



Assessment and management strategies of invasive flora of Chandaka Wildlife Division, Odisha, India

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Abstract

Invasive alien plants can alter native vegetation, ecosystem structure and habitat functions. The present study documented the occurrence, diversity, habitat association and potential impacts of invasive plants in Chandaka Wildlife Division, Odisha, India. Field surveys were conducted across forests, forest margins, roadsides, grasslands, wastelands and aquatic habitats during 2024-2025. A total of 23 taxa belonging to 10 families were recorded, with Asteraceae, Fabaceae and Malvaceae being the major families and herbs the dominant growth form. Several recognized invasive species, including *Ageratum conyzoides*, *Chromolaena odorata*, *Lantana camara*, *Mikania micrantha*, *Mitracarpus hirtus* and *Parthenium hysterophorus*, were recorded. Most species occurred in disturbed habitats and forest margins, while several aquatic invasives were associated with wetlands and water bodies. The major impacts included competition with native vegetation, formation of dense stands and suppression of natural regeneration. The findings provide baseline information for monitoring and management of invasive plants in Chandaka Wildlife Division, Odisha, India.

Keywords: Invasive flora, management strategies, Odisha, weed assessment

Introduction

Invasive alien plants are increasingly recognized as an important driver of biodiversity loss and ecosystem change worldwide (Rajak *et al.*, 2021) ^[12]. Unlike native weeds, invasive alien plants are introduced outside their natural geographical range and may establish, reproduce and spread rapidly, producing ecological or socioeconomic impacts (Lamsal *et al.*, 2018; Rajak *et al.*, 2021) ^[5, 12]. Their ability to tolerate a wide range of environmental conditions, reproduce efficiently and exploit disturbed habitats can facilitate their expansion into natural and semi-natural ecosystems. Invasion processes can consequently modify species composition, vegetation structure and ecosystem functioning (Richardson *et al.*, 2000) ^[15]. India is particularly vulnerable to biological invasions because of its high climatic and ecological diversity, extensive agricultural landscapes, rapidly changing land use and large network of disturbed habitats. A comprehensive assessment of the Indian alien flora documented 1,599 alien plant species, representing 8.5% of the country's vascular flora, with Asteraceae, Fabaceae and Poaceae among the most species-rich families (Khuroo *et al.*, 2012) ^[4]. The large number of alien species and their occurrence across contrasting ecosystems demonstrate the importance of systematic assessment and monitoring of invasive plants in India (Rajak *et al.*, 2021) ^[12].

Invasive plants can influence native communities through competition for light, water, nutrients and space. They may also modify soil properties, nutrient cycling, fire regimes and other ecosystem processes. In India, invasive alien plants have been associated with substantial changes in biodiversity and ecosystem services, although the magnitude of their effects differs among species and habitats (Rai and Singh, 2020) ^[10]. A review of alien plant invasions in India

further emphasized that inadequate information on species distribution, ecological impacts and management effectiveness remains a major challenge for invasion management (Reshi and Khuroo, 2012) ^[4]. Several invasive species have become widely distributed across Indian landscapes. *Lantana camara*, for example, has invaded extensive areas of forests, pastures and wastelands and has been associated with changes in biodiversity, landscape ecology and ecosystem services (Negi *et al.*, 2019) ^[7]. Similarly, *Chromolaena odorata* has established extensively in forest gaps, roadsides and disturbed habitats; habitat characteristics such as open canopy and increased resource availability can facilitate its establishment and spread (Pathak *et al.*, 2019) ^[9]. Invasion by *Ageratum conyzoides* has also been associated with reductions in native plant diversity and biomass in Himalayan ecosystems, demonstrating that herbaceous invaders can substantially alter plant communities (Paraseth and Banerjee, 2024) ^[8].

The impacts of invasive plants can extend beyond changes in species richness. *Parthenium hysterophorus*, one of the prominent invasive weeds of India, has been shown to alter vegetation composition, species richness and evenness as well as soil nitrogen dynamics in invaded grasslands (Srivastava and Raghubanshi, 2021) ^[17]. *Mikania micrantha*, a rapidly growing perennial climber, has demonstrated substantial climatic suitability across India, raising concerns about further expansion into areas that are currently less affected by the species (Banerjee *et al.*, 2017) ^[1]. Aquatic invaders can produce equally serious consequences; *Eichhornia crassipes*, for instance, can form dense floating populations that interfere with aquatic ecosystem functioning and water use. Recent large-scale assessments indicate that invasive plants are already widespread across major Indian ecoregions. Spatial analysis has identified

extensive areas suitable for invasion by species such as *Lantana camara*, *Ageratum conyzoides*, *Chromolaena odorata*, *Parthenium hysterophorus*, *Mikania micrantha* and *Senna tora*, emphasizing the need for systematic monitoring and prioritization of invasion hotspots (Sinha *et al.*, 2022; Mungi *et al.*, 2023) ^[6, 16]. Climate change may further influence invasion patterns by modifying habitat suitability and allowing some invasive species to expand into previously unsuitable environments (Bhatta *et al.*, 2023) ^[3]. Invasive plants may also have complex effects on human wellbeing because rural communities frequently depend on forests, grasslands and other natural resources. A recent review of India reported that plant invasions can influence multiple dimensions of wellbeing, with impacts varying according to species, ecosystem and local socioeconomic conditions (Ravi and Hiremath, 2024) ^[13]. Therefore, invasive-plant management requires approaches that consider both ecological consequences and local human dependence on affected ecosystems. Effective management requires early detection, accurate identification, distribution mapping, regular monitoring and habitat restoration. Mechanical removal, biological control, chemical control and integrated approaches have all been used in India, but their effectiveness varies among species and environmental conditions (Raj *et al.*, 2018) ^[11]. Consequently, detailed inventories of invasive plants at local scales are essential for identifying species composition, abundance and distribution patterns and for developing appropriate management priorities. Such baseline information can support long-term biodiversity conservation and help reduce the ecological impacts of invasive alien plants in forest and wildlife landscapes.

Methodology

Study area: The study was conducted in Chandaka Wildlife Division, Odisha, India, which forms an important forested landscape within the northern part of the Eastern Ghats. The division encompasses the Chandaka-Dampara Wildlife Sanctuary, an important protected area located in the vicinity of Bhubaneswar and Cuttack. The landscape is characterized by undulating terrain, hillocks, valleys, seasonal streams, water bodies and patches of dry deciduous and mixed vegetation. Six major forest types are represented in the sanctuary. These include Moist Bamboo Brakes, Secondary Moist Bamboo Brakes, Lateritic Semi-Evergreen Forests, Peninsular Sal Forests, Secondary Moist Mixed Deciduous Forest and Tropical Dry Evergreen Forests. The area experiences a tropical monsoonal climate, with a distinct wet season during the southwest monsoon and a relatively dry period during the winter and summer months. Seasonal variation in rainfall, temperature and soil moisture influences the growth and distribution of herbaceous and shrubby vegetation. The landscape also contains roads, forest tracks, settlements, agricultural interfaces and other disturbed habitats, which may provide suitable conditions for the establishment and spread of alien plant species (Behera *et al.*, 2025) ^[2]

Survey method: A systematic field survey was conducted across different habitats of Chandaka Wildlife Division, including forest interiors, forest edges, roadsides,

grasslands, wetlands, stream margins and disturbed areas during 2024-2025. Surveys were first undertaken to identify locations supporting alien and potentially invasive plant species. Each recorded species was documented with its scientific name, family, habit, habitat and geographic coordinates (GPS). Photographs were taken for field documentation and species identification. Species identification was confirmed using regional floras, taxonomic literature, herbarium resources and authoritative plant databases. The invasive status of each species was verified from published literature and recognized invasive-plant databases. The collected field records were subsequently compiled into a database for analysis of species composition, occurrence and distribution.

Results and discussion

The survey recorded 23 plants representing 10 families (Table 1; Plate 1). Among the recorded families, Asteraceae was the most represented, with six species, followed by Fabaceae with six species, Malvaceae with four species, Rubiaceae with two species and one species each from Amaranthaceae, Cleomaceae, Pontederiaceae, Lamiaceae, Convolvulaceae, Euphorbiaceae and Araceae. The family-level composition indicates that invasive and potentially invasive taxa were particularly represented by Asteraceae, Fabaceae and Malvaceae (Figure 1). The recorded plants exhibited different growth forms, with herbs being the dominant habit. Shrubs were also common, while climbers, trees and aquatic herbs were represented by fewer species. Terrestrial species such as *Ageratum conyzoides*, *Chromolaena odorata*, *Hyptis suaveolens*, *Lantana camara*, *Mitracarpus hirtus*, *Parthenium hysterophorus*, *Sida acuta* and *Tridax procumbens* were mainly associated with roadsides, grasslands, forest margins, clearings, wastelands and other disturbed habitats. This distribution indicates that disturbed and open habitats provide suitable conditions for the establishment and spread of several alien plant species. The majority of the alien taxa listed in the table originated from tropical America or South America. Important invasive species of tropical American origin included *Ageratum conyzoides*, *Chromolaena odorata*, *Hyptis suaveolens*, *Lantana camara*, *Mikania micrantha*, *Mitracarpus hirtus*, *Parthenium hysterophorus*, *Sida acuta* and *Tridax procumbens*. Their occurrence across multiple habitat types suggests considerable ecological adaptability and the ability to establish under different environmental conditions. Aquatic habitats supported a distinct group of invasive plants (Figure 2). *Alternanthera philoxeroides*, *Eichhornia crassipes*, *Ipomoea carnea* and *Pistia stratiotes* were associated with ponds, wetlands, canals, rivers and other water bodies. These species have the potential to form dense populations, resulting in reduced light penetration, oxygen availability and space for native aquatic vegetation. Their occurrence highlights the importance of water bodies and wetland margins as potential invasion-prone habitats. Several terrestrial invasive species were associated with forest edges and open areas. *Chromolaena odorata* and *Lantana camara* were recorded as species capable of forming dense stands and suppressing native vegetation and regeneration. *Mikania micrantha*, a climbing species, can spread over shrubs and young trees, whereas *Mitracarpus*

hirtus, *Ageratum conyzoides* and *Sida acuta* can establish persistent populations in grasslands and disturbed areas. Such species may increase competition for space, light, nutrients and other resources with native plant communities. Several species were identified as confirmed invasive alien plants, whereas *Acacia auriculiformis*, *Cleome viscosa*, *Crotalaria pallida*, *Mimosa pudica*, *Senna tora*, *Spermacoce exilis* and *Triumfetta rhomboidea* were classified as alien, naturalized or having variable or uncertain invasive status. *Sida cordifolia* was identified as a non-alien species and should therefore not be included when calculating the

number of invasive alien species. The results demonstrate that invasive and potentially invasive plants occur across a broad range of habitats, particularly disturbed terrestrial areas, forest margins and aquatic environments. Their varied growth forms and habitat associations indicate multiple pathways of establishment and spread. The occurrence of dense-forming species in forest edges, open areas and wetlands may pose a potential threat to native vegetation, regeneration and habitat structure, emphasizing the need for continued monitoring and early management of invasive populations.

Table 1: Invasive flora of Chandaka Wildlife Division, Odisha

Scientific name	Family	Native region (s)	Habit	Habitat	Major impacts
<i>Acacia auriculiformis</i> A. Cunn. ex Benth.	Fabaceae	Australia, Papua New Guinea	Tree	Forest margins, plantations, wastelands	Can form dense stands and alter native vegetation.
<i>Ageratum conyzoides</i> L. (Plate 1a)	Asteraceae	Tropical America	Herb	Roadsides, fields, forest edges	Competes with native herbs and regenerating vegetation.
<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Amaranthaceae	South America	Aquatic herb	Wetlands, ponds, canals, waterways	Forms dense mats and reduces aquatic plant diversity.
<i>Chromolaena odorata</i> (L.) R.M. King & H. Rob. (Plate 1b)	Asteraceae	Tropical America	Shrub	Forest edges, grasslands, wastelands	Suppresses native vegetation and forest regeneration.
<i>Cleome viscosa</i> L.	Cleomaceae	Tropical Old World	Herb	Agricultural fields, roadsides, wastelands	Colonizes disturbed habitats.
<i>Crotalaria pallida</i> Aiton	Fabaceae	Tropical America	Shrub	Roadsides, grasslands, disturbed sites	Competes with native herbaceous vegetation.
<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	Tropical America	Shrub	Wetlands, canals, riverbanks, wastelands	Forms dense stands and displaces wetland vegetation.
<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Tropical America	Shrub	Roadsides, wastelands, forest edges	Establishes dense populations in disturbed habitats.
<i>Lantana camara</i> L. (Plate 1c)	Verbenaceae	Tropical America	Shrub	Forests, scrublands, roadsides	Forms dense thickets and inhibits native regeneration.
<i>Mesosphaerum suaveolens</i> (L.) Kuntze	Lamiaceae	Tropical America	Herb/shrub	Roadsides, wastelands, forest margins	Dominates disturbed sites and competes with native plants.
<i>Mikania micrantha</i> Kunth (Plate 1d)	Asteraceae	Tropical America	Climber	Forest edges, plantations, wetlands	Smothers shrubs, herbs and young trees.
<i>Mimosa pudica</i> L. (Plate 1e)	Fabaceae	Tropical America	Herb	Roadsides, grasslands, disturbed land	Dense growth can suppress ground vegetation.
<i>Mitracarpus hirtus</i> (L.) DC. (Plate 1f)	Rubiaceae	Tropical America	Herb	Grasslands, roadsides, forest clearings	Rapid colonization of disturbed habitats.
<i>Parthenium hysterophorus</i> L. (Plate 1g)	Asteraceae	Tropical America	Herb	Roadsides, wastelands, agricultural areas	Reduces native plant diversity; produces allergenic pollen.
<i>Pistia stratiotes</i> L.	Araceae	Tropical regions	Floating aquatic herb	Ponds, lakes, wetlands	Dense floating populations reduce light and oxygen.
<i>Pontederia crassipes</i> Mart.	Pontederiaceae	South America	Aquatic herb	Ponds, lakes, wetlands, rivers	Dense mats reduce light, oxygen and aquatic biodiversity.
<i>Senna occidentalis</i> (L.) Link (Plate 1h)	Fabaceae	Tropical America	Shrub	Wastelands, roadsides, agricultural areas	Competes with native vegetation.
<i>Senna tora</i> (L.) Roxb. (Plate 1i)	Fabaceae	Tropical Asia	Herb	Roadsides, wastelands, disturbed land	Can dominate disturbed habitats.
<i>Sida acuta</i> Burm.f. (Plate 1j)	Malvaceae	Tropical America	Herb	Grasslands, roadsides, agricultural margins	Forms persistent populations and competes with native herbs.
<i>Spermacoce exilis</i> (L.O. Williams) C.D. Adams ex W.C. Burger & C.M. Taylor	Rubiaceae	Tropical America	Herb	Disturbed ground, grasslands	Can colonize disturbed sites.
<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Tropical America	Herb	Roadsides, gardens, forest clearings	Competes with native ground flora.
<i>Tridax procumbens</i> L.	Asteraceae	Tropical America	Herb	Roadsides, agricultural fields, wastelands	Rapid colonization of disturbed habitats.
<i>Triumfetta rhomboidea</i> Jacq.	Malvaceae	Tropical America	Shrub	Forest margins, grasslands, disturbed sites	Can expand in disturbed vegetation.



Plate 1: Invasive flora of Chandaka Wildlife Division, Odisha; a) *Ageratum conyzoides*, b) *Chromolaena odorata*, c) *Lantana camara*, d) *Mikania micrantha*, e) *Mimosa pudica*, f) *Mitracarpus hirtus*, g) *Parthenium hysterophorus*, h) *Senna occidentalis*, i) *Senna tora*, j) *Sida acuta*

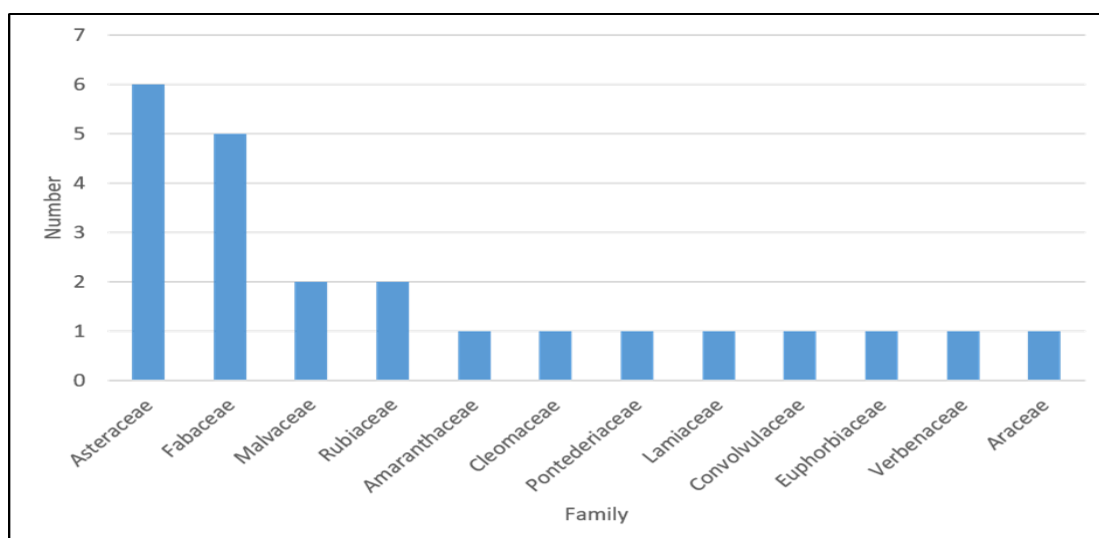


Fig 1: Family-wise composition of recorded taxa

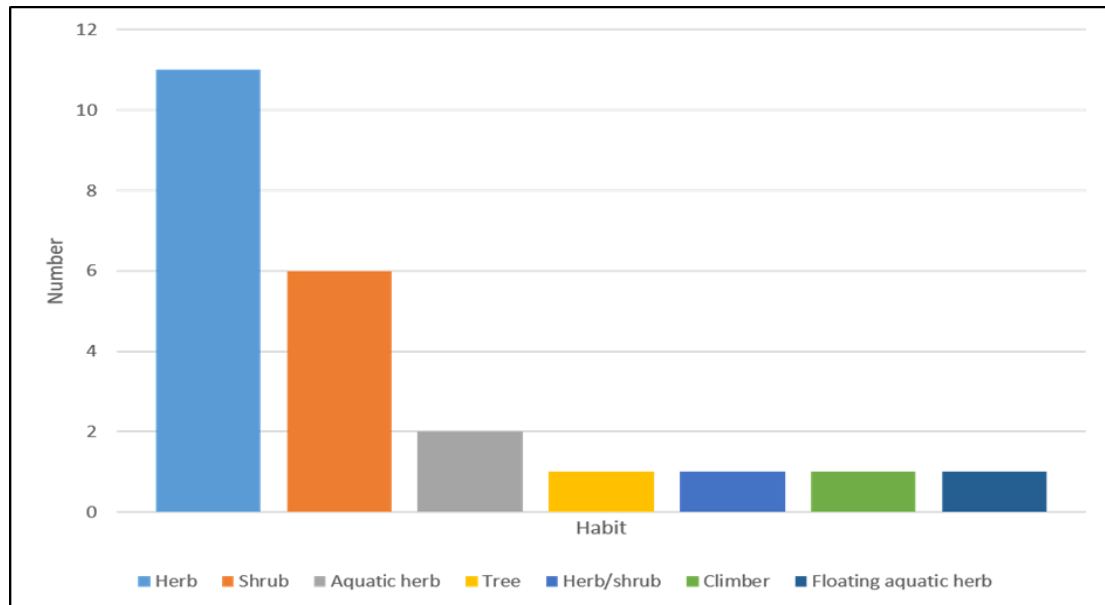


Fig 2: Growth-form composition

Management model

The proposed management model integrates early detection, species prioritization, targeted removal, native vegetation restoration and long-term monitoring. It emphasizes collaboration among forest authorities, local communities, researchers and educational institutions for effective and sustainable invasive plant management in Chandaka Wildlife Division.

Model 1: Early Detection and Rapid Response (EDRR) Model

This model focuses on identifying invasive species at an early stage and removing them before they form large populations

(Figure 3).

- Regular monitoring of roadsides, forest edges, clearings, wetlands and disturbed areas.
- GPS-based mapping of newly emerging invasive populations.
- Priority removal of small and newly established populations.
- Repeated monitoring after removal to detect regeneration.
- Community and forest staff participation in reporting new invasions.
- Suitable for: *Ageratum conyzoides*, *Mitracarpus hirtus*, *Sida acuta*, *Tridax procumbens* and newly established invasive populations.

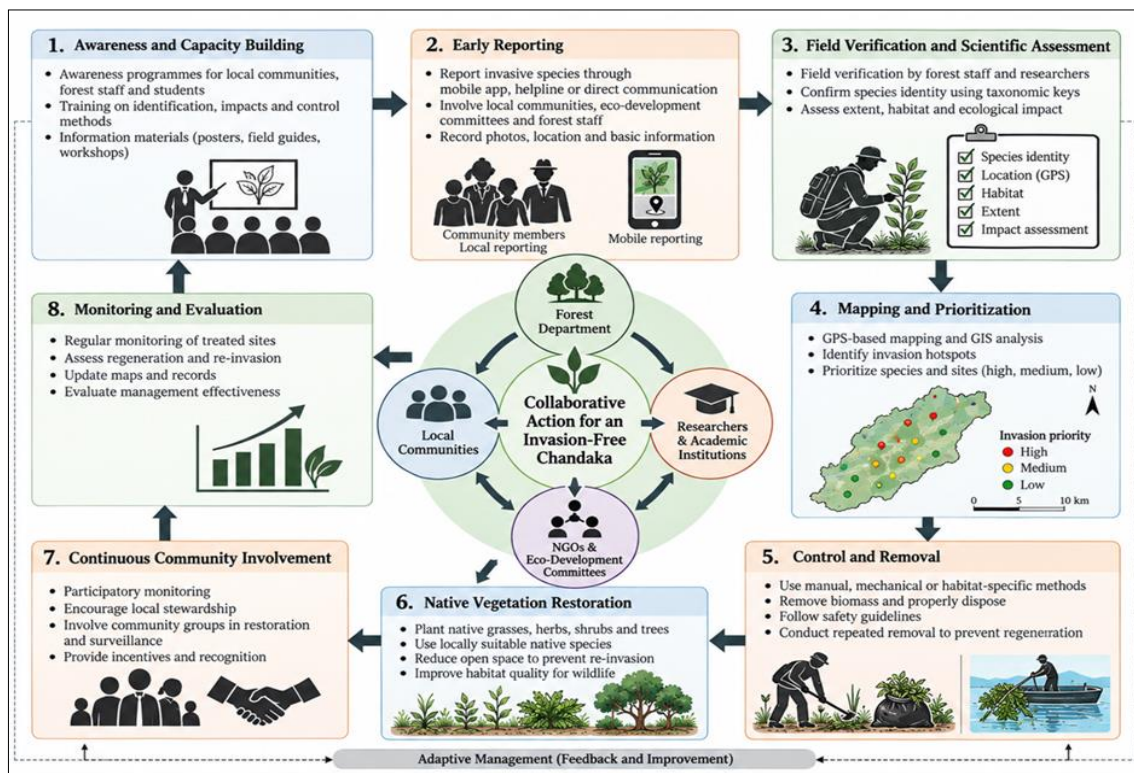


Fig 3: Early detection and rapid response (EDRR) model

Model 2: Habitat-Specific Integrated Management Model

Different invasive species require different management methods depending on their habitat and growth form.

Habitat	Major invasive species	Suggested management
Forest edges	<i>Lantana camara</i> <i>Chromolaena odorata</i>	Manual or mechanical removal followed by native regeneration.
Roadsides & disturbed areas	<i>Ageratum conyzoides</i> <i>Sida acuta</i> <i>Tridax procumbens</i> <i>Mitracarpus hirtus</i>	Repeated weeding and restoration with native ground vegetation.
Forest clearings	<i>Chromolaena odorata</i> <i>Mikania micrantha</i>	Cutting or removal and follow-up control.
Wetlands & water bodies	<i>Eichhornia crassipes</i> <i>Pistia stratiotes</i> <i>Alternanthera philoxeroides</i>	Mechanical removal and regular aquatic habitat monitoring.
Riverbanks/wetlands	<i>Ipomoea carnea</i>	Cutting and removal of regrowth followed by native vegetation restoration.

The main principle is to combine removal with habitat restoration, because simply removing invasive plants may leave open space that can be recolonized.

Conclusion

The present study documented a diverse assemblage of invasive and potentially invasive plant species in Chandaka Wildlife Division, Odisha. The recorded species were associated mainly with disturbed habitats, forest margins, roadsides, grasslands, wastelands and aquatic environments, indicating the importance of habitat disturbance in facilitating their establishment and spread. Several invasive species have the potential to compete with native vegetation, suppress natural regeneration and alter habitat conditions. The study highlights the need for regular field surveys, GPS-based mapping and species-level assessment to identify invasion hotspots and prioritize management actions. An integrated management approach involving forest authorities, local communities, researchers and educational institutions is proposed, combining early detection, rapid control, native vegetation restoration and long-term monitoring. Such collaborative and adaptive management can contribute to reducing invasive plant spread and maintaining the ecological integrity and biodiversity of Chandaka Wildlife Division.

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