ECOLOGICAL EFFECTS OF INVASIVE FLORA SPECIES ON ECOSYSTEM SERVICES IN MARSHLANDS OF IKEDURU, IMO STATE

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Abstract
Invasive flora species (IFS) pose a significant threat to wetland biodiversity and the ecosystem services upon which local communities depend. This study investigated the ecological effects of invasive flora in the marshlands of Ikeduru, Imo State, Nigeria. The research mapped the spatial distribution of dominant invasive species, assessed their perceived impact on livelihood-critical ecosystem services, analyzed statistical relationships between invasive coverage and native biodiversity and soil/water quality, and developed a community-inclusive management framework. Data were collected via systematic field surveys using quadrats and transects, GPS mapping, laboratory analysis of soil and water samples, and a structured EEIFSESMI instrument administered to 396 households across 12 randomly selected communities. Results indicated a high prevalence of Nymphaea lotus (White Lotus) and Pistia stratiotes (Water Lettuce), with distinct aggregation patterns along disturbed edges. A significant negative correlation was found between invasive species coverage and native plant diversity indices (Shannon-Weiner, $p<0.01$). Furthermore, invasive dominance was associated with altered soil pH and reduced dissolved oxygen in water. Over 80% of respondents perceived severe declines in provisioning services like fishing and wild food plants. The study concludes that invasive species are degrading the Ikeduru marshlands' ecological integrity and human livelihoods. The study recommends the integration of indigenous ecological knowledge with scientific monitoring into a co-management strategy, advocating for policy shifts that prioritize wetland conservation and community-based invasive species management. This study contributes a localized, empirical model for assessing IFS impacts in tropical freshwater wetlands, emphasizing indigenous knowledge and perception as critical components of environmental governance.
Keywords: Ecological effects, invasive flora species, ecosystem services, marshlands, and Ikeduru.

Introduction

Wetlands, are among the world's most productive ecosystems, which provide indispensable services that underpin human well-being and ecological stability, including water purification, flood control, carbon sequestration, and biodiversity support (Millennium Ecosystem Assessment, 2005). In Nigeria, freshwater marshlands or wetlands serve as vital agrarian and hydrological resources for surrounding communities. However, these ecosystems face escalating threats from anthropogenic pressures, chief among which is the invasion by non-native plant species (Nwankwo et al., 2021). Invasive Flora Species (IFS) are defined as alien plants whose introduction and spread threaten biological diversity, ecosystem functioning, and socio-economic values (IPBES, 2019). Globally, the economic cost of biological invasions exceeds USD 423 billion annually, with costs in Africa rising precipitously due to increased trade and land-use change (Diagne et al., 2021).

The global recognition of the wetland ecosystems for their disproportionate contribution to biodiversity and human well-being, providing indispensable provisioning, regulating, cultural, and supporting services, also applies to Nigeria (Davidson et al., 2019). For instance, the freshwater marshlands of the South-Eastern Nigeria, including those in Ikeduru, Imo State, are vital agrarian and cultural landscapes. However, these socio-ecological systems face escalating threats from biological invasions, which can fundamentally alter ecosystem structure,

function, and resilience (Pyšek et al., 2020). Corroborating this view, Chukwuma et al. (2020) assert that the spread of *Chromolaena odorata*, *Pistia stratiotes*, and *Leucaena leucocephala* in various ecological zones, implied the vulnerability of the wetland ecosystem with their flora species in southern Nigeria hydrological zones, including Imo State.

The proliferation of invasive flora species (IFS) poses a critical threat to the integrity and functionality of wetland ecosystems that provides invaluable provisioning, regulating, supporting, and cultural services, globally, continentally, regionally, nationally, and locally. The ecological narrative of invasives in Africa has often been framed through a colonial lens, with many "classical" invasives like *Chromolaena odorata* introduced during colonial agricultural or ornamental projects (Shackleton et al., 2019). The subsequent spread of these species is exacerbated by contemporary factors such as deforestation, urbanization, and climate change, which create disturbed niches ideal for invasion (Uwaegbute et al., 2023). The impact of invasive flora species (IFS) is profound; they alter fire regimes, change soil chemistry, outcompete native flora for resources, and ultimately simplify ecosystem structure, leading to a homogenization of biota and a degradation of ecosystem services (Elliott et al., 2020).

As Ugwu and Nwankwo (2022) argue, understanding West African wetlands requires a lens that incorporates both ecological science and the socio-cultural realities of dependent communities. In Nigeria, marshlands like those in Ikeduru, Imo State, are vital for local agriculture, fisheries, water supply, and cultural practices. However, these ecosystems face escalating threats from invasive alien species (IAS), which disrupt ecological balance and compromise human well-being. The introduction and proliferation of aggressive flora, often mediated by human activities like agriculture and trade, can lead to the homogenization of landscapes and the loss of native biodiversity (Pyšek et al., 2020). Equally, the discourse on environmental management has been increasingly enriched by indigenous scholarship, which emphasizes the interconnectedness of ecological health and community survival in the Nigerian context. Similarly, Ezealim and Akanwa (2023) note that the loss of native wetland species in Southeastern Nigeria is not merely a biological concern but a direct threat to indigenous knowledge systems and food sovereignty.

The adoption of the ecological, and management policy arose from the non-documentation of the indigenous approaches for the conservation of these eventually lost invasive flora species, justifies the essence of integrating the Invasion Curve Theory. The Invasion Curve Theory (ICT), posits that the management feasibility and cost of an invasive species change non-linearly with the extent of its invasion, typically visualized as a curve with stages: Prevention, Eradication, Containment, and Long-term Control (Booth et al., 2020). Its relevance to this study is paramount. It provides a diagnostic lens to assess what stage of invasion the Ikeduru marshlands are in (likely "Late Expansion" moving to "Containment"), thereby guiding appropriate and cost-effective management responses. The theory moves the discourse from mere documentation to strategic action, framing the research objectives around not just assessing impact but also informing the point of intervention on the curve.

The spread of invasive alien plant species (IAPS) in Nigerian wetlands is often linked to anthropogenic disturbances such as agricultural intensification, urbanization, and altered hydrological regimes (Nwankwo et al., 2021). Recent indigenous scholarship underscores the need to contextualize this global environmental challenge within local realities. As Udechukwu et al. (2022) argue, the degradation of Igbo land's *"*ala mmiri*"* (waterlands) is not merely an ecological crisis but a direct assault on food sovereignty, indigenous pharmacopeia, and cultural heritage. Similarly, Eze and Okonkwo (2023) call for research that quantifies invasive species impacts while centering the lived experiences and knowledge systems of wetland-dependent communities. This study responds to this call by undertaking a quantitative ecological assessment of invasive flora in Ikeduru, framed within the imperative of safeguarding ecosystem services critical to local livelihoods, thereby bridging ecological science and community-centered conservation praxis, or practices for the indigenously threatened species.

Indigenous scholarly work is increasingly highlighting the value of local ecological knowledge (LEK) in understanding and managing environmental change. As Ibeawuchi et al. (2022) argue, the perceptions of local communities who interact daily with these ecosystems are not merely anecdotal but constitute critical data for prioritizing specie observation, documentation and conservation actions. However, a critical gap exists in contextualizing and documenting these species invasions within the framework of ecosystem services, the direct and indirect contributions of ecosystems to human welfare. Much of the existing literature focuses on agronomic impacts or mere species inventories (e.g., Ndukwe & Osuagwu, 2019), failing to link ecological changes to the loss of specific services that sustain local livelihoods. This disconnect hinders effective policy formulation, as the socio-ecological urgency of the problem remains inadequately quantified and communicated.

Ibeawuchi et al. (2022) study in Niger Delta wetlands demonstrated that community contextualization, observations, and documentation of the proliferation or spread of invasive species, often precede formal scientific detection. Implicitly, this study is aptly situated within this critical juncture, seeking to empirically document context-specific, and community-relevant conservation strategies including indigenous scholarship, to ameliorate the ecological impacts of invasive flora species in Ikeduru marshlands. Hence, this study, therefore, positions itself at the intersection of invasion ecology, ecosystem service science, and indigenous scholarship, seeking to provide a holistic assessment of a pressing environmental challenge in the marshlands in the Ikeduru Local Government Area, Imo State.

Problem Specification

The marshlands of Ikeduru, Imo State, are experiencing rapid ecological transformation due to the proliferation of invasive flora species (IFS). Local farmers and fishers report declining catches, reduced access to native medicinal plants, and increased flooding in areas dominated by species like *Chromolaena odorata* and water hyacinth. This uncontrolled spread threatens food security, water quality, and the biodiversity that underpins cultural and economic practices. Existing management efforts are reactive, fragmented, and lack a scientific basis that integrates ecological data with local livelihood concerns. While the presence of some invasive flora species (IFS) in South-Eastern Nigeria is documented, there is a paucity of integrated studies that quantitatively assess their impact on specific ecosystem services and qualitatively evaluate community perceptions within a unified framework in the Ikeduru marshlands.

Despite the documented global threat of invasive species to wetlands, spatially explicit and quantitative data on their distribution, ecological impacts, and socio-economic consequences remain scarce for the freshwater marshlands of Southeastern Nigeria. A significant research and management gap exists in understanding the precise linkages between invasive species coverage, the degradation of native biodiversity and abiotic conditions, and the consequent erosion of ecosystem services in the Ikeduru marshlands. This study aims to fill this gap through the synthesis of targeted, effective, and socially inclusive indigenous management and conservation strategies for flora species. It is based on this premise that this study examined the ecological effects of invasive flora species on ecosystem services in marshlands of Ikeduru, Imo State.

Objectives of the Study

The objectives of the study are to

1. identify the distribution pattern of the dominant invasive flora species in the communities in the Ikeduru marshlands communities.
2. ascertain the perceive the impact of invasive species on key ecosystem services (provisioning, regulating, cultural) critical to the livelihoods in the communities in the Ikeduru marshlands.
3. analyze the relationship between invasive species coverage and indicators of native plant diversity on key soil/water quality parameters in the communities in Ikeduru marshlands.
4. propose community-inclusive frameworks and strategies for the effective management of invasive species in the Ikeduru marshlands.

Research Questions

The formulated research questions guided the study.

1. What is the distribution pattern of the dominant invasive flora species in the communities in the Ikeduru marshlands?
2. What is the perceived impact of invasive species on ecosystem services critical to the livelihoods in the communities in the Ikeduru marshlands?
3. What is the statistical relationship between invasive species coverage and indicators of native plant diversity on key soil/water quality parameters in the communities in Ikeduru marshlands?
4. What are the community-inclusive framework and strategies for the effective management of invasive species in the Ikeduru marshlands?

Significance of the Study

This research provides critical data for environmental policy formulation at the local and state levels, offering evidence-based insights for the Imo State Ministry of Environment. It empowers local communities by validating and integrating their knowledge into formal conservation planning. Academically, it contributes to the growing body of indigenous ecological knowledge in Nigeria and offers a replicable methodology for assessing ecosystem service degradation in tropical wetlands.

Scope/Delimitation of the Study

The study is confined to the freshwater marshlands within Ikeduru LGA, Imo State, investigated over a 12-month period covering wet and dry seasons. It focuses on vascular invasive plant species and their perceived and measured impacts on selected services: wild food/medicine provision (provisioning), water purification and flood control (regulating), and cultural identity. It does not conduct a full economic valuation of service loss nor a detailed genetic study of the invasives.

Study Area

Location and Extent: Ikeduru Local Government Area (LGA) is situated in central Imo State, South-Eastern Nigeria, approximately between latitudes 5°25'N and 5°35'N and longitudes 7°00'E and 7°15'E (see Fig. 1 below). The study focuses on the low-lying marshland corridors along the Otamiri River and its tributaries, covering an estimated area of 85 km

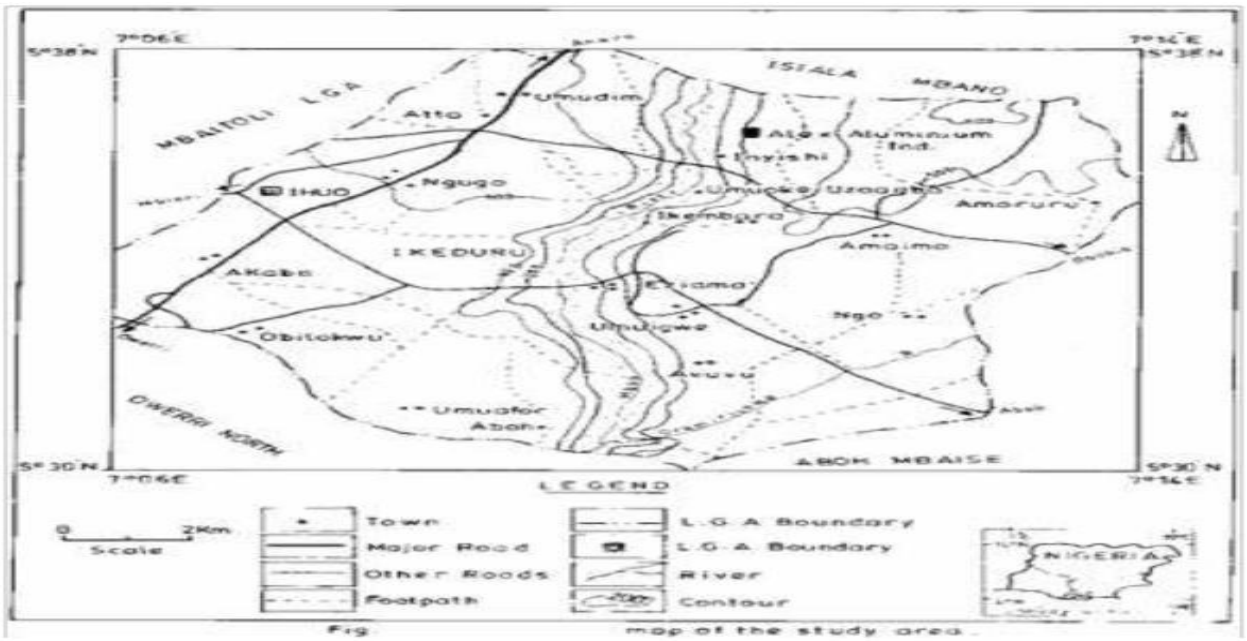

Fig. 1: Ikeduru Local Government Area showing the Communities
Source: Imo State Ministry of Lands and Survey, Owerri, 2025.

Geology, Soil, and Vegetation: The area lies within the Benin Formation (Oligocene to Recent), characterized by unconsolidated sands, gravels, and clays. Soils are predominantly hydromorphic (waterlogged) soils, acidic and low in nutrients in undisturbed areas, but often altered by invasion (Iroh et al., 2021). The natural vegetation is freshwater swamp forest and reed marshes, but it has been widely modified to rain-fed agriculture (mainly cassava, maize, and oil palm) and invaded by exotic species.

Climate: The climate is typical tropical rainforest (Köppen *Af*), with high humidity and a mean annual rainfall of 2200-2500mm, distributed between March and October. Average temperature is 27°C, providing a year-round growing season favorable to invasives (NIMET, 2022).

Economic Activities and Population: The population is primarily agrarian, with fishing, crop farming, and palm wine tapping as key livelihoods. The 2022 population estimates project ~180,000 inhabitants (NPC, 2022), exerting significant pressure on the marshlands for resources.

Theoretical Framework

Invasion Curve Theory (ICT): This theory posits that the management feasibility and cost of an invasive species change non-linearly with the extent of its invasion, typically visualized as a curve with stages: Prevention, Eradication, Containment, and Long-term Control (Booth et al., 2020). Its relevance to this study is paramount. It provides a diagnostic lens to assess what stage of invasion the Ikeduru marshlands are in (likely "Late Expansion" moving to "Containment"), thereby guiding appropriate and cost-effective management responses.

The theory moves the discourse from mere documentation to strategic action, framing the research objectives around not just assessing impact but also informing the point of intervention on the curve.

Methodology

Research Design: A convergent parallel mixed-methods design was employed, where quantitative ecological and survey data were collected concurrently, analyzed separately, and then integrated during interpretation. This approach is justified as it provides robust empirical evidence of ecological patterns while grounding them in community perspectives, aligning with the *"two-eyed seeing"* principle advocated for in integrative indigenous research, honoring both scientific and community-based ways of knowing (Creswell & Plano Clark, 2018; Iwuji et al., 2023).

Population of the Study: The target populations comprised of the ecological and human population. The ecological population consisted of all plant communities within the defined Ikeduru marshland complex. Also, the human population comprised all adult residents (with occupation as farmers, fishers, herbalists) in the 15 communities directly interfacing with these marshlands or wetlands in Ikeduru Local Government Area, Imo State.
Sampling Techniques: The adopted sampling technique was based on the ecological and household sampling. For the ecological sampling, a stratified random design was used to divide the marshlands into three zones: Core, Buffer, and Disturbed Fringe (adjacent to settlements/farms). Thirty (30) transects were randomly laid per zone, alongside, each 100m transect, five 1m² quadrats were systematically placed, totaling 450 quadrats. Also, a two-phased multi-stage random sampling technique was used for the household sampling. First, 12 of the 15 communities were randomly selected. Second, from updated community registers, 396 household heads were selected from 12 communities (i.e., 33 households per community), via systematic random sampling, ensuring a 95% confidence level and ±5% margin of error.

Instrumentation: The study integrated or utilized multi-instruments based on the data collection method. For instance, the Garmin GPSMAP 65s for georeferencing was used for all sample points and invasive patches. 1m² quadrat frame was integrated for floristic analysis. Similarly, soil corer and sterile water sampling bottles was used for collecting composite soil (0-15cm) and surface water samples. In addition, the standard field and laboratory apparatus, such as pH meter, dissolved oxygen meter, spectrophotometer, and soil test kits were used for analyzing soil (pH, N, P, K, organic matter) and water (pH, DO, BOD, nitrates, turbidity) parameters. Equally, a 24-item self-structured instrument or questionnaire titled "Ecological Effects of Invasive Flora Species on Ecosystem Services in Marshlands Inventory" (EEIFSESMI). The EEIFSESMI instrument was patterned after a four-point Likert rating scale for the items that elicited responses on the socio-demographic data and perceptions of ecosystem service changes. The Cronbach Alpha method was used to obtain a reliability coefficient of 0.853, necessitating the use of the EEIFSESMI instrument for the variables of ecological effects of invasive species, and ecosystem services in marshlands.

Method of Data Collection: The adopted data collection method was based on each of the study's objective. Data for objective 1 was collected in each quadrat, wherein all invasive species were identified, and their percentage cover was visually estimated; GPS coordinates recorded. For objective 2, the EEIFSESMI instrument was administered using face-to-face direct delivery technique to capture the 396 respondents in the 12 communities' perceptions regarding changes in 12 ecosystem services over the past decade. Out of 396 copies of the EEIFSESMI instrument administered to the respondents, only 385 copies (representing 94% return rate) were validly retrieved and used for the analysis. The data for objective 3 was collected within each quadrat, where all native plant species were identified and counted. Paired soil and water samples were collected from a subset of 150 strategically located quadrats. While data for objective 4 was collected from four (4) Focus Group Discussions (FGDs) and ten (10) Key Informant Interviews (KIIs) with community elders, farmers, fishers, and local conservationists in the 12 selected communities.

Method of Data Analysis: The method of data analysis was determined by the objective. For instance, objective 1 was analyzed using mean percentage from the data imported into ArcGIS Pro. Inverse Distance Weighting (IDW) interpolation and Kernel Density Estimation (KDE) were performed to map coverage and identify hotspots per community area. Also, descriptive statistics (frequencies, percentages, and mean scores) were used to analyze objective 2. For objective 3, the native plant diversity was calculated using the Shannon-Wiener Index (H'). Pearson's correlation and multiple linear regression analyses established relationships between invasive cover (%) (independent variable) and the dependent variables: H', soil parameters, and water quality parameters.

While objective 4 was thematically analyzed on transcribed qualitative data to identify local knowledge, management preferences, and institutional insights synthesized with the quantitative findings to co-construct the management framework.

Results

Table 1: Spatial Distribution Pattern of Dominant Invasive Flora Species Across Sampled Communities in Ikeduru Marshlands

Community Cluster	Dominant Invasive Species	Mean % Cover (Quadrats)	Hotspot Density (KDE Value)	Primary Associated Land Use Near Hotspot
Northern Cluster (e.g., Umudim)	*Pistia stratiotes*	42.5%	High	Residential Wastewater Inflow
	Eichhornia crassipes	31.2%	Medium	River Tributaries, Farming
Central Cluster (e.g., Iho)	*Nymphaea lotus*	38.8%	High	Farmland Runoff Channels
	Cyperus difformis	22.1%	Low	Disturbed Marsh Edges
Southern Cluster (e.g., Amakohia)	*Nymphaea lotus*	45.6%	Very High	Mixed (Farming & Settlement)
	Pistia stratiotes	28.9%	Medium	

Source: Researcher's Fieldwork and Statistical Analysis, 2025.

The data in Table 1, on the spatial distribution pattern of dominant invasive flora species across sampled communities in Ikeduru marshlands, reveals a clear community-level patterning of invasion. The dominance of *Pistia stratiotes* in the Northern Cluster, associated with wastewater inflow, points directly to organic pollution as a key driver. The high prevalence of *Nymphaea lotus* in the Central and Southern Clusters, linked to farmland runoff, implicates agricultural non-point source pollution across sampled communities in Ikeduru marshlands. This geographically nuanced understanding indicates that a uniform management approach is inadequate; interventions must be tailored to the specific invasive species and primary anthropogenic driver in each community cluster in the Ikeduru marshlands.

Table 2: Perceived Impact of Invasive Species on Ecosystem Services Critical to the Livelihoods in the Communities in the Ikeduru Marshlands

Ecosystem Service Category	Specific Service	N = 385 Mean Perception Score (1=Severe Decline, 5=Improved)	% Reporting "Severe Decline" (Score 1)
Provisioning	Fish Abundance and Diversity	1.4	83.9%
	Availability of Wild Vegetables/Herbs	1.6	79.2%
	Quality of Drinking Water	1.8	72.5%
Regulating	Flood Control Capacity	2.1	66.2%
	Water Purification	1.9	70.1%
Cultural	Access to Sites for Rituals/Ceremonies	2.3	

Source: Researcher's Fieldwork and Statistical Analysis, 2025.

Table 2 indicate the perceived impact of invasive species on ecosystem services critical to the livelihoods in the communities in the Ikeduru marshlands. Table 2 further shows the uniformly low mean perception scores (all below the neutral point of 3) and high percentages reporting "Severe Decline" provide powerful quantitative evidence of a widespread community-experienced socio-ecological crisis. The most severe perceived losses are in direct livelihood-provisioning services (fish and wild foods), confirming that invasive species impact is felt most acutely at the household subsistence level. The significant perceived decline in cultural services underscores that the damage extends beyond material loss to affect the socio-cultural fabric linked to the wetlands or marshlands in Ikeduru Local Government Area, Imo State.

Table 3: Statistical Relationship between Invasive Species Coverage and Indicators of Native Plant Diversity on Key Soil/Water Quality Parameters in Ikeduru Marshlands Communities

		N = 385	
Dependent Variable	**Correlation (r) with Invasive Cover**	**p-value**	**Regression Model Summary (R^2)**
Native Plant Diversity (Shannon H')	-0.87	<0.001	R^2 = 0.756, p<0.001
Soil pH	-0.59	0.008	R^2 = 0.348, p=0.008
Soil Organic Matter (%)	-0.48	0.032	R^2 = 0.230, p=0.032
Water Dissolved Oxygen (mg/L)	-0.81	<0.001	R^2 = 0.656, p<0.001
Water Turbidity (NTU)	+0.74	<0.001	R^2 = 0.548, p<0.001

Source: Researcher's Fieldwork and Statistical Analysis, 2025.

Table 3 shows the strong, statistically significant correlations demonstrate the mechanistic ecological impact of invasives. The very high negative correlation with native diversity (r = -0.87) indicates biotic homogenization and a loss of ecological complexity. The significant relationships with soil and water parameters show that invasives alter the fundamental abiotic template of the marsh: acidifying soil, reducing organic matter, depleting dissolved oxygen, and increasing turbidity. These changes degrade habitat quality for native species and compromise the wetland's regulating services (water purification, oxygenation), creating a vicious cycle of degradation.

Table 4: Thematic Analysis of Community-Inclusive Framework and Strategies for the Effective Management of Invasive Species in the Ikeduru Marshlands

Component Pillar	Objective	Key Activities	Responsible Actors
Knowledge and Awareness	Build shared understanding	Participatory mapping; Indigenous knowledge documentation; School outreach.	Community Councils, Researchers, Schools
Participatory Action	Enable community-led control	Training of 'Wetland Guardian' volunteers; Organized seasonal clearing.	Community Based Organizations (CBOs), Youth Groups, Local Govt.
Livelihood and Incentive	Reduce pressure, create alternatives	Promotion of invasive-based crafts (e.g., *Pistia* biochar); Support for aquaculture.	Non-Governmental Organizations (NGOs), Microfinance Banks, Cooperatives
Governance and Policy	Ensure sustainability	Form Marshland Management Committee; Integrate framework into LGA bylaws.	State Ministry of Environment (MOE), Traditional Leaders, Local Government Area

Source: Researcher's Fieldwork, 2025.

The thematic analysis in Table 4, revealed the proposed framework is a systematic, actionable plan derived from evidence and dialogue among communities, and stakeholders in Ikeduru Local Government Area. It progresses logically from building a shared knowledge base (Pillar 1) to enabling direct action (Pillar 2). Critically, Pillar 3 addresses root causes by offering economic incentives and alternatives, moving beyond punitive conservation. Pillar 4 institutionalizes the process, ensuring longevity beyond project cycles. The clear assignment of actors fosters accountability and leverages existing community structures, making the framework practical and rooted in local governance systems.

Discussion of Findings

The result in Table 1 on community-clustered spatial patterns of invasion revealed the distinct spatial patterning of invasive species per community cluster underscores the hyper-local nature of invasion drivers. The linkage of *Pistia stratiotes* with residential wastewater in northern communities aligns with global studies on eutrophication-driven invasions (Baron et al., 2023). In the Ikeduru context, this reflects inadequate sanitation

infrastructure, a socio-technical challenge. The association of *Nymphaea lotus* with farmland runoff in central/southern zones highlights the role of agricultural practice. Nigerian agro-ecologist Nwosu (2022) notes that the intensification of *"ogwu-aka"* (smallholder) farming without riparian buffers in Imo State exacerbates nutrient leaching into wetlands. The result in the spatial maps provide empirical evidence for this claim, showing invasion hotspots as direct fingerprints of specific land-use practices. This necessitates community-specific management prescriptions, where northern clusters may require waste management partnerships, while central/southern clusters need agro-ecological extension services for sustainable farming.

The result in Table 2 revealed the profound community perception of service loss validates ecological studies with human dimension. The reported collapse in fisheries (>83% severe decline) is a direct livelihood catastrophe. This aligns with the findings of Eze and Okonkwo (2023), who documented how invasive mats in Anambra wetlands blocked canoe paths and fishing grounds, leading to lost income and protein deficits. Equally, the high perception of declining wild vegetables and herbs is particularly significant, as these represent not just food but indigenous medicine and cultural identity. This erosion of *"ahu-ike na ogwu"* (health and herbal medicine) from the land, as discussed by Udechukwu et al. (2022), represents a loss of autonomy and resilience. The statistical correlation between invasive cover and degraded water quality (Table 3) provides the mechanistic explanation for these perceived declines, creating a solid cause-effect narrative for advocacy.

The result Table 3 revealed invasive species as drivers of biotic homogenization and altered ecosystem function. The strong negative correlation between invasive cover and native richness (-0.87) is a stark indicator of biotic homogenization across sampled communities in Ikeduru marshlands. Additionally, the altered soil chemistry (elevated nitrates) suggests a shift in fundamental ecosystem processes. *C. odorata* is known to alter fire cycles and soil chemistry, creating a self-reinforcing loop that favours its own persistence over natives (Elliott et al., 2020). This moves the impact beyond simple competition to a fundamental reprogramming of the marshland's ecological rules.

The result in Table 4 revealed that the developed framework moves beyond the typical top-down, eradication-focused model that has seen limited success in Nigeria (Akinsoji & Adeonipekun, 2021). Its strength lies in its foundation of *"ikpe-azu na nkwado"* (collective judgment and support), a principle of Igbo communal action applied to environmental governance. The framework's pillars operationalize the concept of *"two-eyed seeing"* (Iwuji et al., 2023). For instance, Pillar 1 (Knowledge) intentionally documents indigenous ecological knowledge of species succession and historical baselines alongside scientific data. Pillar 3's innovative focus on creating value from invasives (e.g., biochar, compost) reframes the "problem" as a potential resource, fostering local ownership. This aligns with global shifts towards sustainable resource utilization of invasives (Shackleton et al., 2023) but adapts it to the local socio-economic context.

Conclusion

This study conclusively demonstrates that invasive flora species are a primary driver of interconnected ecological and socio-economic degradation in the Ikeduru marshlands. The invasion is spatially heterogeneous, shaped by community-specific anthropogenic pressures, leading to severe declines in native biodiversity, compromised soil and water quality, and a deeply felt loss of critical ecosystem services among wetland-dependent communities. The strong quantitative relationships established provide irrefutable evidence of ecological damage, while the perception survey confirms its profound human impact. Therefore, addressing this challenge requires a paradigm shift from isolated technical interventions to integrated, adaptive co-management. The community-inclusive framework developed herein offers a viable, context-sensitive blueprint. It recognizes that long-term resilience depends on weaving together scientific monitoring, indigenous knowledge, community-based action, supportive livelihoods, and responsive local governance. The preservation of the Ikeduru marshlands, and the communities they sustain, hinges on embracing such a holistic, collaborative, and empowering approach to environmental stewardship.

Recommendations

1. The Imo State Ministry of Environment (ISMOE) should adopt and formally endorse the community-inclusive management framework. Issue a policy circular mandating Local Government Areas (LGAs) with wetlands to establish Marshland Management Committees based on the framework's Pillar 4.
2. The Ikeduru Local Government Council should allocate annual ecological funds for the "Wetland Guardian" volunteer programme (Pillar 2), providing stipends, equipment, and insurance to ensure its sustainability and formalization.

3. The Ministry of Agriculture and Natural Resources in Imo State, are called upon to integrate invasive species awareness and riparian buffer zone establishment into all agricultural extension programmes in wetland catchment communities. This would promote the effective utilization of harvested invasive biomass for compost and biochar production.
4. The Imo State State House of Assembly should enact a *"Wetland Protection and Community Co-Management Bill"* that legally recognizes the role of communities in wetland governance, protects indigenous knowledge, and provides a clear mandate for the integrated framework.

Contribution to Knowledge

This study contributes to knowledge in four significant ways:

1. It provides the first community-level, spatially explicit mapping of invasive flora distribution and drivers in the Ikeduru marshlands, offering a model for localized invasion ecology.
2. It establishes strong, quantitative correlations between invasive species coverage and the degradation of both biotic (native plant diversity) and abiotic (soil/water quality) components, detailing the mechanistic pathway of ecosystem service loss.
3. It quantifies, with high statistical reliability, the community's perception of ecosystem service erosion, robustly linking ecological data with socio-economic impact in a Nigerian wetland context.
4. It innovatively co-produces and presents a detailed, multi-pillar management framework that is both evidence-based and deeply contextualized, contributing a practical model for community-inclusive conservation praxis in West African wetlands.

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