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The UF/IFAS Assessment of Nonnative Plants in Florida's Natural Areas: History, Purpose, and Use[1]

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Nonnative invasive plant species pose a significant threat to Florida's natural areas. The UF/IFAS Assessment of Nonnative Plants in Florida's Natural Areas (hereafter, UF/IFAS Assessment) uses literature-based risk assessment tools to predict the invasion risk of both nonnative species that occur in the state as well as species proposed for introduction. The UF/IFAS Assessment team has evaluated more than 770 species, including 97 species proposed for introduction or new uses. The team is actively identifying and evaluating potentially problematic nonnative species (and sub-specific or hybrid taxa). Recommendations and supporting information from the UF/IFAS Assessment can be found at http://plants.ifas.ufl.edu/assessment.

Background

Approximately 85% of all nonnative plant species enter the United States through Florida (Simberloff 1994). Only a small percentage of nonnative species become invasive and cause ecological problems such as habitat degradation or biodiversity loss (Williamson and Fitter 1996). Introduced species that become invasive are expensive to manage and cause significant impacts to recreational areas, resulting in economic losses (Adams et al. 2011). In fact, the cost of managing invasive plants on Florida's public lands was more than $37 million in FY 2005–2006 (Langeland 2013).

Florida is particularly vulnerable to nonnative invasive species because of its peninsular geography, tropical/subtropical climate, and diverse ecosystems. More than half of the land area in Florida is either being developed or used for agriculture, and the remaining natural areas are either disappearing or the quality of protected habitat is deteriorating (Langeland 2013). Florida's natural areas are crucial to preserving rare, threatened, or endangered species endemic to the state, including the key deer (*Odocoileus virginianus clavium*), Schaus' swallowtail butterfly (*Heraclides aristodemus*), four-petaled pawpaw (*Asimina tetramera*), and the pine barrens treefrog (*Hyla andersonii*).

Considering that 42% of all endangered and threatened species are declining because of invasive species (Pimentel et al. 2005), the connection between invasive species management and prevention and Florida's natural areas is apparent. It is estimated that approximately 1,400 nonnative plant species are present in the state, with 124 currently present in state parks (Adams et al. 2011; FLEPPC 2011). There are ecological and economic costs associated with invasive species (Pimentel et al. 2005), and having a tool to assess the status of nonnative species in the state can reduce costs and help to prioritize management efforts. Furthermore, there should be a protocol to determine the invasion risk of species proposed for release or more widespread use.

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A subcommittee of the UF/IFAS Invasive Plant Working Group created the UF/IFAS Assessment in 1999 to provide status and risk assessments for nonnative species in Florida's natural areas. The purpose of the UF/IFAS Assessment is to decrease invasion into natural areas by ensuring that plant species with invasive characteristics are not recommended for use by UF/IFAS faculty. In the context of the UF/IFAS Assessment, an invasive, nonnative species is defined as a species that forms (or has a high probability of forming) self-sustaining and expanding populations in a natural plant community with which it had not previously been associated (c.f. "invasive" Vitousek et al. 1995).

UF/IFAS faculty members rely on the recommendations of the UF/IFAS Assessment when discussing the use of nonnative plants. Any UF/IFAS Extension publication or newsletter that refers to specific nonnative plants (e.g., invasiveness, ecology, distribution, management, use, and value) is required to include the recommendations of the UF/IFAS Assessment. Information about how to cite components, conclusions, and results of the UF/IFAS Assessment can be found at http://plants.ifas.ufl.edu/assessment/pdfs/citations_examples.pdf. Additionally, the Florida Department of Agriculture and Consumer Services (FDACS) consults the UF/IFAS Assessment to evaluate proposed biomass and bioenergy crops as a part of its biomass planting rule (5B-57.011). The UF/IFAS Assessment is also used when FDACS considers regulating plants as noxious weeds. Landowners, managers, and industry turn to the UF/IFAS Assessment when deciding on the use of nonnative species in Florida, and the tools employed by the UF/IFAS Assessment have been internationally recognized as models for evaluating nonnative species (Fox, Gordon, and Stocker 2003; Gordon et al. 2008a; Fox and Gordon 2009).

Initially, the UF/IFAS Assessment was composed of a single tool, the Status Assessment. The Status Assessment evaluates the invasiveness of nonnative species that currently occur in Florida's natural areas. In 2008, two new components were added: the Predictive Tool and the Infraspecific Taxon Protocol (ITP). The Predictive Tool was developed based on the Australian Weed Risk Assessment (WRA) protocol and was modified specifically for Florida's climate and geography (Gordon et al. 2008b). The Predictive Tool determines the invasion risk of species that are not currently found in Florida's natural areas but are invasive in other places with similar climate and growing conditions. The Predictive Tool also evaluates new uses of species that may increase propagule production (e.g., bioenergy crops) (Langeland 2013). The ITP evaluates the invasive potential of horticultural, agricultural selections, hybrids, and cultivars, and determines if the UF/IFAS Assessment conclusions differ from those for nonnative parent or related nonnative species found in Florida, regardless of whether they occur in natural areas or are grown in cultivation ("resident species").

Since the UF/IFAS Assessment was first implemented, more than 770 plant species have been evaluated. The results have been of great value in providing a mechanism for UF/IFAS faculty and Extension professionals (and others) to use when making recommendations for the use of plant species.

Status Assessment

The Status Assessment provides a well-defined system to determine if a nonnative plant species is (or is at risk to be) invasive in Florida's natural areas. Recommendations reached through the Status Assessment are intended to prevent invasions and reduce the spread of current invasions. The Status Assessment is intended *only* for plants that *currently* occur in Florida and is not intended to provide evaluations of species that have not yet been introduced to the state. Proposed species and novel or infraspecific taxa would be assessed using the Predictive Tool or the ITP. For more information, see these sections below.

To account for differences in how a species will perform in different regions of the state, Florida has been divided into three zones—North, Central, and South. These zones are roughly based on the USDA hardiness zones (http://planthardiness.ars.usda.gov/PHZMWeb/), and conclusions are developed for each zone independently (Figure 1). For example, some species may be invasive in all parts of the state, while others are limited to particular zones (e.g., subtropical South Florida). Additionally, species are systematically re-evaluated to document changes in their status, and conclusions are amended when necessary.

The Status Assessment consists of questions about ecological, management, and economic aspects of the species and also the species' potential to expand into non-invaded zones. At least three experts (i.e., land managers or scientists) in each region familiar with the status of the species complete questionnaires for the status assessment. These experts provide the following information:

- Distribution of the species (i.e., how many acres are occupied and the habitat types invaded)
- Long-term alterations to ecosystem processes (i.e., changes in fire regimes, allelopathic interactions, and changes in community structure)

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- Life history traits related to fecundity (i.e., number of viable propagules, time to reproductive maturity)
- Management practices (i.e., which management methods are used, difficulty in implementation, and cost)
- Estimated economic value of the species (i.e., is it sold in stores, is it a crop species, is it used as forage, biomass, or for remediation purposes)

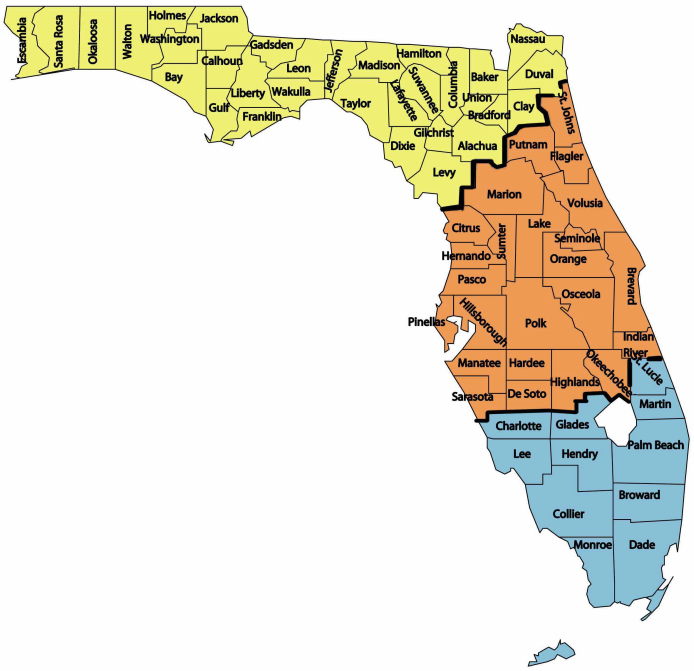

Figure 1. A map of Florida divided into counties and showing the three zones (North, Central, South) used for assessing nonnative species. The North zone is yellow, Central is orange, and South is blue. Credits: Adapted from Wunderlin 1982

Their responses are incorporated with information gathered from an extensive literature search (herbaria records, peer-reviewed primary literature, floras) to reach UF/IFAS Assessment final recommendations.

There are four possible results of the Status Assessment:

1. Not considered a problem species at this time, may be recommended
2. Caution, may be recommended but manage to prevent escape
3. Invasive and not recommended except for "specified and limited" use approved by the UF/IFAS Invasive Plant Working Group
4. Invasive and not recommended

The conclusions include plans for reassessment, after either 2 or 10 years (every 10 years for results 1 and 4, and every 2 years for results 2 and 3). Any species may be reassessed whenever additional relevant information becomes available that might change the conclusions of the Status Assessment.

Predictive Tool

The purpose of the Predictive Tool is to decrease invasions in Florida's natural areas by ensuring UF/IFAS faculty do not recommend the use of plant species not yet introduced or only limitedly introduced to Florida that have a high risk of becoming invasive. The Predictive Tool is a weed risk assessment (WRA) protocol consisting of 49 questions used to evaluate species either new to the state or proposed for a new use. Weed risk assessments have proven to be a cost-effective tool where adopted. Economic analysis conservatively estimated that WRA implementation will save Australia $1.67 billion (U.S.) dollars over a period of 50 years (Keller, Lodge, and Finnoff 2007). Gordon et al. (2008a) tested the accuracy of the Predictive Tool and determined that 90% of major invaders and 70% of non-invaders were accurately categorized by the protocol across a variety of geographies (including Florida). The accuracy of the Predictive Tool minimizes the occurrence of false positives and effectively predicts low-risk plant species that may be economically beneficial and nonnative plant species that have a high risk of invasion.

Questions presented in the Predictive Tool are answered by conducting thorough literature searches, using sources such as herbaria records, agency reports, and peer-reviewed primary literature. The questions in the Predictive Tool address the following areas:

- History of the species (i.e., domestication/cultivation)
- Biogeography (i.e., native range vs. proposed release sites, invasive status in other regions)
- Life history traits (i.e., plant type, growth habit, modes of reproduction)
- Ecology (i.e., persistence attributes, allelopathy, dispersal mechanisms)

Each question receives a numerical score between -3 and 5 points (most -1, 0, or 1), and conclusions are made based on the cumulative score. There are three potential outcomes of the Predictive Tool:

1. Low risk of invasion (<1 point)
2. High risk of invasion (>6 points)
3. Evaluate further (between 1 and 6 points)

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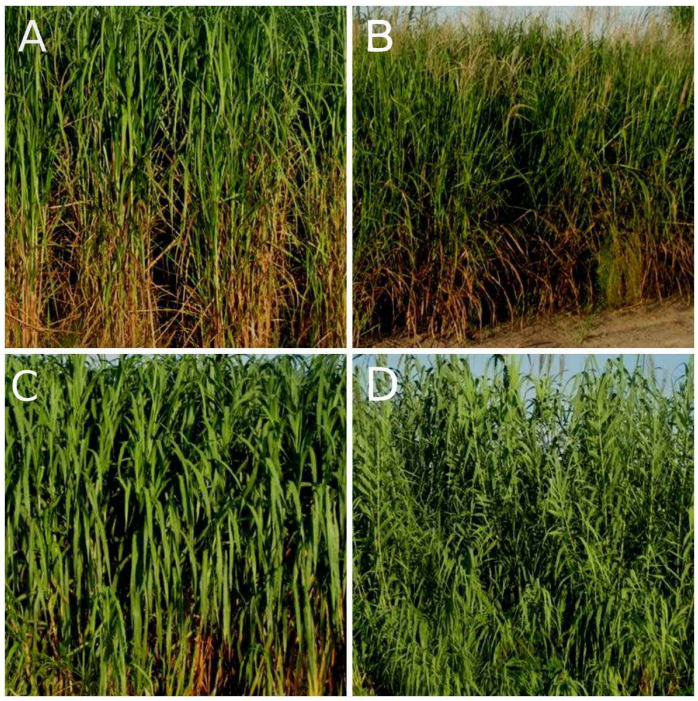

Figure 2. These four potential biofuel crops were evaluated using the UF/IFAS Assessment Predictive Tool. Energycane L 79-1002 sugarcane (A) and Miscanthus x giganteus (B) were predicted to be a low risk for invasion with scores of -1 and 2 respectively. Elephantgrass (*Pennisetum purpureum*; C) and giant reed (*Arundo donax*; D) were both predicted to be a high risk of invasion with scores of 18 and 11, respectively (see Gordon et al. 2011).
Credits: Lynn Sollenberger

Thresholds for each conclusion were established at scores to prevent the introduction of many serious invasive species, to limit the rejection of species that have not become invasive to 10%, and to limit the number of species requiring further evaluation to 30% (Pheloung, Williams, and Halloy 1999).

Like the Status Assessment, conclusions for the Predictive Tool are separately derived for North, Central, and South Florida. USDA Hardiness Zones (http://planthardiness.ars.usda.gov/PHZMWeb/) are again incorporated into the climate tolerance questions to differentiate the risk of invasion in each zone.

If the conclusion is "evaluate further," an additional tool called the Secondary Screen is used. The Secondary Screen is a decision tree consisting of a small subset of risk assessment questions that vary based on life form (Daehler et al. 2004). Trees and shrubs are evaluated on shade tolerance, stand density, dispersal, and generation time. Herbaceous plants (and small stature shrubs) are evaluated on their palatability to herbivores, their status as an agricultural weed, and their stand density (both decision trees are applied to vines) (Daehler et al. 2004). The addition of this supplemental tool has reduced the number of species requiring further evaluation by an average of 60% (Gordon et al. 2008a). Additionally, the Status Assessment was revised to direct species to the Predictive Tool in the following two cases:

- Species that have not escaped into Florida's natural areas but are recent arrivals to the state or are known to cause problems in areas with climate and habitats similar to Florida
- Species that are being proposed for new uses (e.g., biofuel or biomass planting) that will result in significantly higher propagule pressure

The Predictive Tool has also been written into the ITP and is used in cases where obvious traits of the infraspecific taxon will alter its risk of invasion relative to the resident species.

Infraspecific Taxon Protocol

The Infraspecific Taxon Protocol (ITP) is an internal tool for UF faculty, particularly the UF/IFAS Assessment staff and the UF/IFAS Invasive Plant Working Group, to independently evaluate cultivars, varieties, hybrids, or subspecies of resident (nonnative species found in Florida) invasive species to determine if all taxa associated with particular species should receive the same recommendations.

UF/IFAS Assessment staff may initiate an ITP evaluation if new sub-specific taxa or hybrids are being recommended by UF/IFAS faculty or others. UF/IFAS faculty can also initiate an ITP evaluation when they want secondary testing of a taxon whose resident species has received a "do not recommend" conclusion (e.g., to obtain UF/IFAS approval to release a cultivar for commercial use). The petition for assessment must be accompanied by evidence demonstrating that the taxon is a distinct entity and has characteristics that will reduce its invasive potential compared to resident species. Examples of taxa that have been evaluated with the ITP include five *Eucalyptus grandis*, three cultivars of *Ruellia* and four *Lantana* taxa. The conclusion "not a problem species" was found for two of the *Ruellia* cultivars (Figure 3) and all of the *Lantana* taxa. Even though the ITP is used infrequently, it does allow development of recommendations for taxa selected for uses (i.e., landscaping, biomass plantings) that may result in widespread dispersal and higher propagule pressure.

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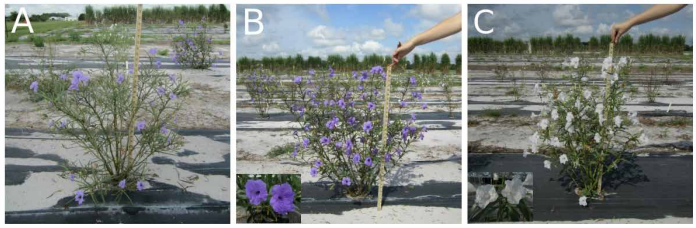

Figure 3. The resident species, *Ruellia simplex* (A), and the two cultivars, Mayan Purple (R10-102; B) and Mayan White (R10-108; C), that were approved by the Invasive Plant Working Group after evaluation using the Infraspecific Taxon Protocol. UF/IFAS approved these two cultivars for recommendation because of their sterility and distinctiveness from the resident species.
Credits: Rosanna Freyre

The ITP consists of 12 questions to determine the following information:

- If botanists/field personnel will be able to distinguish the taxon from the resident species (or other infraspecific taxa) in the field
- If the taxon can regress (or hybridize) to characteristics of the resident species
- The fecundity of the taxon
- If the taxon displays invasive traits that cause greater ecological impacts than the resident species

Depending on the answers, conclusions may be drawn from the ITP, or the infraspecific taxon is directed to the Predictive Tool or the Status Assessment. Recommendations made directly from the ITP fall into the same possible categories outlined in the Status Assessment. Final recommendations and supporting data from the ITP must be evaluated by at least three experts (e.g., professional botanists, horticulturalists, plant breeders). If the ITP cannot be completed because of a lack of appropriate evidence, lack of three suitable experts, or if a consensus cannot be reached among the experts, then the conclusions for the resident species are applied to the infraspecific taxon.

Appeals must be addressed to the UF/IFAS Invasive Plant Working Group for case-by-case review. Recommendations for infraspecific taxa that have been assessed or evaluated using the ITP are listed in the online "Conclusions" table independently from the conclusions of the resident species. These follow the same reassessment schedule as the Status Assessment (http://plants.ifas.ufl.edu/assessment/conclusions.html).

Conclusion

The UF/IFAS Assessment website (http://plants.ifas.ufl.edu/assessment/) contains all information gathered by the UF/IFAS Assessment team. The "Conclusions" page is sorted by Latin name, common name, and region, and summarizes the recommendations for each species. The "Detailed Data" page includes the response forms used to reach a conclusion for a species and questionnaires completed by the experts for the Status Assessment. Predictive Tool data sheets and ITP data sheets (including all citations) may also be accessed from the "Detailed Data" page. Staff members also disseminate information in public presentations where they provide a detailed explanation of the history, purpose, and process of the UF/IFAS Assessment. Additionally, social media accounts have been created to broadcast new information regarding nonnative species in Florida (Twitter: @IFASassessment, https://twitter.com/IFASassessment; Facebook: UF IFAS Assessment, https://www.facebook.com/IFASassessment). UF/IFAS Assessment evaluations have been used to track the status of nonnatives in Florida, prevent the release of potentially invasive species, and approve new varieties of *Ruellia*, *Nandina,* and *Lantana* as safe alternatives to invasive nonnative landscaping plants. The ongoing endeavors of the UF/IFAS Assessment will continue to provide recommendations for nonnative plants to help protect Florida's natural areas.

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