RECORD OF THE YEAR 2010 - 2011

ADVANCES IN KNOWLEDGE

DEPARTMENT OF ENVIRONMETAL SCIENCES

INVASIVE AQUATIC PLANT PROGRAM

Surveillance and Monitoring Program- We are quantifying the presence of invasive aquatic plants in Connecticut's lakes and ponds, determining their effects on native plant communities, establishing baseline data to track their spread and providing information that is critical for developing control strategies.

During the 2010 field season, we mapped native and invasive aquatic vegetation in eight new and eleven previously surveyed water bodies. We now have complete aquatic vegetation surveys of 170 Connecticut lakes and ponds. To begin to discern how invasive plants are affecting plant communities' overtime, we resurveyed four lakes that we originally surveyed in 2004 or 2005. In addition, Lake Candlewood, Connecticut's largest lake, was surveyed for the fourth consecutive year to determine the effects of alternate year deep and shallow winter drawdown on invasive; *Myriophyllum spicatum* (Eurasian watermilfoil), *Najas minor* (minor naiad) and *Potamogeton crispus* (curly leaf pondweed). Lake Zoar (another large lake) was surveyed for the second time to track the long-term population dynamics of the same invasive species. Global positioning system (GPS) derived transects were established within each water body to quantitatively track changes in native and invasive aquatic species abundance and distribution over time. Water samples were collected from all lakes and ponds and analyzed for pH, temperature, dissolved oxygen, clarity, alkalinity, conductivity and phosphorus. This data, along with watershed information, is being used to investigate the factors that influence the susceptibility of water bodies to certain invasive species. We archive dry specimens of all plant species in the CAES herbarium for future reference. All information is incorporated into our publicly accessible Connecticut Agricultural Experiment Station (CAES) Invasive Aquatic Plant website (http://www.ct.gov/caes/IAPP).

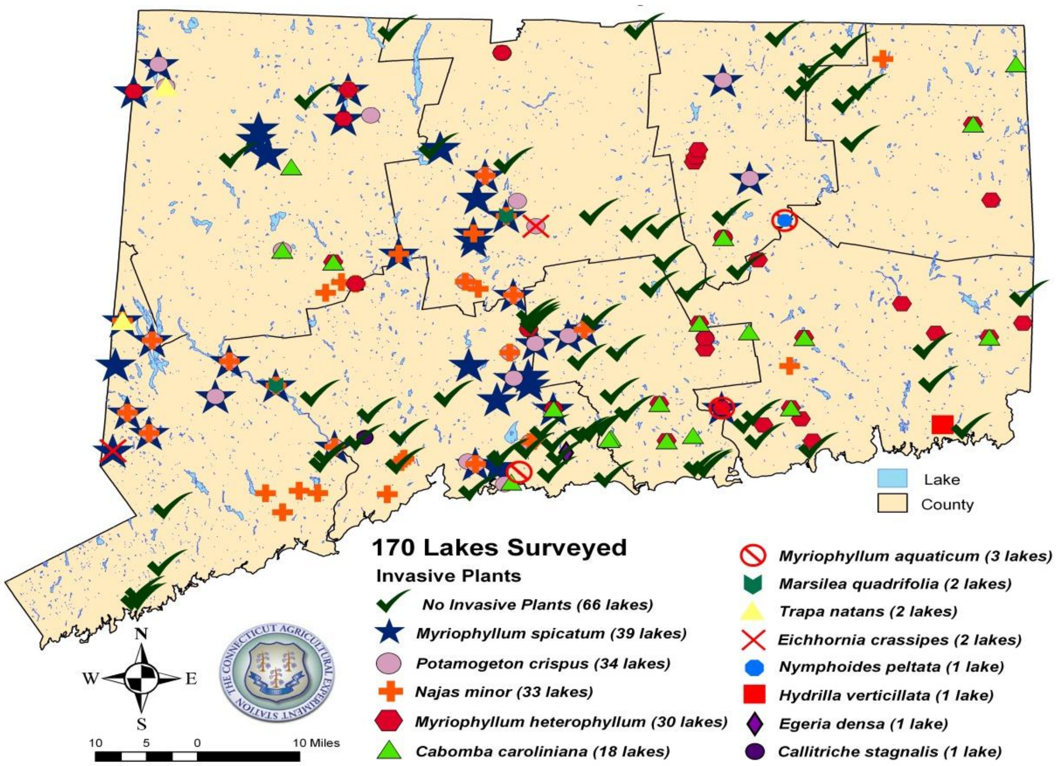

Figure 1. Locations of invasive aquatic plants found by CAES IAPP 2004 – 2010.

More than 60 percent of the surveyed water bodies contain one or more invasive plant species (Figure 1) and some lakes contained as many as four invasive species. The most common invasive plants are *M. spicatum*, *M. heterophyllum*, *N. minor*, *P. crispus* and *Cabomba caroliniana* (fanwort). Less common plants are *Eichhornia crassipes* (water hyacinth), *Marsilea quadrifolia* (water shamrock) and *Hydrilla verticillata* (hydrilla). Our survey of Fence Rock Lake in 2009 discovered Connecticut's first infestation of *Egeria densa* (Brazilian waterweed) and a resurvey in 2010 found it to successfully overwinter. We are working with the local lake association and the Connecticut Department of Energy and Environmental Protection (CT DEEP) to provide control options.

Our resurveys suggest *C. caroliniana* has the capability to out compete even tenacious invasive plants such as *M. heterophyllum*. We surveyed Cedar Lake, Chester, CT in 2004 and again in 2010 (Figure 2). In 2004, the coverage of *M. heterophyllum* and *C. caroliniana* was nearly the same (2.6 and 2.5 ha respectively). In 2010 the area of *C. caroliniana* increased to 5.9 ha while *M. heterophyllum* decreased to 1.9 ha. This trend also was evident in our resurvey of Lake Quonnipaug, Guilford, CT and agrees with anecdotal evidence from lake managers that *C. caroliniana* is increasing statewide.

We continue to investigate using aerial imagery as a surveillance tool. In 2009, we found United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP)

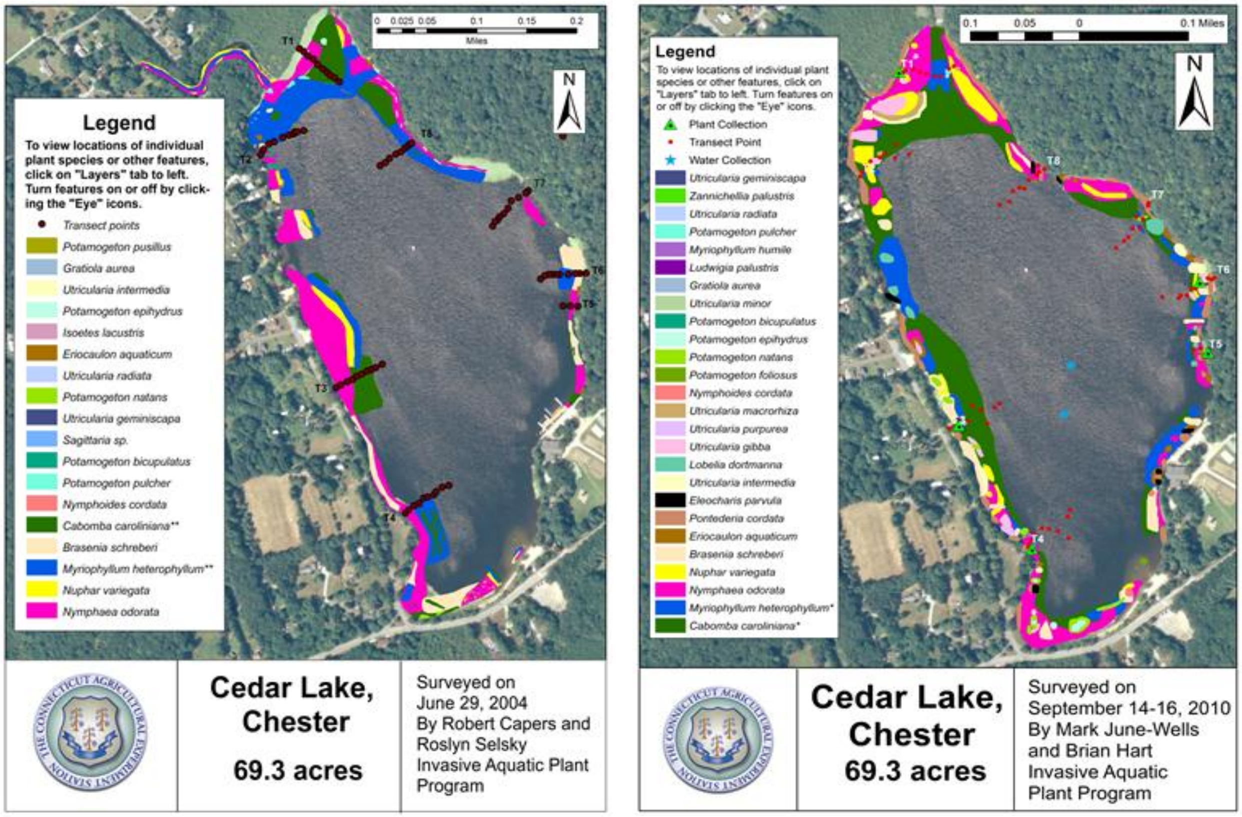

Figure 2. Comparison of aquatic plant communities in Cedar Lake between 2004 and 2010. *C. caroliniana* is dark green and *M. heterophyllum* is medium blue.

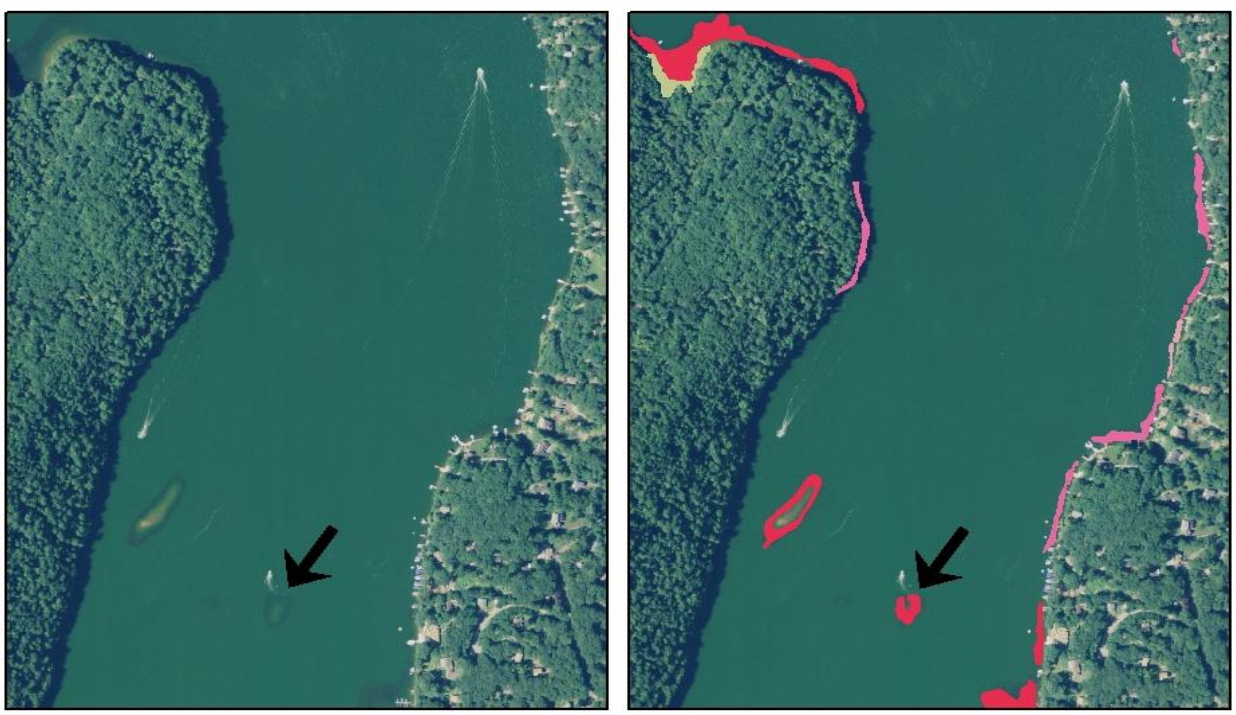

Figure 3. Remote sensing imagery suggested area (arrow left) was *M. spicatum*. This was confirmed by our field survey and an invasive polygon was added to map (arrow right). The other polygons (right) were found without remote sensing but their visibility in the imagery is striking.

Table 1. Predictive water chemistry ranges for each species group.

Species	Alk (mg/L)	Cond (us/cm)	pH	P-conc (ug/L)
Cabomba caroliniana *Myriophyllum heterophyllum*	0.0-28.5	39.4-107.2	5.65-6.96	1.4-27.4
Myriophyllum spicatum *Najas minor* *Potamogeton crispum*	17.5-77.0	107.6-232.3	6.31-8.07	0.000-85.5

imagery (full color) provided reasonably good viewing of the Eurasian watermilfoil beds in Candlewood Lake. In 2010, we compared the imagery to our 2009 field survey and identified four areas that appeared to have milfoil that we missed. These areas tended to be small humps in the center part of the lake where surveyors would expect it to be too deep to support milfoil (Figure 3). A revisit to the areas found all but one to be Eurasian milfoil. More sophisticated software is available for analyzing the imagery could improve our results. We will be investigating this in the future.

Our surveys provide one of the most complete aquatic plant and water chemistry databases available in any state. Using water chemistry and plant presence/absence data from 92 Connecticut lakes with invasive species, allowed us to developed risk assessment ranges for use by local resource managers and policy makers. Our multivariate statistical approach elucidated strong correlations among our five most abundant non-native aquatic plant species and the lake water chemistry variables; alkalinity (buffering), conductivity (total ions), pH (hydrogen ion concentration), and phosphorus concentration (trophic level). This approach allowed us to group lakes by species presence. Two groups derived from the correlation technique (Principal Component Analysis) were: 1) Lakes with *C. caroliniana* and *M. heterophyllum* and 2) Lakes with *P. crispus, N. minor,* and *M. spicatum*. This allowed for a multivariate regression technique to compare whether these groups were significantly different in regards to water chemistry. Our analysis detected highly significant differences among groups (Table 1). The *C. caroliniana* and *M. heterophyllum* group exhibited significant preferences for lakes with lower conductivity, alkalinity, and pH than the *P. crispus, N. minor,* and *M. spicatum* group. Finally, we found Discriminant Function Analysis was able to predict the presence of our five species with nearly 80 percent accuracy.

To prevent the spread of invasive species, Connecticut has enacted laws banning the sale and transport of invasive species. The States banned list contains 20 aquatic plants (Table 2). CAES IAPP evaluated aquarium retailer compliance with invasive aquatic plant mandates. In 2008 and 2010 seventy-five aquatic plant dealers were visited by our staff. All plant species that exhibited similar morphology, to the 20 banned species, were purchased and further identified morphologically. Because we could not positively identify many specimens, we obtained genetic sequences for each specimen and compared them to known genetic sequences in the GENBANK NCBI database. We found that 30% of the stores are selling banned aquatic species and that *Cabomba caroliniana* is the most common banned species being sold (Table 3). Moreover, the species *Egeria densa* (Brazilian waterweed) and species in the genus *Myriophyllum* were misidentified by the retailer more than 50% of the time (Table 3). We believe that this noncompliance to State law is primarily due to mislabeling, difficulties in identifying many

Table 2. Invasive aquatic species banned under Connecticut State Statutes (Sec.22a-381d). Invasive species found in Connecticut lakes and ponds in bold.

#	SCIENTIFIC NAME	COMMON NAME
1	*Butomus umbellatus* L.	Flowering rush
2	***Cabomba caroliniana* Gray**	**Fanwort**
3	***Callitriche stagnalis* Scop.**	**Pond water-starwort**
4	***Egeria densa* Planch.**	**Brazilian water-weed, Anacharis, Egeria**
5	***Hydrilla verticillata* (L. f.) Royle**	**Hydrilla**
6	*Iris pseudacorus* L.	Yellow iris, Yellow flag iris
7	*Lythrum salicaria* L.	Purple loosestrife
8	***Marsilea quadrifolia* L.**	**European waterclover, Water shamrock**
9	*Myosotis scorpioides* L.	Forget-me-not, Water scorpion-grass
10	***Myriophyllum aquaticum* (Vell.) Verdc.**	**Parrotfeather**
11	***Myriophyllum heterophyllum* Michx.**	**Variable-leaf watermilfoil**
12	***Myriophyllum spicatum* L.**	**Eurasian watermilfoil**
13	***Najas minor* All.**	**Brittle water-nymph, Minor naiad**
14	*Nelumbo lutea* (Willd.) Pers.	American water lotus
15	***Nymphoides peltata* (S.G. Gmel.) Kuntze**	**Yellow floating heart**
16	***Potamogeton crispus* L.**	**Curly leaf pondweed, Crispy-leaved pondweed**
17	*Rorippa microphylla* (Rchb.) H.Hyl.	Onerow yellowcress
18	*Rorippa nasturtium-aquaticum* L. Hayek	Watercress
19	*Salvinia molesta* D.S. Mitch.	Giant salvinia
20	***Trapa natans* L.**	**Water chestnut**

Table 3. Connecticut pet stores selling banned invasive aquatic macrophytes in 2008 and 2010.

Year	Stores (n)	Stores Selling Banned Plants (n)	Stores Selling Banned Plants (%)	Stores Selling *Cabomba caroliniana* (%)	Stores Selling *Egeria densa* (%)
2008	28	8	28	14	14
2010	47	14	29	23	11

aquatic plant species and ignorance of state statutes. CAES IAPP has begun educating retailers by offering workshops and distributing copies of the Invasive Aquatic Plant Identification Guide produced in 2010 as part of this program. In addition, our work has provided valuable information to the CT DEP who is charged with inspecting aquarium retailers and enforcing the laws regarding the sale of the banned plants.

Control efforts- The goal of this objective is 1) to investigate novel means of chemical control that minimizes herbicide usage and protect native vegetation and 2) find biological organisms that will provide long-term suppression of invasive species particularly Eurasian watermilfoil

Herbicides - Novel methods of chemical control with herbicides can rapidly remove invasive plants and begin to restore native plant communities to aquatic ecosystems.

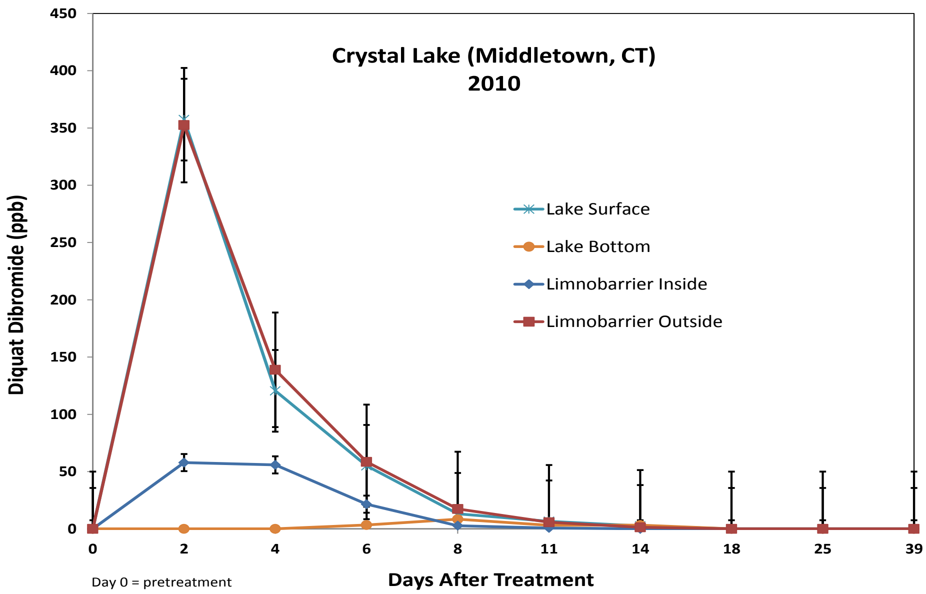

Figure 4. Degradation of diquat dibromide after spring treatment for *Potamageton crispus*.

1. <u>*Bashan Lake – East Haddam, CT*</u> - We are in the 12th year of research involving the use of spot applications of the herbicide 2, 4-D to control *M. heterophyllum* in Bashan Lake. We have largely restored the lake to preinfestation conditions; however, regrowth requires yearly surveys and modest retreatments. For a sixth consecutive year, we have shown the effectiveness of late summer herbicide applications thus limiting the exposure of those who use the lake to the herbicide. We have integrated underwater video equipment with GPS and geographic information system (GIS) technology to precisely locate and treat the patches of *M. heterophyllum*.

2. <u>*Crystal Lake- Middletown, CT*</u> - Crystal Lake has extensive growth of *Potamogeton crispus* and *Myriophyllum spicatum*. Chemical control efforts have been hampered due to the presence of the threatened plant species *Potamogeton vaseyi*. We used limnobarriers to isolate the beds of *P. vaseyi* and treated the lake in late April with diquat dibromide to remove the invasive plants. After several weeks, the unwanted vegetation was controlled. By late summer, re-growth of curly leaf pondweed had begun but no Eurasian milfoil was observed. This trend continued in 2008 with re-growth of the *P. crispus* to pretreatment levels but virtually no re-growth of the *M. spicatum*. This near complete elimination of *M. spicatum* by the April diquat treatment may be a new tool for controlling this plant but further study is needed. In 2008, a survey for *Potamogeton vaseyi* by CT DEP found that the plant was growing well; however, none was located in 2009. Eight species of native plants were found the year after treatment compared to only four the year prior to treatment. This resurgence in native species suggests that the early season application of diquat, and associated reduction in invasive species pressure, may be beneficial to the plant community. Longer term control of the curly leaf pondweed probably requires reducing its bank of reproductive structures in the sediment called turions. Consecutive early season diquat applications were made in 2009 and 2010 to test theory. Again, limnobarriers were installed and plant populations were monitored. In 2010, in collaboration with the CAES Department of Analytical Chemistry, we monitored the movement and degradation of the diquat

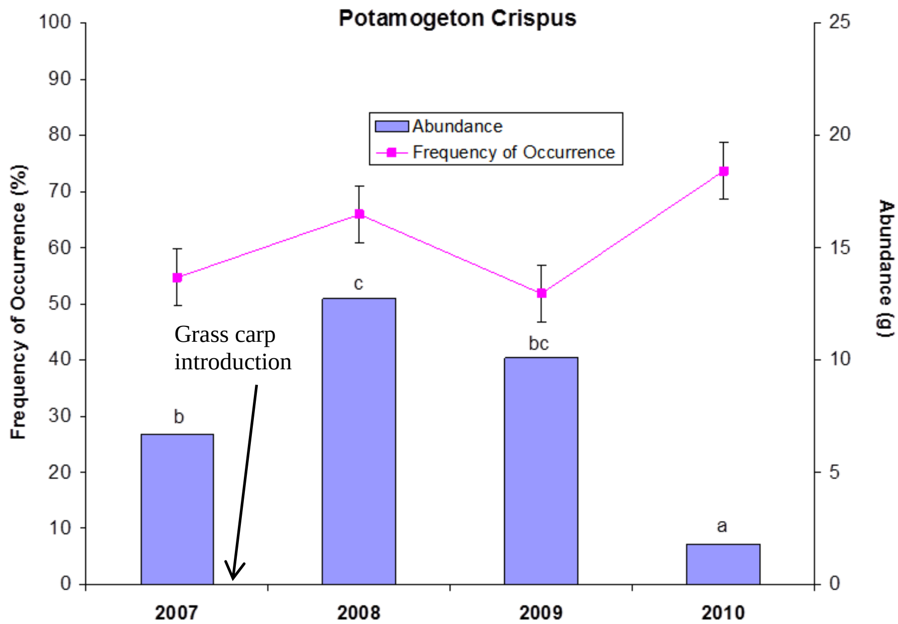

Figure 5. The yearly effects of grass carp herbivory on the frequency of occurrence and the abundance of *Potamogeton crispus* in Grannis Lake, East Haven, CT.

herbicide. We tested the water inside the limnobarriers, just outside the limnobarriers and in the central parts of the lake (surface and bottom), for diquat dibromide for 39 days to monitor its dissipation (Figure 4). The limnobarriers provided substantial reduction in diquat concentrations with levels reaching only near 50 ppb inside compared to 350 ppb outside. Interestingly, the diquat never reached the lake bottom (the herbicide was injected at a depth of 0.5 meters and mixed by the boat propeller) and this may protect native plants that are just starting their new season growth.

Biological control **-** Our biological control program has now been in progress for four years. This year's efforts followed two lines of investigation.

1**.** *Grannis Lake- East Haven, CT* - This was the seventh year of study at Grannis Lake, which has the problematic populations of *M. spicatum, P. crispus* and *N. minor*. After many years of unsuccessful attempts to control the invasive species with herbicides we introduced plant eating fish called grass carp (*Ctenopharyngodon idella*). A total of 200 sterile (triploid) fish averaging 25 cm (10 inch) in length were introduced into the 20 acre lake in September of 2007. We monitored over 200 georeferenced sites in the lake for the effects of the grass carp on both native and invasive plant species. After no decrease in vegetation in 2008 and 2009, our survey in May 2010 finally showed the fish were reducing the abundance (mass per point) of the invasive species (Figure 5). Interestingly, the frequency of occurrence has not yet been reduced and suggests that the fish are consuming the suspended vegetation without any appreciable reduction in basal plant parts. With continued feeding the frequency of occurrence should begin to decline. We expect to restock Grannis Lake, in 2011 or 2012, in conformance with CT DEP guidelines.

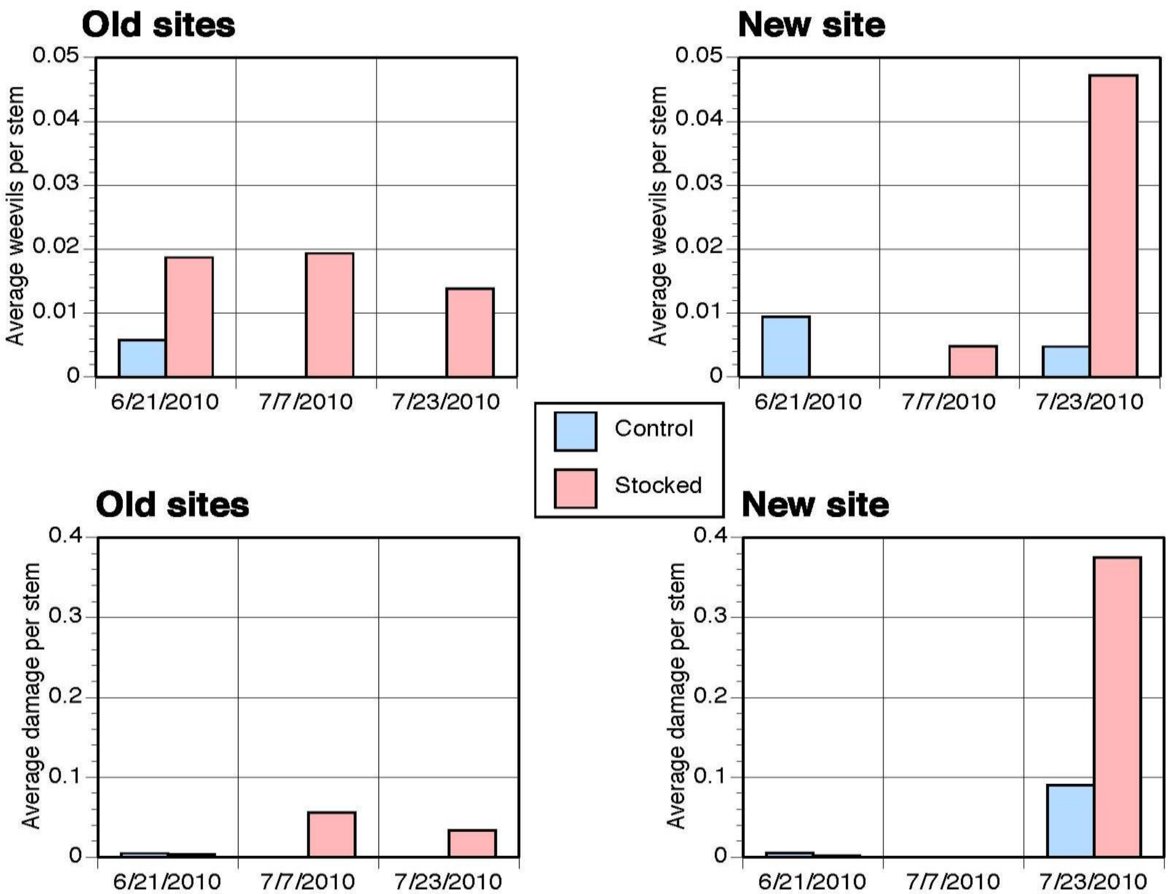

Figure 6. The effects of milfoil weevil augmentation on weevil abundance and stem damage in Candlewood Lake (courtesy of Mitch Wagner, WSCU).

2. Candlewood Lake - Brookfield, New Fairfield, New Milford, Sherman, CT - We have continued our research on the interactions between Eurasian watermilfoil and the milfoil weevil (*Euhrychiopsis lecontei*). We have found that this insect has controlled Eurasian watermilfoil in other states and is native to most lakes with Eurasian watermilfoil in CT. Unfortunately, weevil populations in CT are rarely high enough to cause a significant reduction in milfoil. We are currently conducting two long-term investigations on augmenting milfoil weevil populations to determine if control of Eurasian watermilfoil will result. The first project is in Candlewood Lake. Although Candlewood Lake contains over 350 acres of Eurasian watermilfoil, our surveillance found the weevil to be nearly nonexistent. This offered an excellent opportunity to determine if weevil augmentation can increase the long-term population. CAES in collaboration with Western Connecticut State University (WSCU), the Candlewood Lake Authority and EnviroScience, Inc. introduced 10,000 weevils into three sites in 2008. In 2009, the weevil population in the sites changed little from pretreatment densities. In 2010, an additional 5000 weevils were stocked into an old site and 11,000 weevils were stocked into a new site. Weevils and damage were monitored in the old and new sites in 2010 and small increases were noted when compared to control sites (Figure 6).

Our second milfoil weevil investigation site is located at Indian Lake, in Sharon, CT. The Indian Lake Association initiated a weevil stocking program in 2008. We monitored milfoil and weevil populations prior to augmentation and are currently following populations in a manner similar to that of Candlewood Lake. Unlike Candlewood Lake, Indian Lake already had an abundant weevil population prior to augmentation. Our preliminary data shows that average weevil populations in the augmented areas were similar (1.25 weevils/stem) to the non-augmented areas.

Molecular identification and population genetics- The goal of this objective is three fold; 1) to develop a molecular-based system for plant identification, 2) to utilize microsatellite markers for distinguishing among populations of the milfoil weevil and 3) to determine whether genetic differences in variable milfoil are present and if differences effect invasiveness.

We are largely finished with developing our database of plant DNA sequences for molecular identification of the aquatic invasive and native species. We have positively identified and sequenced at least one gene from 56 different aquatic plant species and have sequenced all three genes (small ribosomal subunit, internal transcribed spacer ribosomal DNA, atpB-rbcL spacer region) from 41 species. We have submitted 130 sequences to GenBank (http://www.ncbi.nlm.nih.gov/Genbank/index.html) where they are now available to researchers worldwide. We have discovered that for certain species interference by other plant constituents makes DNA extraction difficult. Consequently, we have developed novel methods using cesium chloride/ethidium bromide density gradients and ultracentrifugation to effectively isolate and purify DNA bands. We have been able to use our database and molecular sequencing technology to identify or eliminate from possibility, several aquatic plant isolates. We used our molecular identification technology to distinguish species of banned plants being sold in Connecticut aquarium retailers and believe state policy should include the genetic sequences of individual species as an enforcement protocol.

We have completed the isolation of 12 microsatellite markers for distinguishing among populations of the milfoil weevil (*E. lecontei)*. In addition to cloning and sequencing six putative microsatellite loci we have obtained a rough 454 genomic sequence at the Yale Biotechnology Center for the *E. lecontei* genome. With that information we were able to quickly develop more microsatellite loci. This up-coming year we will use these markers to examine differences among populations of this biological control agent in Connecticut water bodies. This information could be extremely valuable in determining how well the augmented weevil populations are doing in lakes as they can be differentiated from their native counterparts by small genetic differences.

We collaborated with Dr. Ryan Thum at Grand Valley State University (Michigan) regarding genetic differences in variable leaf watermilfoil (*Myriophyllum heterophyllum*) that may be contributing to increased invasiveness. It has become widely accepted that pre and post-introduction hybridization, among previously isolated lineages, can play an important role in the evolution of invasiveness. Indeed, molecular investigations have revealed a number of invasive taxa as hybrid lineages as well as revealing intraspecific hybridization following multiple introductions of genetically distinct founding populations. Cryptic biological invasions where hybrid and multiple "pure" lineages have independently invaded a region offer a unique opportunity to test whether hybrid lineages are more invasive than pure lineages.

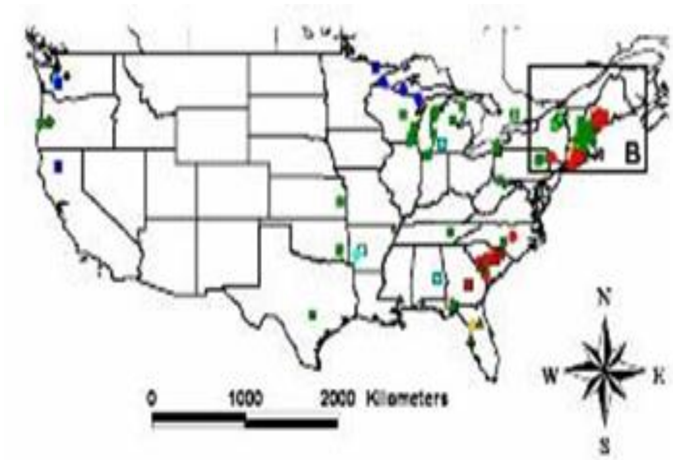

Figure 7.Genetic variation in the native and introduced ranges of *M. heterophyllum*. Different colors correspond to different genotypes. Box B denotes locations in the northeast where samples were obtained in 2010.

The variable-leaf watermilfoil (*Myriophyllum heterophyllum*) invasion in New England provides such an opportunity because it has been independently invaded by three cryptic lineages: an interspecific hybrid (*M. heterophyllum x M. laxum*) and two historically allopatric lineages of pure *M. heterophyllum*. We obtained *M. heterophyllum* samples, from throughout New England (Figure 7), and investigated the potential role of hybridization by combining an analysis of gene flow using AFLPs with quantitative comparisons of 'invasiveness' among lineages in both the field and in greenhouse mesocosms (100 gallon tanks). We found no evidence of gene flow among the three distinct introduced lineages even where they co-occurred. This demonstrates that post-introduction hybridization has not played a significant role in the evolution of invasiveness within the invaded range. In contrast, the hybrid lineage exhibited more invasive characteristics relative to pure lineages in natural water bodies and mesocosms, providing evidence that hybridization has played a role in the evolution of some invasive traits. We did find, however, a significant interaction among lineage and manipulated environmental factors in our mesocosms, suggesting that observed level of 'invasiveness' results from a genotype x environment interaction. Thus, while hybridization can play an important role in the evolution of invasiveness, multiple introductions of ecologically distinct lineages, that have remained distinct following their introductions, may play an important role in the overall success and spread of 'variable leaf milfoil' in New England.

Outreach - We strive to disseminate all information from our program to the public in a timely fashion and educate stakeholders in the identification, prevention and management of invasive aquatic species.

Approach- Given the magnitude of invasion by non-native aquatic plants, we are making significant efforts to engage citizens, lake associations, and other stakeholders. CAES scientists have organized several workshops on the identification of invasive aquatic plants. We have assembled numerous publications that are freely available in hard copy or electronically via our website (http://www.ct.gov/caes/IAPP). Included are all publications in downloadable formats, as well as the digitized interactive maps of all surveyed lakes and our complete herbarium. CAES scientists have also given presentations to professional organizations such as the Northeast Aquatic Plant Management Society (NEAPMS), the Connecticut Conference on Natural Resources (CCNR), the New England Chapter of the North American Lake Management Society (NEC-NALMS), North American Lake Management Society (NALMS), the Northeast Arc User Group (NEARC) and students groups such as the Connecticut Envirothon (Figure 8).

Figure 8. Greg Bugbee gives and an invasive aquatic plant workshop at the 2010 CT Envirothon.

CAES IAPP Public Outreach 2010-2011

7/17/2010 – Greg Bugbee spoke at the annual meeting of the Bashan Lake Association on "Update on Controlling Variable Milfoil in Bashan Lake" (approx. 50 attendees) in East Haddam.

7/30/2010 – Greg Bugbee was interviewed by freelance writer Bob Pollack on "CAES research on invasive aquatic plants."

8/4/2010 – Greg Bugbee gave two demonstration talks on "Identifying Invasive Aquatic Plants" at CAES Plant Science Day in Hamden, CT (approx. 50 attendees).

9/24/2010 – Greg Bugbee spoke to a class from the Hooker School, in New Haven, on "Invasive Aquatic Plants" (approx. 25 attendees).

10/14/2010 – Greg Bugbee spoke on "Connecticut's Invasive Aquatic Plant Problem – Searching for Solutions" at the Annual Connecticut Invasive Plant Working Group Conference at UCONN (approx. 60 attendees).

10/30/2010 – Greg Bugbee gave a seminar on "Using GIS in the Surveillance and Management of Invasive Aquatic Plants" as part of the CT DEP wetlands training workshop at Quinebaug Community College in Danielson (approx. 40 attendees).

11/4/2010 – Greg Bugbee gave a seminar entitled “Using GIS in the Surveillance and Management of Aquatic Vegetation” at A CT DEP wetlands commissioners workshop at Housatonic Community College in Bridgeport (30 attendees).

11/16/2010 – Greg Bugbee gave a seminar entitled “Using GIS in the Surveillance and Management of Aquatic Vegetation” at A CT DEP wetlands commissioners workshop at the UCONN campus in Torrington (32 attendees).

11/17/2010 – Greg Bugbee spoke on “Using GIS in the Surveillance and Management of Aquatic Vegetation” at GIS day at Central Connecticut State University (approx. 50 attendees).

11/22/2010 – Greg Bugbee spoke to a group of students from Post University on “Soil Testing and Invasive Aquatic Plants” (approx. 12 attendees).

12/1/2010 – Greg Bugbee reported on the 2010 invasive aquatic plant survey of Candlewood Lake at a technical committee meeting at the CT DEP in Hartford.

12/4/2010 – Greg Bugbee gave a seminar on “Using GIS to Control Invasive Aquatic Plants” at a workshop for wetlands commissioners at the UCONN Business School in Hartford (Approx. 75 attendees).

1/18-20/2011: Greg Bugbee and Mark June-Wells administered the multistate “Aquatic Supervisory License Recertification Program” at the annual Northeast Aquatic Plant Management Association Conference in New Castle New Hampshire.

2/12/2011 – Greg Bugbee and Jordan Gibbons gave two “Invasive Aquatic Plant Identification Seminars” at the CT Envirothon at Connecticut College (approx. 80 attendees).

2/17/2011 – Greg Bugbee gave a talk on “Connecticut’s Invasive Aquatic Plant Problem” at the CT River Museum in Essex (approx. 40 attendees).

3/7/2011 –Mark June–Wells gave a talk entitled “Water Chemistry Preferences of Five Non-native Aquatic Macrophyte Species in CT USA” at the Connecticut Conference of Natural Resources in Storrs, CT (approx. 50 attendees).

3/10/2011 – Greg Bugbee and Jordan Gibbons gave an Aquatic Plant Workshop at Three Rivers Community College in New London (approx. 35 attendees).

3/26/2011 – Greg Bugbee and Michael Cavadini lead the “Awesome Aquifer” event at the 2011 Science Olympiad at Hartford Academy (approx. 40 attendees).

3/28/2011 –Mark June –Wells gave a talk entitled “Water Chemistry Preferences of Five Non-native Aquatic Macrophyte Species in CT USA” at the Northeast Association of Environmental Biologists in Sturbridge, MA (approx. 50 attendees).

4/1-2/2011 –Mark June –Wells gave a talk entitled “Water Chemistry Preferences of Five Non-native Aquatic Macrophyte Species in CT USA. Society of Ecological Restoration, 2011 Annual Conference, Baltimore, MD.

4/7/2011 – Greg Bugbee and Jordan Gibbons participated in the Connecticut Aquatic Nuisance Species Working Group Meeting at Avery Point in Groton (approx. 50 attendees).

4/26/2011 - Greg Bugbee and Jordan Gibbons gave an invasive aquatic plant workshop to the Middlebury Land Trust (40 attendees)

4/29/2011 - Greg Bugbee and Jordan Gibbons gave an invasive aquatic plant workshop to high school students participating in Project CLEAR at Western Connecticut University (30 attendees).

5/7/2011 – Greg Bugbee spoke at a meeting of the Bashan Lake Association on "Update on Controlling Fanwort in Bashan Lake" (approx. 50 attendees) in East Haddam.

5/17/2011 – Greg Bugbee and Jordan Gibbons spoke to the Northeast Arc Users Group at the annual meeting of the Bashan Lake Association on "Using GIS in the Surveillance and Management of Aquatic Vegetation" (approx. 50 attendees) at Smith College, North Hampton, MA.

SOIL TESTING AND INFORMATION

We test soil for fertility and suggest methods for growing better plants in an environmentally sensitive manner for citizens of Connecticut. At the laboratory in New Haven, Mr. Bugbee tested 6100 samples and answered 1862 inquiries.

PUBLICATIONS

1. Bugbee, G.J. and M. E. Balfour. 2010. Identification Guide to Connecticut's Invasive Aquatic Plants. CAES Bulletin 1027. 37 pp.

2. Bugbee, G.J. 2010. Control of variable watermilfoil in Bashan Lake 2010. Technical Report for town of East Haddam and Bashan Lake Association.

3. Bugbee, G.J. 2011. "Control of *Potamogeton crispus* and *Myriophyllum spicatum* in Crystal Lake, Middletown, CT, 2009." Technical report for CT DEP and the town of Middletown, CT.

4. Bugbee, G.J. 2011. Invasive aquatic plants in Lakes Candlewood, and Zoar. Monitoring Report 2010. Technical report for Federal Energy Regulatory Commission.

5. Vossbrinck, C., J.C. White, G.J. Bugbee, K. Prapayotin-Riveros, M. Marko, R. Thum, Ryan, E. LaRue, N. Havill. Isolation of microsatellite markers for the watermilfoil weevil *Euhrychiopsis lecontei*. Molecular Ecology Resources. *accepted for publication*.

6. Thum, A.R., M.P. Zuellig, R.L. Johnson, M.L. Moody, C. Vossbrinck. 2011. Molecular Markers reconstruct the invasion history of variable leaf watermilfoil (*Myriophyllum heterophyllum*) and distinguish it from closely related species. Biol. Invasions. Published online 04 January 2011.

7. June-Wells M., Capers R., Bugbee, G.J. 2011. Water Chemistry Preferences of Five Non-native Species in Lakes of Connecticut, USA: Using the Community Assembly Hypothesis to Predict Non-native Species Invasion. Journal of Applied Ecology (in review).

8. Tavalire, H.F., G.J. Bugbee, E.A. LaRue, R.A. Thum 2011.The roles of hybridization and cryptic ecological diversity in a biological invasion. Evolution - 2011 (abstract).

9. June-Wells, M., C. R. Vossbrinck, and G.J Bugbee. 2011. The aquarium trade: A potential risk for non-native plant introductions in Connecticut, USA. Lake and Reservoir Management (in review).

SCIENTIFIC OFFICERSHIPS AND MEMBERSHIPS ON STATE, NATIONAL, OR REGIONAL COMMITTEES

- Government Affairs Committee, New England Aquatic Plant Management Society
- Editor – Journal of Aquatic Plant Management
- Director, Clear Lake Improvement Association
- Member, Northeast Soil Testing Committee, NEC-67