Restoration as a Pathway to Invasion: Early Management of Scaevola taccada in a Protected Restinga

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Abstract

Biological invasions are a leading direct driver of biodiversity loss in coastal ecosystems worldwide, undermining conservation investments and the effectiveness of protected areas. Here, we report the first occurrence and incipient invasion of the Indo-Pacific shrub *Scaevola taccada* in a legally protected coastal reserve in southeastern Brazil and quantify its early spread relative to the rare native congener *S. plumieri*. Using systematic shoreline transects and georeferenced mapping, we detected 12 shrubs of the exotic species and only a single large individual of the native species, and classified *S. taccada* as a dominant invader according to a widely used decision key for invasive plant management. Our results show how canopy opening associated with tree-invader removal can inadvertently create establishment opportunities for new invasive species, illustrating a general restoration–invasion trade-off that is relevant for coastal management far beyond Brazil. Building on global evidence for the cost-effectiveness of early detection and rapid response, we provide a practical identification key, a spatially explicit baseline for eradication, and management recommendations aligned with national guidelines for invasive plant control. This case demonstrates how integrating historical herbarium data, targeted surveys, and reserve staff participation can transform an isolated "first record" into a model for proactive management of emerging coastal invaders in protected areas worldwide.

Introduction

Restingas are ecologically important coastal ecosystems primarily found along the Brazilian shoreline. Their vegetation communities thrive on sandy marine deposits aligned parallel to the coast (Araujo, 2000). These ecotones between oceanic and terrestrial environments experience extreme conditions. The ecotone has nutrient-poor, acidic soils, high salinity, strong coastal winds, and limited water availability. Despite these harsh circumstances, restingas support a diverse array of plant communities that have adapted through specialized physiological, anatomical, and morphological strategies (Pimentel et al., 2007). Spanning approximately 7,360 km of Brazil's coastline, restingas include a wide variety of vegetation types, from pioneer herbaceous plants and shrublands on actively shifting dunes to mature forests on stabilized sandy plains. The structure and floristic composition of these ecosystems vary across different spatial and temporal scales (Loureiro et al., 2021).

Restingas are highly valued not just for their botanical and ecological significance but also for their role in coastal stabilization, protection against storm surges and tidal variations, and support of biodiversity. They provide essential ecosystem services, including water regulation, nutrient cycling, and habitat for native species facing extinction risks (Pimentel et al., 2007). According to Brazilian Federal Law 12,651/2012, restingas are legally protected ecosystems due to their importance as meeting points for various phytogeographical domains. This underscores the significance of targeted ecological research to understand species adaptation, community formation, and ecosystem resilience in the context of coastal urbanization, land-use modifications, and climate change (Araujo, 2000; Pimentel et al., 2007). In the restingas, nearest to the shoreline, the halophilic-psamophilic vegetation comprises shrubs, herbs, and grasses, with species adapted to high salinity and sandy soils with low water retention (Araújo &

Oliveira, 1987; Menezes & Araújo, 1999). Immediately beyond this zone, psamophilic species include native plants such as *Scaevola plumieri*, a creeping subshrub.

For over 60 years, the restinga vegetation was dominated by trees forming dense canopies: *Mimusops coriacea* (Sapotaceae) and *Terminalia catappa* (Combretaceae) prevented sunlight from reaching the ground, hindering the development of native species (Silva & Pampolha, 2023). This caused a decline in plant diversity beneath the canopies of these invasive trees. Nevertheless, restoration efforts began in 2023 on 7,500 m² of the State Biological Reserve of Praia do Sul (RBEPS) to prevent the regrowth and dominance of these invasive trees. As the invasive trees were gradually removed, the canopy opened, allowing halophilic-psamophilic plants from adjacent areas to reestablish on the sandy soil. These plants returned from nearby patches and resprouted from roots and propagules carried by animals, wind, and the sea. In this context, two species of the genus *Scaevola* thrived in the managed restinga: the introduced *Scaevola taccada* (Gaertn.) Roxb., and the native from Brazil, *Scaevola plumieri* (L.) Vahl.. Congeneric pairs of *Scaevola* species thrive in tough coastal environments. They play fundamental roles in dune formation and stabilization, enduring salt spray and saline soils, which are vital for survival in coastal regions exposed to the sea.

The native *S. plumieri* is predominantly found along Brazil's coast (Araújo & Oliveira, 1987; Silva & Melo, 2016; Martins, 2012). In contrast, the introduced *S. taccada* forms dense thickets, outcompetes native species, and alters dune and ecosystem functions in invaded areas (Castillo-Campos et al., 2022; Swensen et al., 2024). Both species are crucial for the development and stabilization of dunes, as they flourish in environments characterized by high salt tolerance and exposure to wind and sand. Their seeds can disperse over considerable distances via water and avian vectors, and the plants propagate via both vegetative means and seed dispersal (Swensen et al., 2024). Consequently, in tropical coastal regions where it is invasive, *S. taccada* disrupts native plant communities and ecosystem functions, causing impacts on wildlife, including sea turtles (Swensen et al., 2024), which also inhabit the study area. In this manner, the early identification of invasive plant species facilitates a prompt response to contain or eliminate them prior to their dissemination, thereby preventing ecological damage. Once invasive species become widespread, their eradication proves more challenging, and the associated management costs rise considerably. Consistently, early intervention has proven to be more effective and cost-efficient than controlling invasions that are already well-established (Reaser et al., 2019; Larson et al., 2020; Tataridas et al., 2022; Noar et al., 2021; Kendig et al., 2022).

Consequently, environmental management must go beyond merely removing invasive species; it should also encompass strategies for monitoring and managing these species post-removal to prevent their return and aid in the recovery of native plant communities (Spear et al., 2013; Dechoum et al., 2015; Khaniya & Shrestha, 2020; Martin et al., 2010; Schuster et al., 2020; Carmes et al., 2025). Invasive alien plants are now recognized as one of the most significant threats to coastal ecosystems worldwide (Florens et al., 2016). This threat is especially pronounced on oceanic islands and sandy shorelines, where disturbance, long-distance dispersal, and human introduction pathways converge, allowing woody and shrubby invaders to rapidly transform open dune and strand vegetation into dense thickets. This transformation has a cascading effect on native plant diversity, dune geomorphology, and the animals inhabiting these areas, such as sea turtles and coastal birds (Castillo-Campos et al., 2022; Swensen et al., 2024).

Current policies and management strategies for invasive species focus on early detection and quick response (EDRR). The rising costs and ecological damage associated with species that become widespread and established (Reaser et al., 2019; Larson et al., 2020; Tataridas et al., 2022; Noar et al., 2021; Kendig et al., 2022). Despite the importance of EDRR, well-documented case studies that link initial detection, invasion assessment, and actual management actions in protected coastal environments are scarce. In this way, *Scaevola taccada* serves as an ideal model for exploring these challenges, as it invades numerous tropical and subtropical coastal regions, where it has displaced native species, altered strand vegetation, and prompted regulatory bans and strict planting restrictions (Lach et al., 2010; Castillo-Campos et al., 2021, 2022; Swensen et al., 2024). In contrast, its invasion in Brazil remains at an early stage, and the study area still hosts the native *S. plumieri*, which was previously regarded as rare but is now increasingly a conservation concern in some areas of its Brazilian distribution. This stark contrast between advanced invasion fronts elsewhere and a new invasion in Brazil presents a brief opportunity to apply lessons from other regions to enhance national and regional management before *S. taccada* becomes prevalent along the Atlantic coast.

This study sought to document, for the first time, the presence of *Scaevola taccada* in the restinga regions of southeast Brazil, assess the extent and stage of the invasion, and propose strategies for eradicating the species from a fully protected coastal reserve. By clearly linking the invasion patterns of *S. taccada* in this area to its global spread and by adhering to principles of early detection and rapid response, we aim to derive management insights applicable to coastal protected areas and restoration programs worldwide.

Material and Methods

Study Site

The Reserva Biológica Estadual da Praia do Sul (State Biological Reserve of Praia do Sul – RBEPS) is a fully protected reserve. In Brazil, various types of reserves and protected areas exist, with Biological Reserves being a category specifically designed to ensure the complete preservation of ecosystems through minimal human interference and environmental alteration, except for protective measures and efforts to restore biological diversity and ecological processes (Brasil, 2000). Within its boundaries, construction, housing, and public visits are prohibited. The reserve encompasses an area of 3,309.63 hectares on Ilha Grande in the municipality of Angra dos Reis, Rio de Janeiro state (Figure 1). It covers a broad spectrum of ecosystems, from dense ombrophilous forests to secondary forests, herbaceous formations, rocky outcrops, restingas, mangroves, and beaches, thereby conserving 18% of Ilha Grande’s total area (Alho et al., 2002).

The study focused on the strip of sand nearest to the sea, the pioneer zone of plants adapted to high salinity and bare sand soil with low fertility and high drainage capacity (Araújo & Oliveira, 1987; Menezes & Araújo, 1999). In 1984, Araújo and Oliveira collected a specimen of *S. plumieri* from Praia do Sul, which was deposited at the RB herbarium (at the Botanical Garden of Rio de Janeiro) and noted as a rare plant. These historical data suggest a long-standing low population in the region, corroborated by recent data from the neighboring state of Espírito Santo, where the plant is now considered vulnerable. Herbarium records from Rio de Janeiro are sparse, dated, and originate from areas that currently have significantly diminished restinga due to land conversion, further confirming the rarity and population decline of the species.

Archaeological sites associated with Indigenous peoples are found within the reserve. A floristic survey conducted in 1987 identified 302 plant species, with Fabaceae, Rubiaceae, Orchidaceae, and Bromeliaceae being the most prominent families in RBEPS; no exotic species were mentioned at the time, although *Scaevola plumieri* was recorded (Araújo & Oliveira, 1987). In 2022, 161 exotic plant species were identified along the whole island (Barros et al., 2022). The reserve has implemented an Action Plan for managing invasive exotic species (INEA, personal communication) and is actively working to eradicate two problematic tree species, *Mimusops coriacea* and *Terminalia catappa*, which transform the restinga by converting sunny, treeless environments into shaded forests.

The ecological and management setting of RBEPS is representative of many coastal protected areas worldwide that simultaneously face pressures from historical land-use change, ongoing urbanization, and biological invasions. As in other tropical and subtropical coastal reserves, managers at RBEPS must balance the restoration of native open-canopy vegetation with the risk of facilitating secondary invasions when dense tree stands are thinned or removed (Spear et al., 2013; Dechoum et al., 2015; Joshi et al., 2015; Schuster et al., 2020; Khaniya & Shrestha, 2020). This context makes the reserve an informative case study for understanding how restoration actions interact with invasion risk and how monitoring protocols can be designed to detect and contain new invaders such as *S. taccada* in time.

Exotic Species

Scaevola taccada (Goodeniaceae), known as beach naupaka, is a coastal shrub native to the Pacific and Indian Ocean shorelines, originating in Australia and subsequently dispersing throughout the Indo-Pacific region (Banerjee et al., 2021; Howarth et al., 2003; Shi et al., 2014; Meng et al., 2025). The native range extends from eastern Africa through tropical Asia to Australia and numerous Pacific islands. Both vegetative reproduction and seed-based propagation facilitate the spread and colonization of new areas (Castillo-Campos et al., 2022; Swensen et al., 2024). *S. taccada* has become invasive on several Caribbean islands, including Cozumel, Puerto Rico, the Bahamas, and the Cayman Islands, displacing native coastal flora such as *S. plumieri* and modifying plant community structures and diversity (Castillo-Campos et al., 2021, 2022; Swensen et al., 2024). Introduced in the 1960s for landscaping and erosion control, it is presently classified as a Category 1 invasive exotic species in Florida (Swensen et al., 2024). It is also invasive on various Indian Ocean islands, where it interacts with native flora and fauna, sometimes aided by invasive ants (Lach et al., 2010). In Brazil, the invasion of *S. taccada* is still at an early stage, making effective control still feasible.

Native Species

Scaevola plumieri is native to tropical coastal regions of the Atlantic and Indian Oceans and is one of the few species in its genus that is not native to Australia. Although the genus *Scaevola* originated in Australia, *S. plumieri* is a pantropical coastal species with a wide native distribution across multiple continents, except Oceania, primarily inhabiting coastal sand dunes and beach zones in tropical and subtropical regions (Howarth et al., 2003). In Brazil, *S. plumieri* is found in sandy coastal regions, particularly in restinga habitats, including the states of Rio de Janeiro, Espírito Santo, Santa Catarina, and Bahia (Araújo & Oliveira, 1987; Guarnier et al., 2022).

Data Collection

To assess the extent of the invasion, four transects were established along Praia do Sul beach, from one end to the other, spaced 5 m apart to cover the entire restinga. A systematic search for species of the genus *Scaevola* was conducted along each transect. Every encountered specimen was georeferenced to determine its precise location for future control efforts. We measured the crown projection area and the average height of each shrub (Supplementary Material, Table SM1). To measure crown projection area, the longest diameter (d_1) and the perpendicular diameter (d_2) of the shrub crown were identified and measured from drip line to drip line using a measuring tape on level ground. Crown area (A) was then calculated using the ellipse approximation formula:

$$A = \pi \times (d_1/2) \times (d_2/2)$$

Specimens were collected for herbarium deposition, and exsiccatae were prepared for both species. Species were classified according to their invasion status using the dichotomous key proposed by Durigan et al. (2013), which categorizes exotic species based on the potential threats they pose to native biodiversity and ecosystem services in the region, ranging from occasional exotics to dominant invaders.

Results

A total of 12 bushes of the exotic species (*S. taccada*) were found along the beach, while only one bush of the native species (*S. plumieri)* was identified (Supplementary Material, Table SM1). The mean height of *S. taccada* shrubs was 1.6 m (SD ± 0.93), and mean canopy area was 10.8 m² (SD ± 14.5), with canopy areas ranging from 1.3 to 47.1 m². The single individual of *S. plumieri* was 0.6 m tall with a crown area of 23.6 m².

Please insert the map here (Fig. 1**)**

Following the key provided by Durigan et al. (2013), we classified *S. taccada* as a dominant invader that spreads and alters the composition or structure of the native plant community, suppressing the regeneration of native species. *S. plumieri* was classified as a wild native species.

The small number of *S. taccada* individuals detected, combined with their relatively large canopy areas and the classification of the species as a dominant invader, indicates that the invasion at Praia do Sul is at a nascent but potentially rapidly expanding stage. This configuration—a limited number of established, reproductive shrubs of a known high-impact invader—matches the "containment and eradication feasible" window emphasized in EDRR frameworks (Reaser et al., 2019; Tataridas et al., 2022). From a management perspective, our georeferenced distribution and trait data provide precisely the type of baseline information required to implement targeted removal, monitor reinvasion, and evaluate the effectiveness of control actions—steps that are directly transferable to other coastal protected areas dealing with emerging plant invasions.

Table 1
Traits of the exotic species (*S. taccada*) and native species (*S. plumieri*) to help differentiate them in the field.

Trait	***Scaevola taccada***	***Scaevola plumieri***	**Source**
Growth form	Erect shrub (> 1 m)	Prostrate, creeping shrub	(Jayasuriya, 2006; Swensen et al., 2024)
Leaf size/texture	15–21 cm, papery, rosettes	≤ 8 cm, leathery, rounded	(Jayasuriya, 2006)
Fruit color	White	Red/Black	(Jayasuriya, 2006)
Corolla features	Purple streaks	Fringed lobes	(Swensen et al., 2024)

Please insert Fig. 2 **here**

Comparing the exotic *S. taccada* with the native *S. plumieri* reveals clear botanical differences (Table 1, Fig. 2). *S. taccada* generally grows as a large, upright shrub over 1 m tall, whereas *S. plumieri* has a prostrate growth form (Fig. 2a,b). Leaf shapes also differ significantly: *S. taccada* has larger, papery leaves about 15–21 cm long, usually clustered in rosettes, whereas *S. plumieri* has smaller, rounded, leathery leaves that do not exceed 8 cm (Fig. 2c,d). The fruits also differ, with *S. taccada* producing white drupes and *S. plumieri* producing red to black drupes when ripe (Fig. 2g,h). *S. taccada* flowers exhibit purple streaks that are absent in *S. plumieri*, whose corolla lobes appear fringed (Fig. 2e,f).

The herbarium voucher RBR00062591 (https://rbr.jbrj.gov.br/v2/ficha.php?chtestemunho=62591&sigla=RBR) represents the first record of *S. taccada* in Brazil. In contrast, *S. plumieri* (voucher RBR00062592; https://rbr.jbrj.gov.br/v2/ficha.php?chtestemunho=62592&sigla=RBR) has multiple collections documented along the Brazilian coastline.

Discussion

Our findings illustrate how even a small, localized population of an invasive shrub can pose a disproportionate threat in coastal protected areas when the invader has a well-documented history of ecosystem transformation elsewhere. In Florida, the Caribbean (invaded range), and parts of the Indian Ocean (native range), *S. taccada* has formed dense stands that displace native strand vegetation, modify dune structure, and interfere with wildlife habitat, leading to its classification as a high-priority invasive species subject to planting bans and active control (Lach et al., 2010; Castillo-Campos et al., 2022; Swensen et al., 2024). Detecting the species at an early stage in Brazil, before similar impacts have occurred, demonstrates the practical value of integrating global horizon-scanning information with local field surveillance in coastal reserves (Kendig et al., 2022). This proactive alignment between global risk assessments and local monitoring is central to modern invasive species governance and provides a model for other regions where coastal invaders are just beginning to establish.

The sequence observed at Praia do Sul—removal of invasive trees, increased light availability, and subsequent establishment of a new invasive shrub—exemplifies a broader pattern in which restoration actions can inadvertently create opportunities for secondary invasions. Studies from forests and other ecosystems have repeatedly shown that reductions in canopy cover and changes in resource availability can favour fast-growing invasive species over slower native species, particularly when propagule pressure from exotic species is high (Dechoum et al., 2015; Joshi et al., 2015; Martin et al., 2010; Schuster et al., 2020; Khaniya & Shrestha, 2020). In coastal zones, where propagules of strand species can arrive by sea, wind, or birds, this risk is amplified. Thus, our case reinforces the need to systematically integrate invasion-risk assessments and targeted post-restoration monitoring into the planning of tree removal and other restoration interventions, not only in Brazilian restingas but also in similar coastal restoration programs globally.

Another key aspect is how historical herbarium records and local reserve staff helped early detection and understanding of the invasion. The rarity status of *S. plumieri* at Praia do Sul was initially inferred from historical collections and floristic surveys (Araújo & Oliveira, 1987), and was later corroborated by recent checklists indicating population decline and vulnerability in parts of its range (Guarnier et al., 2022). At the same time, the discovery and mapping of *S. taccada* relied on collaboration with rangers and the implementation of systematic transects across the restinga. This combination of historical botanical information, on-the-ground knowledge, and structured field surveys aligns closely with emerging best practices in EDRR that emphasize multiple detection pathways (professional surveys, citizen science, automated tools) and feedback loops between science and management (Reaser et al., 2019; Larson et al., 2020; Espitalier et al., 2025). Similar integrative approaches could be adopted in other coastal protected areas to increase the likelihood of detecting high-risk invaders before they become widespread.

The management response underscored here emphasizes the importance of prioritizing invasive species that may not yet cause perceptible economic harm but possess significant ecological impacts. For example, *Scaevola taccada* currently does not cause significant economic losses, which may result in its being neglected in policy and funding considerations. Once widespread, a species' ecological impacts on native plants, geomorphology, and coastal biodiversity can be profound and irreversible (Castillo-Campos et al., 2022; Swensen et al., 2024). Our classification, based on Durigan et al. (2013), shows how ecological risk tools guide decision-making, enabling early eradication and preventing long-term biodiversity loss in protected areas.

We also found that *S. taccada* is absent from recent surveys of exotic plant species on Ilha Grande (Callado et al., 2022) and in the state of Rio de Janeiro (Bergallo et al., 2021). Historically, the native species *S. plumieri* was categorized as rare in a 1984 survey (Araújo & Oliveira, 1987). In 2022, the state environmental agency began removing the invasive trees *Mimusops coriacea* and *Terminalia catappa* to restore the restinga ecosystem (Silva & Pampolha, 2023). This intervention created canopy gaps that increased light availability, conditions favourable for the germination and establishment of both native and invasive species (Spear et al., 2013; Dechoum et al., 2015). Invasive species tend to exploit such disturbances efficiently, often growing faster than native species (Joshi et al., 2015; Martin et al., 2010; Schuster et al., 2020). For instance, studies have demonstrated that invasive plant richness increases as canopy cover diminishes, reinforcing the notion that forest canopy openings significantly facilitate invasions (Khaniya & Shrestha, 2020; Lopez, 2012). This dynamic was observed in the restinga following the removal of invasive trees, which transitioned the environment back to its original open, shrubby, heliophytic landscape.

In areas invaded by *S. taccada*, species turnover can reach 34%. Reducing plant cover and threatening native species such as *S. plumieri*, which is critically endangered in some areas due to competition with *S. taccada* (Castillo-Campos et al., 2022; Swensen et al., 2024). Although both species share pollinators, direct competition for pollination appears minimal; however, heterospecific pollen deposition may impair the reproductive success of native plants (Swensen et al., 2024). These factors underscore the need for conservation efforts to mitigate further declines.

Because of the threats they pose to native coastal ecosystems, planting, selling, or propagating *Scaevola taccada* is illegal in Florida and throughout the Caribbean. These regions enforce bans or discourage cultivation in protected areas to protect native species (Swensen et al., 2024). In places like Cozumel's biosphere reserves, efforts focus on controlling and preventing *S. taccada* to preserve biodiversity, even where no legal bans exist (Castillo-Campos et al., 2022; Swensen et al., 2024). Given *S. taccada*'s invasive characteristics and its harmful impact on native plant diversity and ecological interactions, removing it from reserves like RBEPS—where native species such as *S. plumieri* still flourish—is vital to maintaining healthy ecosystems and biodiversity. Implementing rigorous management and conservation efforts to eradicate *S. taccada* is essential to prevent further ecological damage and support the recovery and persistence of native plant communities. Addressing the ecological risks posed by invasive plant species, particularly their capability to adapt quickly and displace native flora, emphasizes the importance of timely and precise detection for effective management strategies (Espitalier et al., 2025). We recommend removing invasive exotic species as promptly as possible to prevent the population expansions observed in other coastal regions (e.g. Florida, Cozumel, Puerto Rico). Removal techniques can adhere to the guidelines from the Brazilian Ministry of the Environment (MMA,2023), which currently recommend either foliar spraying of glyphosate diluted to 4% or manual uprooting. Both methods should be carefully tested on *S. taccada* to prevent resprouting of branches and the establishment of new individuals. Additionally, the production and planting of native species seedlings should be encouraged during restoration efforts in the restinga. Although the specific control recommendations we discuss are based on Brazilian federal guidelines for invasive plant management (MMA, 2023), the decision logic and operational steps are broadly applicable elsewhere. In particular, the use of small, spatially explicit populations as test cases for evaluating chemical versus manual control, the emphasis on preventing resprouting and reinvasion, and the parallel promotion of native plant propagation and planting are consistent with international guidance for invasive plant management in protected areas. By providing detailed information on plant traits, field identification, and the spatial pattern of *S.taccada* in a restinga reserve, this study offers a practical template that can be adapted by managers of similar coastal systems dealing with early invasions of woody shrubs or trees, regardless of the specific species involved.

Conclusion

The early detection of *Scaevola taccada* in the Praia do Sul State Biological Reserve demonstrates that timely, targeted action can still prevent a high-risk coastal invader from becoming entrenched in southeastern Brazil. Detecting only 12 bushes of the exotic species alongside a single large individual of the native *S. plumieri* indicates that eradication is currently feasible and that management actions taken now can avoid the severe ecological impacts documented in other regions where *S. taccada* has become widespread. By combining historical herbarium records, systematic field surveys, and collaboration with reserve staff, we converted an isolated “first record” into an operational baseline that directly supports eradication planning, post-removal monitoring, and restoration of native strand vegetation. More broadly, this case illustrates three key lessons for environmental managers and conservation practitioners globally. First, integrating invasion-risk considerations into coastal restoration projects is essential to avoid secondary invasions following canopy opening or other interventions. Second, early detection and rapid response systems that leverage both scientific and local knowledge can dramatically reduce the long-term costs and ecological damage of plant invasions. Third, invasive species that primarily pose ecological rather than economic threats, such as *S. taccada* in Brazilian restingas, must be recognized and prioritized within decision frameworks that explicitly value biodiversity and ecosystem function. By acting during this narrow window of opportunity, managers in Brazil—and in other coastal regions facing emerging invasions—can safeguard native strand vegetation and contribute to global efforts to reduce the spread and impact of invasive alien species in protected areas.

Statements & Declarations

FAPERJ (Fundação Carlos Chagas de Amparo à Pesquisa do Estado do Rio de Janeiro) supported project E-26/210.328/2022, which funded the fieldwork. INEA (Instituto Estadual do Ambiente) provided logistical support for the fieldwork.

Ethics and Consent to Participate declarations

not applicable.

Data availability statements

All data supporting the findings of this study are available within the paper and its Supplementary Information.

Declarations

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Author Contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by RCRA, RMCS and GPD. RZZ identified the exotic species during the fieldwork. GPD designed figures 1 and 2. The first draft of the manuscript was written by RCRA and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability

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Figures

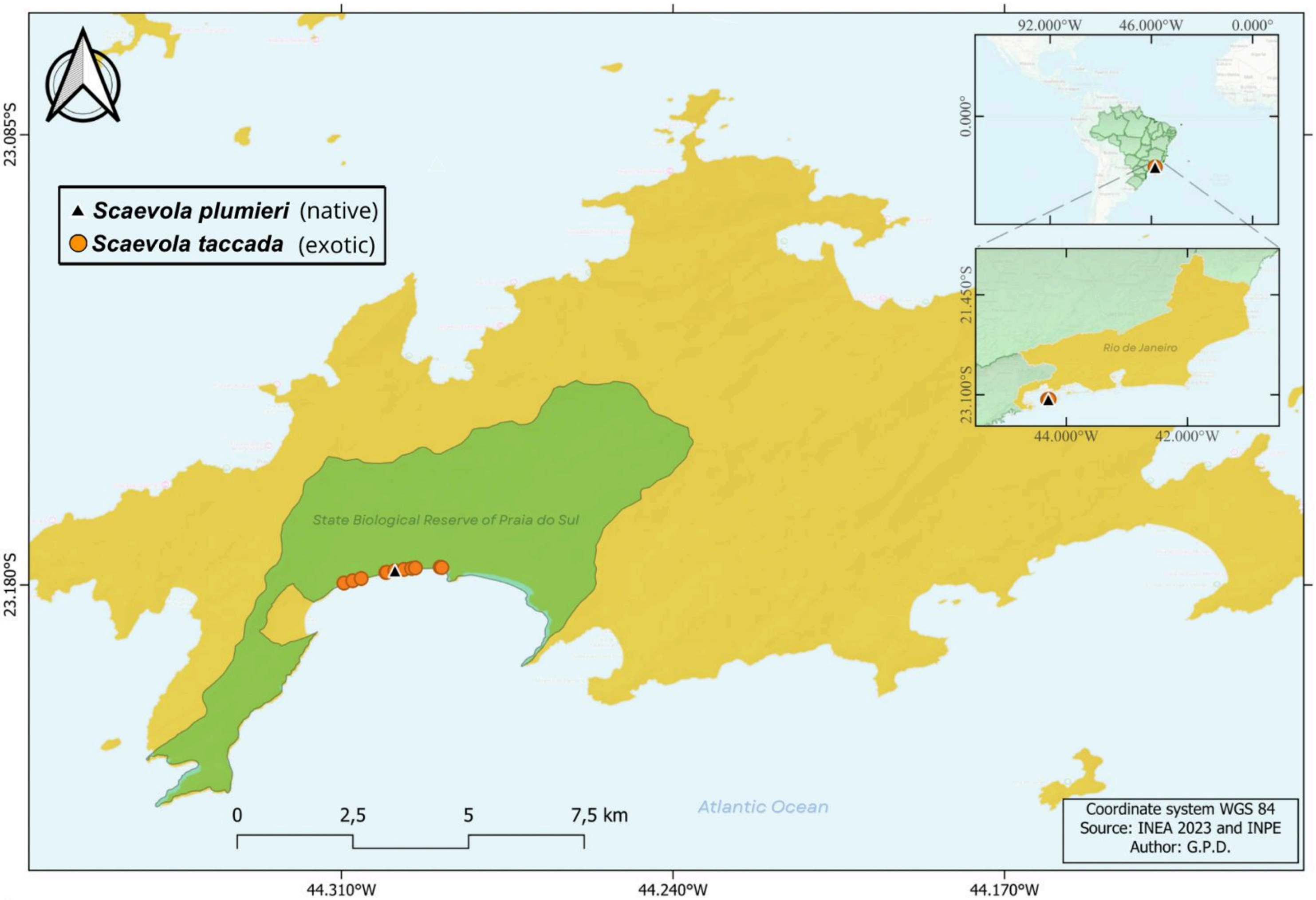

Figure 1

Study site and sampling points featuring the invasive plant, *Scaevola taccada* (red dots), and the native plant, *Scaevola plumieri* (yellow dot), at the South Beach – RBEPS Biological Reserve, Ilha Grande – Angra dos Reis, Brazil.

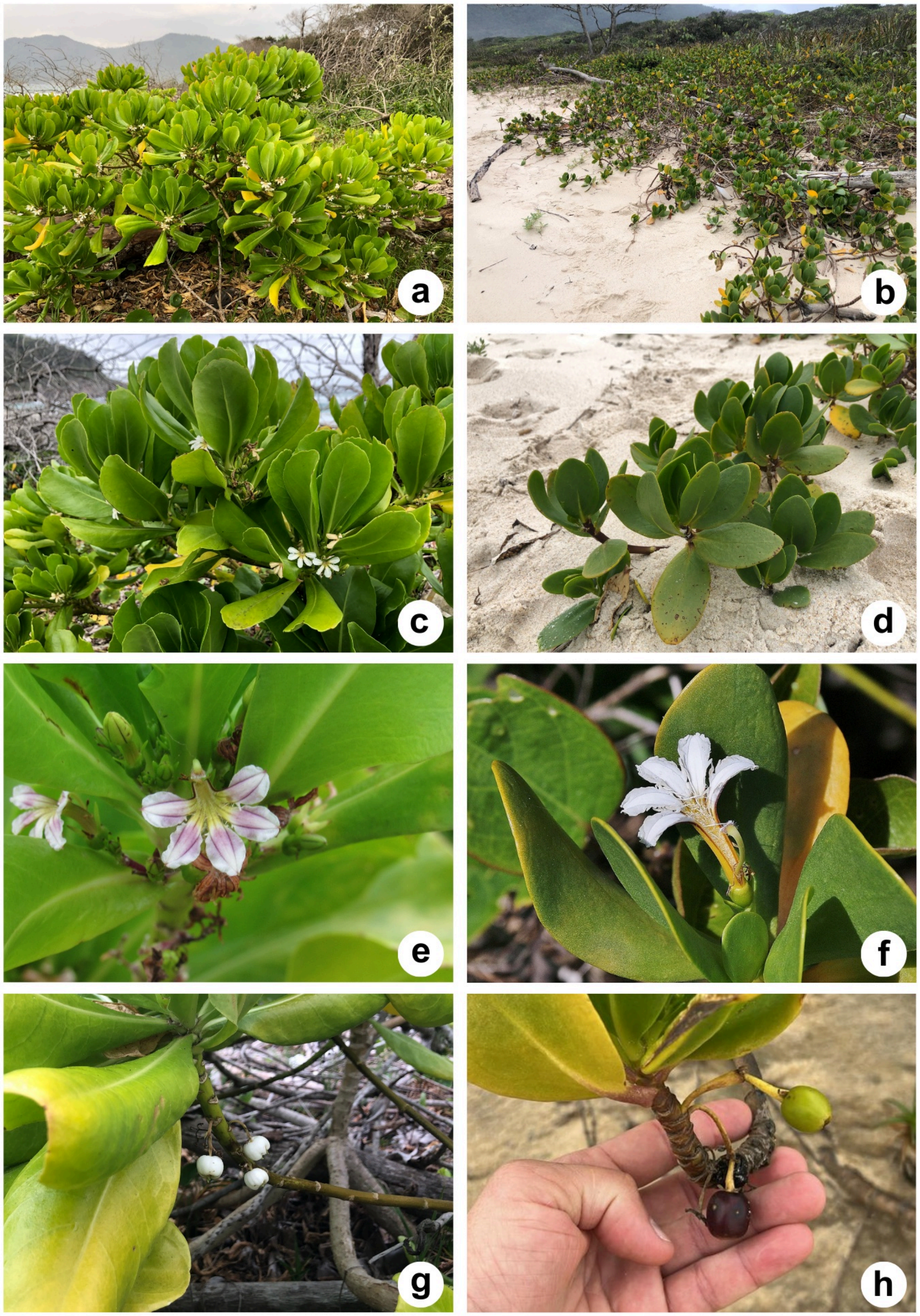

Figure 2

The exotic species *Scaevola taccada* (left) and the native species *Scaevola plumieri* (right). (a) and (b) show general views of their growth forms; (c) and (d) depict branches and leaves; (e) and (f) illustrate flowers; (g) and (h) display fruits.

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