Research to Support Integrated Management Systems of Aquatic and Terrestrial Invasive Species

Annual Report 2007

A Collaborative Effort between Mississippi State University's GeoResources Institute and the U.S. Geological Survey and National Biological Information Infrastructure

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Preface

The research and outreach programs described in the following report are the result of an ongoing partnership between the U.S. Geological Survey Biological Resources Discipline, the National Biological Information Infrastructure, and Mississippi State University. Funding for these programs was provided by an award from USGS BRD to MSU under cooperative agreement 04HQAG0135. The MSU program was managed by the GeoResources Institute. The USGS BRD Invasive Species Program manager was Sharon Gross, the National Biological Information Infrastructure Invasive Species Information Node manager was Annie Simpson, and Randy Westbrooks of USGS BRD worked with MSU on virtually every task.

This report should be cited as:

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Introduction

Invasive species are an enormous problem for terrestrial and aquatic ecosystems in the United States, degrading their biodiversity and the ecosystem services they provide to our society. As a result, over the past decade federal and state agencies and nongovernmental organizations have begun to work more closely together to address it.

While awareness of the problem is becoming more widespread, efforts to address the threat are often piecemeal and fragmented, and new tools to deal with the problems are needed. In particular, the states in the Mid-South Region (AL, AR, LA, MS, and TN) need assistance in developing additional capacity, expertise, and resources for addressing the invasive species problem.

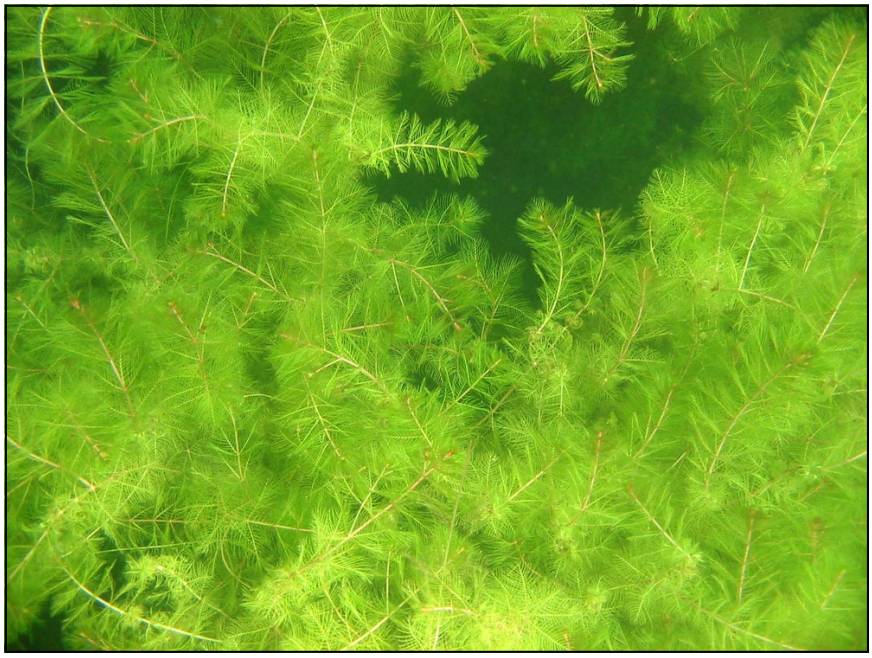

Figure 1. Dense canopy of Eurasian watermilfoil (*Myriophyllum spicatum*) forming in 15 feet water depth, 13 feet above the bottom. While this photo was taken underwater in Pend Oreille Lake, Idaho, this species is also a problem in the Mid-South.

This report presents progress on a program of planned research, extension, and regional coordination for implementation by the GeoResources Institute (GRI) of Mississippi State University (MSU) in collaboration with the U.S. Geological Survey (USGS). We propose three areas of directed, peer-reviewed research to enhance the management of invasive species: aquatic invasive plants, terrestrial invasive plants, and the renegade biocontrol agent, cactus moth (*Cactoblastis cactorum*). For each area, a program of extension and outreach has been developed to deliver the information from our research to those who can best make use of the results, both through traditional printed information and web-based information solutions. Our current webpage effort, the Cactus Moth Detection and Monitoring Network (www.gri.msstate.edu/cactus_moth), has been operating for two years and garnered significant attention as the one source for pricklypear cactus and cactus moth location information nationwide. We have been working through the past year to develop a new webpage, currently funded through USDA CSREES; the Invasive Plant Atlas of the Mid-South (IPAMS) will be launched during January 2008 at www.gri.msstate.edu/ipams. While USDA CSREES is funding the initial program, we have listed USGS BRD and NBII as partners in the effort.

Figure 2. Devil's tongue prickplypear (*Opuntia humifusa*) is one of many pricklypear cactus species that is a potential host to the invasive cactus moth (*Cactoblastis cactorum*). Pricklypear are stress-tolerant species that inhabit many habitats throughout the southeastern United States, including rocky outcrops, sandy river banks, and barrier islands. This specimen was photographed on a granitic dome near Athens, GA.

Specific results and deliverables are proposed for each of the main tasks described below. Specialists in USGS and other entities that are providing information, perspective, and/or oversight for the project are identified as collaborators. The research addresses invasive species issues that are often complex and require long-term cooperation.

MSU Investigators and Participants

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Dr. Richard Brown, Department of Entomology and Plant Pathology and Mississippi Entomological Museum
Dr. John Byrd, Jr., Department of Plant and Soil Sciences
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Dr. Victor Maddox, GeoResources Institute
Dr. John Madsen, Principal Investigator, GeoResources Institute and Department of Plant and Soil Sciences
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Collaborators

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James Grace, U.S. Geological Survey, National Wetlands Research Center
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Annie Simpson, U.S. Geological Survey, Biological Informatics Program, and National Biological Information Infrastructure
David F. Spencer, U.S. Department of Agriculture – Agricultural Research Service
Thomas Stohlgren, U.S. Geological Survey, Fort Collins Science Center
Randy Westbrooks, U.S. Geological Survey, National Wetlands Research Center

Figure 1. MSU graduate student Ryan Wersal enters point location data during a plant survey in Ross Barnett Reservoir near Jackson, MS. Ross Barnett Reservoir is infested with many invasive aquatic plants, including alligatorweed, hydrilla, and waterhyacinth (in background).

Task 1. Aquatic Plants

Figure 2. Giant salvinia (*Salvinia molesta*) infestation of a stream segment near Petal, MS. Giant salvinia is a federal noxious weed which could have significant impact on water resources throughout the southern United States. GRI has been mapping this species in MS through funding from USGS and from the MS Department of Agriculture and Commerce, Bureau of Plant Industries.

Task 1.1.1. Aquatic Plant Habitat Invasibility Models

PI: Gary Ervin
Co-PI: John Madsen

Habitat Suitability Modeling of Invasive Aquatic Plants
Gary N. Ervin and John D. Madsen

Based on readily available coverages of public land in Mississippi (included National Forests, National Wildlife Refuges, highway rights-of-way, John C. Stennis Space Center, and the Natchez Trace Parkway), ArcGIS was used to place random points on public lands across the state. We developed a set of 885 randomly located sample points on public lands in Mississippi, a subset of which were to be visited in the 2007 field season. Vegetation and habitat data were collected at an arbitrarily selected subset of these points for use in developing statistical models to estimate the likelihood of exotic plant invasion. We collected data on plant species present and microhabitat characteristics at the sampled points using a modification of the Beyond NAWMA guidelines (Stohlgren et al. 2003), with the addition of detailed soil sample analyses for each point. Those data ultimately will be augmented with geospatial information, such as land use/cover, soil characteristics, canopy cover, and proximity to such features as urban areas and transportation corridors. Data will be analyzed via one or more methods presently under evaluation to determine the best method(s) for developing habitat models within the study region.

During 2007, we sampled 250 of the 885 points, widely distributed across Mississippi (Figure 1). Of these 250 points, 44 were located in wetland land cover types, 42 of which were in the category of "woody wetlands." These wetland points were less well distributed across the state, reflecting to some extent the localized nature of wetlands in the state. Noticeably absent, however, were points from within the Mississippi alluvial valley (the "Delta").

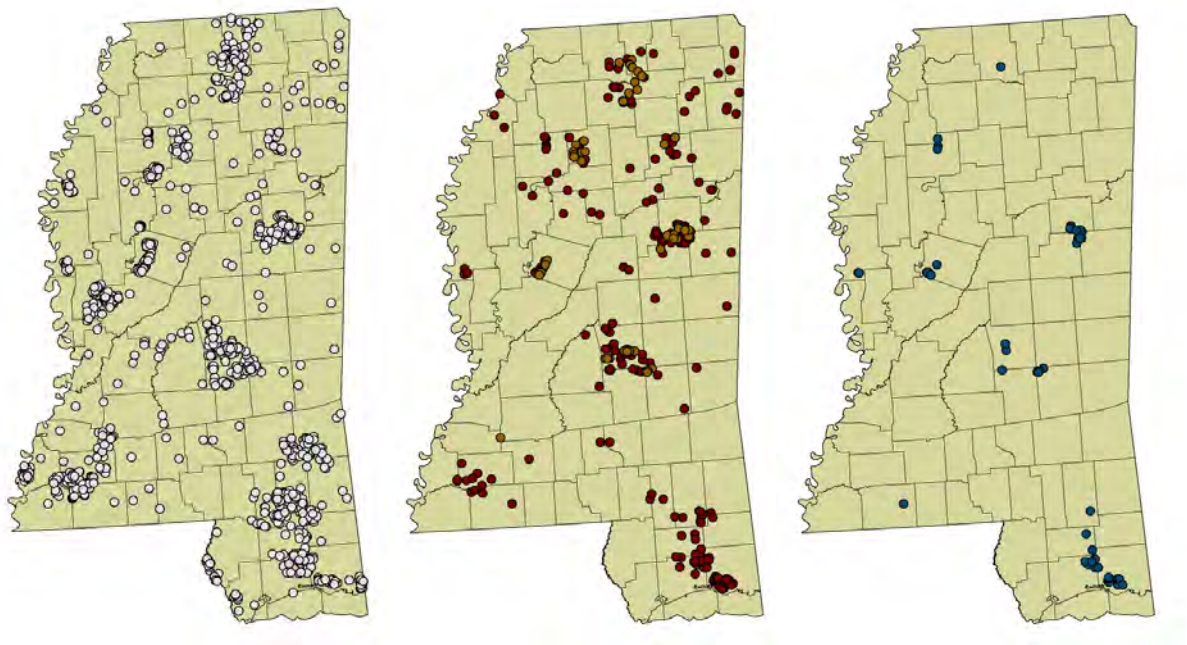


Fig. 1. Left, distribution of potential random sample points for 2007, along with points sampled during 2006 (n = 954); Middle, the 319 points that were actually sampled during 2006 (lighter color) and 2007 (darker); Right, wetland points sampled during the two field seasons (n = 54).

Although the total number of wetland points in this dataset is likely too low to use in developing rigorous models of species invasion, their frequency among the total 319 points sampled is remarkably similar to the relative proportion of the region comprised by wetlands (10 to 15%). It is anticipated that work conducted under Task 1.4 (*Invasive Aquatic Plant Survey for the Midsouth*) will provide substantial data that may be used to augment these random point surveys in the development of habitat models for aquatic plants in the Mid-South region.

References

Stohlgren, T. J., D. T. Barnett, and S. E. Simonson. 2003. Beyond North American Weed Management Standards. Available at: http://www.nawma.org/documents/Mapping%20Standards/ BEYOND%20NAWMA% 20STANDARDS.pdf

Task 1.1.2. Virtual plant models: Development of a three-dimensional growth model for common reed

PI: John Madsen
Collaborators: David Spencer, USDA-ARS, Davis, CA

Development of a three-dimensional growth model for common reed (*Phragmites australis*)

Joshua C. Cheshier[1], John D. Madsen[1], and David Spencer[2]; [1]GeoResources Institute, Mississippi State University, Mississippi State, MS 39762-9652 and [2]USDA ARS Exotic & Invasive Weeds Research Unit, Davis, CA 95616.

Common reed (*Phragmites australis*) is a non-native invasive perennial grass that creates a nuisance in aquatic and riparian environments across the United States. The ability of common reed to reproduce quickly combined with its ability to cycle nutrients has made it an aggressive invader of riparian and wetland ecosystems. *Phragmites* often forms monotypic stands that displace native vegetation more desirable as wildlife food and cover than *Phragmites*. *Phragmites* has been differentiated into 27 haplotypes, 11 haplotypes being native to North America, and 16 non-native haplotypes. The European haplotype M and South American/Asian haplotype I are of concern due to their ability to out compete native vegetation, alter hydrology, and change community structure of aquatic and riparian habitats. A model of *Phragmites* (types I & M) growth can be used as a predictive tool in management regimes and wetland planning and restoration. Our goal was to develop a robust growth model based on empirical data from the plants at different growth stages rather than a mathematical model which is based on allometric relationships. *Phragmites* populations were grown from rhizome fragments in six tanks located at the R.R. Foil Experiment Station, Mississippi State University and at the USDA-ARS Aquatic Weed Laboratory, University of California-Davis consecutively (Photo 1). Two haplotypes, I and M, of *Phragmites* were grown in sterile builder and fertilized with 10 grams of Osmocote® slow release fertilizer. Air, soil moisture, water chemistry and temperature were monitored to optimize growth. *Phragmites* plants were digitized every month from emergence to senescence using a Polhemus Fastrak 3-dimensional digitizer system, utilizing Floradig software (Figure 1). In addition, the plant material was separated by above ground structure, measured, dried and weighed. Three leaves, the upper most, the bottom, and one in the middle, from each stem were separated, photographed, dried, and weighed. This is the second year in a two year study and a digital model will be based on both years of data. Data from year two can be found in Table 1.

Photo 1. Common reed (*Phragmites australis*) digital growth study at MSU.

Figure 1. Output from Floradig, Haplotype I.

Table 1. Comparison of growth metrics between Haplotypes I and M of common reed (*Phragmites australis*).

Growth Metric	Haplotype I	Haplotype M
Number of Leaves per Stem	12.6 ± 0.47	93.1 ± 3.03
Stem Length (cm)	156.9 ± 6.73	7.95 ± 0.371
Stem Weight (g)	13.5 ± 1.11	2.14 ± 0.153
Leaf Weight (g)	2.56 ± 0.221	0.635 ± 0.0388
Flower Weight (g)	0.3 ± 0.114	0.579 ± 0.0759
Average Above Ground Biomass (g)	16.05 ± 1.3	3.077 ± 0.214

Task 1.1.3. Growth of Common Salvinia and Waterhyacinth as Regulated by Loading Rates of Water Column Nitrogen and Phosphorus

PI: John Madsen
Collaborator: Randy Westbrooks, USGS NWRC

Growth of Common Salvinia and Waterhyacinth as Regulated by Loading Rates of Water Column Nitrogen and Phosphorus

Ryan M. Wersal and John D. Madsen

Introduction: Invading species have to overcome several barriers upon introduction before they become established and reproductively viable. An important barrier to surmount is the effect of the local environment, specifically the availability of nutrients. Species- specific growth models have yet to be developed for invasive species to identify interactions of species growth with environmental factors. These models can be developed based on water column nitrogen and phosphorus to estimate the probability of invasion success using available data on watershed water quality. This study will evaluate the effects of oligotrophic, mesotrophic, and eutrophic nitrogen and phosphorus water column concentrations, and loading rates, on the growth of waterhyacinth and common salvinia. The objectives are to 1) determine which nutrient is limiting to plant growth and at what concentration; and 2) model species-specific growth using known water quality parameters as a predictive tool for monitoring.

Fig. 1. Common salvinia (*Salvinia minima*), while not as well-known a weed as cogener giant salvinia, is a nonnative invader to swamps and marshes. Common salvinia is currently one of the largest problem aquatic plants in Louisiana.

Task Description: The study will be conducted in an outdoor mesocosm facility beginning July 2007. The 54 mesocosm tanks (1100 L) will be set in a randomized block design with 2 plant species (waterhyacinth and common salvinia), 3 phosphorus concentrations, 3 nitrogen concentrations, and replicated 3 times. The tanks will be numbered and assigned a treatment combination. Water will be pumped to each tank from a nearby irrigation reservoir. The water will be filtered via a basket strainer and a sand filter before it reaches each tank. A regenerative air blower will supply aeration for all tanks. Air will be circulated in each via 30.5 cm stone diffusers.

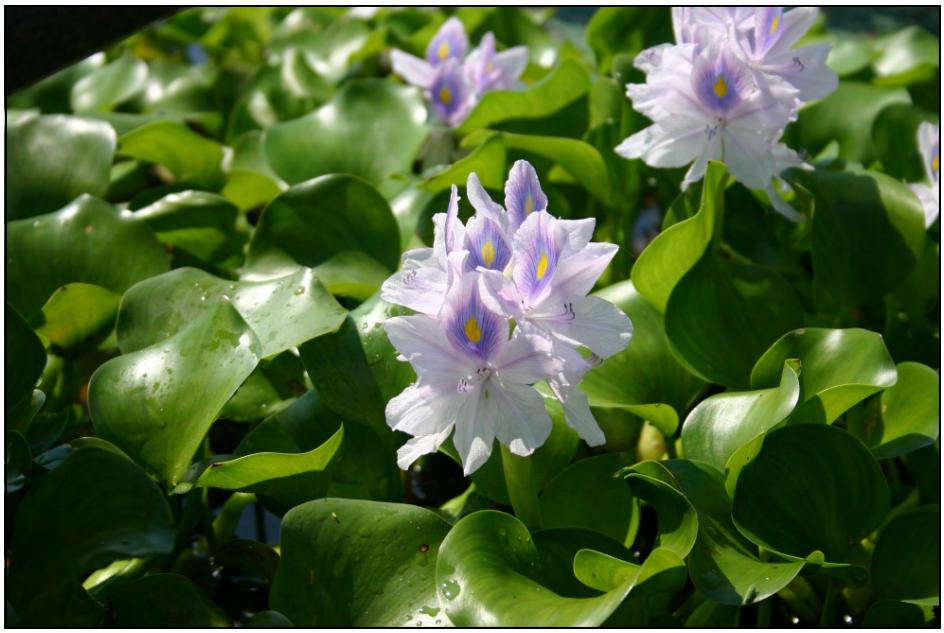


Fig. 2. Waterhyacinth (*Eichhornia crassipes*) is the world's number one aquatic weed, and a significant problem in Mississippi water bodies such as the Ross Barnett reservoir.

Common salvinia (*Salvinia minima*), an invasive species increasingly common to the Gulf Coast states but less well-known than giant salvinia, will be harvested from the Mobile River Delta and propagated at Mississippi State University. Approximately, 300 grams fresh weight of common salvinia will be placed into the appropriate tanks.

Fig. 3. Our experimental setup to evaluate the effect of nutrient levels in the water on the growth of waterhyacinth and common salvinia.

Waterhyacinth (*Eichhornia crassipes*) will be collected from the Tennessee-Tombigbee Waterway and propagated at Mississippi State University. Six rosettes of waterhyacinth will be placed into each of the appropriate tanks.

Plants will be exposed to combinations of differing water phosphorus and nitrogen concentrations. Phosphorus concentrations will be 0.01 mg P/L, 0.03 mg P/L, and 0.09 mg P/L. Similarly, the nitrogen concentrations will be 0.40 mg N/L, 0.80 mg N/L, and 1.80 mg N/L. The nutrient concentrations are meant to represent typical concentrations in oligotrophic, mesotrophic, and eutrophic waters and will be achieved using ammonium nitrate and potassium phosphate. Tanks will be amended weekly with nitrogen and phosphorus to simulate nutrient loading rates of oligotrophic, mesotrophic, and eutrophic waters, and to maintain water column nutrient concentrations.

Biomass will be harvested in three-week intervals for 12 weeks using a 0.01 m^2 PVC quadrat for common salvinia and a 0.05 m^2 quadrat for waterhyacinth. A total of two samples will be harvested from all tanks during each sampling period. Samples will be dried to a constant weight to assess the effects of phosphorus and nitrogen on plant biomass.

This study is currently underway in a greenhouse at the R. R. Foil Plant Science Center, Mississippi State University. Data from this study will be used to begin developing landscape models of habitat invisibility by freefloating invasive aquatic plants.

Task 1.2.1. Assessment of Aquatic Plant Populations

PI: John D. Madsen
Collaborator: Randy Westbrooks, USGS

The Use of Hand-held Computers in Point Intercept Surveys

Ryan M. Wersal and John D. Madsen

Fig. 1. Point intercept applications can be run on a handheld computer with a GPS antenna, for portability for both aquatic and terrestrial studies.

Aquatic macrophytes are an integral component in freshwater systems and understanding the dynamics of macrophyte populations has become increasingly important due to the spread of invasive macrophyte species. One cost effective and efficient method to collect large quantities of data on the distribution and abundance of aquatic macrophytes is the point intercept survey. The point intercept survey has been refined to include the use of hand held computers enabled with GPS (Global Positioning System) capabilities and coupled with software to collect and store site specific spatial data. The use of Farm Works SiteMate® mapping software was used to develop and construct database templates to collect and store spatially explicit data from the Ross Barnett Reservoir, MS, Lake Onondaga, NY, and Lake Gaston, NC. The use of these technologies has increased survey efficiency by decreasing survey time, data handling, and data entry errors. These data can be easily converted to map layers for use in GIS (Geographic Information System) systems and exported to data files for statistical analysis. Our technique is central to survey and assessment efforts ongoing in the Ross Barnett Reservoir, MS and several lakes in Idaho.

Fig. 2. Point intercept survey applications are run on a ruggedized computer for easy data entry on boats. A GPS antenna is on a pole at the back of the boat.

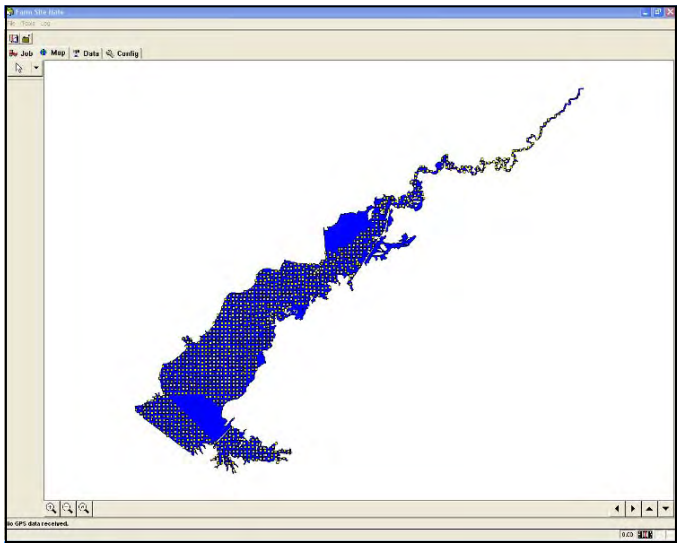


Fig. 3. FarmWorks SiteMate screen display showing the outline map of Ross Barnett reservoir and the survey points within the reservoir.

This method has been utilized and cited in a number of studies, a selection of citations includes:

Case, M.L., J.D. Madsen. 2004. Point intercept surveys of aquatic macrophytes, tubers and sediment in Heron Lake, Minnesota: Identifying factors limiting the growth of *Stuckenia pectinat*a (L.) Borner (Sago Pondweed). Journal of Freshwater Ecology. 19:17-23.

Madsen, J. D., R. M. Wersal, M. Tyler, P. D. Gerard. 2006. The distribution and abundance of aquatic macrophytes in Swan Lake and Middle Lake, Minnesota. Journal of Freshwater Ecology. 21: 421-429.

Wersal, R. M., J. D. Madsen, B. R. McMillan, P. D. Gerard. 2006. Environmental factors affecting the biomass and distribution of *Stuckenia pectinata* in the Heron Lake System, Minnesota, USA. Wetlands. 26:313-321.

Wersal, R. M., J. D. Madsen, M. L. Tagert. 2007. Aquatic Plant Survey within the Littoral Zone of the Ross Barnett Reservoir for 2006. GeoResources Institute Report. GRI #5011.

Wersal, R. M., J. D. Madsen, M. L. Tagert. 2006. Aquatic Plant Survey of Ross Barnett Reservoir for 2005. GRI #5003.

Task 1.2.2. Assessment of Aquatic Plant Populations: Determining Plant Abundance

PI: John D. Madsen
Collaborator: Randy Westbrooks, USGS

A New Core Sampler for Estimating Biomass of Submersed Aquatic Macrophytes

Ryan M. Wersal and John D. Madsen

Fig. 1. Ryan Wersal uses a core sampler to estimate biomass of Eurasian watermilfoil (*Myriophyllum spicatum*) in the Pend Oreille Lake, Idaho during 2007.

We constructed a new core sampler of light-weight PVC pipe to sample above and below ground biomass of submersed macrophytes. The core sampler can be easily constructed, modified, or repaired in the field, as there are no valves or moving pieces. It can be constructed to sample in shallow or deep water. Comparisons were made between above-ground biomass samples collected from the core sampler and samples collected from a 0.10 m^2 quadrat from lakes in Minnesota and New York. There is a significant relationship between macrophyte biomass collected using both sampling methods, indicating that similar above ground biomass data can be collected using a core or a quadrat. The core sampler was more effective at sampling below-ground biomass and propagules, both beneath the sediment and those lying on the sediment surface.

The core sampler is currently being used to assess the life history and phenology of invasive aquatic plants such as hydrilla and parrotfeather, assess the success of management efforts in Mississippi, New York, and Idaho, and collect baseline information for the restoration of littoral plants in Onondaga Lake, New York.

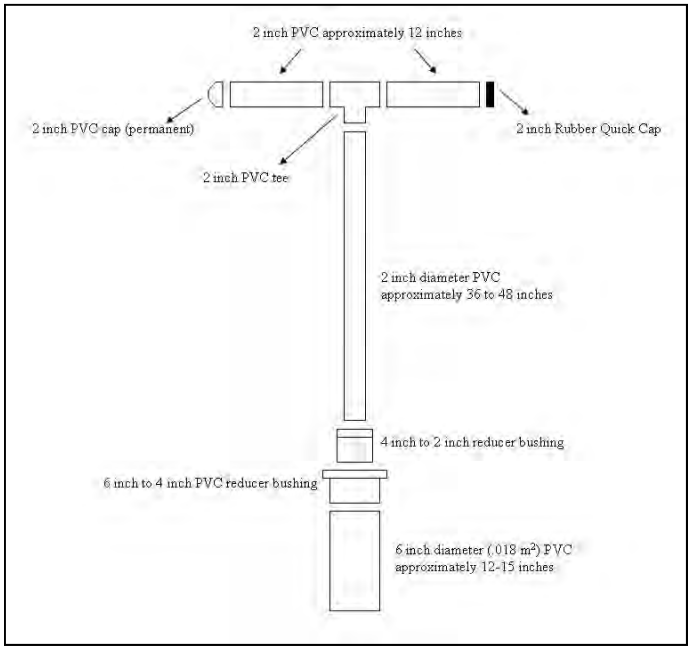


Fig. 2. A diagram for the construction of a core sampler. More information on the construction and use of the core sampler is available in Madsen and others, 2007.

This sampler is further described in a recent journal article:

Madsen, J.D, R.M. Wersal, T.E. Woolf. 2007. A new core sampler for estimating biomass of submersed aquatic macrophytes. Journal of Aquatic Plant Management 45:31-34.

Task 1.3. Environmental Impact of Invasive Aquatic Plants on Aquatic Habitat

PI: Eric Dibble
Co-PI: John Madsen, Todd Tietjen

Experimental Tests of the Effects on Invasive Plants on Aquatic Communities

Eric Dibble, John Madsen, and Todd Tietjen

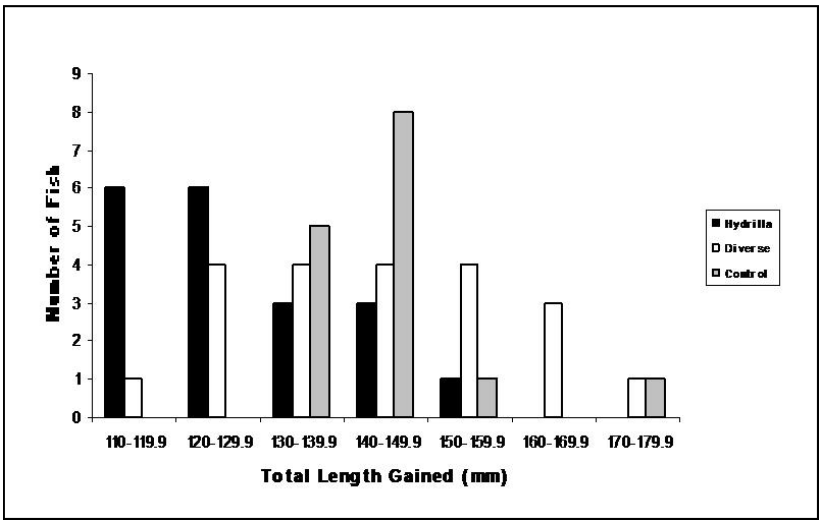


Fig. 1. Frequency distribution of mean gains in individual total length of juvenile largemouth bass measured across treatments in the pond experiment at Mississippi State University from June to November 2005.

We completed two trials of multilevel experiments conducted in ponds and aquaria. First the effect of invasive plant growth on littoral zone fish habitat was evaluated in pond level experiments. In the research ponds, differences in largemouth bass (*Micropterus salmoides*) growth and condition were compared between treatments of diverse native plants, invasive hydrilla (*Hydrilla verticallata*), and a vegetation-free habitat. The native vegetation assemblage yielded higher bass gains in length and weight than the others. The open-water environment resulted in moderate fish growth while the dense hydrilla beds produced poor gains in length and weight. The second experiment used aquaria and videography to assess the effects of different levels of hydrilla invasion on juvenile largemouth bass foraging ability. In a dense hydrilla habitat, bass experienced poorer capture rates, more attempts per capture, longer times required per capture and more attempts that never resulted in a capture. The open-water environment and those possessing a combination of native vegetation and low hydrilla levels provided the best foraging conditions. Finally, in one large research pond, Eurasian watermilfoil (*Myriophyllum spicatum*) and a plant mix were used to compare effects on juvenile largemouth bass and bluegill (*Lepomis macrochirus*) growth using enclosures. Bluegills in the diverse plant beds experienced significantly larger gains in length and weight than those in the monoculture. Sub-sampled juvenile bass had higher length gains and growth rates in the monoculture than in the mixed treatment.

Fig. 2. All largemouth bass cultured in the experimental ponds were measured to determine treatment effect on growth and condition.

The second trial of experiments investigated how aquatic plants mediate ecological processes in aquatic habitats, specifically predator-prey (bluegill sunfish (*Lepomis macrochirus* Rafinesque)-macroinvertebrate) interactions. Macroinvertebrate colonization is directly and indirectly influenced by substrate heterogeneity, interstitial space, and surface complexity. Exotic invasive plant species, such as *Hydrilla verticillata* L.F. Royle, may alter the available structure in aquatic habitat by creating a shift to a homogeneous habitat thus affecting the macroinvertebrate community. Since macroinvertebrates provide a food base

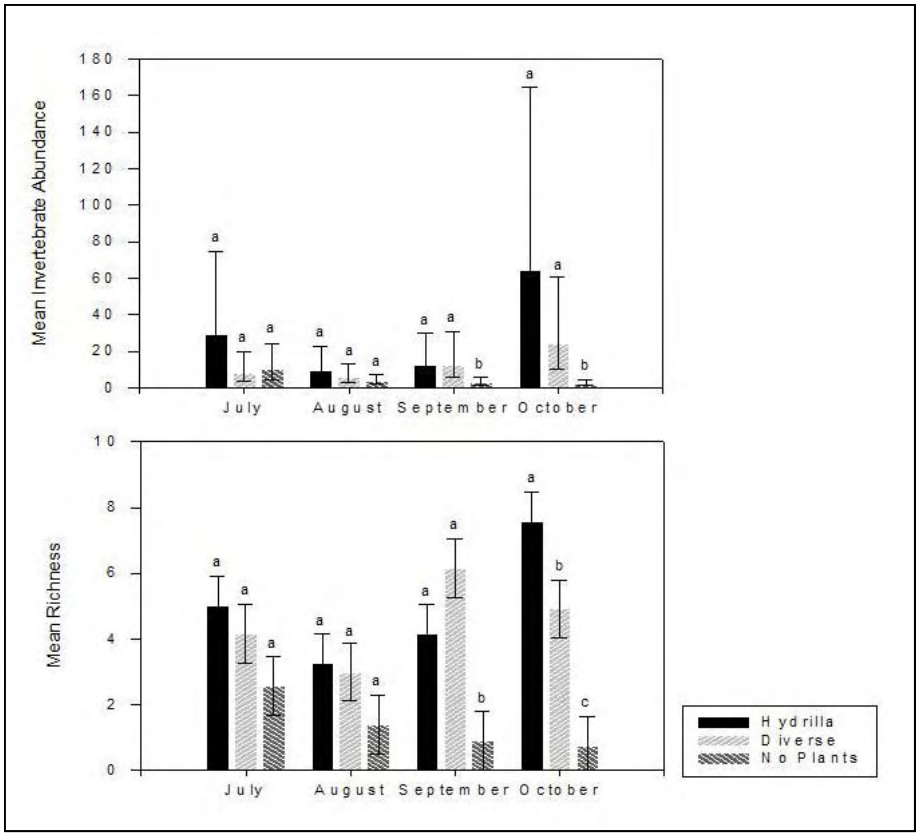


Fig. 3. Mean macroinvertebrate (a) abundance, (b) richness by treatment (hydrilla, native diverse, and no plants) from July-October 2005 in experimental earthen ponds, National Warmwater Aquaculture Center, Mississippi State University. (N = 2 for each treatment and each month). Means with different letters within each sampling date differ statistically ($P \leq 0.05$).

for young phytophilic fishes, changes in their density and abundance may alter food webs. We investigated the hypothesis that macroinvertebrate assemblage and community structure would differ between a heterogeneous native aquatic plant bed, homogenous hydrilla plant bed, and habitat with no plants. Studies were conducted in the field (pond) and the experimental treatments were: 1) no plants, 2) monotypic bed of hydrilla, and 3) diverse native plants. Aquatic plants, regardless of species, supported greater macroinvertebrate abundance, richness, and biomass. Macroinvertebrate abundance, richness, and biomass in a hydrilla-dominated habitat did not differ significantly from a diverse plant habitat, except for richness in October. Indicator taxa did differ significantly between respective treatments, suggesting a change in species composition. However no significant effect of fish predation on macroinvertebrate populations and/or community structure was documented, the data suggest that a shift of a natural mosaic in vegetated habitat to a highly complex monotypic one (e.g. exotic hydrilla) may reduce spatial heterogeneity important in structuring a macroinvertebrate assemblage.

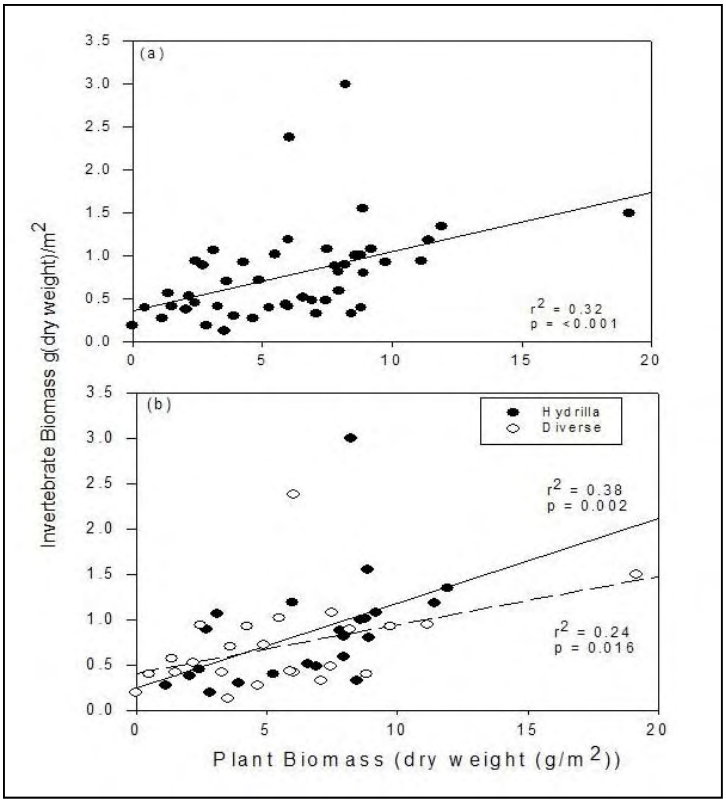


Figure 4. Relationships between plant biomass (g(dry weight)/m^2) and macroinvertebrate biomass (g(dry weight)/m^2) including the hydrilla and diverse treatment combined (N = 47) (a) and the hydrilla and diverse treatments individually (N = 24) (b) for July-October 2005 in experimental earthen ponds, National Warmwater Aquaculture Center, Mississippi State University. Each line represents a linear regression analysis.

Fig. 5. Picture of plant treatment in the experimental aquaria that simulate an exotic aquatic plant (hydrilla) invasion.

Task 1.4. Invasive Aquatic Plant Survey for the Mid-South

PI: John Madsen
Co-PI: Victor Maddox
Collaborators: Thomas Stohlgren, USGS, Fort Collins Science Center; Pam Fuller, USGS, Florida Integrated Science Center; Randy Westbrooks, USGS NWRC

Mississippi Survey for Giant Salvinia (*Salvinia molesta*) and Hydrilla (*Hydrilla verticillata*)

Wilfredo Robles, Victor Maddox, and John Madsen

Introduction: Invasive aquatic plant species have been implicated in the degradation of water bodies worldwide. For instance, the introduction and growth of invasive aquatic plant species may limit the water body function when they displace native flora, as well as impede boat traffic. Two species in particular, hydrilla (*Hydrilla verticillata*) and giant salvinia (*Salvinia molesta*) are considered invasive aquatic plants and listed as a federal noxious weed. However, their current distribution on the Mid-South and number of water bodies impacted is not well known.

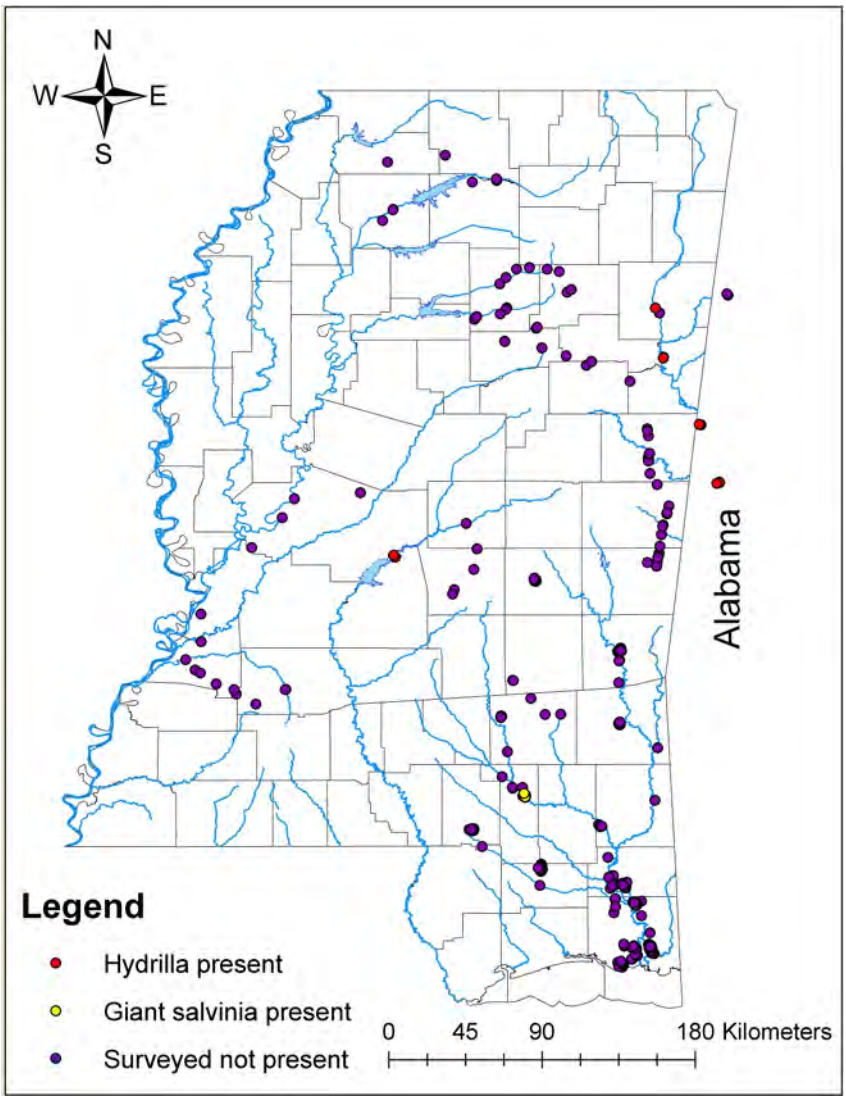


Fig. 1. Survey point location and current status of giant salvinia and hydrilla in Mississippi and western Alabama.

Materials and Methods: Extensive invasive aquatic plant species surveys were conducted throughout Mississippi and western Alabama to detect the presence of giant salvinia and hydrilla. Known locations of each species recorded in 2006 were revisited to document population persistence and establishment. A handheld computer with Global Position System (GPS) capabilities was used to obtain geographic coordinates of surveyed locations. Location maps were produced using ArcGIS-ArcMap, v. 9.1.

Results and Discussion: Giant salvinia still persists along Wedgeworth Creek, Forrest County, MS, but was not found in other locations (Figure 1). A more southern spread of giant salvinia at the mouth of this creek, which drains into the Leaf River, will ultimately result in the escape of giant salvinia into the Leaf River. Additional surveys of southern tributaries should be conducted. Hydrilla still persists and is well established in the following lakes of the Tennessee-Tombigbee Waterway: Columbus, Aberdeen, Aliceville, and Gainesville. Populations of hydrilla in the Ross Barnett Reservoir are located in the northern portion of the lake covering a total of 407 acres. Since 2005, hydrilla has been under management using herbicides, successfully limiting its establishment and slowing its spread. Although hydrilla still persists as individual plants, asexual propagules (e. g. tubers) have not been found.

Fig. 1. Fruit and foliage of tropical soda apple (*Solanum viarem*) from a pasture in southern Mississippi. Tropical soda apple is a federal noxious weed currently the target of a specific USDA APHIS eradication program. Cattle eat the fruits in one pasture and carry the seeds to other pastures, sometimes several states away. MS infestations were likely caused by cattle transported from Florida.

Task 2. Terrestrial Plants

Figure 2. Dr. Victor Maddox stands next to a specimen of hardy sugarcane (*Saccharum arundinaceum* Retz.) at an undisclosed location in Mississippi. Many nonnative ornamental grasses have been imported for the nursery trade, with little evaluation of their invasiveness.

Task 2.1. Terrestrial Plant Habitat Invasibility Models

PI: Gary Ervin
Co-PI: John Madsen, John Byrd

Terrestrial Plant Habitat Invasibility Models

Gary N. Ervin

As mentioned under Task 1.1.1, we sampled 250 random points during the 2007 field season, across the Mississippi (Figure 1.1.1-1). Data from the total set of 319 points is scheduled to be digitized during Spring 2008, and analyses will ensue shortly thereafter. Considerably insight has already been gained from those data, however, and that information was used to design another study targeted at the invasive grass *Imperata cylindrica* (L.) Beauv. (cogongrass). This study is described under subtask 2.1.3.

The following subtask descriptions give an overview of work conducted as part of the terrestrial invasive plant habitat modeling efforts. Two of these subtasks are related directly to habitat modeling, while the others describe supporting studies. A key participant in this work, Christopher Holly, is presently in his final year of Ph.D. studies and has made considerable progress towards understanding important ecological properties of cogongrass. Two of his graduate research projects have already been published, and a third will be submitted during early 2008. That study is described in subtask 2.1.2.

Task 2.1.1. Random Versus Targeted Surveys for Invasive Plant Habitat Modeling

Gary Ervin and Christopher Holly, MSU Biological Sciences

While we have surveyed more than 300 random points, we have encountered many key invasive plant species with a surprisingly low frequency. For example, cogongrass (*Imperata cylindrica*) has been encountered in no more than ten of our plots (ca. 3%), despite our having sampled 71 points in a part of the state that is heavily infested with this species (ca. 22% of all sampled points). In those points where cogongrass was present, it was noted that human disturbance of the physical habitat was almost always present. This information led us to design a stratified survey during Fall 2007 that targeted roads in the southern Mississippi counties to evaluate the distribution of cogongrass. Those surveys yielded data on 329 patches of cogongrass along the 267 km of roads that were surveyed. Sixteen of those patches (5 %) lay more than 30m from the roadside, and only eight were located more than 60m from the road. Only one of the farthest eight patches was not associated with some form of disturbance, whereas only five of the sixteen found more than 30m from the road were in apparently undisturbed habitats. Of the types of disturbance encountered in these surveys, mowing (58% of patches) and soil disturbance (22% of patches) were the predominant forms, followed by fire (5 %). Frequency of patches was highest along federal interstate highway I-10 (2.0 patches per km of road) than along other road types, with state highways (1.5 patches per km) and gravel roads (1.6 patches per km) having the next highest frequencies. Thus, there was no clear association with presumed intensity of traffic along the surveyed roadways; gravel roads were as heavily infested as state highways. However, these results do indicate a distinctly non-random distribution of this key invasive species within the study region – as was suggested by the low frequency of occurrence of cogongrass in our random point surveys. This work is described in more detail under subtask 2.1.3.

Revised from an abstract entitled "Assessing the (in)adequacy of random sampling for invasive plant species in the Mid-South," submitted as part of a symposium proposal for the 2008 Ecological Society of America conference to be held in Milwaukee, Wisconsin.

Task 2.1.2. Effect of an Invasive Grass on Microbial Community Structure and Function in US Gulf Coastal Plain Communities

Christopher Holly and Gary Ervin, MSU Biological Sciences

In situ decomposition of above and belowground plant biomass of the native grass species *Andropogon glomeratus* (Walt.) B.S.P. and exotic *Imperata cylindrica* (L.) Beauv. (cogongrass) was used to evaluate the effects of cogongrass on soil microbial communities. Decomposition was investigated using litter bags filled with above- or belowground tissues of both plant species over the course of a 12 month period. The microbial communities associated with cogongrass-invaded sites often differed from those found in soils under native vegetation. The microbial communities differed not only compositionally, as indicated by ordination analyses of molecular data collected for all fungi, basidiomycete fungi, and bacteria, but also functionally with respect to activity of enzymes involved in the decomposition process. As a functional counterpart to the molecular and enzymatic analyses, the above and belowground biomass of the invasive cogongrass always decomposed faster than that of the native *Andropogon*. Also, belowground biomass of both species decomposed at a consistently faster rate when placed in an area dominated by *Imperata*, as opposed to within a native plant assemblage. This study supports the growing consensus that invasive plant species alter ecological processes and highlights a possible mechanism (alteration of microbial assemblages) by which *Imperata* may alter an ecosystem process (decomposition).

Revised from a paper to be submitted to the *Journal of Ecology* in Spring 2008.

Task 2.1.3. *Imperata cylindrica* (cogongrass) Distribution in Desoto National Forest, Mississippi, USA: Local Habitat Disturbance is More Important than Landscape Context

Christopher Holly and Gary Ervin, MSU Biological Sciences

The ability to predict the successful invasion of non-native plant species into new habitats has the potential to substantially increase the efficiency of early detection of nascent populations of key invaders. The integration of landscape ecology and predictive habitat modeling is a promising area of research that may permit the prediction of large scale patterns of invasion. These techniques enable researchers to use landscape-scale predictor variables to model, statistically and spatially, the habitat characteristics of invaded sites and then to estimate future sites of invasion by identifying suitable habitat across a landscape of interest. These habitat models then can be tested with independent field data and refined to the necessary degree of accuracy. The present study sought to predict future areas of invasion by *Imperata cylindrica* by first evaluating factors that best explained its present location in field survey data collected in Desoto National Forest during the Fall of 2007. The statistical modeling procedure analyzed anthropogenic disturbance factors (habitat disturbance type and proximity to roads) and biotic landscape-scale predictor variables (forest community type and forest cover change from 2004 to 2006). The results indicated that landscape-scale plant community patterns (forest cover change and forest type) were not statistically important in predicting the presence of *Imperata*. However, anthropogenic disturbance factors had a statistically significant influence upon cogongrass presence and provided a robust logistic regression model to predict the occurrence of *Imperata* (and consequently suitable habitat). This finding has management implications as it suggests that the resident forest community type is relatively unimportant in the invasion dynamics of this species, as compared to the influence of anthropogenic disturbance in creating habitat suitable for invasion by *Imperata cylindrica*.

Task 2.1.4. Relative Information Provided by Soil (STATSGO) Versus Canopy Cover Data in Modeling Invasive Species Habitat

Gary Ervin, MSU Biological Sciences

As part of the present research to develop integrated approaches for the management of invasive species, we are attempting to quantify the relationships of invasive species distribution and spread with landscape characteristics. The objective of these efforts is to use that information directly in developing and implementing Early Detection and Rapid Response (EDRR) systems to aid management activities. Two specific activities presently underway along these lines are the Cactus Moth Detection and Monitoring Network (discussed under main Task area 3: *Invasive Insects*) and the Invasive Plant Atlas of the Mid-South (IPAMS). Research associated with these programs includes systematic regional vegetation surveys and the development of habitat models for predicting the occurrence of target species based on geospatial data, such as soil, land use and cover, impervious surfaces, and canopy density data, the latter three representing data provided by the USGS GAP Program.

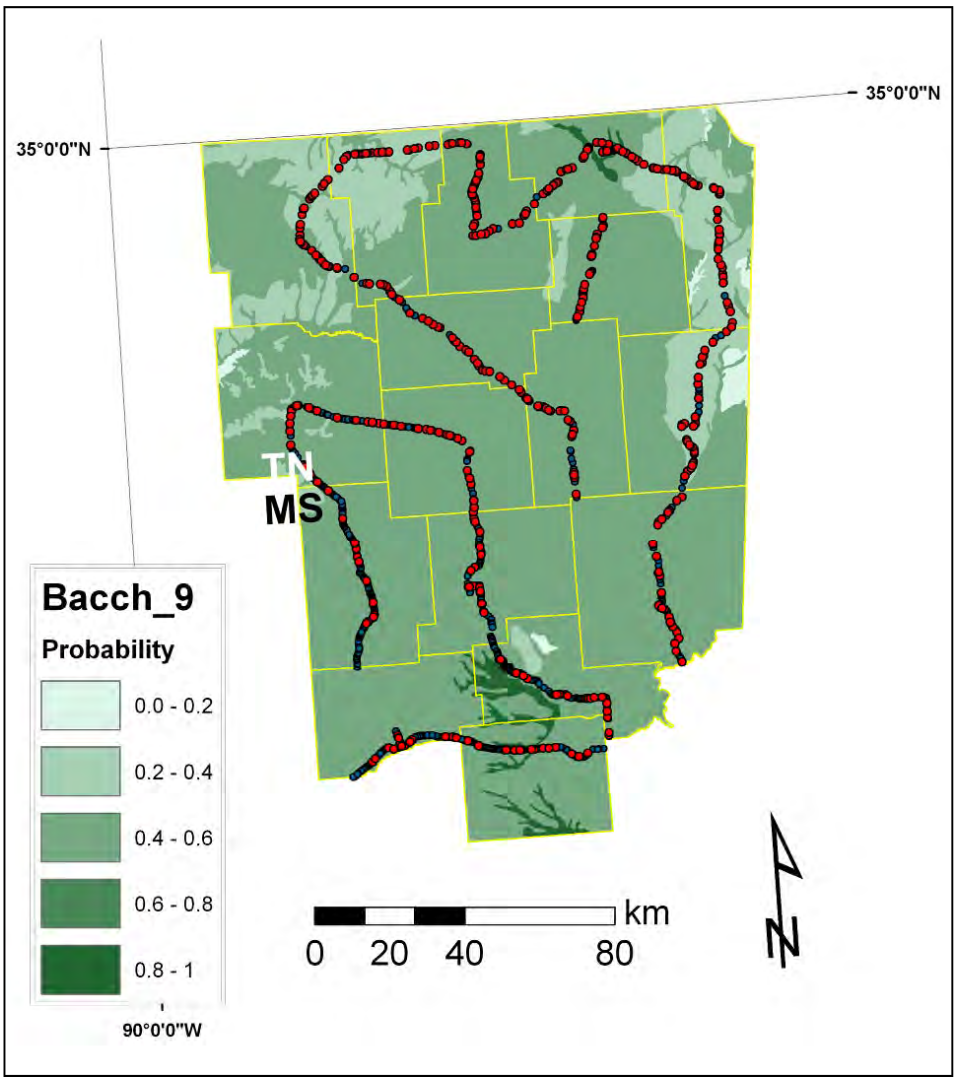


Figure 1. Predicted distribution of *Baccharis halimifolia* across northeastern Mississippi. This predicted habitat distribution was one of two top models, and was based on the combined effects of soil organic matter and bulk density on presence versus absence of *Baccharis*. The top models were selected based on assessment criteria when compared with a validation dataset, versus the training data used to develop and select models via AIC analyses. Darker areas indicate higher probability of encountering suitable *Baccharis* habitat. Red dots indicate absence points, blue are presence points from Fall 2006 surveys.

The present modeling effort used the State Soil Geographic Database (STATSGO; USDA NRCS 1994), along with the USGS GAP canopy cover data, to provide representative environmental predictor variables for distribution of *Baccharis halimifolia* within Mississippi. Despite being native to the southeastern US, *Baccharis* is widely recognized as a weedy invader of pastures in the region. Numerous characteristics of this species' biology make it a useful representative invasive plant for conducting pilot studies on approaches for modeling and managing behavior of invasive plants. It is a wind-dispersed species that reaches sexual maturity in only two to three years and usually is associated with disturbed habitats, such as roadsides, fencerows, utility rights-of-way, and forest edges.

The statistical modeling approach used binary logistic regression models of soil factors and canopy cover as correlates with *Baccharis* presence-absence, followed by information-theoretic analyses to compare resulting models. Regressors on *Baccharis* presence-absence data included available soil water content, bulk density, CEC, clay content, organic matter content, permeability, and pH, each calculated as the minimum & maximum value for each soil mapping unit across MS. Information-theoretic analyses used the Akaike Information Criterion (AIC) to rank the resulting logistic regression models and indicate which provided the best fit to *Baccharis* occurrence across the northeastern portion of the state.

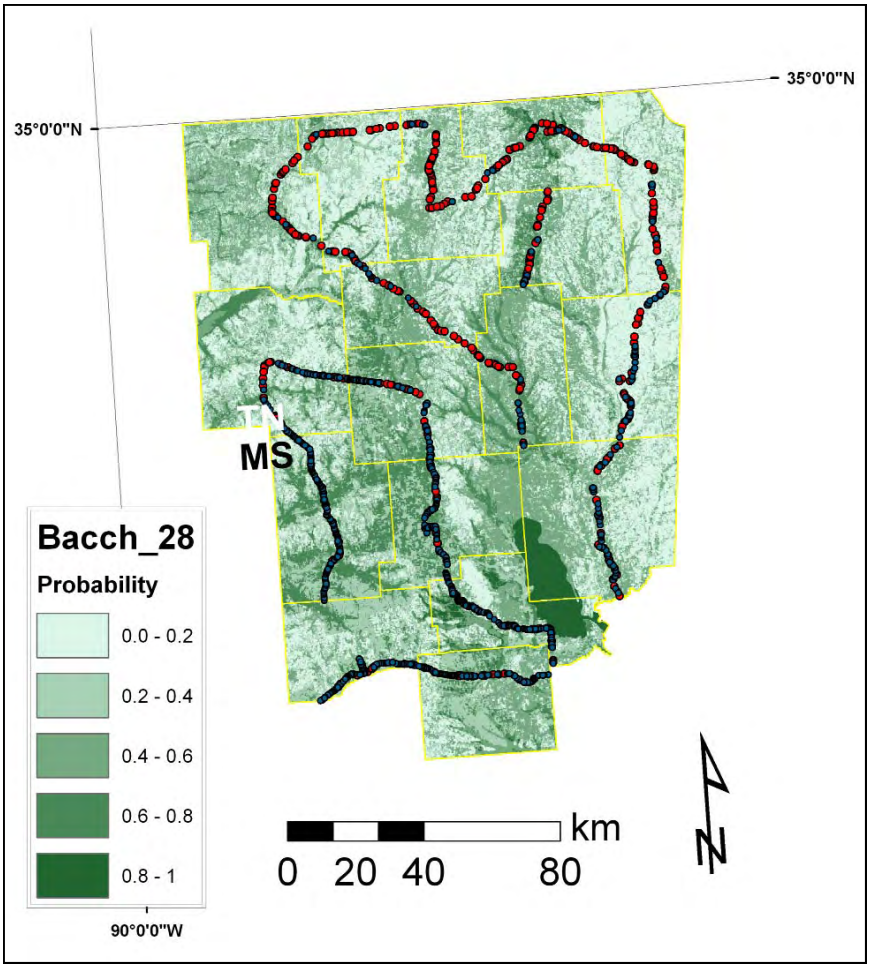


Figure 2. Predicted distribution of *Baccharis halimifolia* across northeastern Mississippi. This predicted habitat distribution was one of two top models, and was based on the combined effects of soil organic matter, clay content, pH, and canopy cover on presence versus absence of *Baccharis*. Darker areas indicate higher probability of encountering suitable *Baccharis* habitat. Red dots indicate absence points, blue are presence points from Fall 2006 surveys.

The resulting best-fit models were evaluated further by comparison with a training dataset, using assessment criteria such as sensitivity, selectivity, Cohen's kappa, and the True Skill Statistic. The top statistical models were incorporated into an ArcMap GIS to generate layers indicating probabilities of occurrence of cogongrass, based on statewide soil characteristics (Figures 1,2).

Although both "winning" habitat prediction layers incorporated soils data, the layer that appeared to provide the most information on potentially suitable habitat for *Baccharis* was that which included data on canopy cover, in addition to soils (Figure 2). This habitat model reflects the importance of the interaction between aboitic habitat features (soil) and biotic interactions (shading, for example) on determining areas where invasive species have the potential to successfully establish and reproduce. One notable concern with the environmental data used in this exercise is illustrated by the large, high-probability oval region in the southeastern corner of Figure 2. This is the result of the geographically large aggregations of soils data in the STATSGO database. This difficulty is ameliorated to some degree by use of SSURGO data, as described in Subtask 3.3.1 below.

References

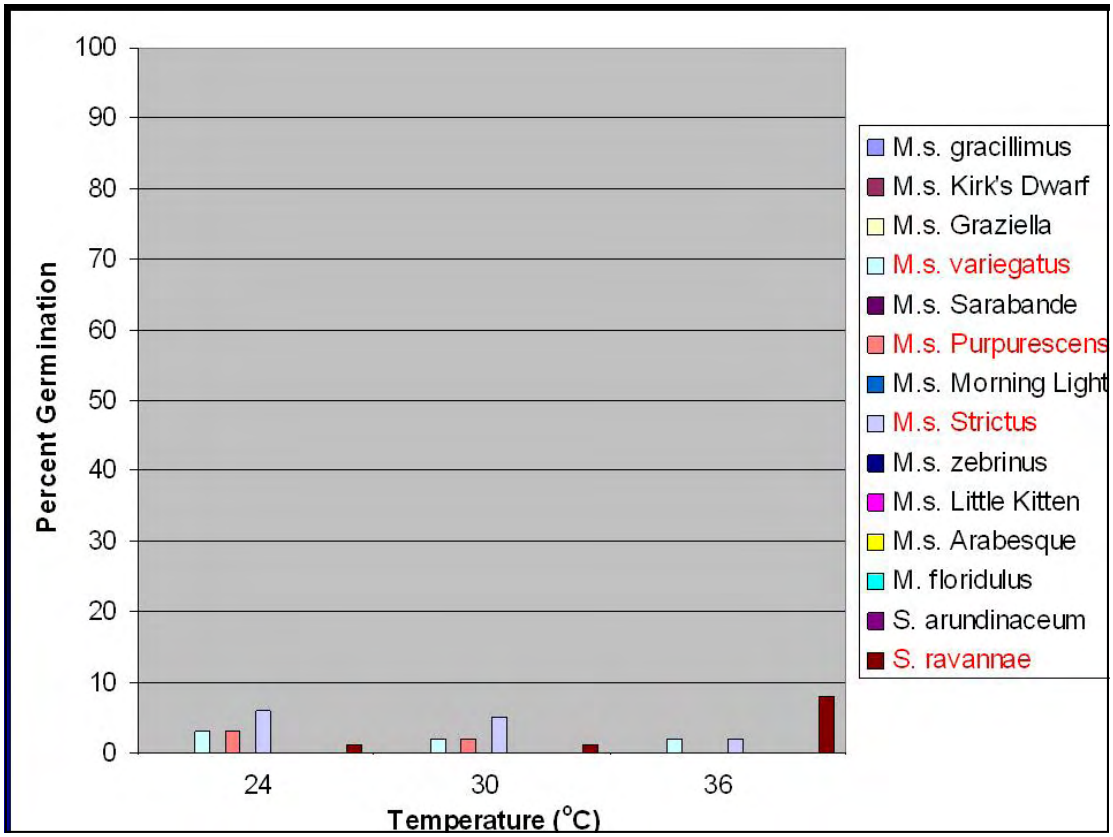
United States Department of Agriculture, Natural Resources Conservation Service. 1994. State Soil Geographic (STATSGO) Database for MS. Accessed January 2006 through: http://www.ncgc.nrcs.usda.gov/products/datasets/statsgo/index.html.

Task 2.2. Assessment of Terrestrial Plant Populations

PI: John Byrd
Co-PI: John Madsen, Victor Maddox
Collaborator: Randy Westbrooks, USGS NWRC

Seed Germination in Selected Varieties of Nonnative Ornamental Grasses

Victor Maddox, John Byrd, John Madsen, and Randy Westbrooks



Figs. 1 & 2. Percent germination of nonnative grasses in 2006 and 2007.

Thousands of exotic species have been introduced to the United States. Many times the potential invisibility of these species is unknown. Determining risk associated with introduced species could be of great benefit in the prevention or early detection of invasions. Grasses are numerous in scope and continue to be introduced into the United States, mostly as forages or ornamentals. Multifaceted efforts on selected species are underway. Efforts conducted from 2005 to 2007 with four warm-season grass species are presented in this summary.

This study focuses on four species of grasses, *Miscanthus floridulus* (Labill.) Warb., *M. sinensis* Anderss. (cultivars and varieties), *Saccharum arundinaceum* Retz., and *S. ravennae* (L.) L. Aside from these four species, *M. sinensis* cultivars and varieties studied were 'Arabescue', g*racillimus* Hitchc., 'Graziella', 'Kirk's Dwarf', 'Little Kitten', 'Morning Light', 'Purpurescens', 'Sarabande', 'Strictus', *variegatus* Beal, and *zebrinus* Beal. *Miscanthus sinensis* and *S. ravennae* are widely cultivated as ornamental. Though not common at present in the southeast, there are reports of both escaping cultivation. Little is known about *S. arundinaceum*, but its rapid growth, large size (Figure 1), and wind dispersed seed may pose problems if invasion where to occur. The purpose of this study was to determine which species and/or cultivars pose a risk of invasion, suitable temperatures for seed germination, and if *M. sinensis* cultivars and/or varieties pose a greater risk when outcrossing is possible.

Seed for the 2006 and 2007 germination studies were collected in the fall of 2005 and 2006, respectively, from field plants and retained in a refrigerator prior to plating. Multiple seedheads from multiple plants were collected for each grass. Two replications of 100 seeds per grass were placed on wet germination paper in petri plates. Petri plates were placed in a curtain germinator under continuous lighting and at constant temperatures of 12°C, 18°C, 24°C, 30°C, or 36°C. Separate runs were conducted at each temperature. Percent germination was recorded for each grass at each temperature (Figures 1, 2).

In 2006, *M.sinensis* 'Purpurescens', *M. sinensis* 'Strictus', *M. sinensis variegatus*, and *S. ravennae* all produced viable seed (Figure 1). All four grasses germinated at temperatures of 24°C, 30°C, and 36°C, except *M. sinensis* 'Purpurescens' which showed no germination at 36°C.

In 2007, germination was observed in *M. sinensis* 'Arabescue', g*racillimus*, 'Graziella', 'Little Kitten', 'Morning Light', 'Purpurescens', 'Sarabande', 'Strictus', *variegatus*, and *zebrinus* and *S. ravennae* (Figure 2). Only 'Kirk's Dwarf' showed no germination at any temperature. 'Little Kitten' showed germination at 24°C and 30°C, but not at temperatures above or below. Germination was highest at 24°C for most grasses in the studies.

Percent germination was considered low since the highest germination in either year was only 36%. However, seed production on these grasses can be at least 1100 seed per inflorescence. No germination was observed at 12°C or 18°C in either year, but germination at higher temperatures may be expected since all are warm-season or C4 grasses. Regardless, germination appears to be inconsistent from year to year. Currently, seed germination studies are being conducted on 2007 seed to determine if outcrossing influences seed viability.

Task 2.3. Integrated Tactics for Cogongrass Management

PI: John Byrd

Integrated Management Tactics For The Control Of Cogongrass [*Imperata cylindrica* (L.) Beauv.]

Matt T. Myers and John D. Byrd, Jr.

Photo 1. Cogongrass growing throughout a recently-planted loblolly pine plantation. Cogongrass increases fire frequency and intensity, endangering newly planted forests.

Cogongrass has become a major problem in many parts of the southern United States for several years. Hundreds of studies have been conducted upon this species with varying results. Management of cogongrass can be grouped into five major areas of control: preventive, cultural, mechanical, biological, and chemical. Each of these methods provides a certain level of control, but an integrated management strategy is the key to success. Three field studies were conducted from 2004 to 2006 in southern Mississippi to evaluate the most effective integrated management programs for cogongrass control. Results indicated that foliage removal either by fire or mowing increased the efficacy of both glyphosate and imazapyr. Tillage alone is an effective control system when multiple tillage events occur within one year or over several years. Also, tillage prior to chemical applications increases the efficacy of both glyphosate and imazapyr.

Revised from Myers, M. T. 2007. Integrated Management Tactics For The Control Of Cogongrass [*Imperata cylindrica* (L.) Beauv.]. M.S. Thesis, Mississippi State University, Mississippi State, MS. 94pp.

Photo 2. A mature cogongrass inflorescence. Cogongrass seeds are easily dispersed by wind or entrapped in clothing.

Task 2.4. Invasive Terrestrial Plant Survey for the Mid-South

PI: John Byrd
Co-PI: Victor Maddox, John Madsen
Collaborators: Randy Westbrooks, USGS NWRC

Invasive plant survey work was conducted in 2007 over a large geographic area of the central and southern United States (Figure 1). The greatest concentration of survey work was conducted within the five core mid-south states of Alabama, Arkansas, Louisiana, Mississippi and Tennessee. Survey work in states outside the mid-south region was limited to less than five trips per state. Numerous populations of both aquatic and terrestrial invasive species were mapped during active surveys.

Individual mapping trips ranged from just a few to over 8000 road miles. During this period, over 2500 invasive species data forms (NAWMA) were taken. Data on many invasive species were collected during these surveys. During 2007, new populations of callery pear, Chinese tallow tree (Figure 2), giant reed, itchgrass, kudzu, and many other species were identified and mapped in the Mid-South region and the central and southern United States.

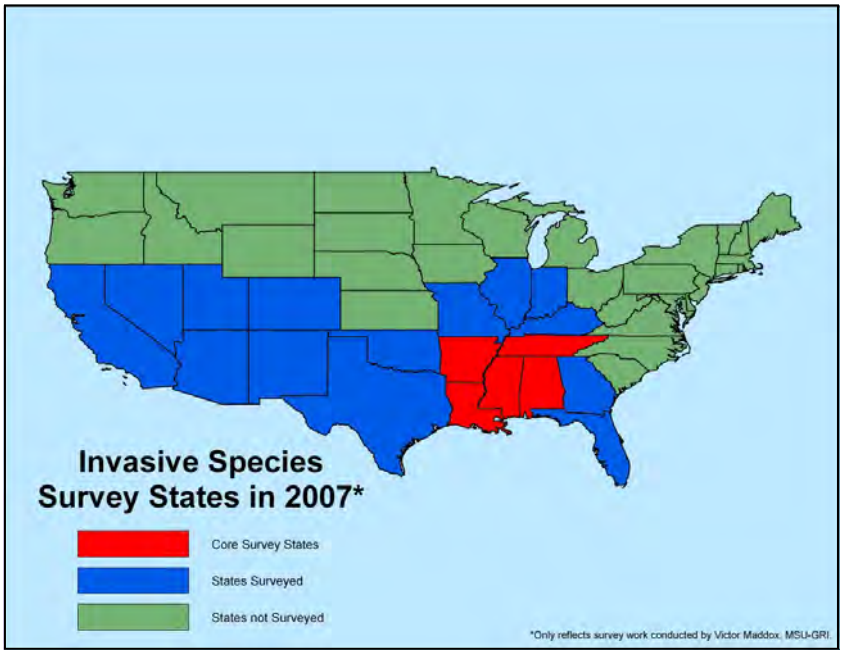


Fig. 1. United States map showing states where active invasive species mapping was conducted in 2007 (blue and red). More aggressive mapping was conducted in core states shown in red.

Fig. 2. Chinese tallow trees (*Triadica sebifera*), a state noxious species in MS, which were mapped in 2007 on a private lake shoreline in MS. Information was provided to the private landowner and entered into the Invasive Plant Atlas of the Mid-South (IPAMS) database.

Much of the survey work was conducted from highway rights-of-way. However, invasive species populations were mapped on federal, state, and privates lands during this period. This data should assist respective stakeholders with monitoring and management efforts.

One of the major goals for 2008 is to complete the entry of this data into the IPAMS (Invasive Plant Atlas of the Mid-south) database. Active survey work is expected to continue in 2008, in addition to citizen scientist training workshops. Research has been initiated on three potentially invasive ornamental grasses identified within or adjacent to the region during survey work.

Figure 1. USDA APHIS personnel set up a cactus moth trap on Petit Bois Island off the coast of Mississippi. All trap samples are processed by Dr. Richard Brown of MSU.

Task 3. Invasive Insects:
Cactus Moth (*Cactoblastis cactorum)*

Figure 2. Pricklypear cactus pad from Dauphin Island, AL showing extensive cactus moth damage inside the dissected pad.

Task 3.1. Early Detection of Cactus Moth

PI: Richard Brown
Co-PI: John Madsen
Collaborator: Randy Westbrook

Cactus Moth Monitoring in the United States

Richard Brown

This project included the following objectives:
1) Maintain and refine techniques for detection and surveillance of cactus moth infestations, 2) expand the cactus moth detection network, 3) refine protocols for identifying cactus moths, and 4) determine pathways of introduction and dispersal of cactus moth by phylogeographic analysis using DNA.

Figure 1. Sentinel site on Hog Island (Harris Co.), Texas monitored by Victor Madamba.

Surveillance: The surveillance of cactus moth during 2007 was based on 415 pheromone traps in five states, establishment and monitoring of sentinel sites, and field surveys in seven states between Alabama (westernmost infestation) and California. Pheromone traps for cactus moths were screened from the following states (with number of traps in parentheses): Mississippi (72), Texas (45), New Mexico (5), Arizona (277), and California (16). Sentinel sites for detection of cactus moths were established in North Carolina, South Carolina, Mississippi, Texas (Fig. 1), and Arizona. Field surveys of *Opuntia* in Alabama, Arizona, Arkansas, Georgia, Louisiana, Mississippi, New Mexico, and Texas resulted in detection of cactus moth only on Dauphin Island and Fort Morgan, AL.

Figure 2. Early instars of cactus feeding larvae on Hog Island, Texas identified as native *Melitara prodenialis* after being reared.

Identification: Based on collections of native larvae of *Melitara* infesting *Opuntia* in eastern U.S., Texas, New Mexico, and Arizona during 2006-2007, no native, cactus-feeding species have the distinctive red and black coloration characteristic of *Cactoblastis*. However, the first 2-3 instars of all species lack distinctive coloration, and examination of setal patterns or rearing is required for identification (Fig. 2). Adults of the cactus moth, *Cactoblastis*, and native species, *Melitara*, are superficially similar, but differ in that males of *Melitara* have pectinate antennae, whereas males of *Cactoblastis* have simple antennae. Females of these species require dissection of genitalia for confirmation of identity. Dissections of both male and female genitalia of the cactus moth were supplied to Mexican Agricultural Survey officials for identification references.

Introduction and Dispersal Rates of *Cactoblastis* in SE United States: Most authors have erroneously reported the first detection of the cactus moth in the U.S. as Big Pine Key, FL, rather than Bahia Honda Key on October 30, 1989 (Terry Dickel, personal comm.). Surveys for the cactus moth beginning in 1990 in the Florida Keys and expanded in 1991 to other areas of Florida documented that *Cactoblastis* was well established from the Keys to Terra Ceia, Manatee Co. on the west coast and to Brevard Co. on the east coast, rather than having dispersed there from the Keys. A phylogeographic study of *Cactoblastis* based on the COI gene showed that two different haplotypes are present in the SE U.S., with one occurring only on the Gulf Coast and the second occurring on the Atlantic Coast with a single occurrence of the Atlantic haplotype on the Gulf Coast at Pensacola (Simonsen Brown, and Sperling, submitted ms). The possibility of multiple introductions of *Cactoblastis* into SE U.S. is supported by numerous interceptions of this species in imports of cactus in Miami and other ports of entry, even though a small percentage of imported cactus were inspected. If *Cactoblastis* was present as far north as Terra Ceia, Manatee Co. in 1989, then its detection on St. George Island in 2002 indicates an annual dispersal rate of 33 km/year, or an average of 11 km/generation given three generations annually.

Task 3.2 Distribution of *Opuntia* in the Region

PI: John Madsen
Co-PI: John Byrd, Richard Brown
Collaborators: Randy Westbrooks

Opuntia Species Surveys for 2007

Victor Maddox, John Madsen, John Byrd, Richard Brown, and Randy Westbrooks

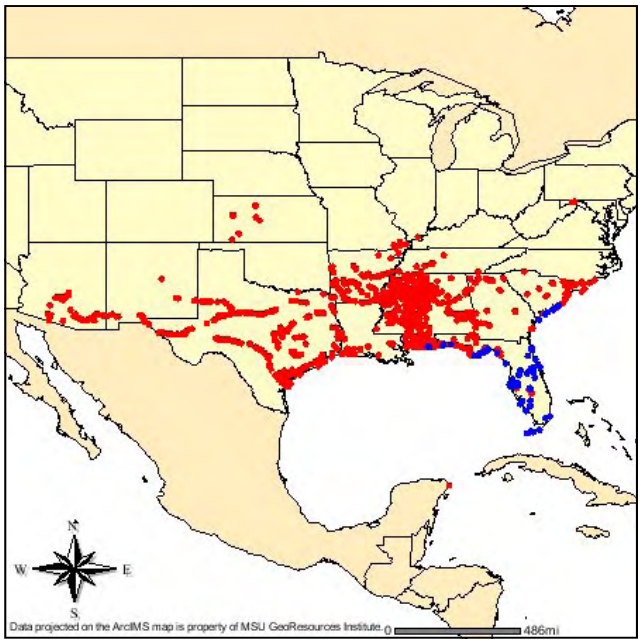


Fig. 1. Cactus Moth Detection and Monitoring Network map showing pricklypear populations (blue and red points) in the database as of 13 December 2007. Blue points also have the cactus moth (*Cactoblastis cactorum*) present.

Pricklypear (*Opuntia* spp.) mapping and data collection was conducted over a large geographic area of the eastern and southern United States by Victor Maddox, GRI, in 2007, although other mapping and data collection was conducted by the GeoResources Institute and its partners during 2007. Most of that information has been entered into the Cactus Moth Detection and Monitoring Network (CMDMN)(Figure 1).

The greatest concentration of mapping and data collection work was conducted in Alabama and Mississippi, which are along the western leading edge of the cactus moth. However, there was an increase in mapping and data collection activity in Florida and the southwestern United States in 2007 (Figure 2). Individual mapping trips ranged from just a few miles to over 8000 road miles. During this period, many pricklypear dataforms were taken. Due to constraints with private land, much of the work was conducted from highway rights-of-way. However, pricklypear populations were mapped on federal, state, and privates lands during this period. During these trips, data from negative locations were also identified.

Currently, the distribution of *Opuntia* in the region continues to expand as new populations are identified. In 2007, surveys were conducted from Indiana to Georgia and Florida, west to California. Pricklypear mapping ranged from Florida to California. Sentinel sites were also established during mapping trips (Figure 2), although some sentinel sites were established by volunteers via the CMDMN database. Most 2007 pricklypear dataforms have been entered into the CMDMN database. Entry completion of the remaining data is expected by early 2008.

Goals for 2008 related to this task will include continued mapping, data collection and entry, development of additional sentinel sites, monitoring of existing sentinel sites, collaboration with volunteers and agencies, and increased focus on *Opuntia* and cactus moth distribution in southeast Alabama and Florida. Mapping data from Alabama and Florida should assist USDA-APHIS with cactus moth eradication efforts in Florida. As of 11 December, only 206 reports from Florida were in the database compared to 753 reports from Mississippi. Although that number is up from 128 on 14 December 2006, it is expected to be much higher for Florida. In addition, most positive reports of cactus moth in Florida are from coastal areas. More *Opuntia* and cactus moth data are needed from Florida's interior.

Figure 2. Populations of pricklypear have been mapped and sentinel sites established at Organ Pipe Cactus National Monument in southern Arizona near the Mexican border with the assistance of Charles Conner, a National Park Service employee.

Task 3.3. *Opuntia* Habitat Models

PI: Gary Ervin
Co-PI: John Madsen, John Byrd
Collaborator: James Grace, USGS, National Wetlands Research Center

Opuntia Habitat Models

Gary N. Ervin and Lucas Majure

Work during 2007 involved continued mapping of natural populations of *Opuntia* in the southeastern US, as well as completion of ecological, morphological, and ecophysiological studies of the southeastern *Opuntia* species. Most of that work was performed by Lucas Majure, a M.S. student in the Department of Biological Sciences. Data from that work has served as the basis for much of the habitat modeling to date, and as described in subtask 3.3.1 below. Majure completed his M.S. degree in Summer 2007, and now is continuing his studies of the southeastern *Opuntia* as a Ph.D. student at the University of Florida (Gainesville).

Fig. 1. *Opuntia cespitosa*, a taxon re-discovered by Lucas Majure during his M.S. thesis research at MSU. This species appears to be very widespread in the eastern U.S. and has been confused with *O. humifusa* for decades.

We anticipate at least three peer-reviewed papers to result from his thesis research, in addition to other papers that are in review or recently in print based on vegetation data collected during his mapping of prickly pear (see *Publications* section of this report). The most important information of practical use is Majure's determination of *Opuntia* species presently in the state of Mississippi (Fig. 1). This chapter of his thesis has been reviewed by Dr. Donald Pinkava, author of the section on *Opuntia* for the Flora of North America project, and is presently under review by the journal *Haseltonia*. His thesis may be accessed at:
http://www.gri.msstate.edu/information/pubs/docs/2007/Majure_Thesis.pdf

Fig. 2. Collecting tissues for genetic analyses of *Opuntia*.

We are in the process of expanding the focus of habitat modeling efforts to include a landscape genetics approach at better understanding the relationship between *Cactoblastis* and *Opuntia* species in the US. This has involved collection of geospatial data and tissue samples from both organisms during the latter half of 2007 (Fig. 2). These efforts also have resulted in increased cooperation with USDA personnel in order to coordinate ecological research with management and tracking efforts, such as pheromone trapping at Dauphin Island and Fort Morgan during 2008. We also plan to being developing habitat models that will be transferred to ARS and APHIS personnel during 2008 working in the area around Pensacola, Florida. The hope is that habitat modeling will aid in targeting areas for monitoring and/or management of the insect in that apparently high density region. This expanded research focus has involved three additional faculty in the Department of Biological Sciences:

Dr. Christopher Brooks – Spatial Ecology and Ecological Modeling
Dr. Lisa Wallace – Plant Molecular Systematics
Dr. Mark Welch – Populations Genetics

References

Majure, L. C. 2007. Thesis: The Ecology and Morphological Variation of *Opuntia* (Cactaceae) Species in the Mid-South, United States. Department of Biological Sciences. Mississippi State University.

Task 3.3.1. Pricklypear Cactus Modeling Efforts

PI: Gary Ervin

Using approaches outlined under Subtask 2.1.4, we are refining the methodology to be used in developing habitat models for plants such as the invasive cogongrass, as well as the native hosts of *Cactoblastis cactorum*. Species occurrence data for geospatial modeling of *Opuntia* habitat have come largely from mapping of natural populations conducted by MSU researchers associated with this invasive species program. The approach used thus far has focused on modeling using combined presence and absence datasets, as describe above. One marked improvement in the reliability of the models has been the inclusion of Soil Survey Geographic (SSURGO) Database data, rather than STATSGO soil data. The SSURGO data are mapped at a resolution about ten times more precise than the STATSGO data, and thus will be expected to provide more reliable predictive models. A comparison of this approach with the two soil datasets was conducted with *Opuntia cespitosa* (formerly considered as part of *O. humifusa*; Majure 2007). In this exercise, a limited region of Mississippi was used in order to restrict potential environmental variation that could decrease the signal-to-noise ratio in the small dataset presently available for this species. Absence points from the vicinity of the presence data were assembled from our invasive species survey points, using points that were believed to be devoid of *Opuntia* (Figures 1,2). Development and evaluation of logistic regression models was carried out as described above (subtask 2.1.4), using the closest possible match of STATSGO and SSURGO data variables within the modeled region of Mississippi. This comparison suggests the SSURGO data will provide a much finer spatial scale of habitat prediction, which should be more compatible with inclusion in EDRR efforts for these and other plant species targeted for management operations.

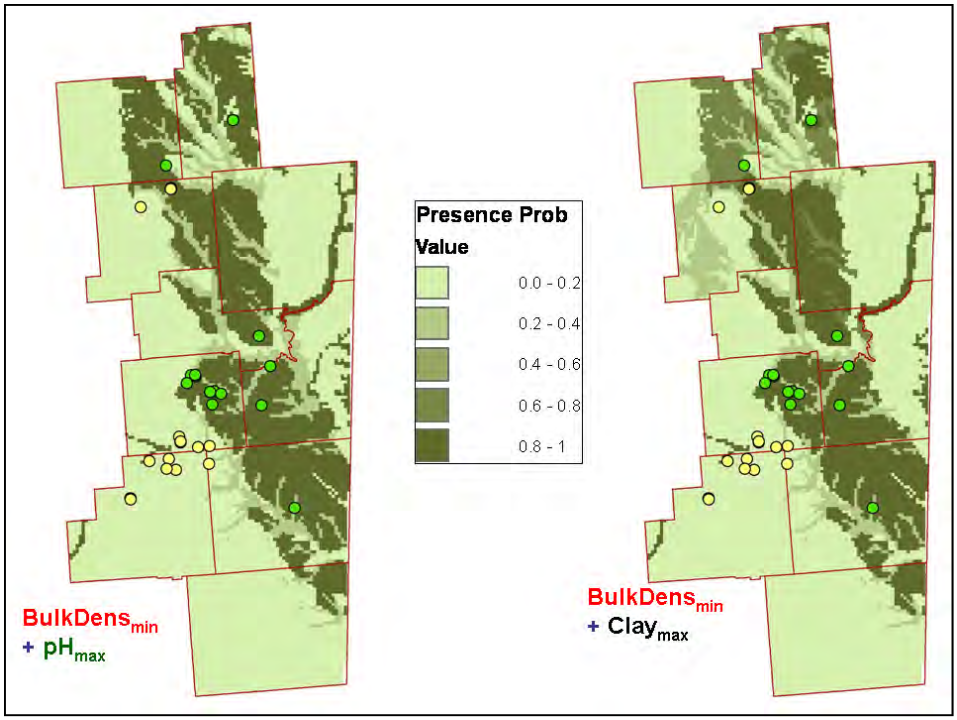


Figure 1. Predicted distribution of *O. cespitosa* in northeastern Mississippi, based on models with **STATSGO** data. These models were based solely on the effects of soil parameters on presence versus absence of *O. cespitosa*. They were selected based on assessment criteria as compared to the original training data, thus they would be considered preliminary at best, but still are useful in assessing the information of the two soil databases. Darker areas indicate higher probability of encountering suitable *O. cespitosa* habitat; yellow dots show absence points, green are presence points.

Plans for the coming months are to evaluate two presence-only modeling approaches in an effort to determine the best of the three methods for generating habitat maps to assist in management activities. The presence-only approaches to be tested are an approach that computes, within ArcView, a probability surface based on Mahalanobis Distance estimates for species occurrence locations dependent upon candidate environmental GIS layers. The other approach is a modification of classification tree methods, termed random trees.

Based on a presentation given at the Interagency Cactus Moth Detection and Monitoring Network Meeting, Mississippi State University, 04 December 2007.

References

Majure, L. C. 2007. Thesis: The Ecology and Morphological Variation of *Opuntia* (Cactaceae) Species in the Mid-South, United States. Department of Biological Sciences. Mississippi State University.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database for Mississippi Counties.
Available URL: "http://soildatamart.nrcs.usda.gov" [Accessed Nov 2007].

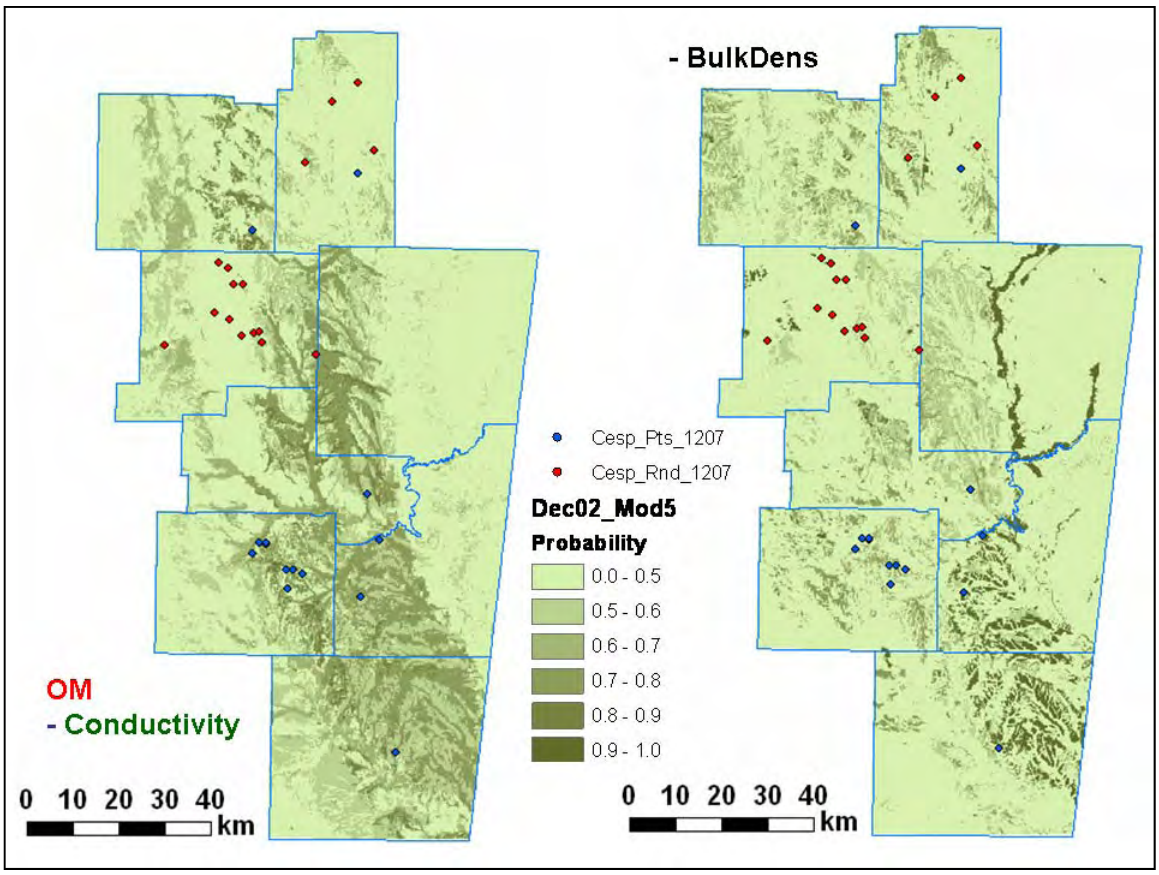


Figure 2. Predicted distribution of *Opuntia cespitosa* in northeastern Mississippi based on models with **SSURGO** data. These models were based solely on the effects of soil parameters on presence versus absence of *O. cespitosa*. They were selected based on assessment criteria when compared with the original training data, thus they would be considered preliminary, but still are useful in assessing the information of the two soil databases. Darker areas indicate higher probability of encountering suitable *O. cespitosa* habitat; red dots are absence points, blue are presence points.

Figure 1. A major avenue of extension and outreach for cactus moth issues is the Cactus Moth Detection and Monitoring Network webpage at http://www.gri.msstate.edu/cactus_moth.

Task 4. Extension and Outreach

Figure 2. Dr. John Byrd of MSU speaks at numerous workshops each year concerning the management of invasive grasses. While web-based tools are valuable, they do not completely replace personal contacts such as this.

Task 4.1. Aquatic Plant Extension Information

PI: John Madsen
Collaborators: USACE (ERDC) Kurt Getsinger, Vicksburg, MS; Annie Simpson, USGS National Headquarters (Biological Informatics Program) and Randy Westbrooks, USGS NWRC

Aquatic Plant Management Information Products for 2007

John D. Madsen

Photo 1. Waterhyacinth (*Eichhornia crassipes*). Photo by author.

During 2007 and early 2008, fact sheets for seven invasive aquatic plant species have been developed in the new shorter two-page format for use in the Invasive Plant Atlas of the Mid-South. These species include alligatorweed, hydrilla, Eurasian watermilfoil, giant salvinia, purple loosestrife, waterhyacinth, and waterprimrose (Table 4.1). For each fact sheet, a description of the plant, information on spread, dispersal, habitat, ecology, and management are included.

These are in addition to fact sheets on several invasive aquatic plants already available at the GeoResources Institute webpage.

Photo 2. Waterprimrose (*Ludwigia grandiflora*). Photo by Joshua Cheshier.

Photo 3. Underwater photo of a dense canopy of Eurasian watermilfoil (*Myriophyllum spicatum*) from Pend Oreille Lake, Idaho. Photo by author.

Table 4.1. Invasive aquatic plant fact sheets available on the Invasive Plant Atlas of the Mid-South webpage (www.gri.msstate.edu/ipams).

Scientific Name	Common name
Alternanthera philoxeroides (Mart.) Griseb.	alligatorweed
Eichhornia crassipes (Mart.) Solms	common water hyacinth
Hydrilla verticillata L.f. Royle	waterthyme (hydrilla)
Ludwigia uruguayensis (Camb.) Hara	Uruguayan primrose-willow
Lythrum salicaria L.	purple loosestrife
Myriophyllum spicatum L.	spike watermilfoil (Eurasian watermilfoil)
Salvinia molesta Mitchell	kariba-weed (giant salvinia)

Task 4.2. Terrestrial Grass Extension Information

PI: John Byrd
Co-PI: Victor Maddox
Collaborators: Annie Simpson, USGS National Headquarters (Biological Informatics Program) and Randy Westbrooks, USGS NWRC

Fig. 1. Image of itchgrass (Federal and State Noxious) and johnsongrass (not regulated) on a roadside in south Mississippi showing similarities and differences between the two grasses.

Terrestrial Invasive Plant Information

Victor Maddox, John Byrd, and Randy Westbrooks

Grasses belong to a large family (Poaceae) consisting of 785 genera and approximately 10,000 species. Most are terrestrial and as a group are similar in appearance, which can make identification challenging. In Mississippi, 18 % of introduced vascular plants are grasses. Approximately 30% of grasses in Mississippi are introduced. Roughly 11 % of the grass species in the United States are introduced (~156 species). Not surprisingly, many grasses tend to be invasive. Cogongrass [*Imperata cylindrica* (L.) Beauv.] and itchgrass [*Roettboellia cochinchinensis* (Lour.) W.D. Clayton](Figure 1) are two examples of problematic grasses in the Mid-south. However, invasive grasses also include crabgrasses (*Digitaria* spp.), johnsongrass [*Sorghum halepense* (L.) Pers.](Figure 1) and others. In addition to existing non-native grasses, species continue to be introduced into the United States and mid-south region making invasion by grasses an ongoing issue. Additionally, some invasive grasses, like cogongrass and itchgrass, are federal and/or state regulated while others are not. In either case, there is a need to assist federal, state, and public stakeholders with issues related to terrestrial grass recognition and control.

In 2007, numerous federal, state, and local meetings were attended to present information on terrestrial grasses to stakeholders. Extension information ranged from formal presentations to fact sheets (Figure 2) handed out at garden and patio shows and other events. The scope of clientele ranged from federal land managers to public landowners. The majority of this activity occurred within the Mid-South, but was not confined to this region. Since clientele attending individual meetings ranged from a handful to just under 10,000 people, the number of people contacted verbally or through literature handed out in 2007 is estimated in the thousands.

Fig. 2. Cover of a new four-page fact sheet on itchgrass is one example of several forms of extension information provided at public meetings in 2007. This information assists with plant identification and provides contacts for clientele needing additional extension information.

Mapping and monitoring efforts were conducted to assist stakeholders, like the Department of Transportation (DOT) and Tennessee Valley Authority (TVA), by providing geographic locations of known invasions. For example, location information on itchgrass in Alabama and Florida, as well as Mississippi, was provided to stakeholders in 2007. In addition, numerous grass identifications and control recommendations were made during 2006 for a wide range of clientele.

A continuation of efforts similar to 2007 is planned for 2008, including numerous meeting presentations, additional fact sheets, and other activities designed to reach stakeholders. Additionally, we plan to assist with the training of public volunteers on how to identify invasive grasses and report information. We plan to continue active monitoring and mapping and provide this invasive terrestrial grass information to clientele via a new invasive species database (IPAMS) in 2008. Active monitoring and mapping efforts will assist with EDRR efforts, as well. Grasses continue to escape from cultivation, such as maidengrass (*Miscanthus sinensis* Anderss.) and others, and related research and extension information will be needed to support EDRR efforts with clientele.

Task 4.3. Cactus And Cactus Moth Extension Information

PI: John Madsen
Co-PI: Richard Brown, John Byrd
Collaborators: Randy Westbrooks, Annie Simpson

Extension Products for 2007

John D. Madsen

The cactus moth working group produced or revised a number of extension and outreach materials for 2007, as seen in the list below. All of these materials are available at the cactus moth webpage, www.gri.msstate.edu/cactus_moth, or at the GRI publication webpage. In addition to the webpage, survey manual, brochure, and four fact sheets, we produced eleven monthly reports (we take December off for the holiday). The monthly reports are available on the cactus moth webpage or by subscription to the e-mail list (send an e-mail to jmadsen@gri.msstate.edu and request to be added to the monthly cactus moth report e-mail list).

Extension Materials Produced or Revised in 2007

Abbott, C. F. 2007. The Cactus Moth Detection and Monitoring Network - 2007. http://www.gri.msstate.edu/cactus_moth.

Floyd, J. P., J. D. Madsen. 2007. Survey Information for the National Cactus Moth (*Cactoblastis cactorum*) Detection and Monitoring Network. GeoResources Institute, Mississippi State University, Mississippi State, MS. GRI #5013.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Cockspur Pricklypear [*Opuntia pusilla* (Haw.) Nutt.]. GeoResources Institute, Mississippi State University. GRI #5022.

Photo 1. Ornamental cactus (*Opuntia ficus-indica*) with fruit found in southern Mississippi.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Devil's Tongue Pricklypear [*Opuntia humifusa* (Raf.) Raf.]. GeoResources Institute, Mississippi State University. GRI #5024.

Photo 2. *Opuntia stricta* pad infested by cactus moth larvae.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Erect Pricklypear [*Opuntia stricta* (Haw.) Haw.]. GeoResources Institute, Mississippi State University. GRI #5023.

Maddox, V. L., J. D. Madsen. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Pricklypear Cactus (*Opuntia* P. Mill) in Mississippi. GeoResources Institute, Mississippi State University. GRI #5025.

Martinez, E. and R. Brown. 2007. Cactus Moth: An Invading Pest. Brochure, GeoResources Institute, Mississippi State University. October 2007.

Task 4.4. Cactus Moth Detection and Monitoring Network Website

PI: John Madsen
Co-PI: Clifton Abbott, Richard Brown, John Byrd
Collaborators: Randy Westbrooks, Annie Simpson

The Cactus Moth Detection and Monitoring Network Website

Clifton Abbott

The cactus moth (*Cactoblastis cactorum* Berg.), a threat to natural biodiversity, horticulture, and forage in the southwestern United States and Mexico, has spread as far as South Carolina on the East Coast and Alabama on the Gulf Coast. Further spreading has been hindered by the control efforts and infestation removal in the leading areas. Monitoring from volunteers at sentinel site locations ahead of the leading edge are providing valuable information through the Cactus Moth Detection and Monitoring Network about the spread of the moth. Volunteers from public and private land management units, garden clubs and Master Gardeners report observations via a web-based system available from the network's website at http://www.gri.msstate.edu/cactus_moth (Figure 1).

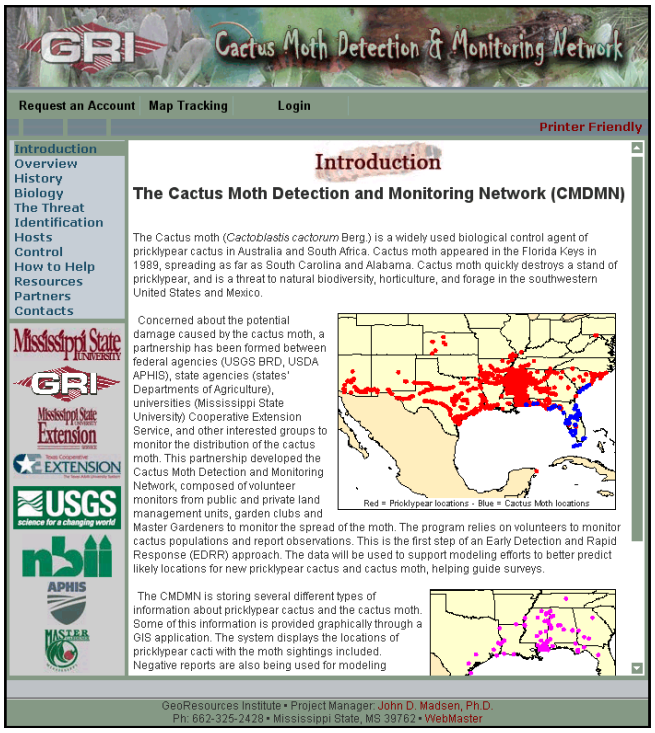


Fig. 1. Cactus Moth Detection and Monitoring Website.

The Cactus Moth Detection and Monitoring Network, online since 2005, has 62 registered users reporting a total of 2,156 pricklypear reports. Of those reports, 2,031 are positive cactus locations leaving 125 negative locations. These reports come from 24 different collectors spanning 16 states and Mexico, and are reporting 33 different *Opuntia* species or varieties. The network has 98 positive reports for the invasive cactus moth, six of which are new for 2007 within the state of Florida. Of these six reports, only four have been verified. The reports that are submitted to the system are being used to model cactus locations in an effort to help predict where cacti are likely to be located. Using this information, collectors can identify areas that have high potential in containing cactus and possibly the cactus moth.

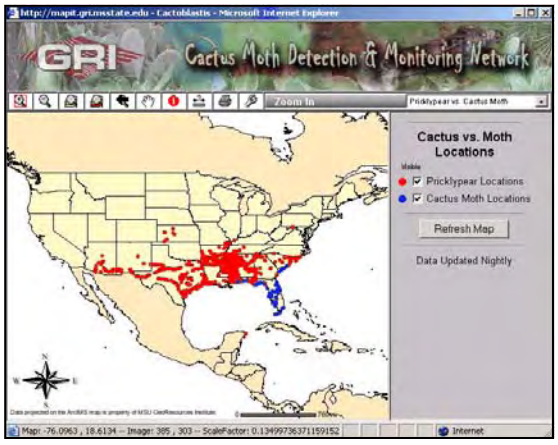


Fig. 2. GIS map tracking feature.

The network's website, the one-stop-shop for information on the cactus moth, was viewed 22,051 times over 2007. A visitor can find the history of the moth, biology information, see what king of threat it poses, and find information on it hosts, identification, and controls. There is a description on how to help as well as valuable resources for someone just interested in the subject or someone interested in being a volunteer. There are real-time maps embedded within the website to give a quick assessment of mapping efforts. A GIS map tracking tool (Figure 2) is also available and provides multiple maps for viewing cactus locations, moth locations, and sentinel site locations. The tracking map provides a visual representation of the detection and monitoring system, which may be used by collectors to identify areas in which there are gaps in the survey. Collectors are then able to plan survey trips into those areas that are lacking observations. The map is also being used to identify potential sentinel site locations on or around the leading edge of the moth's progression.

The GIS map has become useful for other reasons as well. County boundaries, zip code boundaries, roads, and urban areas are displayed to help collectors find routes to certain areas, or to find their way to a certain cactus location. These data layers are also used for reports that have poor descriptions on their locations. Better, or more complete, location descriptions can be obtained. Areas can be zoomed into, maps can be made for printing or publication purposes, and reports can be queried to provide certain survey information on that location.

Task 4.5. Web-based Database of Invasive Plant Species Locations (IPAMS)

PI: John Madsen
Co-PI: Clifton Abbott, David Shaw and John Byrd
Collaborators: Randy Westbrooks, USGS NWRC; Annie Simpson, USGS National Headquarters; and Les Mehrhoff, University of Connecticut (IPANE)

The Invasive Plant Atlas of the MidSouth Web Site
Clifton Abbott

Despite the widespread occurrence of weedy plants, adequate assessment of coarse-scale landscape factors influencing their distribution is lacking for most species. Such information is potentially more useful to land managers and other concerned parties than are plot-scale factors on which most studies of invasive species are focused. The Invasive Plant Atlas of the Mid-South (IPAMS), in an effort to quantify relationships of weed distribution and spread with land use and educate people on potential human-induced opportunities for invasive species to spread, will provide a centralized invasive species database modeled after the Invasive Plant Atlas of New England (IPANE). IPAMS will provide information on the biology, ecology, distribution, and best management practices for an initial suite of forty of the most economically and ecologically significant invasive weeds in the mid-south. Development and implementation of this database will involve intensive outreach/extension and research activities, and will support the USDA NRI's stated goals of enhancing protection of US agriculture and protecting the nation's natural and environmental resources.

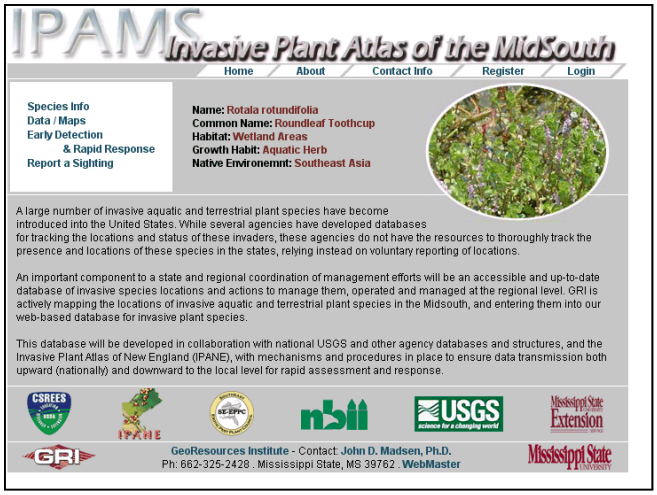


Fig. 1. Invasive Plant Atlas of the Mid-South (IPAMS) web site to be launched.

An initial web presence for IPAMS is available at http://www.gri.msstate.edu/ipams providing an in-house interface for data submission. IPAMS is currently scheduled to be publicly launched in January 2008. IPAMS (Figure 1), when launched, will have a automated public registration process and will provide limited account management tools. Tools for survey submission and management will be available and a report generator will be available at a later date. IPAMS will also provide tools for survey verification and duplicate survey management, along with a host of administration tools. IPAMS will provide detailed species information from descriptions and distributions, to control methods. The species information will limited to a small group of species at launch while more becomes available at a later date. Species without detailed information will be linked to the IPANE system for species information. The ability to sign up for "action alerts" on species within a certain region will be available at a later date. Also in the works is an extension to the system to allow multiple observations at the same location to track spread progress or control efforts. At launch time, map capabilities will be limited.

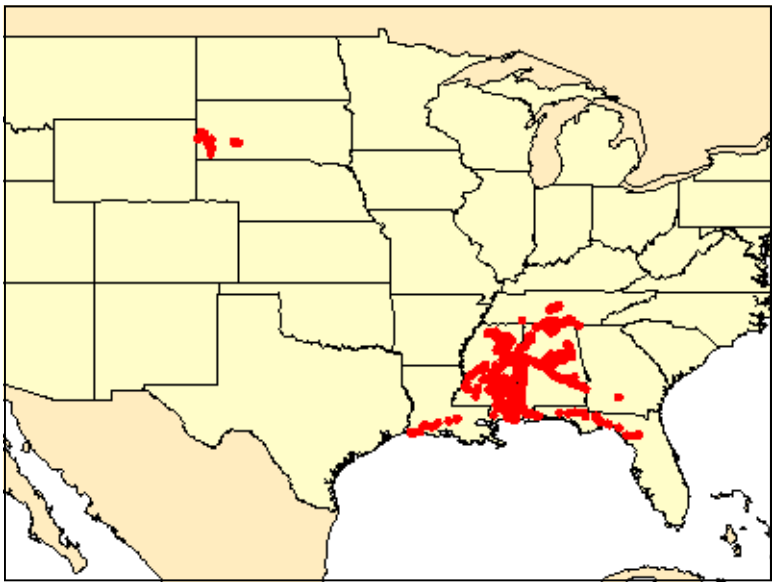


Figure 2. Current Map of IPAMS Surveys.

Currently, IPAMS houses 1689 surveys (Figure 2) and that number is growing daily. These surveys are locating 83 different invasive plants covering 7 states. Thousands of additional surveys have been collected from our in-house personnel and will be entered in 2008.

Figure 1. GRI hosted a meeting in December 2007 of personnel from USGS, NBII, USDA APHIS, and MSU concerning the ongoing cooperative cactus moth effort.

Task 5. Regional Coordination

Figure 2. MSU researchers including Cliff Abbott, Richard Brown, Gary Ervin, Victor Maddox, and John Madsen presented at the International *Cactoblastis cactorum* Conference May 2007 in Phoenix, AZ. The conference was hosted and organized by USDA APHIS, with speakers by invitation. This photo is of the conference attendees.

Task 5.1. State Coordinating Efforts

PI: David Shaw
Co-PI: John Byrd, John Madsen

Invasive Species Coordinating Efforts for the State of Mississippi

John D. Madsen

We were involved in two major ongoing statewide initiatives: the Cogongrass Task Force and the Mississippi Aquatic Invasive Species Task Force.

Dr. John Byrd continued to play a significant role in the statewide Cogongrass Task Force. During 2007, the Mississippi Cogongrass Task Force influenced the formation of task forces in Georgia and South Carolina.

Dr. John Madsen has been a representative to the Mississippi Aquatic Invasive Species Task Force. The MS AIS has a draft plan under preparation that should be near completion. Drs. Eric Dibble, Gary Ervin, and Victor Maddox also contributed to this plan.

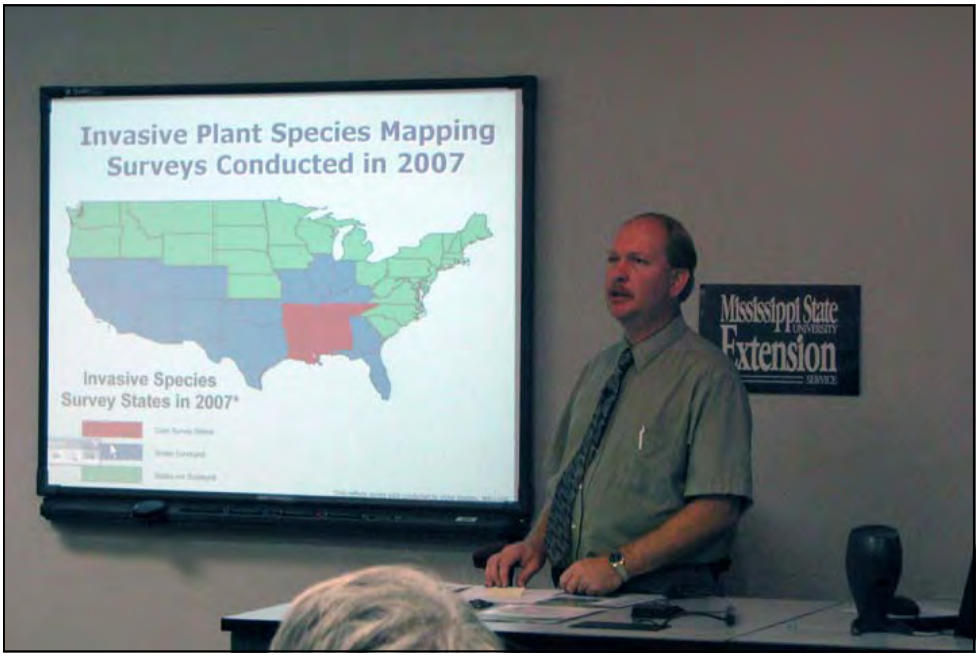


Figure 1. Victor Maddox teaches an extension class by distance learning.

Dr. Victor Maddox attended the Fiscal Year 2007 Mississippi CAPS Committee Meeting, 1 May 2007. Bureau of Plant Industry Conference Room, Mississippi State. Hosted by BPI, Mississippi State, MS.

Dr. Gary Ervin has volunteered to lead an effort in forming a statewide invasive plant list for the Mississippi Exotic Pest Plant Council. This list will be formed in cooperation with specialist representing the nursery industry, consumer horticulture, the turf industry, and home lawns statewide. The Mississippi Exotic Pest Plant Council is a forum for federal, state, and local agencies and nongovernment organizations to discuss invasive plant issues.

Through collaborative efforts with the Mississippi Department of Agriculture and Commerce, an invasive species question has been added to Part 1 of the Landscape Gardening Exam. This portion of the exam will be graded by Victor Maddox. Landscapers must pass this exam to be certified.

Invasive plant species will be presented for the first time in 2008 as part of the Master Gardener basic training. Victor Maddox will be the presenter for this segment of the program. The Master Gardener program is coordinated by the Mississippi State University Extension Service.

Victor Maddox provided invasive species information at three state events hosted by the Mississippi Nursery and Landscape Association at which over 25,000 were in attendance.

Task 5.2. Regional Coordinating Efforts

PI: David Shaw
Co-PI: John Byrd, John Madsen

Invasive Species Coordinating Efforts for the Mid-South Region and Beyond

John D. Madsen

Our group was very active in invasive species coordinating efforts both regionally and nationally through the USGS project.

The MSU team was a regular contributor to the NBII Invasive Species Working Group, a teleconference of the Invasive Species Information Node.

John Madsen and David Shaw attended the National Invasive Weed Awareness Week, 25 February to 3 March 2007, to present a display on the USGS project during the reception. The display was available to the public for the entire week at the US Botanical Garden. The project display will be up again for NIWAW 9 in 2008.

The MSU project was well represented at the International *Cactoblastis cactorum* Conference in Phoenix, AZ on 7-10 May 2007; organized by USDA APHIS. Presentations included:

- Victor Maddox, Distribution of *Opuntia* spp. in the Southeastern United States
- Richard Brown, Taxonomy and Morphology of *C. cactorum* and Other *Opuntia*-Feeding Lepidoptera in the United States
- John Madsen, US Geological Survey Cactus Moth Detection Network
- Gary Ervin and Lucas Majure, Habitat Modeling for *Opuntia* spp. in the Southeastern United States
- Majure, L. C., G. N. Ervin., and P. Fitzpatrick. Storm-driven maritime dispersal of prickly pear cacti (*Opuntia* species).
- Majure, L. C. and G. N. Ervin. Microstructural morphology of *Opuntia* species (Cactaceae) based on scanning electron microscopy.

The Cactus Moth Detection and Monitoring Network webpage was featured in the "Ecology on the Web" section of the July 2007 Bulletin of the Ecological Society of America. A preprint can be viewed at http://www.esapubs.org/bulletin/current/web_pdfs_jul_07/ecoweb_jul07bulletin_print.pdf.

Richard Brown participated in the Horticultural Inspection Society Southern Chapter Annual Meeting in Greenville, MS, September 17, 2007, to call attention to threat of the cactus moth and seek cooperation from state nursery inspectors for monitoring cactus nursery stock.

Victor Maddox participated in the USDA-APHIS Cactus Moth Budget and Planning Meeting, 16-17 Oct 2007, held at the Florida Dept. of Agriculture and Consumer Services-Division of Plant Industry, Gainesville, FL.

MSU hosted a Cactus Moth Detection and Monitoring Network meeting on 4 December 2007 with MSU, USGS, NBII, and USDA-APHIS personnel in attendance. An agenda is attached as table 5.2.1.

Publications and Accomplishments

Peer-Reviewed Journals

Bried, J. T. and G. N. Ervin. 2007. Intraspecific models and spatiotemporal context of size–mass relationships in adult dragonflies. Journal of the North American Benthological Society 26: 680-692.

Bried, J. T, B. D. Herman, and G. N. Ervin. 2007. Conservation umbrella potential of wetland plants and dragonflies: a quantitative case study using the Umbrella Index. Journal of Applied Ecology 44: 833-842.

Ervin, G. N. 2007. An experimental study on the facilitative effects of tussock structure among wetland plants. Wetlands 27: 620-630.

Gray, C. J., J. D. Madsen, R. M. Wersal, K. D. Getsinger. 2007. Eurasian Watermilfoil and Parrotfeather Control Using Carfentrazone-ethyl. Journal of Aquatic Plant Management. Vol. 45. 43-46.

Holly, D. C., G. N. Ervin. 2007. Effects of intraspecific seedling density, soil type, and light availability upon growth and biomass allocation in cogongrass, *Imperata cylindrica*. Weed Technology. Vol. 21. 812-819.

MacGown, J. A., J. G. Hill, L. C. Majure, and J. L. Seltzer. 2008. Rediscovery of *Pogonomyrmex badius* (Latreille) (Hymenoptera: Formicidae) in Mainland Mississippi, with an Analysis of Associated Seeds and Vegetation. Midsouth Entomologist, *In press*.

Madsen, J. D., R. M. Wersal, T. E. Woolf. 2007. A New Core Sampler for Estimating Biomass of Submersed Aquatic Macrophytes. Journal of Aquatic Plant Management. Vol. 45. 31-34.

Majure, L. C. 2007. Noteworthy collections: Mississippi. Castanea. Vol. 72. 121-122.

Photo 1. Graduate student Wilfredo Robles takes in the view on the Pend Oreille River near Cusick, WA. He is either gazing at the mountains in the distance, or at the vast bed of Eurasian watermilfoil that stretches for miles along the shore of the river.

Majure, L. C. 2007. The Vascular Flora of the Chunky River (Mississippi). The Journal of BRIT. Vol. 1. 1179-1202.

Majure, L.C. 2008. New records of *Geranium molle* and *Erodium cicutarium* (Geraniaceae), from Mississippi and other important collections from the state. The Southeastern Naturalist, *In Press*.

Theel, H. J., E. D. Dibble, and J. D. Madsen. 2007. Differential influence of a monotypic native aquatic plant bed on a macroinvertebrate assemblage; an experimental implication of exotic plant induced habitat. Hydrobiologia. (*In Press; DOI10.1007/s10750*).

Theel, H. J., and E. D. Dibble. 2007. Simulation of an exotic aquatic macrophyte invasion and its influence on foraging behavior of bluegill. J. Freshwater Ecology. (*In Press*).

Wersal, R. M., J. D. Madsen. 2007. Comparison of imazapyr and imazamox for control of parrotfeather (*Myriophyllum aquaticum* (Vellozo) Verdecourt). Journal of Aquatic Plant Management. Vol. 45. 132-136.

Peer-Reviewed Conference Papers

Madsen, J. D., G. N. Ervin. 2007. Integrating effects of land use change on the invasive plant species distribution into an invasive plant atlas for the Mid-South (IPAMS). 2007 Proceedings, Southern Weed Science Society. Vol. 60. 197.

Madsen, J. D., G. N. Ervin. 2007. Invasive Plant Atlas for the Mid-South (IPAMS): The collaboration of volunteers and citizen scientists in locating key invasive plants for modeling land-use interactions. Agronomy Society of America-Crop Science Society of America-Soil Science Society of America Annual Meeting, November 6, 2007, New Orleans, LA.

Wersal, R. M., J. D. Madsen, M. L. Tagert. 2007. Littoral Zone Plant Communities in the Ross Barnett Reservor, MS. Proceedings of the 37th Annual Mississippi Water Resources Conference. 102-108 pp.

Non-Refereed Conference Papers, Abstracts, or Posters

Baker, G.T. and R.L. Brown. 2007. Sensory structures of larval mouthparts of *Cactoblastis* and *Melitara* (Pyralidae). 15th European Congress of Lepidopterology, Berlin, Germany, September 8-12, 2007.

Baker, G.T. and R.L. Brown. 2007. Sensory structures of larval mouthparts of *Cactoblastis* and *Melitara* (Pyralidae). 54th Annual Conference of the Mississippi Entomological Association, Mississippi State, MS, October 24-26.

Brown, R.L. and G. Baker. 2007. Taxonomy and morphology of *C. cactorum* and other *Opuntia* feeding Lepidoptera in the United States. International Cactoblastis cactorum Conference. Phoenix, AZ. May 7-9, 2007.

Bryson, C. T., J. D. Byrd, G. N. Ervin, K. N. Reddy. 2007. Is diverse morphology of cogongrass in Mississippi related to edaphic characteristics or biotypic variation. Southern Weed Science Society, 60th Meeting, Nashville, TN, January 22-24, 2007.

Cheshier, J. C., J. D. Madsen, R. M. Wersal. 2007. Common Reed *Phragmites australis* Cav. Trin. Ex. Steud: Life history in the Mobile River Delta, AL. 37th Annual Mississippi Water Resources Conference, 24-25 April 2007, Jackson, MS.

Cheshier, J. C., J. D. Madsen. 2007. Digital growth of common reed (*Phragmites australis* (Cav.) Trin ex Steud). Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Ervin, G. N. 2007. Using GAP data to guide integrated management of invasive species. US Geological Survey National Gap Analysis Program Conference, Asheville, NC, 10-13 September 2007.

Ervin, G. N. 2007. A multi-scale examination of the state of our understanding in hydrophyte ecology. 30th Congress of the International Association of Theoretical and Applied Limnology, Montreal, Canada, 12-18 August 2007.

Ervin, G. N. 2007. Integrating research and undergraduate teaching (in wetland ecology) – Society of Wetland Scientists International Meeting, Sacramento, CA, 10-15 June, 2007.

Ervin, G. N. 2007. Using GAP data to guide integrated management of invasive species. US Geological Survey National Gap Analysis Program Conference, Asheville, NC, 10-13 September 2007.

Ervin, G. N., B. D. Herman, J. T. Bried, D. C. Holly. 2007. Floristic Assessment Quotients for Wetlands – New England Association of Environmental Biologists, 31st Annual Conference, Grand Summit Hotel and Conference Center, West Dover, Vermont. March 14-16, 2007.

Ervin, G. N., J. D. Madsen. 2007. Developing an invasive plant atlas for the Mid-South. Society of Wetland Scientists International Meeting, Sacramento, CA, June 10-15, 2007.

Ervin, G. N., L. C. Majure. 2007. Habitat modeling for *Opuntia* species in the southeastern United States. USDA, Animal and Plant Health Inspection Service, International *Cactoblastis cactorum* Conference, Phoenix, AZ, May 7-10, 2007.

Kovalenko, K., E. Dibble, R. Fugi, and J. Slade. 2007. Community effects of large-scale changes in plant composition after a whole-lake herbicide treatment. 47th Annual Meeting of the Aquatic Plant Management Society. July 15-18, 2007. Nashville, TN.

Kovalenko, K., E. Dibble, R. Fugi, and J. Slade. 2007. Community effects of large-scale changes in plant composition after a whole-lake herbicide treatment. 15th Southern Division American Fisheries Society Spring Meeting. February 8-11, 2007. Memphis, TN.

Kovalenko, K., E. Dibble, R. Fugi, and J. Slade. 2007. Community Effects of Large-scale Eradication of Invasive Watermilfoil. The Ecological Society of America Meeting, August 29-July 5, 2007. San Jose, CA.

Maddox, V. L., C. Abbott. 2007. Distribution of *Opuntia* spp. in the Southeastern United States. International *Cactoblastis cactorum* Conference, 7-10 May 2007, Desert Botanical Garden, Phoenix, AZ.

Maddox, V. L. 2007. Invasive species identification and management. 2007 Mississippi Turfgrass Conference and Trade Show, 28-30 Oct 2007, Pearl River Resort, Choctaw, MS.

Maddox, V. L., J. Madsen. 2007. Use of the USGS Cactus Moth Detection Network. International *Cactoblastis cactorum* Conference, 7-10 May 2007, Desert Botanical Garden, Phoenix, AZ.

Madsen, J. D. 2007. Ecologically-based invasive aquatic plant management: Using life history analysis to manage aquatic weeds. 37th Annual Mississippi Water Resources Conference, 24-25 April 2007, Jackson, MS.

Madsen, J. D., G. N. Ervin. 2007. Integrating effects of land use change on invasive plant species distribution into an Invasive Plant Atlas for the Mid-South (IPAMS). Weed Science Society of America 47th Annual Meeting, 5-8 February 2007, San Antonio, TX.

Photo 2. Eurasian watermilfoil (*Myriophyllum spicatum*) in flower on the Pend Oreille River near Cusick, WA.

Madsen, J. D. 2007. Biology and ecology of Eurasian watermilfoil. Western Aquatic Plant Management Society 26th Annual Meeting, 25-27 March 2007, Couer D'Alene, ID.

Madsen, J. D. 2007. Evaluating environmental impacts of aquatic plant management techniques: Examining direct and indirect effects. Western Aquatic Plant Management Society 26th Annual Meeting, 25-27 March 2007, Couer D'Alene, ID.

Madsen, J. D. 2007. U.S. Geological Survey - MSU Cactus Moth Detection Network. International *Cactoblastis cactorum* Conference, 7-10 May 2007, Phoenix, AZ.

Madsen, J. D., K. D. Getsinger, R. M. Wersal. 2007. Combinations of Endothall with 2,4-D and Triclopyr for the Control of Eurasian Watermilfoil. Midwest Aquatic Plant Management Society 27th Annual Meeting, March 3-5, 2007, Milwaukee, WI.

Madsen, J. D., G. N. Ervin, V. Maddox, J. D. Byrd, Jr., R. G. Westbrooks, L. J. Mehrhoff. 2007. Integrating effects of land use change on invasive plant species distribution into an invasive plant atlas for the Mid-South (IPAMS). 9th Annual Southeast Exotic Pest Plant Council Symposium, March 20-22 2007, Athens, GA.

Madsen, J. D., K. D. Getsinger, R. M. Wersal. 2007. Wild Rice (*Zizania aquatica* L.) Susceptibility to the Aquatic Herbicide Triclopyr. Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Madsen, J. D., K. D. Getsinger, R. M. Wersal. 2007. Endothall Combinations with 2,4-D and Triclopyr for Control of Eurasian Watermilfoil. Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Madsen, J. D. 2007. Aquatic weed control. Mississippi Vegetation Management Association, November 13-14, 2007, Jackson, MS.

Madsen, J. D. 2007. Problematic Aquatic Plants of the MidSouth. Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Madsen, J. D., G. N. Ervin. 2007. Integrating effects of land use change on invasive plant species distribution into an Invasive Plant Atlas for the Mid-South (IPAMS). Southern Weed Science Society Annual Meeting, 22-24 January 2007, Nashville, TN.

Madsen, J. D., K. D. Getsinger, R. M. Wersal. 2007. Sensitivity of wild rice (*Zizania aquatica* L.) to the aquatic herbicide triclopyr. Weed Science Society of America 47th Annual Meeting, 5-10 February 2007, San Antonio, TX.

Madsen, J. D., K. D. Getsinger, R. M. Wersal. 2007. Combinations of endothall with 2,4-D and triclopyr for control of Eurasian watermilfoil. Northeast Aquatic Plant Management Society Eighth Annual Meeting, 15-17 January 2007, West Dover, VT.

Majure, L. C., G. N. Ervin, P. J. Fitzpatrick. 2007. Storm-driven maritime dispersal of prickly pear cacti (*Opuntia* species). USDA, Animal and Plant Health Inspection Service, International *Cactoblastis cactorum* Conference, Phoenix, AZ, May 7-10, 2007.

Majure, L. C., G. N. Ervin. 2007. Microstructural morphology of *Opuntia* species (Cactaceae) based on scanning electron microscopy. USDA, Animal and Plant Health Inspection Service, International *Cactoblastis cactorum* Conference, Phoenix, AZ, May 7-10, 2007.

Majure, L. C., G. N. Ervin. 2007. Microstructural morphology of *Opuntia* species (Cactaceae) based on scanning electron microscopy. Southeastern Microscopy Society, Decatur, GA, April 11-13, 2007.

Robles, W., J. D. Madsen, V. L. Maddox, R. M. Wersal. 2007. The Invasive Status of Giant Salvinia and Hydrilla in Mississippi. 37th Annual Mississippi Water Resources Conference, 24-25 April 2007, Jackson, MS. CD-Rom. 109-113.

Robles, W., J. D. Madsen. 2007. Detection of herbicide injury on waterhyacinth using Landsat 5 TM simulated data. Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Simonsen, T. and R. L. Brown. 2007. Molecular analysis of worldwide *C. cactorum* populations. International *Cactoblastis cactorum* Conference. Phoenix, AZ. May 7-9, 2007.

Simonsen, T.S., R.L. Brown, and F.A. Sperling. 2007. Phylogeography and possible spreading patterns of the invasive cactus moth, *Cactoblastis cactorum*, in SE USA based on CO1. 15th European Congress of Lepidopterology, Berlin, Germany, September 8-12, 2007.

Theel, H. J. and E. Dibble. 2007. Hydrilla's altering effects on aquatic plant complexity and bluegill foraging behavior. The 68th Midwest Fish and Wildlife Conference. December 9-12, 2007. Madison, WI.

Theel, H. J. and E. Dibble. 2007. Hydrilla's altering effects on aquatic plant complexity and bluegill foraging behavior. The 33rd Annual Meeting of the Mississipi Chapter of the American Fisheries Society. February 14-16, 2007. Vicksburg, MS. Oral Presentation. 1st Place, Best Student Oral Presentation.

Theel, H. J. and E. Dibble. 2007. Hydrilla's altering effects on aquatic plant complexity and bluegill foraging behavior. The 15th Southern Division AFS Spring Meeting. February 8-11, 2007. Memphis, TN.

Theel, H. J. and E. Dibble. 2007. Home sweet home: macroinvertebrate assemblages in beds of monotypic hydrilla, diverse native aquatic plants, and a plant-less habitat. 47th Annual Meeting of the Aquatic Plant Management Society. July 15-18, 2007. Nashville, TN.

Tietjen, T. E. and G. N. Ervin. 2007. Stream restoration in the Mississippi Alluvial Valley: Streamflow augmentation to improve water quality in the Sunflower River, Mississippi, USA – Ecological Society of America/Society for Ecological Restoration International Conference, San Jose, CA, August 5-10, 2007.

Tietjen, T. E. and G. N. Ervin. 2007. Water quality and floristic quality assessments of the Big Sunflower River following streamflow augmentation using groundwater – 37th Annual Mississippi Water Resources Conference, Jackson, MS, April 24-25, 2007.

Wersal, R. M., J. D. Madsen. 2007. The Phenology, Ecology, and Management of Parrotfeather (*Myriophyllum aquaticum* Vell. Verdc.): An Overview of My Dissertation Research. Midwest Aquatic Plant Management Society 27th Annual Conference, March 3-5 2007, Milwaukee, WI.

Wersal, R. M., J. D. Madsen. 2007. Comparison of imazapyr and imazamox for control of parrotfeather *Myriophyllum aquaticum* (Vell.) Verdc.). Aquatic Plant Management Society 47th Annual Meeting, 15-18 July 2007, Nashville, TN.

Wersal, R. M., J. D. Madsen. 2007. Influences of Light Intensity Variations on Growth Characteristics of Parrotfeather (*Myriophyllum aquaticum* (Vell.) Verdc.). 47th Annual Meeting of the Aquatic Plant Management Society.

In-House

Ervin, G. N., R. A. White. 2007. Assessing vegetative growth potential of exotic *Rotala rotundifolia* (Roxb.) Koehne (roundleaf toothcup), in comparison with *Alternanthera philoxeroides* (Mart.) Griseb. (alligatorweed), a known successful invader. GeoResources Institute Report. GRI #5015.

Floyd, J. P., J. D. Madsen. 2007. Survey Information for the National Cactus Moth (*Cactoblastis cactorum*) Detection and Monitoring Network. GeoResources Institute, Mississippi State University, Mississippi State, MS. GRI #5013

.**Maddox, V. L., J. D. Byrd, R. Westbrooks, B. Brabson.** 2007. Invasive Species Fact Sheet: Beach Vitex (*Vitex rotundifolia* L.f.). GeoResources Institute, Mississippi State University. GRI #5020.

Photo 3. Waldemar Robles measures dissolved oxygen and temperature within a dense bed of vegetation on the Pend Oreille River near Cusick, WA.

Maddox, V. L., R. G. Westbrooks, J. D. Byrd. 2007. Invasive Species Fact Sheet: Itchgrass [*Rottboellia cochinchinensis* (Lour.) W.D. Clayton]. GeoResources Institute, Mississippi State University. GRI #5017.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Cockspur Pricklypear [*Opuntia pusilla* (Haw.) Nutt.]. GeoResources Institute, Mississippi State University. GRI #5022.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Devil's Tongue Pricklypear [*Opuntia humifusa* (Raf.) Raf.]. GeoResources Institute, Mississippi State University. GRI #5024.

Maddox, V. L., J. D. Byrd. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Erect Pricklypear [*Opuntia stricta* (Haw.) Haw.]. GeoResources Institute, Mississippi State University. GRI #5023.

Maddox, V. L., J. D. Madsen. 2007. Invasive Species Fact Sheet: Cactus Moth Host Plant, Pricklypear Cactus (*Opuntia* P. Mill) in Mississippi. GeoResources Institute, Mississippi State University. GRI #5025.

Maddox, V. L., R. G. Westbrooks, J. D. Byrd. 2007. Invasive Species Fact Sheet: Multiflora Rose (*Rosa multiflora* Thunb. ex Murr.). GeoResources Institute, Mississippi State University. GRI #5026.

Madsen, J. D., W. Robles, V. L. Maddox, R. M. Wersal. 2007. Distribution of Hydrilla and Giant Salvinia in Mississippi in 2006: An Update. GeoResources Institute, Mississippi State University, Mississippi State, MS. GRI #5012.

Madsen, J. D. 2007. Assessment of Lake Gaston Hydrilla Management Efforts in 2006. GeoResources Institute, Mississippi State University, Mississippi State, MS. GRI #5010.

Madsen, J. D., C. Abbott, R. Brown, L. Bruce, J. Byrd, Jr., E. Dibble, G. Ervin, V. Maddox, D. Shaw, and D. McBride. 2007. Research to Support Integrated Management Systems of Aquatic and Terrestrial Invasive Species 2006 Annual Report. GeoResources Institute. GRI #5014.

Madsen, J. D. 2007. Invasive Species Fact Sheet: Curleyleaf Pondweed (*Potamogeton crispus* L.). GeoResources Institute, Mississippi State University. GRI #5021.

Madsen, J. D., R. M. Wersal. 2007. Assessment of Eurasian watermilfoil (*Myriophyllum spicatum* L.) Populations in Lake Pend Oreille, ID for 2007. GeoResources Institute. GRI #5015.

Majure, L. C. 2007. Thesis: The Ecology and Morphological Variation of *Opuntia* (Cactaceae) Species in the Mid-South, United States. Department of Biological Sciences. Mississippi State University.

Perret, A. J. 2007. A multi-scale approach to evaluate the effect of the invasive aquatic plant hydrilla (*Hydrilla verticillata*) on littoral zone habitat of juvenile largemouth bass (*Micropterus salmoides*). M.S. Thesis, Mississippi State University, 59pp.

Theel, H. J. 2007. Habitat alteration by hydrilla and its effect on macroinvertebrae community structure and bluegill foraging efficiency. M.S. Thesis, Mississippi State University. 73pp.

Wersal, R. M., J. D. Madsen, M. L. Tagert. 2007. Aquatic Plant Survey within the Littoral Zone of the Ross Barnett Reservoir for 2006. GeoResources Institute Report. GRI #5011.

Web Publications

Abbott, C. F. 2007. The Cactus Moth Detection and Monitoring Network - 2007. http://www.gri.msstate.edu/cactus_moth.

Abbott, C. F. 2007. Invasive Plant Atlas of the MidSouth - 2007. http://www.gri.msstate.edu/ipams.

Professional Presentations

Abbott, C. F. 2007. Webpage Development: The Cactus Moth Detection and Monitoring Network. Cactus Moth Detection and Monitoring Network Meeting, GeoResources Institute, Starkville, MS, December 7, 2007.

Brown, R.L. 2007. Cactus Moth Survey. Horticultural Inspection Society Southern Chapter Meeting and In-Service Training. Greenville, MS. Sept. 19, 2007.

Ervin, G. N. 2007. Habitat models as tools for invasive plant monitoring and management. Department of Biological Sciences, University of Southern Mississippi, 12 October 2007.

Ervin, G. N. 2007. Prickly Pear Cactus Modelling Efforts. Interagency Cactus Moth Detection and Monitoring Network Meeting Mississippi State University, 04 December 2007.

Ervin, G. N. 2007. Developing an invasive plant list for Mississippi. MS Exotic Pest Plant Council, May 2007.

Ervin, G. N. 2007. Modeling invasive species distribution and spread. Digital Biology Learning Community, Mississippi State University, April 2007.

Holly, D. C., G. N. Ervin. 2007. Relative importance of propagule pressure, light availability, and nutrient concentration upon the establishment and physiology of a model invasive species, *Imperata cylindrica*. Graduate Student Research Symposium, Mississippi State University, Starkville MS, March 30, 2007.

Holly, D. C., G. N. Ervin. 2007. Invasive species and their impacts upon decomposition dynamics: Insights from *Imperata cylindrica*. Graduate Student Research Symposium, Mississippi State University, Starkville MS, March 30, 2007.

Maddox, V. L., K. Johnson, T. Needham. 2007. Identification of 30 plant families important in horticulture. 16 May 2007, 135 Dorman Hall, Mississippi State University, Mississippi State, MS.

Maddox, V. L. 2007. Invasive species ID and management. Fall Flower and Garden Fest, 20-21 Oct 2007, Truck Crops Experiment Station, Crystal Springs, MS.

Maddox, V. L. 2007. MSU Cactus Moth Detection and Monitoring Network Update. USDA-APHIS Cactus Moth Budget and Planning Meeting, 16-17 Oct 2007, Florida Dept. of Agriculture and Consumer Services-Division of Plant Industry, Gainesville, FL.

Maddox, V. L. 2007. Identification of invasive and other plant species. 2007 Gulf Coast Garden and Patio Show, 23-25 Feb 2007, Mississippi Coast Coliseum, Biloxi, MS.

Maddox, V. L., L. S. Kelly. 2007. HOR 409-1: Identification of 40 invasive plant species. Mississippi State University, 409 Bost Extension Center, Mississippi State, MS.

Maddox, V. L. 2007. Plant identification and invasive species information. 10th Annual Jackson Garden and Patio Show, 16-18 Mar 2007, Mississippi Trade Mart, Jackson, MS.

Maddox, V. L. 2007. Poisonous and invasive plants. Mississippi Nursery Professional Certification Training, 12-14 Nov 2007, Central Mississippi Research and Extension Center, Raymond, MS.

Maddox, V. L. 2007. Invasive species information and plant identification. 2007 Hattiesburg Garden and Patio Show, 30 Mar-1 Apr 2007, Forrest County Multipurpose Center, Hattiesburg, MS.

Photo 4. Research Associate Ryan Wersal collects a biomass sample in the Pend Oreille River near Priest River, ID.

Madsen, J. D. 2007. Cactus Moth Detection and Monitoring Network on Public and Private Lands in the United States. A partnership between USDA-APHIS, USGS, and Mississippi State University. Invasive Species Working Group, NBII, April 26, 2007.

Madsen, J. D. 2007. Survey of Pat Harrison Waterways District Lakes. Presentation to the Board of Directors, Pat Harrison Waterways District, Hattiesburg, MS, 26 July 2007.

Madsen, J. D., G. N. Ervin, V. Maddox, J. D. Byrd, Jr., R. G. Westbrooks, and L. J. Mehrhoff. 2007. Integrating effects of land use change on invasive plant species distribution into an Invasive Plant Atlas for the Mid-South (IPAMS). MS Exotic Pest Plant Council.

Madsen, J. D. 2007. Pend Oreille Lake Eurasian Watermilfoil Survey for 2007. Public Meeting, Bonner County, 13 June 2007, Sandpoint, ID.

Madsen, J. D. 2007. Pend Oreille Lake Eurasian Watermilfoil Survey for 2007. Pend Oreille Lake Milfoil Task Force Meeting, 7 June 2007, Sandpoint, ID.

Madsen, J. D., R. M. Wersal, M. L. Tagert. 2007. Aquatic Plant Survey within the Littoral Zone of the Ross Barnett Reservoir for 2006. Pearl River Valley Water Supply District Board Meeting, April 19, 2007, Jackson, MS.

Madsen, J. D. 2007. Nonchemical methods for control of Eurasian watermilfoil and curlyleaf pondweed. Tahoe Aquatic Invasive Species Technical Workshop, University of California Cooperative Extension Service, May 2, 2007, Incline Village, NV.

Madsen, J. D. 2007. Nonchemical methods for control of Eurasian watermilfoil and curlyleaf pondweed. Tahoe Aquatic Invasive Species Stakeholder Workshop, University of California Cooperative Extension Service, May 3, 2007, Incline Village, NV.

Madsen, J. D. 2007. Reproductive ecology of submersed aquatic vegetation and its application to submersed aquatic vegetation restoration. SAV Reproductive Ecology Workshop, Chesapeake Bay Program Science and Technical Advisory Committee, 6-7 March 2007, Annapolis, MD.

Madsen, J. D. 2007. Welcome and Cactus Moth Detection Network Overview. Cactus Moth Detection and Monitoring Network Meeting, GeoResources Institute, Starkville, MS, December 7, 2007.

Simonsen, T.S., R.L. Brown, and F.A. Sperling. 2007. Introduction and dispersal of the cactus moth in the Southeast U.S. – A phylogeographic analysis. Cactus Moth Detection and Monitoring Network Meeting. Dec. 4, 2007.

Items of Pride

Cheshier, J. C. 2007. Midwest Aquatic Plant Management Society Scholarship for 2007.

Ervin, G. N. 2007. GeoResources Institute Academic Professor of the Year.

Ervin, G. N. 2007. Beverly B. and Gordon W. Gulmon Dean's Eminent Scholar. MSU College of Arts & Sciences.

Madsen, J. D. 2007. Associate Editor, Invasive Plant Science and Management, Weed Science Society of America.

Madsen, J. D. 2007. Research Professor of the Year. GeoResources Institute, Mississippi State University.

Majure, L. C. 2007. M. S. Thesis: "The Ecology and Morphological Variation of *Opuntia* (Cactaceae) Species in the Mid-South, United States." Majure now is enrolled in Ph.D. studies at the University of Florida, working on the systematics of eastern U.S. *Opuntia* species.

Majure, L. C. (M.S. student in MSU Biological Sciences) was selected as the 2007 M.S. level Graduate Student Association Graduate Research Assistant of the Year.

Theel, H. J. and E. Dibble. 2007. Hydrilla's altering effects on aquatic plant complexity and bluegill foraging behavior. The 33rd Annual Meeting of the Mississipi Chapter of the American Fisheries Society. February 14-16, 2007. Vicksburg, MS. Oral Presentation. 1st Place, Best Student Oral Presentation.

Wersal, R. M. 2007. Awarded 2nd Place, Student Presentation Contest. 37th Annual Mississippi Water Resources Conference.

Wersal, R. M. 2007. Awarded 1st place in the student poster competition. 47th Annual Meeting of the Aquatic Plant Management Society.

Wersal, R. M. 2007. Awarded 3rd place in the student paper competition. 47th Annual Meeting of the Aquatic Plant Management Society.

Collaborating Partners