Invasive Plant Management Research & Outreach Newsletter

Florida Fish and Wildlife Conservation Commission (FWC)
Division of Habitat and Species Conservation
Invasive Plant Management Section

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Newsletter Index

New this year – Because of restricted travel budgets to scientific conferences due to the bad economy, this newsletter has been expanded and now includes summaries of non-FWC funded invasive plant management research in Florida to help keep you apprised of the latest findings. In addition, because there is no current venue, or portal, for invasive animal management research in Florida, the latest research for this topic is now included in the newsletter and located on page 16. We hope to have additional summaries of invasive animal research in next year's newsletter.

The following information summarizes year end reports for invasive plant management research and outreach projects and studies during the state fiscal year 2010-11 (July through June). All FWC funded research and outreach projects are designated as **(FWC-Funded)**.

Some of these studies are completed and others are multi-year in nature and are continuing. Because these studies have not gone through the scientific peer-review process, and many are not complete, please consider this information to be preliminary. The researcher's name, affiliation(s), and location are located at the end of each research summary.

Please forward this newsletter to ensure a wide distribution of this information. Questions? Please contact Don C. Schmitz, Editor (see page 16 for contact information).

Hydrilla (*Hydrilla verticillata*)

Herbicide Release and Plant Uptake Dynamics of Selected Granular Aquatic Herbicides **-** Granular formulations of herbicides have been utilized in aquatics for many years and have been an essential part of many management strategies. There are approximately ten different granular formulations available for use in aquatics, ranging from shorter half-life contact herbicides, such as endothall, to the longer half-life systemic herbicides like fluridone. Many studies have been performed on herbicide dissipation, from granular and liquid formulations alike, but little work has been done to determine the factors that affect the release of the herbicide from the granule. Factors such as temperature, sediment

type, and water movement potentially influence the release of herbicide from a granule.

Under static conditions, in the laboratory, the amount of time required for 50% of the herbicide to release from the granule (ET_{50}) ranged from rapid, 12 h for Renovate OTF, to slow, 72 d for Sonar SRP. The four fluridone formulations tested varied significantly from each other requiring from 27 d to 72 d to release 50% of the herbicide, for Sonar Q and SRP respectively. Preliminary studies were conducted similar to the static studies, but with the addition of gentle aeration to mix the water, yielded much different results. The addition of aeration (slight water movement) increased the ET_{50} of both Renovate OTF and Sonar SRP by >10x, and the other formulations to a lesser but still significant degree. Quantification of this water movement was achieved by exposing granules to flow rates of 0.00001 MPH and 0.001 MPH and comparing the release to static experiments. Triclopyr had increased release at 0.001 MPH requiring 3 h for 50% release, compared to 12 h under static conditions. The slowest flow was similar to static conditions, therefore greater than 0.00001 MPH is required to alter release from static conditions.

Sediment interaction was also evaluated by repeating the procedures of the static experiments, but with the addition of a sediment layer. Although no binding to the sediment was identified, the addition of soil slowed the release of triclopyr from granules to 60 h for 50% release compared to 12 h under static conditions. Fluridone release on non-sterilized sediments was very minimal, with only 24% and 7% of the applied concentration, Sonar Q and SRP respectively, ever detected in the water column. Experiments with sterilized soil will be required to rule out degradation. Herbicide, granule type, water movement, and sediment all affected the release of herbicide from aquatic granules, and at the very least these results demonstrate a few of the factors that could impact herbicide availability for management purposes under field conditions. **(FWC Funded)** ***Bultemeier, B.W. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Technical Support for Evaluating Large-scale and Experimental Hydrilla Management Projects **-** Evaluating large-scale operational herbicide applications for selective control of hydrilla is a multifaceted challenge, as new products, new use patterns, different timing and levels of hydrilla and native plant biomass, changing water conditions and levels, low stocking rates of grass carp, and different expectations from managers all work to confound the ability to provide a standard assessment of efficacy and selectivity. Moreover, the herbicides have very different activity and use patterns with some working very quickly and others acting quite slow and taking several months to provide results.

As of 2007, there have been four new products registered for hydrilla control in Florida, and several recent strategies involve combining different products. This project is focused on large-scale management efforts as well as small treatments that employ novel control strategies. Monitoring efforts have been conducted in the following areas: 1) collection of water samples to link hydrilla control and selectivity to herbicide residuals; 2) collection of water quality data in conjunction with certain treatments and sampling events 3) collection of hydrilla and native plant biomass data over time to assess changes following operational and evaluation treatments; 4) development and use of *Lowrance* fathometers to record short and long-term response of hydrilla to large-scale management efforts; 5) temporal sampling of hydrilla from the Kissimmee Chain of Lakes to determine response to fluridone, penoxsulam, and endothall using newly developed laboratory assays 6) sampling of sediment porewater in the Kissimmee Chain of Lakes following heavy endothall use over the past several seasons; and 7) direct interaction with FWC Regional Biologists to discuss treatment strategies and strengths and weaknesses of different management approaches and participation in numerous public and professional meetings to discuss results of our ongoing research efforts. Research and demonstration efforts for the past fiscal year have focused on Osceola County (Lakes Tohopekaliga, Cypress, Hatchineha, and Kissimmee), Orange County (Butler, Blanche, Chase, Down, Louise, Isleworth, Pocket, Sheen, and Tibet), Lake County (Harris, Johns), Highlands County (Istokpoga), and Alachua County (Orange Lake). **(FWC Funded)** ***Netherland, M. US Army ERDC, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

***Cricotopus lebetis* (Diptera: Chironomini), a fortuitous biological control agent of *Hydrilla verticillata* (Hydrocharitaceae)** **-** A chironomid midge, *Cricotopus lebetis* Sublette (Diptera: Chironomidae), was discovered attacking hydrilla in Crystal River, Citrus Co., Florida in the 1990s and

may be a recent introduction into Florida. Larvae of the midge mine in the apical meristems of hydrilla causing basal branching and stunting of the plant. The midge has been found in other Florida water bodies, but is not often abundant.

Water temperature and quality are important environmental indicators and may influence the distribution and density of this midge. Survey work has been conducted around the state to correlate water quality, including temperature, to the presence or absence of *C. lebetis*. The upper and lower temperature thresholds for development of *C. lebetis* were determined by exposing neonate larvae to hydrilla tips in growth chambers. Results indicate that larval development was highest at temperatures between 20 and 30°C. In addition, the host range of *C. lebetis* is being evaluated as this information will be crucial in determining whether *C. lebetis* can be released in states and countries where it does not occur already.

Initial results of host range suggest that *C. lebetis* can complete development on hydrilla and related submersed aquatic plants. The results of these studies will be used to assess the potential of *C. lebetis* as a biological control agent of hydrilla. **(FWC Funded)** ***Stratman, K.[1], Overholt, W.[1] , Cuda, J.[2], Netherland, M.[3], and P.C. Wilson[4]. [1]Department of Entomology and Nematology, University of Florida, Indian River, FL., [2]Department of Entomology and Nematology, University of Florida, Gainesville, FL., [3]Department of Agronomy, University of Florida, Gainesville, FL., [4]Department of Soil and Water Science, University of Florida, Indian River, FL.***

Improved Understanding of Factors that Influence Expansions and Declines of Hydrilla in Florida Water Bodies **-** While hydrilla has repeatedly shown the ability to cover large contiguous areas of Florida waterbodies, the process of expansion and decline (and often subsequent expansion) is not well described in the literature. The vast majority of research on hydrilla in Florida has been conducted on systems where hydrilla had already grown to high densities. Through review of prior literature, reviewing state survey and management records, and use of personal interviews, this study seeks to improve the understanding of factors that influence expansions and declines of hydrilla. Based on initial reviews of the literature and various field observations, a research trial is being conducted to evaluate the role of sediment type and nutrition following sampling of eight different lakes with widely disparate histories of supporting dense hydrilla growth. Sediment sampling from littoral and open water sites was initiated in March 2011 and these growth trials are currently ongoing.

We are particularly interested in the contrast between East Lake Tohopekaliga that currently supports large stands of Illinois pondweed and vallisneria, and the Goblit's Cove area of West Lake Tohopekaliga where dense hydrilla growth has been sustained for several years. The close proximity, direct hydraulic connection between E. Lake and Goblit's, and the historical differences in the ability to support prolific hydrilla growth suggest this may be a good model system for evaluating factors that limit hydrilla growth (East Lake Toho) and factors that support dense growth (West Lake Toho).

Lastly, we completed a research paper that describes rates of hydrilla elongation to explain how this plant can rapidly occupy large areas of open water in Florida Lakes. While previous studies have focused on measuring biomass, we focused on simple rates of overall extension starting from a 10 cm apical shoot and monitoring growth weekly over a 35 day period. Due to radial growth and prolific branching, we found that the original 10 cm (4 inch) shoot had expanded to over 8128 cm (3200 inches) in a 35 day period. During the 4th and 5th week of the study, the plant was increasing by over 375 cm (150 inches) per day. This near log phase growth helps to explain how hydrilla can rapidly colonize large areas of lakes. Future work will focus on factors that cause short and long-term declines. **(FWC Funded)** ***Netherland, M. US Army ERDC, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Evaluating Fish Habitat Quality in Dense Hydrilla Managed with Different Herbicide Approaches - Hydrilla can provide quality fish and wildlife habitat, but when it grows and produces a dense surface canopy, it can influence dissolved oxygen concentrations for fish and cause problems with angler and boating access. Hydrilla control measures (e.g., herbicides) could be used to improve habitat for fish, but information on dissolved oxygen dynamics is lacking, and sampling fish in dense hydrilla is problematic.

The objectives of this study are to: 1) develop new sampling methods for assessing fish abundance, size, and species composition in dense (surface matted) hydrilla and associated edges, 2) evaluate the spatial and temporal patterns in dissolved oxygen (DO,

mg/L) dynamics and fish community composition and abundance in dense hydrilla, and 3) conduct experimental spatial configurations of hydrilla treatments and monitor fish community and dissolved oxygen responses.

We evaluated dissolved oxygen dynamics in dense hydrilla at Orange Lake using optical DO recorders and measurements with hand-held meters in the field. The DO levels declined with water depth, but hydrilla habitats were not hypoxic in fall of 2010, possibly owing to cooler water temperatures from fall sampling. The video camera has been tested in tank experiments and shows promise for measuring fish abundance. The probability of fish detection declined with hydrilla coverage in the tanks, but estimates were relatively precise, indicating potential to estimate fish abundance. More tank experiments and use of the camera in hatchery ponds will continue in summer 2011. We plan to move work to Lake Norris, near Eustis, and Lake Tohopekaliga to quantify spatial and temporal DO dynamics in dense hydrilla. **(FWC Funded)** ***Bradshaw, E.[1], Wilson, K.[1], Allen, M.S.[1], and M. Netherland[2]. [1]University of Florida School of Forest Resources and Conservation, Gainesville, FL., [2]US Army ERDC, Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Flumioxazin and Bispyribac-sodium Combinations for Controlling Hydrilla **-** Federally registered aquatic and experimental use permit (EUP) herbicides were evaluated in two growth chamber studies to determine the impact of low dose combinations on mature dioecious hydrilla. The aquatic herbicides bispyribac-sodium (10 µg L^{-1}), diquat (100 µg L^{-1}), endothall (500 µg L^{-1}, dipotassium salt), flumioxazin (50 µg L^{-1}), imazamox (50 µg L^{-1}), and penoxsulam (5 µg L^{-1}) were applied alone and in combination for experiment 1. In experiment 2, the EUP herbicides bensulfuron methyl (5 µg L^{-1}), mesotrione (50 µg L^{-1}), quinclorac (50 µg L^{-1}), and topramezone (15 µg L^{-1}) were applied alone and in combination with the aquatic herbicides carfentrazone (25 µg L^{-1}), diquat (100 µg L^{-1}), endothall (500 µg L^{-1}), and flumioxazin (50 µg L^{-1}). None of the alone or combination treatments in either experiment reduced hydrilla shoot biomass compared to the non-treated control 9 WAT. Root dry weight was reduced 59 to 63% with endothall, bispyribac + imazamox, and endothall + penoxsulam in the first experiment. Combinations of endothall plus bensulfuron methyl, carfentrazone, mesotrione, quinclorac, or topramezone as well as quinclorac and endothall applied alone reduced root dry weight 62 to 85% compared to the non-treated control in the second experiment. All the products evaluated in these two trials were applied at ca. 12.5 to 50% of hydrilla efficacious use rates. The lack of acceptable control with the combinations could be attributed to herbicide concentrations being too low, the maturity of hydrilla at the time of treatment, or these products were not synergistic when used in combination. Although the combinations and doses evaluated in these two studies were not efficacious against hydrilla, further research should evaluate these combinations and concentrations against immature hydrilla as well as increase the concentration of one or both of the herbicides. **(FWC Funded)** ***Mudge, C.R. and L.S.. Nelson. U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, MS***

New herbicides for activity against hydrilla and non-target plants **-** In 1995 only six herbicides were registered for aquatic use in Florida. Stimulated by the discovery of fluridone resistant hydrilla populations, an additional 5 new herbicides with two modes of action have been registered since 2004 and research is in progress to find and register additional herbicides, particularly new modes of action, herbicides with greater selectivity and additional contact herbicides. Results from the screening for new ALS and PPO inhibitors are:

Bispyribax and penoxsulam	Provides hydrilla control at < 40 ppb, some differences in selectivity and half-life
Imazamox and imazapr	Imazamox at 200 ppb provides 90-100% hydrilla control, imazapyr has no effect on hydrilla at 5,000 ppb
Imazapic and imazethapyr	No effect on hydrilla at concentrations up to 500 ppb and 400 ppb respectively

Nicsulfuron and halosulfuron	First provides 50% biomass reduction in hydrilla at 100 ppb compared to halosulfuron which has no effect on hydrilla at concentrations to 200 ppb
PPO INHIBITORS	
Formesafen and flumioxazin	Formesafen has no effect on hydrilla at < 400 ppb, flumioxazin produces > 60% biomass reduction in hydrilla (PH7) at 100 ppb
Flufepyrl and acifluorfen	First reduces hydrilla biomass by 50% at 400 ppb while acifluorfen has < 10% activity at the same concentration

Preliminary results of topramezone indicate that Illinois pondweed and hydrilla are the most susceptible to typical application rates of 20-50 ppb of topramezone. Pond treatment of 30 ppb topramezone in March 2009 and bumped with 10 ppb in May 2009 resulted in two years of hydrilla and Illinois pondweed control with no effects on Chara or S. naiad. Treatment of a lake at 40 ppb and bumped once with 20 ppb controlled hydrilla and allowed extensive expansion of coontail. Pickerel-weed at was not affected by the treatment. **(FWC Funded)** ***Haller, W.T. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Waterhyacinth (*Eichhornia crassipes*) and Waterlettuce (*Pistia stratiotes*)

Biocontrol of waterhyacinth and waterlettuce - Twenty-eight sites in northern Argentina have been surveyed for waterlettuce herbivores. Various extraction methods have been tested and individual insect colonies have been created. Rearing and collection efforts have concentrated on four weevil species: *Argentinorhynchus breyeri, A. squamosus, A. bruchi* and *Pistiacola cretatus*. A *P. cretatus* colony has been established in the laboratory, and permits for shipping to quarantine facilities in the US are underway. Rearing methods for the species of *Argentinorhynchus sp.* have not been mastered yet.

Releases of the original colony of *Megamelus scutellaris* targeting waterhyacinth were continued starting in April at selected locations in Florida. New tactics were used and, to date, populations appear to be persisting in the field. In March, more than 500 *M. scutellaris* were collected from the field in Formosa province, Argentina and near Curitiba in Brazil. Colonies have been initiated at cooperators labs in both countries as we await export permits. A temperature study conducted on *M. scutellaris* nymph development found rapid development at 25C, reduced development at 30C, and no emergence at 35C. Nymphs emerged at 30C but did not appear to develop past the second or third instar. We completed another year of pre-release baseline studies of waterhyacinth and waterlettuce in Florida, each at two separate sites. The existing waterhyacinth herbivores reduced the number of flowers, individual plant size, and biomass per area. Although this attack reduced the amount of waterhyacinth by 89.4 tons per acre, less than 800 square feet of open water was created per acre. Unlike waterhyacinth, waterlettuce herbivores significantly reduced both biomass and coverage. For example, waterlettuce herbivores reduced waterlettuce biomass by about 24.2 tons per acre and created up to 16,000 square feet of open water. New pre-release studies with waterlettuce were initiated at two sites starting in March. **(FWC Funded)** ***Tipping, P.W., Center, T.D., and J. Briano. USDA-ARS, Ft. Lauderdale, FL.***

Eurasian watermilfoil (*Myriophyllum spicatum*)

Methods for characterizing herbicidal effects of submersed aquatic vascular plants in the laboratory **-** Invasive watermilfoils are submersed aquatic plants that present many similarities in growth patterns and management to hydrilla. Eurasian watermilfoil has been heavily managed in the upper Midwest for many years while hybrid watermilfoil (*M. spicatum* x *M. sibiricum*) has been recently documented and shown to exhibit invasive characteristics as well.

Fluridone herbicide is used in the state of

Michigan to control hybrid and Eurasian watermilfoils for several years. Economic and selectivity issues have led to lower and lower use rates, which can increase selection pressure for resistance to develop. In May 2010, possible fluridone resistance was thought to have occurred in a lake in Central Michigan, Townline Lake. This research focuses on developing methods to evaluate both susceptible and suspected resistant or tolerant invasive watermilfoils in the laboratory.

Optimal shoot length for laboratory assays was determined to be 6 cm to obtain a relatively quick and differential response to fluridone. Chlorophyll extraction incubation time was previously documented at 6 hours, while it was found that a 1 hour incubation time was sufficient, thus making the process more time-efficient. Lastly, the use of a PAM fluorometer was shown to be a non-complex method to document differential response to fluridone in the laboratory. These methods will improve upon the existing methods used to document resistance to fluridone. **(FWC Funded)** ***Berger, S. and G. MacDonald. Agronomy Department, University of Florida, Gainesville, FL.***

West Indian marsh grass (*Hymenachne amplexicaulis*)

Hymenachne control using graminicides during the dry season **-** West Indian marsh grass (*Hymenachne amplexicaulis* or WI marsh grass) is a problematic semi-aquatic perennial grass in many natural areas of central and south Florida. Experiments were conducted to determine if graminicides could be utilized for WI marsh grass control during the dry season when water is not present in many of these natural areas.

Overall, greenhouse results showed that high rates of some graminicides had some activity on WI marsh grass, but the results were somewhat ambiguous as plant biomass was not significantly different from the untreated control plants four weeks after treatment. Therefore, only the high rates (Select at 32 oz/A, Fusilade at 24 oz/A, Fusion at 24 oz/A, and Poast Plus at 60 oz/A) of the graminicides were tested under field conditions and compared to the standard treatments of glyphosate (64 oz/A) and imazapyr (64 oz/A).

The results of the field studies confirmed those from the greenhouse experiments as no control was observed with the graminicides under field conditions. Therefore, resource managers should continue to rely upon the standard non-selective treatments of glyphosate and imazapyr. **(FWC Funded)** ***Sellers, B. and K. Langeland. University of Florida, Ona and Gainesville, FL***

Wetland nightshade (*Solanum tampicense*)

Biological control of wetland nightshade. Multiple-choice & no-choice tests were conducted at the Department of Agriculture-Division of Plant industry Quarantine facility in Gainesville to determine the specificity of a Mexican/Central-American leaf-feeding weevil (Coleoptera: Curculionidae) intended for biological control of wetland-nightshade in Florida. Fifty-four plant species in nine families were included in the feeding-oviposition multiple-choice tests including the target weed and six major cultivated Solanaceae *Capsicum annuum* L. *Capsicum frutescens* L., *Lycopersicon esculentum* Mill., *Nicotiana tabacum* L., *Solanum melongena* L., and *Solanum tuberosum* L. Seven to eight plant species randomly selected, including always *S. tampicense* were simultaneously exposed to 10 weevil adults during four weeks. Observation of oviposition and feeding were made twice a week. No-choice host-specificity tests were also conducted with weevil adults using potted plants in cages made of clear-plastic cylinders. Ten adults were exposed to 28 plant species individually tested during four weeks. Plant species in each test were replicated 3-4 times. Results indicated that the leaf-feeding weevil fed and laid eggs not only on the target weed wetland nightshade, but also on eggplant cultivar Black Beauty, and on the Florida threatened native mullein nightshade, *Solanum donianum*. No eggs were deposited on any of the other 51 plant species tested. The host-specificity tests indicated that a host range expansion of the leaf weevil to include the cultivated eggplant and the native *Solanum* species is highly likely, and this insect will not be considered as a candidate for biological control of wetland nightshade. **(FWC Funded)** ***Medal, J.[1] and O. Avila.[2] [1]University of Florida, Entomology and Nematology Department, Gainesville, FL. [2]Ministry of Agriculture, San Jose, Costa Rica.***

Crested floating heart (Nymphoides cristata)

Biology and Management of Nymphoides cristata. Crested floating heard is an invasive exotic dicotyledonous aquatic plant of the Menyanthaceae or buckbean family. Despite being recognized by the FLEPPC as a Category I invasive plant, there is limited peer reviewed literature available regarding the biology and management of this rapidly spreading species. The plant grows best in tropical to sub tropical climate zones where it inhabits shallow areas of lakes, ponds, canals, reservoirs and areas of rivers with low current flow (Burks, 2002). Inside the United States the plant has escaped from cultivation and become established in several bodies of water in the State of Florida as well as a large-scale infestation in Lake Marion, South Carolina. The plant forms dense mats of overlapping leaves. This dense mat shades out the entire water column below it, reducing native plant growth and dissolved oxygen concentrations in the water under the mat. Due to crested floating heart's fast, aggressive growth and vegetative spread, chemical control is likely to be the best way to achieve short-term control of established infestations and to address spread by managing newly identified colonies.

In Florida, Collier County Storm Water Management has achieved up to 4 weeks of control of crested floating heart growing in shallow water by using a combination of glyphosate and imazapyr. In greenhouse studies, 1.5-2.5 ppm endothall resulted in 98-100% control at 8 weeks after treatment when applied to the foliage. Approximately 80-90% control was achieved when endothall was applied to the water column. This research will address many unanswered questions about herbicide efficacy and application method, factors that influence herbicide translocation, and biological factors that influence growth of the plant. **(FWC Funded) W*illey, L. University of Florida, Center for Aquatic and Invasive Plants, Gainesville, FL.***

Phragmites (Phragmites australis)

Detecting cryptic invasions of Phragmites australis in Florida waterways using genetic markers **-** A Eurasian haplotype of *Phragmites australis* invaded North America in the 1800s and has become invasive at many locations. The Eurasian type is known to occur in the lower Mississippi River Delta and coastal Atlantic USA, but it was not known whether it had invaded Florida. Samples of *Phragmites* were collected from 69 locations in Florida and several locations in South Carolina, Georgia, Alabama, Mississippi, Louisiana, Canada, Australia, Egypt and Burundi. Examination of chloroplast DNA sequences of these samples detected no Eurasian plants in Florida. All populations sampled in South Carolina and Georgia were the exotic haplotype, as well as one population in Mississippi, two in Louisiana and two in Ontario, Canada. The closest that exotic *Phragmites* was found to Florida was 64 km north of the Florida/Georgia border along Interstate 95. Samples from Burundi, Australia and Egypt represented five new haplotypes of *Phragmites*, but none of these were closely related to the Gulf Coast type. Genetic diversity at microsatellite and amplified fragment length polymorphism (AFLP) loci were very low for the Gulf Coast haplotype suggesting most *Phragmites* in Florida and across the Gulf Coast are a single clone and that sexual reproduction if it occurs is very rare. **(FWC Funded)** ***Overholt, W.A.[1], Williams, D.A.[2], and R. Diaz.[1] [1]University of Florida, Ft. Pierce, FL. [2]Department of Biology, Texas Christian University, Ft. Worth, TX.***

Brazilian pepper (*Schinus terebinthifolius*)

Qurantine risk assessment studies for classical biological control of Brazilian pepper **-** A new species of psyllid, probably a new ***Calophya*** sp., was discovered in Urubi, Santa Catarina state, Brazil. Adults were collected and brought back for colonization in our quarantine but the colony did not establish. These individuals were believed to be the known *Calophya terebinthifolii* but following DNA analysis were found to be a new species. T**hrips** were discovered during our Nov-Dec survey 2009. Specimens were forward to D. Williams, Texas Christian Univ, and L. Mound, Canberra Australia for molecular and morphological identifications. These results suggested the existence of several new species collected on the related species *Lithrea* and *Schinus terebinthifolius* in Minas Gerais and Parana states of Brazil. The morphological determinations were forwarded from L. Mound. These results confirm the molecular results indicating that several new species of thrips were collected. These appear to be new species of *Pseudophilothrips,* members of the same genus currently being investigated. Additionally, we also recovered new species of *Liothrips*, a genus very closely aligned with

Pseudophilothrips. We returned to this area in February 2011 and collected thrips but few were available and all that were collected are believed to be the known P. ichini. These new discoveries are high priorities and will be the focus of subsequent foreign surveys.

Colonization of the stem galling moth, ***Crasimorpha infuscata*** has been successful and preliminary testing has begun. Collections of over 300 galls during both the Aug-Sep 2010 and the Feb 2011 surveys resulted in the emergence of over 100 adults. The latter collected galls are still producing adults. Despite heavy parasitism of the field collected larvae, these adults produced over 400 eggs that hatched. The next generation has established new galls in quarantine on Florida plants successfully beginning a research colony. Initial results indicate that this species might oviposit on other species, e.g., Rhus copallinum, Pistacia texana, but the larvae will not mature.

Results of testing the ***Eucosmophora schinusivora*** leaf mining moth indicate a broad host range that includes *Pistacia chinensis* and *Rhus copallinum*. Adults were produced on *S. terebinthifolius* (20 of 20 reps), *S. molle* (2 of 2 reps), *Pistacia chinensis* (1 of 4 reps) and *Rhus copallinum* (2 of 5 reps) suggesting that this insect has a host range that includes these plants (Table 3a). Mines were also produced on leaves of all species tested except *Anacardium occidentale,* although no adults emerged from the leaves of these species. Testing of this species will be completed as soon as we have sufficient replicates for publication and this colony will be discontinued. **(FWC Funded)** ***Wheeler, G.[1] and D. Williams.[2] [1]USDA-ARS, Ft. Lauderdale, FL. [2]Texas Christian University, Ft. Worth, TX.***

New potential biological control agents of Brazilian peppertree - Recent surveys of natural enemies of Brazilian peppertree were conducted in the area around Salvador, Brazil. Three candidate agents were identified and imported into the UF/IFAS Biological Control Research and Containment Laboratory in Fort Pierce, Florida: 1) a thrips, *Pseudophilothrips ichini* (Phlaeothripidae), 2) a moth, *Paectes* sp. (Euteliidae), and 3) a psyllid, *Calophya* sp. (Calophyidae). Laboratory colonies of the thrips and the moth have been successfully established. Preliminary studies indicate that the Salvador thrips has a very narrower host range, and therefore holds promise as a biological control agent. The thrips completed development only on Brazilian peppertree and the closely related Peruvian peppertree (*Schinus molle*) which does not occur in Florida. Further host-range testing is underway. Several studies on the biology and host-range of *Paectes* sp. are underway. Larvae feed on the foliage of Brazilian peppertree and can completely defoliate small plants in the laboratory. Temperature-dependent development and cold tolerance studies suggest that *Paectes* sp. may be able to establish throughout Florida if permission to release is obtained. A total of 14 plant species in the family Anacardiaceae have been tested under no-choice conditions. High survival to adulthood was obtained on the target weed (50%) followed by *S. molle*, while low survival (<10%) was obtained on few non-target species. However, in multiple choice tests, adult moths preferred to lay eggs on Brazilian peppertree. Additional host range testing will determine whether *Paectes* sp. is sufficiently host-specific to release in Florida. Finally, a new species of leaflet galling psyllid in the genus *Calophya* was discovered attacking Brazilian peppertree in Salvador. A colony was established in quarantine, but collapsed after completing one generation. Species in the genus *Calophya* are known to be highly host-specific, and thus hold promise for biological control. New efforts will be made to collect the psyllid so that host range testing can be initiated. Research on biological control of Brazilian at the UF/IFAS Fort Pierce quarantine laboratory is supported through a grant from the Florida Department of Agricultural and Consumer Services. ***Manrique, V., R. Diaz and W. A. Overholt. University of Florida, Ft. Pierce, FL.***

Overseas surveys and risk assessment studies for classical biological control of Brazilian pepper -
Efforts were mainly focused on the stem galling insects: *Crasimorpha infuscata* Hodges (Lepidoptera: Gelechiidae), *Allorhogas* sp. (Hymenoptera: Braconidae) and an unidentified Gelechiidae. A one-week field survey was conducted in May 2011.

At eight sites, coexisting plants of *S. terebinthi-folius* ; *S. molle*; *S. longifolius* ; *S. lentiscifolius* , *S. weinmannifolius* and *Lithrea molleoides* were visually inspected for stem galls. Galls of *C. infuscata* and *Allorhogas* sp. were only found on *S. terebinthifolius* plants. An unidentified Gelechiidae small stem galls were found on *S. terebinthifolius* and possibly on *L. molleoides*. **(FWC Funded)** ***Mc Kay, F. and N. Cuadra. USDA-ARS South American Biological Control Lab, Buenos Aires, Argentina.***

Chinese tallow (*Triadica sebifera*)

Foreign exploration and risk assessment for biological control of Chinese tallow in Florida - Quarantine studies Jun 2010 – May 2011 focused on two potential biocontrol agents of Chinese tallow, *Bikasha collaris* (Coleoptera: Chrysomelidae) and *Gadirtha inexacta* (Lepidoptera: Noctuidae) with the primary effort spent on standardizing and conducting host ranges tests of *B. collaris*. A total of 45 non-target species were screened in no choice development tests of *B. collaris* larvae on cut roots, and 46 species in no choice feeding, survivorship, and oviposition, tests of adults on cuttings. Larvae fed on cut roots of 14 nontarget species. One larvae completed development on the nontarget species *Ricinus communis* or castorbean. This is a widespread introduced, possibly weedy plant probably from Africa; seeds have medicinal and industrial uses and is the source of the biological toxin ricin, previously used by terrorists groups.

Eighteen larvae developed to the pupal stage and three completed development on *Sapium japonicum*, an introduced and currently marketed ornamental from Asia. One larva developed to the pupal stage on *Hippomane mancinella,* a native species of Florida, Puerto Rico, and the Virgin Islands and endangered in Florida. Tests of larvae of these three species on potted plants, a more natural situation, are underway.

B. collaris adults fed on cuttings of 25 of 46 nontarget species, damaging three, *Gymanthes lucida* (Florida native), *Sapium japonicum*, and *Hippomane mancinella*, similarly to Chinese tallow. Feeding sustained at least one female on each of these species for four weeks or longer. Feeding on other species was not of cosmetic concern but sustained some females between 2-3 weeks. Females seem to be indiscriminate in their oviposition behavior when confined in small cages in the laboratory. Eggs were collected from cuttings and or test containers of 20 species.

Two shipments of *Gadirtha inexacta* (Lepidoptera: Noctuidae) were received from Hubei, Hong Kong. Few adults were reared out, 1♂6♀ from the first shipment and 4♂ from the second. Females from the first shipment did oviposit but caged potted plants with eggs became heavily infested with thrips which caused leaf drop and egg desiccation. However, valuable biological information and developmental data under quarantine conditions was obtained from both shipments which will aid in the receipt and handling of future shipments and establishment of a quarantine colony.

Confirmation studies conducted in China demonstrated that *Gadirtha inexacta* is specific as larvae only completed development on the close relatives *Triadica sebifera, T. rotundifolia*, and *Sapium chihsinianum*. Foreign exploration for new agents continues and during this past 6 months we recovered gall wasps identified to the Tetrastichinae subfamily (Hymenoptera: Eulophidae) and possibly a parasitoid assigned to the Toryminae subfamily. These species are likely undescribed new species. This work will continue to collect, rear, and identify these wasps with the eventual short term goal of establishing a colony for testing against other related species. **(FWC Funded)** ***Wheeler, G.[1], Ding, J.[2], Wang, Y.[2], Huang, W.[2], Zhang, J.[2], Purcell, M.[3], and S. Steininger.[4] [1]USDA-ARS, Ft. Lauderdale, FL. [2]Invasion Biology and Biocontrol Lab, Wuhan Botanical Institute, Chinese Academy of Sciences, Wuhan, Hubei Province, China. [3]USDA-ARS Australian Biological Control Lab, Brisbane, Australia. [4]USDA-ARS Invasive Plant Research Lab, Gainesville, FL.***

Air potato (*Dioscorea bulbifera*)

Pre-Release colonization of Lilioceris sp. nr. impressa (Coleoptera: Chrysomelidae: Criocerinae) for control of air potato **-** Air potato beetles tested for host fidelity have been identified as belonging to the taxon *Lilioceris cheni* rather than representing a species new to science, as had been previously thought. Additional morphological and molecular taxonomic work confirmed that specimens collected in Yunnan Province, People's Republic of China, belong to this same species.

Field collections in Yunnan during late September/early October produced 32 individuals of this species, but all died while in transit to the lab. Air potato is deciduous, so another collecting trip was conducted in May 2011 when the plants had begun re-foliating and the insects had emerged from diapause and begun producing young. This latter trip produced over 300 *Lilioceris* beetles which were hand-carried to the U.S. and are currently being monitored for disease and/or parasitism.

Disease/parsitoid-free lines of *Lilioceris cheni* will be established in the IPRL quarantine facility. An APHIS permit for field release of this insect was received 23 March 2011, so progeny from the clean lines will be removed from quarantine to establish

non-quarantine colonies and for field release. **(FWC Funded)** ***Center, T.D.[1], Rayamajhi, M.B.[2], Purcell, M.F.[3], Makinson, J.[3], and J. Ding.[4] [1]USDA-ARS, Ft. Lauderdale, FL. [2]USDA-ARS Australian Biological Control Lab, Brisbane, Australia. [4]Invasion Biology and Biocontrol Lab, Wuhan Botanical Institute, Chinese Academy of Sciences, Wuhan, Hubei Province, China.***

Downy Rose Myrtle (*Rhodomyrtus tomentosa*)

Quarantine risk assessment of biological control candidates for downy rose myrtle - Four foreign shipments of *Rhodomyrtus tomentosa* shoots and flower buds infested with potential biocontrol candidates were processed during the funding year. Collections were made in Hong Kong, China and shipped to FDACS DPI quarantine by CSIRO/USDA ABCL scientists J Makinson in May 2010 (N= 3 shipments) and B Brown and T Wright in Mar 2011 (N= 1 shipment).

A total of 10 species of lepidopteran larvae were present in the four shipments; eight were reared out to adults. The ninth species is still being reared and is presently a pupa. The tenth species was parasitized and died at the larval stage. Six of the 10 species were collected as unknowns in small numbers, 1-3 larvae/species, as part of continuing surveys of *R. tomentosa* for herbivores. They were reared to obtain specimens for identification.

All larvae were leaf feeders except for a fruit/seed feeder *Mesophleps albilinella* (Gelechiidae). One of the 10 species, *Carea varipes*, was collected previously and is considered to be good candidate for future evaluation. It was reared to obtain additional voucher specimens. Two species, *Metharmostis* sp. (Cosmopterigidae) and *Hermenias* sp. (Tortricidae), were present in larger numbers in the first three shipments and were reared to obtain life history data. Their larvae have overlapping niches on *R. tomentosa* shoots and were reared together until the F1 adults eclosed and then reared separately for two to three generations. Sexual dimorphism was confirmed, eggs and oviposition sites were identified, preferences for larval feeding and pupation observed, and development time under quarantine conditions determined for both species. *Metharmostis* was selected as the candidate to assess further. From the fourth or Mar 2011 shipment, a new colony was established and expanded twofold in one generation (by May 2011).

The larvae feed in leaf buds, adjoining shoots, and in flower buds. Plant tissue is hollowed out and dies, including the flower buds. This damage makes *Metharmostis* an ideal candidate for assessment as it could curtail shoot growth year round and flowering/fruit production seasonally. While the May 2010 shipment had several species of parasitoids present which emerged from the mix of *Metharmostis* and *Hermenias* immatures, only one species, prob. *Apanteles* sp. (Hymenoptera: Braconidae) emerged from *Metharmostis* pupae in the Mar 2011 shipment. At least 44 percent of the shipment pupae were parasitized by this species. It was eliminated in the next generation. Specimens have been sent to a specialist for species identification. Since *Metharmostis* is a new undescribed species, specimens, images, and data of *Metharmostis* sp. have been and continue to be provided to D Adamski USDA SEL for the preparation of a manuscript on its description.

Other work during the funding period included increasing the stock of *R. tomentosa* plants through field collection and small numbers through seed propagation. Studies of induction of seed germination via breaking the seed coat using various techniques were tried, but no method proved highly successful. However, scarification improved percent and possibly rate of germination. One shoot rooted by chance in a vial of water but when efforts were made to duplicate this, efforts failed. An informal survey of arthropods found on Florida *R. tomentosa* was conducted and is ongoing. Eleven species have been found to date. Five are new Florida host records and one, a mealybug *Paracoccus solani* (Hemiptera: Pseudococcidae), also a new Florida record. The primary objectives for the funding period 2011-2012 are to finalize a mass rearing protocol, expand the *Metharmostis* colony. **(FWC Funded)** ***Center, T.[1], Pratt, P.[1], Purcell, M.F.[2], Makinson, J.[2], Brown, B.[2], Wright, S.A.[3], and J.A. Lollis.[3] [1]USDA-ARS, Ft. Lauderdale, FL. [2]USDA-ARS Australian Biological Control Lab, Brisbane, Australia. [4]USDA-ARS Invasive Plant Research Lab, Gainesville, FL.***

Old World climbing fern (*Lygodium microphyllum*)

Field trial evaluations of the effectiveness of untested herbicides for control of Old World climbing fern (OWCF) **–** Research was conducted at three sites in southeastern Florida: Cypress Creek Natural Area (Palm Beach County), J.W. Corbett Wildlife Management Area (Palm Beach County) and

Port St. Lucie West Subdivision (Port St. Lucie County) Herbicide treatments were repeated twice at Cypress Creek Natural Area and J.W. Corbett Wildlife Management Area, and once at Port St. Lucie West Subdivision. Untreated control plots were included at each site. An initial evaluation of OWCF and native plant cover occurred in September 2010, and all OWCF was treated at this time. A hand-pressurized backpack sprayer with a flatfan nozzle was used to apply herbicide solutions on a spray-to-wet basis with herbicide concentrations listed in Table 1. Herbicides were diluted in water along with 1% v/v non-ionic surfactant. Treatments with imazamox, metsulfuron, aminocyclopyrachlor, quinclorac, and aminocyclopyrachlor+metsulfuron resulted in > 97% control of OWCF at six months post-treatment. No live OWCF was observed in plots treated with imazamox. Bensulfuron, topramezone, and trifloxysulfuron treatments were ineffective at the concentrations used and were not significantly different from control plots ($P < 0.05$). New OWCF growth was numerous in plots treated with topramezone, trifloxysulfuron, and bensulfuron indicting these herbicides are ineffective for control of OWCF at the concentrations used in this study. These results indicate that imazamox, amino-cyclopyrachlor, and quinclorac exhibit high efficacy for control of OWCF at six months post-treatment and are comparable to historically used herbicides such as metsulfuron, glyphosate, triclopyr and imazapic. We suggest that herbicides such as imazamox, aminocyclopyrachlor, quinclorac and imazapic can be effectively used for follow-up spot-treatments of OWCF following an initial treatment with metsulfuron, glyphosate, triclopyr. These herbicides have shown a high degree of effectiveness for control of OWCF and should be considered by land managers for long term management of OWCF. **(FWC Funded)** ***Hutchinson, J.T. and K.A. Langeland. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Exploration for biological control agents of lygodium in Southeast Asia **-** Exploration for biological control agents of *L. microphyllum* began in 1997. Significant parts of the native range of the fern have been searched in Australia, Asia and the Pacific. More than 20 species of insects and mites have been collected from *L. microphyllum* including six species of pyralidmoths (*Austromusotima camptozonale*, *Neomusotima conspurcatalis*, *Lygomusotima stria*, *Siamusotima aranea* and two other stem-boring species.), a tenthredinid sawfly (*Neostrombocerus albicomus*), two species of noctuid moth (*Callopistria* spp) and an eriophyid mite (*Floracarus perrepae*). Most of these species have undergone preliminary quarantine testing and evaluation in Australia.

The most promising agents have been prioritized for comprehensive host range testing in quarantine in Florida (*A. camptozonale*, *L. stria, N. conspurcatalis*, *N. albicomus*) or Australia (*F.perrepae*) to determine their safety in preparation for approval to release from state and federal regulatory agencies in the United States. Three agents, the lygodium moth *A. camptozonale*, the brown lygodium moth, *N. conspurcatalis* and the lygodium gall mite, *F. perrepae* have been approved for release in the United States. Plans are also in place with a fourth agent, the lygodium sawfly, *N. albicomus,* to perform a final series of rearing tests on Caribbean *Lygodium* species to complete the host range testing. It is anticipated that *L. volubile* from Jamaica will be available for testing later in 2011, at which time new collections of the sawfly will be made in Southeast Asia and shipped to quarantine in Fort Lauderdale. Testing then can be completed.

Overseas exploration is now focused on locating populations of the lygodium stem-boring pyralid moths that are known to occur in Singapore, Hong Kong, mainland China, Malaysia and Thailand. Research is also underway to survey the abundance of these moths at different times of the year to understand seasonal fluctuations in abundance that will hopefully allow more effective scheduling of future collecting trips.

During August 2010, stem-borers were collected from 18 localities, comprising 74 L*ygodium microphyllum*, all over Hong Kong. Over 650 damaged stems were collected and shipped to Brisbane quarantine along with 26 pupae. In smaller surveys in October, a further 53 damaged stems and 3 pupae were collected and shipped. **(FWC Funded)** ***Center, T.[1], M. Purcell,[2] A. Boughton,[1] and J. Makinson.[2] [1]USDA-ARS Invasive Plant Research Lab, Fort Lauderdale, FL. [2]USDA/ARS Australian Biological Control Lab, Brisbane, Australia.***

Host range testing in U.S. quarantine of potential insect agents for biological control of Old World climbing fern **-** During the funding period, domestic U.S. research on the multi-year lygodium biocontrol project has moved forward on several fronts.

Preparations are underway to begin comprehensive host range testing of a new species of musotiminine crambid moth, *Lygomusotima stria*, native to southern Thailand, peninsula Malaysia and Singapore. A shipment of this insect was recently sent from the Australian Biological Control Laboratory in Brisbane Australia, and received into quarantine at USDA-ARS Invasive Plant Research Laboratory in Fort Lauderdale, Florida. These insects appear to be healthy and it is hoped they can be used to establish a quarantine colony that can be used for host range testing.

In preparation for host range testing of this new candidate agent, a major effort has been mounted to assemble the necessary congeneric test plants needed for preliminary phases of the non-target host testing. Efforts to propagate new sporelings of three non-target lygodium species, and two other *Lygodium* congeners, have met with good success, and stocks of the native American climbing fern have also been recently been obtained to support planned testing. On other fronts, plans are in place to obtain a critical non-target test plant species, *Lygodium volubile*, from the Caribbean to support a final series of multi-generation rearing tests with the lygodium sawfly. The Jamaican government has issued a plant export permit and cooperators are in place to collect and ship spores and plants of this species once USDA Animal Plant Health Inspection Service issues an importation permit.

In domestic quarantine, studies to compare low temperature development and survival of the lygodium moth, *Austromusotima camptozonale* and brown lygodium moth, *Neomusotima conspurcatalis* are drawing to a close. Although studies are not totally completed yet, preliminary findings appear to be contrary to expectations, and fail to demonstrate better low temperature survival and performance of the subtropical species *A. camptozonale* relative to the tropical species *N. conspurcatalis*. Although disappointing in not identifying an agent that might perform better than *N. conspurcatalis* in colder areas further north in Florida and in interior portions of the Florida peninsula, the findings are nevertheless useful and will avoid wasted efforts arising from releases of *A. camptozonale* into colder areas in which it is unlikely to thrive. **(FWC Funded)** ***Center, T. and A. Boughton. USDA-ARS Invasive Plant Research Lab, Fort Lauderdale, FL.***

Host range testing in the Australian quarantine of potential insect agents for the biological control of Old World Climbing Fern (Lygodium microphyllum) **-** More than 20 species of insects and mites have been collected from *L. microphyllum* in Australia, South-east Asia and the Pacific. Most of these species have undergone preliminary quarantine evaluation and testing in Australia, prior to the initiation of comprehensive host range testing on the most promising agents. The *Lygodium* moth *A. camptozonale* was released in Florida in 2005, but this first round of releases did not result in establishment. A second moth from Australia, *Neomusotima conspurcatalis*, was released in 2008 and established and is causing considerable damage in some stands in the central east coast of Florida. The Lygodium gall mite, *Floracarus perrepae*, underwent comprehensive host range testing in quarantine in Australia and subsequently received regulatory approval for release in the United States. *Floracarus perrepae* was shown to have a significant impact on *L. microphyllum* in field plot and lab studies in Australia, but multiple introductions in Florida have only resulted in poor establishment, apparently due to host acceptance problems on locally occurring biotypes of *Lygodium*.

Over recent years, quarantine research in Australia has focused on several species of *Lygodium* stem-boring pyralids known from Southeast Asia and Hong Kong. These agents appear to have great potential for biological control of *L. microphyllum* because feeding by the larvae causes the death of entire, climbing stem in the field. However, rearing the larvae of these moths in quarantine has proved difficult. Although much progress on rearing methods has been made over recent years, synchronizing male and female adult emerge for mating in cages remains a challenge. A method to overcome this problem was to intensively collect borers over the peak season for at least one month in Hong Kong during 2010. Rearing results improved with the first F1 generation adult obtained in quarantine, though the colony could not be sustained.

Intensive field collections will be repeated in 2011 where additionally, data on the microclimate associated within the native habitats of these moths in Asia will be utilized to fine tune quarantine conditions for colonization at ABCL and to predict new locations for concentrated foreign exploratory surveys.

A new “state of the art” quarantine with glasshouses is also online at ABCL which should improved rearing success. The insects will now be

held under natural lighting in controlled conditions rather than under artificial or indirect lighting. This may have implications for improved mating. Further releases of the defoliating pyralid moth, *A. camptozonale*, were made in 2011 after new insects were shipped from Australia. Additional shipments of this insect may still be required to support the ongoing release effort, in which case supplemental collections of this moth will be made from field sites in Australia during 2011/2012 for shipment to USDA-ARS, Fort Lauderdale. Another defoliating pyralid from Singapore, *Lygomusotima stria*, will be shipped to IPRL quarantine as necessary to supplement quarantine cultures established following shipments from ABCL quarantine in May 2011. **(FWC Funded)**

Center, T.[1], Purcell, M.[2], Boughton, A.[1], Zonneveld, R.[2], and J. Makinson.[2] [1] USDA-ARS Invasive Plant Research Lab, Fort Lauderdale, FL. [2]USDA/ARS Australian Biological Control Lab, Brisbane, Australia.

Japanese climbing fern (Lygodium japonicum)

Assessing the timing and sequence of prescribed fire and herbicide applications on the control of the invasive Japanese climbing fern in Florida's natural areas- Japanese climbing fern is a non-native, invasive fern that is widespread in the panhandle through central Florida. It poses both economic and ecological threats to forest systems managed for a variety of products and ecosystem services. Herbicide treatments can provide at least short-term control of the fern, but prescribed burning, also an integral part of forest management throughout the southeast, may actually stimulate fern regrowth. Though "brown and burn" techniques (e.g. Fall herbicide and dormant season burning) have been common for other types of vegetation management, less is known about the timing of herbicide applications with growing season burns to effectively control Japanese climbing fern. The objective of this research was to evaluate the timing and sequence of herbicide and burning on control of Japanese climbing fern in southeastern forest ecosystems. A 4% v:v solution of glyphosate (Accord XRT) was applied to 20' by 20' plots at least six weeks before or after prescribed fire. Two sites were burned earlier in the growing season (June), three sites were burned in the later growing season (August-September), and one site served as a reference for dormant season burns.

The results from this study suggest that sequencing of herbicide treatments with prescribed fires may not be as important to controlling Japanese climbing fern as is selecting a herbicide application period when there is sufficient fern foliage to absorb the chemical. This may be a consequence of the type of herbicide used in this study, since glyphosate is a foliar application in which the herbicide translocates down from the leaves to the roots. Herbicide treatments applied in May were not effective, likely because there was not enough foliage to absorb the chemical, or perhaps also because new gametophytes germinated and developed after the herbicide application and before burning. Plots treated in May show nearly as much fern regrowth as untreated (burn-only) plots one year after treatment. Both the plots treated in July before burning and the plots treated in after burning in August or September, when sufficient regrowth occurred, showed between 85-100% reductions in fern cover. These plots will be monitored through the 2011 growing season to fully determine differences in fern reduction as a function of herbicide timing. **(FWC Funded)**

Bohn, K.[1] and P.J. Minoque.[2] [1]University of Florida, WFREC, Milton, FL. [2]University of Florida, NFREC, Quincy, FL.

Para grass (*Urochloa mutica*)

Integrating chemical and cultural practices to control para grass **-** Non-native para grass (*Urochloa mutica*) is no longer used as a forage grass and has invaded Florida wetlands. This perennial grass species out-competes native vegetation and results in monotypic swards; an unsuitable wildlife habitat. The goal of this research was to improve wetland ecosystem health by reducing para grass invasions via an integrated approach using cultural and herbicide inputs. Experiments were conducted to determine herbicide efficacy on paragrass under different water depths in combination with burning and flooding. Herbicides were applied in late fall, and subsequently burned and flooded in early summer. At 1month after treatment (MAT) all rates of imazapyr (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1-H-imidazol-2-yl]-3-pyridinecarboxylic acid) and glyphosate (N-(phosphonomethyl) glycine) provided similar level of control ranging from 70 to 88% and 91 to 95%, respectively, regardless of the initial water level. It was observed that burning followed by immediate flooding reduced the initial para grass ground cover

in the untreated checks by at least 62% at 12 MAT, which was 8 months after burning-flooding (MAB-F). The reestablishment of native species was similar in all imazapyr and glyphosate treated plots. Stolon and crown tissues were sampled at monthly intervals for two years and analyzed for total non-structural carbohydrate (TNC) concentrations. Carbohydrate concentrations in stolon and crown tissues were typically lowest in the late winter and early spring, but increased from May through September.

Therefore, para grass may be more susceptible to herbicide applications in early summer when herbicide will be transported with carbohydrates to reproductive tissues. These data indicate that excellent control of para grass can be obtained with fall applications of 1.12 kg/ha glyphosate or 0.86 kg/ha imazapyr in combination with early summer burning followed by flooding. However, a early- to mid-summer application of glyphosate and imazapyr may be more effective for areas where flooding cannot be controlled. **(FWC Funded)** **Chaudhari, S.[1], B. A. Sellers,[1] S. V. Rockwood,[2] J. A. Ferrell,[3] G. MacDonald,[3] and K. E. *Kenworthy.*[3 1] *IFAS Range Cattle Research and Education Center, University of Florida, Ona, FL.* [2] *Florida Fish and Wildlife Conservation Commission, Fellsmere, FL.* [3] *Agronomy Department, University of Florida, Gainesville, FL.***

Outreach Efforts

Invasive Plant Management FAQs and Videos to Enhance the FWC-IFAS Plant Management in Florida Waters website **-** In order to continue the successful management of invasive plants in Florida, continued education and outreach of constituents is critical. Using web-based video and print material is an important tool to effectively communicate the basic concepts of Integrated Plant Management to the public. Thanks to years of support by the FWC Invasive Plant Management Section (formerly the DEP/BIPM), a strong public outreach component has been established in the form of the FWC-UF/IFAS Plant Management in Florida Waters website (http://plants.ifas.ufl.edu/guide), as well as a video archive of hundreds of hours of raw footage about plant management in Florida waters. This project was proposed to add an additional tool to provide reliable, trusted and easy access to information about the management of invasive plants in Florida. It will also serve as another method of bridging the gap between researchers, plant managers, and citizens.

Citizens often mistrust various plant management techniques largely because they do not understand the extensive research, long-term experience and science that go into making plant management decisions while also protecting Florida's native biodiversity. The use of video technology to communicate key concepts about Integrated Plant Management in Florida waters will add value to the FWC-IFAS Invasive Plant Management website. Online videos have become increasingly popular and user-friendly and make it possible to communicate a significant amount of information in a short amount of time. Video also captures the attention of those looking for quick answers and can help lead them to additional sources for more in-depth information. **(FWC Funded)** ***Brown, K. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Maintenance and expansion of the APIRS online database and library **-**The Aquatic, Wetland and Invasive Plant Information Retrieval System (**APIRS**) collects and catalogs the published scientific literature on aquatic, wetland and invasive plant species. APIRS is the only database dedicated exclusively to these topics and has been in service for more than twenty years. APIRS is a stand-alone database with selected, subject-specific content, containing historical sources and grey literature (conference proceedings, government reports, etc) in addition to current peer-reviewed journal citations, plus listings for digital media such as DVDs, CDs and videos. APIRS citations to the literature disclose content using keywords and plant names provided by a subject expert, and relevant records can be e-mailed to user's who create their own accounts. The database is searchable via the Internet at no cost to the management and scientific communities at large. APIRS has professional staff with many years of experience in searching academic research libraries and other institutional resources for relevant information pertaining to this broad subject area, cataloging it, and compiling it into a large searchable database. In addition, with new invasive species appearing in or threatening to invade Florida, either by naturalizing or by introduction as potential biofuel feedstocks, APIRS staff provides expertise and rapid delivery in searching the literature for new and retrospective publications. **(FWC Funded)** ***Brown, K. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Florida Invasive Plant Education Initiative and Curriculum **-** The Florida Invasive Plant Education Initiative was launched in November 2005 with the support of the Invasive Plant Management Section of the Florida Fish and Wildlife Conservation Commission. The short term goal is to inspire Florida educators to bring this important topic into their classroom and to provide the information and resources they need to teach the material with confidence. The long term goal is to bolster the next generation with the tools they need to become responsible environmental stewards as they move into adulthood. This endeavor is not going to be accomplished in just a few years' time. It is a work in progress that continues to build on the foundation that has been developed over the past five years.

During this time, CAIP staff collaborated with dozens of teachers to develop curriculum about aquatic and upland invasive plants in Florida. The result was the production of a number of audio-visual presentations and a host of activities and hands-on learning materials for use in the classroom, all of which continue to be correlated to the Florida Sunshine State Standards.

As well, an annual invasive plant teacher-training workshop, one of the first of its kind in the country, is hosted by CAIP and FWC each June, with the objective of generating excitement and interest in the topic and curriculum. These annual 5-day PLANT CAMP workshops include field trips, rigorous hands-on plant identification activities, as well as classroom lectures. The events are designed to provide teachers with greater background knowledge on Florida's native, non-native and invasive plants before they begin to teach it to their students. So far, more than 160 teachers have been formally trained by CAIP-FWC staff. According to our recent survey, PLANT CAMP graduates have trained or introduced the topic of invasive plants to an estimated 1169 teacher-colleagues and an estimated 17,679 students as a result of these efforts.

In addition to the annual teacher training workshops, CAIP staff members (2 full time, 1 half-time IT person) continue to develop classroom activities about invasive species management (with emphasis on aquatic plants); maintain the Florida Invasive Plant Education Initiative website; and cultivate an active communication network with teachers by providing additional support and materials, when needed. While production of new materials was reduced significantly this year due to limited funding, existing materials continue to be provided to teachers and used as outreach tools.

This year, time was also spent evaluating the effectiveness of these efforts (i.e., before developing any new strategies or activities). A survey was distributed among participating teachers to determine if (1) they are using their training and materials and (2) if they are experiencing an increased *awareness* of the seriousness of the issue; an *understanding* of the practices and strategies; and an *acceptance* of the plant management practices they learned about**. (FWC Funded)** ***Richard, A. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Maintenance and structural upgrade of the UF-IFAS Center for Aquatic and Invasive Plant Websites **-** Plant managers and the interested public continue to look to the University of Florida, Center for Aquatic and Invasive Plants (CAIP) for accurate, relevant information concerning aquatic and upland plant species, their biology, ecology and management. CAIP provides detailed information concerning aquatic and invasive plants and their environments. This content is provided via the CAIP website (plants.ifas.ufl.edu) and three companion "portal" sites (see Figure 1). The CAIP sites are friendly enough for the novice user, yet contain technical information that should be closely considered by every plant manager and plant management program. Maintenance for all these sites is ongoing and requires regular edits and updates.

The main focus of this year's project was to maintain the primary UF-IFAS Center for Aquatic and Invasive Plants website and its three portals, while also implementing a complete redesign and overhaul of the structure and content of the "Plant Management in Florida Waters" website, originally placed online in 2005. The goal was to update and improve content, reorganize hierarchy, and provide effective navigation and increase readability, while also meeting new National Pollutant Discharge Elimination Systems (NPDES) permitting mandates from the U.S. Environmental Protection Agency (US EPA). **(FWC Funded)** ***Brown, K. Center for Aquatic and Invasive Plants, University of Florida, Gainesville, FL.***

Non-Native species in the Atlas of Florida VascularPlants Website database **–** The *Atlas of Florida Vascular Plants* website provides distribution and nomenclature information for the currently

known 4,268 native and naturalized taxa of vascular plants in the State of Florida. Of these, 1,403 (33%) are non-native taxa. Data includes county-by-county distribution documented by herbarium specimens and complete nomenclature for all Florida taxa. This is fully integrated with herbarium specimen images. *The Atlas* contains online data and images of over 58,000 specimens from the University of South Florida Herbarium. Of the 243 Florida plant families recognized for Florida, 138 (57%) have been fully databased for the state. **(FWC Funded)** ***Wunderlin, R.P. Department of Cell Biology, Microbiology, and Molecular Biology, University of South Florida, Tampa, FL.***

Maintenance of the Florida Exotic Pest Plant Council database and herbarium service **–** The Robert K. Godfrey herbarium at Florida State University manages over 205,000 botanical specimens. The herbarium specializes in the flora of the Florida Panhandle, and it represents the most extensive collection of plants from that region. As such, it is a irreplaceable resource to Florida's natural resources managers and policy makers, as well as the local and international botanical community. FWC management activities facilitated by the herbarium include the rapid identification of unknown plant specimens, the permanent documentation of rare native and invasive exotic plant distributions, the comprehensive inventory of plants in management areas, the precise mapping of plant communities, and the proper description of new plant species. Since 2003, the curator of the herbarium has also maintained the Florida Exotic Pest Plant Database. The database currently includes 5,695 site records for plants listed as category I or II by the Florida Exotic Pest Plant Council. **(FWC Funded)** ***Knight, G.[1] and A. Mast.[2]***
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Florida Invasive Animal Species Management Research

Reptiles: Monitors (Varanus sp.) and Tegus (Tupinambis sp.)

Demography, Diet, and Population Genetics of two Florida Invasives: Monitor (Varanus sp.) and Tegu (Tupinambis sp.) Lizards **-** In response to proliferating Nile monitors (*Varanus niloticus*) and Argentine black and white tegus (*Tupinambis merianae*) in southern Florida, the University of Louisville will be launching a three year-study in an effort to develop a comprehensive understanding of monitor and tegu biology and genetics in Florida.

The objectives of the study are to: (1) assess the density of monitors and tegus in southern Florida by surveying the surrounding areas of Miami, Tampa Bay, West Palm Beach, and Cape Coral during the summers of 2012, 2013, and 2014; (2) describe the demography, habitat-use, and diet of monitors and tegus in Florida; and to (3) examine the genetic structure of monitor and tegu populations in Florida. The overall goal is to integrate this information in order to assess the threat that these invasive species pose to native wildlife; and to recommend management guidelines for limiting the impact of large exotic lizards on native wildlife and their habitats.

This study is a multi-agency collaboration currently including the FWC, NPS, City of Cape Coral, Hillsborough County, University of Tampa, and Florida Atlantic University. Even though full-scale trapping efforts will not begin until 2012, the Reed Lab is currently requesting the donation of specimens, stomachs, or tissues of any species of monitor or tegu caught in Florida. In addition to samples, the Reed Lab is also interested in monitor and tegu sightings. For more information concerning the donation of specimens, stomachs, or tissues or to report monitor and tegu sightings, please contact: Jared Wood: Email - jpwood07@cardmail.louisville.edu; Phone (580-677-1608). ***Wood, J. and D. Reed, Department of Biology, University of Louisville, Louisville, KY***

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