# Results of a plant screening test with implications for animal screening approaches

Session: Science and Economics of Pre-import Screening for Animal Species

Doria R. Gordon[1]

## Introduction

Several types of screening tools for precluding purposeful import of taxa with high probability of becoming invasive in a new geography have been developed. Such tools are generally developed through a retroactive test of taxa with known invasiveness in the new range. These taxa should represent the full range of both invasiveness, from never invasive to highly invasive with clear economic and environmental impacts, and type (family, growth form, life history, etc.) likely to be imported. An effective screening tool would accurately distinguish non-invaders from invaders, with few taxa requiring further evaluation before a determination is possible (Pheloung et al. 1999). Validation of the tool requires implementation on a second suite of known taxa. Further, the tool should minimize the need for expert opinion, potential for (unintentional) bias introduced by the assessor(s), and time and expense of implementation.

Most screening tools fall into one of three categories: 1) spatially explicit modeling of environmental characteristics in the native and invaded range and in a new potential range, using climate matching tools alone (e.g., Hoddle 2004, Rodda et al. 2008) or with other abiotic factors (Arriaga et al. 2004); 2) quantitative tools that are developed from measurement of multiple species, environmental, and historical traits and discriminant analysis (e.g., Reichard and Hamilton 1997, Kolar and Lodge 2002), classification and regression trees (e.g., Caley and Kuhnert 2006, Keller et al. 2007), path analysis, or multiple regression (Veltman et al. 1996) of those traits with invasiveness to identify the best predictors; and 3) tools or protocols that qualitatively assess species, environmental, and historical questions. This latter approach can result in either a written synthesis of the available information and a decision of risk level (e.g., Lehtonen 2001, Nico et al. 2005) or a point system with either additive (e.g., Pheloung et al. 1999, Copp et al. 2005) or multiplicative (e.g., Parker et al. 2007) final scores that indicate the probability that the taxon will be invasive.

## Main Text

Florida is an appropriate location for testing a plant screening system because over 70% of the plants imported into the U.S. enter through the ports of Miami and Orlando (M. Caporaletti, personal communication, 2006). Earlier comparisons of quantitative and qualitative plant screening tools concluded that the qualitative Australian Weed Risk Assessment system (WRA; currently in regulatory use in Australia and New Zealand) was more accurate and addressed more growth forms than other more quantitative systems (Daehler & Carino 2000, Křivánek & Pyšek 2006; but see Jefferson et al. 2004). As a result, we tested the accuracy of the WRA, modified for Florida's environment and including a secondary screen for species requiring further evaluation (Daehler et al. 2004). The test included 158 annuals and perennials in six growth forms from 52 families in 27 orders. The

[1] The Nature Conservancy, Department of Botany, University of Florida, P.O. Box 118526, Gainesville, FL 32611. dgordon@tnc.org.

modified WRA met the hypothesized accuracy levels: it correctly rejected over 90% of test species that have been documented to be invasive in Florida and correctly accepted over 70% of the non-invaders (Gordon et al. 2008a). Only 10% of the 158 species required further evaluation. Invaders of natural areas and agricultural systems were identified with equal accuracy. Receiver Operator Characteristic (ROC) analysis demonstrated high separation of invaders from non-invaders (Gordon et al. 2008a).

We then compared the accuracy of the WRA in Florida with that in the other six geographies in which it has been tested (Gordon et al. 2008b): Australia (Pheloung et al. 1999), New Zealand (Pheloung et al. 1999), Hawaii (Daehler and Carino 2000), Hawaii and Pacific Islands (Daehler et al. 2004), Czech Republic (Křivánek and Pyšek 2006), and Bonin Islands (Kato et al. 2006). The latter three tests and the Florida test (Gordon et al. 2008a) used the secondary screening tool, which decreased the number of species needing further evaluation by over 60% on average, to 10%. Averaging across all tests demonstrated that the WRA system accurately identified major invaders 90%, and non-invaders 70%, of the time. Examined differently, a species of unknown invasive potential was on average likely to be correctly accepted or rejected over 80% of the time for all of these geographies. Comparisons of the ROC curves generated for each test showed equivalent levels of separation across the geographies (Gordon et al. 2008b). These results suggest that this tool functions similarly across islands and continents in tropical and temperate climates and has been sufficiently tested to be adopted as an initial screen for plant species proposed for introduction to a new geography.

However, comparison of the accuracy numbers across the different WRA tests demonstrated several requirements for any screening tool intended for use by multiple parties in different areas.

1. Not surprisingly, if the results are to be consistent, several factors need to be consistently defined. For tests of the tool, the *a priori* categories in which taxa are placed and against which tool accuracy will be evaluated need clear definition. If non-, minor, and major invader categories are used, as in many of the WRA tests, an *a priori* decision of how accuracy of the tool will be determined for the minor invaders is necessary. Highly precautionary approaches would suggest that minor invaders should be identified *a priori* as invasive, as the taxa may be in lag phase of their population growth. Less precautionary approaches might assume that these taxa will never become significantly harmful invaders and would identify that category as non-invasive. For Australian use, identification of 60% of the minor invaders as having high probability of becoming invasive was determined appropriate (Pheloung et al. 1999). Full determination of the accuracy of a screening tool is not possible without a decision about this category.
2. Related to the previous point is whether the outcomes of the screening tool should differentiate minor from major invaders for different regulatory outcomes. This approach is not taken by the WRA, but is suggested by other systems (e.g., Parker et al. 2007).
3. For qualitative approaches, clear guidance on the data necessary to distinguish ‘yes’, ‘no’, and ‘don’t know’ responses should be specified. Such guidance is currently under development for the WRA (Gordon et al. in prep). The particular data required to support a conclusion need to be clear. For example, if a taxon has fleshy fruit in a particular size range, is that sufficient to conclude that it is dispersed by birds, or is evidence that birds consume the fruit necessary, or evidence that seeds can germinate after defecation? Additionally, the difference between a negative and an inconclusive

response is necessary, particularly where the scoring is different for the two (true for 18 of the 49 WRA questions).

4. If questions about whether the taxon is invasive in other locations are included in the screening tool, two factors need further definition here as well. As described above, the level of evidence supporting a positive response needs to be clear as there are many lists of “invasive” taxa that were developed using different criteria. Second, while understanding the definition of ‘elsewhere’ is clear when screening is implemented on islands, developing the boundaries for continental regions is less obvious. Elsewhere may simply be beyond the political boundaries of the region of interest, or may be defined to assure biogeographical isolation from the region of interest.
5. If comparison of the accuracy of a screening tool used in different regions or transparency of the results of such use are desired, consistent reporting of all results is necessary. The different tests of the WRA compared by Gordon et al. (2008b) reported their results differently and generally incompletely.
6. Maintenance of an openly available database with all results for different taxa where they have been evaluated would maximize the efficiency of subsequent evaluations in new geographies and development of more accurate or effective screening systems (e.g., http://www.hear.org/pier/wra.htm).
7. Few systems specify how infraspecific taxa (sub-species, hybrids, cultivars, etc.) should be addressed. As insufficient data will likely be available for many of these taxa, development of clear guidance will be necessary.
8. Other components of an effective screening system include: a comprehensive list of taxa currently in trade in the region, clear taxonomic identification of the taxa present and proposed for introduction, the requirement of an import permit prior to any export activity, and regulations for trade within national borders consistent with those across those borders.

## Conclusion

Considerations identified during investigation of the accuracy of the WRA should contribute to development of effective screening tools for animals. While final regulatory implementation will vary by country, consideration of potential confounding factors like those identified here should facilitate development and comparison of promising standards and systems that would prevent movement of invaders along the dominant introduction pathway for many groups of species.

## References

Arriaga, L., Castellanos V, A.E., Moreno, E. and Alarcón, J. 2004. Potential Ecological Distribution of Alien Invasive Species and Risk Assessment: a Case Study of Buffel Grass in Arid Regions of Mexico. *Conservation Biology 18*: 1504–1514

Caley, P. and Kuhnert, P.M. 2006. Application and evaluation of classification trees for screening unwanted plants. *Austral Ecology 31***:** 647-655.

Copp, G. H., Garthwaite, R. and Gozlan, R.E. 2005. Risk identification and assessment of non-native freshwater fishes: a summary of concepts and perspectives on protocols for the UK. *Journal of Applied Ichthyology 21*: 371–373

Daehler, C.C. and Carino, D.A. 2000. Predicting invasive plants: prospects for a general screening system based on current regional models. *Biological Invasions 2*: 93-102.

Daehler, C.C., Denslow, J.S., Ansari, S. and Kuo, H. 2004. A risk-assessment system for screening out invasive pest plants from Hawaii and other Pacific islands. *Conservation Biology 18*: 360-368.

Gordon, D.R., Onderdonk, D.A., Fox, A.M., Stocker, R.K. and Gantz, C. 2008a. Predicting Invasive Plants in Florida using the Australian Weed Risk Assessment. *Invasive Plant Science and Management 1*: 178-195.

Gordon, D.R., Onderdonk, D.A., Fox, A.M. and Stocker, R.K. 2008b. Accuracy of the Australian Weed Risk Assessment system across varied geographies. *Diversity and Distributions 14*: 234-242.

Gordon, D.R., Riddle, B., Pheloung, P., Ansari, S., Buddenhagen, C., Chimera, C., Daehler, C., Dawson, W., Denslow, J., Jaqualine, T.N., LaRosa, A., Nishida, T., Onderdonk, D.A., Panetta, D., Pyšek, P., Randall, R., Richardson, D., Virtue, J. and Williams, P. In prep. International WRA Workshop 2007 Protocol: Guidance for answering the Australian Weed Risk Assessment questions. *Proceedings of the 2nd International WRA Workshop*, Sept. 14-15, 2007. Perth, Australia.

Hoddle, M.S. 2004. The potential adventive geographic range of glassy-winged sharpshooter, *Homalodisca coagulata* and the grape pathogen *Xylella fastidiosa*: implications for California and other grape growing regions of the world. *Crop Protection 23*: 691-699.

Jefferson, L., Havens, K. and Ault, J. 2004. Implementing invasive screening procedures: the Chicago Botanic Garden model. *Weed Technology 18*: 1434-1440.

Kato, H., Hata, K., Yamamoto, H. and Yoshioka, T. 2006. Effectiveness of the weed risk assessment system for the Bonin Islands. In: Koike, F., Clout, M. N., Kawamichi, M., De Poorter, M. and Iwatsuki, K. (eds). *Assessment and Control of Biological Invasion Risk*. Shoukadoh Book Sellers, Kyoto, Japan and IUCN, Gland, Switzerland, pp. 65-72.

Keller R.P., Drake, J.M. and Lodge, D.M. 2007 Fecundity as a basis for risk assessment of nonindigenous molluscs. *Conservation Biology 21*:191-200.

Kolar, C.S. and Lodge, D.M. 2002. Ecological predictions and risk assessment for alien fishes in North America. *Science 298*: 1233-1236.

Křivánek, M. and Pyšek, P. 2006. Predicting invasions by woody species in a temperate zone: a test of three risk assessment schemes in the Czech Republic (Central Europe). *Diversity and Distributions 12*: 319-327.

Lehtonen, P.P. 2001. Pest risk assessment in the United States: guidelines for qualitative assessments for weeds. In: Groves, R.H., Panetta, F.D. and Virtue, J.G. (eds). Weed Risk Assessment. CSIRO Publishing, Collingwood VIC, Australia, pp. 117-123.

Nico, L.G., Williams, J.D. and Jelks, H.L. 2005. Black carp biological synopsis and risk assessment of an introduced fish. American Fisheries Society Special Publication 32, Bethesda, Maryland.

Parker, C., Caton, B.P. and Fowler, L. 2007. Ranking nonindigenous weed species by their potential to invade the United States. *Weed Science 55*: 386-397.

Pheloung, P.C., Williams, P.A. and Halloy, S.R. 1999. A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. *Journal of Environmental Management 57*: 239-251.

Reichard, S.H. and Hamilton, C.W. 1997. Predicting invasions of woody plants introduced into North America. *Conservation Biology 11*: 193-203.

Rodda, G., Reed, R. and Snow, S. 2008. USGS maps show potential non-native python habitat along three U.S. coasts. U.S. Geological Survey, Reston, Virginia. Accessed (3/29/08) at: http://www.usgs.gov/newsroom/article.asp?ID=1875.

Veltman, C.J., Nee, S. and Crawley, M.J. 1996. Correlates of introduction success in exotic New Zealand birds. *American Naturalist 147*: 552-557.