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Mail Order, the Internet, and Invasive Aquatic Weeds

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ABSTRACT

Aquatic and wetland weeds pose serious threats to the freshwater resources of the United States. Essentially unregulated sale of plants for aquarium and ornamental pool use has resulted in the recent introduction and spread of several highly invasive weeds, including giant salvinia. This problem has been exacerbated during the past few years by mail-order and e-commerce. The objective of this study was to examine mail order and the internet as sources for sale of invasive aquatic weeds, with primary emphasis on the Internet. An online search was conducted using the search engine Yahoo™. Data were collected on twelve of the most common and highly invasive weeds sold by the industry. The data from the first 100 hits were grouped into regulatory, educational, commercial, hobbyist, and foreign sites. Essentially every aquatic or wetland plant listed in the United States as either a Federal Noxious Weed or as a noxious weed in one or more states was found. Twelve highly invasive plants intentionally sold by the wetland nurseries and water garden dealerships were found listed for sale by sites throughout the United States and internationally. This study shows that stronger enforcement of laws and regulations and an intensive education and outreach effort are needed to prevent further introductions of invasive weeds through the aquatic and wetland plant industry.

Key words: water gardens, ornamental pools, aquascaping, aquatic plants, websites, e-commerce.

INTRODUCTION

Water is the most critical and sensitive commodity both biologically and politically in the United States and worldwide, due to the wide range of uses including irrigation, commercial and recreational fishing, aquaculture, drinking water supplies, industrial use, power generation, transportation, and a myriad of recreational activities. The presence of invasive weeds in inland waters and wetlands presents special problems for water resources managers and often provokes conflicts among different users. Weeds may inhibit drainage and interfere with all of the intended uses of a body of water as well as provide habitat for the vectors of human and animal diseases. Weeds also interfere with ecosystem function and are a serious threat to biodiversity and the productivity of aquatic and wetland habitats. Invasive species (including weeds) are considered to be the second most serious threat to biodiversity in all ecosystems, after habitat destruction (Pimm and Gilpin 1989, Randall 1996).

Invasive, exotic weeds have been serious problems in freshwater systems in the United States for more than a century. Highly invasive species, including waterhyacinth (*Eichhornia crassipes* (Mart.) Solms), Eurasian watermilfoil (*Myriophyllum spicatum* L.), purple loosestrife (*Lythrum salicaria* L.), parrotfeather (*Myriophyllum aquaticum* (Vell.) Verdc.), Brazilian elodea (*Egeria densa* Planch.), and hydrilla (*Hydrilla verticillata* (L.f.) Royle), largely have been the result either of intentional introductions for ornamental use or subsequent use as ornamentals after the initial introduction (Countryman 1970, Couch and Nelson 1985, Nelson and Couch 1985, Penfound and Earle 1948, Schmitz 1990, Sutton 1985). Escape of these species from cultivation and/or spread from intentional plantings have caused the expenditure of hundreds of millions of dollars of taxpayers' money for control and management. Les and Mehrhoff (1999) state that 76% of all aquatic plants introduced into southern New England have escaped from cultivation.

Weeds occurring as contaminants among other plants also have resulted in the spread of invasive aquatic weeds. The hydrilla infestation found in Connecticut apparently entered as a contaminant from ornamental waterlily plantings (Les 1996). Apparently accidental introductions of other invasive weeds and quick recognition within the aquatic and wetland plant nursery industry that some of these plants are attractive, easy to grow, and could have a market potential also have caused serious problems. For example, giant salvinia (*Salvinia molesta* Mitchell) was being sold in the nursery industry in Texas, but was not identified until the fall of 1998 when it was discovered at Toledo Bend Reservoir in Texas and Louisiana. Similarly, it had been sold for several years by nurseries in North Carolina but was not identified until October 1998, after it was found in a commercial wetland nursery display at the North Carolina State Fair. In October of 1999, an odd-appearing mosquito fern was collected by S. H. Kay at a wetland nursery in Raleigh, NC. This mosquito fern was identified tentatively as *Azolla pinnata* R. Brown (a Federal Noxious Weed), and the identity was later confirmed (author's unpublished data). Both of these plants have been listed for sale in catalogs and have been found in nurseries in several states.

The water garden industry has grown rapidly in the United States during the past decade. Hutchins (2001) indicated that this industry will reach more than $1 billion in 2001. The continuing growth of this industry greatly enhances the likelihood for the release of more invasive aquatic weeds. The advent of easy consumer access to the Internet and the intensive development of e-commerce also have exacerbated the spread of invasive aquatic and wetland species through-

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out the United States and worldwide. Over the past three years, we have found numerous listings in on-line nursery catalogs for almost every invasive aquatic or wetland plant known worldwide as well as hobbyist groups selling or swapping these plants. This situation raises significant concern about the impacts that on-line sources have on the introduction, distribution, and spread of noxious aquatic and wetland plants in the United States and worldwide.

The objective of this study was to examine mail order and internet sites as sources of invasive aquatic and wetland weeds.

METHODS

We conducted a search of the internet to determine the types and distribution of websites offering aquatic plants for exchange or sale. We also examined several mail order catalogs from large U.S. nurseries and supply houses offering aquatic and wetland plants. Most of these nurseries also had their own websites. Consequently, we then shifted the focus of the project to examine listings on a few of the larger commercial websites.

We conducted an on-line search of the most popular web search engine, Yahoo™, to find website listings for a total of twenty-seven highly invasive aquatic and wetland plants, with primary emphasis on those species listed either as Federal Noxious Weeds (USDA-APHIS 2000) or as noxious weeds in one or more states (USDA-NRCS 2001). We also included several native species that either are sold or occur commonly as contaminants among wetland and aquatic plant purchases.

We quickly found that the numbers of sites listed by the search engine could vary widely from day to day and that many of the sites beyond the first 100 listed by the search engine either were duplicate listings or no longer existed. Consequently we decided to limit our search to the first 100 active website hits we found on each species and to limit our search to twelve aquatic or wetland plants that currently are of great concern within the United States and that also are sold intentionally for use in aquaria or ornamental aquatic gardens. We grouped the results of our search into five general categories: regulatory (illegal weed listings, etc.), educational, commercial (i.e., U.S., for sale), hobbyist (individual chat, swap, and sale), and foreign (commercial only).

RESULTS AND DISCUSSION

Our initial examination of catalogs and websites revealed most species of aquatic and wetland plant listed either as Federal Noxious Weeds or as noxious weeds in one or more states (Table 1). On-line commercial sites selling invasive weeds were present worldwide. The largest sites we found were based in New York, California, Texas, and Denmark.

A more detailed examination of websites showed great variation in the total numbers of website hits among the species selected (Table 2). There were as few as 113 for African

TABLE 1. PARTIAL LISTING OF INVASIVE AQUATIC AND WETLAND PLANTS OFFERED FOR SALE IN THE U.S. BY AQUARIUM OR WATER GARDEN DEALERSHIPS, ADVERTISED ON COMMERCIAL WEBSITES, OR OCCURRING AS COMMON CONTAMINANTS AMONG PLANTS THAT ARE OFFERED FOR SALE. PLANTS INDICATED WITH AN ASTERISK (*) USUALLY ARE CONTAMINANTS, BUT OCCASIONALLY HAVE BEEN SOLD.

Scientific name	Common name	Growth habit	Native[1] or exotic
*Alternanthera philoxeroides**	alligatorweed	emergent	E
Azolla caroliniana	mosquito fern	floating	N
Azolla pinnata	mosquito fern	floating	E
Ceratophyllum demersum	coontail	submersed	N
Egeria densa	Brazilian elodea	submersed	E
Eichhornia crassipes	waterhyacinth	floating	E
Eichhornia azurea	rooted waterhyacinth	emergent	E
*Eleocharis baldwinii**	proliferating spikerush	submersed	N
*Hydrilla verticillata**	hydrilla	submersed	E
Hygrophila polysperma	Indian hygrophila	submersed	E
Lagarosiphon major	African elodea	submersed	E
Lemna spp.*	duckweed	floating	N
Limnophila sessiliflora	limnophila	submersed	E
Ludwigia hexapetala	creeping water primrose	emergent	E
Lythrum salicaria	purple loosestrife	emergent	E
Myriophyllum aquaticum	parrotfeather	submersed	E
Myriophyllum heterophyllum	variable-leaf milfoil	submersed	Q
*Myriophyllum spicatum**	Eurasian watermilfoil	submersed	E
Phragmites australis	common reed	emergent	Q
Pistia stratiotes	water lettuce	floating	E
Salvinia minima (*S. rotundifolia*)	water spangles	floating	E
Salvinia molesta	giant salvinia	floating	E
Spirodela spp.*	duckweed	floating	N
Sparganium erectum	branched bur-reed	emergent	E
Trapa natans	water chestnut	floating	E
Typha spp.	cattail	emergent	N
Utricularia spp.*	bladderwort	submersed	N

[1]E = exotic; N = native; Q = questionable origin: considered by some to be native, but probably exotic and well naturalized in the U.S.

TABLE 2. CATEGORIZATION OF WEBSITE LISTINGS OF TWELVE HIGHLY INVASIVE AQUATIC AND WETLAND PLANTS.[1]

Scientific name	Common name	Growth habit	Federal[2] noxious weed	Total number of hits	Numbers of hits out of the first 100 listings for each plant				
					Regulatory	Educational	Commercial	Hobbyist	Foreign
Azolla pinnata	mosquito fern	floating	X	145	14	31	6	2	2
Egeria densa	Brazilian elodea	submersed		882	16	52	7	8	9
Eichhornia crassipes	waterhyacinth	floating		1700	10	66	10	8	3
Hygrophila polysperma	Indian hygrophila	submersed	X	695	11	28	30	24	4
Lagarosiphon major	African elodea	submersed	X	113	15	45	4	10	2
Limnophila sessiliflora	limnophila	submersed	X	232	11	23	9	3	2
Lythrum salicaria	purple loosestrife	emergent		3980	6	74	5	5	3
Myriophyllum aquaticum	parrotfeather	submersed		562	12	71	5	8	1
Phragmites australis	common reed	emergent		3420	3	78	4	3	6
Salvinia molesta	giant salvinia	floating	X	796	25	68	2	1	0
Sparganium erectum	branched bur-reed	emergent	X	387	16	43	10	6	19
Trapa natans	water chestnut	floating		701	7	61	9	7	14

[1]The data shown reflect information found only in the first 100 hits of a search by each plant's scientific name using the search engine "Yahoo". All plants included above are highly invasive and are being sold and distributed intentionally for use in aquaria, ornamental pools, or aquascaping.
[2]The species marked appears on the Federal Noxious Weed List. All of the plants above also are listed by one or more states as noxious aquatic weeds. Several states adopt the Federal Noxious Weed List and may or may not list these plants separately on their own noxious weed lists. Lists of noxious weeds also may differ among state agencies.

elodea (*Lagarosiphon major* (Ridley) Moss) and as many as 3980 for purple loosestrife. The first 100 hits per weed revealed that most of the websites either were educational or regulatory in nature (Table 2). Indian hygrophila (*Hygrophila polysperma* (Roxb.) T. Anderson) was the most commonly found commercial species, followed by waterhyacinth and branched bur-reed (*Sparganium erectum* L.). The plants most commonly listed on hobbyist sites were Indian hygrophila and African elodea. Foreign websites most commonly mentioned branched bur-reed and water chestnut (*Trapa natans* L.).

The potential for introduction of a species repeatedly and on a large scale into a new area is one of the most important factors that lead to invasiveness (Randall and Marinelli 1996). The proliferation of hobbyist, domestic commercial, and foreign commercial websites discussing the beauty and qualities of invasive aquatic weeds thus is a very serious concern for federal and state regulatory officials as well as resource managers throughout the United States. Swapping and sale of plants among aquarium and water garden hobbyists poses a serious threat to our inland water resources. Plants often are misidentified and are not recognized as invasive by many of the hobbyists. There also have been some suggestions that some hobbyists and others either may not be looking at the websites and/or ignoring them entirely. I personally have had several "so what?" responses to my own inquiries about plants that were being offered for sale or swap on the internet. Another issue is that hobbyists frequently throw unwanted plants into ponds, ditches, streams and lakes, rather than destroying them. Discarding of unwanted plants in this manner has led to serious weed infestations when growing conditions outside of the ornamental pool or aquarium were suitable. Consequently, the hobbyist is an important vector for the distribution and spread of noxious aquatic weeds.

Many wetland and aquatic plant nurseries and dealerships also have minimal knowledge of the aquatic and wetland plants that they sell. Similarly-appearing species often are misidentified and accidentally (occasionally intentionally) misrepresented as other, non-invasive species. This apparently was the case with the giant Salvinia that the wetland nursery trade was selling in North Carolina. The invasive, exotic creeping water primrose, (*Ludwigia hexapetala* (Hook & Arn) Zardini, Gu, and Raven) (formerly called *L. uruguayensis*) is another case of misidentification. Plants collected from several nurseries in North Carolina and represented as other *Ludwigia* species have been greenhouse grown and subsequently identified (author's unpublished data) as the invasive, *L. hexapetala*, which is listed as a noxious aquatic weed in North Carolina. Other plants, such as the mosquito fern, *Azolla pinnata*, and hydrilla may occur as minor contaminants among other plants sold by these nurseries and dealerships. The purchase of legal aquatic and wetland plants from these nurseries and dealerships consequently poses another serious risk for the spread of noxious weeds.

Another major concern and serious complicating factor is that many regulatory officials at both the federal and state levels are unfamiliar with and may overlook noxious aquatic and wetland plants, particularly if they are small and are mixed with other larger plants. Additionally, both state and federal noxious weed laws are not enforced uniformly and rigorously. Regulatory loopholes also exist which pronounce plants "innocent until proven guilty" at the ports of entry. These shortcomings result in the continued importation, propagation, sale, and spread of invasive aquatic and wetland weeds.

An immediate and major educational effort is needed to combat the problems occurring from the unintentional and intentional distribution of noxious aquatic and wetland weeds in the United States and worldwide. The Aquatic Plant Management Society and several of its chapters are in the early stages of developing educational and outreach programs. Sea Grant recently funded a national outreach initiative to address these concerns (Crawford et al., this issue). Further regulatory effort is needed to locate and prosecute (if necessary) those nurseries, dealerships, and individuals

who intentionally and wantonly continue to grow, sell, and distribute noxious aquatic and wetland weeds.

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