# Protocols for testing the invasiveness of plants in Florida©

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## INTRODUCTION

Globalization has facilitated the movement of non-native species worldwide through increasing connectedness between isolated ecosystems (Meyerson and Mooney, 2007). Only a small proportion of non-native species introduced to a new range become established, and those species that do become invasive have significant economic and ecological impacts, often resulting in reduced biodiversity and changes in biogeochemical cycling, hydrology, and disturbance regimes (Gordon, 1998; Mack and D'Antonio, 1998; Vitousek et al., 1996). Invasive species can be defined as an organism (plant, animal, fungus, or bacterium) that is not native and has negative effects on our economy, our environment or our health.

Florida and California lead the continental United States in the number of invasive species (Vitousek et al., 1996). In particular, Florida is notorious for its conspicuous invasions by plants and animals including the Burmese python (*Python bivittatus*), lionfish (*Pterois volitans*), giant African land snail (*Lissachatina fulica*), and old-world climbing fern (*Lygodium microphyllum*). The combination of the peninsular shape and a northern frost boundary creates a subtropical island with biogeographical implications including reduced native fauna and flora, and increased susceptibility to biological invasions (Ewel, 1986; Gordon, 1998). Additionally, approximately 85% of all non-native plants enter the US through Florida (Simberloff, 1996). It is estimated that over 25,000 species have been introduced to the state with over 1400 establishing, many of those in sensitive natural areas (Gordon, 1998; Adams et al., 2011). To date, over 15% of natural areas have been invaded by one or more non-native plant species (Jubinsky et al., 2007). Once these species take hold, there are significant impacts to recreation and species are expensive to manage with management costs in the tens of millions of dollars (Langeland, 2013).

There are many common biological traits associated with invasive species including high relative growth rates, longer flowering and fruiting periods, high fecundity, efficient propagule dispersal, short minimum generation times, tolerance to a wide range of habitats, and efficient resource utilization (Gordon, 1998). Unfortunately, many of these biological traits are also common in most horticultural and landscaping plants. In fact, 60% of all the invasive, non-native species are linked to the ornamental plant trade, forestry, or agriculture (Grotkopp et al., 2010) and 82% of the invasive woody plants in the USA were introduced through horticulture or landscaping (Reichard and Hamilton, 1997). But not all non-native plants intentionally introduced become invasive and many are economically beneficial with total sales of the nursery and landscaping industry in Florida topping $15.3 billion in 2010 (Florida Nursery Growers and Landscape Association, http://www.fngla.org). Effective screening tools can utilize information regarding the traits associated with invasive species to assess the invasive potential of non-native species to prevent future invasions and not hinder economic growth.

## WHAT IS THE ASSESSMENT?

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. These recommendations reduce invasion into natural areas by ensuring that plant species with invasive characteristics are not recommended for use by UF/IFAS faculty. The UF/IFAS Assessment has three assessment protocols: the Status Assessment for non-native species already present in the state, the Predictive Tool for species proposed for

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release (or a new use), and the Infraspecific Taxon Protocol to assess cultivars, subspecies, or hybrids of known invasive 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. 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 based roughly on the USDA hardiness zones (http://planthardiness.ars.usda.gov/PHZMWeb/), and conclusions are developed for each zone independently. 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).
- 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).

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 years for "caution" and 10 years for "not a problem" and "invasive." Additionally, 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 implementation of WRA will save Australia $1.67 billion (USA) dollars over a period of 50 years (Keller et al., 2007). Gordon et al. (2008) 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 range 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:

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

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 et al., 1999).

Like the Status Assessment, conclusions for the Predictive Tool are separately derived for North, Central, and South Florida. 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., 2008). 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 cultivars of *Eucalyptus grandis*, three cultivars of *Ruellia*

and four *Lantana* taxa. The conclusion "not a problem species" was found for two of the *Ruellia* cultivars 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. 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).

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