A Q U A P H Y T E

A Newsletter about Aquatic, Wetland and Invasive Plants

Center for Aquatic and Invasive Plants
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To Be or Not To Be:

Assessment Methods and Invasive Plant Prediction Models

Land managers, facing increasing non-native species and exploding non-native plant abundance, obvious to all, want help beyond mere anecdotes and generalizations; managers are in urgent need of at least two tools: 1) a **predictive method** (a screening protocol) that enables managers to know in advance which non-native plants will remain prettily in the yard, and which are likely to escape their domestic confines and invade natural areas; and 2) an **assessment method** that makes it possible to classify and prioritize already-in-place non-native plants according to their invasiveness.

Being able to predict plant invasiveness, and being able to classify existing non-native plants

- would enable regulators to allow or prohibit certain species;
- would enable eco-managers to determine which areas should be regularly surveyed so that new invasions might be quickly controlled;
- would enable eco-managers to develop and employ smarter plant management strategies to reduce environmental damage;
- would help nurserymen, retailers and their customers who want to enjoy plants that are from somewhere else; and
- would inform plant-buying consumers so that they, too, can join the fray against non-native plant invasions.

What progress have scientists made in developing predictive methods and assessment means? The first place one might look is the **APIRS** database, an expanding 65,000-item collection of the scientific literature about invasive plants in Florida, the US and beyond. (Go to: http://plants.ifas.ufl.edu/ - click on "**APIRS** Online Database.")

The **APIRS** bibliographic database includes more than 250 research articles and books that include variations of the keywords, "assess," "predict" and "invasiveness." (Many more "abstracts" about the subject are included in dozens of proceedings of management societies, and are listed in **APIRS** bibliographies, but abstracts are not included in the following.)

Among the items listed in **APIRS** are two ambitious assessment methods, the National Assessment and the Florida Assessment.

National Assessment

The national assessment protocol is the work of NatureServe, The Nature Conservancy and the National Park Service. Its purpose is to "make the process of assessing and listing invasive plants objective and systematic," and is used to assess species individually for a specified "region of interest." This protocol is being used to "assess the biodiversity impact of the approximately 3,500 non-native vascular plant species established outside cultivation in the United States."

Of the 3,500 plant species targeted for assessment, 382 are complete and may be downloaded. (These 382 assessments are included in the 2,052 page PDF file.)

The national assessment classifications include "National I-Rank," "Ecological Impacts," "Current Distribution," "Trend in Distribution" and "Management Difficulty." The national assessment protocol was authored by L.E. Morse, J.M. Randall, N. Benton, R. Hiebert and S. Lu, 2004.

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Mary's Picks!

Items throughout this issue marked with "" are from articles that particularly piqued the interest of Mary Langeland, the reader/cataloger for the **APIRS** database.*

*** Fruits and seeds of *Ruppia* (Potamogetonaceae) from the Pliocene of Yushe Basin, Shanxi, northern China and their ecological implications.** 2004. By L.-C. Zhao, M.E. Collinson and C.- S. Li. *Botanical Journal of the Linnean Society 145:317-329.*

This reports the discovery of fossil fruits and seeds from monotypic stands of *Ruppia* in northern China dating from 3.5 to 2.3 million years ago. Their presence apparently indicates the existence of a temperate climate in this area. The discovery also increases the range of *Ruppia* from Europe to eastern Asia.

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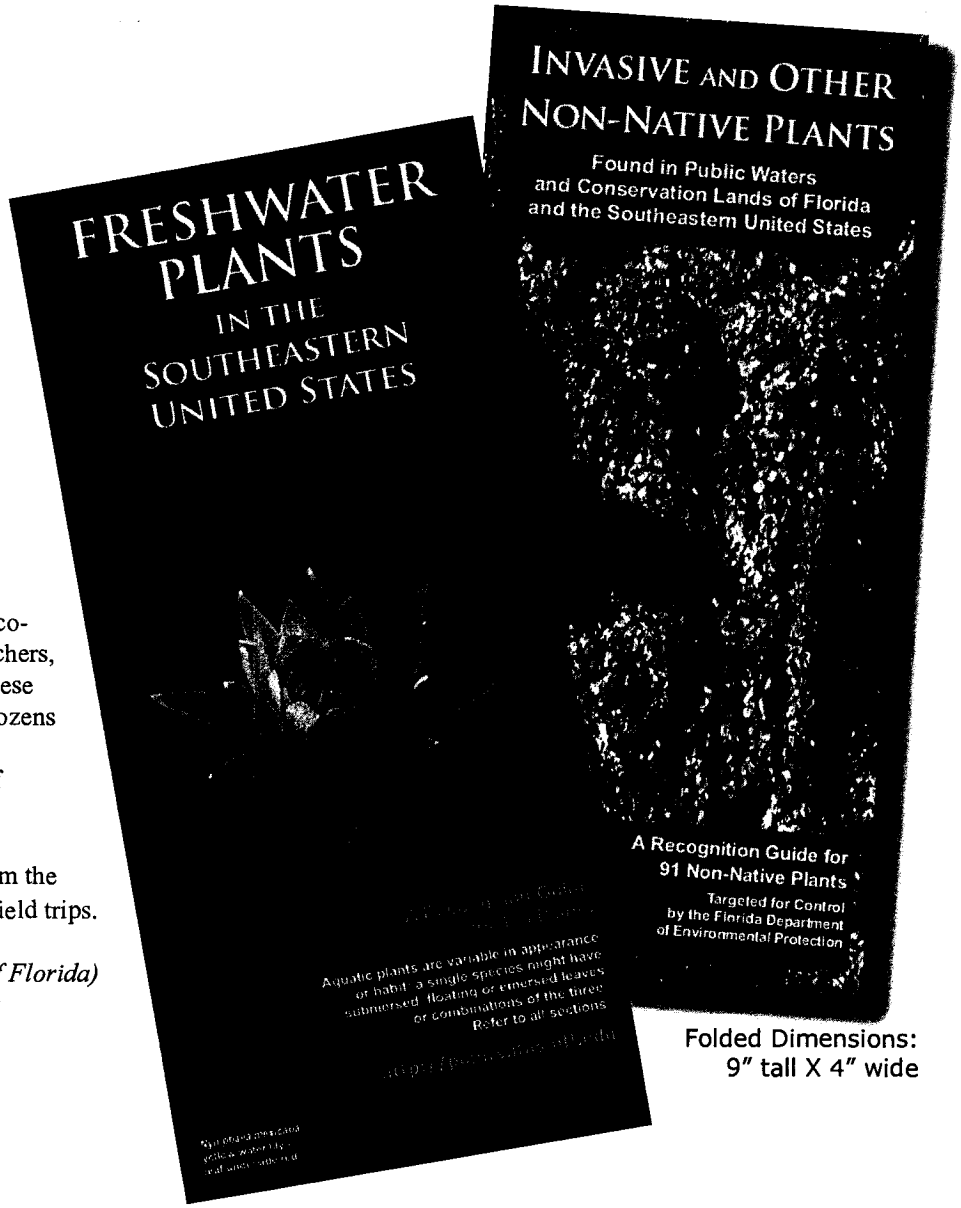

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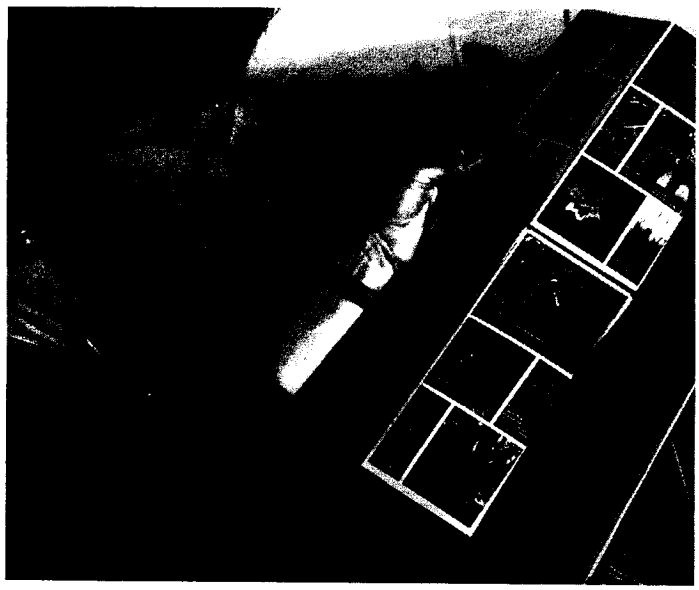

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Florida Assessment

The Florida assessment protocol is the work of collaborators from the University of Florida, Santa Fe Community College (Gainesville, Florida) and The Nature Conservancy. The purpose of the Florida assessment is to impartially classify hundreds of non-native plants in our state, by area (North, Central and South zones). The result is that many non-native plants are deemed "OK" to be recommended for use in certain zones of the state. The original purpose of the assessment was to conform university publications so that Extension and other university workers were giving consistent information to the public regarding the use of non-native plants.

The authors stress this is not a predictive instrument but is intended only for plant species or cultivars that currently occur within Florida. Species not yet introduced to Florida "would require a separate predictive instrument, still to be developed." Of the 193 species selected for assessment, 159 are complete and may be downloaded.

The IFAS Assessment classifications include

"Not eligible for any uses" (61 plants);

"May be eligible for limited uses if approved by the Invasive Plant Working Group" (19 plants);

"Caution: may be recommended but manage to prevent escape" (37 plants);

"Not a problem species, but has been documented in undisturbed natural areas" (42 plants); and

"Not a problem species, and has not been documented in undisturbed natural areas" (87 species).

Another 34 plants are "not yet assessed" or are "in progress."

The Florida assessment protocol was authored by A.M. Fox, D.R. Gordon, J.A. Dusky, L. Tyson and R.K. Stocker, 2005, University of Florida.

Both the National and Florida assessments are online, and include PDF files of their method protocols, field survey forms, and results lists of non-native plants that are believed to be invasive. The national list includes completed US national assessments for 382 plant species; the Florida list includes completed assessments for 158 plant species.

NatureServe U.S. Invasive Species Assessment Protocol and Results: http://www.natureserve.org/getData/plantData.jsp

IFAS Assessment of the Status of Non-Native Plants in Florida's Natural Areas Protocol and Results: http://plants.ifas.ufl.edu/assessment.html

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Current Prediction and Assessment Literature Found in the APIRS Database

The first flurry of research about predictive models and invasive plant assessment methods appear in the **APIRS** database from the mid-1980s. Ten years later came the next small batch of "prediction" research. Then for 2000 the database reported 12 research items about invasive plant predicting; in 2001 there were 28; in 2002, 22...

One thing is clear from looking at these papers: there are a number of methods for counting plants in a big area, there is some good information about the morphology and physiology of many non-native plants and what climates they prefer, etc., **but there seems to be little usable science for the land manager** whose job it is to beat back the hundreds of invading plant species.

By the mid 1980s, plant researchers were asking questions they felt would be useful in creating a predictive mathematical model, such as: "do invading species have definable genetic characteristics?" At the same time, other scientists had decided that models cannot be as good as empirical evidence ("what we've seen a plant do before provides a good indication of what it will do again"). Roughgarden (1986) said that we can "make just as good a prediction, though perhaps restricted to the short term, by using ad hoc methods requiring less work" than model building and testing. Thus, strong pants and shoes, a compass, a map and pen, and the willingness to walk, will yield information for a good prediction. However, "if the community that is to be invaded is itself sufficiently variable, then predicting anything about an invasion will assume the status of a weather report."

By the end of the 1990s, scientists were trying to create useful predictive models using site characteristics, species characteristics and environmental disturbances (Clarke, 2002). In 1999, Goodwin found that the original range alone was an effective predictor - to 70% accurate. But he concluded that "prediction of invasiveness on a species-by-species basis is not likely to help stem the flow of accidentally introduced invasive species."

Was significant progress made between 1980 and 1999? See Rejmanek (2000) for a review of predictive approaches. See Werren (2001) for reviews of Risk Assessment Systems (RASs); he was looking to screen non-native species to identify and control the "sleeper weeds" - i.e. plants in the initial stage of invasion - "before their rate of spread is exponential."

More recently, a scant few researchers have worked on ways to predict invasions and to assess non-native plants already in new ranges:

- the **Weed Invasion Susceptibility Prediction (WISP)** model was 85% to 97% accurate for individual rangeland species (Gillham, 2004);

- the **US Geological Survey** ranking system, a "semiquantitative ranking system," was used to classify 167 species into four invasive categories (Drake, 2002);

- the **Rapid Ecological Assessment** method was evaluated by Krauss (2003);

- the **Genetic Algorithm for Rule-set Prediction,** the "ecological niche model" called **GARP**, developed models on native geographic distribution and projected them to other regions to "predict the geographical potential of species' invasions with high accuracy" (Peterson, 2003);

- the authors believe Australia's robust, simple, and understandable **National Significance Assessment System** to be the "first ever attempt at devising a generic scoring system to rank the importance of established weeds on a national basis"; with it they listed Australia's 25 most significant invasive plants (Virtue, 2001);

- and Pysek (2004), in search of a reliable predictor, says that it's important to distinguish between archaeophytes (plants introduced by man to a new area as long ago as several thousand years) and neophytes (more recent introductions), and that archaeophytes should be considered non-native plants for modelling purposes.

v.r.

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*Following are articles on prediction and assessment of invasive plants from refereed journals and books, in ascending order by year. **APIRS** also lists many more abstracts and shorts from proceedings of various invasive plant societies.*

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1993 - Daehler, CC; DR Strong. Prediction and biological invasions. Trends in Ecology and Evolution 8:380.

1994 - McIntyre, S; S Lavorel. Predicting richness of native, rare and exotic plants in response to habitat and disturbance variables across a variegated landscape. Conservation Biology 8(2):521-531.

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*** Plant invasion ecology - dispatches from the front line.** 2004. By D.M. Richardson. *Diversity and Distributions 10(5-6):315-319.*

Mary calls this "a thoughtful and broad-ranging editorial" about biotic invasions, biotic resistance, manipulative experiments, modelling and impacts.

*** *Archaefructus* - angiosperm precursor or specialized early angiosperm?** 2003. By E.M. Friis, J.A. Doyle, P.K. Endress and Q. Leng. *Trends in Plant Sciences 8(8):369-373.*

The authors are skeptical that *A. lianoningensis* is the oldest known angiosperm. They think *Archaefructus* "might be a crown-group angiosperm specialized for aquatic habit rather than a more primitive relative."

*** Seed germination responses of *Monochoria korsakowii* Regel et Maack, a threatened paddy weed, to temperature and soil moisture.** 2004. By X.-C. Wan, G.-X. Wang and I Washitani. *Plant Species Biology 19:203-207.*

What were once common paddy weeds have now become protected species. Here's a report on one of them. The authors conclude that *M. korsakowii* has declined because it has not adapted to today's farming system in Japan, which includes laying rice fields fallow and the use of herbicides.

*** Blitzkrieg in a marine invasion: *Caulerpa racemosa* var. *cylindracea* reaches the Canary Islands (north-east Atlantic).** 2004. By M. Verlaque, J. Afonso-Carrillo, M. C. Gil-Rodriguez, et al. *Biol. Invasions 6(3):269-281.*

An invasive variety of this species, introduced from Australia to the Mediterranean Sea, now has been found in the Canary Islands. The finding in proximity to harbors supports the hypothesis of possible dispersal by ship traffic. Other parts of the world could soon become infested without more control on the aquarium trade and ships, according to the authors.

*** How interactions between ecology and evolution influence contemporary invasion dynamics.** 2004. By J.G. Lambrinos. *Ecology 85(8):2061-2070.*

The author states that "invading populations often experience rapid evolutionary changes associated with or soon after their introduction." The genetics of the invading plants can be altered by founder effects, drift, interbreeding and hybridization, local adaptation, migration and dispersal patterns, strong selectivity, human dispersal and landscape change. This article reviews previous research that focused on these issues.

*** Astroturf seed traps for studying hydrochory.** 2004. By M. Wolters, J. Geertsema, E.R. Change, R.M. Veeneklaas, et al. *Functional Ecology 18(1):141-147.*

Seed dispersal by water (hydrochory) "is an important aspect of the vegetation dynamics of plant species growing near streams, rivers, oceans and seas." Described here is a new method for collecting seeds and other propagules as they drift and disperse in tidal marshes.

ALIEN PLANT ENTRY

Some Observations from the West-Central Illinois Flora

by Dr. Robert Henry, Retired Curator of the RM Myers Herbarium, Ohio State University

Flora authors have observed and recorded alien plants probably since the beginning of plant records. The presence of aliens in a flora is documented by records and collections, but these may not be accurate or complete and therefore, do not necessarily represent the actual time of entry. Most data are post-European settlement. However, Native Americans, European and other pre-settlement explorers, traders, trappers, itinerants and temporary homesteaders could, by their inter- and intra-continental activities and movements, provide ample opportunities for alien plant entry and establishment. Also, alien propagules could arrive by air, water and animals before and after human presence. This essay presents some composite observations concerning alien plant entry during the period of 1833 (post-settlement) to 1987 into the west-central Illinois spontaneous or non-cultivated vascular flora. The time of the first entry of an alien plant into the west-central Illinois flora is unknown.

Systematics

During this period, the alien plants have always been and still are mostly angiosperm (99%) dicots (79%). The plant families with the most species are: Poaceae, Asteraceae, Brassicaceae, Fabaceae, Malvaceae, Chenopodiaceae, Amaranthaceae, and Lamiaceae. By 1987 aliens were in 43% of the families and 8% of the families were all aliens. *Chenopodium, Rumex, Malva, Amaranthus*, and more recently *Bromus, Brassica* and *Polygonum* are a few of the genera with the most aliens. By 1987 aliens were in 38% of the genera and 24% of the genera were all aliens.

Floristics

Increasing numbers of aliens in the flora is indicated by six percent in 1846 to 25% by 1987. From 1846 to 1952 there was one alien species average increase per year, whereas from 1953 to 1987 there were about three. The geographical origin has been consistently and predominately European, being from 74% to the present 82%. The western United States is the source of most aliens from within this country. Deliberate introductions, most being cultivated, have been about 50%, leaving spontaneous occurrences at about 50%. Naturalization of alien species has increased from zero percent from the original entries to about 80% now.

Ecology

The alien species have been 98% terrestrial, with about 25% of all terrestrial species alien. Aquatic alien species were few (1%) early and now only about two percent of the alien species are aquatic, with six percent of all aquatic species being alien. Almost all alien species occur on disturbed land (disturbophytes). Land cover is over 90% alien species, principally due to agriculture. There is an interesting paradox regarding the attitude toward alien plants: The effort to eradicate alien weedy plants vs. the effort to propagate alien food plants (corn, soybeans, etc) and other utilitarian species on the same land. Forty-six percent of alien species are considered weeds and 40% of weed species are aliens. Of alien weed species in Hancock County, IL, 47% were once cultivated, 85% are from the Old World, 44% were in the county before 1881, and between 1833 and 1978 one species was introduced per year. 13% of woody weed species were alien, and 40% of herbaceous weed species were alien. Most alien species are annual and biennial (56%), while 50% of annuals are alien. Most alien species are herbaceous (88-94%). The number of woody species has doubled (6-12%) including ill-advised plantings such as *Elaeagnus* spp., *Rosa multiflora*, and *Lonicera* spp. promoted by government entities. The latter two are now illegal to sell and plant in Illinois. Twenty-five percent of all herbaceous species and 22% of woody species are alien.

Once arrived, alien species have often become detrimental to the ecosystem as has been extensively documented. Aliens are increasingly occupying disturbed and natural areas, becoming naturalized and causing a rapid change in vegetation cover and in flora composition, causing more native species to be rare, threatened, endangered and possibly extinct. As urbanization (including urban sprawl), industrialization, transportation, recreation, agriculture (including bioengineered species), clearing and extraction increase, so does disturbed land with alien species, including alien weeds. The potential for alien species to become weeds is not static but varies with time and environmental conditions. Climate change could favor aliens also. We probably can expect the percent of alien species to increase and their geographical origin to vary as the flora becomes increasingly homogenized due to introductions both purposeful and accidental as a result of world commerce. Although most alien immigrants in the near future will continue to be angiosperms, terrestrial, and herbaceous, this could change in the future.

There is now a rapid increase in our interest and awareness of alien species and their effects on both the native species in our ecosystems and the functioning and beneficial services of these ecosystems. In earlier times, alien floristic data was presented to document what was occurring in the flora, but response was limited, perhaps due to the fact that the data were floristic and local; they did not stress the present overall ecological/ecosystem deterioration paradigm that is the basis of the current interest in invasive alien plants.

> *"An informal survey indicates that no American taxonomists are specialists on alien plants and that few are much concerned about the status of aliens in [published] floras." 1979.*
>
> From **Changes in the alien flora in two west-central Illinois counties during the past 140 years** by RM Myers and RD Henry, *American Midland Naturalist 101(1):226-230.*

To decrease or prevent future alien entry, purposeful introductions are being more closely monitored and regulated and a major effort is being made to reduce accidental entry especially along transportation corridors. Of the recent alien entries in one west-central Illinois county, 68% entered along railroad and highway corridors, locations where disturbed habitats and other environmental parameters are conducive to alien establishment. Many of the early alien species were purposely introduced to meet settlers' needs for food and other utilitarian and cultural uses, which then escaped and became naturalized. We still, and will continue to need native and alien species for these uses. Wildlife commonly uses alien species present in their habitat. Alien entry most likely will not be stopped and the ones already present will not be eradicated. A more efficient use of the enormous money and labor being spent is needed in their management, which should include a tolerable objective threshold that is productive, useful, beneficial and compatibly integrated with the dynamic flora of the ecosystem.

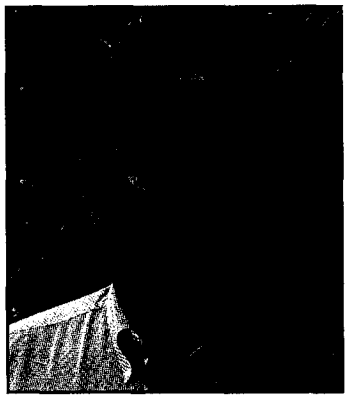
DEP - IFAS Review of Aquatic and Invasive Plant Research in Florida

Aquatic and invasive plant research being performed throughout Florida was reviewed in Gainesville recently as the **Florida Department of Environmental Protection (DEP), Bureau of Invasive Plant Management**, and the **University of Florida, Institute of Food and Agricultural Sciences (UF-IFAS), Center for Aquatic and Invasive Plants** hosted a meeting to review current research being funded by the state agency and UF-IFAS. Other objectives were to communicate ideas and needs for future research on aquatic and invasive plants in Florida.

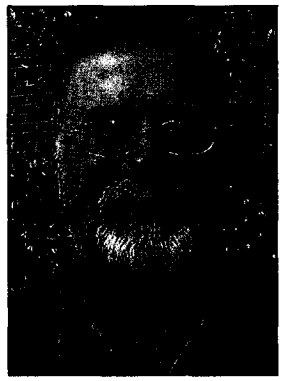
William Torres, Chief of the DEP Bureau of Invasive Plant Management, and **William Haller**, Acting Director of the Center for Aquatic and Invasive Plants welcomed invasive plant scientists from throughout Florida to the one and a half day gathering. **Don Schmitz**, Biologist and Research Contract Manager for the Bureau, stated in his overview that more than 88 million dollars is spent annually on invasive plants and animals by all of the various state agencies in Florida. Of that 88 million, less than $800,000 is spent on research and outreach. The bulk of the Bureau's money pays for management efforts, with about half going toward hydrilla control. Most research money is spent on biological control with about half of the projects being investigated at UF-IFAS.

Projects covered in the research review included multiple presentations on biocontrol insects being considered for control of *Casuarina* spp., *Hydrilla, Lygodium microphyllum, Schinus terebinthifolius, Paederia foetida* and *Dioscorea bulbifera*. Potential invasiveness of ornamental plant species was reviewed as well as ecological studies of *Scleria lacustris, Imperata cylindrica* and *Hemarthria altissima*. Work on mycoherbicides was reviewed as well as chemical herbicide studies for controlling *Hydrilla, Lygodium* and *Imperata cylindrica*. Mapping and survey research was presented, as was an overview of **APIRS** activities. **APIRS** has been a long-time recipient of DEP and UF-IFAS funding for maintaining and expanding the database and for educational products and services.

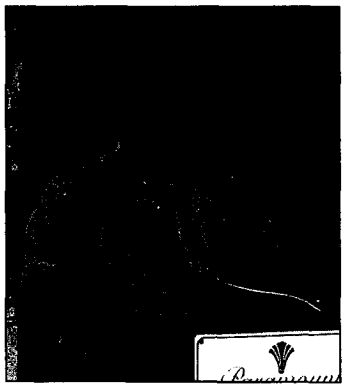
DEP areas of current research interest include biological control, improved practices for chemical control, economic impacts, development of screening protocols, and evaluations of mechanical harvesters and tussock shredding machines. High priority species for the current year are *Hydrilla* and *Lygodium microphyllum*. High priority *Hydrilla* research includes tuber formation and viability, grass carp/herbicide combinations, and development of new herbicide tools. High priority *Lygodium microphyllum* objectives are to continue biological control research, determining optimal times for herbicide treatments, finding new herbicide tools, effects of fire, and decontamination methods for workers and equipment in the field for this spore dispersed fern species.



Dr. William Haller, Acting Director, Center for Aquatic and Invasive Plants, University of Florida, IFAS.



Mr. Don Schmitz, Biologist and Research Contract Manager, Bureau of Invasive Plant Management, Florida Department of Environmental Protection.



Mr. William Torres, Bureau Chief, Bureau of Invasive Plant Management, Florida Department of Environmental Protection,

*** Do alien plants reduce insect biomass?** 2004. By D.W. Tallamy. *Conservation Biology18(6):1689-1692*

Considering how important insects are to the food chain, the author asks why so little research has been done to answer important questions about the effects of non-native plants on native insects, questions such as: 1) Many non-native plants were spread by humans because of their unpalatability to insects; as these unpalatable plants spread, what will native insects eat? 2) How many herbivores will associate with a non-native plant compared to the number of herbivores in the plant's native range? 3) Do "generalist" insects do as well on non-native plants as on natives? 4) To what extent do generalist insects eat non-native plants? 5) To what extent does non-native plant abundance affect egg-laying and feeding? 6) How does replacement of native plants with non-native species affect insectivorous mammals, reptiles and amphibians? "Given the pervasiveness of alien plants in North America and the speed with which they continue to replace native vegetation, addressing such questions should become a priority among funding agencies and researchers alike."

*** What makes a weed a weed: life history traits of native and exotic plants in the USA.** 2004. By S. Sutherland. *Oecologia 141(1):24-39.*

The author compared ten life history traits for the 19,960 plant species that occur in the USA. He found that a) life span was the most significant life history trait for weeds - weeds were more likely to be annuals and biennials than perennials; b) weeds were more likely to be wetland adapted, toxic and shade intolerant; and c) weeds were more likely to be monoecious and trees.

Look at the Web Sites, Complete the Crossword, Win a Prize!

The first 10 people (any state, any country) who return the correctly-completed crossword puzzle will win four each of the two laminated ID guides described on page 2. This puzzle can be solved by referring to two web sites: the original **APIRS** web site: *http://plants.ias.ufl.edu* and our new web site: *http://plants.ifas.ufl.edu/guide* Read the clue, refer to the URL cited, find the answer and fill it in. Photocopy your completed crossword puzzle at 100% and send it via snail mail to: CROSSWORD, Center for Aquatic and Invasive Plants, 7922 NW 71 Street, Gainesville, FL 32653, USA.

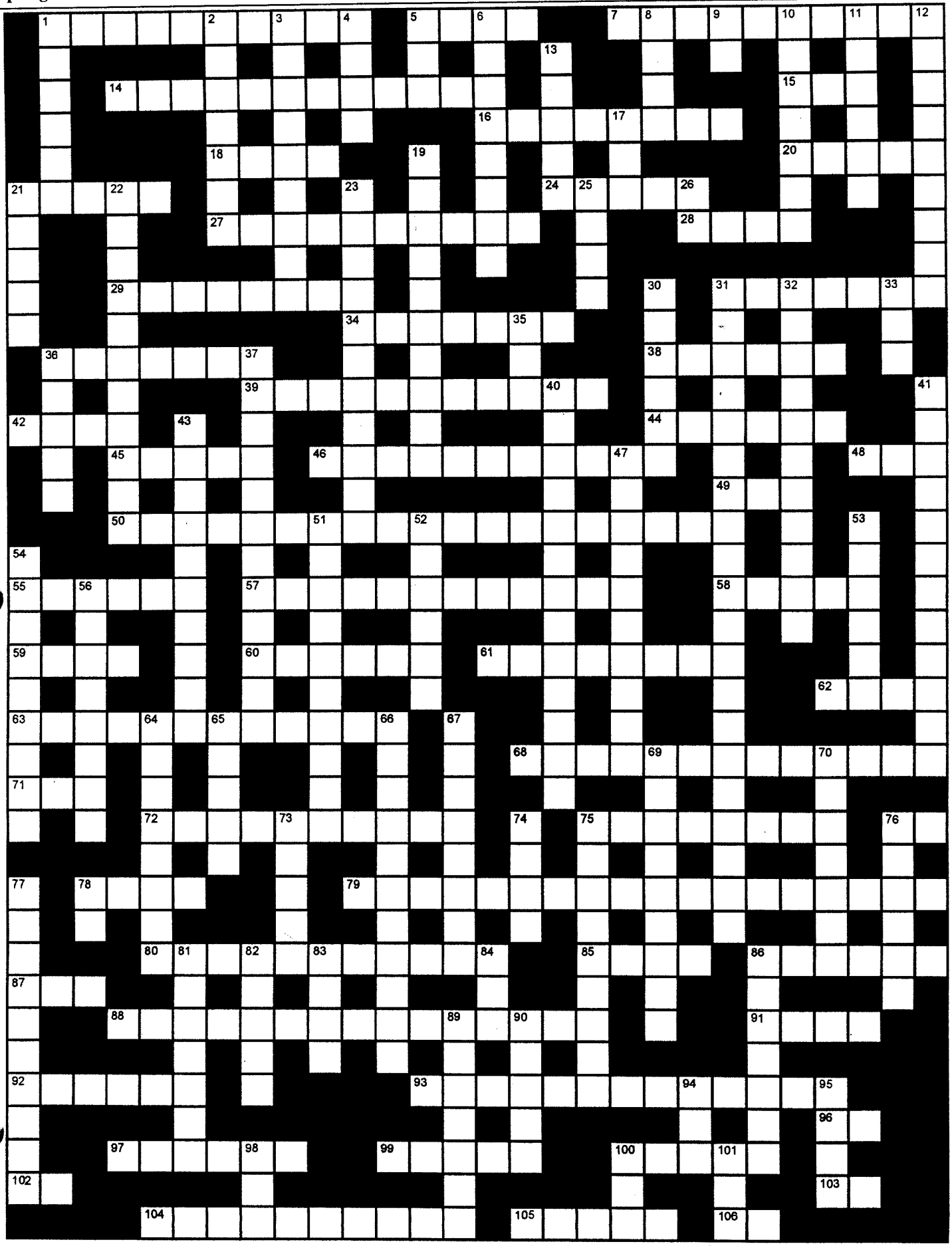
Across

1. salt grass, _____ *spicata*, (...edu/disspi.html)
5. DEP Bureau of Invasive Plant Management
7. banana lily (...edu/photocom.html)
14. *Ipomoea* common name
15. *Dioscorea bulbifera*, _____ potato
16. underwater soil
18. below-ground plant part (...edu/glosin10.html)
20. _____ duckweed, _____salvinia, _____reed
21. upright stems are _____
24. arranged from center (...edu/glosstu.html)
27. *Colubrina asiatica* (...edu/colasi.html)
28. freshwater sportfish (...edu/guide/fish.html)
29. herbicide modifier (...edu/guide/adjuva.html)
31. "_____ tolerances" (...edu/l-mental.html)
34. _____ River State Park: colorful! (...edu/gallery2.html)
36. President _____'s Executive Order 13112 (...edu/assessment.html)
38. _____ Prairie State Preserve (...edu/gallery2.html)
39. *Microcystis* is a _____ alga (...edu/guide/2algae.html)
42. Chinese grass _____ (...edu/guide/biocons.html)
44. drink of the gods (...edu/gloss-no.html#n2)
45. measure your _____ width (...edu/guide/calibinf.html)
46. giant cut grass (...edu/zizmil.html)
48. facultative wetland plant (abbr.)
49. ___ World climbing fern (...edu/lygod.html)
50. *Saccharum giganteum* common name (...edu/photos.html)
55. Plant ID chapter (...edu/b-conten.html)
57. section on _____ lakes (...edu/guide/lakes.html#lakdisap)
58. very low nutrients, _____trophic (...edu/guide/trophstate.html)
59. *Xyris* is yellow_____ grass (...edu/photos.html)
60. Origin of *Iris pseudacorus* (...edu/iripse.html)
61. cord grasses (...edu/photocom.html)
62. *Sapium, Schinus, Taxodium...*
63. white-flowered wandering Jew (...edu/traflu.html)
68. *Spirodela polyrhiza* common name (...edu/photos.html)
71. 10 million years is a long time _____
72. last subject on this page (...edu/guide/mechcons.html)
75. Cookie Cutter is a kind of _____ (...edu/guide/mechcons.html)
76. milligram (abbr.)
78. 11th lake down (...edu/guide/lakesnor.html)
79. wild petunia (...edu/photocom.html)
80. hyacinths won't grow in freezing _____
85. Florida Extension's "Electronic Data Information Source" (abbr.)
86. 5th mollusc listed under "Endangered Animals" (...edu/guide/endanger.html)
87. hard-shelled dry fruit (...edu/gloss-no.html#n11)
88. *Spartina alterniflora* common name (...edu/photos.html)
91. where skunk vine comes from (...edu/paefoe.html)
92. AKA "the fish hawk" (...edu/guide/birds.html)
93. not from around here (...edu/mcdef.html)
96. University of Florida (abbr.)
97. Florida Exotic Pest Plant Council (abbr.)
99. A river _____ along its course.
100. *Juncus roemerianus*, _____ needlerush (...edu/junroe.html)
102. one _____ equals one gm of water (...edu/o-conver.html)
103. implying removal or reversal
104. water's ability to neutralize acids (...edu/guide/alkaln.html)
105. egg-shaped (...edu/gloss-no.html)
106. weight (abbr.)

Down

1. EPA's highest level advisory language on herbicide labels - go to guide, click on keyword "labels"
2. maintenance _____ of plants (...edu/guide/sup1herb.html)
3. _____ *punctata* = *Spirodela punctata* (...edu/lanpun.html)
4. *Potamogeton pectinatus* = _____ pondweed (...edu/allplants.html)
5. _____logical; _____graphy;
6. hand-pulling and raking are _____ control (...edu/guide/physcons.html)
8. our example of a "solution (sinkhole) lake" (...edu/guide/lakes.html)
9. acidity scale (...edu/guide/ph.html)
10. Florida's most valuable non-native plants (...edu/guide/agricul.html)
11. "pertaining to the back" (...edu/gloss-de.html#d26)
12. shaped like an arrow-head (...edu/gloss-html#s2)
13. first one in row of pictures (...edu/guide/invplant.html#invvine)
17. a large disorderly crowd
19. duckweed of starlike colonies (...edu/wolflo.html)
21. number of herbicide compounds registered for use in Florida (...edu/guide/herbcons.html)
22. fifth tree in the row (...edu/treplants.html)
23. "hyacinth _____ boat" 1939 (...edu/guide/mechcons.html)
25. what water hyacinth is to a water hyacinth weevil; breakfast, lunch, dinner
26. pound (abbr.)
30. torpedograss, _____ *repens*
31. inundated beakrush (...edu/rhyinu.html)
32. the green word: (...edu/guide/invplant.html#invsteward)
33. Uniform Resource Locator (abbr.)
35. wetland code for plant that lives in water
36. sandhill; whooping (...edu/guide/birds.html)
37. spatterdock (...edu/photocom.html)
40. West Indian marsh grass, *Hymenachne* _____
41. common name of *Pontederia cordata*
43. a rush with leaf blades, *Juncus* _____ (...edu/photos.html)
47. agricultural canals are used for flood control and for _____ (...edu/guide/canals.html)
51. attracting to a surface; a possible fate of aquatic herbicides in the environment (...edu/l-mental.html)
52. Brazilian _____ tree, *Schinus terebinthifolius*
53. *Marsilea* is water _____
54. endangered plant, *Nemastylis floridana*, _____ lily (...edu/guide/endanger.html)
56. "_____ boat", 1914 (...edu/guide/mechcons.html)
64. *Pennisetum purpureum*, _____ grass
65. caric sedges, _____ species (...edu/photocom.html)
66. Florida's second largest industry at $6.85 B (...edu/guide/assets.html)
67. "time-release _____ pellets of herbicide" (...edu/guide/mgmtpics.html)
69. turbidity - a measurement of water clarity
70. EPA's mid-level advisory language on herbicide labels - go to guide, click on keyword "labels"
73. national bird, bald _____
74. *Zephyranthes atamasco*, _____ lily (...edu/photos.html)
75. hydrilla is a _____ (underwater) plant
76. go to Guide; click on "Map of public waters..."; click on Leon County; read Lake _____, 255 acres
77. genus for camphor tree. on APIRS web site, click on "401 Native and..."; click on "Plant type category"; click on "Trees"; find "camphor"
78. ounce (abbr.)
81. ...edu/p-words.html. 37th definition - "A population wthin a species..."
82. ...edu/guide/springpics.html. 2nd column, 6th springs down: _____ Springs
83. wild _____ (...edu/zizaqu.html)
84. elephant _____ (...edu/xansag.html)
86. ...edu/guide/springs.html. Under "Some Florida Springs", fourth pic from left: _____ Springs
89. The subject of this page. (...edu/guide/geology.html)
90. acronym: Aquatic, Wetland and Invasive Plant Information Retrieval System
94. About _____-Registration (...edu/guide/sup7herb.html)
95. Accidentally killed plants? Prepare to be _____.
98. pounds per acre (abbr.)
100. *Limnobium spongia*, frog's_____ (...edu/lisppic.html)
101. _____ lily: another common name for *Nuphar advena*. (...edu/floplants.html)

Bonus question for 2 extra plant recognition guides: What do you hear when you go to: http://plants.ifas.ufl.edu ? In left column, click on "Florida Photo Sets," scroll down and click on "Paynes Prairie State Preserve."



FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic, wetland and invasive plant database since Summer 2004.

The APIRS database contains more than 64,500 citations. To use the free database online, go to http://plants.ifas.ufl.edu/ and click on APIRS Online Database.

To obtain articles, contact your nearest academic library, or a document delivery service. Full text of records cited in APIRS is not stored electronically.

ALMEIDA, C.M.R., MUCHA, A.P., VASCONCELOS, M.T.S.D.
Influence of the sea rush *Juncus maritimus* on metal concentration and speciation in estuarine sediment colonized by the plant.
ENVIRON. SCI. TECHN. 38(11):3112-3118. 2004.

ANONYMOUS
Main points of the Invasive Alien Species Act.
MINISTRY OF THE ENVIRONMENT - JAPAN, ONLINE REPORT, HTTP://WWW.ENV.GO.JP/EN/TOPIC/AS.HTML, 2 PP. 2004.

BALATA, D., PIAZZI, L., CINELLI, F.
A comparison among assemblages in areas invaded by *Caulerpa taxifolia* and *C. racemosa* on a subtidal Mediterranean rocky bottom.
MARINE ECOL. 25(1):1-13. 2004.

BARIK, A., BHATTACHARYA, B., LASKAR, S., BANERJEE, T.C.
The determination of n-alkanes in the cuticular wax of leaves of *Ludwigia adscendens* L.
PHYTOCHEM. ANAL. 15(2):109-111. 2004.

BATARY, P., WINKLER, H., BALDI,A.
Experiments with artificial nests on predation in reed habitats.
J. ORNITHOL. 145(1):59-63. 2004.

BENNETT, D.J., COLODNEY, E.
Propagation protocol for lizard's tail (*Saururus cernuus*).
NATIVE PLANTS J. 2(1):44-45. 2004.

BENNICELLI, R., STEPNIEWSKA, Z., BANACH, A., SZAJNOCHA,K., ET AL
The ability of *Azolla caroliniana* to remove heavy metals (Hg(ii), Cr(iii), Cr(vi)) from municipal wastewater.
CHEMOSPHERE 55(11):141-146. 2004.

BOLSUNOVSKY, A.
Artificial radionuclides in aquatic plants of the Yenisei River in the area affected by effluents of a Russian plutonium complex.
AQUATIC ECOLOGY 38(1):57-62. 2004.

BORNMAN, T.G., ADAMS, J.B., BATE, G.C.
The influence of floodplain geohydrology on the distribution of *Sarcocornia pillansii* in the Olifants Estuary on the west coast, South Africa.
J. ARID ENVIRONMENTS 56(4):603-625. 2004.

BULL, J.S., REED, D.C., HOLBROOK, S.J.
An experimental evaluation of different methods of restoring *Phyllospadix torreyi* (surfgrass).
RESTORATION ECOLOGY 12(1):70-79. 2004.

BURNS, J., JOYNER, J., PAERL, H., SHAW, G.
Evaluation of the production and toxicity of *Lyngbya* spp. in Florida springs.
15TH ANNUAL CONF., FLORIDA LAKE MANAGE. SOC., EDS. HARPER, H.H., AND DARLING, S.H., TAMPA, FL, SESSION 8, P. 5. 2004.

BUSCH, J., MENDELSSOHN, I.A, LORENZEN, B., BRIX, H., ET AL
Growth responses of the Everglades wet prairie species *Eleocharis cellulosa* and *Rhynchospora tracyi* to water level and phosphate availability.
AQUATIC BOTANY 78(1):37-54. 2004.

CHEN, L.J., LEE, D.S., SONG, Z.P., SUH, H.S., ET AL
Gene flow from cultivated rice *(Oryza sativa)* to its weedy and wild relatives.
ANNALS OF BOTANY 93(1):67-73. 2004.

CIRUJANO, S., CAMARGO, J.A., GOMEZ-CORDOVES, C.
Feeding preference of the red swamp crayfish *Procambarus clarkii* (Girard) on living macrophytes in a Spanish wetland.
J. FRESHWATER ECOLOGY 19(2):219-226. 2004.

COFFMAN, G.C., KNIGHT, R.
Giant reed eradication project would provide economic benefits to impoverished communities (South Africa).
ECOL. RESTORATION 22(2):146-147. 2004.

COLAUTII, R.I., MACISAAC, H.J.
A neutral terminology to define 'invasive' species.
DIVERSITY DISTRIB. 10(2):135-141. 2004.

COOPER, C.M., MOORE, M.T., BENNETT, E.R., SMITH, S., ET AL
Innovative uses of vegetated drainage ditches for reducing agricultural runoff.
WATER, SCIENCE, & TECH. 49(3):117-123. 2004.

COSTANTINI, M.L., SABETTA, L., MANCINELLI, G., ROSSI, L.
Spatial variability of the decomposition rate of *Schoenoplectus tatora* in a polluted area of Lake Titicaca.
J. TROPICAL ECOL. 20(3):325-335. 2004.

COWELL, B.C., DAWES, C.J.
Growth and nitrate-nitrogen uptake by the cyanobacterium *Lyngbya wollei.*
J. AQUAT. PLANT MANAGE. 42:69-71. 2004.

CUDA, J.P., BRAMMER, A.S., PEREIRA, R.M., BROZA, M.
Interference of natural regulation of the aquatic weed mosquito fern *(Azolla caroliniana)* by the red imported fire ant.
AQUATICS 26(2):20-26. 2004.

DAVIS, H.G., TAYLOR, C.M., CIVILLE, J.C., STRONG, D.R.
An allee effect at the front of a plant invasion: *Spartina* in a Pacific estuary.
J. ECOLOGY 92(2):321-327. 2004.

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Vegetation of upper coastal plain depression wetlands: environmental templates and wetland dynamics within a landscape framework.
WETLANDS 24(1):23-42. 2004.

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Diel variation in methane emissions from the stands of *Carex lasiocarpa* and *Deyeuxia angustifolia* in a cool temperate freshwater marsh.
ATMOSPHERIC ENVIRON. 38(2):181-188. 2004.

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Water use by black wattle (*Acacia mearnsii*): implications for the link between removal of invading trees and catchment streamflow response.
S. AFR. J. SCI. 100(1):40-44. 2004.

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Intercontinental similarities in riparian-plant diversity and sensitivity to river regulation.
ECOL. APPLICATIONS 14(1):173-191. 2004.

ELLISON,C.A., BARRETO,R.W.
Prospects for the management of invasive alien weeds using co-evolved fungal pathogens: a Latin American perspective.
BIOLOGICAL INVASIONS 6(1):23-45. 2004.

EWE, S.M.L., OVERHOLT, W.A., MORGAN, E.C., DIAZ, R., ET AL
A potential biocontrol agent of West Indian marsh grass (*Hymenachne amplexicaulis* (Poaceae)): documenting the impacts of *Ischnodemus variegatus* (Hemiptera: Blissinae) on the photosynthesis and growth of the invasive exotic grass.
WEST OF EDEN - WHERE RESEARCH, POLICY AND PRACTICE MEET, SOUTHEAST EPPC AND FLORIDA EPPC, APRIL 28-30, 2004., PENSACOLA BEACH, FL, P. 26 (POSTER). 2004.

FIGUEROLA, J., GREEN, A.J.
Effects of seed ingestion and herbivory by waterfowl on seedling establishment: a field experiment with wigeongrass *Ruppia maritima* in Donana, South-west Spain.
PLANT ECOL. 173(1):33-38. 2004.

GAGNE, R.J., SOSA, A., CORDO, H.
A new neotropical species of *Clinodiplosis* (Diptera: Cecidomyiidae) injurious to alligatorweed, *Alternanthera philoxeroides* (Amaranthaceae).
PROC. ENT. SOC. WASH. 106(2):305-311. 2004.

GALLON, C., MUNGER, C., PREMONT, S., CAMPBELL, P.G.C.
Hydroponic study of aluminum accumulation by aquatic plants: effects of fluoride and pH.
WATER, AIR, SOIL POLL. 153(1-4):135-155. 2004.

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Lake Panasoffkee restoration plan: dredging to restore fisheries habitat and restore the historic shoreline.
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IN: ABSTRACTS, 88TH ANNUAL MEETING ECOL. SOC. OF AMERICA. 2004.

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Initial findings from experimental introductions reveal clues for restoring an endangered wetland grass (California).
ECOL. RESTORATION 22(2):152-153. 2004.

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Seed germination in wild celery, *Vallisneria americana* Michx. from Lake Okeechobee, Fla, U.S.A.: preliminary experimental results.
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OECOLOGIA 139(1):140-149. 2004.

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EVOLUTION. ECOL. RES. 6(1):147-161. 2004.

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Induction of high affinity phosphate transporter in the duckweed *Spirodela oligorrhiza.*
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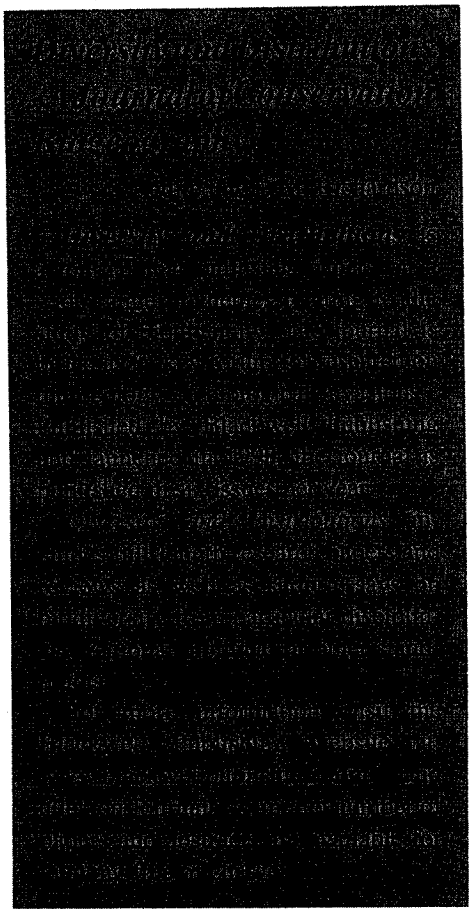
*** Impact of rising CO_2 on emissions of volatile organic compounds: isoprene emission from *Phragmites australis* growing at elevated CO_2 in a natural carbon dioxide spring.** 2004. By P.A. Scholefield, K.J. Doick, B.M.J. Herbert, et al. *Plant, Cell and Environment 27:393-401.*

It is hypothesized that feedback loops exist between isoprene emission and global warming. Therefore it is important to know how isoprene emission is affected by CO_2 concentrations, so that a figure can be entered into global warming models. Isoprene is a chemical produced and emitted by plants; it may control the concentration of OH in the atmosphere, and thereby determine the lifetime of methane in the atmosphere, methane being the third most important "greenhouse gas". This experiment shows that isoprene is likely to be reduced under elevated CO_2 levels...



*** Invasive species: the search for solutions.** 2004. By C.L. Dybas. *BioScience 54(7):615-621.*

This reporter's timely article reviews the views of the foremost U.S. invasive species scientists - invading species really are a problem!

*** Causes and consequences of invasive plants in wetlands: opportunities, opportunists and outcomes.** 2004. By J.B. Zedler and S. Kercher. *Critical Reviews in Plant Sciences 23(5):431-452.*

This is an extensive review of wetland invasive plants.

*** The Lantana mess - A critical look at the genus in Florida.** 2004. By R.L. Hammer. *The Palmetto 23(1):21-23.*

"Avoid low-growing, yellow-flowered lantanas entirely," the author suggests. Figuring out the taxonomy of lantana in Florida is critical if we are to know which ones to control. Here is the story of one mis-identification after another, by growers and researchers alike.

MEETINGS

April 13-15, 2005; Asheville, North Carolina
SOUTHEASTERN LAKES MANAGEMENT CONF.
http://www.nalms.org/symposia/seconference/index.htm

April 13-15, 2005; Florence, Alabama
ASSOCIATION OF SOUTHEASTERN BIOLOGISTS
http://www.asb.appstate.edu/

April 18-22, 2005; Reno, Nevada
INVASIVE SPECIES CONFERENCE, ASTM
http://peaches.nal.usda.gov/insp/conf.asp

April 16-19, 2005; Alexandria, Virginia
NATIONAL ASSOCIATION OF ENVIRONMENTAL PROFESSIONALS -
http://www.naep.org/

April 27-28, 2005; Tampa, Florida
STORMWATER RESEARCH & WATERSHED MANAGEMENT CONFERENCE -
http://www.mcraeco.com/Stormwater_conf.html

April 26-29, 2005; Chicago, Illinois
EPA- ENHANCING THE STATES' LAKE MANAGEMENT PROGRAMS -
http://www.nalms.org/symposia/chicago/

May 4-6, 2005; Birmingham, Alabama
JOINT MEETING; SOUTHEAST EPPC AND ALABAMA INVASIVE PLANT COUNCIL - http://www.se-eppc.org/

May 5-6, 2005; Florence, Italy
BIOLOGICAL INVASIONS IN INLAND WATERS
http://www.gisp.org/events/showevent.asp?id=201

May 9-11, 2005; Key West, Florida
FLORIDA EXOTIC PEST PLANT COUNCIL
http://www.fleppc.org/

May 12-15, 2005; Melbourne, Florida
FLORIDA NATIVE PLANT SOCIETY
http://www.fnps.org/

May 12-18, 2005; Nebraska City, Nebraska
PROJECT WET ANNUAL CONFERENCE
http://www.projectwet.org/

May 16-20, 2005; Fort Lauderdale, Florida
AQUATIC WEED SHORT COURSE
http://conference.ifas.ufl.edu/aw/

June 6-9, 2005; Duck Key, Florida
FLORIDA LAKE MANAGEMENT SOCIETY
http://flms.net/index.html

June 5-10, 2005; Charleston, South Carolina
SOCIETY OF WETLAND SCIENTISTS
http://www.sws.org/

July 10-13, 2005; San Antonio, Texas
NATIONAL AQUATIC PLANT MANAGEMENT SOCIETY
http://www.apms.org/

July, 2005; Marco Island, Florida
FLORIDA ASSOCIATION OF ENVIRONMENTAL PROFESSIONALS - http://www.faep-fl.org/

July 19-22, 2005; Dubuque, Iowa
IZAAC WALTON LEAGUE NATIONAL CONVENTION
http://www.iwla.org/

July 20-26, 2005; Bethlehem, Pennsylvania
INTERNATIONAL WATERLILY & WATER GARDENING SOCIETY -
http://www.iwgs.org

August 16-17, 2005; Philadelphia, Pennsylvania
MID-ATLANTIC EXOTIC PEST PLANT COUNCIL
http://www.ma-eppc.org/

August 17-19, 2005; Springmaid Beach, South Carolina
SOUTH CAROLINA AQUATIC PLANT MGMT SOCIETY
http://www.scapms.org/

September 8, 2005; Murfreesboro, Tennessee
TENNESSEE EXOTIC PEST PLANT COUNCIL
http://www.tneppc.org

September 11-15, 2005; Anchorage, Alaska
AMERICAN FISHERIES SOCIETY
http://www.fisheries.org/html/index.shtml

October, 2005
MID-SOUTH AQUATIC PLANT MANAGEMENT SOCIETY - http://www.ag.auburn.edu/aquaplant/

October, 2005; South Padre Island, Texas
TEXAS VEGETATION MANAGEMENT ASSOCIATION
http://www.tvma.net/home.htm

October, 2005; Tampa, Florida
ECOSYSTEMS RESTORATION AND CREATION
http://www.hccfl.edu/depts/detp/ecoconf.html

November 8-10, 2005; St. Petersburg, Florida
FLORIDA AQUATIC PLANT MANAGEMENT SOCIETY
http://www.homestead.com/fapms/main.html

November 9-11, 2005; Madison, Wisconsin
NORTH AMERICAN LAKE MANAGEMENT SOCIETY
http://www.nalms.org/

November 29 - December 2, 2005; Lucknow, India
INTERNATIONAL SOC. ENVIRONMENTAL BOTANISTS & NATIONAL BOTANICAL RESEARCH INSTITUTE -
http://www.geocities.com/isebindia/index.html

*** Enzymatic activities in traps of four aquatic species of the carnivorous genus *Utricularia.*** 2003. By D. Sirova, L. Adamec and J. Vrba. *New Phytologist 159:669-675.*

Tiny animals such as mites, rotifers and crustaceans are sucked into the traps (bladders) of bladderworts, thus making meals. This is a study of the digestion of animals inside the traps. The authors found that at least three digestive enzymes are produced, at least partly, inside the traps.

Books/Reports

WATERLILIES AND LOTUSES - Species, Cultivars and New Hybrids, by P.D. Slocum. 2005. 328 pp.

(Published by Timber Press, 133 SW 2nd Avenue, Suite 450, Portland, OR 97204. ISBN 0-88192-684-1. US$34.95 plus S/H. www.timberpress.com)

This is the fully updated work by the late Perry Slocum, one of the most important breeders of aquatic plants. Nearly 500 species and cultivars are described and beautifully photographed. (The book includes species of the genera *Nymphaea, Nelumbo, Nuphar, Victoria, Euryale, Barclaya* and *Ondinea.*)

DECLARED PLANTS OF AUSTRALIA - An Identification and Information System, by S. Navie. 2004. CD.

(Published by the Centre for Biological Information Technology, University of Queensland, Brisbane 4072 AUSTRALIA. ISBN 186499785-0. AU$80.00 plus S/H. WWW: www.cbit.uq.edu.au/ software/declaredplants/default.htm)

This CD is easily used by your PC. Using the Lucid computer product, the ID system combines up to 35 characters to help you key out 300 noxious weeds ("declared plants") plus another 600 weed species in Australia. The plants are depicted in more than 5,000 color photos.

ICONOGRAFIA Y ESTUDIO DE PLANTAS ACUATICAS de la ciudad de Mexico y sus alrededores, by A. Lot and A. Novelo, Ilustraciones by E. Esparza. 2004. 206 pp.

(Published by Universidad Nacional Autonoma de Mexico, Instituto de Biologia, Ciudad Universitaria, 04510, Mexico, DF. ISBN 970-32-21319. Contact the authors: loth@servidor.unam.mx; lanovelo@servidor.unam.mx)

As Mary says, "This book is awesome!" Its large format includes beautiful full-page colored drawings of plants and plant parts, plus large-font descriptions in Spanish. Includes 10 emersed plants; 16 submersed plants; 6 floating-leaved plants; 10 floating plants.

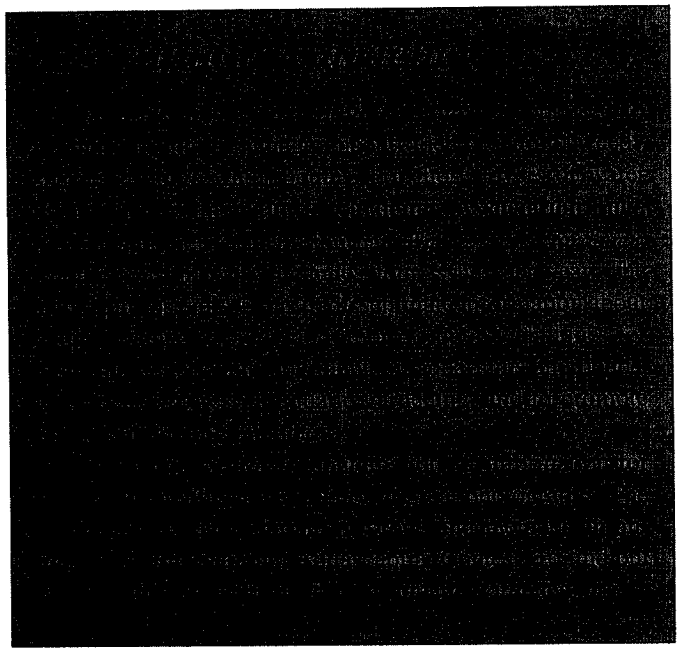
BIOLOGICAL CONTROL OF INVASIVE PLANTS IN THE UNITED STATES, edited by E.M. Coombs, J.K. Clark, G.L. Piper and A.F. Cofrancesco, Jr. 2004. 467 pp.

(Published by Oregon State University Press, 102 Adams Hall, Corvallis, OR 97331;. ISBN 0-87071-029-X. WWW: http://oregonstate.edu/dept/press)

This is a very thorough review of previous and current bio-control projects in the US. The first 138 pages cover 16 topics under the general title of "The Theory and Practice of Biological Control". All steps and procedures are well-described in logical, straight-forward language: anyone who wants to understand, can understand.

The next 300 pages, "Target Plants and the Biological Control Agents", reviews all bio-control agents and experiences for more than two dozen aquatic, wetland and terrestrial plants, and include color photos of individual agents, and full descriptions of their biology, release and effect. The final 20 pages introduces new bio-control projects for 15 more major invasive plants of the US.

This book might be considered an essential reference for invasive plant workers world-wide.



*** Perry Slocum leaves outstanding legacy.** By C.B. Thomas. 2004. *Water Garden Journal 19(4):15.*

"Water gardeners around the globe are mourning the passing of Perry Dean Slocum on November 29, 2004. At the same time, they are celebrating Perry's life and his outstanding legacy of achievement."

"[Perry] entered Cornell University with the idea of be-coming a medical doctor. However, well before he graduated in 1935, waterlilies had captured his imagination and soon became his life-long passion. He began growing them along with other ornamental aquatics as a teen. He gave up becoming a doctor so that he could grow and share his beloved aquatics....It became obvious that although he didn't become a doctor to the body, he became a doctor for the human spirit through his beloved *Nymphaeas, Nelumbos*, and other aquatics."

Mr. Slocum was a member of the Hall of Fame of the International Waterlily and Water Gardening Association.

*** The red waterlilies of Claude Monet - their origin and their venue to Giverny.** By M. Wallsten, J. Thorson and G. Werlemark. 2004. *Water Garden Journal 19:5-10*

Monet painted red waterlilies. Did he really see them? Where did they come from? Maybe from Lake Fagertarn in Sweden?

*** A rare feeding observation on water lilies (*Nymphaea alba*) by the capped langur (*Trachypithecus pileatus*).** 2004. By A. Kumar and G.S. Solanki. *Journal of Raptor Research 75(3):157-159.*

The authors show pictures of a troop of monkeys in India wading in water and pulling up water lilies, all parts of which they then eat. Upon analysis, the lilies are shown to be 23% crude protein.

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AQUAPHYTE

AQUAPHYTE is the newsletter of the Center for Aquatic and Invasive Plants and the Aquatic, Wetland and Invasive Plant Information Retrieval System (**APIRS**) of the University of Florida Institute of Food and Agricultural Sciences (IFAS). Support for the information system is provided by the Florida Department of Environmental Protection, the U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Research Program (APCRP), the St. Johns River Water Management District and UF/IFAS.

EDITORS: Victor Ramey
Karen Brown

AQUAPHYTE is sent to managers, researchers and agencies in 71 countries around the world. Comments, announcements, news items and other information relevant to aquatic and invasive plant research are solicited.

Inclusion in **AQUAPHYTE** does not constitute endorsement, nor does exclusion represent criticism, of any item, organization, individual, or institution by the University of Florida.