

Rapid Communication

Invasiveness of pongamia, *Millettia pinnata* (L.) Panigrahi, in South Florida: an observational reportSeokmin Kim¹, Zachary Brym², McCoy Murphy³, Michael Sthreshley⁴ and Deah Lieurance⁵¹ Department of Agronomy, University of Florida, Gainesville, Florida, USA² Tropical Research and Education Center, University of Florida, Homestead, Florida, USA³ Environmental Resource Department of St. Lucie County, Fort Pierce, Florida, USA⁴ Terraformation, Kailua-Kona, Hawaii, USA⁵ Department of Ecosystem Science and Management, Pennsylvania State University, University Park, PA, USACorresponding author: Seokmin Kim (kimseokmin@ufl.edu)

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Abstract

In response to substantial losses in crop production, Florida producers have been seeking alternative species for cultivation. Pongamia (*Millettia pinnata* / *Pongamia pinnata*), a fast-growing, subtropical, leguminous tree native to southern Asia, Australia, and the western Pacific islands, has emerged as a potential substitute after a historical period as a landscape ornamental in the region. However, due to its toxicity, prolific production, and ability to disperse long distances along bodies of freshwater, pongamia is considered an environmental weed and was assessed as high invasion risk for Florida in 2016. To examine the establishment status in anticipated escaped populations in south Florida, we surveyed 15 sites with reported occurrences and found established populations at five sites. Among the established populations, we observed clear evidence of rapid spread along the St. Lucie and Coghatchee rivers, with over 300 recorded individuals of varying sizes and ages across these two sites. These results strongly indicate that pongamia is established in southern Florida and spreading rapidly along freshwater channels. Furthermore, we suspect that poorly managed landscapes such as abandoned nurseries and private horticultural properties have facilitated the observed spread of pongamia. Therefore, we stress the importance of proper management to prevent seed escape from production areas, especially those near bodies of water. Additionally, we highlight the need for expanded surveillance and management for pongamia in Florida.

Key words: alternative crops, dispersal, horticulture species, karanja, secondary pathways

Introduction

Pongamia (*Millettia pinnata* (L.) Panigrahi / *Pongamia pinnata* (L.) Panigrahi) is a fast-growing, subtropical to tropical leguminous tree with a wide native range that encompasses southeast Asia, Australia, and the western Pacific Islands (Sangwan et al. 2010; Gilman et al. 2019). While highly adapted to a variety of habitats and environmental conditions, it prefers coastal, mangrove, and riverine habitats in regions with 500–2,500 mm of annual rainfall (Orwa et al. 2009). Primarily evergreen, pongamia can produce seeds in about four to seven years, although some plants were observed to

produce pods as early as two years old (Csurhes and Hankamer 2016; Mukati and Sreevalli 2010). A mature tree fruits from fall to spring, which produces up to 30,000 seeds (Csurhes and Hankamer 2016; Gilman et al. 2019). These are primarily water-dispersed, as pongamia pods have been documented to remain buoyant for more than two months (Arathi et al. 1999). These seeds, as well as flowers, are toxic and have been noted to emit a respiratory, skin, and eye irritant (Gilman et al. 2019; Csurhes and Hankamer 2016) and have been used traditionally as fish poison (Usharani et al. 2019). These characteristics and others (e.g., shade tolerance, nitrogen fixation) contribute to its invasiveness, and as a result, it was assessed as “High Invasion Risk” in Florida by the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) Assessment and listed as a “Controlled Landscape Plant” in Miami-Dade county, Florida (University of Florida 2015; Miami-Dade n.d.). Additionally, an assessment in Hawaii (USA) classified pongamia as high invasion risk (Pacific Islands Ecosystems at Risk 2018), and it is documented as naturalized in Hawaii (Murphy et al. 2012) and Queensland, Australia (Csurhes and Hankamer 2016).

Despite such invasion risk, this plant is considered agriculturally valuable. This taxon has been used as traditional medicine, animal fodder, timber, and fuel within its native range (Morton 1990; Sangwan et al. 2010) and has also found additional usage outside of its native range (e.g. Florida and Hawaii) for biomass and biofuel purposes. In Florida for instance, pongamia was tested for its agricultural feasibility as early as 2011 (Harry 2018), with plans to plant millions of additional trees by 2034 (Morrison 2024). Additionally, this taxon has been used horticulturally. It was likely first introduced to Florida as an ornamental plant in 1910 (Setzer 2013) and had been recommended as street trees and within lawns (Gilman and Watson 1994). However, it has more recently been considered a significant management concern due to its prolific growth and spread, especially around freshwater or brackish systems (Setzer 2013; A. Onisko, *personal communication*, May 6, 2025), and it has been strongly discouraged for landscaping as early as 1990 (Morton 1990).

To evaluate the current distribution of escaped pongamia populations and assess potential secondary invasion pathways (pathways facilitating spread after its initial introduction), we surveyed 15 sites in south Florida with reported occurrences and population establishment status. We specifically looked for 1) number of individuals, 2) age class of individuals, 3) evidence of reproduction, 4) local distribution of pongamia populations, and 5) potential sources of established populations.

Materials and methods

From April 2019 to July 2019, we surveyed (by foot or by boat) 14 locations in Collier, Miami-Dade, and Broward counties to document the presence of mature pongamia trees as well as trends in seed dispersal and germination.

13 sites were selected from a list of reported pongamia occurrences compiled by the Institute for Regional Conservation (IRC), the Institute for Systematic Botany (ISB), and the Florida Exotic Pest Plant Council (FLEPPC; currently Florida Invasive Species Council) and defined as either 1) minimal management/abandoned, 2) recreational/public use, and 3) managed natural areas. These classifications provide insight regarding the level of management that may affect the occurrence and spread of invasive species. For instance, managed natural areas are closely monitored for alien species and are more likely to eradicate species considered a threat to natural ecosystems. Recreational and Public use locations administer some degree of landscape maintenance, such as mowing, which may also restrict pongamia spread as an invasive species. Areas with minimal management represent scenarios that may permit for unhindered invasion of pongamia.

All sites were chosen based on their proximity to natural areas and accessibility from the Tropical Research and Education Center in Homestead during the survey period. Additionally, one site (not provided by IRC, ISB, or FLEPPC) was observed and included in the survey along a water channel within an urban setting in Broward County. In February 2025, we conducted a supplementary survey along the St. Lucie River as this location was noted by the Florida Fish and Wildlife Conservation Commission (FWC) as having pongamia individuals.

At each of the survey sites, we recorded the number of mature trees, the presence of seedlings under the eaves as an indication of tree maturity and reproduction, as well as other relevant details about the trees' environment. Depending on site accessibility, an area of at least 20 meters was searched for additional "escaped seedlings" around each identified tree. Seedling presence within five meters of bodies of water was also noted as indication of seedling spread via water. Finally, we supplemented these surveys with citizen science observations from the Global Biodiversity Information Facility (GBIF) and Early Detection and Distribution Mapping System (EDDMapS) to determine the extent of reported occurrences beyond our survey locations.

Results

Pongamia seedling spread beyond the eaves of mature trees was found in five instances: (1) in the median downslope of a parking lot in Chapman Field Park, Miami-Dade county, (2) along a water channel in an urban setting on Cougar St, Broward county, (3) in the vicinity of mangrove habitat at Matheson Park (Miami-Dade county), the (4) Cocohatchee River (Collier county), and (5) along the St. Lucie River (St. Lucie county). Cocohatchee and St. Lucie rivers showed clear evidence of pongamia populations that had been established over a long period with multiple age classes present (Figure 1). We found more than 80 and 220 individuals of

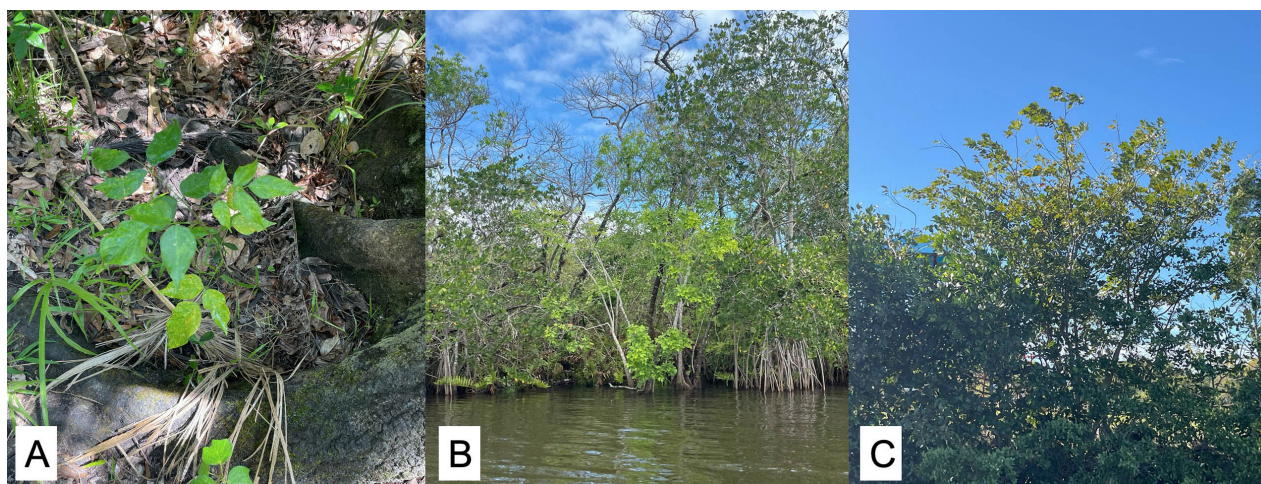


Figure 1. Seedling (A), immature (B), and mature (C) pongamia individuals from the St. Lucie river survey. Photo credit: McCoy Murphy.

various ages, sizes, and maturity along ~ 2.5 km (~ 1.5 mile) of the Cocohatchee and ~ 16 km (~ 10 mile) of the St. Lucie rivers respectively. While most of the Cocohatchee River is minimally managed, the St. Lucie River survey sites included both managed natural preserves or public recreational areas and minimally managed areas. Pongamia individuals observed at these survey sites often occurred in clusters, and a definitive “founder tree”, one which may represent the original seed disperser, was not identified for either locations. However, a single large pongamia tree of an estimated 10-meter height located at the uppermost accessible portion of the river appeared to have been intentionally incorporated into an ornamental landscape about 10 meters from the Cocohatchee riverfront. The existence of any additional trees upstream of this point was not determined due to inaccessibility for the Cocohatchee River. In addition, we identified an abandoned pongamia nursery adjacent to canal systems that connect to the St. Lucie River upstream of our survey sites (Supplementary material Appendix 1).

In contrast, none of the other 13 survey sites had more than 14 individuals, many of which appeared to have been intentionally planted as part of the landscape. We found seedlings within the eaves for four locations (SW 26th St, Chapman Field Park, Highlands Oak Park, and Cougar St.). Of these, SW 26th St and Chapman Field Park were classified as minimal management areas, while Highlands Oak Park and Cougar St. were defined as recreational/public use. In contrast, we found only one pongamia individual in managed natural areas (Miami Dade Scrub Preserve), where the individual was found at the property perimeter, although our ability to investigate further was limited due to the restricted access to the site. Meanwhile, no pongamia trees were found at the following locations: Tall Cypress Natural Area, Fern Forest Nature Center, Secret Woods Nature Center, and Coral Pine Park (Table 1; see Appendix 1 for detailed records on all survey sites).

Table 1. Pongamia occurrence and spread in south Florida by survey location. Survey locations are categorized as minimal management/abandoned (blue), recreational/public use (orange), and managed natural areas (green).

Site Location	Planted/Estab-lished Trees: Count	Seedlings Within Eaves	Seedling Spread: Count	Seedlings Near Water: Count
Minimal Management, Abandoned				
SW 26th St: 26.087644, -80.42813	2	Yes	0	No
Cocohatchee River, Colliers Reserve	80+	Yes	Numerous	Yes
Chapman Field Park	12	Yes	5	No
Managed Natural Areas				
Matheson Hammock Park	8	No	0	No
Highlands Oak Park	14	Yes	2	Yes
Greynold's Park	10	No	0	NA
A. D. Barnes Park	6	No	0	NA
Hugh Taylor	1	No	0	No
Cougar St: 26.24841, -80.18551	5	Yes	2	Yes
Miami Dade Scrub Preserve	1	NA	NA	No
Tall Cypress Natural Area	NA	NA	NA	NA
Fern Forest Nature Center	NA	NA	NA	NA
Secret Woods Nature Center	NA	NA	NA	NA
Coral Pine Park	NA	NA	NA	NA
St. Lucie River (mixed)	220	Yes	Numerous	Yes

Regarding the presence of seed pods, we found very few seeds pods remaining on trees during the 2019 survey. Instead, we often found mature, dehydrated seeds in unfavorable conditions such as open lawns and lots. Additionally, any seedlings found (mostly in managed lawns) were several weeks old, indicating that most viable seeds had already germinated several weeks prior. In contrast, we found numerous, mature seeds floating along the St. Lucie River during our 2025 survey.

As of April 21, 2025, we found 152, non-duplicated georeferenced occurrences from GBIF and EDDMapS, with the oldest occurrence being in Key West from 1934 (EDDMapS 2025; GBIF 2025). There was a distinct increase in reports in recent years, with almost half of all occurrences being reported on or after 2022. From all available occurrences, ~ 60% were from counties within our survey sites (Broward County: 32; Collier County: 8; Miami-Dade County: 43; St. Lucie County: 7). The rest were from the following counties – Glades (1), Indian River (1), Lee (11), Manatee (1), Martin (16), Monroe (4), Palm Beach (22), Pinellas (2), Sarasota (3) (Figure 2).

Discussion

Our investigation shows incontrovertible evidence of established populations of pongamia (*Millettia pinnata* / *Pongamia pinnata*) in Florida. We found multiple populations that have escaped cultivation, with rates of observations increasing dramatically in recent years. Generally, these escaped populations appear to originate from poorly managed landscapes. Such landscapes, especially those around rivers and canals, appear to have facilitated the prolific dispersal of pongamia propagules. Our observation supports the general understanding that hydrochory, or water-mediated seed dispersal, is likely the main dispersal mechanism, especially as we found no evidence

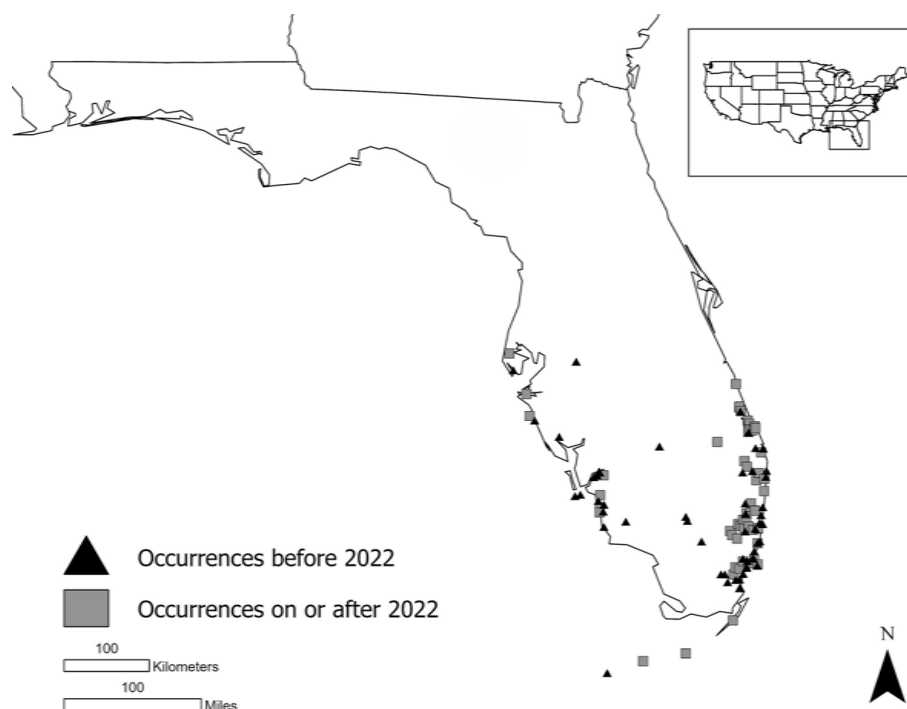


Figure 2. Occurrences of pongamia in Florida. Half of all occurrences were reported before 2022.

of animal-mediated seed dispersal in our surveys. Therefore, the high concentrations of both natural and artificial freshwater/brackish channels in south Florida makes the region ideal for the establishment of pongamia. This characteristic may also explain the contrasting observations of pongamia seedlings generally failing to disperse long distances in Hawaii (Daehler 2018), as Hawaii has much less freshwater/brackish channels than Florida. Meanwhile, seedling occurrence under the eaves of mature trees reflected previous observations of pongamia seed germination in heavy leaf litter or dense turf cover as seen in pongamia production fields (D. Lieurance, *personal communication*, May 22, 2025).

The Cocohatchee River and St. Lucie River surveys revealed a very high rate of seed establishment via hydrochloric seed dispersal. The presence of mature and immature trees along the river suggests multiple generations of establishment, although understanding the exact timeframe requires additional investigation. These sites, more than any others, illustrate pongamia’s potential invasiveness under natural environmental conditions. Notably, seedling establishment in proximity to state protected, red mangrove habitats in both rivers may be a new phenomenon for the state of Florida. This finding is consistent with records from India and South China where pongamia has been described as a “mangrove associate”, exhibiting similar ecological traits to true mangrove species while still not physiologically a fully adapted halophyte (Wang et al. 2011). This phenomenon is relevant to our understanding of pongamia’s salt tolerance in Florida, as our observations of mature pongamia trees growing near red mangroves suggest that pongamia may tolerate certain levels of salinity and follows findings

from existing literature that documents pongamia's partial salt tolerance in its native range (Arpiwi et al. 2013; Marriboina et al. 2017; Tomar and Gupta 1985).

Land management intensity appears to influence the establishment of pongamia populations. Well managed conservation areas as well as recreational parks that emphasized invasive species removal and minimal exotic landscaping had lower occurrence of pongamia seedlings or an absence of pongamia trees altogether, especially in conservation areas. In contrast, areas with the least amount of landscape maintenance—SW 26th Street, Cocohatchee River, and Chapman field Park—had the highest occurrence of seedlings with one site (Cocohatchee River) containing mature and reproductive seedlings. While we found pongamia individuals in managed locations within St. Lucie River, these individuals may have been spread there from parent trees within neighboring unmanaged areas—such as the abandoned pongamia plantation located upriver from our surveyed populations or from the numerous nearby private properties—given the high connectivity of artificial and natural waterways in the area.

It is important to note, however, that we currently do not have convincing evidence linking any escaped populations to locations that currently cultivate pongamia for agricultural purposes. This may be due to such areas being removed from canals and natural waterways or being more intensely maintained and properly managed. However, the growing number of pongamia observations and increased management concerns in recent years may reflect increasing concern of potential impacts and the need for future management effort. This is especially true given how accessibility to sites occasionally affected our survey efforts and as how only 60% of total occurrences from publicly available sources were found from the counties that we surveyed. These factors strongly suggest that current estimations of escaped pongamia populations may be grossly underestimated. The observation of escaped pongamia trees near abandoned nursery production facilities such as the one adjacent to the St. Lucie River raises even more concerns about invasion risk, particularly given the number of potentially abandoned pongamia plantations and the volume of seed transportation across the region associated with the species' recent rise in agricultural use. Meanwhile, since pongamia fruiting season (fall to spring; Gilman et al. 2019) coincides with Florida's hurricane season, flooding associated with storms may facilitate seed dispersal, even from individuals that are not adjacent to water bodies. Therefore, we stress the importance of proper monitoring and management of landscapes including an adequate buffer around production areas, especially those near bodies of water. Additionally, we emphasize the need for expanded surveillance and management in several locations in Central and South Florida, particularly along the Cocohatchee and St. Lucie rivers, to monitor and contain further spread. Public education on the proper management of this plant is also critical to support these efforts.

Authors' contribution

ZB and DL conceived the project. MM and MS conducted the surveys. SK, ZB, MS, and DL wrote the manuscript. SK, ZB, MM, MS, and DL provided editorial advice.

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Supplementary material

The following supplementary material is available for this article:

Appendix 1. Reports on each of the survey sites where escaped pongamia was found.

This material is available as part of online article from:

http://www.reabic.net/journals/bir/2026/Supplements/BIR_2026_Kim_et_al_SupplementaryMaterial.pdf