# Ecological Restoration Plan for Historical Brickell Hammock
# Alice C. Wainwright Park, City of Miami, Florida

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## Introduction

This ecological restoration plan for the remnant native ecosystems within Alice C. Wainwright Park (AWP) in the City of Miami (City), Florida, has been prepared by The Institute for Regional Conservation (IRC) per agreement with the City. These native ecosystems are protected through the 11.25 acre designated Natural Forest Community (NFC) that dominates much of the park. Containing a key remnant patch of historical Brickell Hammock, once the largest tropical forest on the mainland of the continental United States, AWP is a high value asset of the City of Miami with regional, state, and national importance. In addition to the intrinsic value of the native ecosystems themselves, they are also habitat for at least 20 state-listed plants and numerous native wildlife species including songbirds and butterflies. Until recently, it was the sole known location in North America for one Florida endangered plant species (*Tropidia polystachya*). Furthermore, AWP delivers numerous ecosystem services to the residents and visitors of the City of Miami, including climate change mitigation, filtration of air pollution, open green space, and outdoor recreational opportunities, and contains an important prehistoric and historic archaeological site (Carr et al. 2016). This plan provides recommendations for the ecological restoration and ongoing management of the remnant native tropical hardwood hammock, or rockland hammock, and adjoining ecotonal coastal ecosystems. It focuses on the treatment of invasive species and the natural recovery of desired native species wherever possible, supplemented by the augmentation, reintroduction, or introduction of native species where needed and appropriate. This plan was jointly developed by IRC and the City of Miami, and conforms with the City of Miami's *Miami Parks and Public Spaces Master Plan*. It is informed by meetings between the City and IRC and by several site visits by the authors and City of Miami staff in 2022 and 2023.

The guidance presented herein is consistent with the Society for Ecological Restoration's International Principles and Standards for the Practice of Ecological Restoration (Fig. 1, Table 1; Gann et al. 2019, hereafter SER Standards), invasive plant best management practices in Florida (e.g., Enloe et al. 2018), and the recommendations of the archeological consultants. The SER Standards recommend the identification of target native reference ecosystems and conditions informed by reference models based on multiple indicators of six key ecosystem attributes (Table 1), which are discussed below. The SER Standards also call for meaningful, informed, reciprocal engagement with key stakeholders, preferably at the initial planning stage of a restoration project and continuing throughout the duration of a project or program.

The plan is informed by decades of experience by the lead author in rockland hammock restoration and *Guidelines for planting a rockland hammock in South Florida*. Plant names and data reported here are consistent with the Floristic Inventory of South Florida (FISF) database online (Gann et al. 2023b), which has been maintained by IRC continuously since 2001. As part of the FISF, IRC has compiled historical floristic date for AWP, although some of these data are of plants observed within the park but outside of the NFC; floristic data for the park can be found here.


**Figure 1. Eight principles for ecological restoration (reprinted from Gann et al., 2019).**

**Table 1. Description of the key ecosystem attributes used to characterize the reference ecosystem, as well as to evaluate baseline condition, set project goals, and monitor degree of recovery at a restoration site. These attributes are suited to monitoring in Principle 5 and the Five-star System discussed in Principle 6. Descriptions in this table represent a 5-star condition. Reprinted from Gann et al. 2019.**

| Attribute | Description |
|---|---|
| Absence of threats | Direct threats to the ecosystem such as overutilization, contamination, or invasive species are absent. |
| Physical conditions | Environmental conditions (including the physical and chemical conditions of soil and water, and topography) required to sustain the target ecosystem are present. |
| Species composition | Native species characteristic of the appropriate reference ecosystem are present, whereas undesirable species are absent. |
| Structural diversity | Appropriate diversity of key structural components, including demographic stages, trophic levels, vegetation strata, and spatial habitat diversity are present. |
| Ecosystem function | Appropriate levels of growth and productivity, nutrient cycling, decomposition, species interactions, and rates of disturbance. |
| External exchanges | The ecosystem is appropriately integrated into its larger landscape or aquatic context through abiotic and biotic flows and exchanges. |

# Assessment

## Historical Context and Overview

The 11.25 acres of NFC at Alice Wainwright Park represent a small remnant of the approximately 1000-acre Brickell Hammock tropical forest and associated coastal ecotone that once stretched from the south bank of the Miami River south to Coconut Grove and west to west of present-day US 1 (Fig. 2-3). The first wagon road from Miami to Coconut Grove was built in 1892 (Smiley 1973), beginning the process of conversion of Brickell Hammock to modern human uses. Other important patches of Brickell Hammock have been preserved at Simpson Park (8.33 acres; City of Miami) and Vizcaya Museum and Gardens (15.5 acres; Miami-Dade County). Thus, due to pressures of urban development, only 35 acres of historical Brickell Hammock are publicly protected and under NFC designation, making the remnant hammock at AWP exceptionally valuable. Brickell Hammock was also once part of a regional landscape dominated by pine rockland forests, hammocks, and wetland drainageways that stretched from north of the Miami River south to Long Pine Key in what is now Everglades National Park; immediately to the east is Biscayne Bay, a saltwater body with historical freshwater springs along its western edges, including the Punch Bowl, which was located just south of AWP (Fig. 4). Due to the development of urban Miami, AWP is highly isolated from other upland native ecosystems, with extremely low connectivity to beneficial external ecological exchanges and highly vulnerable to external threats such as invasions by nonnative species.

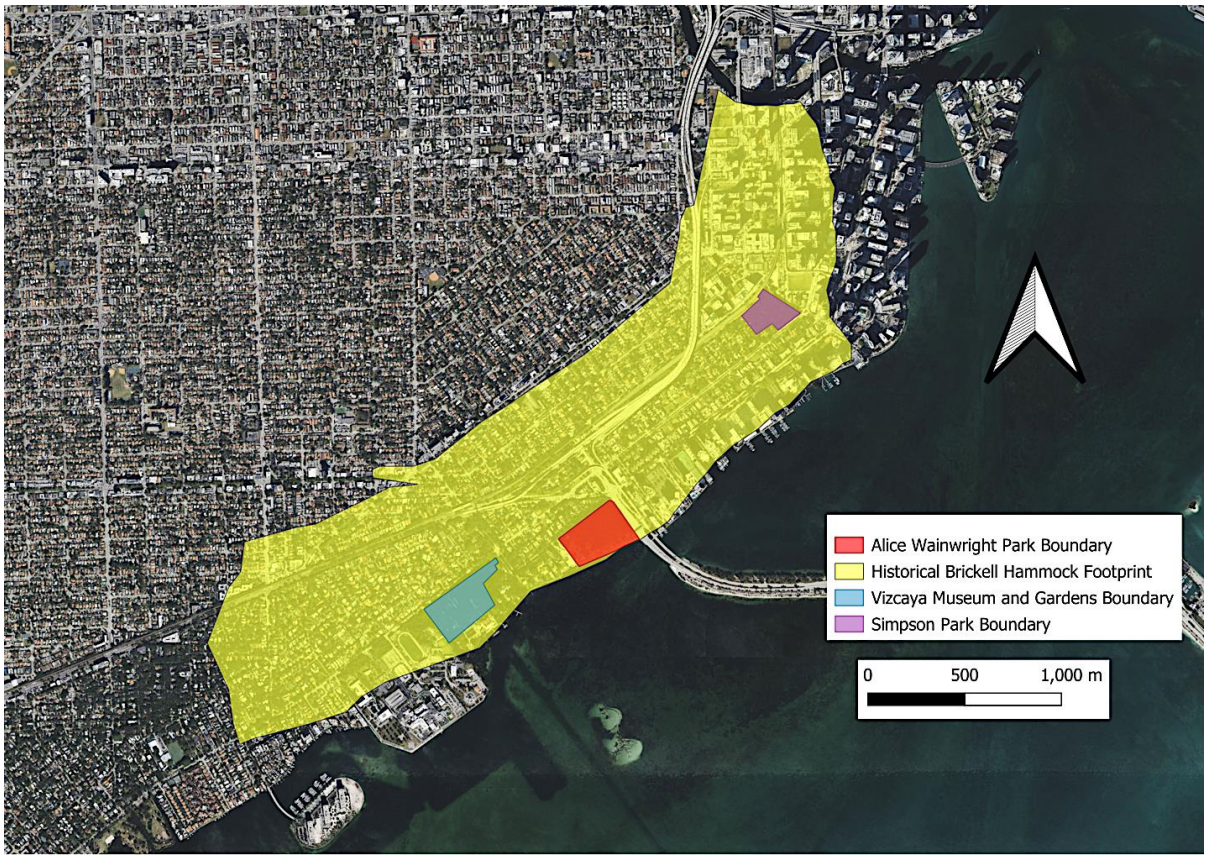


**Figure 2. Location of protected Brickell Hammock remnants in relation to the historical footprint.**


**Figure 3. Alice Wainwright Park picture in the urbanized matrix of the City of Miami.**

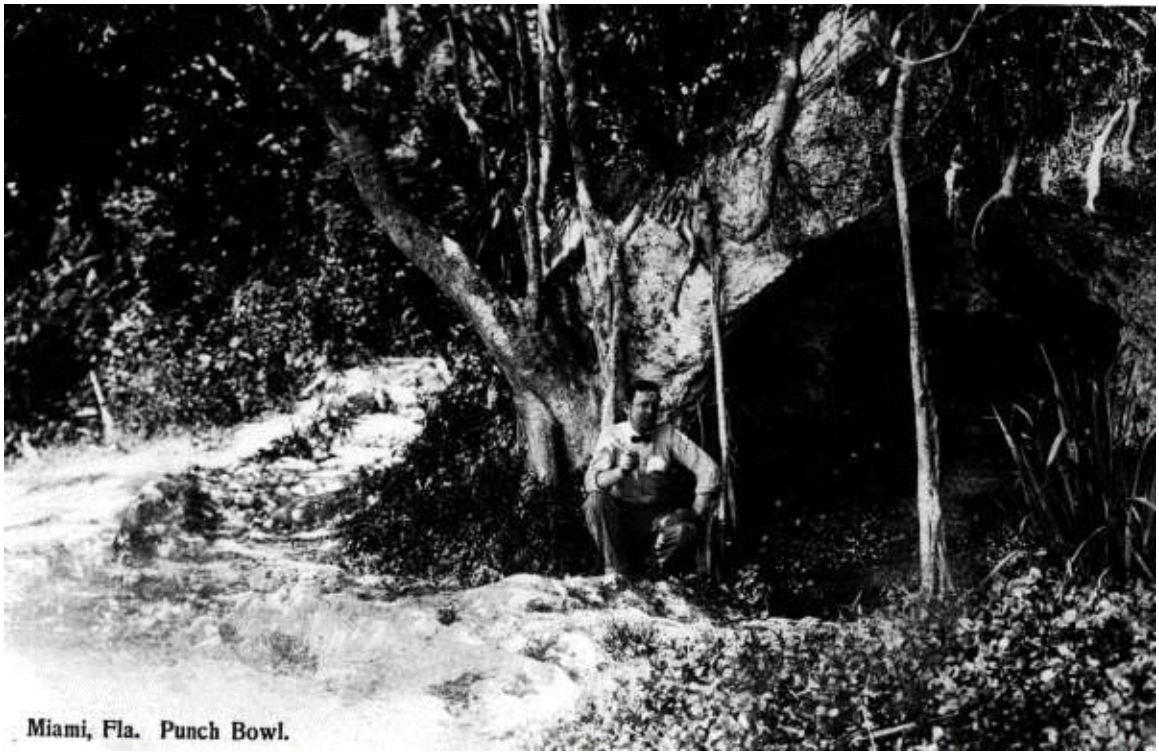


**Figure 4. The Punch Bowl - https://www.floridamemory.com/items/show/33335**

Brickell Hammock was historically perched on top of a massive block of Miami Oolite that terminated along the eastern face directly into Biscayne Bay in a formation known as the Silver Bluff (Fig. 5). Over time, dredge fill was placed in the shallow Bay waters along the edge to increase valuable real estate, cutting off the direct connection of Brickell Hammock to Biscayne Bay. In addition, drainage of the Everglades reduced regional freshwater flow, drying all the freshwater springs by the early 1900s and reducing freshwater availability to native species in Brickell Hammock. At AWP, this has resulted in a slow reduction and loss of hammock species that require relatively higher levels of freshwater availability, including trees (e.g., *Celtis laevigata*), shrubs (e.g., *Sambucus nigra* subsp. *canadensis*), ferns (e.g., *Vittaria lineata*), and

**Figure 5. The Silver Bluff, with the edge of Brickell Hammock on top and the coastal Florida endemic *Agave decipiens* along the upper edge. Ralph M. Monroe Family Papers.**

wildlife. Drier conditions have also led to some oxidation of the rich organic material that normally accumulates on the surface of the limestone and is available to plant roots. Since rockland hammocks are located on nutrient poor limestone substrate, rather than rich soils, the role of the organic horizon is critical in terms nutrient cycling and availability. Less organic material can lead to drier conditions for plant roots and reduce overall nutrient availability over time.

Historically, the most important natural periodic disturbance regimes affecting Brickell Hammock were hurricanes and freezes. Freezing temperatures would have selected for more cold hardy species and limited the distributions of some tropical species, which are mostly limited to barrier islands north of Miami. Temperatures as low as 27˚ F were recorded as recently as 1977, but the last recorded frost at Miami International Airport was more than three decades ago in 1989. In addition to regulating plant growth and distribution, freezing temperatures may have helped regulate some diseases and slowed down or mitigated the spread of invasive species from the tropics. In contrast, the intensity, frequency, and duration of North Atlantic hurricanes, as well as the frequency of Category 4 and 5 hurricanes, have increased since the early 1980s (Third National Climate Assessment 2014). Hurricane-associated storm intensity and rainfall rates are projected to increase as the climate continues to warm, and, according to the National Oceanic and Atmospheric Administration (NOAA 2021), the 2020 was a record-breaking season in the Atlantic with 14 hurricanes and seven major hurricanes, with 11 named storms hitting the U.S. coastline. The 2022 Atlantic season logged nine hurricanes, including three named storms making landfall in Florida (NOAA 2023), including major Hurricane Ian that struck the barrier islands of southwestern Florida with windspeeds of 144 miles per hour and devastating storm surge. While rockland hammocks and coastal upland vegetation are adapted to periodic tropical cyclones, including Category 4 and 5 hurricanes, disturbances from hurricanes can rapidly contribute to the explosion of invasive species and vastly increase control costs.

Another important periodic disturbance regime would have been fire entering the edges of Brickell Hammock from pine rocklands to the west and south, and likely from wetland marsh vegetation along the Miami River to the north. This was important in maintaining a thick, shrubby, high light environment along the forest edges, which sealed in humidity and provided habitat for many species. This natural disturbance regime has been completely lost, resulting in overhanging tree limbs along the edges, and a reduction in high light habitats for edge species.

Despite invasion by nonnative species, regional impacts such as filling along Biscayne Bay, freshwater drainage, and a changing climate, and the overall interior structure of Brickell Hammock at AWP is relatively intact. However, the long-term consequences of historical fragmentation and damage caused over decades must be taken into consideration when planning ecological restoration (Fig. 6-8). These impacts include loss of edge vegetation resulting in lower humidity conditions inside of the hammock and the loss of many species, and direct forms of damage such as clearing of understory vegetation to create ‘parklike’ conditions.

**Figure 6. Exposed edge of Brickell Hammock following clearing. John Kunkel Small, 1916.**

**Figure 7. Natural edge of Brickell Hammock, protecting the humid interior. John Kunkel Small, 1916.**

**Figure 8. Brickell Hammock patch with the native understory cleared away to create 'parklike' conditions. John Kunkel Small, 1916.**

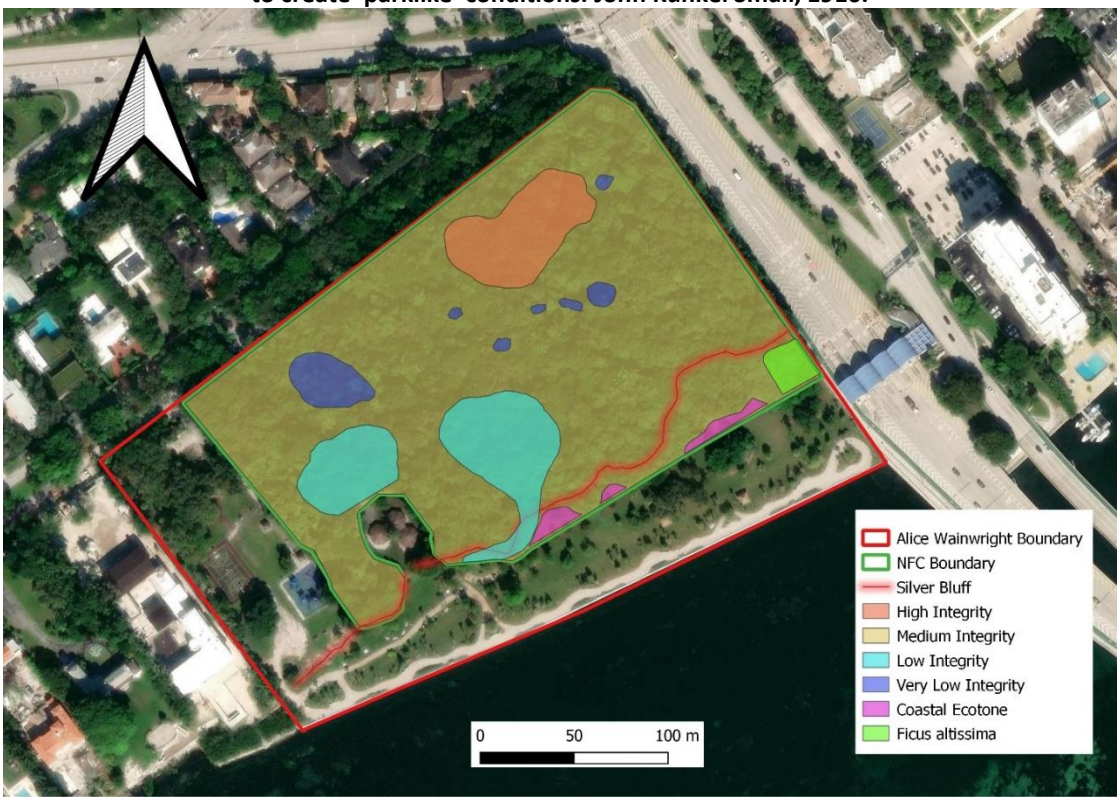


**Figure 9. Current conditions at Alice Wainwright Park.**

The NFC at AWP can be divided into six conditions (Fig. 9). Most of the area is historical Brickell Hammock in various conditions relating mostly to invasion by nonnative species (high integrity, <5% invasive cover, Fig. 10; medium integrity, 5-25% invasive cover, Fig. 11; low integrity, 25-75% invasive cover, Fig. 12; very low integrity, >75% invasive cover, Fig. 13). There is also degradation within these areas from homeless camps and other recent forms of human degradation. At present, the entire NFC is fenced. The fence has been compromised in the past (Fig. 14), but repairs have been made. A small area along the southeastern border represents a remnant coastal ecotone with medium integrity (Fig. 15), and another small area at the eastern corner is dominated by a very large invasive council tree (*Ficus altissima*, Fig. 16).

In general, the canopy layer of the NFC is intact and dominated by native species such as gumbo-limbo (*Bursera simaruba*), strangler fig (*Ficus aurea*), live oak (*Quercus virginiana*), and willow-bustic (*Sideroxylon salicifolium*). Exceptions are the open coastal ecotone and the eastern corner dominated by the very large council tree. Other invasive trees in the canopy are sporadic except in the areas assessed as very low integrity where large numbers of red sandalwood (*Adenanthera pavonina*), Deviltree (*Alstonia macrophylla*), and paper-mulberry (*Broussonetia papyrifera*) are found. The subcanopy is also largely intact except in the very low integrity areas, dominated by native species such as pigeon-plum (*Coccoloba diversifolia*) and lancewood (*Nectandra coriacea*) and common natives in the shrub layer include shiny-leaved wild-coffee (*Psychotria nervosa*) and saplings of subcanopy and canopy trees. The main degradation factor affecting this site that can be addressed through ecological restoration is the

**Figure 10. High integrity hammock with low cover of invasive species and good structure and composition**

**Figure 11. Medium integrity hammock with invasive solitaire palms (*Ptychosperma elegans*).**

**Figure 12. Low integrity hammock with high cover of invasive species in the groundcover and subcanopy layers.**

**Figure 13. Very low integrity hammock dominated by red sandalwood (*Adenanthera pavonina*).**

**Figure 14. Perimeter fence with break allowing for unauthorized access, now repaired.**

**Figure 15. Disturbed coastal upland ecotone.**

spread of invasive species in the groundcover, shrub, and subcanopy layers. Of note are invasive vines, including rosary-pea (*Abrus precatorius*), common air-potato (*Dioscorea bulbifera*), claw vine (*Dolichandra unguis-cati*), golden pothes (*Epipremnum pinnatum* cv. *Aureum*), jasmines (*Jasminum dochotomum*, *J. fluminese*), and nephthytis (*Syngonium podophyllum*). These species are well established in the ground and shrub layers and are beginning to expand aggressively into the canopy. Other invasive shrubs and small trees of particular concern include shoe-button ardisia (*Ardisa elliptica*), bamboo palm (*Chamaedorea seifrizii*), Surinam-cherry (*Eugenia uniflora*), smallflower jungleflame (*Ixora pavettta*), dotted wild coffee (*Psychotria punctata*), and solitaire palm (*Ptychosperma elegans*).

More than 360 species of native vascular plants have been recorded growing in rockland hammock in South Florida, about 25% of the entire South Florida flora. These native plants include trees, shrubs, vines, grasses and sedges, wildflowers, ferns, and epiphytes. Rockland hammock diversity is not concentrated in any one layer but is found throughout the system including specialized habitats such as solution holes and exposed limestone rocks. Excluding native weeds and plants not found in the NFC, 98 species of native rockland hammock plants have been recorded at AWP, including 19 species of state listed plants; iconic Brickell Hammock state-listed species currently present at AWP are redberry stopper (*Eugenia confusa*),

**Figure 16. Large invasive council tree at the NE corner of the NFC.**

bitterbush (*Picramnia pentandra*), and young palm orchid (*Tropidia polystachya*). One additional species is listed as critically imperiled in South Florida by IRC (*Amphitecna latifolia*), and two other species are ranked as imperiled (*Petiveria alliacea, Triphora gentianoides*). However, overall native diversity is falling at the site, with 27 (26%) of the historical native species not recorded in recent surveys, including about one-third of the state-listed species. Total extant native richness currently recorded for the entire site, including outside of the NFC, is 84 species. Based on prior experience, some of the missing species may have been overlooked or would be expected to re-emerge following restoration activities, whereas others may be considered for reintroduction during the restoration process. Of the 255 plant species that have been recorded at the site to date, including areas outside of the NFC, 120 are native to rockland hammock or coastal uplands (two of these are cultivated only), 12 are native weeds, 30 are cultivated nonnatives, and 91 are naturalized nonnatives, including 65 invasives or potentially invasive species listed by the Florida Invasive Species Council (FISC) or otherwise known to be invasive in South Florida (Table 2). On a positive note, 29 of the nonnative species were not recorded in recent surveys, including 12 invasive or potentially invasive species.

While no comprehensive animal surveys have been completed per correspondence with the City of Miami, more than 60 species of native (Fig. 17) and nonnative wildlife have been recorded on iNaturalist within the immediate neighborhood of Alice Wainwright Park. Of special note is the absence of the native arboreal snail *Liguus fasciatus*, of which several named forms were historically known from Brickell Hammock. Regardless of the loss of historical species, it is important to recognize that remnant patches of undeveloped habitat such as that as Alice Wainwright Park are critical for the survival of native wildlife, including butterflies, bees and other pollinators, birds, and small mammals, reptiles. and amphibians. However, native animals are threatened by feral cats (Florida Fish and Wildlife Conservation Commission 2021) and other invasive wildlife species (e.g. green iguana) threaten native plants or animals.

There is ongoing degradation along the edges of the site, and in the interior due to human incursions. Offsite threats from invasive plants and animals are ongoing, and other threats, such as off-target damage to native invertebrates from insect spraying, are assumed to be present.

**Figure 17. Native wildlife at Alice Wainwright Park, outside and inside the NFC.**

**Table 2. Nonnative invasive species recently recorded at Alice Wainwright that are listed by the Florida Invasive Species Council (FISC 2022, categories I or II), Everglades Cooperative Invasive Species Management Area (E-CISMA), or locally by IRC. TBW indicated 'To Be Watched' – which is not an official designation.**

| Scientific name | Common name | Category | In NFC? |
|---|---|---|---|
| *Abrus precatorius* | Rosary-pea, Crab-eyes | FISC I | Yes |
| *Adenanthera pavonina* | Red sandalwood, Red beardtree | FISC II | Yes |
| *Alstonia macrophylla* | Deviltree | FISC II | Yes |
| *Ardisia elliptica* | Shoe-button ardisia | FISC I | Yes |
| *Asparagus setaceus* | Common asparagus-fern | IRC | Yes |
| *Bauhinia variegata* var. *variegata* | Orchid tree, Mountain ebony | FISC I | No |
| *Broussonetia papyrifera* | Paper-mulberry | FISC II | Yes |
| *Casuarina equisetifolia* | Australian-pine | FISC I | No |
| *Casuarina glauca* | Suckering Australian-pine, Gray sheoak | FISC I | No |
| *Chamaedorea seifrizii* | Bamboo palm | FISC II | Yes |
| *Citrus x aurantium* | Sour orange | IRC | Yes |
| *Costus spicatus* | Spiral flag | IRC | Yes |
| *Dioscorea bulbifera* | Common air-potato | FISC I | Yes |
| *Dolichandra unguis-cati* | Claw vine, Catclawvine | FISC I | Yes |
| *Dypsis lutescens* | Yellow palm, Areca palm | FISC TBW, IRC | Yes |
| *Epipremnum pinnatum cv. Aureum* | Golden pothos | FISC II | Yes |
| *Eriobotrya japonica* | Loquat | IRC | Yes |
| *Eugenia uniflora* | Surinam-cherry | FISC I | Yes |
| *Ficus altissima* | Council tree | FISC II | Yes |
| *Hylocereus undatus* | Nightblooming cereus | FISC TBW, IRC | Yes |
| *Ixora pavetta* | Smallflower jungleflame | IRC | Yes |
| *Jasminum dichotomum* | Gold Coast jasmine | FISC I | Yes |
| *Jasminum fluminense* | Brazilian jasmine | FISC I | Yes |
| *Lantana camara* | Shrubverbena | FISC I | Yes |
| *Leucaena leucocephala* | White leadtree | FISC II | Yes |
| *Mangifera indica* | Mango | IRC | Yes |
| *Manilkara zapota* | Sapodilla | FISC I | Yes |
| *Melaleuca quinquenervia* | Punktree | FISC I | No |
| *Melicoccus bijugatus* | Spanish-lime | E-CISMA TBW, IRC | Yes |
| *Millettia pinnata* | Karum tree, Poonga-oil tree | E-CISMA, IRC | Yes |
| *Murraya paniculata* | Orange jessamine | FISC II | Yes |
| *Oeceoclades maculata* | African ground orchid, Monk orchid | FISC TBW | Yes |
| *Persea americana* | Avocado | IRC | Yes |
| *Phoenix reclinata* | Senegal date palm | FISC II | No |
| *Pithecellobium dulce* | Manila-tamarind, Monkey pod | IRC | No |
| *Psychotria punctata* | Dotted wild coffee | IRC | Yes |
| *Ptychosperma elegans* | Solitaire palm, Alexander palm | FISC II | Yes |
| *Richardia grandiflora* | Largeflower Mexican clover | FISC II | Yes |
| *Ricinus communis* | Castor-bean | FISC II | No |
| *Sansevieria hyacinthoides* | Bowstring-hemp | FISC II | Yes |
| *Schefflera actinophylla* | Australian umbrellatree | FISC I | Yes |
| *Schinus terebinthifolius* | Brazilian-pepper | FISC I | Yes |
| *Sphagneticola trilobata* | Creeping wedelia, Creeping oxeye | FISC II | Yes |
| *Stenotaphrum secundatum* | St. Augustine grass | IRC | Yes |
| *Syagrus romanzoffiana* | Queen palm | FISC II | Yes |
| *Syngonium podophyllum* | Nephthytis, American evergreen | FISC I | Yes |

| Scientific name | Common name | Category | In NFC? |
|---|---|---|---|
| *Tabebuia heterophylla* | White-cedar | E-CISMA | Yes |
| *Thespesia populnea* | Portiatree | FISC I | Yes |
| *Tradescantia spathacea* | Oysterplant | FISC II | Yes |
| *Triumfetta semitriloba* | Burweed, Sacramento burrbark | IRC | Yes |
| *Youngia japonica* | Rocketweed, Oriental false hawksbeard | IRC | Yes |

## 3.0 Native Target Reference Ecosystems and Reference Models

Rockland hammocks are lush tropical hardwood forests on upland sites where limestone is often exposed (FNAI 2010) and were historically scattered along the Miami Rock Ridge in areas protected from frequent fire (Fig. 18). They are diverse forests with dozens of tree and shrub species in the canopy and subcanopy layers, and contain numerous rare native species including epiphytes, ferns, and wildlife, and were especially known for myriad forms of the Liguus tree snails (*Liguus fasciatus*). Although the flora and vegetation vary according to substrate, hydrological conditions, local climate, and other factors, rockland hammocks are similar throughout their range. Brickell Hammock was by far the largest rockland hammock on the mainland, and an estimated 250 species of native plants may have been historically present there (Gann, unpublished data), of which 102 (40%) have been recorded at AWP (Gann et al. 2023b). Other large hammocks on the Miami Rock Ridge to the south of Brickell include Matheson (168 rockland hammock species), R. Hardy Matheson (130 rockland hammock species), Bill Sadowski Park (130 rockland hammock species), and Deering (227 rockland hammock species) (Gann et al. 2023b). A full suite of animals from all trophic levels were historically present, including Florida panthers (*Puma concolor coryi*) and eastern diamondback rattlesnakes (*Crotalus adamanteus*). Importantly, rockland hammocks intersected with pine rocklands and freshwater wetlands, where many ecotonal species could be found. Unlike interior hammocks on the mainland, or coastal hammocks separated from Biscayne Bay by coastal prairies (e.g., Deering, Matheson), Brickell Hammock was immediately adjacent to Biscayne Bay and shared some species with Florida Keys hammocks otherwise unknown from the mainland (e.g., *Agave decipiens*, *Exostema caribaeum*, *Schaefferia frutescens*). A combination of information including from historical photography, ecological descriptions (e.g., U.S. Fish and Wildlife Service 1999, FNAI 2010), reference site data (e.g., Gann et al. 2023b), ecological research publications, restoration practitioner guidance (e.g., Gann 2006, Gann et al. 2023a), and other resources have been utilized to build preliminary reference model to inform the targets, goals, and objectives for rockland hammock restoration at AWP.

**Figure 18. Historical hammock in Coconut Grove. Ralph M. Monroe Family Papers.**

# 4.0 Vision, Targets, Goals, and Objectives

The Society for Ecological Restoration recommends developing a project Vision, Targets, Goals, and Objectives, and the use of monitoring indicators that are specific, quantifiable measures of attributes, to directly connect longer-term goals and shorter-term objectives (Gann et al. 2019, Principle 5).

## 4.1 Sample Vision Statement for City of Miami, Alice Wainwright Park

A broad coalition of stakeholders assists the recovery of historical Brickell Hammock at Alice Wainwright Park and Simpson Park, and other native ecosystems within the City of Miami wherever they still exist and in areas where they have previously been converted to other uses, including at sites with recognized or previously unrecognized potential for restoration. These native ecosystems are cared for and enjoyed by the residents of City of Miami, as well as visitors and scientists from around the world. This results in an elevated sense of social cohesion and a significant contribution toward sustainable ecosystem management, including the recovery of local biodiversity, the delivery of ecosystem services, and the mitigation of and adaptation to climate change. This vision operates consistent with the Society for Ecological Restoration's International Principles and Standards for the Practice of Ecological Restoration and is carried out in partnership with the United Nations Decade on Ecosystem Restoration (2021-2030) and aligned global initiatives. The restoration of these native ecosystems becomes a flagship restoration program within the City of Miami and is promoted as an example of best practice restoration assessment, planning, implementation, ongoing management, and monitoring underpinned by sound science and broad community support. Encouragement of and technical support for the use of native plants in the built landscape, including road easements, schools, and residential gardens, is provided by the City of Miami in collaboration with stakeholders and other collaborators.

## 4.2 Recommended Ecological Targets

Restored rockland hammock within the NFC at Alice Wainwright Park is a closed canopy forest composed of a diverse assemblage of tropical, subtropical, temperate tree species in the canopy, and diverse subcanopy (2-5 m), understory (1-2 m), and groundcover layers (<1 m). Native epiphytes and vines are found in the canopy and subcanopy layers, and tropical ferns and other herbaceous plants are present in the groundcover layer, especially where limestone rock is exposed. All layers are dominated by tropical species, with some subtropical and temperate elements present, including species such as American beautyberry (*Callicarpa americana*), coralbean (*Erythrina herbacea*), live oak (*Quercus virginiana*), and cabbage palm (*Sabal palmetto*). Iconic Brickell Hammock species such as black calabash, redberry stopper, bitterbush, and young palm orchid are protected and supported. The forest structure is expressed as a mosaic, and patches of species or groups of species may occur. The rockland hammock intergrades into a coastal upland ecotone along the southeastern edge, which

includes coastal species such as yellow joyweed (*Alternanthera flavescens*) and bladdermallow (*Herissantia crispa*).

A wide diversity of native plants is present, and invasive or weedy plants and animals are minimized as practicable. Excluding weeds, at least 110 species of native plants occur in reproducing populations, including all plant forms. Historical loss of diversity from drier conditions and long-term effects of fragmentation are mitigated through the augmentation, reintroduction, or introduction of appropriate species recorded from or likely to have been present in historical Brickell Hammock (Table 3). The NFC is habitat for an abundance of native wildlife, including pollinators, migratory birds, and small mammals; invasive animals are controlled. Rare, threatened, and listed species are documented, protected, and augmented or reintroduced when and where appropriate. Generally, the substrate of limestone and disturbed soil is covered by a rich organic layer, providing critical habitat for many native plant and animal species. However, areas of exposed limestone are present and provide key habitat for rockland hammock and coastal upland species. Ecosystem processes, including pollination and dispersal, predation and herbivory, and recruitment, are present and operating. Altered substrates and hydrology are restored to the extent practicable, and opportunities to deliver freshwater to areas of exposed limestone are explored; changes in regional hydrology and irreversible soil modifications are considered when assessing, designing, implementing, managing, and monitoring rockland hammock restoration projects.

The interface of the NFC with areas outside of the NFC are optimized, allowing for the restoration of edge species, and the planting of extirpated rockland hammock species to facilitate recruitment along the edges or inside of the rockland hammock or coastal upland ecotone inside the NFC.

## 4.3 Recommended Social Targets

City of Miami residents and visitors benefit from restored, well-managed rockland hammock and coastal upland ecotones at AWP, with ample opportunities to experience native ecosystems through accessible nature trails, informal paths, and vistas, engage in citizen science and the arts, and participate as volunteers in restoration and management activities. Information about native ecosystems, their conservation, restoration, and management, and their contributions to preventing local and global extinctions of plants and animals, mitigating climate change, and providing essential ecosystem services are integrated into robust educational programs for students of all ages. Native ecosystems are considered green infrastructure that provide essential ecosystem services including improved air and water quality, reduction of urban heat effect, reduction in noise pollution, beneficial wildlife and native plant habitat, and improved aesthetics. Native ecosystems provide much needed green spaces that provide numerous contributions to mental health and human wellbeing in the largely urban landscape of South Florida. They are embraced and cared for by a wide constituency of stakeholders. This process is underpinned by the organization of a broad coalition of stakeholders representing local and national government, nonprofits and other

**Table 3. Examples of species documented at or highly likely to have been present in historical Brickell Hammock to consider for reintroduction or introduction at Alice Wainwright Park. Habitat Codes: CU (coastal upland), PR (pine rockkland, RH (rockland hammock).**

| Scientific name | Common name | Form | Habitat |
|---|---|---|---|
| *Abildgaardia ovata* | Flatspike sedge | Graminoid | RH/PR edge |
| *Abutilon permolle* | Coastal Indian mallow | Shrub | RH/CU edge |
| *Adiantum tenerum* | Brittle maidenhair | Fern | RH on rocks |
| *Agalinis fasciculata* | Beach false foxglove | Wildflower | RH/PR edge |
| *Agave decipiens* | False-sisal | Shrub | RH/CU edge |
| *Andropogon glomeratus var. pumilus* | Common bushy bluestem | Graminoid | RH/PR edge |
| *Anemia adiantifolia* | Pine fern, Maidenhair pineland fern | Fern | RH/PR edge |
| *Argythamnia blodgettii* | Blodgett's wild mercury | Wildflower | RH edge |
| *Baccharis dioica* | Hammock groundsel | Shrub | RH edge |
| *Bourreria succulenta* | Smooth strongback, Bahama strongbark | Tree/Shrub | RH edge, gap |
| *Byrsonima lucida* | Locustberry | Shrub | RH edge |
| *Capsicum annuum var. glabriusculum* | Bird pepper, Cayenne pepper | Wildflower | RH edge, gap |
| *Casasia clusiifolia* | Sevenyear-apple | Shrub | RH/CU edge |
| *Centrosema virginianum s.str.* | Spurred butterfly-pea | Vine | RH/CU edge |
| *Crossopetalum ilicifolium* | Quailberry, Christmasberry | Low shrub | RH edge |
| *Crossopetalum rhacoma* | Rhacoma, Maidenberry | Shrub | RH edge |
| *Cyperus tetragonus* | Fourangle flatsedge | Graminoid | RH |
| *Dichanthelium commutatum* | Variable witchgrass | Graminoid | RH edge |
| *Dichanthelium portoricense* | Hemlock witchgrass | Graminoid | RH/PR edge |
| *Dicliptera sexangularis* | False-mint, Sixangle foldwing | Wildflower | RH edge, gap |
| *Dodonaea viscosa var. angustifolia* | Narrow varnishleaf | Shrub | RH/PR edge |
| *Echites umbellatus* | Devil's-potato, Rubbervine | Vine | RH/CU edge |
| *Erithalis fruticosa* | Blacktorch | Shrub | RH/CU edge |
| *Erythrina herbacea* | Coralbean, Cherokee bean | Shrub | RH edge |
| *Euphorbia conferta* | Everglades key sandmat | Wildflower | RH/PR edge |
| *Exostema caribaeum* | Caribbean princewood | Tree/Shrub | RH edge |
| *Forestiera segregata* | Florida privet | Shrub | RH edge |
| *Galium bermudense* | Coastal bedstraw | Wildflower | RH edge, gap |
| *Guettarda scabra* | Rough velvetseed | Tree/Shrub | RH edge |
| *Hippocratea volubilis* | Medicine vine | Vine | RH |
| *Koanophyllon villosum* | Florida shrub thoroughwort | Shrub | RH edge |
| *Lantana involucrata* | Wild-sage, Buttonsage | Shrub | RH edge |
| *Lysiloma latisiliquum* | Wild-tamarind, False tamarind | Tree | RH |
| *Myrcianthes fragrans* | Simpson's stopper, Twinberry | Tree/Shrub | RH edge |
| *Orthosia scoparia* | Hairnetvine, Leafless swallowwort | Vine | RH |
| *Paspalum blodgettii* | Coral paspalum, Blodgett's crowngrass | Graminoid | RH edge |
| *Paspalum caespitosum* | Blue paspalum, Blue crowngrass | Graminoid | RH edge |
| *Pentalinon luteum* | Wild-allamanda, Hammock viperstail | Vine | RH edge |
| *Peperomia obtusifolia* | Florida peperomia, Baby rubberplant | Epiphyte | RH |
| *Pithecellobium keyense* | Florida Keys blackbead | Shrub | RH edge |
| *Polystachya concreta* | Greater yellowspike orchid | Epiphyte | RH |
| *Pteris bahamensis* | Bahama ladder brake | Fern | RH/PR edge |
| *Quadrella cynophallophora* | Jamaica caper | Tree/Shrub | RH edge |
| *Randia aculeata* | White indigoberry | Shrub | RH edge |
| *Rhynchosia parvifolia* | Small-leaf snoutbean | Wildflower | RH/PR edge |
| *Schaefferia frutescens* | Florida boxwood | Tree/Shrub | RH edge |

| Scientific name | Common name | Form | Habitat |
|---|---|---|---|
| *Senna ligustrina* | Privet senna | Shrub | RH edge, gap |
| *Senna mexicana var. chapmanii* | Bahama senna | Shrub | RH/PR edge |
| *Smilax havanensis* | Havana greenbrier | Vine | RH edge |
| *Tillandsia flexuosa* | Banded wild-pine, Twisted airplant | Epiphyte | RH edge, gap |
| *Tillandsia paucifolia* | Twisted wild-pine, Potbelly airplant | Epiphyte | RH edge, gap |
| *Tillandsia usneoides* | Spanish-moss | Epiphyte | RH edge, gap |
| *Tournefortia hiursutissima* | Chiggery grapes | Vine | RH |
| *Vanilla dilloniana* | Leafless vanilla, Mrs. Lott's vanilla | Vine | RH edge, gap |
| *Verbesina virginica* | Frostweed, White crownbeard | Wildflower | RH edge |
| *Vitis shuttleworthii* | Calusa grape | Vine | RH edge, gap |

community groups, schools, foundation and corporate funders, private owners of conservation lands, and the public. Managers of native ecosystems are provided the technical and financial support essential to their restoration and ongoing management.

## 4.4 Long-term Ecological Goals and Shorter-term Objectives for Rockland Hammock

1. Formalize stakeholder engagement regarding ecological restoration and ongoing management of native ecosystems at Alice Wainwright Park within one year.
    a. Develop a stakeholder engagement schedule within six months.
2. Design and implement a restoration monitoring program.
    a. Initiate long-term monitoring of ecological components of ecological restoration implementation within one year.
    b. Contribute monitoring data from Alice Wainwright to peer-reviewed papers covering a component of conservation, restoration, or ongoing management within 10 years.
3. Reduce cover of nonnative and native invasive plant species throughout the NFC at Alice Wainwright Park to <2% within 5 years.
    a. Reduce average cover of native invasive, ruderal, and nonnative plant species to <2% within three years following initiation of restoration in each restoration area.
4. Control or extirpate populations of invasive nonnative and nuisance animals at Alice Wainwright Park within 10 years.
    a. Reduce by half populations of invasive nonnative and nuisance animals within 5 years.
5. Design plan for structure and composition of coastal upland ecotone, and ongoing management needs, within three years.
6. Restore total native species richness to at least 95% of the reference model (e.g., 110 species) considering unsurmountable changes including changes to hydrology, fragmentation effects, and climate change, including rare, threatened, and listed species (e.g., IUCN Red List, US Fish and Wildlife Service, State of Florida, IRC), through natural recovery, and appropriate augmentation, reintroduction, and introduction of species native to the Brickell Hammock area.

    a. Restore native species richness to 90% of the reference model (e.g., 105 species) within 10 years.
    b. Restore native species richness to 85% of the reference model (e.g., 99 species) within five years.
7. Protect and restore populations of native epiphytes, vines, and groundcover species as appropriate.
8. Restore populations of lithophytes (plants that grow on rocks) where appropriate.
9. Restore depleted or extirpated populations of native animals considering unsurmountable changes including changes to hydrology, climate change, and fragmentation effects.
    a. Compile list of target depleted or extirpated animal species that may be appropriate for restoration within three years.
    b. Restore half of target native animal species within 10 years.
10. Protect native ecosystems from point and non-point source pollution to the extent practicable within 5 years.
    a. Evaluate point and non-point source pollution sources and effects on native plant and animal populations within three years.
    b. Develop plans to protect Alice Wainwright Park from point and non-point source pollution, including insect spraying, within five years.
11. Restore substrate and hydrological conditions, including topographical variation on former cleared sites, where possible.
12. Increase the connectivity of rockland hammock to critical ecotonal (e.g., coastal uplands, pine rocklands, freshwater wetlands) or surrogate habitats (e.g., native landscapes) as practicable.
13. Increase education about native ecosystems within 10 years.
    a. Evaluate current education programs on native ecosystems and establish education targets within three years (e.g., number of students and educational programs participating annually).
14. Create and maintain community access through accessible trials, informal paths, and vistas.
15. Secure long-term funding adequate to support these goals and objectives.
16. Participate in an organized yet decentralized network that curates and facilitates the sharing of guidance and data on ecological restoration, including GIS data layers, site assessments, restoration monitoring reports, and technical guidance.

# 5.0 Best Practices

## 5.1 Site Planning

Agreement on the restoration targets and where they are located spatially on the site is critical. Some restoration activities will not constrain future decision-making, for example treatment of invasive species in historical Brickell Hammock. However, implementation of other activities, especially planting, would make future changes to the restoration targets inefficient or costly to change at a future date.

## 5.2 Restoration Approaches

The SER Standards call for the identification and justification of specific restoration approaches, descriptions of specific treatments for each restoration area, and prioritization of actions. Whenever possible, the best approach is to remove sources of degradation and to utilize natural recovery potential through the process of natural regeneration. However, in many cases, restoration requires removal of the causes of degradation and interventions to correct damage and trigger recovery. This may include enrichment planting or reintroduction of species no longer present on or near the site, and follow-up removal of invasive species. This is the assisted regeneration approach. Finally, in cases where damage is high, the reconstruction approach may be utilized. In this case not only do causes of degradation need to be removed or reversed, and biotic and abiotic damage corrected, but also all or a major proportion of its desirable biota may need to be reintroduced. In practice, all of these approaches may be combined at a restoration site. At AWP, the natural regeneration approach can be utilized where smaller concentrations of invasive species are removed (e.g., areas of high and medium integrity). Assisted regeneration may needed where biodiversity has been depleted and invasive species are more pervasive (e.g., areas of low or very low integrity), but planting should be limited to only what is needed to stimulate recovery. That said, assisted regeneration can target the recovery of depleted species within the core hammock and along the edges. The construction approach is best employed only where necessary but may include some areas outside of the NFC where the restoration of edge habitats may be considered.

## 5.3 Invasive Species

A complete list of the nonnative species recorded at AWP can be found on the Floristic Inventory of South Florida website, along with images and links to other identification tools. Not all nonnative species are currently invasive, but some may become invasive in the future. Predicting which species may become invasive in the future can be informed by knowledge of the species' behavior in other parts of the world. To date, about 90 species of naturalized nonnative plants have been observed at Alice Wainwright Park, of which about 65 pose a substantial threat. Some of these are common or exist in large patches (e.g., red sandalwood (*Adenanthera pavonina*; Fig. 19), while others are currently limited to a few scattered individuals or small patches, or are found outside of the NFC.

**Figure 19. A dense patch of invasive red sandalwood in a low integrity area.**

Comprehensive resources are available on the control of invasive species including updated guidance from the State of Florida (Enloe et al. 2018), which include information on biological, manual, mechanical, cultural (e.g., prescribed burning, flooding), and chemical control methods. Specific control methods for many individual species are also indicated. At AWP, most invasive species can be controlled through a combination of manual control (e.g., weeding by hand, digging up), cutting and treating with herbicide, basal bark herbicide applications, and targeted foliar spray. Mechanical clearing of vegetation should not be necessary at AWP, but a special plan will be needed to remove the large council tree present in the eastern corner. Regionally, other municipalities are working on finding a non-synthetic replacement for targeted foliar applications of glyphosate (Roundup), but that has not yet been successful. For foliar control, in addition to glyphosate, water-soluble formulations of triclopyr (e.g., Garlon 3A) may be used to control broadleaf plants, and a variety of graminicides may be used to target grasses. To treat woody vegetation, such as many of the trees and shrubs listed in Table 2, triclopyr has generally been found to be safe and effective. The oil-soluble formulations (e.g., Garlon 4 mixed with plant-based oil, Pathfinder) are effective for basal bark and cut stump applications but cannot be used near water, while the water-soluble formulations (e.g., Garlon 3A) can be used on land as well as near or over water but requires cut stump or hack-and-squirt methods.

To reduce herbicide usage and increase overall efficiency, invasive species control should be conducted as part of an ecological restoration plan and implemented on a schedule. If done properly, repeat use of synthetic herbicides should generally not be necessary after one year, but resprouting of some individuals should be expected, especially within the first few months. Because of the large number of species involved at AWP, work should be conducted by a highly trained crew, preferably led by a supervisor holding a Natural Areas Weed Management license from the State of Florida or who is a Certified Ecological Restoration Practitioner (CERP), or CERP In Training (CERPIT) through the Society for Ecological Restoration. Teams of 2-4 should traverse each target area within about 10 feet of each other, carrying supplies needed to deal with most control measures expected. GPS coordinates are recorded for any return work required.

## 5.4 Native Species Management

Native plants may grow in such a way that they need to be managed as part of the restoration process. At AWP, these may include removing large hardwood trees that invade areas targeted for rockland hammock edge species. Native vines such as Virginia-creeper (*Parthenocissus quinquefolia*), hoopvine (*Trichostigma octandum*), and muscadine grape (*Vitis rotundifolia*) can overtop trees and slow or arrest recovery. Other examples are native weeds, which can proliferate in areas of recent soil disturbance and in areas with high light and organic soils. Strategies to monitor and treat these weedy areas can be an important part of the ecological restoration process.

## 5.5 Extra-Limital Natives

While adapting to climate change and planning for shifting ranges of native plants and animals is critical to long-term sustainability, ecological restoration standards do not sanction translocating species beyond currently understood ecologically based native ranges. Species native elsewhere in Florida planted beyond their ecologically mediated ranges can be described as “extra-limital” natives. Species in this category that are known to naturalize and have been recorded at AWP include royal palm (*Roystonea regia*). Any extra-limital natives should be removed from restoration project sites when they are found.

## 5.6 Restoration Planting

Tools for selecting native species for restoration planting can be found on IRC’s Natives For Your Neighborhood website, including guidelines for rockland hammock (Gann 2006) and pine rockland (Gann et al., 2020). Contrary to common horticultural practice, other than the soil that came in the pot and fertilizer which can be mixed into the bottom of the hole, no other material should be added. In pine rocklands, the idea is to minimize organic content and nutrients at the surface, which would increase weeds and weed competition. For rockland hammocks, an appropriate layer of mulch in newly planted areas can facilitate growth and recovery and suppress weeds. Water is key to successful planting. Once the plant is placed in the planting hole, water thoroughly to eliminate air pockets under and around the plant. Use a shovel or

trowel to lightly pack the back fill around the plant. Water in the plant to set the roots. Finally, level out the planting surface so that it grades smoothly into the surrounding terrain or create a slight depression to allow irrigation water to pool. As a general rule, no more than 10 total waterings should be needed. Generally, watering should occur once per day for the first week. During the next three weeks, water every other day, and during the next four weeks, water once per week. Each watering should be equivalent to one inch or more of rainfall, or about 10 seconds at city water pressure for a 1-gallon and 30 seconds for a 3-gallon container – the idea is to provide a few deep waterings to drive the roots downward and away from the dry surface. Additional watering may be necessary during the hot, dry periods of the spring and summer.

## 6.0 Ongoing Management

The SER Standards reserve the term maintenance for activities that take place after restoration is complete; that is when the attributes of the ecosystem resemble the reference model. Aftercare is the term applied to special care given to plants or animals when they have been introduced to a restoration site (e.g., watering newly installed plants). In practice, however, restoration practitioners and others responsible for implementing restoration projects use the term maintenance for many restoration interventions that are applied throughout the restoration process. Regardless of the terminology used, the important thing is that ecological restoration takes time (years, decades, or centuries depending on the ecosystem), and interim interventions will be needed throughout the process (e.g., reducing weed competition, trimming as a surrogate to fire, removing new infestations of invasive species, reintroducing depleted or extirpated species that require mature and high integrity ecosystem conditions).

For areas where reconstruction and most assisted natural regeneration approaches will be used, long-term care primarily involves watering installed plants, weeding, trimming, and perhaps re-mulching in rockland hammock areas. Fertilizing plants after installation is unnecessary and can be counterproductive. For ongoing management of rockland hammock planting areas see Gann (2006) and for pine rocklands see Gann et al. (2020).

## 7.0 Monitoring and Adaptative Management

Most restoration projects are trials or experiments, and, because of this, there is a need to monitor and evaluate the extent to which they achieve project goals and objectives. Therefore, monitoring and evaluation are critical components of the restoration process. However, for monitoring to be effective, it cannot be an afterthought. Monitoring must be planned and budgeted for and included throughout the restoration process. Because each type of monitoring question requires specific types of information collected at specific time-periods, it is important to determine the questions and approach to monitoring during project planning. Timely monitoring and evaluation of results, as well as funding for ongoing restoration, allows for adaptive management, which can and should be the standard approach for any ecological restoration project, irrespective of how well-resourced that project may be. For more information on monitoring and adaptive management, see Principle 5 in the SER Standards.

Tools that can assist in monitoring and communicating about ecological restoration projects include the SER Five-star System, the Ecological Recovery Wheel (ERW), and the Social Benefits Wheel. The 5-star System and ERW represent a gradient from very low (0-1 stars) to very high (4-5 stars) similarity to the reference model. As a generic framework, users must develop indicators and monitoring metrics specific to the ecosystem and sub-attributes they identify. A baseline ERW for the NFC at AWP has been prepared to help visualize the baseline condition at AWP prior to the initiation of new ecological restoration activities (Fig. 20, Table 4). See also Table 1 (p. 3) for a description of 5-star conditions of the Key Attributes.

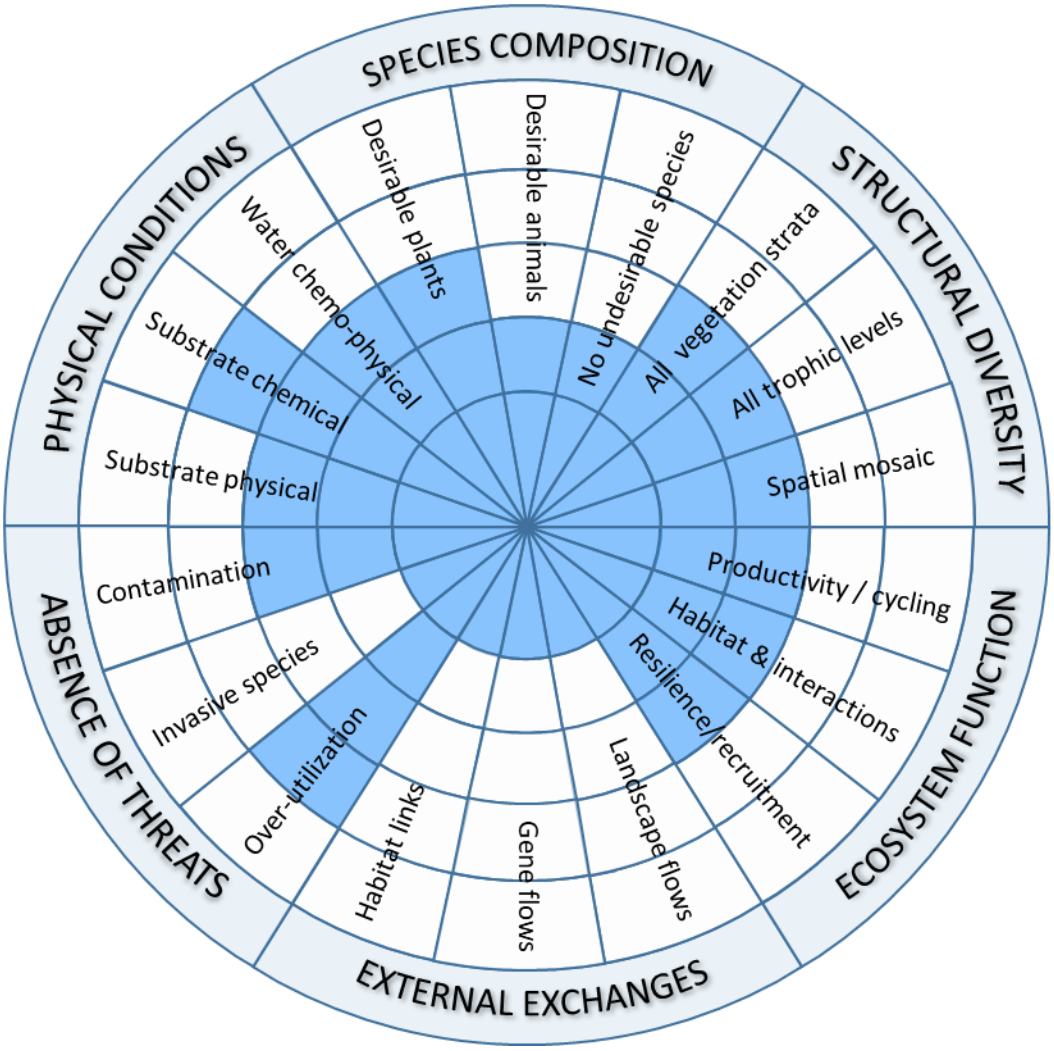


**Figure 20. Baseline Ecological Recovery Wheel for AWP, December 2023**

**Table 4. Baseline condition of 18 ecological sub-attributes at the NFC at Alice Wainwright Park, City of Miami, Florida, December 2023, relative to the reference model. Based on SER Five-star System (Gann et al. 2019).**

| ATTRIBUTE CATEGORY | CONDITION (1-5) | EVIDENCE FOR BASELINE CONDITION |
|---|---|---|
| **ATTRIBUTE 1. Absence of threats** | | |
| Over-utilization | 4 | Homeless camps and unauthorized entry |
| Invasive species | 1 | Many internal and external threats |
| Contamination | 3 | Threats e.g., from insecticides need review and mitigation |
| **ATTRIBUTE 2. Physical conditions** | | |
| Substrate physical | 3 | Substrate generally intact except on edges, but oxidation of O horizon |
| Substrate chemical | 4 | Substrate chemistry generally intact |
| Water chemo-physical | 3 | Water delivery and water table compromised, but supports many characteristic species |
| **ATTRIBUTE 3. Species composition** | | |
| Desirable plants | 3 | 50-75% richness and evenness compared to historical da |
| Desirable animals | 2 | Estimated <25% of richness and evenness compared to reference model |
| No undesirable species | 2 | Average 25-50% cover of nonnative and weedy species |
| **ATTRIBUTE 4. Structural diversity** | | |
| All strata present | 3 | Edge shrub stratum largely absent |
| All trophic levels | 3 | Apex predators missing, many consumers missing |
| Spatial mosaic | 3 | Intermediate similarity to reference |
| **ATTRIBUTE 5. Ecosystem function** | | |
| Productivity, cycling etc. | 3 | Intermediate numbers and levels of physical and biological processes and functions |
| Habitat interactions | 3 | Provision of habitats for edge species, wetland species largely absent |
| Resilience, recruitment etc. | 3 | Disturbance regimes along edges absent |
| **ATTRIBUTE 6. External exchanges** | | |
| Landscape flows | 1 | Few positive exchanges due to urban location |
| Gene flows | 1 | Few positive exchanges due to urban location |
| Habitat links | 1 | Few positive exchanges due to urban location |

## 8.0 Volunteers

While some restoration activities require trained professionals, there are many opportunities to involve volunteers in the restoration process. Volunteers can include adults and children, formal groups and individuals, and both the trained and untrained. Volunteers can help remove invasive species, especially smaller plants that are readily removed by hand, such as oysterplant (*Tradescantia spathacea*). They can help haul, dig holes, and install plants, and water both during and following events. Volunteers, when trained, can help with weeding restoration planting areas, and assist with project monitoring such as through repeat photography. Using tools such as iNaturalist, volunteers can help document species occurrences, especially lesser-known groups such as bees, moths, beetles, and invasive animals. To quote from the SER Standards, Principle 1:

> Ecological restoration is undertaken for many reasons including to recover ecosystem integrity and to satisfy personal, cultural, social-economic, and ecological values. This combination of ecological and social benefits can lead to improved social–ecological resilience. Humans benefit from a closer and reciprocal engagement with nature. Participating in restoration projects can be transformative, for example, when children involved in restoration projects develop personal ownership over restoration sites, or when community volunteers seek new career or vocational paths in restoration practice or science. Communities located within or near degraded ecosystems may gain health and other benefits from restoration that improves the quality of air, land, water, and habitats for native species.

## 9.0 Recommendations

A proposed timetable and scope of work for the first phase of implementation of ecological restoration at Alice Wainwright Park, focused on invasive species control, is provided in Appendix A. A proposed public access trail system is provided in Appendix B.

## 10.0 Acknowledgements

We acknowledge assistance and support from Gloria A. Antia and Etienne Hernandez-Perez from the City of Miami.

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**APPENDIX A**
**Recommended Restoration Protocols and Timetable, Phase 1**
**Alice Wainwright Park, City of Miami, Florida**

**December 22, 2023**

## Background

The total area of Alice Wainwright (AWP) designated as Natural Forest Community (NFC) is 11.25 acres, but the area of work inside the NFC fence is slightly larger. Two restoration targets for Alice Wainwright are proposed: 1) rockland hammock over most of the site; and 2) small areas of coastal upland ecotone along the southeastern edge of the site (Fig. A-1). Assessment of current conditions is focused on the threat and impact of invasive plant species on ecosystem structure and composition. The areas labeled High Integrity, Medium Integrity, Low Integrity, and Very Low Integrity are proposed to be restored to rockland hammock habitat. The coastal upland ecotone is also assessed as Medium Integrity. Descriptions are: high integrity, <5% invasive cover (2.25 acres); medium integrity, 5-25% invasive cover (8.29 acres); low

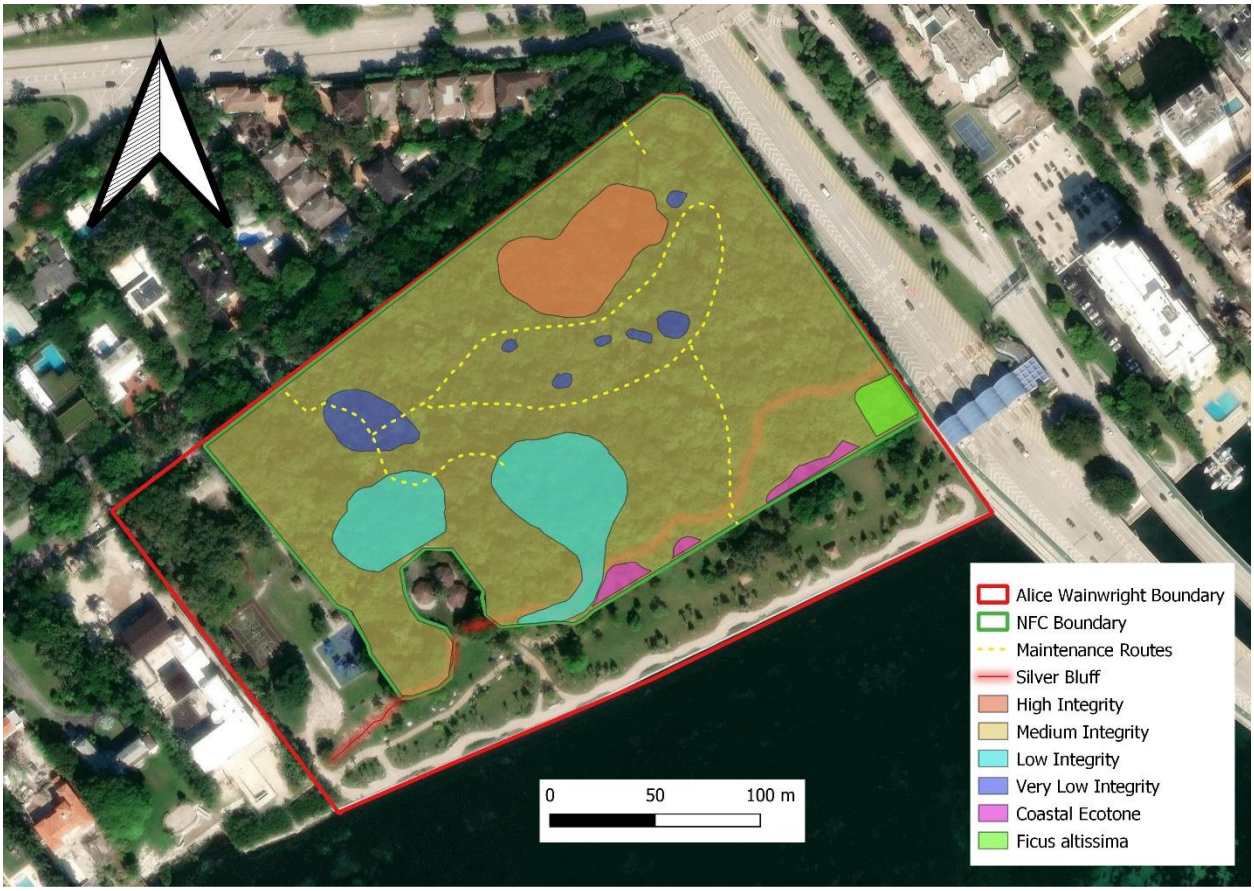


**Figure A-1. Current conditions and proposed restoration targets for Alice Wainwright Park**

integrity, 25-75% invasive cover (1.184 acres); very low integrity, >75% invasive cover (0.326 acres). As indicated in Fig. A-1, the condition of the site exists in a mosaic.

Phase 1 will focus on the treatment of invasive species, which is intended to trigger natural regeneration and the recovery of native plant species, including those that have been depleted due to invasive species and other reversable drivers of degradation, and associated native wildlife. Some control of native ruderal (weedy) species may be needed in the coastal upland ecotone to control competition and trigger recovery. Later phases may include: 1) removal of large council tree (*Ficus altissima*) from eastern corner of NFC; 2) direct seeding or planting of missing or depleted native plant species in areas within the NFC currently assessed as low or very low integrity to increase species richness and evenness as compared to the reference; 3) reducing shade along southwestern NFC edges that intersect the interior of AWP to create a rockland hammock / pine rockland ecotone analog; 4) creating small scale rockland hammock / pine rockland or coastal upland ecotones, including planting depleted or missing Brickell Hammock species.

## Recommended Schedule

**Year 1**

Year 1 activities are broken down into biannual phases: 1) first six months and 2) second six months. During these phases the primary goal is to stabilize high integrity areas and transition medium integrity areas into high integrity areas. Recovery will also be initiated in areas of low and very low integrity, with low integrity areas transitioning into medium integrity and very low integrity areas transitioning into low integrity areas by the end of year one. Costs for year one of this project are projected to be high ($80,000-$90,000).

**First six (6) months**

- High Integrity (<5% invasives), 2.25 acres, once in first six months.
- Medium Integrity (5-25% invasives), 8.29 acres, every two months for first six months.
- Low Integrity (25-75% invasives), 1.184 acres, every two months for first six months.
- Very low Integrity (>75% invasives), 0.326 acres, monthly for first six months.

**Second six (6) months**

- High integrity (<5% invasives), 10.54 acres, once next six months.
- Medium integrity (5-25% invasives), 1.184 acres, every three months for next six months.
- Low integrity (25-75% invasives), 0.326 acres, every two months for next six months.

**Year 2**

Year 2 activities are broken down into quarters. The primary goal is to stabilize all areas and prepare to transition medium integrity areas into high integrity areas and low integrity areas to

medium integrity areas by the end of year two. Direct seeding of desirable species to align with structure and composition targets may be trialed during this period time. Costs for year two of this project are projected to be moderate ($40,000-$45,000).

- High integrity (<5% invasives), 10.54 acres, once every two quarters.
- Medium integrity (5-25% invasives), 1.184 acres, once every quarter.
- Low integrity (25-75% invasives), 0.326 acres, once every quarter.

**Year 3**

Year 3 activities are broken down into two biannual treatments. The majority, except for 0.326 acres, is anticipated to be in high integrity category. Costs for year three of this project are projected to be moderate ($25,000-$30,000).

- High integrity (<5% invasives), 11.724 acres, twice per year.
- Medium integrity (5-25% invasives), 0.326 acres, twice per year.

**Year 4**

The entire site is anticipated to be in a high integrity maintenance condition regarding invasive plant species and undergo treatment once per year. Costs for year four of this project are projected to be low ($10,000-$15,000) and remain at this level adjusted for inflation thereafter unless the site is affected by a tropical cyclone or other event that requires additional activities to keep the site on a trajectory of recovery.

Treatment Protocols

Task 1: Control and/or eradicate invasive nonnative plants within the NFC Boundary

The entire site will be surveyed for invasive species identified as a threat to AWP (Table 2) or identified as invasive to Florida by the Florida Invasive Species Council, Everglades Cooperative Invasive Species Management Area, or locally by The Institute for Regional Conservation (IRC). All invasive species present within the site, except for the large council tree (*Ficus altissima*) in the far east corner of the NFC, will be treated as per the recommended schedule above. Areas labeled as medium integrity, low integrity, and very low integrity will be brought successively into the next highest category until all areas are assessed as high integrity regarding invasive species.

Methods will include hand pulling and bagging, cutting with hand tools (e.g., chain saws, weed whackers), and chemical treatments (e.g., cut stump, cut stem basal bark, directed foliar). The basal bark method should be used sparingly but is necessary for directed control of woody invasive species. Care should be taken not to injure or otherwise harm native species (especially the roots).

Invasive broadleaf groundcovers, such as *Richardia grandiflora*, and native ruderal species, such as *Bidens alba var. radiata*, may be controlled with directed foliar herbicide applications, hand pulling, or basal applications (in the form of "basal dots" for prostrate species).

Invasive palms, such as *Ptychosperman elegans,* may be treated by hand pulling seedlings, cutting down below the terminal bud, or applying herbicide to the terminal foliage/bud. No native palms are to be harmed or controlled.

Woody invasives, such as *Adenanthera pavonina* and *Brousssonetia papyrifera*, may be treated by the frill/gridle or basal bark method and killed in place. This will prevent possible damage to the canopy structure, by allowing the undesirable species to naturally decompose while simultaneously allowing native species to regenerate and replace them.

In some areas of the rockland hammock, small but dense groves of invasive trees have formed. These stands are to be treated with herbicide and left in place. Due to the small dimensions of these patches and the ability of the surrounding area to naturally regenerate, no planting is recommended during the first year after treatment. Need for possible planting or direct seeding can be evaluated after one year has passed.

Vine species (excluding aroids), such as *Dioscorea bulbifera*, *Dolichandra unguis-cati,* and *Jasminum spp*., may be treated by cut stem, treating the root side of the stem with appropriate herbicide. Small plants of *Dioscorea bulbifera* can be hand pulled and bulbils that have fallen on the ground can be collected, bagged, and removed from the site.

When growing on trees, aroids, such as *Epipremnum aureum* and *Syngonium podophyllum*, may be hand pulled, or cut stem at a node (area of rooted ariel growth) treating both above and below this section; there should be at least a 1-foot gap between the remaining aerial portion and the lower portion leading to the ground. When growing over the ground, these species may be controlled with directed foliar herbicide applications. Care should be taken with the sap as plants in the Araceae can contain oxalic crystals that may cause intense skin irritation.

The Contractor shall locate and protect all native species within the treatment area. The Contractor shall systematically traverse, locate, and treat 100% of the Florida Invasive Species Council (FISC) listed, Early Detection and Rapid Response (EDRR) invasive plants currently listed for the Everglades Cooperative Invasive Species Management Area, and other invasive species listed in Table A-1 below, within the designated areas, with a minimum of 90% of the pre-treatment target plants being killed within the treatment year.

**Table A-1. Nonnative invasive species targeting for treatment at Alice Wainwright and their listing designation by the Florida Invasive Species Council (FISC 2022, categories I or II), Everglades Cooperative Invasive Species Management Area (E-CISMA), or locally by IRC. TBW indicated 'To Be Watched' – which is not an official designation, but these species are also targeted for treatment.**

| Scientific name | Common name | Category | In NFC? |
|---|---|---|---|
| *Abrus precatorius* | Rosary-pea, Crab-eyes | FISC I | Yes |
| *Adenanthera pavonina* | Red sandalwood, Red beardtree | FISC II | Yes |
| *Alstonia macrophylla* | Deviltree | FISC II | Yes |
| *Ardisia elliptica* | Shoe-button ardisia | FISC I | Yes |
| *Asparagus setaceus* | Common asparagus-fern | IRC | Yes |
| *Bauhinia variegata* var. *variegata* | Orchid tree, Mountain ebony | FISC I | No |
| *Broussonetia papyrifera* | Paper-mulberry | FISC II | Yes |
| *Casuarina equisetifolia* | Australian-pine | FISC I | No |
| *Casuarina glauca* | Suckering Australian-pine, Gray sheoak | FISC I | No |
| *Chamaedorea seifrizii* | Bamboo palm | FISC II | Yes |
| *Citrus x aurantium* | Sour orange | IRC | Yes |
| *Costus spicatus* | Spiral flag | IRC | Yes |
| *Dioscorea bulbifera* | Common air-potato | FISC I | Yes |
| *Dolichandra unguis-cati* | Claw vine, Catclawvine | FISC I | Yes |
| *Dypsis lutescens* | Yellow palm, Areca palm | FISC TBW, IRC | Yes |
| *Epipremnum pinnatum cv. Aureum* | Golden pothos | FISC II | Yes |
| *Eriobotrya japonica* | Loquat | IRC | Yes |
| *Eugenia uniflora* | Surinam-cherry | FISC I | Yes |
| *Ficus altissima* | Council tree | FISC II | Yes |
| *Hylocereus undatus* | Nightblooming cereus | FISC TBW, IRC | Yes |
| *Ixora pavetta* | Smallflower jungleflame | IRC | Yes |
| *Jasminum dichotomum* | Gold Coast jasmine | FISC I | Yes |
| *Jasminum fluminense* | Brazilian jasmine | FISC I | Yes |
| *Lantana camara* | Shrubverbena | FISC I | Yes |
| *Leucaena leucocephala* | White leadtree | FISC II | Yes |
| *Mangifera indica* | Mango | IRC | Yes |
| *Manilkara zapota* | Sapodilla | FISC I | Yes |
| *Melaleuca quinquenervia* | Punktree | FISC I | No |
| *Melicoccus bijugatus* | Spanish-lime | E-CISMA TBW, IRC | Yes |
| *Millettia pinnata* | Karum tree, Poonga-oil tree | E-CISMA, IRC | Yes |
| *Murraya paniculata* | Orange jessamine | FISC II | Yes |
| *Oeceoclades maculata* | African ground orchid, Monk orchid | FISC TBW | Yes |
| *Persea americana* | Avocado | IRC | Yes |
| *Phoenix reclinata* | Senegal date palm | FISC II | No |
| *Pithecellobium dulce* | Manila-tamarind, Monkey pod | IRC | No |
| *Psychotria punctata* | Dotted wild coffee | IRC | Yes |
| *Ptychosperma elegans* | Solitaire palm, Alexander palm | FISC II | Yes |
| *Richardia grandiflora* | Largeflower Mexican clover | FISC II | Yes |
| *Ricinus communis* | Castor-bean | FISC II | No |
| *Sansevieria hyacinthoides* | Bowstring-hemp | FISC II | Yes |
| *Schefflera actinophylla* | Australian umbrellatree | FISC I | Yes |
| *Schinus terebinthifolius* | Brazilian-pepper | FISC I | Yes |
| *Sphagneticola trilobata* | Creeping wedelia, Creeping oxeye | FISC II | Yes |
| *Stenotaphrum secundatum* | St. Augustine grass | IRC | Yes |
| *Syagrus romanzoffiana* | Queen palm | FISC II | Yes |

| Scientific name | Common name | Category | In NFC? |
|---|---|---|---|
| *Syngonium podophyllum* | Nephthytis, American evergreen | FISC I | Yes |
| *Tabebuia heterophylla* | White-cedar | E-CISMA | Yes |
| *Thespesia populnea* | Portiatree | FISC I | No |
| *Tradescantia spathacea* | Oysterplant | FISC II | Yes |
| *Triumfetta semitriloba* | Burweed, Sacramento burrbark | IRC | Yes |
| *Youngia japonica* | Rocketweed, Oriental false hawksbeard | IRC | Yes |

The use of glyphosate is prohibited for use by City of Miami contractors. Therefore, the Contractor shall employ other treatment protocols in situations where glyphosate has historically been used.

The Contractor shall monitor and record wind speed and direction when preparing to apply or applying herbicides. The Contractor shall follow the most restrictive wind law or policy when there are conflicting thresholds between laws/policies. Contractors shall follow all laws regarding herbicide wind restrictions including but not limited to the Florida Organo-Auxin Herbicide Rule 5 E-2.033 (http://edis.ifas.ufl.edu/wg051). Herbicide applications shall not occur when wind speeds are greater than 10.0 miles per hour (mph). The Contractor shall take all precautions to minimize and mitigate herbicide drift.

All herbicides must be EPA/FDACS registered or have the appropriate Florida Special Local Needs (Section 24(c) FIFRA) registration. ALL HERBICIDES SHALL BE USED IN ACCORDANCE WITH THE EPA LABEL. The Contractor is liable for any penalty, fines or damages resulting from the misuse of herbicides.

All herbicide applications shall be carried out in a manner consistent with Environmental Protection Agency (EPA) and Special Local Need 24(c)(SLN) herbicide labels. Crews will have access to all appropriate labels and Safety Data Sheets (SDS) while transporting, mixing, or applying herbicides. The Contractor shall comply with all pertinent regulations set forth by Florida Department of Agriculture and Consumer Services (FDACS).

The Contractor shall follow all laws and regulations including but not limited to those set forth by the United States Environmental Protection Agency (EPA), Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Environmental Protection (FDEP) and Florida Department of Agriculture, and Consumer Services (FDACS). Contractors will comply with all applicable permits. Ground crew supervisors must obtain an FDACS license in the category of Natural Area Weed Management.

Work activities shall be recorded in a Daily Progress Report each day. At the discretion of the City of Miami, the Daily Progress Reports may be requested and must be provided upon request.

GPS tracks are used to record monitoring treatments. GPS units shall be used to identify and document treatment area boundaries for each day worked. Each applicator must carry a GPS unit (track setting should collect least often), a smart phone with an application capable of recording GPS tracks, or equivalent. The Contactor will save project tracks for each project and (if requested), email tracks to the Project manager.

Coordination shall be maintained by the Contractor with a Point of Contact (POC) designated the City of Miami.

The Contractor will occasionally observe noteworthy conditions, activities, plants and animals, or other things in the field. Noteworthy observations include, but are not limited to, the presence of biological controls, nesting birds, rare species, additional nonnative plants, nonnative wildlife, hazardous site conditions, and evidence of illegal activities. The Contractor shall report all noteworthy observations to the POC in a timely manner.

**Standard Treatment Methods**

Manual removal: Includes hand pulling and using chainsaws, weed whackers, and loppers to cut and pile or bag targeted vegetation. Seedlings may be hand pulled to reduce the impact of herbicides on non-target vegetation. Pulled seedlings should be left where roots do not make contact with the soil to reduce the possibility of regrowth.

Directed foliar: Herbicide is diluted in water and applied to leaves or target species using backpack applicators or spray bottles.

Stump treatment: After felling vegetation, herbicide is applied to the cut stump surface.

Basal bark: Herbicide is applied with a backpack or spray bottle directly to the bark around the circumference to each stem/tree. Herbicide must be in an oil-soluble formulation.

Frill, girdle, and hack and squirt: Cuts into the cambium are made completely around the circumference of each stem/tree no higher than one foot off the ground and herbicide is applied completely around the girdle.

All methods above have been found to be effective under specific circumstances; however, many factors can affect the performance of an herbicide application and results can vary. Choice of application method, herbicide, and rate for individual species depends on environmental conditions and professional experience. Marker dyes are required to keep track of what vegetation has been treated.

The Contractor will provide a list of herbicides and methods to be used for prior approval by the POC.

Additional information on recommended control methods for invasive plants can be found in the University of Florida's Institute of Food and Agricultural Sciences publication Integrated Management of Invasive Plants in Natural Areas in Florida (Enloe et al. 2018).

**Protected Species**

The Contractor's employees and representatives shall not harass, injure, kill, or otherwise interfere with native wildlife, including snakes, that may be encountered during the work being conducted under this contract. Any encounters with non-native wildlife shall be immediately reported to the POC.

It shall be the Contractor's responsibility to exercise care and protect all native vegetation at the project site. The Contractor is responsible for the restoration or replacement of all significant damage to native vegetation to the satisfaction of the City of Miami, at no cost to the city.

The Contractor is responsible for protecting non-targeted species including those species with a similar appearance to the targeted species. The Contractor shall be responsible for replacement of non-targeted species damaged by work activities including those damaged due to herbicides or unapproved vehicle use.

The Contractor shall be responsible for compliance with all Federal and State laws regarding protected species including but not limited to the Endangered Species Act.
The Contractor shall be familiar with listed species (plant and animal) identification and any physical or temporal setbacks associated with them. The Contractor shall be aware of and prevent damage to any rare or endangered native species. When working in an area where these species may be present, the Contractor must follow any established restrictions including those of U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission (FWC).

# APPENDIX B
# Proposed Location of Public Access Nature Trail
# Alice Wainwright Park, City of Miami, Florida

## December 22, 2023

Due to the sensitivity of the habitats and presence of many listed species, it is recommended that regular public access to the NFC within Alice Wainwright Park be limited to a raised walkway with handrails following an existing path system as indicated in Fig. B-1 below. More extensive public tours guided by City of Miami Parks staff, given on special occassions on an inviation only basis, could follow portions of the maintenance trail system also indicated below.

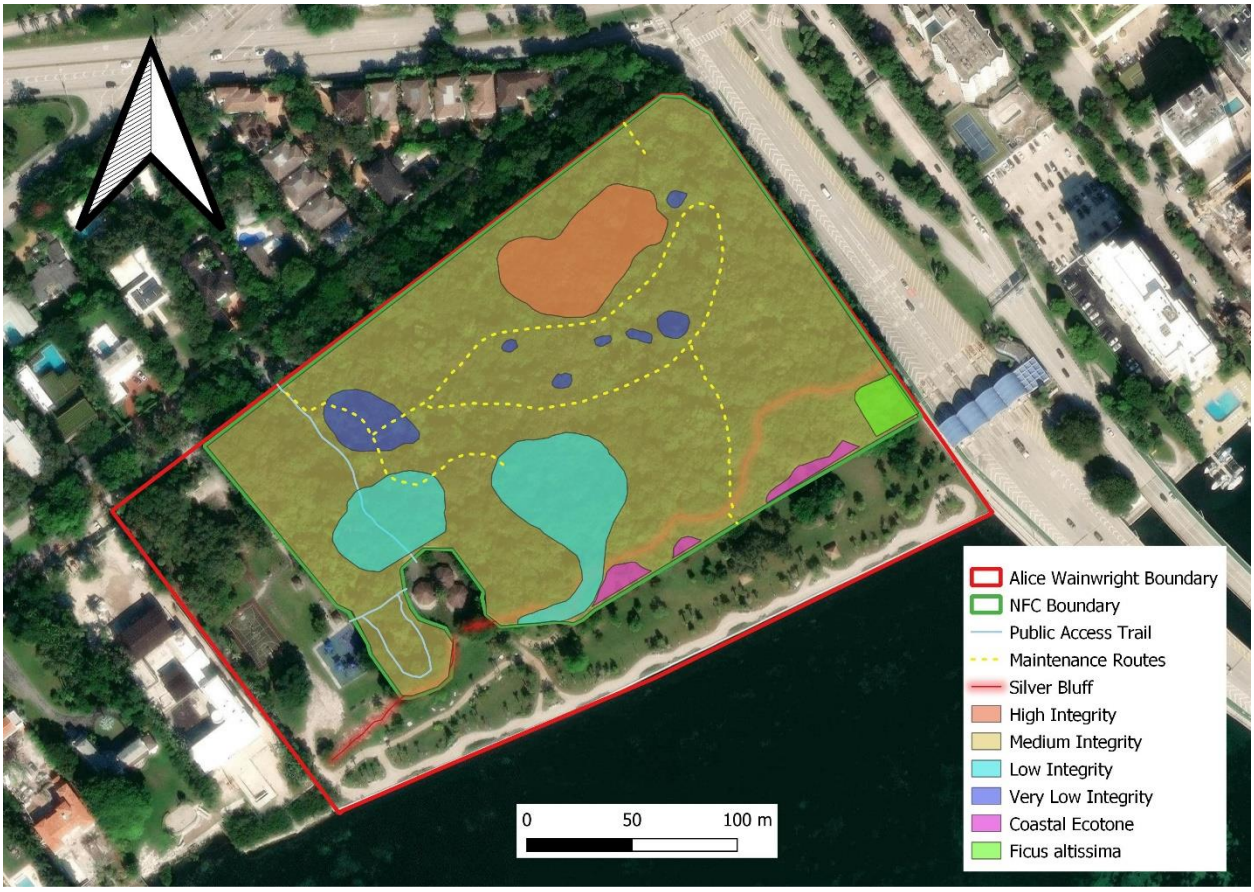


**Figure B-1. Proposed public access Nature Trail and maintenance trail system at AWP.**