J. Aquat. Plant Manage. 38: 1-4

Presidential Address

DAVID F. SPENCER[1]

Good morning ladies and gentlemen. Welcome to the 39th Annual Meeting of the Aquatic Plant Management Society (APMS). This Society is a unique blend of people with interests in all aspects of aquatic plant management. Service as an officer has provided me with a wonderful opportunity to interact with many talented and highly skilled members of this group. One person who has served the Society extremely well during the past year, under some very difficult circumstances, is the Chair of the Local Arrangements Committee, Eric Barkemeyer. We all owe Eric a big thank you, and if you see him this week, please mention it to him. A few years ago, when I was asked to accept nomination as Vice-President, a course that eventually leads one to being President of the Society, I was greatly honored. However, if I had been fully aware of the enormity of my present duty, preparing and presenting an address to such a gathering, I might have reconsidered. This morning my purpose is to provide a brief introduction to our meeting site, describe the status of the Society, and give a brief review of what in my opinion are some important recent advances in the science that provides the basis for sound aquatic plant management.

Our meeting this week is in Asheville, North Carolina, seat of Buncombe Co., at the confluence of the French Broad and Swannanoa rivers. Asheville is a place with a long history, being incorporated in 1882. Asheville is a commercial and manufacturing center and a mountain resort. Tourist attractions include the boyhood home of the American writer Thomas Wolfe, and Biltmore, an estate built by Richard Morris Hunt for the American philanthropist George W. Vanderbilt (1862-1914), and the University of North Carolina at Asheville (1927). Asheville is named for Samuel Ashe (1725-1813), who was governor of North Carolina in the 1790s.

One of Asheville's most celebrated citizens was Thomas Wolfe. Not far from here stands his mother's boarding house which he immortalized as "Dixieland" in his epic autobiographical novel, *Look Homeward Angel*. This work provided a description of the lives of ordinary people and was so frank that it was banned from Asheville's public library for over seven years. It is a classic of American literature and has never gone out-of-print since it publication in 1929.

Asheville is the eighth largest city in North Carolina whose inhabitants number some 7.5 million. In a way it's appropriate that we meet in North Carolina. In ancient times the entire eastern portion of the state was underwater and the domain of giant megladon sharks. Today, North Carolina has a bustling economy led by real estate, health services, chemicals, construction, banking, tobacco, and textiles. Aquaculture is a growing concern in the state. There are more than 110 aquaculture facilities in North Carolina which produce trout, catfish, striped bass, crayfish, and soft shell crabs that worth about $16 million annually.

Now, I would like to inform you of what has been happening with APMS. Since it's founding in Florida nearly 40 years ago, the Society has grown to include more than 400 members in 40 states and some 21 countries worldwide. APMS has seven regional chapters (Florida, Midsouth, Midwest, Nile Basin, South Carolina, Texas, and Western). Nile Basin, the newest chapter, was founded two years ago and will soon hold its first annual meeting. Plans are also under way to form a chapter that will cover the northeastern United States. APMS continues to publish the Newsletter (three times a year) and the *Journal of Aquatic Plant Management*. The *Journal* presently comprises 36 volumes with over 700 individual contributions on aquatic plant management. The *Journal* is received by more than 70 libraries at universities around the world.

Our newest method of communicating with members is the APMS home page (www.apms.org) on the world wide web. At the moment you can find the Society's bylaws, operations manual, and a directory that includes telephone numbers and e-mail addresses among other items. As with most home pages it's still evolving. If you have suggestions for features or subject to include, feel free to contact the webmaster, Dave Petty, whose address is on the page, or any member of the Board.

I am pleased to report that APMS is financially sound.

APMS is a conference member of the WSSA (Weed Science Society of America) which allows us to participate in WSSA's liaison office in Washington DC. This has afforded APMS the opportunity to comment on national policy issues that relate to weeds and weed management. APMS is also a member of CAST (Council for Agricultural Science and Technology). CAST produces high quality reports on issues that affect all aspects of agriculture including topics such as invasive weeds. APMS is also a member of the Aquatic Ecosystem Restoration Foundation (AERF). In addition, we have a memorandum of understanding (MOU) with BASS (Bass Anglers Sportsmen Society). This MOU provides a way for our two groups to interact on matters that are of mutual interest. These partnerships have provided a way for APMS to amplify its presence and do some things that are not otherwise possible.

This year marks a very exciting beginning for APMS. For the first time the Aquatic Plant Management Graduate Scholarship will be awarded at this meeting. One goal of the founders was to "to provide for the scientific advancement of members of the society, to encourage scientific research, to promote university scholarship, and to extend and develop public interest in the aquatic plant science discipline" APMS has joined with the regional chapters each of whom has contributed at least $1,000 dollars and the AERF to offer a graduate scholarship worth $16,000 for each of two years.

[1]USDA-ARS Exotic and Invasive Weeds Research Unit, Robbins Hall, 1 Shields Avenue, Davis, California, 956116. Presented at the 39th Annual Meeting of the Aquatic Plant Management Society, July 1999 in Asheville, North Carolina.

Another new opportunity for the Society has come from our interaction with BASS. After considerable discussion within APMS and a meeting held earlier this year between representative of APMS, BASS, and American Fisheries Society, these three groups, all of whom have interests relating to watery habitats, have agreed to hold a national symposium on aquatic vegetation management. APMS' interactions with BASS began more than a decade ago with contacts made by Ken Langeland. Since then, David Tarver, Steve de Kozlowski, Lewis Decell, Jeff Schardt, and others have worked to foster this interaction and keep the lines of communication open. We have great hopes for this national meeting which will be held next year, possibly in conjunction with our meeting in San Diego.

Now, I would like to turn your attention to recent advances in applied ecology that, in my opinion, have had and will continue to have important impacts on aquatic plant management. Ecology is the branch of science which seeks to answer questions about the abundance and distribution of organisms. Two specific questions that are relevant to us are:

Why does this plant grow here?

Why is it more abundant here than there?

If we were able to provide complete answers to these questions for species of weedy aquatic plants, we might manipulate their environment so as to reduce or eliminate the major problems caused by aquatic weeds. In this context, environment is broadly defined to include both abiotic (temperature, light, nutrients, substrate, etc.) and biotic (competition, herbivory) components. In their excellent review, Barko et al. (1986) summarized the available knowledge on how many abiotic components (temperature, light, nutrient availability, substrate properties) affect aquatic weed distribution and abundance. Since that time, there have been significant contributions to understanding of another important abiotic factor, water movement or flow, and how it affects aquatic plant management and indirectly aquatic weed distribution and abundance.

Studies by Getsinger et al. (1990) documented that flow patterns inside a weed bed were clearly different from those adjacent to the weed bed and speculated that this information might be useful in weed management efforts. This paper marked an important recognition that elements of the aquatic environment impact management efforts. Other researchers (Fox et al. 1991, 1993, 1994, Fox and Haller 1992, Turner et al. 1994) demonstrated that flow patterns could be studied using dyes and that dye movements were closely correlated with those of herbicides that were applied at the same time.

Subsequently, there was a series of papers (Green and Westerdahl 1990, Lembi and Chand 1992, Netherland and Getsinger 1992, Netherland et al. 1991, 1993, Van and Vandiver 1994) reporting the relationships between herbicide concentrations and length of exposure and weed impacts. These studies dovetailed nicely with the information from the water movement studies and led to treatment schemes that attempted to use this information to optimize the treatment conditions. For example, in habitats with shorter exposure times (due to water movements) higher herbicide concentrations were needed. Conversely, situations with longer exposure times meant that less herbicide would be needed. It is my opinion that this information has greatly influenced the field of aquatic plant management, spurring product development and, in some instances, changing the way aquatic herbicides are applied. Using this kind of information, it is possible to understand and thus prevent some of the variation in efficacy. In fact it may be possible to treat weed problems in areas that previously were not feasible, such as in some rivers or tidal areas (Fox et al. 1994, Getsinger et al. 1997).

In their review Barko et al. (1986) did not cover the roles played by biotic components in regulating aquatic weed distribution and abundance. In fact they commented that while biotic components were undoubtedly important, relatively little was known about them. Competition is one such biotic interaction. An important concept that ecologists know as the competitive exclusion principle suggests that organisms with the same growth requirements are not able to live in the same place over a long period of time, if one of the resources (such as a particular nutrient or light) required for growth is in limited supply. The role that competition plays in determining which plants live where, is an area of very active research for people who work with plant communities either on land or in the water. Much controversy about this idea remains. An important problem for competition studies is identifying which resource limits growth.

In 1991, an article appeared which provides some of the most compelling and convincing evidence for the importance of competition in aquatic plant communities. This study documented with real numbers the impact that invasive species have on native plant communities. In this study, Madsen et al. (1991) established permanent plots and recorded the abundance of Eurasian watermilfoil (*Myriophyllum spicatum*) and of native plant species over time. Their data document development of the Eurasian watermilfoil canopy over time. They reported that Eurasian watermilfoil frequency did not change, reflecting the fact that the Eurasian watermilfoil was present in nearly all of the subplots in their study. Conversely, plant cover (the proportion of the surface taken up by Eurasian watermilfoil) increased linearly over the three years of their study. Concurrently with these changes in Eurasian watermilfoil, Madsen et al. (1991) observed a decrease in the number of native plant species present in their plots. The data indicate that Eurasian watermilfoil abundance did not change that much, but that the canopy became more fully developed over the three year period studied. This information combined with other data, which clearly show that a closed canopy of Eurasian watermilfoil greatly reduces light penetration (Madsen 1997a), explains the decline in the number of native species present under the Eurasian watermilfoil canopy. This elegant study confirms observations made in many lakes that had been invaded by Eurasian watermilfoil and provides a mechanism to explain how the changes occurred. This information is significant because it demonstrates Eurasian watermilfoil's impact on a newly invaded water body. Unless a reduction in the diversity of native plant species is desirable, then in many cases management efforts are needed to prevent Eurasian watermilfoil from becoming the dominant aquatic plant in a given habitat. The study by Madsen et al. (1991) clearly demonstrates that doing nothing is not a viable choice if diverse aquatic plant communities are the goal.

Studies with terrestrial plants indicate that plants that start growing earlier in the growing season may be better competitors. So in some situations, such as areas in newly formed bodies of water, information on competitive abilities of aquatic plants dictate that it may be advantageous to take pre-emptive action and plant species which are either more compatible or easier to manage. Butts et al. (1991) offer guidelines for some Florida ecosystems, but much remains to be learned before similar guides can be produced for aquatic systems in other geographic regions.

Plant characteristics change seasonally. Seasonal changes are affected by environmental factors and they may in turn affect a plant's response in the face of competitors or herbivores. Knowledge of these changes and the ability to predict their occurrence may be applied to aquatic plant management. For example, it may be possible to identify growth stages that are especially susceptible to treatments, which remove the plant's stems and leaves, the site of photosynthesis. Ross and Lembi (1985) state, "In many perennial weeds, the period in which underground reserves have been maximally depleted and carbohydrate is beginning to move back down to form new underground structures occurs when the plant has attained approximately one-fourth of its maximal height or is at the early flower bud stage. This time is ideal for initiating treatments . . . which result in top removal and the exhaustion of storage materials. It also is an ideal time for using . . . translocated herbicides." Aquatic plant managers are not yet able to predict the occurrence of such susceptible periods for many aquatic weeds, but progress is being made.

Luu and Getsinger (1990) reported on the seasonal allocation of carbohydrates by water hyacinth grown in Vicksburg, Mississippi, and concluded that a potential weak point in the life cycle occurred around mid-September to mid-October when the plants were actively storing carbon in their stem bases. Madsen and Owens (1998) followed levels of stored reserves in dioecious hydrilla grown in Lewisville, Texas. They were able to clearly identify periods when stored reserves were lowest and speculated that the plant was especially susceptible to management techniques during these periods. In a similar study Madsen (1997b) reported susceptible periods for Eurasian watermilfoil. More studies of this type are needed to determine if the low points occur at the same time in lakes and rivers in different geographic regions. We also need to develop the ability to predict the occurrence of these susceptible periods either from some easily measured environmental parameter or some correlated plant characteristic.

What about the future of aquatic plant management? Solley et al. (1998) reported on water use patterns in the United States between 1950 and 1995. Their data show a clear increase in the demand for surface water from 1950-1980. After that the demand has leveled off due to conservation and improved methods of irrigation. However, given the likely population increase there will always be a need for high quality water for extractive uses and for aesthetic or recreational purposes. Given the known impacts of aquatic plants on water quality, the need for sound aquatic plant management can only increase in the future. We have good reason to be enthusiastic about the future of APMS.

Another reason for optimism is advanced technology which may directly impact aquatic plant management in the future. For example, a new micromachined mass measurement tool can now detect changes of less than 0.5 nanogram (half a billionth of a gram) in liquid media. This is much smaller than the mass of many living cells and it works under water or in solution. Another item of interest is a micropump without valves that moves microliter volumes of fluids by thermal expansion or phase change. Ten sequentially powered tiny heating elements under a micromachined channel drive the fluid from one end to the other.

Researchers have also developed robotic fish (Proctor 1994). Engineers at MIT have come up with the robo-tuna. Being a first generation robot, it was tethered to a floating sledge which housed its controlling mechanisms. A second generation device is the robo-pike, also developed at MIT (Ward 1998). At 80 cm long, it is controlled through a radio in its fiberglass nose cone. The robo-pike is a fiberglass spring covered with a lycra skin with servo motors in the nose cone. Mitsubishi Heavy Industries has developed another robo-fish which strongly resembles a sea bass in appearance and movement (Guernsey 1999). Given these technological advances, it is not hard to imagine that at some future weed-infested lake, a robotic fish will be released into the water. On-board computers will evaluate its position by comparing its satellite supplied latitude and longitude with a bathymetric map of the lake that shows the locations of different types of aquatic plants. The robot will swim to the site of the target weed and may either activate micropumps to inject each plant with a carefully measured dose of herbicide (reducing environmental exposure) or perhaps it will activate tiny flails which will shred the plant into tiny pieces. I don't know how realistic this vision of the future is, but I am confident that members of APMS will be involved in creating the aquatic weed management options of the future. Have a great meeting!

LITERATURE CITED

Barko, J. W., M. S. Adams, and N. L. Clesceri. 1986. Environmental factors and their consideration in the management of submersed aquatic vegetation: A review. J. Aquat. Plant Manage. 24: 1-11.

Butts, D., J. Hinton, C. Watson, K. Langeland, D. Hall, and M. Kane. 1991. Aquascaping: planting and maintenance. University of Florida Circular 912, Gainesville. 9 pp.

Fox, A. M. and W. T. Haller. 1992. Improving herbicide efficacy in spring-fed tidal canals by timing and application methods. J. Aquat. Plant Manage. 30: 58-62.

Fox, A. M., W. T. Haller, and D. G. Schilling. 1991. Correlation of fluridone and dye concentrations in water following concurrent application. Pesticide Sci. 31: 25-36.

Fox, A. M., W. T. Haller, and K. D. Getsinger. 1992. Correlation of bensulfuron methyl and dye concentrations in water following concurrent application. J. Aquat. Plant Manage. 30: 73-74.

Fox, A. M., W. T. Haller, and K. D. Getsinger. 1993. Correlation of endothal and fluorescent dye concentrations following concurrent application to tidal canals. Pesticide Sci. 37: 99-106.

Fox, A. M., W. T. Haller, and D. G. Schilling. 1994. Use of fluridone for hydrilla management in the Withlacoochee River, Florida. J. Aquat. Plant Manage. 32: 47-55.

Getsinger, K. D., W. R. Green, and H. E. Westerdahl. 1990. Characterization of water movement in submersed plant stands. Misc. Paper A-90-5, US Army Engineer Waterways Exper. Sta., Vicksburg, MS.

Getsinger, K. D., E. G. Turner, J. D. Madsen, and M. D. Netherland. 1997. Restoring native vegetation in a Eurasian watermilfoil-dominated plant community using the herbicide triclopyr. Regul. Rivers 13: 357-375.

Green, W. R. and H. E. Westerdahl. 1990. Response of Eurasian watermilfoil to 2,4-D concentrations and exposure times. J. Aquatic Plant Manage. 28: 27-32.

Guernsey, L. 1999. Engineered for the aquarium, but will they take the bait? New York Times (June 3, p. D3).

Lembi, C. A. and T. Chand. 1992. Response of hydrilla and Eurasian watermilfoil to flurprimidol concentrations and exposure times. J. Aquat. Plant Manage. 30: 6-9.

Luu, K. T. and K. D. Getsinger. 1990. Seasonal biomass and carbohydrate allocation in waterhyacinth. J. Aquat. Plant Manage. 28: 3-11.

Madsen, J. 1997a. Methods for management of nonindigenous aquatic plants. *In:* J. O. Luken and J. W. Thieret, eds. Assessment and Management of Plant Invasions. Springer-Verlag, New York. pp. 145-171.

Madsen, J. D. 1997b. Seasonal biomass and carbohydrate allocation in a southern population of Eurasian watermilfoil. J. Aquat. Plant Manage. 35: 15-21.

Madsen, J. D. and C. S. Owens. 1998. Seasonal biomass and carbohydrate allocation in dioecious hydrilla. J. Aquat. Plant Manage. 36: 138-145.

Madsen, J. D., J. W. Sutherland, J. A. Bloomfield, L. W. Eichler, and C. W. Boylen. 1991. The decline of native vegetation under dense Eurasian watermilfoil canopies. J. Aquat. Plant Manage. 29: 94-99.

Netherland, M. D. and K. D. Getsinger. 1992. Efficacy of triclopyr on Eurasian watermilfoil—concentration and exposure time effects. J. Aquat. Plant Manage. 30: 1-5.

Netherland, M. D., K. D. Getsinger, and E. G. Turner. 1993. Fluridone concentration and exposure time requirements for control of Eurasian watermilfoil and hydrilla. J. Aquat. Plant Manage. 31: 189-194.

Netherland, M. D., W. R. Green, and K. D. Getsinger. 1991. Endothall concentration and exposure time relationships for the control of Eurasian watermilfoil and hydrilla. J. Aquat. Plant Manage. 29: 61-67.

Proctor, P. 1994. Robo-tuna! forget UAVs. Aviation Week & Space Technology 141: 17.

Ross, M. A. and C. A. Lembi. 1985. Applied weed science. Burgess Publishing Company, Minneapolis. 340 pp.

Solley, W. B., R. R. Pierce, and H. A. Perlman. 1998. Estimated use of water in the United States in 1995. U.S. Geological Survey Circular 1200. Denver, CO.

Turner, E. G., K. D. Getsinger, and M. D. Netherland. 1994. Correlation of triclopyr and rhodamine WT dye dissipation in the Pend-Oreille river. J. Aquat. Plant Manage. 32: 39-41.

Van, T. K. and V. V. Vandiver. 1994. Response of hydrilla to various concentrations and exposures of bensulfuron methyl. J. Aquat. Plant Manage. 32: 7-11.

Ward, M. 1998. Follow that pike—a lycra skin could reveal how a fish cuts hydrodynamic drag. New Scientist 157: 11.