

6 North Key Largo Invasive Exotic Vegetation Mapping and Assessment

Curtis R. Kruer

Florida Keys Environmental Restoration Trust Fund, P.O. Box 420334, Summerland Key, Florida 33042;
crkruer@aol.com

Jennifer E. Taylor

Crocodile Lake National Wildlife Refuge, P.O. Box 370, Key Largo, Florida 33037

Abstract

This project mapped the distribution of eight invasive, non-native plants currently considered the greatest threats to the native plant communities of North Key Largo, the northernmost developed island of the Florida Keys archipelago. This island supports the largest tract of the globally imperiled West Indian tropical hardwood hammock in the continental United States. Many plants with distributions limited to south Florida and the Keys occur here, as well as four federally endangered animals. Approximately 9500 ac of buttonwood and mangrove wetlands, tropical hardwood hammock, and disturbed lands are publicly owned and managed in North Key Largo: 6700 ac as the Crocodile Lake National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service, and 2800 ac as the Key Largo Hammocks State Botanical Site, managed by the Florida Department of Environmental Protection. Plant species of primary focus were Australian pine (*Casuarina* spp.), Brazilian pepper (*Schinus terebinthifolius* Raddi), and Asiatic colubrina (*Colubrina asiatica* (L.) Brongn). Five other plants mapped were Burma reed (*Neyraudia reynaudiana* (Kunth) Hitchc.), lead tree (*Leucaena leucocephala* (Lam.) de Wit), mahoe or portia (*Thespesia populnea* (L.) Correa), melaleuca (*Melaleuca quinquinervia* (Cav.) S.T. Blake), and bowstring hemp (*Sansevieria hyacinthoides* (L.) Druce). Field surveys were performed on about 4400 ac of public and private lands with conditions suitable for supporting exotic plants. Strands of Australian pine, Brazilian pepper and Asiatic colubrina, and individual trees of all eight species, were mapped onto 36 in x 36 in field aerial photo sheets. This information was then transferred to the aerial film for easy reproduction as volumes of aerial photo maps. Eighty two strands of the three main plants of interest were mapped, totaling 95.02 ac (just over 2% of the 4400 ac of uplands and high transitional wetlands on the island). In addition, many scattered individuals of all eight species were mapped. Approximate numbers and height of exotics, along with substrate type, abutting habitats, and ownership, were recorded and reported for all mapped stands. Management recommendations for the land managers and land management agencies on North Key Largo were made.

Introduction

Native plant communities found in the Florida Keys are some of the most unique and diverse in North America (Tomlinson 1980). They consist of numerous endemic plant and animal species, including many listed as threatened and endangered by state and federal agencies. These natural areas, however, are being lost to and degraded by encroachment from development and invasion by exotic plants.

The purpose of this project was to map the distribution of eight invasive, non-native plants currently considered the greatest threat to the native plant communities of North Key Largo, a unique setting located in the northern extent of the Keys. The three species of primary focus were Australian pine (*Casuarina cunninghamiana* Miq., *C. equisetifolia* L., and *C. glauca* Spreng.), Brazilian pepper (*Schinus terebinthifolius* Raddi), and Asiatic colubrina or latherleaf (*Colubrina asiatica* (L.) Brongn.). Five other mapped species, not as prolific on North Key Largo and of secondary focus, were Burma reed (*Neyraudia reynaudiana* (Kunth) Hitchc.), lead tree (*Leucaena leucocephala* (Lam.) de Wit), seaside mahoe or portia tree (*Thespesia populnea* (L.) Correa), melaleuca (*Melaleuca quinquinervia* (Cav.) S.T. Blake), and bowstring hemp (*Sansevieria hyacinthoides* (L.) Druce).

The ultimate goal for exotic vegetation management in the Florida Keys is a long-term, comprehensive, Keys-wide exotic vegetation control plan. Such a plan, if adequately funded, would incorporate the myriad of scattered exotics management efforts currently pursued, provide follow-up control after initial eradication occurs, and allow for increased coordination among all levels of government, especially land management agencies. The objective of this mapping and assessment project is to contribute to this goal of a Keys-wide exotics plan by providing detailed field mapping data in a useful format, namely printed on large scale aerial photographs in an Aerial Map Volume.

Project area

Although a large portion of the island of Key Largo has succumbed to development, the northern portion (excluding Ocean Reef Club at the northern tip) is relatively undeveloped (Fig. 1). Since 1980, the U.S. Fish and Wildlife Service (USFWS) and the Florida Department of Environmental Protection (FDEP) have acquired thousands of acres in North Key Largo, including many disturbed sites, spending approximately \$100 million in their conservation efforts. The establishment here of Crocodile Lake National Wildlife Refuge (CLNWR) and Key Largo Hammocks State Botanical Site (KLHSBS) occurred in 1980 and 1986, respectively.

Approximately 9500 ac of buttonwood and mangrove wetlands, globally imperiled tropical hardwood hammock, and disturbed lands are publicly owned and managed on North Key Largo: 6700 ac by USFWS and 2800 ac by FDEP. North Key

Largo includes the largest contiguous tract of tropical hammock in the continental United States. It extends virtually the entire length of the island and harbors three federally listed endangered species: Key Largo woodrat (*Neotoma floridana* var. *smalli*), Key Largo cotton mouse (*Peromyscus gossypinus* var. *allapaticola*), and Schaus swallowtail butterfly (*Heraclides aristodemus* var. *ponceanus*). In addition, surrounding wetlands support the endangered American crocodile (*Crocodylus acutus*). Many rare plants with distributions limited to south Florida and the Keys occur on North Key Largo (Kruer 1992).

The project area includes federal, state, county, and privately owned land. Approximately 4400 ac of land with potential to support invasive exotics was assessed

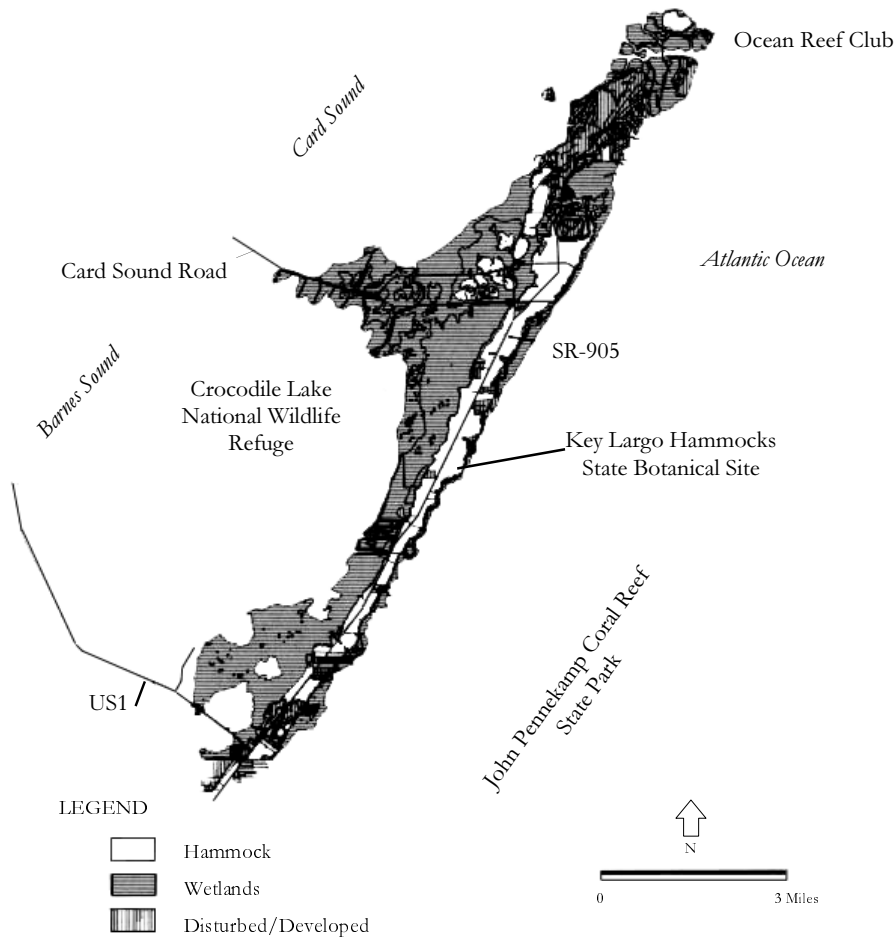


Figure 1. North Key Largo.

and mapped. North Key Largo and the hardwood hammock is bisected by State Road 905 (SR-905) (Fig. 1). Crocodile Lake National Wildlife Refuge is located on the west side of SR-905, with several hundred acres of private inholdings remaining. State lands (KLHSBS) occur on the east side of SR-905, extending north to the Ocean Reef Club, also with several hundred acres of private inholdings.

Species mapped

Of the many exotic plants now found in the Keys, Australian pine, Brazilian pepper, and Asiatic colubrina are invasive plants that are well established and of immediate concern due to their large size, rapid growth, and continuing rapid spread. These three species were the primary focus of this mapping project. The five invasive plants of secondary focus, generally including Burma reed, lead tree, seaside mahoe/portia, melaleuca, and bowstring hemp, are listed by the Florida Exotic Pest Plant Council as Category I or II plants (Appendix). Descriptive information and means of managing and eradicating these plants are provided as an appendix to the final project report. Other exotic plants on North Key Largo not included in this mapping project are also listed in the Appendix.

Methods

Twenty-one 36 in x 36 in aerial photo sheets (1:2400 scale) available from the Monroe County Property Appraisers Office were used for field mapping (Fig. 2). Available natural color and color-infrared aerial photography of North Key Largo were used as collateral information. Systematic field surveys were conducted in 1997, primarily on disturbed land (subdivisions, abandoned development projects, road edges, clearings, dumps, etc.), in hammocks bordering disturbed lands, and in most of the transitional buttonwood wetland zones and abutting hammock edge in the KLHSBS. Most undisturbed areas of closed-canopy hammock were not surveyed, nor were mangrove wetlands if no disturbance was evident on the aeri-als. Public and private lands were mapped. Small exotic plants were pulled by hand as time allowed during field surveys, and several hundred were removed rather than mapped.

All "stands" of Australian pine, Brazilian pepper, and Asiatic colubrina, were field mapped directly onto field aerial sheets by the best fit polygon delineation method. A stand was defined as an area where one or more species dominated the plant community. A minimum size for a polygon was about 0.05 ac (ca. 2000 sq ft). A unique site number with species present, e.g., 44A, 76AB, was attached as a label to each polygon. Scattered, individual plants of the eight species not forming a stand or not meeting the minimum size requirement for a stand were also mapped onto the aeri-als. All individual plants of the three main species were mapped, whereas an adequate representation of the other five species was made when they were encountered, so that their location and relative number could be

determined.

Data recorded for each stand/polygon included species, approximate number of trees, approximate height, substrate (disturbed or natural), habitat (hardwood hammock, transitional wetland, mangrove wetland, or disturbed/developed), and ownership (federal, state, county, or private). Ownership was determined from ownership maps obtained from the USFWS, FDEP, and Monroe County Property Appraiser.

Following the completion of field mapping, all polygons and labels and locations of individual plants were transferred in permanent ink to 36 in x 36 in positive film of the aerial photo sheets. This allowed for inexpensive printing of the aerial photo maps which were eventually bound in an Aerial Map Volume (Fig. 2). Map details and associated field data were produced in a format suitable for eventual incorporation into geographic information system (GIS) map coverage.

Results and Discussion

Eighty-two stands of exotic vegetation, totaling 95.02 ac, were mapped in the project area on North Key Largo. Stands were found in both CLNWR and KLHSBS, primarily on developed or disturbed land. Fourteen stands (17% of total) were Australian pine, totaling 6.63 ac (7% of total); Thirty-five stands (43%) of Brazilian pepper covered 17.04 ac (18%); one stand of Asiatic colubrina totaled 0.06 ac (<1%); Eighteen stands (22%) of mixed Australian pine and Brazilian pepper covered 27.20 ac (29%); Eleven stands (13%) contained Brazilian pepper and Asiatic colubrina, totaling 7.43 ac (8%); three stands (4%) contained a combination of Australian pine, Brazilian pepper, and Asiatic colubrina, totaling 36.66 ac (38%). The largest stand mapped (#30ABC) was 23.15 ac. For the three focal species growing outside of stands, 1679 plants, with an estimated total area of 0.58 ac., were mapped. Therefore, the total area of these three species was 95.60 ac.

Seventy-six (93%) of the stands occurred in disturbed substrate, such as fill, debris piles, and previously scarified land where substrates had been altered. Only six stands (7%) were mapped in natural substrates. Exotic plant stands growing in natural substrates included Brazilian pepper, Asiatic colubrina, mahoe, and lead tree.

Twenty-two (27%) stands were on federal land, totaling 16.93 ac (18%); Forty-one (50%) were on state land, totaling 64.09 ac (67%); three (4%) were on county land, totaling 2.08 ac (2%); Sixteen (19%) were on private land, totaling 11.92 ac (13%).

The value of accurate maps of exotics distribution was demonstrated in 1997 when FDEP contracted for \$46 000 in exotics eradication at 13 sites on North Key Largo using maps created for this project. Two other Keys invasive exotic plant

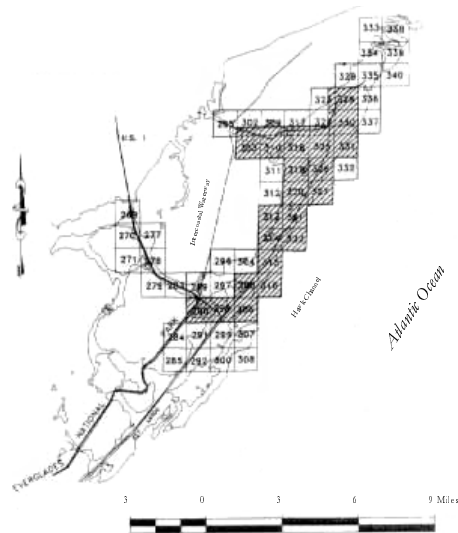
NORTH KEY LARGO INVASIVE EXOTIC VEGETATION MAPPING PROJECT

1997
Curtis Kruer, Manager
Florida Keys Environmental Restoration Trust Fund
P.O. Box 420334,
Summerland Key, FL 33042
And
Jen Taylor
U.S. Fish and Wildlife Service
Crocodile Lakes National Wildlife Refuge
P.O. Box 370
Key Largo, FL 33037

MAPPING LEGEND
7A = Stand of Exotics
A and X = Australian Pine
B and O = Brazilian Pepper
C and Δ = Asiatic Pepper
BR = Burma Reed
M = Mahoe/Cork Tree
LT = Leadtree
S = Sansiveria
ML = Melaleuca
..... = Trail or Pathway

1994 aerial photo (1:2400) numbers correspond to numbers used by the Monroe County Property Appraiser's Office

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Figure 2. Cover sheet from 36 in x 36 in volume of Aerial Photo Maps.

mapping projects have been performed to date. An aerial map volume and data base similar to those reported here were completed during 1993-1994 for all of Big Pine Key and No Name Key and other lands of the National Key Deer Refuge (Kruer 1995). In addition, in November 1996, members of the Florida Keys Invasive Exotics Task Force performed a Keys-wide invasive exotic vegetation mapping project. That project, funded by the Florida Keys Environmental Restoration Trust Fund, will result in volumes of 71 color maps and exotics acreage data for the entire Keys. Publication of the volumes as well as CAD and GIS compatible digital information on CD-ROM is anticipated for June 1998.

Management Recommendations

This project accomplished a necessary first step in exotic vegetation control and management on North Key Largo - mapping and quantification of exotic plants present. The Aerial Map Volume, along with the final report and database, should be used to assess and prioritize eradication and management of infested areas. Based on our work on North Key Largo, several factors should be considered in this prioritization.

First, the most prolific exotic plant on North Key Largo is Brazilian pepper, found in 66 (80%) of the 82 stands. The Florida Exotic Pest Plant Council's Brazilian pepper management plan for Florida (Ferriter 1997) reports that this plant is the most widespread exotic species in the state, occupying more than 700 000 ac. Eradication and control of this species on North Key Largo should be top priority for land management agencies. Second, high priority should be given to natural areas (public and private) that are currently lightly infested with these exotics. Third, eradicating exotics from lightly infested areas removes plants and seed sources while they are still manageable and requires minimal resources. Fourth, infested areas on or abutting public land should be a higher priority than sites located in and surrounded by private land. Fifth, road and power line right-of-ways should be a high priority due to their disturbed nature, scattered infestations, and ability to serve as corridors for migration of exotics.

To curtail the proliferation of exotic vegetation on North Key Largo, restore impacted natural areas, and improve habitat conditions for rare and endangered plants and animals, we recommend that an exotics management plan be implemented by local, state, and federal land management agencies. In addition to the above listed recommendations for prioritization, eight measures are proposed to be initiated and/or continued:

- (1) *Restoration of previously disturbed public lands through fill removal to natural elevations, typically Key Largo limestone or wetland soils, must continue.* The removal of fill and subsequent revegetation with native plants is essential to the elimination of both the disturbance and the potential for exotics proliferation.
- (2) *Continue acquisition of remaining private inholdings and establish cooperative land management plans with private land owners.* If purchasing these parcels is not an option, coordination with the land owner for exotics control should be pursued.
- (3) *Funding sources for exotics eradication and management within local, state, and federal agencies, as well as from non-governmental programs, should be pursued.*
- (4) *An exotics control partnership between CLNWR and KLHSBS should be developed as soon as possible, to allow sharing of expertise, equipment, and other resources.* Volunteer groups could be further developed to assist managers in eradication and routine maintenance, as they have in the past in the KLHSBS.

(5) *Education and training of all resource agency employees on invasive exotic vegetation and eradication techniques should be mandatory.* Available information specific to the Keys exotic plant problem (Florida Keys Invasive Exotics Task Force 1997) should be widely distributed. Increased public education and awareness of invasive exotics should be achieved through park/refuge presentations, field trips, and brochures.

(6) *All land management agencies on North Key Largo should maintain active participation in the Florida Keys Invasive Exotics Task Force.* The Task Force is an interagency group organized by the Restoration Trust Fund in 1996 with a mission to "develop and implement a long-term program of removal and management of invasive exotic vegetation in the Florida Keys."

(7) *Monroe County Public Works and Florida Keys Electric Cooperative right-of-way management practices should be reviewed to ensure no unintentional promotion of exotics is occurring.*

(8) *Preparation and planning for hurricane impacts to natural areas and plant communities and the resultant spread of invasive exotics, including non-indigenous vines, is a necessity* (Horvitz 1994; Ross et al. 1995).

Acknowledgements

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Appendix. Florida Keys Invasive Exotics Task Force (FKIETF) modified list of invasive exotic plants of North Key Largo.

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIETF Category I				
<i>Casuarina cunninghamiana</i>		Suckering, somewhat cold tolerant; very limited in Keys	Wind blown, year round	Basal bark or cut stump with Garlon 4 (25%-30%)
<i>Casuarina equisetifolia</i>	I	Highly invasive in wetlands and uplands	Wind blown, year round	Basal bark or cut stump with Garlon 4 (25%-30%)
<i>Casuarina glauca</i>	I	Less salt tolerant and less widespread than <i>C. equisetifolia</i>	Wind blown, year round	Basal bark or cut stump with Garlon 4 (25%-30%)
<i>Colubrina asiatica</i>	I	Highly invasive, especially on beaches and coastlines	Floating, year round	Foliar with 10% Garlon 4 in cut grid pattern
<i>Leucaena leucocephala</i>	II	Invasive mainly on roadways and disturbed edges at present	Wind blown, Jun. - Aug.	Basal bark or cut stump with Garlon 4 (25%-30%)
<i>Melaleuca quinquinervia</i>	I	Localized invasion in N. Key Largo, Stock Island and Boca Chica	Wind blown, Aug. - Dec.	Hack and squirt with Arsenal (50%) in water
<i>Schinus terebinthifolius</i>	I	Highly invasive in wetlands and uplands	Animals, Oct. - Jan.	Basal bark or cut stump with Garlon 4 (10%-15%)
<i>Thespesia populnea</i>	II	High localized invasion in transitional areas	Floating, year round	Basal bark or cut stump with Garlon 4 (10%-15%)

¹ EPPC category classification based on Florida Exotic Pest Plant Council's 1993 *List of Florida's Most Invasive Species*.

² Dispersal method and fruiting/flowering season in the Keys.

Appendix. *continued*

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIETF Category II				
<i>Acacia auriculiformis</i>	I	Local problem in Upper Keys; has appeared in Lower Keys	Wind blown	
<i>Albizia lebbek</i>	II	Problem in Upper Keys, but occurs throughout Keys	Wind blown	Basal bark or cut stump with Garlon 4 30%
<i>Cryptostegia grandiflora</i>	II	Occurs in transitional wetlands in Upper Keys	Year round	Basal application of strong Garlon 4 (25%)
<i>Kalanchoe</i> spp.	III	Spreads from landscapes and establishes where dumped		
<i>Lantana camara</i>	I	Spreads from landscapes; disruptive due to its ability to hybridize with the native species, <i>L. depressa</i> Small	Animals, year round	
<i>Neyraudia reynaudiana</i>	I	Prefers disturbed and ruderal sites but moves into undisturbed hammocks; occurs on all roadsides in Upper Keys; at least one fairly large patch treated on Big Pine Key	Spreads by seed and rhizome	Foliar with Roundup Pro (2%)

¹ EPPC category classification based on Florida Exotic Pest Plant Council's *1993 List of Florida's Most Invasive Species*.

² Dispersal method and fruiting/flowering season in the Keys.

Appendix. *continued*

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIETF Category II				
<i>Pennisetum purpureum</i>	II	Planted for landscaping and is currently spreading on roadside and median; doesn't mind mowing, still seeds	Seeds, Sep. - Nov.	Foliar with Roundup Pro (2%)
<i>Rhoeo spathacea</i>	II	Spreads from landscaping and establishes where dumped		
<i>Sansevieria hyacinthoides</i>	II	Spreads from landscaping and establishes where dumped	Seeds, rhizomes	Cut close to ground, use foliar with Garlon 3A
<i>Scaevola sericea</i>	I	Spreads quickly from landscaping, especially on beaches and coastal edges/causeways	Animals, water	Basal bark or cut stump with Garlon 4
<i>Scheffler aactinophylla</i>	I	So far seen in disturbed sites: roadsides, bridge approaches, and spoil islands in the Upper Keys		
<i>Wedelia trilobata</i>	II		Year round	
<i>Tribulus cistoides</i>		Moving down the roadside; also on beaches	Animals, year round	

¹ EPPC category classification based on Florida Exotic Pest Plant Council's 1993 *List of Florida's Most Invasive Species*.

² Dispersal method and fruiting/flowering season in the Keys.

Appendix. *continued*

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIETF Category III				
<i>Ardisia elliptica</i>	I	Moving south on Card Sound Road; not yet over bridge	Birds, year round	
<i>Merremia tuberosa</i>	II	It's planted in Keys; is a problem in Miami-Dade County	Year round	
<i>Plumeria</i> sp.		One seedling found at Pennekamp Park so far		
<i>Tradescantia zebrina</i>		Spreads from landscaping, localized problem; spreading along some forest edges in the Upper Keys		
FKIETF Category IV ³				
<i>Callistemon</i> sp.		Several trees along SR-905 and in Port Bouganville		
<i>Calophyllum antillanum</i>	II	Single known occurrence at landscape dumping		

¹EPPC category classification based on Florida Exotic Pest Plant Council's *1993 List of Florida's Most Invasive Species*.

²Dispersal method and fruiting/flowering season in the Keys.

³This category lists invasive plants included in the *List of Exotic Species Currently Threatening Natural Areas of North Key Largo*, revised 3 February 1998 by J. Duquesnel, Key Largo Hammock State Botanical Site.

Appendix. *continued*

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIETF Category IV ³				
<i>Cupaniopsis anacardioides</i>	I	Reportedly used by landscapers in Ocean Reef Club		
<i>Furcraea</i> sp.		Expanding from old cultural sites throughout North Key Largo		Foliar treatment with Garlon 4
<i>Hibiscus tiliaceus</i>	II	Seedlings appear in tidal overwash areas		
<i>Manilkara zapota</i>	II	Expanding colonies in several hammock locations		Thick bark of older trees resists tricopyr
<i>Pedilanthus tithymaloides</i>		Persists near dump sites along SR-905 and residences		
<i>Peltophorum</i> sp.		Identified colony at Nike Radar Site being treated		
<i>Pennisetum setacea</i>		One clump removed along Card Sound Rd.		
<i>Pithecellobium dulce</i>		Found in Ocean Reef Shores Subdivision		

¹EPPC category classification based on Florida Exotic Pest Plant Council's 1993 *List of Florida's Most Invasive Species*.

²Dispersal method and fruiting/flowering season in the Keys.

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Appendix. *concluded*

Scientific name	EPPC ¹	Keys invasion pattern and comments	Seeding ²	Eradication recommendations
FKIEFT Category IV ³				
<i>Ricinus communis</i>	III	Expanding in Ocean Reef Shores Subdivision		Easily controlled with most herbicides
<i>Tecoma stans</i>		Scattered populations persisting along FKEC right-of-way		
<i>Turnera ulmifolia</i>		Few populations on old SR-905 and along FKEC right-of-way		
Species listed as most significant post-Hurricane Andrew non-native upland invaders in North Key Largo (Ross et al. 1995)				
<i>Carica papaya</i>		Unlikely to persist for more than a decade or so		
<i>Oeceoclades maculata</i>	II	Occupies niche in hammock ground layer which may interfere with tree species regeneration		

¹EPPC category classification based on Florida Exotic Pest Plant Council's 1993 *List of Florida's Most Invasive Species*.

²Dispersal method and fruiting/flowering season in the Keys.

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