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Role of Invasive Species in Changing Native Faunal Diversity and Ecological Interactions

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Abstract: *Biological invasions are among the leading drivers of biodiversity loss and ecological degradation worldwide. Invasive species are organisms introduced intentionally or unintentionally outside their native geographical range, where they establish, spread, and cause significant ecological, economic, and social impacts. Their influence on native faunal diversity extends beyond direct competition, encompassing predation, hybridization, habitat alteration, disease transmission, and disruption of ecosystem processes.*

These changes often modify ecological interactions such as food webs, pollination, seed dispersal, predator-prey relationships, and mutualistic associations. The increasing globalization of trade, climate change, urbanization, and habitat fragmentation have accelerated the spread of invasive species, making biological invasions a major conservation challenge. This review synthesizes current knowledge regarding the mechanisms through which invasive species alter native faunal diversity and ecological interactions. It discusses major invasion pathways, ecological consequences across terrestrial, freshwater, and marine ecosystems, management approaches, and future research directions. Understanding these impacts is essential for developing effective conservation strategies aimed at preserving biodiversity and maintaining ecosystem resilience.

Keywords: Invasive species, biodiversity, ecological interactions, native fauna, ecosystem functioning, biological invasion, conservation.

I. INTRODUCTION

Biological invasions have emerged as one of the greatest threats to global biodiversity. Human activities such as international trade, tourism, transportation, agriculture, and climate change have facilitated the movement of organisms beyond their natural distribution ranges. Many introduced species fail to establish populations; however, a small proportion become invasive by rapidly expanding and negatively affecting native ecosystems.

Native fauna have evolved through long-term ecological interactions involving competition, predation, mutualism, and environmental adaptation. The arrival of invasive species often disrupts these relationships, resulting in declining populations of indigenous organisms and altered ecosystem functioning. According to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), invasive alien species contribute significantly to species extinctions worldwide.

The impacts of invasive species vary among ecosystems depending on invasion intensity, environmental conditions, and ecological resilience. Terrestrial ecosystems frequently experience vegetation changes that indirectly affect wildlife, whereas aquatic ecosystems often witness rapid displacement of native fish, amphibians, and invertebrates. Marine invasions alter benthic communities, coral reef ecosystems, and fisheries productivity.

This review examines the ecological mechanisms through which invasive species modify native faunal diversity, explores their influence on ecological interactions, summarizes representative case studies, and highlights management strategies for mitigating invasion impacts.

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II. CHARACTERISTICS OF INVASIVE SPECIES

Successful invasive species generally possess several adaptive characteristics.

Characteristic	Ecological Significance
Rapid reproduction	Enables fast population growth
Broad environmental tolerance	Survives diverse habitats
High dispersal ability	Facilitates geographical expansion
Generalist feeding habits	Exploits multiple food resources
Efficient resource utilization	Outcompetes native organisms
Lack of natural predators	Promotes unchecked population increase
High genetic variability	Enhances adaptability
Strong competitive ability	Displaces native species

III. MAJOR PATHWAYS OF BIOLOGICAL INVASION

Table 2. Common Introduction Pathways

Pathway	Examples	Ecological Impact
International trade	Insects, rodents	Forest damage
Shipping	Ballast water organisms	Marine invasions
Agriculture	Pest species	Crop ecosystem alteration
Ornamental plants	Garden escapees	Habitat modification
Aquaculture	Exotic fishes	Native fish displacement
Pet trade	Reptiles, birds	Competition and predation
Tourism	Seeds attached to clothing	Habitat colonization

IV. MECHANISMS AFFECTING NATIVE FAUNAL DIVERSITY

i. Competition

Invasive species frequently compete with native organisms for food, nesting sites, breeding habitats, and shelter. Competitive exclusion often results in reduced reproductive success and population decline of indigenous fauna.

Examples include invasive rodents replacing native mammals and exotic fish outcompeting indigenous freshwater species.

ii. Predation

Novel predators introduced into ecosystems often prey upon species lacking evolutionary defenses.

Examples include:

1. Brown tree snake eliminating birds on Guam
2. Lionfish consuming juvenile reef fishes
3. Domestic cats threatening island bird populations

iii. Habitat Modification

Some invasive species physically alter habitats.

Examples include:

1. Water hyacinth reducing oxygen in lakes
2. Invasive grasses increasing wildfire frequency
3. Earthworms changing forest soil structure

Habitat changes subsequently affect numerous animal communities.

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iv. Disease Transmission

Introduced organisms may carry pathogens absent in native ecosystems.

Examples include:

1. Amphibian chytrid fungus
2. Avian malaria
3. White-nose syndrome spread among bats

Disease outbreaks often accelerate biodiversity loss.

v. Hybridization

Closely related invasive species may interbreed with native populations, reducing genetic diversity.

Examples include:

1. Native trout hybridizing with introduced trout
2. Wildcats hybridizing with domestic cats

V. EFFECTS ON ECOLOGICAL INTERACTIONS

Table 3. Ecological Interactions Affected by Invasive Species

Ecological Interaction	Impact of Invasive Species	Consequence
Competition	Resource monopolization	Native species decline
Predation	Increased mortality	Population collapse
Herbivory	Vegetation loss	Habitat degradation
Mutualism	Pollinator disruption	Reduced plant reproduction
Parasitism	Disease spread	Increased mortality
Seed dispersal	Altered dispersers	Reduced regeneration
Nutrient cycling	Changed decomposition	Ecosystem imbalance
Food webs	Trophic cascade	Biodiversity decline

VI. CHANGES IN FOOD WEB STRUCTURE

Invasive species often restructure food webs by introducing new predators, prey, or competitors.

Major consequences include:

1. Loss of trophic diversity
2. Collapse of specialist species
3. Simplified ecological networks
4. Increased dominance of invasive organisms
5. Reduced ecosystem resilience

Food web disruption frequently triggers trophic cascades affecting multiple trophic levels simultaneously.

VII. EFFECTS ACROSS DIFFERENT ECOSYSTEMS

Table 4. Ecosystem-wise Ecological Impacts

Ecosystem	Major Invasive Species	Effects on Native Fauna
Forest	Lantana camara	Reduced habitat quality
Grassland	Prosopis juliflora	Decline in herbivore diversity
Freshwater	Water hyacinth	Fish mortality
Wetlands	Common carp	Sediment disturbance
Marine	Lionfish	Reef fish decline
Islands	Rats	Bird extinction

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Agricultural	Fall armyworm	Pest outbreaks

VIII. INFLUENCE ON BIODIVERSITY

Invasive species reduce biodiversity through multiple mechanisms.

These include:

1. Species extinction
2. Reduced population sizes
3. Lower reproductive success
4. Genetic erosion
5. Habitat fragmentation
6. Ecosystem homogenization

Many endemic species with limited geographical ranges are particularly vulnerable.

IX. CLIMATE CHANGE AND BIOLOGICAL INVASION

Climate change enhances invasion success by expanding suitable habitats for invasive organisms.

Key interactions include:

1. Rising temperatures favor tropical invaders.
2. Altered rainfall changes habitat suitability.
3. Extreme weather facilitates dispersal.
4. Native species become physiologically stressed.
5. Ecosystem resistance declines.

Climate change and invasive species therefore act synergistically to accelerate biodiversity loss.

X. REPRESENTATIVE GLOBAL CASE STUDIES

Table 5. Selected Invasive Species and Ecological Consequences

Invasive Species	Region	Native Species Affected	Major Ecological Impact
Brown tree snake	Guam	Native birds	Multiple extinctions
Lionfish	Caribbean	Reef fishes	Reduced fish diversity
Cane toad	Australia	Reptiles and mammals	Predator poisoning
Zebra mussel	North America	Freshwater mussels	Competition
Water hyacinth	Africa & Asia	Fish communities	Oxygen depletion
European rabbit	Australia	Native vegetation	Habitat degradation
Argentine ant	California	Native ants	Community replacement
Grey squirrel	Europe	Red squirrel	Disease and competition

XI. ECOLOGICAL CONSEQUENCES

The cumulative ecological consequences include:

1. Declining native species richness
2. Altered ecosystem productivity
3. Disrupted nutrient cycling
4. Reduced pollination efficiency
5. Changes in predator-prey dynamics
6. Increased extinction risk
7. Reduced ecosystem services
8. Economic losses in agriculture, forestry, and fisheries

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XII. MANAGEMENT STRATEGIES

Table 6. Invasive Species Management Approaches

Strategy	Description	Advantages	Limitations
Prevention	Border inspection and quarantine	Cost-effective	Requires strict enforcement
Early detection	Monitoring programs	Rapid response	High monitoring costs
Mechanical control	Removal by trapping or cutting	Environmentally friendly	Labor intensive
Chemical control	Herbicides and pesticides	Rapid reduction	Non-target impacts
Biological control	Natural enemies	Long-term solution	Risk assessment required
Habitat restoration	Native vegetation recovery	Improves resilience	Slow process
Public awareness	Community participation	Sustainable management	Requires continuous education

XIII. CONCLUSION

Invasive species represent one of the most significant threats to native faunal diversity and ecological stability. Their impacts extend beyond direct competition and predation to include habitat modification, disease transmission, hybridization, and disruption of ecological networks. These changes alter food webs, reduce biodiversity, and impair ecosystem services across terrestrial, freshwater, and marine environments. Climate change further amplifies invasion risks by creating favorable conditions for the establishment and spread of non-native organisms.

Effective management requires a combination of prevention, early detection, rapid response, ecological restoration, public participation, and international collaboration. Continued interdisciplinary research integrating ecology, genetics, remote sensing, and conservation biology will be essential for mitigating biological invasions and safeguarding native biodiversity in the future.

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