# Playing with the forest: invasive alien plants, policy and protected areas in India

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*Protected areas (PAs) are inviolate and invaluable landscapes that promote the in situ conservation of endangered, threatened and rare species. Accordingly, and in keeping with this definition, PA managers ensure that PAs are free from fire, poaching, grazing, non-timber forest products collection, mining, etc. In India, following the Indian Wildlife (Protection) Act (1972), there are today 102 and 515 National Parks and Wildlife Sanctuaries respectively. Many of these have in recent decades been heavily threatened by the spread of invasive alien plant species, notable among them being Lantana and Eupatorium. These species may have usurped as yet unestimated number of native plants and fauna, besides depressing the reproduction of native plant species. In fact, it is realized that the threat to biodiversity by invasive alien species (IAS) may only be second to that of fragmentation. Yet there seems to be no major attempts to eradicate, contain or manage IAS in PAs. Ironically, the justification for the lack of action lies in the definition of PAs – that they need to be kept inviolate and therefore above any active intervention. In this article we bring home this serious contradiction in the approach to management of PAs in India and discuss the philosophical origins of this practice. We argue that if we are to protect our PAs from the serious scourge of invasive species, we would have to relook at the policy governing PA management and revise it to be more inclusive than exclusive.*

**Keywords:** Forest policies, invasive alien species, protected area network.

COLONIZATION of Africa and Asia by the European powers between the 15th and 19th centuries led to a quantum jump in the introduction of alien species into the colonized territories for food, fodder, energy and ornamental purposes[1,2]. The Indian subcontinent was one such region in which colonial invasions brought in a number of invasive alien species (IAS) that greatly transformed the native landscapes. For a major part the introductions and subsequent naturalization of plant species native to other countries into India were guided by the colonial government policies[3]. However, over the years, many of these introductions went on to become IAS. For example, Sankaran *et al.*[4] listed *Chromolaena odorata*, *Lantana camara*, *Mikania micrantha* and *Mimosa diplotrichaas* as the major IAS in India. In the recent past, *Prosopis juliflora* was introduced as an alternative fuelwood tree in southern India. *Lantana* was introduced into India at the East India Botanical Gardens, Calcutta in 1807 as an ornamental plant by the British[3]. Since then, *Lantana* has spread to most parts of the country, in farmlands and forestlands, and has posed a formidable challenge to farmers and foresters alike. Conventional management efforts to control *Lantana* have not been successful. To date there is no robust management or monitoring mechanism against IAS in India. Large numbers of forest-dependent communities still depend on forest resources and their livelihood is at stake due to pervasive landscape alteration by major IAS in different parts of India. Against this background, it is important to review the existing policies and their implications on IAS management in India with special reference to protected areas (PAs).

We reviewed the Indian Forest Policy documents such as the National Forest Commission Report, Indian Forest Act, Wildlife Protection Act, etc. to understand the policy implications over the last half a century towards management of IAS. We also interviewed 73 retired forest officials who worked across the Western Ghats in Tamil Nadu, Kerala, Karnataka, Maharashtra and Goa and also reviewed the management practices of major IAS to identify their contribution in IAS management.

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**Table 1.** Number and extent of designated protected areas in India

| Type | Status | Number | Area (km$^2$) |
|---|---|---|---|
| National Parks | Declared | 102 | 36,579 |
| Wildlife Sanctuaries | Declared | 515 | 119,929 |
| Conservation Reserve | Declared | 47 | 1,382 |
| Community Reserve | Declared | 4 | 20 |

Source: Protected Area Network (MoEF); http://envfor.nic.in/downloads/public-information/protected-area-network.pdf

## The protected area network in India

In 1970, the Indian Wildlife Board drafted the National Wildlife Policy which highlighted the major threats to wildlife species and habitats in the country, such as hunting, poaching, habitat alteration or destruction, forest fire, introduction of exotic species and commercial exploitation of forest resources[5]. This catalysed the enactment of the Wildlife (Protection) Act in 1972, which emphasized the need for creating PAs devoid of anthropogenic pressures such as livestock grazing, anthropogenic fires, land holdings and so on. This act classified the protection status into three categories, namely National Parks, Wildlife Sanctuaries and Closed Areas. Prior to 1972 there were only five National Parks and 64 Wildlife Sanctuaries in India, but within the next three decades these numbers increased almost ten times to 102 National Parks and 515 Wildlife Sanctuaries (Table 1).

## Protected areas as undisturbed land

In India, as well as internationally, the guiding philosophy in declaring PAs is that they are parcels of land in which human disturbance is minimal or absent, so as to promote *in situ* conservation of representative or essential ecosystem services and processes, or habitats and species, with a special emphasis on endangered, threatened and rare species. Thus, they are expected to be largely devoid of anthropogenic pressures such as land clearing, agriculture, logging, hunting, human-induced fires and grazing by livestock[6]. In India, this objective is supported by a number of policies and management plans which restrict or deny most anthropogenic impacts in PAs (Table 2). However, the high human population pressures and historical land rights in India, result in many PAs having villagers living within them[7], although expropriations continue in flagship PAs[8]. These residents have recognized rights of access and use, although with prescription and with significantly more restriction pressures than is the case outside PAs[9].

National Parks are afforded the highest protection status, such that livestock grazing is totally prohibited, as is cultivation and private land holdings, along with the control of fire[10]. On the other hand, in Wildlife Sanctuaries a degree of local flexibility is usually afforded, such that the Chief Wildlife Warden can control, regulate or prohibit grazing or movement of livestock, non-timber forest produce (NTFP) collection and so on. However, most PA managers in India view forest fires, grazing, and fuelwood and NTFP collection as a major threat to conservation outcomes and therefore seek to eliminate them[11]. Fire control programmes and anti-poaching are an integral part of every PA management system, consuming a significant portion of the budget.

## Invasive alien plants as a threat to biodiversity

The Millennium Ecosystem Assessment (2005) lists IAS as one of the five primary drivers of change in ecosystem composition, structure and function. Moreover, global climate change may well accelerate the rate of introduction and spread of IAS into areas where they were previously absent, or increase their performance relative to indigenous species[12]. Invasive alien species can have large detrimental economic impacts on human enterprises such as fisheries, agriculture, grazing and forestry. Globally, the costs associated with the negative impacts of IAS have been put at US$ 1.4 trillion per year, close to 5% of global GDP at that time[13]. A review by Clavero and García-Berthou[14] concluded that IAS were the main cause of avifaunal extinctions worldwide, and the second highest cause for the extinction of freshwater fish and mammals. Overall, examination of the IUCN database on species extinctions implicated a negative role of IAS in 50% of those extinctions where a cause could be identified or inferred, second only to habitat transformation[15]. At a national level, Pimentel *et al.*[16] estimated the environmental costs associated with IAS in the United States to be approximately US$ 120 billion per year, and that IAS were the primary threat to about 42% of the indigenous species already on the threatened and endangered species inventories. At a sub-national level, Turpie *et al.*[17] estimated at the turn of the millennium that the negative economic impact of IAS on ecosystem services in the Fynbos biome in South Africa (the world's most florally biodiverse area), was in the vicinity of US$ 110 million per annum and that IAS threaten 55% of South Africa's Red Data plants and up to 60% of endemic freshwater fish species in the country. Born *et al.*[18], however, caution that most studies calculating the economic

**Table 2.** Commonly encountered pressures on protected areas in India

| Pressure | Prevalence of pressure in PAs | Origin of the pressure | Prevalence of management responses to the pressure | Strength of on-the-ground management response |
|---|---|---|---|---|
| Fire[29,43] | Very common | Internal | Common | Strong |
| Fuelwood collection[8] | Very common | External | Common | Strong |
| Grazing by livestock[8] | Very common | External | Common | Medium |
| NTFPs harvest[44] | Very common | External | Common | Strong |
| Invasive plants[28,45] | Very common | Internal | Absent | Absent |
| Animal poaching[46] | Common | External | Common | Very strong |
| Land encroachment[44] | Common | External | Common | Very strong |
| Shifting agriculture[47] | Common | Internal | Common | Very strong |
| Dam construction[47,48] | Rare | Internal | Case specific | Very strong |
| Mining activities[47] | Rare | Internal | Case specific | Very strong |

impacts of IAS are underestimates and they require more robust methodologies.

India also suffers the impacts of IAS, many of which are highly invasive. Khuroo *et al.*[2] recently reported that the alien flora of India amounts to 1599 species, belonging to 842 genera in 161 families and constituting 8.5% of the total vascular flora found in the country. The negative impacts have been felt through losses to grazing, agricultural production and for some species, human health[19].

## Invasive alien species and protected areas in India

Given the significance of IAS in imperiling biodiversity throughout the world, there has been a steady development of international conservation policies and agendas to create awareness and support national agencies to develop national policies and strategies. For example, Article 8(h) of the Convention on Biological Diversity, to which India is a signatory, behooves countries to eradicate IAS which threaten local ecosystems, habitats and species. The Global Invasives Species Programme was set up to create awareness and provide advice and support in combating IAS.

However, these developments not seem to have filtered into PA policies and management plans within India, even though IAS can jeopardize the protection status of PAs[20]. Table 2 shows that explicit policies and management responses on the control of IAS are absent from most Indian PA plans, whereas in many other countries (e.g. South Africa, USA) IAS control plans are an integral component of individual PA management plans.

This absence of a policy and management response is in spite of the growing numbers of the reports of IAS and their impacts in the Indian PAs. For example, Kerala Forest Research Institute and CAB International (2009) collaboratively compiled a manual on *Chromolaena odorata*, *Lantana camara*, *Mikania micrantha*, *Mimosa diplotricha* and *Parthenium hysterophorus* as major IAS in India. Most of the PAs in the Western Ghats and Eastern Himalayas are highly infested by at least one of these five IAS, and the spread and negative impacts are increasing. For example, Sundaram and Hiremath[21] monitored 134 plots across 540 $km^2$ in the Biligiri Rangaswamy Tiger Reserve between 1997 and 2008, and found that the percentage of *L. camara* stems per unit area increased from 5.5% in 1997 to 57.2% by 2008. Sharma *et al.*[22] and Love *et al.*[23] have previously drawn attention to the rapid spread of *Lantana* throughout India, including in PAs. Recently, Prasad[24] noted how *Lantana* was rapidly spreading in Bandipur Tiger Reserve in southern India and that it suppressed grass cover and indigenous tree sapling density, which mirrors the results of Ramaswami and Sukumar[25] for selected species in Mudumalai Wildlife Sanctuary. Sharma and Raghubanshi[26] reported negative impacts of *Lantana* cover on herbaceous species diversity and cover in several areas of Central India. Such negative impacts of IAS are not limited to plant species, but also other taxa such as insectivorous and canopy birds in MM Hills Forest Reserve[27], certain antelope species[28] and rhinoceros[29], which are amongst the national priority species for conservation in India. IAS also negatively impact the livelihoods of local communities, with respondents at BR Hills and MM Hills reporting that *Lantana* invasion was reducing the grazing in the forest and NTFP harvests[30].

Ironically, however, some PA managers suggest that *Lantana* might be playing a positive role in that it provides cover for carnivores and some other game species[31], seemingly forgetting that such a role was played by indigenous understorey species prior to being replaced by vast swathes of *Lantana*, now dominant in many PAs and also increasing.

## Inaction against invasive species in Indian protected areas

Despite the clear negative trends and impacts, very few PAs in India have active and vigorous programmes to stem the tide against IAS. Love *et al.*[23] demonstrated the cut rootstock method as an effective physical removal

technique of *Lantana* in Corbett Tiger Reserve in the northern part India. It is cost-effective on a smaller scale (Rs 4000–5000 per ha), but expensive on a larger scale. Typically, the only extremely limited action to control IAS is to clear some areas as a component of fire control practices, not for their biodiversity impacts per se. However, the common practices are to cut and burn IAS that occur within a few metres of roadsides within the PA, which provides a firebreak against wild fires as well as some improved short-range visibility in the forest for viewing of game species. Our experience is that there are very few efforts to seriously control or remove IAS deeper in the forest, a feature also noted by Bhagwat *et al.*[31]. Indeed, Bhagwat *et al.*[31] go so far as to suggest that PA managers in India have given up trying to eradicate IAS, but simply seek to control them. But it would be fair to mention that the fact that managers have given up on controlling *Lantana*, rests on the belief that it is uncontrollable. However, the same is not the issue with say control of fire, or poaching, or for the matter, firewood collection, where all these are easily managed. On the other hand, all the scientific evidence in the country, however small, shows that IAS are continuing to spread into newer areas and forming thickets in areas already invaded; a stark testament that the said control efforts along roadsides are having no effect.

We conducted a questionnaire survey among the retired forest officers of Karnataka, Kerala, Tamil Nadu and Maharashtra Forest Departments. They were asked the following: (a) When and where they had first seen *Lantana* during their first, second and third decades of service? (b) Was there any management plan for IAS such as *Lantana*? The key findings of this study were that more than 85% officers reported that there were hardly any management programmes to control IAS such as *L. camara* and more than 25% of them mentioned that IAS were cleared to raise plantations or clear-off roadsides inside the forest. The only method that they knew for control was to manually cut and burn. This is labour-intensive and offers only a short-term solution because the seed bank of the major IAS remains and hence reinvasion occurs rapidly. Some IAS, such as *Lantana*, which are buried deeply can be stimulated to germinate when exposed to light and fire[32]. Thus, the clearing and burning of a few metres along roadsides or for raising plantations has no impact whatsoever on the spread of IAS in Indian PAs.

In instances where clearing of larger areas deeper in the forests have occurred, they are associated with development of plantations of valuable timber species for revenue, or restoration plantings[22]. Our interaction with some of the forest managers of the PAs in the Western Ghats indicates that their species selection for plantations is based on three criteria: (a) fast growth, (b) good timber value and (c) unpalatability to game species. These criteria encourage the planting of exotic species such as eucalyptus, silver oak (*Grevillea robusta*) and acacia (*Acacia auriculiformis*); in effect replacing one IAS with another alien species. Thus, the clearing of IAS for establishment of plantations is not linked to biodiversity conservation objectives and outcomes. These plantations in PAs have their own impacts on forest ecosystem processes and biodiversity. For example, eucalyptus plantations are well known for their high water use, groundwater depletion, suppression of undergrowth species and plant species richness[33–36]. Denslow[20] emphasized in the management guidelines for PAs that forest managers need to be careful and evaluate exotic species used in rehabilitation and restoration projects to avoid introducing or facilitating the spread of IAS.

On the surface, this inaction against IAS in Indian PAs is slightly complex to understand. The case against IAS because of their negative impacts on biodiversity and ecosystem services has been well argued internationally. Thus, why the absence of any coherent and meaningful response? We pose two possible explanations, namely (a) lack of appropriate policy or awareness and (b) perverse application of policy and regulations.

The suggestion that there is a lack of appropriate policy and awareness by conservation policy-makers and PA managers is undermined by India having a rich legacy of policies and regulations spanning almost a century relating to the control of IAS (Table 3). Thus, at the policy and legislative level at least, there seems to be a suite of enabling policies, even if there is no exclusive national legislation or policy addressing the problem of IAS[37]. Nevertheless, the recently introduced operational guidelines of the 'intensification of forest management scheme'[38] of the Ministry of Environment and Forests, New Delhi emphasizes the need for control and eradication of forest invasive species and providing assistance to state-owned or supported research institutions to carry out research into management or eradication of IAS. Notably, the recent legislation of the scheduled tribes and other traditional forest-dwellers (Recognition of Forest Rights Act 2006) provides an enabling policy space for the participation of local communities in protection as well as management of PAs, forests and biodiversity in general. It recognizes and vests rights to the local Gram Sabha (village committee) to protect the wildlife and biodiversity of the PAs. In the Act, chapter 5(a), (b) and (d) strongly urges local communities to ensure the protection of ecologically sensitive areas, regulate the access to community NTFPs, and stop any activity which adversely affects wild animals, forests and biodiversity.

If these policies are not being acted upon at the management level, then there are either unseen barriers to implementation, or awareness at the management level is lacking. In case of the latter, training curricula at forestry and conservation institutions need to be revised to include sufficient materials and promote understanding of the threats to biodiversity and ecosystem services posed

**Table 3.** Examples of policies and Acts relating to invasive alien species in India

| Policy on invasive species | Year promulgated |
|---|---|
| The Livestock Importation Act | 1898 |
| The Destructive Insects and Pests Act | 1914 |
| The Madras Agricultural Pests and Diseases Act | 1919 |
| The Travancore Plant Pests and Plant Diseases Regulation | 1919 |
| The Coorg Agricultural Pests and Diseases Act* | 1933 |
| The Patiala Destructive Insects and Pests Act | 1943 |
| The Bombay Agricultural Pests and Diseases Act | 1947 |
| The Rewa State Agricultural Pests and Diseases Act | 1947 |
| The East Punjab Agricultural Pests, Diseases and Noxious Weeds Act | 1949 |
| The East Punjab Agricultural Pests, Diseases and Noxious Weeds Act as extended to Himachal Pradesh | 1949 |
| The Assam Agricultural Pests and Diseases Act | 1950 |
| Plant Quarantine (Regulation of Import into India) Order | 2003 |

*****Coorg Noxious weed Act 1914 was proposed due to *Lantana* invasion in the coffee plantations and followed by heavy forest fire. However, the act was not implemented until 1933 due to the World War I and its heavy expenses for the British. Source: Agricultural legislation in India[49].

by IAS. Besides these, it is imperative that PA managers understand the need to manage IAS by developing active early detection programmes, prevent spread by active monitoring and develop corridors devoid of IAS for free movement of large mammals to maintain forest connectivity which is otherwise threatened by forest fragmentation. Unfortunately, because of a single-track mission (of eradication), many of the above-mentioned perceptions have hardly influenced, and entered, the management portfolio of PA managers.

The notion of a blind application of legislation as an explanation for inactivity against the threats of IAS originated during discussions with individual PA managers in the Western Ghats area during 2008–2010. These dialogues revealed perhaps a more insidious reason for the lack of meaningful programmes to control IAS in PAs. The explanation was provided, on several occasions, that the Wildlife Act (1972), which was the foundation of the growth of PAs in India, prevents the harvesting and removal of plant and animal materials from PAs. This interpretation of the 1972 Act was reinforced by a ruling of the Supreme Court order (Writ Petition (Civil) No. 171/1996) on 12 December 1996 (along with its subsequent extension in 2004) that prevents removal of dead, diseased, dying or wind-fallen trees, drift wood and grasses, etc. from any national park. Thus, a paradoxical situation arises when the very legislative Act used to conserve biodiversity in PAs can also be referred by the PA managers to prevent the eradication of IAS which actually threaten the same biodiversity. This is especially so for National Parks, where all harvesting is strictly prohibited. There is some leeway in Wildlife Sanctuaries. Management officials argue, therefore, that even with sufficient awareness and budget, they would be acting illegally.

However, the Supreme Court order also created a space for addressing the legal concerns through ordering the constituting of a Central Empowered Committee (CEC) to look into the issues related to environment and forests. The track record of the issues handled by the CEC is impressive. The CEC has submitted numerous findings and recommendations to the Supreme Court on PA and forest policy and management issues. For example, farming encroachment in the Western Ghats and northeastern Himalayas, closure of mining activities to protect the flora and fauna in the Kudremukh National Park, and protecting endangered species such as olive ridley sea turtles in Odisha[39]. So, although a strict reading of the Wildlife Protection Act (1972) does prohibit harvesting in PAs, the Supreme Court ruling provided a mechanism for this to be reviewed and for flexibility on a case-by-case basis. Thus, we see a compelling case for scientists/managers to approach the CEC for clear guidelines and exemptions regarding programmes for the vigorous control and removal of IAS from the PAs.

## Conclusion

The negative impacts of IAS on biodiversity and ecosystem services are well known and decried throughout the world. In this article we have argued that the presence and increasing spread of IAS is threatening biodiversity in PAs (and outside) of India, thereby undermining the very reason for their existence. Yet, in the face of this severe threat, there appears to be very little coherent and meaningful response to limiting the impacts in PAs by halting the spread of IAS into new areas and removing them from the millions of hectares already invaded[40]. The precise reasons for this lack of response need to be clearly understood and then addressed. Scientists and conservationists need to work together to address the scourge with vigour and urgency drawing on examples and best practices from around the world and adapting

them to the Indian context. Researchers need to categorize alien species according to the level of threat and rate of spread in each of the bioclimatic zones (e.g. Robertson *et al.*[41]). After the classification, broad and replicable management strategies need to be developed based on a range of options[42] related to (a) early detection, (b) control and removal, and (c) ecosystem management and monitoring of IAS.


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ACKNOWLEDGEMENTS. The participation of R.K. and C.M.S. in this work was partially supported by a grant from the South African National Research Foundation, Rainforest Concern, United Kingdom and Jamshedji Tata Trust, Mumbai. We thank Mr Sachidananda Joshi for providing the contact details of retired forest officers of southern India. We also thank the anonymous reviewer for valuable comments that helped improve the manuscript.

Received 22 June 2012; revised accepted 6 March 2013