Everglades Cooperative Invasive Species Management Area

21st Annual Summit

Leveraging R Shiny and Stakeholder Engagement to Develop a Nonnative Species Prioritization Tool

Adrian Figueroa[1]*
Luke Evans[1]
Wes Daniel[2]
Christina Romagosa[1]

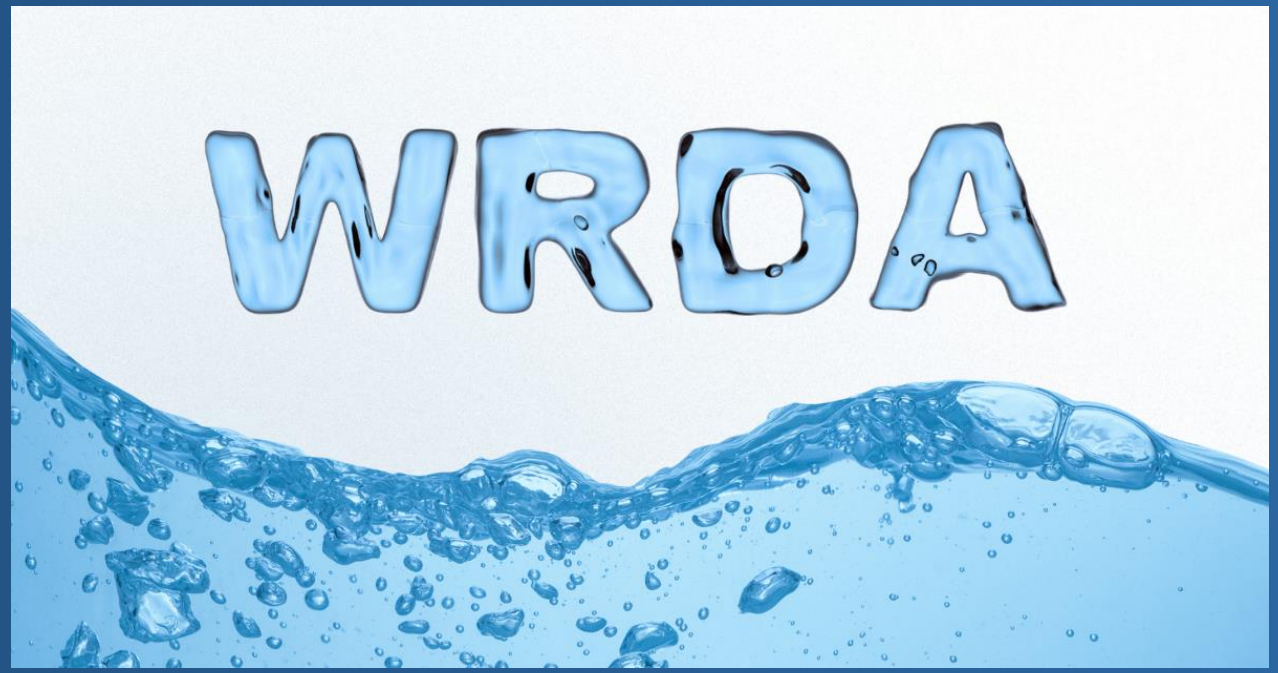
[1]University of Florida, Department of Wildlife Ecology and Conservation
[2]United States Geological Survey, Wetland and Aquatic Research Center

OUTLINE:

- Water Resources Development Act (WRDA)
- Project Objectives
- Methods
- Results
- R Shiny Description and Tool Preview
- Next Steps

Water Resources Development Act (WRDA):

- Signed into law in 1986.
- Crucial for legislative support of Everglades restoration.
- Establishes/funds key restoration projects and plans.
  - Comprehensive Everglades Restoration Plan (CERP)
  - Everglades Agricultural Area (EAA) Reservoir
  - Nonnative species priority list



WRDA Actions:

WRDA 1996

- Created the South Florida Ecosystem Restoration Task Force (SFERTF).
- Established the Office of Everglades Restoration Initiatives (OERI) to coordinate Everglades restoration responsibilities and ensure integration of various stakeholders.

WRDA 2000

- Authorized the Comprehensive Everglades Restoration Plan (CERP).

WRDA Actions (contd.):

WRDA 2020

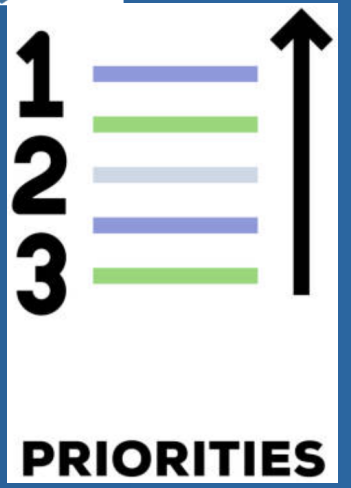
- Required that the Task Force "develops and updates, as appropriate, a priority list of invasive species that:
  - **i.** **Reflects** an assessment of **ecological risk**.
  - **ii.** **Includes** populations of **invasive plants** and **animals** that:
    - i. Are **significantly impacting** the structure and function of **ecological communities**, native species, or habitat within the South Florida ecosystem; or
    - ii. Demonstrate a **strong potential** to **reduce**, **obscure**, or **otherwise alter** **key indicators used to measure Everglades restoration progress**."

Project Objectives:

1. Develop a decision support tool that uses a transparent, defensible and updateable approach.
2. Prioritize invasive species of greatest threat to Everglades restoration.
3. Ensure the tool is taxon agnostic, minimizing bias.

Methods:

1. Coordinated a workshop through OERI.
   - Identified questions that best quantified invasion risk and ecological, human, and Everglades system-wide impacts (Doren et al. 2009).
2. Leveraged R Shiny to create a web app where species are assessed.
3. Preliminarily validated the tool's functionality.



Methods (contd.):

- Grouped workshop participants (30 invasive species experts) by taxon expertise.
  - Birds, Fish, Herps (Amphibians/Reptiles), Invertebrates, Mammals, and Plants.
- Question sets provided to taxon experts by theme (Abiotic Factors, Biotic Factors, Management Feasibility, etc.). 63 questions total.
- Participants scored questions based on its importance for their taxon.
  - If 7 questions in a theme, most important question scored 7 while least important scored 1.
- Recorded and analyzed data from participant worksheets to determine:
  - Which questions are most important **<u>across all taxa</u>** when considering invasion/impact risk.

Methods (contd.):

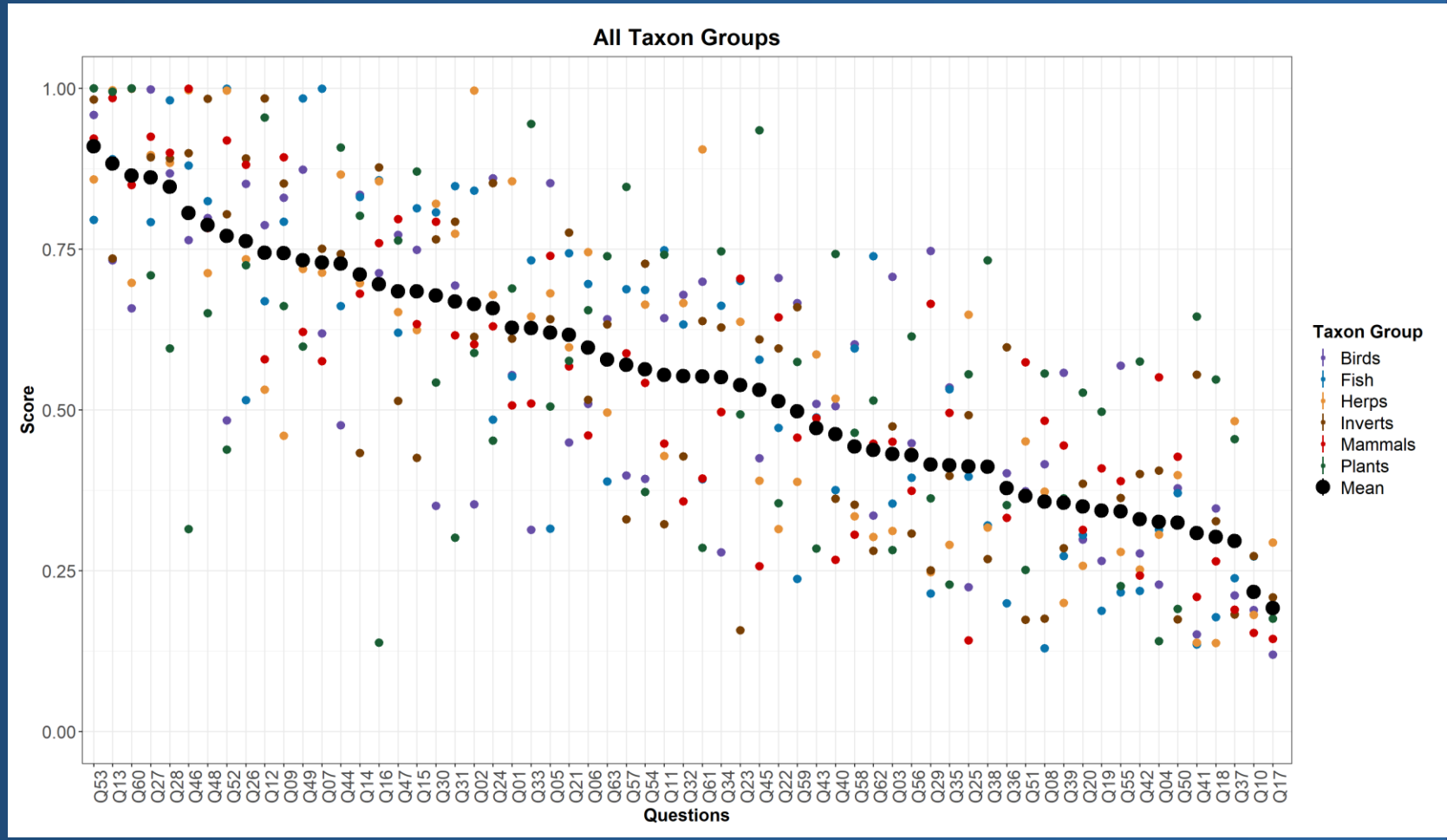
- Normalized question scores between 0.00 and 1.00.
- Compiled a Bayesian Generalized Linear Mixed Model (GLMM), using ordered beta regression (Kubinec 2022).
  - Default uninformative prior used:
    - **Slope:** normal(0,5)
    - **Intercept:** student_t(3, 0.5, 2.5)
    - **SD:** student_t(3, 0, 2.5)
  - norm.score ~ question*taxon + (1|individual)
  - Model accounts for taxon-specific bias and individual variation.
- 3 questions omitted from R Shiny tool due to lack of consensus.
- Used scores from model output in question weightings.

Question Score	Normalization	Normalized score
1	1/7	0.14
2	2/7	0.29
3	3/7	0.43
4	4/7	0.57
5	5/7	0.71
6	6/7	0.86
7	7/7	1.00

Results:

Top 5 Questions:

1. Is species known or suspected to be a vector for a human pathogen or parasite?
2. Is species invasive elsewhere?
3. Could species influence landscape-level characteristics in the Everglades?
4. What stage along the invasion curve is the species in?
5. Does species appear to have a self-sustaining population?

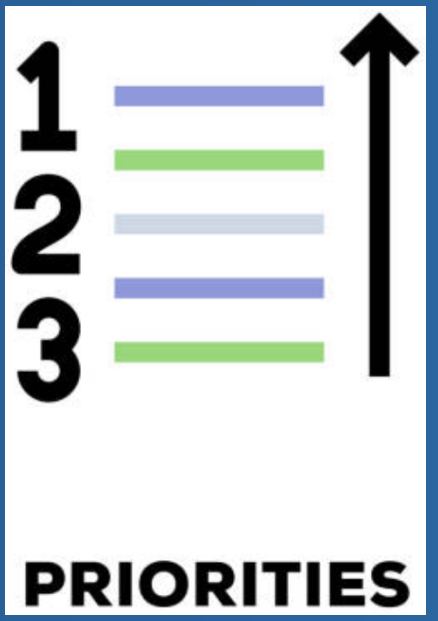


R Shiny:

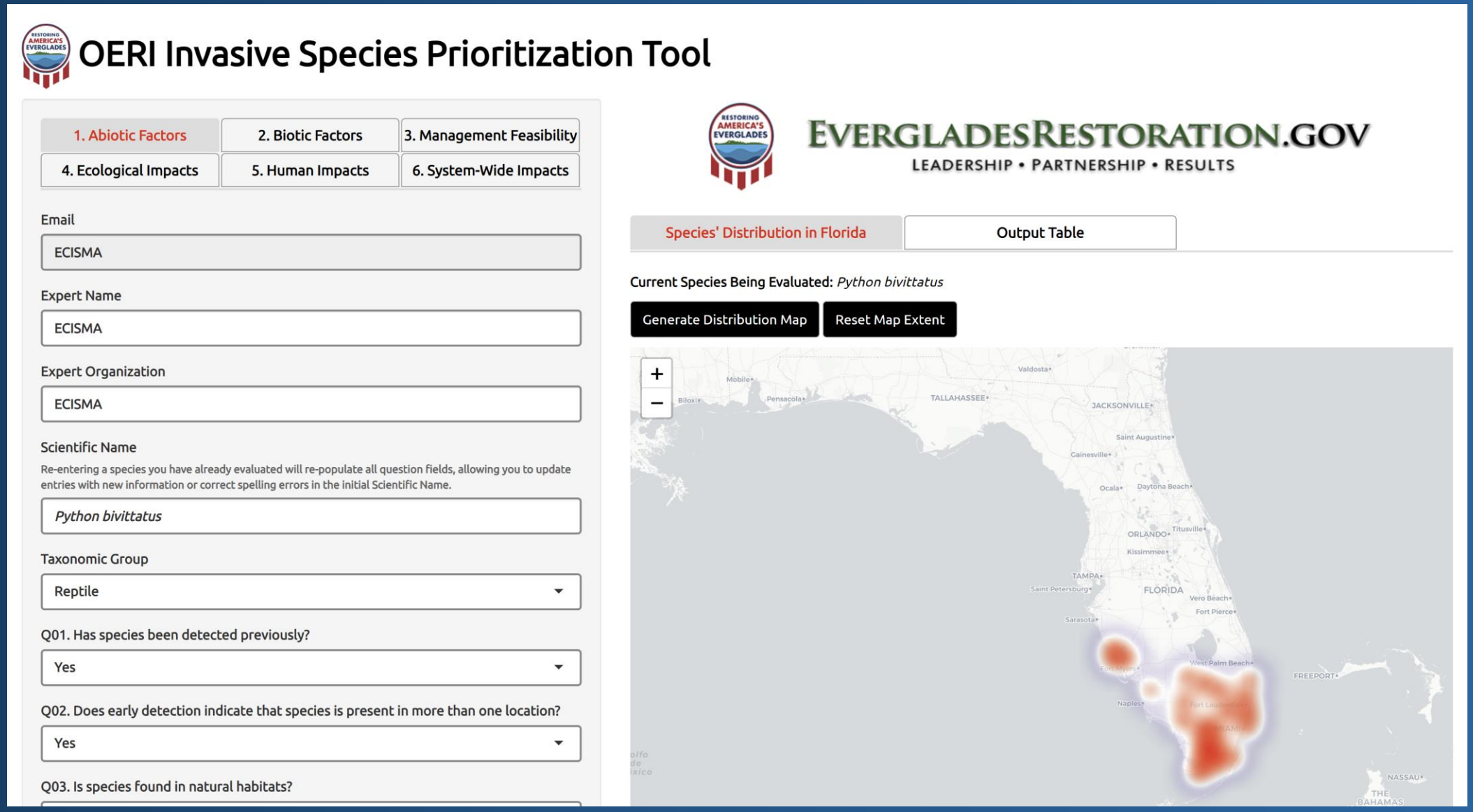
- Platform for web-based applications.
- Widely used in:
  - Decision-making
  - Data analysis
  - Research
- Interactive functionality:
  - Save previous assessments, view species distributions, etc.
- Provides various outputs (CSV, PDF, etc.).
- Automatically updateable interface.
  - Would maintain a living list automatically.
- Secure access through approved users in an independently maintained whitelist.

Question/Answer Weightings in Tool:

- All weights normalized to sum to a total score of 10.
- Answers in the affirmative grant 100% of the question weight to total score.
- Answers in the negative grant 50% of the question weight.
- Answers indicating respondent is unsure grants 0% of the question weight.



Decision Support Tool Interface:



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Tool Outputs:

- Users can access their previous entries.
- New entries automatically sorted based on Priority Score.
- Users can copy table, download as a CSV, or they can print or download list as a PDF.
- Users can search for species they've already assessed.

Priority Number	Scientific Name	Taxon Group	Priority Score
All	All	All	All
1	*Highest Priority Species*	Bird	10.00
2	*Lygodium microphyllum*	Plant	8.26
3	*Imperata cylindrica*	Plant	7.84
4	*Python bivittatus*	Reptile	7.74
5	*Acacia auriculiformis*	Plant	7.72
6	*Eichhornia crassipes*	Plant	7.66
7	*Cenchrus purpureus*	Plant	7.65
8	*Iguana iguana*	Reptile	7.64
9	*Senna pendula var. glabrata*	Plant	7.46
10	*Syngonium podophyllum*	Plant	7.43

Preliminary Tool Validation:

- Alpha testers accessed the app and assessed multiple species.
- Tester with the most species assessed (n=13) was asked to rank species in their ideal order.
- Calculated Spearman's rank correlation between tool output and expert's ideal list order.

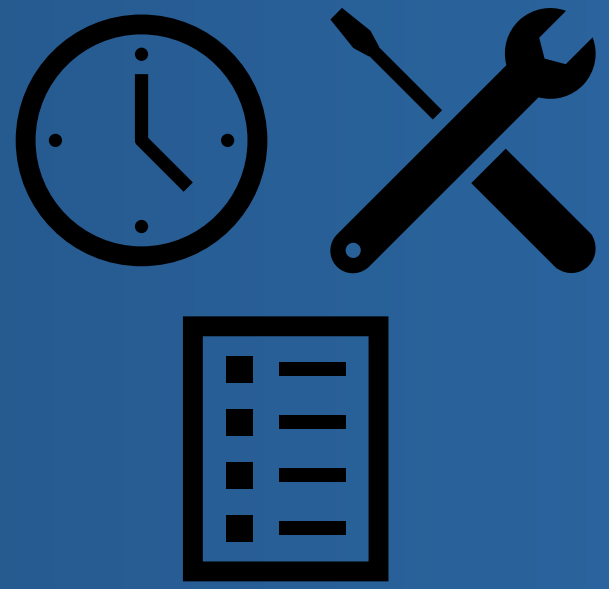
Decision Support Tool List Order	Ideal List Order	Species	Taxon	Score
1	1	*Lygodium microphyllum*	Plant	8.256592
2	2	*Imperata cylindrica*	Plant	7.842044
3	4	*Acacia auriculiformis*	Plant	7.71906
4	3	*Eichhornia crassipes*	Plant	7.656684
5	7	*Cenchrus purpureus*	Plant	7.652054
6	5	*Senna pendula var. glabrata*	Plant	7.458862
7	6	*Syngonium podophyllum*	Plant	7.434629
8	8	*Schefflera actinophylla*	Plant	7.388927
9	11	*Momordica charantia*	Plant	7.089784
10	10	*Urena lobata*	Plant	7.047109
11	9	*Syzygium cumini*	Plant	6.593447
12	12	*Tradescantia fluminensis*	Plant	6.371889
13	13	*Castanea mollissima*	Plant	3.938658
Spearman's Rank Correlation:	95.60%			

```
        Spearman's rank correlation rho

data:  validation.data$OERI.Tool and validation.data$Ideal.Order
S = 16, p-value < 2.2e-16
alternative hypothesis: true rho is not equal to 0
sample estimates:
     rho
0.956044
```

Next Steps:

1. Further validation to ensure tool works across all taxa.
2. Calculate mean priority score across all user entries to generate authoritative priority list.
3. Fine-tune tool outputs for user-specific needs.



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THANK YOU

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  - Jose Cabaleiro
- **Florida Atlantic University Center for Environmental Studies:**
  - MaryBeth Hartman Kerber
- **Workshop Participants:**
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Think Locally, Act neighborly

invasive species know no boundaries!

Questions?

CONTACT INFORMATION:
Email: adrian721@ufl.edu

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