnos minor Dennst.			
LORANTHACEAE			
Dendrophthoe falcata (L.f.) Blume			
Elytranthe capitellata (Wight & Arn.) Engl.			

Species / Family	Local name	Endemism	IUCN
Scurrula parasitica L.			
Taxillus tomentosus (B.Heyne ex W.Roth) Tiegh.			
Tolypanthus lagenifer (Wight) Tiegh.		Endemic WG	
LYTHRACEAE			
Lagerstroemia microcarpa Wight	Nana		
Lagerstroemia parviflora Roxb.			
Rotala densiflora (Roth ex Roem. & Schult.) Koehne			
Rotala rotundifolia (Buch.-Ham. ex Roxb.) Koehne			
Woodfordia fruticosa (L.) Kurz	Dhayti		
MALPIGHIACEAE			
Aspidopterys canarensis Dalzell		Endemic WG	CR
MALVACEAE			
Abelmoschus manihot (L.) Medik.	Ambadi		
Abutilon persicum (Burm.f.) Merr.			
Daceschistia trilobata Wight		Endemic WG	
Hibiscus hirtus L.			
Hibiscus hispidissimus Griff.			
Kydia calycina Roxb.			
Sida acuta Burm.f.			
Sida cordata (Burm.f.) Borss.			
Sida rhombifolia L.	Tupkadi		
Thespesia lampas (Cav.) Dalzell ex Dalzell & A.Gibson			
Urena lobata L.			
MARANTACEAE			
Schumannianthus virgatus (Roxb.) Rolfe			
MELASTOMATACEAE			
Melastoma malabathiricum L.			
Memecylon talbotianum D.Brandis			
Memecylon terminale Dalzell		Endemic PI	
Memecylon umbellatum Burm.f.			
Memecylon wightii Thwaites			
Osbeckia muralis Naud.			
MELIACEAE			
Aglaia eleagnoidea (A.Juss.) Benth.			
Aglaia lawii (Wight) C.J. Saldanha ex Ramamoorthy	Maharsangal		
Chukrasia tabularis A.Juss.		Endemic IND	
Naregamia alata Wight & Arn.	Pitmado	Endemic IND	
Toona ciliata M.Roem.			
Trichlia connaroides (Wigh & Arn.) Bentv.			
Turraea villosa A.W.Benn.			
Walsura trifoliata (A.Juss.) Harms			
MENISPERMACEAE			
Anamirta cocculus (L.) Wight & Arn.			
Cocculus hirsutus (L.) Theob.			
Cyclea peltata (Lam.) Hook.f. & Thomson			

Species / Family	Local name	Endemism	IUCN
Diploclisia glaucescens (Blume) Diels	Ramwel, Ramrukhi		
Stephania elegans Hook. f. & Thomson			
Stephania japonica (Thunb.) Miers			
MOLLUGINACEAE			
Glinus oppositifolius (L.) A.DC.			
MORACEAE			
Artocarpus gomezianus Wall. ex Trecul ssp. *zeylanicus* Jarrett	Patphanas		
Artocarpus heterophyllus Lam.	Patphanas	Endemic WG	
Artocarpus hirsutus Lam.	Patphanas		
Ficus arnottiana (Miq.) Miq.	Payar		
Ficus benghalensis L.	Wad		
Ficus callosa Willd.			
Ficus drupacea Thunb. var. *pubescens* (Roth) Corner			
Ficus exasperata Vahl			
Ficus heterophylla L.f.			
Ficus hispida L.f.	Karwat		
Ficus microcarpa L.f.	Nandangol		
Ficus nervosa Heyne ex Roth			
Ficus racemosa L.	Rumad		
Ficus tinctoria G.Forst. ssp. *parasitica* (Koenig ex Willd.) Corner			
Ficus tsjahela Burm.f.	Kel		
MUSACEAE			
Ensete superbum (Roxb.) Cheesman		Endemic WG	
Musa x *paradisiaca* L.	Keli		
MYRISTICACEAE			
Knema attenuata (Wall. ex Hook.f. & Thomson) Warb.		Endemic WG	
Myristica malabarica Lam.		Endemic WG	
MYRSINACEAE			
Ardisia solanacea Roxb.	Bugadi		
Embelia tsjeriam-cottam (Roem. & Schult.) DC.			
Maesa indica (Roxb.) DC.			
MYRTACEAE			
Eugenia mooniana Wight			
Eugenia roxburghii DC.			
Syzygium caryophyllatum (L.) Alston	Bhirand		
Syzygium cumini (L.) Skeels	Bhirand		
Syzygium hemisphericum (Wight) Alston	Zamlo		
Syzygium laetum (Buch.-Ham.) Gandhi		Endemic SWI	
Syzygium salicifolium (Wight) J.Graham		Endemic SWI	
Syzygium zeylanicum (L.) DC.			
OCHNACEAE			
Ochna obtusata DC.			
OLACACEAE			
Olax imbricata Roxb.			

Species / Family	Local name	Endemism	IUCN
OLEACEAE			
Jasminum coarctatum Roxb.			
Jasminum malabaricum Wight		Endemic PI	
Jasminum multiflorum (Burm.f.) Andr.			
Jasminum ritchiei C.B.Clarke			
Ligustrum perrottetii A.DC.		Endemic WG	
Olea dioica Roxb.			
Schrebera swietenoides Roxb.			
ONAGRACEAE			
Ludwigia hyssopifolia (G.Don) Exell			
Ludwigia octovalvis (Jacq.) P.H.Raven ssp. *octovalvis*			
Ludwigia octovalvis (Jacq.) P.H.Raven ssp. *sessiliflora* (Micheli) P.H.Raven			
ORCHIDACEAE			
Acampe praemorsa (Roxb.) Blatt. & McCann			
Aerides crispa Lindl.		Endemic WG	
Aerides maculosa Lindl.		Endemic PI	
Aerides ringens (Lindl.) C.E.C.Fisch.			
Bulbophyllum neilgherrense Wight	Bendli	Endemic WG	
Cleisostoma tenuifolium (L.) Garay			
Conchidium microchilos (Dalzell) Rauschert		Endemic PI	
Cottonia peduncularis (Lindl.) Rchb.f.			
Cymbidium aloifolium (L.) Sw.			
Dendrobium barbatulum Lindl.		Endemic WG	
Gastrochilus flabelliformis (Blatt. & McCann) C.J.Saldanha		Endemic WG	
Habenaria diphylla (Nimmo) Dalzell			
Habenaria heyneana Lindl.		Endemic PI	
Habenaria longicorniculata J.Graham		Endemic PI	
Habenaria marginata Coleb.			
Habenaria multicaudata Sedgew.		Endemic WG	EN
Habenaria plantaginea Lindl.			
Liparis deflexa Hook.f.			
Liparis nervosa (Thunb.) Lindl.			
Luisia tenuifolia Blume		Endemic WG	
Malaxis versicolor (Lindl.) Abeyw.			
Nervilia aragoana Gaudich.			
Oberonia brachyphylla Blatt. & McCann		Endemic WG	VU
Pecteilis gigantea (J.E.Sm.) Raf.			
Peristylus plantagineus (Lindl.) Lindl.			
Pholidota imbricata Hook.			
Porpax jerdoniana (Wight) Rolfe		Endemic WG	
Porpax reticulata Lindl.			
Rhynchostylis retusa (L.) Blume			
Smithsonia viridiflora (Dalzell) C.J.Saldhanha			
Tropidia angulosa (Lindl.) Blume			
Vanda tessellata (Roxb.) Hook. ex G.Don			

Species / Family	Local name	Endemism	IUCN
Vanda testacea (Lindl.) Rchb.			
Zeuxine longilabris (Lindl) Trim			
OROBANCHACEAE			
Aeginetia indica L.			
OXALIDACEAE			
Biophytum sensitivum (L.) DC.			
Oxalis corniculata L.			
PANDANACEAE			
Pandanus odorifer (Forssk.) Kuntze			
PAPAVERACEAE			
Argemone mexicana L.			
PASSIFLORACEAE			
Adenia hondala (Gaertn.) J.Wilde	Salkando		
PEDALIACEAE			
Sesamum orientale L.			
PIPERACEACE			
Peperomia pellucida (L.) Humb.			
Piper argyrophyllum Miq.	Miri		
Piper nigrum L.			
PITTOSPORACEAE			
Pittosporum dasycaulon Miq.		Endemic WG	
POACEAE			
Apluda mutica L.			
Arundinella leptochloa (Nees ex Steud.) Hook.f.		Endemic PI	
Arundinella metzii Hocht ex Micq.		Endemic PI	
Arundinella pumila (Hochst. ex A.Rich.) Steud.			
Bambusa bambos (L.) Voss			
Brachiaria ramosa (L.) Stapf			
Capillipedium filiculme (Hook.f.) Stapf		Endemic PI	
Centotheca lappacea (L.) Desv.			
Cynodon dactylon (L.) Pers.			
Cyrtococcum oxyphyllum (Hochst. ex Steud.) Stapf			
Dendrocalamus strictus (Roxb.) Nees			
Dichanthium annulatum (Forssk.) Stapf			
Dimeria stapfiana C.E.Hubb. ex Pilger			
Echinochloa colona (L.) Link			
Eragrostis gangetica (Roxb.) Steud.			
Eragrostis unioloides (Retz.) Nees ex Steud.			
Eulalia trispicata (Schult.) Henrard			
Garnotia arborum Stapf. ex T.Cooke		Endemic PI	
Glyphochloa acuminata (Hack.) Clayton		Endemic WG	
Glyphochloa veldkampii M.A.Fonseca & Janarth.		Endemic Goa	CR
Isachne globosa (Thunb.) Kuntze			
Ischaemum barbatum Retz.			
Ischaemum dalzellii Stapf. ex Bor			

Species / Family	Local name	Endemism	IUCN
Ischaemum semisagittatum Roxb.			
Jansenella griffithiana (C.Muell.) Bor			
Ochlandra talboti Brandis			
Oplismenus burmanni (Retz.) P.Beauv.			
Oplismenus compositus (L.) P.Beauv.			
Panicum antidotle Retz.			
Paspalum canarae (Steud.) Veldk.			
Paspalum scrobiculatum L.			
Pennisetum pedicellatum Trin.			
Pennisetum polystachion (L.) Schult.			
Polytrias indica (Houtt.) Veldkamp			
Pseudanthistiria heteroclita (Roxb.) Hook.f.			
Pseudoxytenanthera stocksii (Munro) T.Q.Nguyen			
Sacciolepis indica (L.) A.Chase			
Setaria pumila (Poir.) Roem. & Schult.			
*Spodiopogon rhizo*phorus (Steud.) Pilger			
Themeda triandra Forssk.			
PODOSTEMACEAE			
Dalzellia ceylanica (Gardn.) Wight			
Zeylanidium sessile (Willis) C.D.K.Cook & Rutish.			
POLYGALACEAE			
Polygala elongata Klein ex Willd.		Endemic IND	
Salmonia ciliata (L.) DC.			
POLYGONACEAE			
Persicaria glabra (Willd.) M.Gomez			
Persicaria auriculata (Meissn.) S.K.Dixit, B.Datt & G.P.Roy			
Polygonum plebeium R.Br.			
PONTEDERIACEAE			
Monochoria vaginalis (Burm.f.) C.Presl			
PORTULACACEAE			
Portulaca oleracea L.	Gungune		
RANUNCULACEAE			
Clematis gauriana Roxb. ex DC.			
Naravelia zeylanica (L.) DC.			
RHIZOPHORACEAE			
Carallia brachiata (Lour.) Merr.	Phanshi		
RHAMNACEAE			
Gauania microcarpa DC.			
Scutia myrtina (Burm.f.) Kurz.			
Smythea bombaiensis (Dalzell) S.P.Banerjee & P.K.Mukh.		Endemic WG	
Ventilago denticulata Willd.		Endemic IND	
Ziziphus mauritiana Lam.			
Ziziphus oenoplia (L.) Mill.			
Ziziphus rugosa Lam.	Churan		
Ziziphus xylopyra (Retz.) Willd.			

Species / Family	Local name	Endemism	IUCN
RUBIACEAE			
Argostemma courtallense Arn.		Endemic WG	
Argostemma verticillatum Wall.			
Canthium rheedei DC.			
Catunaregam spinosa (Thunb.) Tirveng.	Gela		
Chassalia curviflora (Wall.) Thwaites var. *ophioxyloides* (Wall.) Deb & B.Krishna			
Discospermum sphaerocarpum Dalzell ex Hook.f.			EN
Haldina cordifolia (Roxb.) Ridsdale	Hedu		
Hedyotis auricularia L.			
Hedyotis corymbosa (L.) Lam.			
Hedyotis herbacea L.			
Hedyotis trinervia (Retz.) Roem. & Schult.			
Hymenodictyon obovatum Wall.		Endemic IND	
Ixora brachiata Roxb.		Endemic IND	
Ixora coccinia L.	Pentkul		
Ixora elongata B.Heyne ex G.Don			
Ixora malabarica (Dennst.) Mabb.			
Ixora nigricans R. Br. Wight & Arn.			
Meyna laxiflora Robyns			
Mitragyna parvifolia (Roxb.) Korth.			
Mussaenda glabrata (Hook.f.) Hutch. ex Gamble	Sharwad	Endemic PI	
Mussaenda laxa (Hook.f.) Hutch. ex Gamble	Sharwad	Endemic WI	
Neanotis rheedei (Wall. ex Wight & Arn.) W.H.Lewis		Endemic WG	
Neanotis subtilis (Miq.) Govaerts		Endemic WG	
Neolamarckia cadamba (Roxb.) Bosser	Kadamb		
Neonauclea purpurea (Roxb.) Merr.			
Ophiorrhiza rugosa Wall. var. *prostrata* (D. Don) Deb & D.C.Mondal			
Oxyceros rugulosus (Thw) Tirveng.			
Pavetta crassicaulis Bremek.			
Pavetta indica L. var. *tomentosa* (Roxb. ex Sm.) Hook.f.			
Psychotria dalzellii Hook.f.	Endi	Endemic WG	
Psydrax umbellata (Wight) Bridson	Tupya		
Rubia cordifolia L.			
Saprosma glomeratum (Gardn.) Bedd.		Endemic PI	
Spermacoce articularis L.			
Spermacoce ocymoides Burm.f.			
Spermacoce pusilla Wall.			
Tamilnadia uliginosa (Retz.) Tirveng. & Sastre			
Wendlandia thyrsoidea (Roth) Steud.		Endemic WG	
RUTACEAE			
Atlantia racemosa Wight	Malkadlimbi		
Atlantia wightii Tanaka		Endemic WG	
Glycosmis pentaphylla (Retz.) DC.	Menaka		
Luvunga eleutherandra Dalzell		Endemic WG	
Milicope lunu-ankenda (Gaertn.) T.G.Hartely			

Species / Family	Local name	Endemism	IUCN
Murraya koenigii (L.) Spreng.	Karpil		
Murraya paniculata Jack			
Paramigna monophylla Wight			
Toddalia asiatica (L.) Lam.			
Zanthoxylum rhetsa (Roxb.) DC.	Tirphal		
SANTALACEAE			
Osyris quadripartita Salzm. ex Decne.			
SAPINDACEAE			
Allophylus cobbe (L.) Raeusch.			
Dimocarus longan Lour.			
Harpullia arborea (Blanco) Radlk.			
Lepisanthus tetraphylla (Vahl) Radlk.			
Schleichera oleosa (Lour.) Oken	Koshim		
SAPOTACEAE			
Chrysophyllum roxburghii G.Don			
Mimusops elengi L.	Owal		
Palaquium ellipticum (Dalzell) Baill.			
Xantolis tomentosa (Roxb.) Raf.	Kumbal		
SCROPHULARIACEAE			
Angelonia gardneri Hook.			
Centranthera indica (L.) Gamble			
Dopatrium junceum (Roxb.) Buch.-Ham. ex Benth.			
Lindernia antipoda (L.) Alston.			
Lindernia caespitosa (Blume) Panigrahi			
Lindernia ciliata (Colsm.) Pennell			
Lindernia crustacea (L.) F. Muell.			
Lindernia multiflora (Roxb.) Mukerjee			
Lindernia oppositifolia (Retz.) Mukerjee			
Mecardonia procumbens (Mill.) Small			
Rhamphicarpa longiflora (Arn.) Benth.		Endemic WG	
Scoparia dulcis L.			
Striga asiatica (L.) Kuntze			
Striga gesnerioides (Willd.) Vatke ex Engl.			
Torenia indica C.J.Saldanha		Endemic WG	
Torenia violacea (Azaolo ex Blanco) Pennell			
SMILACACEAE			
Smilax zeylanica L.			
SOLANACEAE			
Lycianthes laevis (Dunal) Bitter			
Physalis minima L.			
Solanum anguivi Lam.			
STERCULIACEAE			
Helicteres isora L.	Kewan		
Melochia corchorifolia L.			
Pterospermum diversifolium Blume	Mothi Daman		

Species / Family	Local name	Endemism	IUCN
Sterculia guttata Roxb. *ex* DC.			
SYMPLOCACEAE			
Symplocos cochinchinensis (Lour.) S. Moore ssp. *laurina* (Retz.) Noot.			
Symplocos racemosa Roxb.			
THYMELAEACEAE			
Gnidia glauca (Fresen.) Gilg.			
TILIACEAE			
Corchorus capsularis L.			
Corchorus olitorius L.			
Grewia nervosa (Lour.) Panigrahi	Asoli, Chiwar		
Grewia serrulata DC.	Chopdi		
Grewia tillifolia Vahl	Dhaman		
Triumfetta rhomboidea Jacq.			
ULMACEAE			
Celtis timorensis Spanoghe			
Holoptelea integrifolia (Roxb.) Planch.	Wawal		
Trema orientalis (L.) Blume			
URTICACEAE			
Boehmeria macrophylla Hornem.			
Debregeasia longifolia (Burm.f.) Wedd.			
Laportea interrupta (L.) Chew			
Pilea microphylla (L.) Liebm.			
VERBENACEAE			
Lantana camara L.			
VISCACEAE			
Viscum monoicum Roxb. ex DC.			
VITACEAE			
Ampelocissus indica (L.) Planch.			
Amplelocissus latifolia (Roxb.) Planch.			
Caryatia tenuifolia (Wight and Arn.) Gagnep.			
Caryatia trifolia (L.) Domin			
Cissus elongata Roxb.			
Cissus javanica DC.			
Cissus rependa Vahl	Palkonde		
Cyphostemma auriculatum (Roxb.) P.Singh & B.V.Shetty			
Tetrastigma sulcatum (M.A.Lawson) Gamble			
ZINGIBERACEAE			
Alpinia galanga (L.) Willd.			
Curcuma decipiens Dalzell		Endemic PI	
Curcuma zanthorrhiza Roxb.			
Kaempferia scaposa (Nimmo) Benth.		Endemic WG	
Zingiber neesanum (J. Graham) Ramamoorthy		Endemic PI	
Zingiber nimmonii (J. Graham) Dalzell		Endemic PI	
Zingiber zerumbet (L.) Roscoe ex J.E.Sm.			

Appendix III. Checklist of mammal species in Bhagwan Mahavir Sanctuary derived from open-source lists, IUCN Red List database and field-guides on Indian mammals

	Order	Family	Species	Common name	IUCN Red List Category$	WPA schedule$
1	Carnivora	Felidae	*Panthera tigris*	Bengal Tiger	Endangered	I
2	Carnivora	Felidae	*Panthera pardus*	Common Leopard	Vulnerable	I
3	Carnivora	Felidae	*Prionailurus bengalensis*	Leopard Cat	Least Concern	I
4	Carnivora	Felidae	*Prionailurus rubiginosus*	Rusty-spotted Cat	Near Threatened	I
5	Carnivora	Felidae	*Felis chaus*	Jungle Cat	Least Concern	II
6	Carnivora	Canidae	*Cuon alpinus*	Dhole	Endangered	II
7	Carnivora	Canidae	*Canis aureus*	Golden Jackal	Least Concern	II
8	Carnivora	Ursidae	*Melursus ursinus*	Sloth Bear	Vulnerable	I
9	Carnivora	Herpestidae	*Herpestes/ Urva vitticollis*	Stripe-necked Mongoose	Least Concern	II
10	Carnivora	Herpestidae	*Herpestes/ Urva smithii*	Ruddy Mongoose	Least Concern	II
11	Carnivora	Herpestidae	*Urva edwardsii*	Indian Grey Mongoose	Least Concern	II
12	Carnivora	Mustelidae	*Aonyx cinereus*	Small-clawed Otter	Vulnerable	I
13	Carnivora	Mustelidae	*Lutrogale perspicillata*	Smooth-coated Otter	Vulnerable	II
14	Carnivora	Viverridae	*Viverricula indica*	Small Indian Civet	Least Concern	II
15	Carnivora	Viverridae	*Paradoxurus jerdoni*	Brown Palm Civet	Least Concern	II
16	Carnivora	Viverridae	*Paradoxurus hermaphroditus*	Common Palm Civet	Least Concern	II
17	Cetartiodactyla	Bovidae	*Bos gaurus*	Gaur	Vulnerable	I
18	Cetartiodactyla	Bovidae	*Tetracerus quadricornis*	Four-horned antelope	Vulnerable	I
19	Cetartiodactyla	Cervidae	*Rusa unicolor*	Sambar	Vulnerable	III
20	Cetartiodactyla	Cervidae	*Axis axis*	Chital	Least Concern	III
21	Cetartiodactyla	Cervidae	*Muntiacus vaginalis*	Northern Red Muntjac	Least Concern	III
22	Cetartiodactyla	Tragulidae	*Moschiola indica*	Indian Chevrotain/ Mouse deer	Least Concern	I
23	Cetartiodactyla	Suidae	*Sus scrofa*	Wild Boar	Least Concern	III
24	Pholidota	Manidae	*Manis crassicaudata*	Indian Pangolin	Endangered	I
25	Primates	Cercopithecidae	*Semnopithecus hypoleucos*	Black-footed Gray Langur	Vulnerable	II
26	Primates	Cercopithecidae	*Macaca radiata*	Bonnet Macaque	Least Concern	II
27	Primates	Lorisidae	*Loris lydekkerianus*	Slender Loris	Least Concern	I
28	Lagomorpha	Leporidae	*Lepus nigricollis*	Indian Hare	Least Concern	IV
29	Rodentia	Sciuridae	*Ratufa indica*	Indian Giant Squirrel	Least Concern	II
30	Rodentia	Sciuridae	*Petaurista philippensis*	Indian Giant Gliding Squirrel	Least Concern	II
31	Rodentia	Sciuridae	*Funambulus tristriatus*	Western Ghats Striped Squirrel	Least Concern	IV[a]
32	Rodentia	Sciuridae	*Funambulus palmarum*	Common Palm Squirrel	Least Concern	IV[a]
33	Rodentia	Hystricidae	*Hystrix indica*	Indian Crested Porcupine	Least Concern	IV
34	Rodentia	Muridae	*Tatera indica*	Indian Gerbil	Least Concern	V[b]
35	Rodentia	Muridae	*Vandeleuria oleracea*	Asiatic Long-tailed Climbing Mouse	Least Concern	V[b]
36	Rodentia	Muridae	*Mus musculus*	House Mouse	Least Concern	V[b]
37	Rodentia	Muridae	*Mus booduga*	Indian Field Mouse	Least Concern	V[b]
38	Rodentia	Muridae	*Mus saxicola*	Brown Spiny Mouse	Least Concern	V[b]
39	Rodentia	Muridae	*Mus terricolor**	Pygmy Field Mouse	Least Concern	V[b]
40	Rodentia	Muridae	*Millardia meltada**	Soft-furred Metad	Least Concern	V[b]
41	Rodentia	Muridae	*Madromys blanfordi*	White-tailed Wood Rat	Least Concern	V[b]
42	Rodentia	Muridae	*Golunda ellioti*	Indian Bush-rat	Least Concern	V[b]
43	Rodentia	Muridae	*Bandicota indica*	Greater Bandicoot Rat	Least Concern	V[b]
44	Rodentia	Muridae	*Bandicota bengalensis*	Lesser Bandicoot Rat	Least Concern	V[b]
45	Rodentia	Muridae	*Rattus rattus*	House Rat	Least Concern	V[b]
46	Rodentia	Muridae	*Rattus satarae**	Sahyadris Forest Rat	Vulnerable	V[b]

	Order	Family	Species	Common name	IUCN Red List Category$	WPA schedule$
47	Chiroptera	Pteropodidae	*Pteropus medius*	Indian Flying Fox Bat	Least Concern	V[b]
48	Chiroptera	Pteropodidae	*Rousettus leschenaultii*	Leschenault's Rousette	Least Concern	V[b]
49	Chiroptera	Pteropodidae	*Cynopterus sphinx*	Greater Short-nosed Fruit Bat	Least Concern	V[b]
50	Chiroptera	Pteropodidae	*Cynopterus brachyotis*	Lesser Short-nosed Fruit Bat	Least Concern	V[b]
51	Chiroptera	Pteropodidae	*Eonycteris spelaea**	Dawn Bat	Least Concern	V[b]
52	Chiroptera	Molossidae	*Tadarida aegyptiaca**	Egyptian Free-tailed Bat	Least Concern	
53	Chiroptera	Molossidae	*Chaerephon plicatus**	Wrinkle-lipped Free-tailed Bat	Least Concern	
54	Chiroptera	Molossidae	Otomops wroughtoni*	Wroughton's Free-tailed Bat	Data Deficient	I
55	Chiroptera	Emballonuridae	*Taphozous longimanus**	Long-winged Tomb Bat	Least Concern	
56	Chiroptera	Emballonuridae	*Taphozous nudiventris**	Naked-rumped Tomb Bat	Least Concern	
57	Chiroptera	Emballonuridae	*Taphozous melanopogon*	Black-bearded Tomb Bat	Least Concern	
58	Chiroptera	Emballonuridae	*Taphozous theobaldi**	Theobold's Bat	Least Concern	
59	Chiroptera	Emballonuridae	*Saccolaimus saccolaimus**	Bare-rumped Sheathtail Bat	Least Concern	
60	Chiroptera	Megadermatidae	*Megaderma lyra**	Greater False Vampire Bat	Least Concern	
61	Chiroptera	Megadermatidae	*Megaderma spasma*	Lesser False Vampire Bat	Least Concern	
62	Chiroptera	Rhinolophidae	*Rhinolophus rouxii*	Rufous Horseshoe Bat	Least Concern	
63	Chiroptera	Rhinolophidae	*Rhinolophus lepidus*	Blyth's Horseshoe Bat	Least Concern	
64	Chiroptera	Rhinolophidae	*Rhinolophus beddomei*	Beddome's Horseshoe Bat	Least Concern	
65	Chiroptera	Hipposideridae	*Hipposideros fulvus**	Fulvus Leaf-nosed Bat	Least Concern	
66	Chiroptera	Hipposideridae	*Hipposideros speoris**	Schneider's Leaf-nosed Bat	Least Concern	
67	Chiroptera	Hipposideridae	*Hipposideros galeritus**	Cantor's Leaf-nosed Bat	Least Concern	
68	Chiroptera	Hipposideridae	*Hipposideros lankadiva*	Kelaart's Leaf-nosed Bat	Least Concern	
69	Chiroptera	Vespertilionidae	*Myotis horsfieldii**	Horsfield's Bat	Least Concern	
70	Chiroptera	Vespertilionidae	*Pipistrellus coromandra*	Indian Pipistrelle	Least Concern	
71	Chiroptera	Vespertilionidae	*Pipistrellus tenuis*	Least Pipistrelle	Least Concern	
72	Chiroptera	Vespertilionidae	*Pipistrellus ceylonicus**	Kelaart's Pipistrelle	Least Concern	
73	Chiroptera	Vespertilionidae	*Scotozous dormeri**	Dormer's Bat	Least Concern	
74	Chiroptera	Vespertilionidae	*Scotophilus heathii**	Greater Asiatic Yellow Bat	Least Concern	
75	Chiroptera	Vespertilionidae	*Scotophilus kuhlii**	Lesser Asiatic Yellow Bat	Least Concern	
76	Chiroptera	Vespertilionidae	*Hesperoptenus tickelli**	Tickell's Bat	Least Concern	
77	Chiroptera	Vespertilionidae	*Kerivoula picta*	Painted Bat	Near Threatened	
78	Chiroptera	Vespertilionidae	*Tylonycteris pachypus**	Lesser Bamboo Bat	Least Concern	
79	Chiroptera	Miniopteridae	*Miniopterus schreibersii* ssp. *fuliginosus*	Schreiber's Long-fingered Bat	Near Threatened	
80	Eulipotyphla	Soricidae	*Suncus murinus*	House Shrew	Least Concern	
81	Scandentia	Tupaiidae	*Anathana ellioti*	Madras Tree Shrew	Least Concern	

*Possible occurrence; [a] Five-striped palm squirrel mentioned in Schedule IV; [b]Fruit Bats, Mice, & Rats mentioned in Schedule V; $Distribution records follow IUCN Range maps and Menon (2014).

Appendix IV. List of fish species in the Mhadei sub-basin (neighbouring Bhagwan Mahavir Wildlife Sanctuary), with status in terms of endemicity to the Western Ghats and IUCN Red List (Atkore 2017).

	Species	Western Ghats Endemic	IUCN status
1.	*Aplocheilus lineatus* (Valenciennes, 1846)		Least Concern
2.	*Arothron leopardus* (Day, 1878)		Data Deficient
3.	*Carinotetraodon travancoricus* (Hora & Nair, 1941)	Endemic	Vulnerable
4.	*Chanda nama* Hamilton, 1822		Least Concern
5.	*Channa gachua* (Hamilton, 1822)		Least Concern
6.	*Channa marulius* (Hamilton, 1822)		Least Concern
7.	*Channa striata* (Bloch, 1793)		Least Concern
8.	*Dawkinsia filamentosa* (Valenciennes, 1844)	Endemic	Least Concern
9.	*Devario spp*		
10.	*Devario malabaricus* (Jerdon, 1849)		Least Concern
11.	*Etroplus suratensis* (Bloch, 1790)		Least Concern
12.	*Garra bicornuta* Narayan Rao, 1920	Endemic	Near Threatened
13.	*Garra mullya* (Sykes, 1839)		Least Concern
14.	*Garra stenorhynchus* (Jerdon, 1849)		Least Concern
15.	*Glossogobius giuris* (Hamilton, 1822)		Least Concern
16.	*Glossogobius* spp.		
17.	*Haludaria melanampyx* (Day, 1865)	Endemic	Data Deficient
18.	*Hypselobarbus curmuca* (Hamilton, 1807)	Endemic	Endangered
19.	*Hypselobarbus dobsoni* (Day, 1876)	Endemic	Data Deficient
20.	*Hypselobarbus jerdoni* (Day, 1870)	Endemic	Least Concern
21.	*Lepidocephalichthys thermalis* (Valenciennes 1846)		Least Concern
22.	*Mastacembelus armatus* (Lacépède, 1800)		Least Concern
23.	*Microphis cuncalus* (Hamilton, 1822)*		Least Concern
24.	*Mystus armatus* (Day, 1865)		Least Concern
25.	*Mystus cavasius* (Hamilton, 1822)		Least Concern
26.	*Mystus gulio* (Hamilton, 1822)		Least Concern
27.	*Mystus keletius* (Valenciennes, 1840)	Endemic	Least Concern
28.	*Migul* spp.		
29.	*Osteochilichthys nashii* (Day, 1869)	Endemic	Least Concern
30.	*Osteochilichthys thomassi* (Day, 1877)	Endemic	Least Concern
31.	*Parambassis ranga* (Hamilton, 1822)		Least Concern
32.	*Paracanthocobitis mooreh* (Sykes, 1839)	Endemic	
33.	*Pangio goaensis* (Tilak, 1972)*	Endemic	Least Concern
34.	*Pethia narayani* (Hora, 1937)	Endemic	Least Concern
35.	*Pethia punctata* (Day, 1865)	Endemic	Least Concern
36.	*Pethia setnai* (Chhapgar & Sane, 1992)	Endemic	Vulnerable
37.	*Pethia ticto* (Hamilton, 1822)		Least Concern
38.	*Pseudetroplus maculatus* (Bloch, 1795)		Least Concern
39.	*Puntius amphibius* (Valenciennes, 1842)		Data Deficient
40.	*Rasbora daniconius* (Hamilton, 1822)		Least Concern
41.	*Rasbora labiosa* Mukerji, 1935	Endemic	Least Concern
42.	*Salmostoma bacaila* (Hamilton, 1822)		Least Concern
43.	*Salmostoma boopis* (Day, 1874)		Least Concern
44.	*Salmostoma novacula* (Valenciennes, 1840)		Least Concern
45.	*Schistura denisoni* (Day, 1867)		Least Concern
46.	*Schistura* spp.		
47.	*Sicyopterus griseus* (Day, 1877)	Endemic	Least Concern
48.	*Tor khudree* (Sykes, 1839)	Endemic	Least Concern
49.	*Xenentodon cancila* (Hamilton, 1822)		Least Concern

* Recorded by other researchers in the Mhadei sub-basin | *Pangio goaensis* recorded by Talwar & Jhingran (1991); *Microphis cuncalus* likely occurs based on Pollom (2016)

Appendix V. Checklist of butterfly species in Bhagwan Mahavir Wildlife Sanctuary and National Park.

	Order	Family	Common name	Scientific name	WPA Schedule
1	Lepidoptera	Papilionidae	Southern Birdwing	*Troides minos*	
2	Lepidoptera	Papilionidae	Malabar Or Ceylon Rose	*Pachliopta pandiyana*	
3	Lepidoptera	Papilionidae	Common Rose	*Pachliopta aristolochiae*	
4	Lepidoptera	Papilionidae	Crimson Rose	*Pachliopta hector*	I
5	Lepidoptera	Papilionidae	Southern Bluebottle *	*Graphium teredon*	
6	Lepidoptera	Papilionidae	Common Jay	*Graphium doson*	
7	Lepidoptera	Papilionidae	Tailed Jay	*Graphium agamemnon*	
8	Lepidoptera	Papilionidae	Spot Swordtail	*Graphium nomius*	
9	Lepidoptera	Papilionidae	Five-Bar Swordtail *	*Graphium antiphates*	
10	Lepidoptera	Papilionidae	Common Mime	*Papilio clytia*	I
11	Lepidoptera	Papilionidae	Lime	*Papilio demoleus*	
12	Lepidoptera	Papilionidae	Malabar Raven	*Papilio dravidarum*	
13	Lepidoptera	Papilionidae	Red Helen	*Papilio helenus*	
14	Lepidoptera	Papilionidae	Common Mormon	*Papilio polytes*	
15	Lepidoptera	Papilionidae	Blue Mormon	*Papilio polymnestor*	
16	Lepidoptera	Papilionidae	Paris Peacock	*Papilio paris*	
17	Lepidoptera	Papilionidae	Malabar Banded Peacock	*Papilio budha*	
18	Lepidoptera	Pieridae	Common Emigrant *	*Catopsilia pomona*	
19	Lepidoptera	Pieridae	Mottled Emigrant	*Catopsilia pyranthe*	
20	Lepidoptera	Pieridae	Small Grass Yellow	*Eurema brigitta*	
21	Lepidoptera	Pieridae	Spotless Grass Yellow	*Eurema laeta*	
22	Lepidoptera	Pieridae	Common Grass Yellow	*Eurema hecabe*	
23	Lepidoptera	Pieridae	Three-Spot Grass Yellow	*Eurema blanda*	
24	Lepidoptera	Pieridae	One-Spot Grass Yellow *	*Eurema andersonii*	II
25	Lepidoptera	Pieridae	Common Jezebel	*Delias eucharis*	
26	Lepidoptera	Pieridae	Psyche	*Leptosia nina*	
27	Lepidoptera	Pieridae	Common Gull	*Cepora nerissa*	
28	Lepidoptera	Pieridae	Lesser Gull	*Cepora nadina*	II
29	Lepidoptera	Pieridae	Pioneer Or Caper White	*Anaphaeis aurota*	
30	Lepidoptera	Pieridae	Plain Puffin *	*Appias indra*	II
31	Lepidoptera	Pieridae	Chocolate Albatross *	*Appias lyncida*	II
32	Lepidoptera	Pieridae	Common Albatross	*Appias albina*	II
33	Lepidoptera	Pieridae	Common Wanderer	*Pareronia valeria*	II
34	Lepidoptera	Pieridae	Dark Wanderer	*Pareronia ceylonica*	
35	Lepidoptera	Pieridae	Great Orange Tip	*Hebomoia glaucippe*	
36	Lepidoptera	Nymphalidae	Southern Duffer *	*Discophora lepida*	II
37	Lepidoptera	Nymphalidae	Common Evening Brown	*Melanitis leda*	
38	Lepidoptera	Nymphalidae	Great Evening Brown *	*Melanitis zitenius*	II
39	Lepidoptera	Nymphalidae	Dark Evening Brown	*Melanitis phedima*	
40	Lepidoptera	Nymphalidae	Common Palmfly	*Elymnias hypermenstra*	
41	Lepidoptera	Nymphalidae	Bamboo Treebrown *	*Lethe europa*	
42	Lepidoptera	Nymphalidae	Tamil Treebrown	*Lethe drypetis*	
43	Lepidoptera	Nymphalidae	Common Treebrown	*Lethe rohria*	
44	Lepidoptera	Nymphalidae	Common Bushbrown	*Mycalesis perseus*	

	Order	Family	Common name	Scientific name	WPA Schedule
45	Lepidoptera	Nymphalidae	Dark Branded Bushbrown *	*Mycalesis mineus*	
46	Lepidoptera	Nymphalidae	Gladeye Bushbrown	*Mycalesis patnia*	
47	Lepidoptera	Nymphalidae	Medus Brown	*Orsotrianea medus*	
48	Lepidoptera	Nymphalidae	Common Three-ring *	*Ypthima asterope*	
49	Lepidoptera	Nymphalidae	White Or Ceylon Four-ring *	*Ypthima ceylonica*	
50	Lepidoptera	Nymphalidae	Common Four-ring	*Ypthima huebneri*	
51	Lepidoptera	Nymphalidae	Common Five-ring	*Ypthima baldus*	
52	Lepidoptera	Nymphalidae	Common Nawab *	*Polyura athamas*	II
53	Lepidoptera	Nymphalidae	Anomalous Nawab *	*Polyura agraria*	
54	Lepidoptera	Nymphalidae	Blue Nawab *	*Polyura schreiberi*	I
55	Lepidoptera	Nymphalidae	Tawny Rajah	*Charaxes bernardus*	II
56	Lepidoptera	Nymphalidae	Black Rajah *	*Charaxes solon*	II
57	Lepidoptera	Nymphalidae	Tawny Coster	*Acraea violae*	
58	Lepidoptera	Nymphalidae	Tamil Lacewing	*Cethosia nietneri*	
59	Lepidoptera	Nymphalidae	Cruiser	*Vindula erota*	
60	Lepidoptera	Nymphalidae	Rustic	*Cupha erymanthis*	
61	Lepidoptera	Nymphalidae	Common Leopard	*Phalanta phalantha*	
62	Lepidoptera	Nymphalidae	Small Leopard	*Phalanta alcippe*	II
63	Lepidoptera	Nymphalidae	Tamil Yeoman	*Cirrochroa thais*	
64	Lepidoptera	Nymphalidae	Black Prince *	*Rohana parisatis*	
65	Lepidoptera	Nymphalidae	Painted Courtesan *	*Euripus consimilis*	II
66	Lepidoptera	Nymphalidae	Chestnut-Streaked Sailer	*Neptis jumbah*	
67	Lepidoptera	Nymphalidae	Common Sailer	*Neptis hylas*	
68	Lepidoptera	Nymphalidae	Clear Sailer *	*Neptis nata*	II
69	Lepidoptera	Nymphalidae	Shortbanded Sailer *	*Neptis columella*	I
70	Lepidoptera	Nymphalidae	Yellow Jack Sailer	*Neptis viraja*	
71	Lepidoptera	Nymphalidae	Common Lascar	*Pantoporia hordonia*	
72	Lepidoptera	Nymphalidae	Extra Lascar *	*Pantoporia sandaka*	
73	Lepidoptera	Nymphalidae	Colour Sergeant	*Athyma nefte*	
74	Lepidoptera	Nymphalidae	Staff Sergeant *	*Athyma selenophora*	II
75	Lepidoptera	Nymphalidae	Blackvein Sergeant	*Athyma ranga*	
76	Lepidoptera	Nymphalidae	Common Sergeant	*Athyma perius*	
77	Lepidoptera	Nymphalidae	Commander	*Limenitis procris*	
78	Lepidoptera	Nymphalidae	Clipper	*Parthenos sylvia*	II
79	Lepidoptera	Nymphalidae	Grey Count	*Tanaecia lepidea*	II
80	Lepidoptera	Nymphalidae	Common Baron	*Euthalia aconthea*	II
81	Lepidoptera	Nymphalidae	Gaudy Baron	*Euthalia lubentina*	IV
82	Lepidoptera	Nymphalidae	Redspot Duke *	*Dolpha evelina*	II
83	Lepidoptera	Nymphalidae	Angled Castor	*Ariadne ariadne*	
84	Lepidoptera	Nymphalidae	Common Castor	*Ariadne merione*	
85	Lepidoptera	Nymphalidae	Common Map	*Cyrestis thyodamas*	
86	Lepidoptera	Nymphalidae	Club Beak *	*Libythea myrrha*	
87	Lepidoptera	Nymphalidae	Yellow Pansy	*Junonia hierta*	
88	Lepidoptera	Nymphalidae	Lemon Pansy	*Junonia lemonias*	
89	Lepidoptera	Nymphalidae	Peacock Pansy	*Junonia almana*	

	Order	Family	Common name	Scientific name	WPA Schedule
90	Lepidoptera	Nymphalidae	Grey Pansy	*Junonia atlites*	
91	Lepidoptera	Nymphalidae	Chocolate Pansy	*Junonia iphita*	
92	Lepidoptera	Nymphalidae	Painted Lady *	*Cynthia cardui*	
93	Lepidoptera	Nymphalidae	Great Eggfly	*Hypolimnas bolina*	
94	Lepidoptera	Nymphalidae	Danaid Eggfly	*Hypolimnas misippus*	I and II
95	Lepidoptera	Nymphalidae	Autumn leaf (Malabar)	*Doleschallia bisaltide malabarica*	II
96	Lepidoptera	Nymphalidae	South Indian Blue Oakleaf	*Kallima horsfieldi*	II
97	Lepidoptera	Nymphalidae	Glassy Tiger	*Parantica aglea*	II
98	Lepidoptera	Nymphalidae	Blue Tiger	*Tirumala limniace*	
99	Lepidoptera	Nymphalidae	Dark Blue Tiger *	*Tirumala septentrionis*	
100	Lepidoptera	Nymphalidae	Plain Tiger	*Danaus chrysippus*	
101	Lepidoptera	Nymphalidae	Striped Or Common Tiger	*Danaus genutia*	
102	Lepidoptera	Nymphalidae	Common Indian Crow	*Euploea core*	
103	Lepidoptera	Nymphalidae	Double-Branded Crow *	*Euploea sylvester*	
104	Lepidoptera	Nymphalidae	Brown King Crow *	*Euploea klugii*	
105	Lepidoptera	Nymphalidae	Malabar Tree Nymph	*Idea malabarica*	
106	Lepidoptera	Riodinidae	Double-Banded Judy *	*Abisara albofasciatus*	
107	Lepidoptera	Lycaenidae	Apefly *	*Spalgis epius*	
108	Lepidoptera	Lycaenidae	Common Pierrot	*Castalius rosimon*	I
109	Lepidoptera	Lycaenidae	Angled Pierrot	*Caleta caleta*	
110	Lepidoptera	Lycaenidae	Banded Blue Pierrot	*Discolampa ethion*	
111	Lepidoptera	Lycaenidae	Dark Pierrot	*Tarucus ananda*	IV
112	Lepidoptera	Lycaenidae	Spotted Pierrot *	*Tarucus nara*	
113	Lepidoptera	Lycaenidae	Zebra Blue *	*Leptotes plinius*	
114	Lepidoptera	Lycaenidae	Common Hedge Blue	*Acytolepis puspa*	I
115	Lepidoptera	Lycaenidae	Plain Hedge Blue *	*Celastrina lavendularis*	
116	Lepidoptera	Lycaenidae	Quaker	*Neopithecops zalmora*	
117	Lepidoptera	Lycaenidae	Malayan	*Magisba malaya*	
118	Lepidoptera	Lycaenidae	Dark Grass Blue	*Zizeeria karsandra*	
119	Lepidoptera	Lycaenidae	Lesser Grass Blue	*Zizina otis*	
120	Lepidoptera	Lycaenidae	Tiny Grass Blue	*Zizula hylax*	
121	Lepidoptera	Lycaenidae	Lime Blue	*Chilades laius*	II
122	Lepidoptera	Lycaenidae	Plains Cupid	*Chilades pandava*	
123	Lepidoptera	Lycaenidae	Grass Jewel *	*Freyeria trochylus*	
124	Lepidoptera	Lycaenidae	Gram Blue	*Euchrysops cnejus*	II
125	Lepidoptera	Lycaenidae	Forget-Me-Not	*Catochrysops strabo*	
126	Lepidoptera	Lycaenidae	Pea Blue *	*Lampides boeticus*	II
127	Lepidoptera	Lycaenidae	Dark Cerulean *	*Jamides bochus*	
128	Lepidoptera	Lycaenidae	Common Cerulean	*Jamides celeno*	
129	Lepidoptera	Lycaenidae	Metallic Cerulean *	*Jamides alecto*	
130	Lepidoptera	Lycaenidae	Large 4-Line Blue *	*Nacaduba pactolus*	II
131	Lepidoptera	Lycaenidae	Pale 4-Line Blue *	*Nacaduba hermus*	
132	Lepidoptera	Lycaenidae	Transparent 6-Line Blue *	*Nacaduba kurava*	
133	Lepidoptera	Lycaenidae	Opaque 6-Line Blue *	*Nacaduba beroe*	
134	Lepidoptera	Lycaenidae	Common Line Blue *	*Prosotas nora*	

	Order	Family	Common name	Scientific name	WPA Schedule
135	Lepidoptera	Lycaenidae	Tailless Line Blue *	*Prosotas dubiosa*	
136	Lepidoptera	Lycaenidae	Dingy Line Blue *	*Petrolaea dana*	
137	Lepidoptera	Lycaenidae	White-Tipped Line Blue *	*Prosotas noreia*	
138	Lepidoptera	Lycaenidae	Red Pierrot	*Talicada nyseus*	
139	Lepidoptera	Lycaenidae	Common Ciliate Blue *	*Anthene emolus*	
140	Lepidoptera	Lycaenidae	Pointed Ciliate Blue	*Anthene lycaenina*	
141	Lepidoptera	Lycaenidae	Western Centaur Oakblue *	*Arhopala pseudocentaurus*	
142	Lepidoptera	Lycaenidae	Large Oakblue	*Arhopala amantes*	
143	Lepidoptera	Lycaenidae	Rosy Or Kanara Oakblue *	*Arhopala alea*	I
144	Lepidoptera	Lycaenidae	Aberrant Oakblue *	*Arohopala abseus*	
145	Lepidoptera	Lycaenidae	Tamil Oakblue	*Arhopala bazaloides*	
146	Lepidoptera	Lycaenidae	Common Acacia Blue *	*Surendra quercetorum Surendra*	
147	Lepidoptera	Lycaenidae	Silverstreaked Acacia Blue *	*Zinaspa todara*	II
148	Lepidoptera	Lycaenidae	Silverstreak Blue	*Iraota timoleon*	
149	Lepidoptera	Lycaenidae	Leaf Blue	*Amblypodia anita*	
150	Lepidoptera	Lycaenidae	Common Silverline	*Spindasis vulcanus*	
151	Lepidoptera	Lycaenidae	Longbanded Silverline *	*Spindasis lohita*	II
152	Lepidoptera	Lycaenidae	Yamfly *	*Loxura atymnus*	
153	Lepidoptera	Lycaenidae	Common Imperial	*Cheritra freja*	
154	Lepidoptera	Lycaenidae	Monkey Puzzle	*Rathinda amor*	
155	Lepidoptera	Lycaenidae	Redspot *	*Zesius chrysomallus*	
156	Lepidoptera	Lycaenidae	Silver Royal *	*Ancema blanka*	
157	Lepidoptera	Lycaenidae	Broadtail Royal *	*Creon cleobis*	
158	Lepidoptera	Lycaenidae	White Royal *	*Pratapa deva*	II
159	Lepidoptera	Lycaenidae	Peacock Royal *	*Tajuria cippus*	II
160	Lepidoptera	Lycaenidae	Orchid Tit *	*Hypolycaena othona*	I
161	Lepidoptera	Lycaenidae	Fluffy Tit *	*Zeltus amasa*	
162	Lepidoptera	Lycaenidae	Cornelian *	*Deudorix epijarbas*	
163	Lepidoptera	Lycaenidae	Common Guava Blue *	*Deudorix isocrates*	
164	Lepidoptera	Lycaenidae	Large Guava Blue *	*Deudorix perse*	
165	Lepidoptera	Lycaenidae	Plane *	*Bindahara phocides*	II
166	Lepidoptera	Lycaenidae	Indian Red Flash *	*Rapala iarbus*	
167	Lepidoptera	Lycaenidae	Slate Flash	*Rapala manea*	
168	Lepidoptera	Lycaenidae	Indigo Flash *	*Rapala varuna*	II
169	Lepidoptera	Lycaenidae	Indian Sunbeam	*Curetis thetis*	
170	Lepidoptera	Lycaenidae	Shiva Sunbeam *	*Curetis siva*	
171	Lepidoptera	Lycaenidae	Malabar Flash *	*Rapala lankana*	
172	Lepidoptera	Lycaenidae	Common Onyx	*Horaga onyx*	II
173	Lepidoptera	Hesperiidae	Orange-Striped Awl/Orange Awlet *	*Burara jaina*	
174	Lepidoptera	Hesperiidae	Orangetail Awl/Pale Green Awlet *	*Bibasis sena*	II
175	Lepidoptera	Hesperiidae	Common Banded Awl *	*Hasora chromus*	
176	Lepidoptera	Hesperiidae	White Banded Awl *	*Hasora taminatus*	
177	Lepidoptera	Hesperiidae	Common Awl *	*Hasora badra*	
178	Lepidoptera	Hesperiidae	Brown Awl	*Badamia exclamationis*	

	Order	Family	Common name	Scientific name	WPA Schedule
179	Lepidoptera	Hesperiidae	Common Spotted Flat	*Celaenorrhinus leucocera*	
180	Lepidoptera	Hesperiidae	Malabar Spotted Flat *	*Celaenorrhinus ambareesa*	
181	Lepidoptera	Hesperiidae	Tamil Spotted Flat *	*Celaenorrhinus ruficornis*	
182	Lepidoptera	Hesperiidae	Common/Ceylon Snow Flat *	*Tagiades jepetus*	
183	Lepidoptera	Hesperiidae	Water Snow Flat	*Tagiades litigiosa*	
184	Lepidoptera	Hesperiidae	Fulvous Pied Flat	*Psuedocoladenia dan*	
185	Lepidoptera	Hesperiidae	Tricolour Flat	*Psuedocoladenia indrana*	
186	Lepidoptera	Hesperiidae	Common Small Flat	*Sarangesa dasahara*	
187	Lepidoptera	Hesperiidae	Spotted Small Flat *	*Sarangesa purendra*	
188	Lepidoptera	Hesperiidae	Angled Flat/Black Angle	*Tapena twaithesi*	
189	Lepidoptera	Hesperiidae	Golden Angle	*Odontoptilum ransonnetti*	
190	Lepidoptera	Hesperiidae	Indian Grizzled/Indian Skipper *	*Spialia galba*	
191	Lepidoptera	Hesperiidae	Pygmy Grass-/Scrub-Hopper *	*Aeromachus pygmaeus*	
192	Lepidoptera	Hesperiidae	Bush Hopper *	*Ampittia dioscorides*	
193	Lepidoptera	Hesperiidae	Indian Ace *	*Halpe homolea*	II
194	Lepidoptera	Hesperiidae	Madras Ace	*Thoressa honorei*	IV
195	Lepidoptera	Hesperiidae	Moore's Ace *	*Halpe porus*	
196	Lepidoptera	Hesperiidae	Chestnut Bob	*Lambrix salsala*	
197	Lepidoptera	Hesperiidae	Coon	*Psolos fuligo*	
198	Lepidoptera	Hesperiidae	Common Banded Demon	*Notocrypta paralysos*	
199	Lepidoptera	Hesperiidae	Restricted Demon	*Notocrypta curvifascia*	
200	Lepidoptera	Hesperiidae	Grass Demon	*Udaspes folus*	
201	Lepidoptera	Hesperiidae	Indian Palm Bob *	*Suastus gremius*	
202	Lepidoptera	Hesperiidae	Tree Flitter *	*Hyarotis adrastus*	IV
203	Lepidoptera	Hesperiidae	Giant Redeye	*Gangara thyrsis*	
204	Lepidoptera	Hesperiidae	Common Redeye *	*Matapa aria*	
205	Lepidoptera	Hesperiidae	Tamil Grass Dart	*Taractrocera ceramas*	
206	Lepidoptera	Hesperiidae	Pale Palm Dart *	*Telicota colon*	
207	Lepidoptera	Hesperiidae	Plain Palm Dart *	*Cephrenes acalle*	
208	Lepidoptera	Hesperiidae	African Straight/Straight Swift *	*Parnara naso*	
209	Lepidoptera	Hesperiidae	Bevan's Swift *	*Borbo bevani*	
210	Lepidoptera	Hesperiidae	Dark Small-Branded Swift *	*Pelopidas mathias*	
211	Lepidoptera	Hesperiidae	Conjoined Swift *	*Pelopidas conjucta*	
212	Lepidoptera	Hesperiidae	Paintbrush Swift *	*Baoris farri*	IV
213	Lepidoptera	Hesperiidae	Blank Swift *	*Caltoris kumara*	
214	Lepidoptera	Hesperiidae	Philippine Swift *	*Caltoris philippina*	II
215	Lepidoptera	Hesperiidae	Maculate Lancer *	*Salanoemia sala*	
216	Lepidoptera	Hesperiidae	Small Palm Bob *	*Suastus minutus*	
217	Lepidoptera	Hesperiidae	Wax Dart *	*Cupitha purreea*	
218	Lepidoptera	Hesperiidae	Common Dartlet	*Oriens goloides*	

Source: India Biodiversity Portal (https://indiabiodiversity.org/checklist/show/228); Rangnekar & Dharwadkar (2009); *Direct Sightings by Parag Rangnekar, Omkar Dharwadkar & Ravindra Bhambure

Appendix VI. Odonates of Bhagwan Mahavir Wildlife Sanctuary and National Park.

	Common name	Scientific name	Family	IUCN status	Western Ghat Endemism
1	Pale Dartlet	*Agriocnemis pieris*	Coenagrionidae		
2	Pygmy Dartlet	*Agriocnemis pygmea*	Coenagrionidae		
3	Splendid Dartlet	*Agriocnemis splendissima*	Coenagrionidae		
4	Orange-tailed Marsh Dart	*Ceriagrion cerinorubellum*	Coenagrionidae		
5	Coromandel Marsh Dart	*Ceriagrion coromandelianum*	Coenagrionidae		
6	Rusty Marsh Dart	*Ceriagrion olivaceum*	Coenagrionidae		
7	Sindhudurg Marsh Dart	*Ceriagrion chromothorax*	Coenagrionidae		
8	Rusty Marsh Dart	*Ceriagrion olivaceum*	Coenagrionidae		
9	Golden Dartlet	*Ischnura rubilio*	Coenagrionidae		
10	Pygmy Bluespot	*Mortonagrion varralli*	Coenagrionidae		Endemic
11	Yellow-striped Blue Dart	*Pseudagrion indicum*	Coenagrionidae		Endemic
12	Saffron-faced Blue Dart	*Pseudagrion rubriceps*	Coenagrionidae		
13	Yellow Bush Dart	*Copera marginipes*	Platycenemididae		
14	Blue Bush Dart	*Copera vittata*	Platycenemididae		
15	Pied Reedtail	*Protosticta gravelyi*	Platystictidae		Endemic
16	Red-spot Reedtail	*Protosticta sanguinostigma*	Platystictidae	Vulnerable	Endemic
17	Black Bambootail	*Prodasineura verticalis*	Platycenemididae		
18	Blackwinged Bambootail	*Disparoneura quadrimaculata*	Platycenemididae		
19	Coorg Bambootail *	*Caconeura ramburi*	Platycenemididae		
20	Black & yellow bambootail	*Elattoneura tetrica*	Platycenemididae		Endemic
21	Emerald Spreadwing	*Lestes elatus*	Lestidae		
22	Stream Glory	*Neurobasis chinensis*	Calopterygidae		
23	Black-tipped Forest Glory	*Vestalis apicalis*	Calopterygidae		
24	Clear-winged Forest Glory	*Vestalis gracilis*	Calopterygidae		
25	River Heliodor	*Libellago indica*	Chlorocyphidae		Endemic
26	Stream Ruby	*Rhinocypha bisignata*	Chlorocyphidae		
27	Malabar Torrent Dart	*Euphaea fraseri*	Euphaeidae		Endemic
28	Black Torrent Dart	*Dysphaea ethela*	Euphaeidae		Endemic
29	Plain sinuate Clubtail	*Burmagomphus laidlawi*	Gomphidae		Endemic
30		*Cyclogomphus flavoannulatus*	Gomphidae		Endemic
31	Kodagu Clubtail	*Gomphidia kodaguensis*	Gomphidae		Endemic
32	Forest Hooktail	*Heliogomphus promelas*	Gomphidae	Near Threatened	
33	Wayanad Bowtail	*Macrogomphus wynaadicus*	Gomphidae		Endemic
34	Common Clubtail	*Ictinogomphus rapax*	Gomphidae		
35	Giant Clubtail	*Megalogomphus hannyngtoni*	Gomphidae	Near Threatened	
36	Long-legged Clubtail	*Merogomphus longistigma*	Gomphidae		Endemic
37	Pigmy Clubtail	*Microgomphus souteri*	Gomphidae		Endemic
38	Laidlaw's Clubtail	*Onychogomphus acinaces*	Gomphidae		Endemic
39	Commmon Hooktail	*Paragomphus lineatus*	Gomphidae		
40	Blue-tailed Green Darner	*Anax guttatus*	Aeshnidae		
41	Blue Darner *	*Anax immaculifrons*	Aeshnidae		
42	Brown Darner	*Gynacantha dravida*	Aeshnidae		
43	Parakeet Darner	*Gynacantha bayadera*	Aeshnidae		

	Common name	Scientific name	Family	IUCN status	Western Ghat Endemism
44	Common River Hawk	*Epophthalmia vittata*	Macromidae		
45		*Macromia flavicincta*	Macromidae		
46		*Macromia irata*	Macromidae		Endemic
47	Evening Torrent Hawk	*Idionyx saffronata*	Cordulidae		Endemic
48	Goan Shadowdancer	*Idionyx gomantakensis*	Cordulidae		Endemic
49	Ditch Jewel	*Brachythemis contaminata*	Libellulidae		
50	Granite Ghost *	*Bradinopyga geminata*	Libellulidae		
51	Konkan Rock Dweller *	*Bradinopyga konkanensis*	Libellulidae		
52	Emerald-banded Skimmer	*Cratilla lineata*	Libellulidae		
53	Ruddy Marsh Skimmer	*Crocothemis servilia*	Libellulidae		
54	Ground Skimmer	*Diplacodes trivialis*	Libellulidae		
55	Amber-winged Glider	*Hydrobasileus croceus*	Libellulidae		
56	Blue Hawklet	*Hylaeothemis indica*	Libellulidae		
57	Dark Ground Skimmer	*Indothemis carnatica*	Libellulidae	Near Threatened	
58	Asian Bloodtail	*Lathrecista asiatica*	Libellulidae		
59	Fulvous Forest Skimmer	*Neurothemis fulvia*	Libellulidae		
60	Pale Forest Skimmer	*Neurothemis intermedia*	Libellulidae		
61	Pied Paddy Skimmer	*Neurothemis tullia*	Libellulidae		
62	Stellate River Hawk *	*Onychothemis testacea*	Libellulidae		
63	Cherry Skimmer	*Orthetrum chrysis*	Libellulidae		
64	Blue Marsh Hawk	*Orthetrum glaucum*	Libellulidae		
65	Crimson-tailed Marsh Hawk	*Orthetrum pruinosum*	Libellulidae		
66	Blue-eyed Marsh Hawk	*Orthetrum luzonicum*	Libellulidae		
67	Green Marsh Hawk	*Orthetrum sabina*	Libellulidae		
68	Tiny Flufftail *	*Palpopleura sexmaculata*	Libellulidae		
69	Wandering Glider	*Pantala flavescens*	Libellulidae		
70	Yellow-tailed Ashy Skimmer	*Potamarcha congener*	Libellulidae		
71	Common Picturewing	*Rhyothemis variegata*	Libellulidae		
72	Pigmy Skimmer	*Tetrathemis platyptera*	Libellulidae		
73	Coral-tailed Cloud-wing *	*Tholymis tillarga*	Libellulidae		
74	Red Marsh Trotter	*Tramea basilaris*	Libellulidae		
75	Black Marsh Trotter	*Tramea limbata*	Libellulidae		
76	Crimson Marsh Glider	*Trithemis aurora*	Libellulidae		
77	Black Stream Glider	*Trithemis festiva*	Libellulidae		
78	Long-legged Marsh Glider *	*Trithemis pallidinervis*	Libellulidae		
79	Iridescent Stream Glider *	*Zygonyx iris*	Libellulidae		
80	Brown Dusk Hawk	*Zyxomma petiolatum*	Libellulidae		

Compiled from: Prasad & Varshney (1995); Rangnekar et al. (2010); Rangnekar & Naik (2014); Rangnekar et al. (2019); Subramanian et al. (2013); direct sightings (indicated by *) by Parag Rangnekar, Omkar Dharwadkar, Rohan Naik, Sridhar Halali, & Dhiraj Halali.

Appendix VII. Checklist of reptiles in Bhagwan Mahavir Wildlife Sanctuary and National Park.

	Order	Family	Species	Common name	IUCN Red List category	WPA schedule
1	Testudines	Bataguridae	*Melanochelys trijuga*	Indian Black Turtle	Near Threatened	
2	Testudines	Trionychidae	*Lissemys punctata*	Indian Flapshell Turtle	Least Concern	I
3	Squamata	Gekkonidae	*Cnemaspis goaensis*	Goan Day Gecko	Endangered	
4	Squamata	Gekkonidae	*Cyrtodactylus albofasciatus*	Boulenger's Indian Gecko	Not Evaluated	
5	Squamata	Gekkonidae	*Hemidactylus frenatus*	Asian House Geck	Least Concern	
6	Squamata	Gekkonidae	*Hemidactylus prashadi*	Prashad's Gecko	Least Concern	
7	Squamata	Lacertidae	*Ophisops beddomei*	Beddome's Snake-eyed Lizard	Least Concern	
8	Squamata	Mabuyidae	*Allapalli grass skink*	Allapalli Grass Skink	Least Concern	
9	Squamata	Mabuyidae	*Eutropis macularia*	Bronze Grass Skink	Least Concern	
10	Squamata	Mabuyidae	*Eutropis carinata*	Common Keeled Skink	Least Concern	
11	Squamata	Lygosomidae	*Lygosoma goaensis*	Goan Supple Skink	Least Concern	
12	Squamata	Lygosomidae	*Lygosoma punctatum*	Spotted Supple Skink	Least Concern	
13	Squamata	Varanidae	*Varanus bengalensis*	Bengal Monitor Lizard	Least Concern	
14	Squamata	Chamaeleonidae	*Chamaeleo zeylanicus*	Indian Chamaeleon	Least Concern	II
15	Squamata	Agamidae	*Calotes rouxii*	Roux's Forest Lizard	Least Concern	
16	Squamata	Agamidae	*Calotes versicolor*	Indian Garden Lizard	Least Concern	
17	Squamata	Agamidae	*Draco dussumieri*	South Indian Flying Lizard	Least Concern	
18	Squamata	Typhlopidae	*Indotyphlops braminus*	Brahminy Worm Snake	Least Concern	
19	Squamata	Typhlopidae	*Grypotyphlops acutus*	Beaked Worm Snake	Least Concern	
20	Squamata	Erycidae	*Eryx whitakeri*	Whitaker's Boa	Least Concern	
21	Squamata	Uropeltidae	*Melanophidium khairei*	Khaire's Shieldtail	Least Concern	
22	Squamata	Uropeltidae	*Uropeltis beddomii*	Beddome's Shieldtail	Least Concern	
23	Squamata	Pythonidae	*Python molurus*	Rock Python	Near Threatened	I
24	Squamata	Viperidae	*Daboia russelii*	Russell's Viper	Least Concern	II
25	Squamata	Viperidae	*Echis carinatus carinatus*	Indian Saw-scaled Viper	Not Evaluated	
26	Squamata	Viperidae	*Hypnale hypnale*	Common Hump-nosed Pit Viper	Not Evaluated	
27	Squamata	Viperidae	*Trimeresurus gramineus*	Bamboo Pit Viper	Least Concern	
28	Squamata	Viperidae	*Trimeresurus malabaricus*	Malabar Pit Viper	Least Concern	
29	Squamata	Elapidae	*Bungarus caeruleus*	Common Indian Krait	Not Evaluated	
30	Squamata	Elapidae	*Calliophis castoe*	Castoe's Coral Snake	Not Evaluated	
31	Squamata	Elapidae	*Calliophis melanurus*	Slender Coral Snake	Not Evaluated	
32	Squamata	Elapidae	*Naja naja*	Spectacled Cobra	Least Concern	II
33	Squamata	Elapidae	*Ophiophagus hannah*	King Cobra	Vulnerable	II
34	Squamata	Natricidae	*Amphiesma stolatum*	Striped Keelback	Not Evaluated	
35	Squamata	Natricidae	*Atretium schistosum*	Olive Keelback Water Snake	Least Concern	
36	Squamata	Natricidae	*Hebius beddomei*	Beddome's Keelback	Least Concern	
37	Squamata	Natricidae	*Macrophistodon plumbicolor*	Green Keelback	Not Evaluated	
38	Squamata	Natricidae	*Rhabdops aquaticus*	Aquatic Forest Snake	Not Evaluated	
39	Squamata	Natricidae	*Xenochrophis piscator*	Checkered Keelback	Not Evaluated	II
40	Squamata	Colubridae	*Ahaetulla nasuta*	Common Vine Snake	Not Evaluated	
41	Squamata	Colubridae	*Ahaetulla pulverulenta*	Brown Vine Snake	Least Concern	
42	Squamata	Colubridae	*Boiga beddomei*	Beddome's Cat Snake	Data Deficient	

	Order	Family	Species	Common name	IUCN Red List category	WPA schedule
43	Squamata	Colubridae	*Boiga forsteni*	Forsten's Cat Snake	Least Concern	
44	Squamata	Colubridae	*Chrysopelea ornata ornata*	Ornate Flying Snake	Not Evaluated	
45	Squamata	Colubridae	*Coelognathus helena monticollaris*	Montane Trinket Snake	Not Evaluated	
46	Squamata	Colubridae	*Dendrelaphis ashoki*	Ashok's Bronzeback Snake	Least Concern	
47	Squamata	Colubridae	*Dendrelaphis tristis*	Common Bronzeback Snake	Not Evaluated	
48	Squamata	Colubridae	*Boiga forsteni*	Forsten's Cat Snake	Least Concern	
49	Squamata	Colubridae	*Lycodon aulicus*	Common Wolf Snake	Not Evaluated	
50	Squamata	Colubridae	*Oligodon taeniolatus fasciatus*	Russell's Kukri Snake	Least Concern	
51	Squamata	Colubridae	*Ptyas mucosa*	Indian Rat Snake	Not Evaluated	II
52	Crocodylia	Crocodylidae	*Crocodylus palustris*	Mugger or Marsh Crocodile	Vulnerable	I

Source: Aengals et al. (2018); Sharma (1976).

Appendix VIII. Checklist of amphibians in Bhagwan Mahavir Wildlife Sanctuary and National Park.

	Order	Family	Species	Common name	IUCN Red List category	WPA schedule
1	Anura	Bufonidae	*Duttaphrynus melanostictus*	Asian Common Toad	Least Concern	
2	Anura	Bufonidae	*Duttaphrynus stomaticus*	Indian Marbled Toad	Least Concern	
3	Anura	Bufonidae	*Pedostibes tuberculosus*	Malabar Tree Toad	Endangered	
4	Anura	Dicroglossidae	*Euphlyctis cyanophlyctis*	Indian Skipper Frog	Least Concern	
5	Anura	Dicroglossidae	*Minervarya rufescens**	Malabar Wart Frog	Least Concern	
6	Anura	Dicroglossidae	*Minervarya syhadrensis**	Small Cricket Frog	Endangered	
7	Anura	Dicroglossidae	*Minervarya gomantaki**			
8	Anura	Dicroglossidae	*Minervarya goemchi**			
9	Anura	Dicroglossidae	*Minervarya cepfi**			
10	Anura	Dicroglossidae	*Minervarya agricola**			
11	Anura	Dicroglossidae	*Hoplobatrachus tigerinus*	Indian Bull Frog	Least Concern	Schedule IV
12	Anura	Dicroglossidae	*Sphaerotheca breviceps*	Indian Burrowing Frog	Least Concern	
13	Anura	Dicroglossidae	*Sphaerotheca dobsonii*	Dobson's Burrowing Frog	Least Concern	
14	Anura	Microhylidae	*Microhyla ornata*	Ornate Narrow-mouthed Frog	Least Concern	
15	Anura	Microhylidae	*Microhyla nilphamariensis*	Niphamarai Narrow-mouthed Frog	Not Evatuated	
16	Anura	Microhylidae	*Uperodon globulosus*	Indian Balloon Frog	Least Concern	
17	Anura	Microhylidae	*Uperodon mormoratus*	Indian Dot Frog	Endangered	
18	Anura	Nyctibatrachidae	*Nyctibatrachus danieli*	Daniel's Night Frog	Least Concern	
19	Anura	Nyctibatrachidae	*Nyctibatrachus petraeus*	Castle Rock Night Frog	Least Concern	
20	Anura	Ranixalidae	*Indirana chiravasi*	Amboli Leaping Frog	Not Evatuated	
21	Anura	Ranixalidae	*Indirana salelkari*	Leaping Frog	Not Evatuated	
22	Anura	Rhacophoridae	*Pseudophilautus amboli*	Amboli Bush Frog	Critically Endangered	
23	Anura	Rhacophoridae	*Philautus bombayensis*	Maharashtra Bush Frog	Vulnerable	
24	Anura	Racophoridae	*Polypedates maculatus*	Common Indian Tree Frog		
25	Anura	Rhacophoridae	*Rhacophorus malabaricus*	Malabar Gliding Frog	Least Concern	
26	Anura	Rhacophoridae	*Raorchestes bombayensis*	Maharashtra Bush Frog		
27	Anura	Ranidae	*Hydrophylax malabaricus*	Fungoid Frog	Least Concern	

28	Anura	Ranidae	*Hydrophylax bahuvistara*	Wide-spread Fungoid Frog		
29	Anura	Ranidae	*Indosylvirana temporalis*	Bronzed Frog	Near Threatened	
30	Anura	Ranidae	*Indosylvirana caesari*	Maharashtra Golden-backed Frog		
31	Anura	Ranidae	*Clinotarsus curtipes*	Bicoloured Frog	Near Threatened	
32	Anura	Micrixalidae	*Micrixalus uttaraghati*	Northern Dancing Frog		
33	Gymnophiona	Ichthyophiidae	*Ichthyophis davidi*	Chorla Striped Caecilian		
34	Gymnophiona	Ichthyophiidae	*Ichthyophis bombayensis*	Bombay Caecilian	Least Concern	
35	Gymnophiona	Indotyphlidae	*Gegeneophis danieli*	Daniel's Ceacilian		
36	Gymnophiona	Indotyphlidae	*Gegeneophis mhadeiensis*	Mhadei Caecilian		

*Genus *Minervarya* used provisionally. Freshwater Frogs are mentioned in Schedule IV.
Source: Dinesh et al. (2020); Kulkarni et al. (2013); Gosavi et al. (2020)

Appendix IX. Ants of Bhagwan Mahavir Wildlife Sanctuary and National Park.

	Species
	AMBLYOPONINAE
1	*Mystrium* sp.
2	*Stigmatomma* sp.
	DOLICHODERINAE
3	*Tapinoma indicum* Forel, 1895
4	*Tapinoma melanocephalum* (Fabricius, 1793)
5	*Technomyrmex albipes* (Smith, 1861)
	DORYLINAE
6	*Aenictus ceylonicus* (Mayr, 1866)
7	*Dorylus orientalis* Westwood, 1835
8	*Ooceraea biroi* Forel, 1907
9	*Parasyscia aitkenii* Forel, 1900
10	*Parasyscia indica* Brown, 1975 (E)
	FORMICINAE
11	*Anoplolepis gracilipes* (Smith, 1857) (I)
12	*Camponotus angusticollis* (Jerdon, 1851)
13	*Camponotus compressus* (Fabricius, 1787)
14	*Camponotus irritans* (Smith, 1857)
15	*Camponotus parius* Emery, 1889
16	*Camponotus radiates* Forel, 1892 (E)
17	*Camponotus sericeus* (Fabricius, 1798)
18	*Lepisiota capensis* (Mayr, 1862)
19	*Lepisiota opaca* (Forel, 1892)
20	*Oecophylla smaragdina* (Fabricius, 1775)
21	*Paratrechina longicornis* (Latreille, 1802) (I)
22	*Polyrhachis exercita* (Walker, 1859)
23	*Polyrhachis illaudata* Walker, 1859
24	*Polyrhachis lacteipennis* Smith, 1858
25	*Polyrhachis rastellata* (Latreille, 1802)
26	*Polyrhachis scissa* (Roger, 1862)
27	*Polyrhachis tibialis* Smith, 1858
	MYRMICINAE
28	*Aphaenogaster beccarii* Emery, 1887
29	*Carebara affinis* (Jerdon, 1851)
30	*Carebara diversa* (Jerdon, 1851)
31	*Cataulacus latus* Forel, 1891
32	*Cataulacus taprobanae* Smith, 1853
33	*Crematogaster dalyi* Forel, 1902
34	*Crematogaster rogenhoferi* Mayr, 1879
35	*Crematogaster rothneyi* Mayr, 1879
36	*Crematogaster subnuda* Mayr, 1879
37	*Lophomyrmex quadrispinosus* (Jerdon, 1851)
38	*Meranoplus bellii* Forel, 1902
39	*Meranoplus bicolor* (Guerin-Meneville, 1844)
40	*Monomorium atomum* Forel, 1902
41	*Monomorium dichroum* Forel, 1902
42	*Monomorium indicum* Forel, 1902
43	*Monomorium pharaonis* (Linnaeus, 1758) (I)
44	*Myrmicaria brunnea* Saunders, 1842
45	*Pheidole grayi* Forel, 1902 (E)
46	*Pheidole sharpi* Forel, 1902
47	*Solenopsis geminata* (Fabricius, 1804) (I)
48	*Strumigenys hostilis* Bolton, 2000 (E)
49	*Strumigenys peraucta* Bolton, 2000 (E)
50	*Tetramorium mixtum* Forel, 1902
51	*Tetramorium rugigaster* Bolton, 1977 (E)
52	*Tetramorium simillimum* (Smith, 1851) (I)
53	*Tetramorium wroughtonii* (Forel, 1902)
54	*Trichomyrmex destructor* (Jerdon, 1851) (I)
55	*Trichomyrmex wroughtoni* Forel, 1902
	PONERINAE
56	*Anochetus graeffei* Mayr, 1870
57	*Anochetus* (cf) *pupulatus* Brown, 1978
58	*Bothroponera henryi* Donisthorpe, 1942 (E)
59	*Bothroponera sulcata* (Mayr, 1867)
60	*Bothroponera tesseronoda* (Emery, 1877)

	Species
61	*Brachyponera luteipes* (Mayr, 1862)
62	*Diacamma indicum* Santschi, 1920
63	*Diacamma ceylonense* Emery, 1897
64	*Diacamma rugosum* (Le Guillou, 1842)
65	*Harpegnathos saltator* Jerdon, 1851
66	*Leptogenys diminuta* (Smith, 1857)
67	*Leptogenys chinensis* (Mayr, 1870)
68	*Leptogenys processionalis* (Jerdon, 1851)
69	*Odontomachus simillimus* Smith, 1858
70	*Parvaponera darwinii* (Forel, 1893)
71	*Platythyrea parallela* (Smith, 1859)
72	*Pseudoneoponera rufipes* (Jerdon, 1851)
	PSEUDOMYRMECINAE
73	*Tetraponera allaborans* (Walker, 1859)
74	*Tetraponera nigra* (Jerdon, 1851)
75	*Tetraponera rufonigra* (Jerdon, 1851)

Source: Baidya (2020)

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Monograph

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