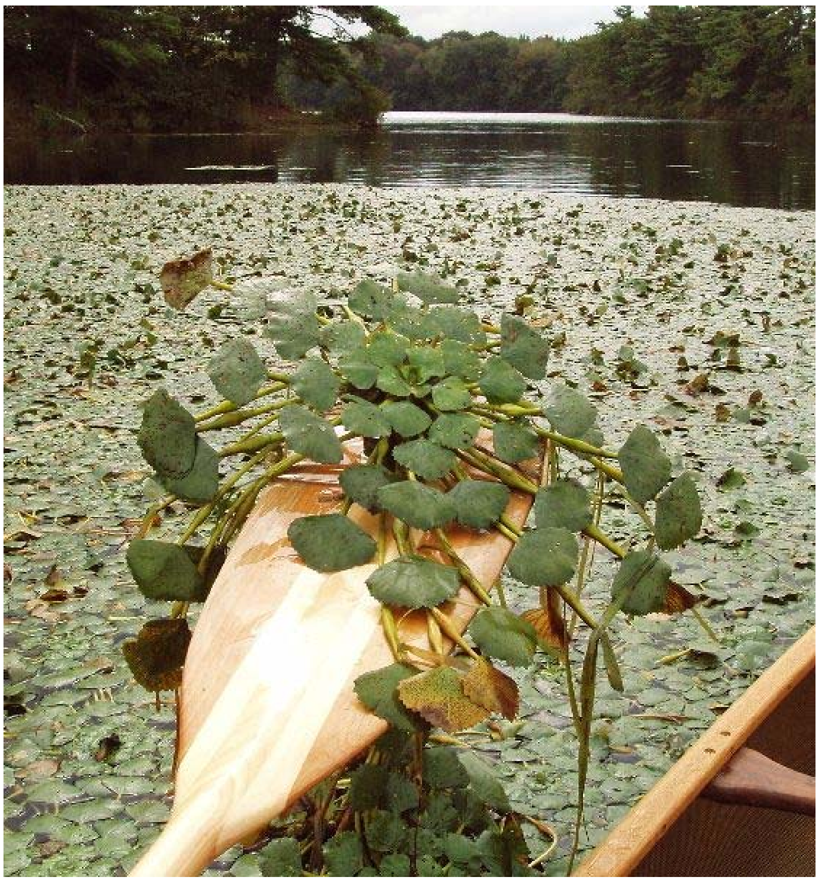
dcr
Massachusetts

Aquatic Invasive Species Assessment and Management Plan



Water Chestnut (*Trapa natans*) at Sudbury Reservoir
Photograph by Dave Worden, DCR

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Massachusetts Department of Conservation and Recreation
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Office of Watershed Management

Abstract

The *Aquatic Invasive Species Assessment and Management Plan* explains the threat of aquatic invasive species (AIS), details the current status of AIS in the Department of Conservation and Recreation/Massachusetts Water Resources Authority (DCR/MWRA) reservoir system, and describes the management program implemented to control existing infestations and prevent new introductions. Two species of invasive macrophyte (Eurasian Water-milfoil and fanwort) have been actively managed in the upper reaches of Wachusett Reservoir since 2002. Recently adopted management efforts focus on protecting the DCR/MWRA reservoir system from AIS through a strategy that integrates three main techniques: (1) public education and outreach, (2) exclusion and decontamination measures at boat ramps and other potential entry points, and (3) an expanded monitoring program.

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1.0 The Threat of Aquatic Invasive Species

Aquatic invasive species (AIS) are a taxonomically diverse group of nonindigenous organisms that share a sinister key characteristic: the ability to become established and spread rapidly within native aquatic communities. Nonindigenous organisms tend to be invasive because the predators, parasites, and diseases that constrained them in their historic range have been left behind in the process of introduction to geographically separate places. Additionally, some nonindigenous organisms possess structural, physiological, or behavioral adaptations that are novel in their place of introduction and for which native species have no defense. Biological characteristics that contribute to invasiveness by nonindigenous species include high fecundity, efficient propagation and dispersal mechanisms, and tolerance to a broad range of environmental conditions. Native aquatic species generally cannot compete effectively against nonindigenous species with these invasive traits. If an invasive species establishes a pioneer infestation in an aquatic system, it is usually impossible to eradicate and the invasion that follows is irreversible.

The spread of AIS is usually accompanied by detrimental effects on native communities, aquatic habitats, and human economies (see Pimentel *et al*. 2005 for a comprehensive overview of the impacts of aquatic and terrestrial invasive species in the United States). In the context of the DCR/MWRA reservoir system, the most important potential impacts from AIS are loss of native species, habitat degradation, damage to infrastructure, disruption of ecosystem function, and impairments to water quality.

In response to the nationwide problem of AIS and recognizing that nonindigenous species have a high potential for invasiveness, the U. S. Geological Survey sponsors the Nonindigenous Aquatic Species (NAS) website (http://nas.er.usgs.gov). As stated on the home page "this site has been established as a central repository for spatially referenced biogeographic accounts of nonindigenous aquatic species in the USA." The definition of a nonindigenous aquatic species given on the NAS website is "a member(s) (i.e. individual, group, or population) of a species that enters a body of water or aquatic ecosystem outside of its historic or native range." This information resource encompasses a wide-ranging database on over 1,100 nonindigenous species of aquatic vertebrates, invertebrates, and vascular plants and is the source of much of the information on AIS presented in the sections that follow.

1.1 Aquatic Invasive Species in Massachusetts

The NAS database currently lists 184 nonindigenous organisms that have been reported in Massachusetts. Fish account for the largest percentage of the list (73 species, about

41%) followed by vascular plants (57 species, about 32%). The remaining 27% of NAS reported in Massachusetts are comprised of reptiles, amphibians, and a variety of invertebrates including bivalves, snails, and crustaceans.

Approximately 44% of this diverse array of aquatic organisms consists of species native to North America that have been transported beyond their historic range and introduced into Massachusetts. Examples of "native transplants" include smallmouth bass (a fish native mainly to the upper Mississippi and Ohio River drainage areas, *Micropterus dolomieu*), rainbow trout (a fish native to Pacific Coast drainage areas, *Oncorhynchus mykiss*), and fanwort (a plant native to the southeastern United States, *Cabomba caroliniana*). The majority of nonindigenous fish in Massachusetts are transplants from other regions of North America that were intentionally stocked for the purpose of sport fishing (including the two listed above).

Slightly more than half of the nonindigenous organisms reported in Massachusetts are species that arrived from outside of North America and are commonly referred to as "aliens" or "exotics." Examples of nonindigenous species from other continents include Eurasian Water-milfoil (a plant native to Eurasia; *Myriophyllum spicatum*), Brazilian waterweed (a plant native to South America; *Egeria densa*), northern snakehead (a fish native to China, Russia, and Korea; *Channa argus*), and zebra mussel (a bivalve mollusk native to the Black, Caspian, and Azov Seas of Eurasia; *Dreissena polymorpha*).

1.2 Pathways of Introduction and Secondary Spread

The pathways by which exotic AIS arrive in North America from other continents involve both intentional and unintentional transport of organisms. Commercial importation of organisms via the aquarium and pet trade has long been a major vector of AIS from other continents and this activity continues both legally and illegally. Release of ballast water from transatlantic ships into the Great Lakes is the most significant example of unintentional introduction; resulting in the devastating invasion of zebra mussels as well as other exotic AIS.

The introduction pathways outlined above are examples of original or primary conduits by which exotic AIS are delivered to North America. Once established on this continent, secondary spread of AIS out from the "epicenter" of introduction is channeled initially within waterways and waterbodies that are connected to the pioneer infestation. Dispersal in this situation is generally due to advective transport of organisms and/or their propagules downstream within a watershed. Secondary spread can also occur upstream within a watershed in the case of highly mobile AIS, such as fish.

In contrast to the dispersal of AIS via connections within a watershed described above, secondary spread of AIS overland to separate aquatic systems that are isolated from the original infestation is affected mainly by human activities (Table 1 on following page). People spread AIS by releasing exotic pets and dumping the unwanted contents of aquaria into natural waters, including both exotic fish and plants. Escape from aquaculture facilities accounts for the spread of some exotic fish. Similarly, spread of exotic plants that are cultivated as aquatic ornamentals occurs when they escape from water gardens or aquatic nursery facilities.

Foremost among human mechanisms of secondary spread of AIS is transient recreational boating. This is due to an unfortunate convergence between adaptations by certain AIS that promote "hitch-hiking" and attributes inherent to boating that make it susceptible to the transport of "stowaways." Specifically, many AIS have life-cycle stages that are small to microscopic in size and that are tolerant or even resistant to desiccation for varying durations. Examples include the planktonic larval stage (veliger) of the zebra mussel (*Dreissena polymorpha*) and juvenile mussels newly settled on substrates, the thick-walled "resting" eggs produced by spiny water flea (*Bythotrephes longimanus*) that can remain dormant for long periods of time, and the vegetative fragments generated by numerous species of invasive plants that enable them to disperse and propagate independent of seed production. Combine these adaptations with the many surfaces, nooks, and crannies of boats, trailers, and nautical gear that are immersed in water and there is great potential for AIS to stowaway in live wells or bilges with standing water, in a wet heap of line, or fouled on anchors, propellers, or undercarriages of boat trailers.

Table 1.
Categories of AIS and Associated Human Mechanisms of Secondary Spread

- Fish - intentional stocking, bait release, aquarium release, aquaculture escape
- Turtles and Frogs - released or escaped pets
- Snails - aquarium release, water garden or aquatic nursery escape
- Bivalves (e.g., zebra mussel) - recreational boating ("hitch-hiker")
- Crayfish - intentional stocking, bait release, aquarium release, aquaculture escape
- Micro-crustaceans (e.g., spiny water flea) - recreational boating ("hitch-hiker")
- Plants - recreational boating ("hitch-hiker"), aquarium release, water garden or aquatic nursery escape

Research has confirmed that traffic of trailered boats between water bodies is a key mechanism of overland transfer of a variety of AIS. Interbasin boat movements disperse viable propagules of plants (Johnstone *et al*. 1985), zebra mussels (Bossenbroek *et al*. 2001, Buchan and Padilla 1999, Frischer *et al*. 2005, Leung *et al*. 2006), both plants <u>and</u> zebra mussels (Johnson *et al*. 2001), and spiny water flea (MacIsaac *et al*. 2004).

Here in Massachusetts, the DCR Lakes and Ponds Boat Ramp Monitoring Program (www.mass.gov/dcr/watersupply/lakepond/lakepond.htm) has documented that boating is a vector of nonindigenous plants. The 2008 summary of the program states "During the five years, since the launch of this program in 2004, DCR boat ramp monitors have conducted 11,572 surveys and inspected 10,941 boats. Of the boats inspected, 2132

(19.5%) were carrying plant fragments and of these fragments, 879 (41.2%) fragments were non-native."

As new water bodies are invaded, they become "hubs" for further introductions and, in this way, eventually spread the invader to a network of water bodies far removed from the original infestation (as demonstrated for spiny water flea by Muirhead and MacIsacc 2005). DCR efforts at public education about spiny water flea were triggered by the new infestation detected in September of 2008 in Great Sacandaga Lake (New York), only 108 miles northwest of Quabbin, for this reason. Policies and procedures are available to neutralize recreational boating as a vector of AIS including those instituted at Quabbin Reservoir during the summer of 2009 (see Section 3.0 below).

1.3 Potential Impacts to DCR/MWRA Reservoir System

Potential impacts from the spread of AIS vary according to the characteristics of the invading organism (Table 2). Many AIS cause local extinctions of native species through competition or predation. This loss of biodiversity causes changes in the trophic structure of the community due to disruptions of food web connections, productivity, energy flow, and nutrient cycling. The spiny water flea provides an example of this scenario in its role as a planktonic predator where it competes directly with juvenile fish for food. Both the spiny water flea and young fish prey almost entirely on native water fleas and other zooplankton. Research has shown that spiny water flea predation is capable of reducing the diversity and density of native zooplankton, thus impoverishing the food chain that sustains adult fish (Barbiero and Tuchman 2004, Strecker and Arnott 2008).

Table 2.
Categories of AIS and Associated Potential Impacts to DCR/MWRA Reservoirs

- Fish - loss of native species, changes in trophic structure/food web effects
- Turtles and Frogs - loss of native species
- Snails - loss of native species, changes in trophic structure/food web effects
- Bivalves (e.g., zebra mussel) - biofouling of substrates and infrastructure, habitat degradation, loss of native species, changes in trophic structure/food web effects
- Crayfish - loss of native species, changes in trophic structure/food web effects
- Micro-crustaceans (e.g., spiny water flea) - loss of native species, changes in trophic structure/food web effects
- Plants - loss of native species, habitat degradation, impairments to water quality

The most notorious organism for degrading habitats and fouling infrastructure is the zebra mussel. These mussels attach themselves to hard substrates at such high densities that they become encrusted on rocks, pilings, boat hulls, within pipes, and on other organisms such as crayfish and native mussels. As filter-feeders, zebra mussels also severely impact the plankton communities of water bodies where they become established with associated disruptions of trophic structure as discussed above.

Another example of an invasive species that causes habitat degradation is the alga "Didymo" (*Didymosphenia geminata*; also known as "rock snot"). This organism is generally restricted to lotic (running water) habitats, but can smother substrates in streams and rivers with a thick layer of mucopolysaccharides that are secreted to form the attachment stalk of each cell. As a member of the group of algae known as diatoms, Didymo is not included in the USGS NAS website (which covers vascular plants), but a USGS publication provides a comprehensive overview of this organism (see Spaulding and Elwell 2007).

In a few cases, invasion by certain AIS may appear harmless in the short-term, but impacts may be delayed or undetected for some time. An example of this is the Chinese Mystery Snail (*Cipangopaludina chinensis malleata*; the genus name *Bellayma* is also in use for this organism) which inhabits Wachusett Reservoir with no apparent impacts (see Section 2.0 below). However, it is likely that they compete with native snails for food and space and they may serve as vectors for the transmission of parasites and diseases.

The group of AIS that poses the greatest threat to water quality is rooted vascular plants ("macrophytes"). Their unique menace can be encapsulated in one word: <u>biomass</u>. Invasive aquatic macrophytes aggressively displace native plants and grow so densely that littoral zone habitats become choked with vegetation. Water quality is impaired by excessive macrophyte growth because macrophytes function as nutrient "pumps," extracting nutrients from sediment with their roots and releasing them to the surrounding water (Wetzel, 1983). Root uptake of nutrients from sediment (both nitrogen and phosphorus) is crucial to macrophyte growth, whereas uptake from ambient water via stem or leaves is minimal (Carignan and Kalff 1980, Chambers *et al*. 1989).

Nutrients translocated from sediment to macrophyte biomass are released to the water during most life cycle stages of macrophytes, but especially during senescence and death. These releases are comprised of organically bound nutrients (released as dissolved and particulate organic matter) as well as inorganic forms. The water quality implications of nutrient pumping and organic loading by dense beds of invasive macrophytes are serious and include increases in water color, turbidity, phytoplankton growth, and trihalomethane (THM) precursors.

This "nutrient pumping" function is especially intense with Eurasian Water-milfoil (present in Wachusett Reservoir; see Section 2.0 below) due to its characteristically rapid and prolific growth habit. In addition to releasing nutrients late in the year when most of the plant is fragmenting, dying, and decomposing, Eurasian Water-milfoil also releases nutrients and organic matter during summer "canopy" formation when lower leaves and branches are sloughed as upper stems grow horizontally along the surface.

2.0 Current Status of AIS in the Reservoir System and Vulnerability to New Introductions

Aquatic invasive species currently known to occur in the DCR/MWRA reservoir system consist of five species of macrophyte, one species of snail, and one species of crayfish (Table 3). Eurasian Water-milfoil and fanwort have the potential to severely impair water quality in Wachusett Reservoir and have been targeted by control activities since 2002 (see Section 2.1 below).

Table 3. Aquatic Invasive Species in the DCR/MWRA Reservoir System

Name of Organism	Type of Organism	Estimated Time of Introduction	Threat and Management Status
WACHUSETT RESERVOIR			
Eurasian Water-milfoil (*Myriophyllum spicatum*)	Macrophyte ("Exotic")	1997 or 1998	High impact potential; actively managed since 2002
Fanwort (*Cabomba caroliniana*)	Macrophyte ("Native Transplant")	1997 or 1998	High impact potential; actively managed since 2002
Variable Water-milfoil (*Myriophyllum heterophyllum*)	Macrophyte ("Native Transplant")	Prior to 1994 (probably in the 1970s)	Population localized and stable with minimal impacts; no management efforts
Chinese Mystery Snail (*Cipangopaludina chinensis malleata*)	Gastropod Mollusk ("Exotic")	Unknown	No obvious impacts; no management efforts
Virile Crayfish (*Orconectes virilis*)	Decapod Crustacean ("Native Transplant")	Unknown	No obvious impacts; no management efforts
QUABBIN RESERVOIR			
Variable Water-milfoil (*Myriophyllum heterophyllum*)	Macrophyte ("Native Transplant")	Prior to 1973	Population localized and stable with minimal impacts; no management efforts
SUDBURY RESERVOIR			
Water Chestnut (*Trapa natans*)	Macrophyte ("Exotic")	Pioneer infestation detected in 2006	High impact potential; actively managed since 2006
Curly-leaf Pondweed (*Potamogeton crispus*)	Macrophyte ("Exotic")	Unknown	Population very sparse and observed only infrequently; no management efforts
Eurasian Water-milfoil (*Myriophyllum spicatum*)	Macrophyte ("Exotic")	Unknown	Population widespread; management impractical

More recently, in 2006, a pioneer infestation of Water Chestnut (*Trapa natans*) was detected in Sudbury Reservoir. The rosette of floating leaves formed by this plant could blanket extensive areas of the reservoir surface. Efforts to control this plant were initiated immediately upon detection and these are also documented in Section 2.1 below.

The other invasive plants in Sudbury Reservoir are not targeted for control because the population is so well-established that removal efforts would be futile (Eurasian Water-milfoil) or because the population has been detected only as sporadic observations of individual specimens (Curly-leaf Pondweed).

Variable Water-milfoil (*Myriophyllum heterophyllum*) is the only invasive macrophyte known in Quabbin Reservoir. This species is a "native transplant" that was originally restricted to southeastern and midwestern United States, but was recorded in Connecticut in 1932 and has since spread to all New England states. It has long been established in Massachusetts and was recorded as the dominant macrophyte in Pottapaug Pond, a component of the Quabbin Reservoir system, as early as 1973 (Gunner and Rho 1977).

Although variable water-milfoil is the dominant macrophyte in certain areas of Wachusett and Quabbin Reservoirs, these areas are limited and the plant has not spread aggressively in the manner characteristic of the more virulent Eurasian species (see results of Geosyntec 2006 Quabbin macrophyte survey and DCR Quabbin macrophyte surveys conducted from 1998 through 2006 as documented in the 2006 DCR annual water quality report on Quabbin). Furthermore, in Wachusett Reservoir, variable water-milfoil occupies substrate that would likely be exploited by Eurasian Water-milfoil or fanwort and thereby functions beneficially to delay and restrict the spread of these invasive macrophytes. In view of these considerations, variable water-milfoil is not targeted for control in Wachusett or Quabbin Reservoirs.

The Chinese Mystery Snail is widespread in Wachusett Reservoir and appears to have been established for a long time with little impact to native species. The lack of strong interactions with North American fauna is consistent with recent observations of this species in Wisconsin (Solomon *et al*. 2009). The original distribution of this gastropod ranged from southeast Asia to Japan and eastern Russia. Its use as a food item in Asian cultures was probably the mechanism of its introduction to North America because it was sold in Chinese food markets in San Francisco in the late 1800s and was collected in Boston as early as 1914.

Similar to the snail described above, the virile crayfish appears to have been established in Wachusett Reservoir for a long time (identified specimen was collected from a large population in Kendall Cove on August 28, 2003). This crayfish is a "native transplant" that was originally restricted to the Missouri, upper Mississippi, lower Ohio, and Great Lakes drainages, but was recorded in Massachusetts around 1935. Transport in bait buckets is likely the most common mechanism of interbasin spread. This species is now probably the most common crayfish in Massachusetts, occupying most permanent aquatic habitats (Smith 1988). It may have displaced native crayfish species in the reservoir, but this is unknown and there have been no obvious impacts to community dynamics.

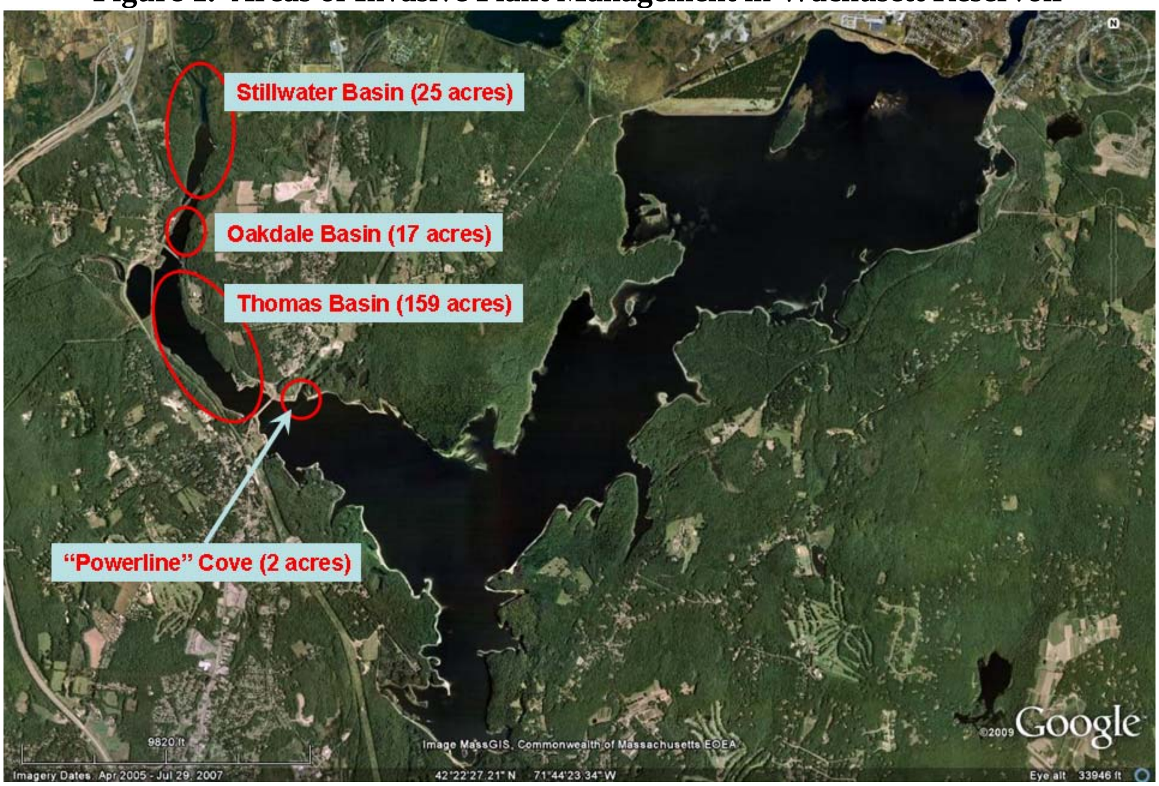
No AIS are known from the Ware River watershed. However, except for a macrophyte survey of Queen Lake in Phillipston, no other water bodies in this watershed have been inspected. The survey of Queen Lake was conducted by DCR staff on July 20, 2001 and documented the absence of any invasive plant species. This and other water bodies in the

Ware River watershed will be inspected on a routine basis according to updated monitoring plans (see Section 3.0 below).

2.1 Management of Macrophyte Infestations in Wachusett and Sudbury Reservoirs

In August of 2001, a pioneering colony of Eurasian Water-milfoil (subsequently referred to as EWM in this section) was observed for the first time in Oakdale Basin, a small basin in the upper reaches of the Wachusett Reservoir system (Figure 1). Prior to 2001, this invasive plant was restricted to the uppermost component of the reservoir system, Stillwater Basin, where its distribution had been monitored since 1999. The expansion of EWM into Oakdale Basin represented a significant increase in the risk of a potentially rapid and overwhelming dispersal of this plant into the main reservoir basin with associated impairments to water quality (as discussed in Section 1.3 above).

Figure 1. Areas of Invasive Plant Management in Wachusett Reservoir



The 2001 expansion of EWM into Oakdale Basin prompted DCR to design an invasive macrophyte control program which was implemented in 2002 and, in collaboration with MWRA, has continued to the present. A variety of mechanical, chemical, physical, and biological techniques are available for managing infestations of invasive macrophytes (see comprehensive review given in Mattson *et al*. 2004), but only a limited number of these are appropriate for water supply reservoirs.

The main components of the DCR/MWRA control program are the following: deployment and maintenance of benthic barriers, annual hand-harvesting efforts, and deployment of floating fragment barriers. Benthic barriers are sheets of plastic (polyvinyl chloride or PVC) that function to smother plant infestations when installed over bottom substrates. Hand-harvesting consists of SCUBA divers physically uprooting specimens of invasive plants and removing them by hand. Hand-harvesting is intended to preserve populations of native macrophytes as these provide the first line of defense against the establishment of new specimens of invasives. The consulting firm Aquatic Control Technology, Inc. (ACT) of Sutton, Massachusetts was contracted to initiate the program in 2002 and they have been involved every year since then, primarily conducting the fundamental control technique of hand-harvesting (Table 4 on following page).

Floating fragment barriers are deployed to restrict downstream movement of invasive plant fragments into other portions of the reservoir system. Fragmentation is the most important mode of reproduction and dispersal of EWM (and other invasive macrophytes including fanwort). Vegetative fragments are generally released at the end of the growing season when the plants undergo senescence. These fragments float for some time before sinking to the bottom where they can take root and become established in suitable littoral zone habitat. Floating fragment barriers consist of floating “spill containment” booms with a submerged skirt or curtain. They are deployed at two strategic “bottleneck” locations consisting of the railroad bridge between Stillwater Basin and Oakdale Basin and the Beaman Street Bridge between Oakdale Basin and Thomas Basin. The floating fragment barriers were initially purchased and deployed in 2002 and have been maintained at these locations since that time.

The original 2001 infestation of EWM in Oakdale Basin was mostly limited to a 2-acre (0.8 hectare) area of growth located at the extreme northern end adjacent to the railroad bridge where water enters from Stillwater Basin located upgradient. This was the area targeted for benthic barriers when the program commenced in 2002. Installation of benthic barriers was initiated on June 18th and completed on July 3rd. A total of 72 panels of barrier material, each measuring 1,200 square feet (24’ x 50’), were used to cover the northern end of Oakdale Basin. Lengths of steel “re-bar” were laid down over each panel to anchor the barrier material. In 2005, sediment that had accumulated on the barrier material was removed by suction pumping. Currently, the barrier is covered with low, sprawling growth of the native macrophyte Naiad (*Najas flexilis*) and no additional maintenance has been necessary.

In the first year of the program, an estimated 78,500 to 97,900 specimens of EWM were removed by hand-harvesting in addition to the original 2-acre infestation smothered by benthic barrier at the northern end of Oakdale Basin (Table 4). It is likely that many of the specimens removed in the initial 2002 hand-harvesting effort originated as fragments from the population that became established in Oakdale Basin in 2001.

Table 4. Synopsis of Invasive Macrophyte Control Efforts at Wachusett Reservoir

HAND-HARVESTING (ACT) PROGRAM ESSENTIALS	2002(1)	2003(2)	2004	2005(3)	2006	2007	2008	2009
Number of Eurasian Water-milfoil Plants Removed	78,500 to 97,900	3,251	7,424	4,847	6,937	3,913	5,901	9,940
Number of Fanwort Plants Removed	<100	<100	1,372	860	7,510	4,711	4,693	21,173
Diver-Hours Expended	496.5	93.25	135.5	97	174	147.5	158	370.25
Plants Removed Per Diver-Hour	158 - 197	35	55	50	83	58	67	84
Number of Days Divers Active	28	8	9	7	11	11	11	16
Time Periods of Diver Activity	July 8 - Aug. 5 Oct. 1 - 9	June 30 - July 9 Aug. 15 and 19 Sep. 10	July 6 - 9 Sep. 2 - 8 Sep. 13	July 13 - 18 Aug. 23 – 26	July 10 - 14 Aug. 28 – Sep. 1 Sep. 5	July 10 – 13 Aug. 27 – 31 Sep. 19 and 20	June 30 – July 9 Sep. 9 – 22	July 6 – 17 Aug. 19 - 26

Notes:

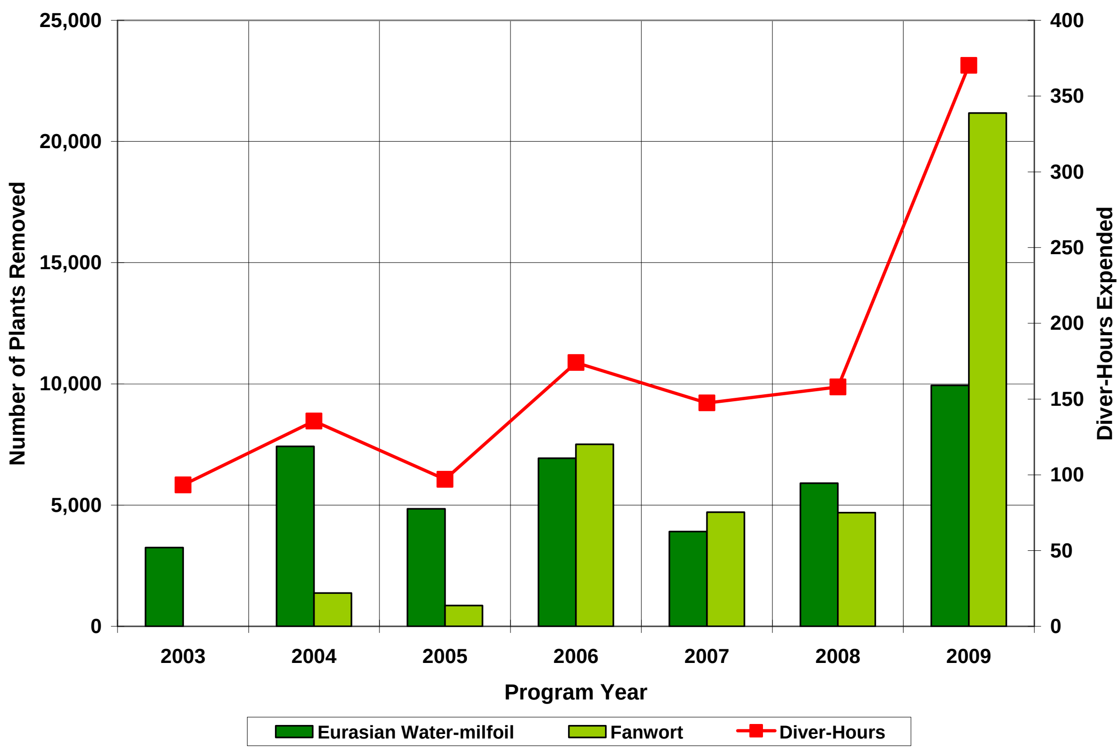
1. Initial year of control program also included installation of benthic barriers (72 panels totaling 2 acres) at the northern end of Oakdale Basin and deployment of floating fragment barriers at two "bottleneck" locations upgradient of the main basin (the railroad bridge between Stillwater Basin and Oakdale Basin and the Beaman Street Bridge between Oakdale Basin and Thomas Basin); currently the floating fragment barriers are maintained at these locations year-round.
2. Also in 2003, "milfoil" weevils (*Euhrychiopsis lecontei*) were introduced into Stillwater Basin by GeoSyntec in an attempt at biocontrol (a total of 10,000 weevils, mostly in the form of eggs and larvae); subsequent monitoring demonstrates minimal effectiveness with no evidence of significant weevil herbivory on Eurasian Water-milfoil.
3. Also in 2005, ACT performed maintenance on the benthic barrier installation (suction removal of accumulated sediment) and Lycott conducted a dredging feasibility assessment of Stillwater Basin (commissioned by MWRA).

Subsequent annual hand-harvesting efforts had to contend with many fewer plants (Table 4). Annual efforts are required because regrowth occurs from plants missed the previous season (EWM is a perennial that overwinters as root crowns or as an intact plant) and because of reintroductions via fragment delivery from Stillwater Basin located upstream. Hand-harvesting efforts are generally pursued until targeted areas appear free of infestation or, late in the season, when the plants become fragile and easily fragmented.

Similar to EWM, fanwort was restricted to Stillwater Basin prior to 2001, but gradually spread into Oakdale Basin. The spread of fanwort was less rapid than that of EWM but, in recent years, fanwort has become as problematic as EWM and both are targeted by annual hand-harvesting efforts. Hand-harvesting efforts initially focused on Oakdale Basin, but both EWM and fanwort have gradually spread throughout Thomas Basin, located directly downstream (Figure 1), so this basin is also targeted in annual removal efforts.

In comparison to previous hand-harvesting efforts of recent years, over twice as much fanwort was removed as EWM in 2009 totaling much greater numbers of plants removed (Figure 2; initial 2002 effort not depicted). Fanwort appears to be able to regenerate itself more rapidly than EWM and the increase in numbers of this species is due, at least in part, to its ability to exploit substrates previously occupied by EWM. Most of the fanwort removed in 2009 consisted of very small specimens, so the actual vegetative biomass removed was not significantly greater than in previous years.

Figure 2. Hand-Harvesting of Invasive Macrophytes: 2003-2009



The year 2009 was also notable for the record number of EWM and fanwort specimens removed from "Powerline Cove" (59 and 17 specimens respectively; see Table 5). This cove is located immediately east of the Route 12 Bridge on the northern shoreline of the main basin where powerlines span the reservoir (Figure 1). Specimens of EWM have been detected and removed from this cove intermittently since 2002 and one specimen of fanwort was removed in 2007. The increase in occurrence of EWM and fanwort in Powerline Cove indicates that "propagule pressure" (Lockwood *et al*. 2005), in the form of fragments derived from populations in upper reaches of the system, is intensifying despite deployment of floating fragment barriers and annual removal efforts. In future, it may be necessary to conduct hand-harvesting in vulnerable portions of the main basin.

Table 5. Summary of Hand-harvesting Results in "Powerline" Cove

Year of Program and Species	2002	2003	2004	2005	2006	2007	2008	2009
EWM	14	0	0	21	18	1	0	59
Fanwort	0	0	0	0	0	1	0	17

No conventional techniques are practicable for controlling EWM in Stillwater Basin due to the extent and density of the infestation, but biological control was attempted with the introduction of the "milfoil weevil" (*Euhrychiopsis lecontei*) in 2003. Unfortunately, monitoring efforts since then have shown no significant reduction in the population of EWM (Table 4).

Each summer, DCR conducts routine scouting for invasive macrophytes throughout the Wachusett Reservoir system to insure early detection of pioneering infestations. Particular attention is given to Thomas Basin and upper reaches of the main basin because these areas are most susceptible to colonization by fragments originating from EWM and fanwort populations in Stillwater and Oakdale Basins. Scouting is generally conducted two or three times a month, often in conjunction with other monitoring activities.

Details of control activities targeting invasive macrophytes in Wachusett Reservoir are documented each year in DCR annual water quality reports (DCR 2002 through 2009 available online at www.mass.gov/dcr/watersupply/watershed/dwmwq.htm) and through report deliverables by DCR/MWRA-contracted consultants (ACT, 2002-09).

As part of ongoing collaboration with MWRA, DCR staff conducted a preliminary macrophyte survey of Sudbury Reservoir on September 15, 2006. A pioneer infestation of water chestnut (*Trapa natans*) was discovered in the extreme northern end of the reservoir adjacent to Marlborough and the inlet of Mowry Brook. This infestation consisted of two large patches each 30 to 40 feet in diameter and four smaller patches. Prompt response by MWRA and the hand-harvesting contractor ACT resulted in the removal of these patches on September 29th with the biomass deposited on an adjacent small island.

Unlike EWM and fanwort, water chestnut is an annual that overwinters as a nut-like seed, so this species could potentially be eradicated if hand-harvesting efforts remove plants before they produce seeds. Annual hand-harvesting has continued to the present in the expectation that eventually the existing seed bank will be exhausted (seeds can remain viable for up to 12 years). DCR staff continue to monitor water chestnut and other macrophytes in Sudbury Reservoir on an annual basis.

2.2 Vulnerability of the Reservoir System to New Introductions of AIS

Aquatic invasive species are an escalating problem because global trade and commerce continue to homogenize the world's flora and fauna. Secondary spread of existing infestations in North America will result in chronic delivery of AIS into Massachusetts. The objective of collaborative efforts by DCR and MWRA is to prevent any new introductions of AIS to the reservoir system and associated watersheds. Macrophytes, certain invertebrates, and the alga Didymo are of the highest priority to avoid based on their potential impacts, geographic proximity, and vector potency (Table 6).

Table 6. Aquatic Invasive Species of High Priority for Preventing Introduction

Name of Organism	Type of Organism	Nearest Infestation
Hydrilla (*Hydrilla verticillata*)	Macrophyte ("Exotic")	South Meadow Pond complex (Clinton, MA)
Brazilian waterweed (*Egeria densa*)	Macrophyte ("Exotic")	Hemenway Pond (Milton, MA)
Zebra Mussel (*Dreissena polymorpha*)	Bivalve Mollusk ("Exotic")	Laurel Lake (Lee and Lenox, MA) and the Housatonic River
Asian clam (*Corbicula fluminea*)	Bivalve Mollusk ("Exotic")	Fort Meadow Reservoir (Marlborough, MA)
Spiny Water Flea (*Bythotrephes longimanus*)	Micro-crustacean ("Exotic")	Great Sacandaga Lake (N.Y.)
Didymo (*Didymosphenia geminata*)	Diatom Alga ("Native Transplant")	Upper Connecticut River, the White River, and the Batten Kill (N.H. and VT)

The organisms listed above are not the only AIS that deserve consideration, but they represent the types of organisms that should be the primary focus of public education, exclusion measures, decontamination procedures, and monitoring efforts that comprise the AIS management program (detailed in Section 3.0 below). Vertebrate species of invasives such as fish, turtles, and frogs are of lower priority because they generally do not cause severe impairments to water quality and are not spread as "hitch-hikers" on boats and trailers. However, Ranger staff should be watchful for illegal disposal of aquarium biota, release of exotic pets, or stocking of fish in DCR watersheds.

Hydrilla and Brazilian waterweed are similar to Eurasian Water-milfoil in their ability to aggressively displace native vegetation and grow to nuisance densities with associated impairments to water quality. They are also perennials that propagate and disperse by fragmentation and, therefore, are readily transported by boats and trailers as "hitch-hikers."

In the case of Hydrilla, with a newly discovered (August 2010) infestation in the South Meadow Pond complex only about 600 m (1,970 feet) north of Wachusett Reservoir in the Town of Clinton, waterfowl are also a potential vector of seeds or fragments. Although this has not been explicitly demonstrated for Hydrilla, seeds of some aquatic plants are ingested by waterfowl, carried to distant waterbodies, and passed through the gut in a viable condition. Even though the South Meadow Pond complex is outside the DCR watershed and does not support access by trailered boats, the close proximity of the Hydrilla infestation to Wachusett Reservoir necessitates special monitoring and management efforts (see Section 3.0 below).

The arrival of the zebra mussel in western Massachusetts in July 2009 precipitated responses by many agencies and organizations and has served to greatly increase awareness and concern about AIS. However, in the context of the DCR/MWRA reservoir system, the zebra mussel is unlikely to become established because of its relatively high calcium requirement in comparison to the "soft" water quality of the reservoirs (low in calcium and other dissolved minerals). This property of reservoir waters is determined mainly by the geology of the watersheds, so there is little chance that the reservoirs could ever become hospitable to the zebra mussel. This supposition is currently being tested using Quabbin water in a laboratory microcosm experiment organized by Paula Packard, DCR Aquatic Biologist. Dr. Sandra Nierzwicki-Bauer is conducting the experimental "tank study" at the Darrin Fresh Water Institute of Rensselaer Polytechnic Institute (RPI) in Bolton Landing, N.Y. Study results will be reported as they become available. If this study shows that zebra mussels can survive in Quabbin Reservoir, in contradiction to current understanding of the organism, then a rapid response plan will be formulated (see Appendix A).

Asian clam is included in the list of high priority AIS because they are known to clog pipes similar to the zebra mussel and have been observed in Fort Meadow Reservoir (just north of Marlborough). This exotic bivalve has limited survivorship below 2°C, so is not expected to be able to establish reproducing populations in New England where winter temperatures are sustained near freezing in most water bodies. However, given the trend of warming average temperatures resulting from global climate change, this species may become problematic and its life-cycle includes a tiny larval phase that is suspended in the water column and thus amenable to "hitch-hiking" on boats and trailers.

Spiny water flea is native to Eurasia and was introduced into the Great Lakes via freighter ballast in the mid-1980s. It was discovered in Great Sacandaga Lake, N.Y. in September 2008, just 108 miles northwest of Quabbin. In addition to the food web effects of this species (presented in Section 1.3 above), the barbed tail of this organism catches on fishing gear, especially fishing lines and downrigger cables. Masses of the organism can accumulate as gelatinous, cotton-like clumps, fouling gear, and interfering with fishing. The thick-walled resting eggs produced by spiny water flea make it an ideal candidate for "hitch-hiking" on boats and trailers and also on fishing gear because of entanglement in line or cable. Even if the organisms die in the interval between deployments of fishing gear in different water bodies, their bodies may contain resting eggs that remain viable.

Traffic of trailered boats between water bodies is the main vector of all the invasive macrophytes and invertebrates discussed above. The policies and procedures instituted at Quabbin Reservoir during the summer of 2009 function to deactivate "hitch-hiking" as a vector and minimize the vulnerability of Quabbin to introductions of all AIS (see Section 3.0 below). Since public boating is not allowed on Wachusett or Sudbury Reservoirs, this vector is not a factor except in instances of boat use by contractors, law enforcement agencies (environmental and state police), and staff from the Division of Fisheries and Wildlife. These entities must comply with strict decontamination protocols that have been designed to eliminate AIS from boats and trailers before launching in any DCR/MWRA reservoir (see Appendix B). Additionally, illegal boater activity, such as has occurred occasionally on Sudbury Reservoir must be the target of intensified Ranger interdiction efforts.

In consideration of the major role of interbasin boat movements as a vector of AIS, public education and monitoring efforts will be expanded to include the numerous lakes and ponds within the watersheds composing the reservoir system. The vulnerability of lakes and ponds to new introductions of AIS can be ranked as follows:

- Highly vulnerable - water bodies with ramps suitable for launching trailered boats.
- Moderately vulnerable - water bodies lacking ramps, but with launch areas for car-top boats such as canoes and kayaks.
- Minimally vulnerable - water bodies lacking or prohibiting boat access.

Water bodies accessible to trailered boats will receive first priority for public education and monitoring efforts (see Section 3.0 below and Appendix C). Although decontamination procedures cannot be imposed on boaters using these lakes and ponds, it may be possible to employ boat ramp monitors at high priority locations to facilitate public awareness efforts.

Didymo is unique from other AIS in being restricted mainly to stream habitats where the primary vector of spread is the felt soles of wading boots worn by anglers. It may also be transported by waders, boots and boot laces, boats, clothing, lures, hooks, fishing line and other equipment used in the stream. Cells of this alga become enmeshed in the felt soles of wading boots as the angler contacts infested stream substrates. Felt soles remain moist for a long time after immersion and enable Didymo cells to remain viable until the next use of the waders.

This alga could potentially impair water quality if thick layers of mucopolysaccharides formed by the organism accumulate in reservoir tributaries, then slough off to be carried downstream and discharged into a reservoir where the material decomposes. The most vulnerable tributaries are those large enough to support significant populations of gamefish and are accordingly popular with anglers. Decontamination protocols exist for waders and other gear used by stream anglers to eliminate Didymo and these will be included in public education efforts (see Section 3.0 below).

3.0 AIS Management Program: Protecting the DCR/MWRA Reservoir System

Managing the reservoir system to prevent the introduction of AIS requires a comprehensive strategy that integrates three main techniques: (1) public education and outreach, (2) exclusion and decontamination measures at boat ramps and other potential entry points, and (3) an expanded monitoring program. Public education must focus particularly on recreational anglers and boaters, but may also appropriately include those involved in the commerce of bait, aquarium fish, water gardens, and exotic pets. Exclusion and decontamination measures will require increased vigilance by Quabbin boat ramp staff and the Ranger staff in all DCR watersheds. Routine monitoring must be expanded beyond the reservoirs and their immediate tributaries to include lakes and ponds in each of the watersheds. Details of each of these components are presented in the sections that follow.

3.1 Public Education and Outreach

While the Division has a lot of control over potential introductions of AIS to the reservoirs from equipment such as boats and trailers, there is a greater challenge in preventing introductions from anglers fishing from shore, as well as introductions to water bodies in the watersheds. The approach to providing public outreach on the threats from AIS must be multifaceted to reach the general public as well as user groups.

Educational brochures are a key element in any public outreach and DCR has previously developed many that highlight threats from AIS and the steps needed to protect against them. Brochures prepared by DCR to date consist of "Stop the Spread" (focused on Didymo), "Attention Boaters" (addresses AIS in general), "Invasive Mussels" (zebra and quagga), and "Spiny Water Flea Alert" (directed at Quabbin boaters and anglers).

Entities targeted for distribution of brochures include the following: Bait shops, Municipal libraries, Sportsman Clubs, Town Clerk offices for distribution with fishing licenses, DCR public programs and visitor centers for participants, and other entities that DCR can partner with so that brochures can made available at other destinations such as historic societies, Mass Audubon sites, etc.

Other approaches that will be considered for educating the public on the subject of AIS include the following:

- Develop packaged presentation (PowerPoint) for use with Sportsman Clubs, QWAC meeting, fishing organization banquets, visitor center, and lake association meetings.
- Local cable station written public service messages.
- Consider development of Public Service Announcements for cable stations.
- Articles in Local Newspapers.
- Take inventory of Public Boat Ramps (see Appendix C). Look at potential for signage, kiosks to display information (signs are already displayed at Quabbin boat areas).
- Consider potential for Boat Ramp Monitors at lakes and ponds in the DCR watersheds.
- Look at ownership along larger rivers and around ponds and lakes. Develop specific mailings to those owners regarding risks and impacts of AIS.
- Have a DCR booth at the "Big E" and at hunting and fishing expositions; prepare poster boards for display and distribute brochures at these venues.
- Approach Wal-Mart to see if they would be willing to have DCR brochures available at their sporting goods department where fishing licenses are sold.
- In coordination with Clif Read at Quabbin, update color insert on AIS for inclusion in the 2010 Quabbin Fishing Guide.
- Update Watershed/Water Supply section of DCR website to highlight problem of alien species (coordinated with Lakes and Ponds Program).
- Conduct training for Rangers and staff that oversee Quabbin fishing areas on the subject of AIS and provide Rangers with brochures for distribution to visitors.

Investigations in the watersheds will be completed in order to tailor an expanded public outreach program. Approaches selected from those listed above will be specifically tailored to each watershed and each water resource based upon the potential for introduction of AIS and will be routinely evaluated for effectiveness.

3.2 Exclusion Measures and Decontamination Procedures

Starting from July 2009 through February 2010 a number of inspection/decontamination programs were instituted at Quabbin Reservoir to neutralize "hitch-hiking" on private boats as a vector of AIS. The first was a pilot program conducted in August 2009 followed by large scale public boat decontamination in late summer and fall, a winter Quarantine program in February 2010 and a 2010 Warm Weather Decontamination Program. A summary on each program is presented below.

Pilot Boat Decontamination Program: August 2009
Due to the discovery of zebra mussels in Laurel Lake in Lee, MA (June 29, 2009), and the threat of an infestation of this and other aquatic invasive species at Quabbin Reservoir, the Quabbin's boat fishing program was closed to all private boats on July 16,

2009. Subsequently DCR and MWRA staff researched paths of transmission for AIS, as well as consulting with other reservoir managers on implementation of boating controls. In addition, the public weighed in on the issue at two very well attended meetings of the Quabbin Watershed Advisory Committee (QWAC) held on July 27 and July 30, 2009. During these meetings, a potential course of action to protect Quabbin while allowing private boats was proposed and discussed. DCR/MWRA proposed using the Special Olympics August Fishing Tournament as a pilot to develop and test a program with three components: inspection, decontamination, and sealing (a chain of custody system).

On August 4 and 5, 2009, DCR/MWRA staff inspected, decontaminated, and sealed 21 boats at the Mass Highway facility in Belchertown, MA. No invasive species were identified during the visual inspection and all boats were decontaminated with a high temperature wash, and then sealed with a special plastic tag between the boat and the trailer. The plastic seal was placed on the inspected boat/trailer to ensure that any boat decontaminated would not be utilized anywhere else but on Quabbin reservoir. If the plastic seal were to be broken, the boat would be required to be decontaminated again prior to use on Quabbin Reservoir. DCR/MWRA staff completed the inspection and decontamination of these 21 boats in a total of six hours. This process included an interview, an explanation of threat of AIS and information on control measures, completion of a survey of each boat owner, and an inspection and decontamination with the sealing of each boat.

Boat Inspection, Decontamination, and Education Program: Summer and Fall 2009
The Quabbin program continued to evolve based on data collected from water sampling (e.g., reservoir, boat launch areas, and major tributaries) and zebra mussel inspection fieldwork (e.g., dive inspections and underwater camera survey at Shaft 12) conducted by DCR staff. Visual inspections by staff, divers and underwater camera found no zebra mussels present within Quabbin Reservoir. Further, water sampling found low levels of calcium, hardness, and pH, limiting factors for zebra mussel growth.

The boat/trailer inspection and decontamination protocol, first developed and implemented in August for the pilot boat decontamination program, was modified following a staff debriefing and additional literature review. During this program phase, which was conducted from August 16th to September 26th, over 662 boats were inspected and decontaminated (Table 7 on following page). DCR staff identified five occurrences of "hitch-hiking" by invasive plants from samples collected during the inspection program. Plant species represented by these five samples consisted of Eurasian Water-milfoil, Fanwort, and Curly-leaf Pondweed. No zebra mussels were found during this phase.

The 2009 program to reduce the risk of AIS introduction to the Quabbin Reservoir through the boat fishing program comprised three steps: visual inspections, physical decontamination, and education. The first step was motor/boat/trailer inspections conducted by DCR staff supervised by a DCR aquatic biologist. The second step of high pressure/ high temperature washing/decontamination of inspected engines/boats/trailers included an additional safety factor for the removal of any microscopic organisms according to a checklist (Appendix D). The third step attached a Quabbin Boat Seal (QBS) between the boat and trailer to ensure that only DCR-certified decontaminated boats were launched onto the reservoir for the remainder of the 2009 season. Shortly after the Quabbin Boat inspection and decontamination program ended, Environmental Quality staff met for a post program discussion to improve the future procedures. In addition, DCR staff collected input from Advisory Members, fisherman, and sister agencies to improve on the decontamination procedures.

Table 7. Synopsis of 2009 Quabbin Boat Decontamination Program (August 16 - September 26, 2009)

PROGRAM SPECIFICS	Facility #1 Belchertown, MA[1]	Facility #2 Orange, MA[2]	Grand Totals
Number of appointments scheduled	296	416	712
Number of inspections conducted	280	382	662
Number of boats rejected	4	4	8
Number of cancellations or no-shows	12	30	42
Total number of DCR staff involved/estimated hours	1, AB, 1 WR, 1 EQ, 3 MWRA	1 AB, 1 WR, 1 EQ, 1 HOW	N/A
Total Days of Activity	12 days	19 days	N/A

Source: (DCR-IT, 2009)

Cold Weather Quarantine Program: Winter 2010

The Cold Weather Quarantine program took place from January 26th through February 19th. The purpose of the Cold Weather Quarantine (CWQ) was three fold: (1) to assure that no AIS are visibly present on or in the boat, trailer, and associated equipment; (2) to allow for freezing and dehydrating conditions that kill any AIS, especially zebra mussels during the quarantine period, and (3) to assure that boats are sealed securely to prevent launching on bodies of water other than Quabbin Reservoir. The procedure implemented in this program

[1] Belchertown Facility: The southern boat decontamination facility was located in Belchertown, MA, at a MassDOT (formerly MassHighway facility) on Route 9. The Belchertown facility had two covered bays with water, lights, and power to accommodate the high-pressure, steam, power wash equipment. This facility is on a tight tank.

[2] Orange Facility: The northern facility, located in Orange, MA, was a commercial car wash on Route 2A. The Orange facility had one dedicated covered bay with high-pressure, steam/power wash equipment. This facility is on public sewer.

used time, temperature, and humidity as a method[3] to kill zebra mussels and other AIS. The theory behind lethal temperature humidity and time was adopted from work completed through the 100th Meridian Initiative (www.100thmeridian.org/emersion.asp). Three days continuously below 32 degrees or 46 days with an average low temperature of 30 degrees were conditions determined to be sufficient time/temperature for cold thermal death[3].

As with the Summer Program, all boat owners pre-arranged appointments through the Quabbin Visitors Center. The owner was instructed that their boats must be clean to pass the inspection. A comprehensive visual inspection was conducted using a DCR inspection checklist. If the boat passed the inspection, it was sealed for the quarantine phase. The boat was sealed to the trailer using the Quabbin Boat Seal (QBS). If a chain is used to attach the QBS to the boat a welded chain will be used. Once sealed, boats are approved for launching in Quabbin Reservoir as long as the seal and chain are intact and show no signs of tampering when the boat arrives at the boat launch area on the reservoir. Following the inspection, a short survey was given to gain information on boat storage and boat use since the end of the Quabbin Reservoir Fishing season. During the Quarantine program, sixty-nine inspections were conducted (including one motor only). Five plant fragments were collected for identification, but identification was not possible due to desiccation. According to the user survey, 22% (15) boats had been previously decontaminated; and 78% (53 boats) of the 68 boats had never been decontaminated. The users reported that 44% (30) had last been used on Quabbin Reservoir compared to 13% (9) last used on the Connecticut River. DCR is planning a second 2010 Cold Weather Quarantine Program to begin in December.

Quabbin Boat Decontamination Program: Summer 2010

The 2010 program is fundamentally the same as the 2009 program with improvements identified over the past six months. Procedural modifications include written standard operating procedures for DCR inspectors, cleaners, and sealers; carpeted trailer components (bunks, wheel wells) will not be allowed for the warm weather decontamination; a vinegar rinse for internal motor areas will be an option available to boat owners; controlled water temperature above 140° F will be also be instituted; new Quabbin Boat Seal (QBS) which also provide for sealing only motors; and a comprehensive database has been developed to track inspected boats. Sufficient inspection decontamination days have been set aside with both weekend and weekdays scheduled. Additional details on the 2010 Warm Weather Decontamination Protocol are given in Appendix E.

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3 Temp/humidity recommendations are based on U.S. Army Corps of Engineers Contract Report EL-93-1, June 1993, “Use of Emersion as a Zebra Mussel Control Method” by Robert F. McMahon, Thomas A. Ussery, and Michael Clarke, The University of Texas at Arlington. Humidity Zones are based on the United Nations Environment Program's *World Atlas of Desertification,* 2nd Edition, 1977. Nick Middleton and David Thomas (Editors). Temperature Zones are based on archived 2005 data from NOAA/National Weather Service, Climate Prediction Center.

Except for the groups listed below, no "outside" boats will be allowed access onto the Quabbin Reservoir without an AIS protection procedure in place.

- MassWildlife: DCR has developed a standard operating procedure for decontamination of fish stocking truck use at Quabbin and Wachusett Reservoirs based on meeting with MassWildlife (Appendix F). MassWildlife also decontaminated and sealed their work boat in 2009 and will have a dedicated boat for Quabbin only access.
- MA Environmental Police: MA Environmental Police officer (EPO) will have a dedicated boat for Quabbin only access.

In addition to the exclusion measures and decontamination procedures that focus on private and agency boats used at Quabbin discussed above, a 2010 Aquatic Invasive Species/Boat Ramp Monitor Program is currently under development. The program's two prong goal is to prevent the introduction of AIS into any water bodies in the Quabbin and Ware River watersheds and to prevent the spread of AIS from ponds that already have invasive species. To reach this goal, DCR staff intends to contact a large percent of all boat ramp and shoreline users between Memorial Day and Labor Day and to mail educational information to shoreline property owners within the Quabbin and Ware River Watersheds.

The Boat Ramp and Shoreline Program will include a Pilot Boat Decontamination Self-Certification Program on select ponds (e.g., Comet Pond, and Long Pond - Route 122 Ware River Ramp). Two dedicated boat ramp monitors will have contact with the public, assist the supervising Aquatic Biologist with sampling and surveys or other tasks as needed, carry out voluntary boat inspections, as well as gather data and opinions. Educational meetings are planned with each Lake and Pond Association (if there is one) at all the high priority ponds especially Comet Pond, Queen Lake, and Lake Mattawa.

3.3 Routine Monitoring: Current Program and Plans for Expanded Efforts

The current DWSP program of water quality monitoring at Quabbin, Wachusett, and Sudbury Reservoirs encompasses a broad spectrum of parameters integrated into six major components. These components consist of the following: (1) phytoplankton, (2) hydrographic parameters, (3) nutrients, (4) bacteria, (5) macrophytes, and (6) aquatic invasive species. Monitoring of plankton and hydrographic parameters at Wachusett Reservoir has been conducted routinely since 1987. Routine monitoring of hydrographic parameters at Quabbin Reservoir dates back to 1990 and routine plankton monitoring was initiated in 2007. Monitoring of nutrients has been conducted routinely at Wachusett and Quabbin Reservoirs since 1998 and was initiated at Sudbury Reservoir in 2009. Sampling for nutrients and analysis of water samples is undertaken in collaboration with MWRA staff at the Deer Island Central Laboratory who provide sample containers and where all grab samples are sent for analysis. Bacteria sampling has been conducted routinely at Wachusett Reservoir since 1991 in coordination with the gull harassment program.

The macrophyte communities of Wachusett and Quabbin Reservoirs have been monitored routinely since 1998 and Sudbury Reservoir was added to the program in 2006. Efforts to detect and control AIS have been conducted routinely since 1998 and initially focused on invasive macrophytes. A program to control invasive macrophytes in the upper reaches of Wachusett Reservoir was initiated in 2002 and has continued to the present as described in Section 2.1 above. To augment DWSP monitoring efforts MWRA commissioned comprehensive aquatic macrophyte surveys at Quabbin Reservoir, Ware River near the intake, Sudbury Reservoir, and other smaller distribution reservoirs in 2006-07. MWRA has commissioned consultant survey updates at these water bodies and a new survey at Wachusett Reservoir to be completed in 2010.

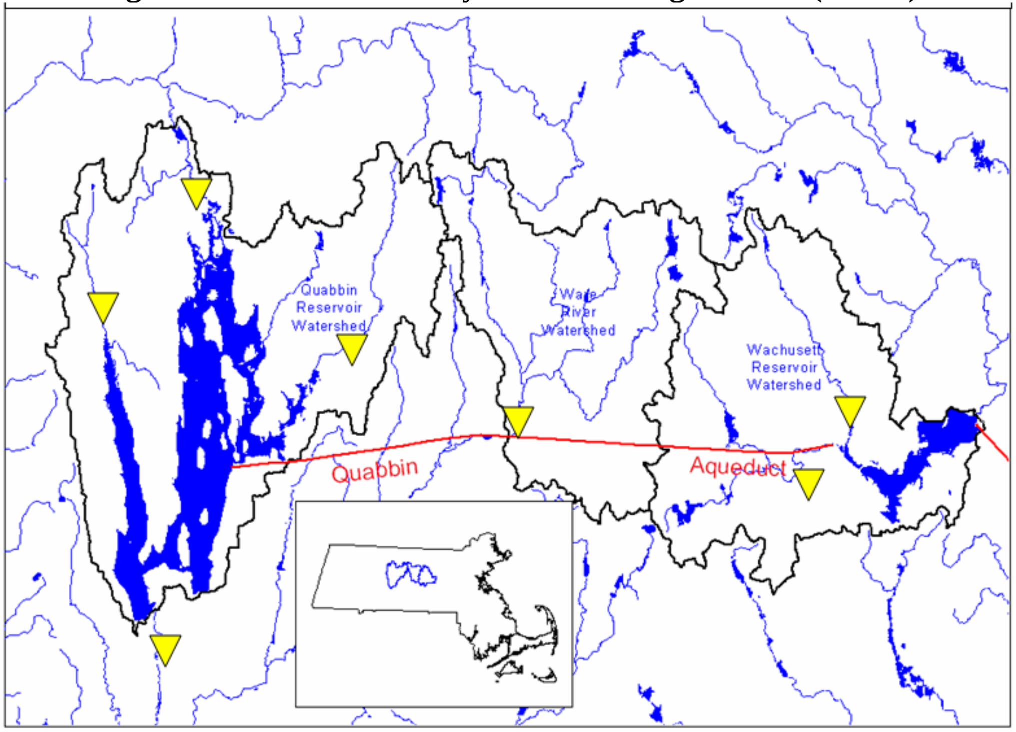
The discovery of a Hydrilla infestation in August 2010 just north of Wachusett Reservoir in the South Meadow Pond complex has prompted MWRA and DCR to evaluate response options. A scope of work is being prepared for a feasibility study focused on methods for suppressing Hydrilla in the South Meadow Pond complex as well as rapid response measures that could be initiated should pioneer specimens of this plant be discovered in Wachusett Reservoir. At a minimum, scouting of the reservoir will be intensified with more frequent inspections of the northern shoreline adjacent to the North Dike and Route 110. Scouting conducted in September 2010 of East and West Waushacum Ponds, located just west of South Meadow Pond in the Town of Sterling, showed no evidence of Hydrilla.

In response to recent alerts about threats from new kinds of invasive species, DWSP has implemented procedures and techniques to detect these novel invaders. Specifically, in 2007 when the outbreak of Didymo was reported in northern New England, DWSP staff implemented a monitoring program focused on the major tributaries of each watershed. This program consists of deployment of glass slides as artificial substrates in the selected tributaries. Artificial substrates provide a surface for colonization by attached algae and other organisms ("periphyton") and deployment of glass slides is a standard technique for investigation of this component of aquatic communities.

Artificial substrates were deployed in the Fall of 2007 at a total of seven locations to monitor for Didymo in the Wachusett, Quabbin, and Ware watersheds (Figure 3 on following page). At Wachusett the locations are the USGS gaging stations on the Quinapoxet and Stillwater Rivers. At Quabbin the locations are on the three branches of the Swift at existing sampling stations (West Branch #211 at Rt. 202, Middle Branch #213 at Gate 30, and East Branch #216 at Rt. 32A) and at a fourth location downstream of Winsor Dam in a section the Swift River popular for fly fishing (about 1 km downstream of Route 9 off Enoch Sanford Road). On the Ware River, sampling station #101 was selected.

Artificial substrates are checked and replaced on a monthly schedule (river stage and ice conditions permitting). Results to date have been negative for Didymo. Routine inspection and renewal of artificial substrates at the monitoring stations will continue until the threat of Didymo subsides. This monitoring program will facilitate early detection of Didymo should it ever enter the rivers comprising the DWSP watershed system.

Figure 3. Locations of Didymo Monitoring Stations (7 total)



In response to alerts about spiny water flea, zebra mussel, and quagga mussel, DWSP staff routinely conduct net sampling for zooplankton at the three Quabbin boat areas. Net sampling captures microscopic organisms in the water column and enables detection of spiny water flea and the veligers (larval form) of zebra and quagga mussels. This boat area sampling was initiated in April of 2009 and is performed in addition to the routine plankton sampling conducted at Quabbin Stations #202 and #206 since 2007. Net sampling has been conducted at Wachusett Reservoir since 1998. Net sampling results to date have been negative for all invasive species.

Monitoring efforts in each of the watersheds beyond the reservoirs and their immediate tributaries has been limited except in the Stillwater River watershed. Macrophyte scouting was conducted in the five major ponds located within this watershed in an effort to locate the potential source of the Eurasian Water-milfoil and fanwort infestations in Stillwater Basin (see Section 2.1 above). Scouting of Paradise Pond (Princeton), Bartlett Pond (Leominster), and Stuart Pond (Sterling) was conducted on September 8, 2005, but results were negative for both macrophytes of concern (Variable Water-milfoil was observed in Paradise Pond and Stuart Pond). Hy-Crest Pond in Sterling was scouted on October 17, 2006, but results were again negative. Lastly, observations of Snow Pond in Princeton revealed no Eurasian Water-milfoil or fanwort. Based on the absence of these invasive macrophytes in all major ponds of the Stillwater River watershed, it appears that the infestations in Stillwater Basin originated from direct introductions to that water body or to the river itself.

Macrophyte scouting of Lake Mattawa in Orange was conducted on July 20, 2001. This lake discharges to Quabbin Reservoir via the Middle Branch Swift River and was found to support a small population of Variable Water-milfoil, but not aggressive invasives such as Eurasian Water-milfoil or fanwort. As mentioned previously, macrophyte scouting in the Ware River watershed has consisted only of Queen Lake in Phillipston where no invasive plants were present in 2001 (see Section 2.0 above).

Future efforts will be expanded to include routine monitoring of significant water resources in all the watersheds with emphasis on water bodies with ramps suitable for launching trailered boats (see Section 2.2 above). In the Quabbin watershed, only Lake Mattawa in Orange meets this criterion whereas, in the Ware watershed, four water bodies have ramps that accommodate trailers. These are the Long Pond/Whitehall Pond complex and Demond Pond in Rutland and Asnacomet and Brigham Ponds in Hubbardston (see Appendix C). Also in the Ware watershed, Queen Lake (in Phillipston) will receive priority due to related risk factors (use of power boats from private property, see Appendix C). None of the lakes and ponds within the Wachusett and Sudbury watersheds have ramps suitable for launching trailered boats and generally only car-top boat have access or are allowed.

Ongoing monitoring efforts will be coordinated between Wachusett and Quabbin staff to accommodate the increased scope and geographic extent of the program (Table 8 on following page). Scouting for invasive macrophytes in Wachusett and Quabbin Reservoirs is generally conducted two or three times a month during the summer growing season, often in conjunction with other monitoring activities. Sudbury Reservoir will be inspected twice per year. Priority lakes and ponds in the Quabbin and Ware watersheds will be inspected at least once per year. Net sampling for microscopic forms of AIS is an augmentation of routine plankton monitoring, except for the addition of boat area sampling at Quabbin. The Didymo monitoring program will continue as described above.

Lastly, Zebra and Quagga mussel samplers will be deployed to serve as an additional early warning system and will be placed at each Quabbin boat area, Shaft 11A, Quabbin sampling stations #202 and #206, Long Pond, and Asnacomet Pond. Samplers will be monitored monthly (weather permitting) for any settlement of mussels. MWRA conducted underwater camera inspections for potential mussel settlement on concrete structures at Quabbin using a submersible remotely operated vehicle (ROV). These inspections included ramps, horseshoe dams, and bridges at the Fishing Areas and at the DCR Boat Cove area. No visible evidence of zebra mussels was detected at any of the locations, but additional ROV inspections will be conducted as needed.

Table 8. Synopsis of Current and Planned Monitoring Efforts Focused on AIS

Primary AIS Monitoring Tasks and Locations	Primary Period(s) of Activity
Reservoir Scouting for Invasive Macrophytes • Field work, plant identification, and documentation/reporting • Wachusett, Quabbin, and Sudbury Reservoirs	Year-round, but mainly during May through September growing season (frequency varies)
Watershed Scouting for Invasive Macrophytes • Field work, plant identification, and documentation/reporting • Priority water bodies in Quabbin watershed (Lake Mattawa) • priority waterbodies in Ware watershed (Asnacomet Pond, Brigham Pond, Demond Pond, Long Pond/Whitehall Pond complex, and Queen Lake)	Year-round, but mainly during May through September growing season (frequency varies)
Net Sampling for Microscopic Forms of AIS • Net sampling of zooplankton to detect spiny water flea and the veligers (larval form) of zebra and quagga mussels, microscopic analysis, and documentation/reporting • Wachusett and Quabbin Reservoirs (including the three boat areas)	Year-round (twice per month or monthly, ice conditions permitting)
Didymo Monitoring • Deployment of artificial substrates (glass slides) in major tributaries, microscopic analysis, and documentation/reporting • Wachusett, Quabbin, and Ware watersheds	Year-round (monthly, river stage and ice conditions permitting)

4.0 Summary and Conclusions

AIS threatening the DCR/MWRA reservoir system originate from North America ("native transplants") as well as from distant continents ("exotics") and, once established, are usually impossible to eradicate. Human activities are the main vectors of overland spread with the foremost vector being traffic of trailered boats between water bodies. The group of AIS with the greatest potential for causing ecological impacts and impairing water quality are macrophytes. This is because invasive macrophytes replace beds of native species with profuse accumulations of vegetative biomass that function to "pump" nutrients from sediments into the surrounding water along with releases of dissolved and particulate organic matter.

Two species of invasive macrophyte (Eurasian Water-milfoil and fanwort) have been actively managed in the upper reaches of Wachusett Reservoir since 2002. Hand-harvesting has been the primary control technique and efforts to date have been successful in confining the infestations mostly within upper subbasins of the reservoir system. However, recurring pioneer specimens in Powerline Cove indicate unremitting dispersal of invasive propagules into the main reservoir basin. In Sudbury Reservoir, the invasive macrophyte water chestnut has been actively managed since detection of pioneer colonies in 2006.

Aquatic invasive species are an escalating problem worldwide and the DCR/MWRA reservoir system is vulnerable to a variety of these organisms due to their potential impacts, geographic proximity, and vector potency. Secondary spread of invertebrate AIS have advanced their invasion fronts to the near horizon in Massachusetts including zebra mussel, Asian clam, and spiny water flea. Most troubling of all, the invasive macrophyte Hydrilla has appeared at the "doorstep" of Wachusett Reservoir just over the North Dike in the South Meadow Pond complex.

Managing the reservoir system to prevent the introduction of AIS requires a comprehensive strategy that integrates three main techniques: (1) public education and outreach, (2) exclusion and decontamination measures at boat ramps and other potential entry points, and (3) an expanded monitoring program. The constant and growing threat of AIS requires a long-term commitment to management efforts if existing infestations are to be controlled and new introductions prevented. To meet this challenge, DCR and MWRA continue to work collaboratively on all aspects of this management plan.

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Appendices

Appendix A - Preliminary Outline of Zebra Mussel Early Detection and Rapid Response Plan

Appendix B - DCR/DWSP Aquatic Invasive Species Decontamination Protocol

Appendix C - Expanded Public Education and Monitoring: High Priority Lakes and Ponds in the Watersheds (including map of Ware River Watershed)

Appendix D - 2009 Decontamination Checklist

Appendix E - 2010 Quabbin Warm Weather Decontamination Protocol

Appendix F - Mass Wildlife Fishing Stocking Truck Decontamination Memo

Appendix A
Preliminary Outline of Zebra Mussel Early Detection and Rapid Response Plan

Due to the suboptimal conditions (low pH and calcium levels) for zebra mussel establishment at the Quabbin Reservoir, if zebra mussels were introduced, they would form a localized colony. Reproduction would be minimal or non-existent as nutrients became depleted. An early detection plan to document the presence of colonies or veligers is necessary. Net sampling as well as ongoing visual examination of suitable habitats should be routinely conducted. A rapid response team of divers should be on contract and able to hand harvest mussels immediately upon detection. This method has been extremely successful when used to eliminate zebra mussels at Lake George in New York.

Appendix B
DCR/DWSP Aquatic Invasive Species Decontamination Protocol

Complete this checklist after visiting any water body:

1. Carefully inspect boat, trailer, and equipment for any possible contamination (this includes all interior and exterior boat surfaces, anchors, lines, downriggers, fishing gear, boots, clothing, buckets, tools, and other items exposed to water).

2. During the inspection, remove all plants fragments (even those that are native), mud, and debris. Dispose of these materials in an area that is "high and dry" well away from open water and not near any catch basins or watercourses that might discharge into a water body. Feel the boat hull for any rough spots - these may be newly attached zebra mussels. Any rough areas should be thoroughly cleaned until smooth to the touch (see below).

3. Drain all water from boat, bilge, engines, jet drives, live wells, and other equipment, and remove standing water from every nook and cranny that cannot be drained. Water should be released in an area that is "high and dry" just as with disposal of removed plant fragments, mud, and debris.

4. If time permits, impose downtime for boat, trailer, and equipment that entails 5-days of complete dryness before visiting a different water body. Complete drying (desiccation) is considered to be effective against aquatic "stowaways" and precludes the need for the additional decontamination measures given below.

5. If drying downtime for boat, trailer, and equipment is not practicable and a visit to another water body is planned, complete steps 1, 2, and 3 above and then perform one or some combination of procedures tabulated below (some cleaning solutions may damage equipment so care must be use in determining the best method for treating each individual item).

Boat, Trailer, and Equipment	Wash with hot water (over 104 degrees) or steam clean
	If hot water/steam cannot be provided, wash with detergent and high pressure
Equipment only	Dip into 100% vinegar for at least 20 minutes
	Soak in 1% salt (NaCl) solution for 24 hours
	Soak in 5% bleach solution for approximately one hour

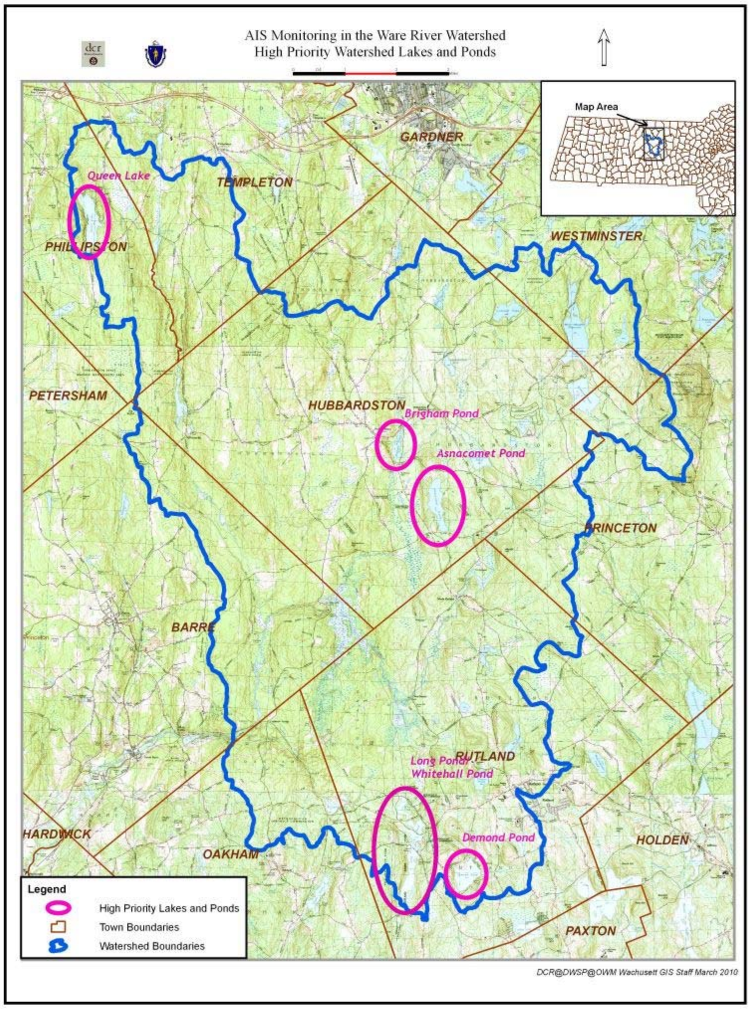
Appendix C
Expanded Public Education and Monitoring: High Priority Lakes and Ponds in the Watersheds (including map of Ware River Watershed)

Quabbin Watershed: Lakes, Ponds, and Boat Ramps

Water Body Name	Area (acres)	Location by Town	Ramp/Boat Status
Brown Pond (Wilson Pond)	10	Petersham	
Carter Pond	45	Petersham	
Connor Pond	21	Petersham	
Gaston Pond	16	Rutland	
Harvard Pond (Brooks Pond)		Petersham	cartop
Lake Mattawa (North Pond Brook Reservoir)	112	Orange	ramp
Nichewaug Pond	10		
Racoon Hill Pond	6		
Sibley Swamp (Sibley Swamp Pond)	22	Wendell	no power boats
South Mattawa Pond	6		power boats used

Ware Watershed: Lakes, Ponds, and Boat Ramps

Water Body Name	Area (acres)	Location by Town	Ramp/Boat/Fish Status
Asnacomet/Comet Pond	127	Hubbardston	ramp/stocked
Bemis Road Pond	15		
Bennett Pond	4	Hubbardston	
Bickford Pond (Ropers Reservoir, Bickford Reservoir)	154	Hubbardston/Princeton	
Brigham Pond	43	Hubbardston	power boats used
Charnock Road Pond	6		
Cunningham Pond	28	Hubbardston	no power boats
Demond Pond	119	Rutland	cartop/stocked
Edson Pond		Rutland	
Long Pond/Whitehall Pond complex	168	Rutland	ramp/stocked
Lovewell Pond		Hubbardston	
Marcan Pond	3		
Mare Meadow Reservoir	287	Westminister/Hubbardston	no power boats
Moosehorn Pond	60	Hubbardston	cartop
Moulton Pond (Caulkins Pond)	76	Rutland	
Muddy Pond	26	Oakham/Rutland	
Natty Pond	6	Hubbardston	
Queen Lake	139	Phillipston	power boats used
Stone Bridge Pond	15	Templeton/Phillipston	
Thayer Pond		Rutland	
Waite Pond	37	Hubbardston	
Williamsville Pond	54	Rutland	



Wachusett Watershed: Lakes, Ponds, and Boat Ramps

Waterbody	Town	Boating	Public Accessibility for boats
Paradise Pond	Princeton	Non motorized boating/canoeing	Parking area and boat ramp (in State Park; heavily used)
Glutner Pond	Princeton	Possibly by permission of owner	None
Snow Pond	Princeton	By abutters/homes on pond	None
Unnamed pond Goodnow Road	Princeton	Canoeing - member events only	Access at Goodnow Road
Norce Sportsmens Club	Princeton	Too small for boats	Members only
Bartlett Pond	Leominster	Boats allowed (no gas powered motors)	Members only although there is a large boat ramp and parking area
Streeter Pond	Paxton	None	None
Asnebumskit Pond	Paxton	None PWS	None
Muschopauge Pond	Rutland	None PWS	None
Eagle Lake	Holden	Non motorized boats/canoes	Parking area and small boat ramp
Maple Spring Pond	Holden	frequented by small boats	Lacks designated public access
Pine Hill Reservoir	Holden	No boats PWS	None
Kendall Reservoir	Holden	No Boats PWS	None
Dawson Pond	Holden	frequented by small boats	Lacks designated public access
Chaffins Pond	Holden	Non motorized boats/canoes	Access at Chaffins Recreation Area
Poutwater Pond	Holden	Non motorized boats/canoes are allowed	Boat launch area on Mason Road
Unionville Pond	Holden	Non motorized boats/canoes	Not from DCR property
Stump Pond	Holden	frequented by small boats	Lacks designated public access
Stuart Pond	Sterling	frequented by small boats	Lacks posted designated public access/ boat launch area at intersection
HyCrest Pond	Sterling	None	Perimeter of pond privately owned and posted no trespassing
West Waushacum	Sterling	Non motorized boats/canoes	Boat launch area Gates Road
East Waushacum	Sterling	Non motorized boats/canoes/jet skis	Boat ramp but parking lot for use by Sterling residents only
Quag	Sterling	Non motorized boats/canoes	Access from Rte 12
Muddy Pond	Sterling	Non motorized boats/canoes	Access from Muddy Pond Road

Appendix D
2009 Decontamination Checklist

Inspection #

DCR Quabbin Reservoir Vessel Inspection, Education, Decontamination Checklist

Owner/Operator (Print Name): ________________________________ Phone Number:________________

Owner Address:____

Boat make:_________________________________ Motor make and HP:_____________________ _______________

Boat Registration #: _________________________________

Season Pass #:_________________

Date: ____________ Inspection location:____________________ _______________

□ Complete vessel information above, give informational handout, explain procedure.

□ Inform owner/operator that Quabbin has a no-tolerance policy for any debris or growth found on any vessel, due to possible transportation of invasive species by vessels and trailers.

□ Request vessel owner to open all compartments and have the bilge plug pulled.

□ 5 minute engine flush. Start engine time: ___________ Stop engine time: ___________

□ Check boat for oil and gas leaks, inform owner that boats with leaks will not be allowed on Quabbin.

Vessel Inspection Decontamination: Inspect vessel for **WATER, DEBRIS** or **GROWTH** and clean all surfaces with 140^0 F high pressure water. Flush all bilges, live wells etc. with 140^0 F, motor with tap water.

Check appropriate box below to indicate it has been inspected and power washed.

Inspection: Dry	Inspection: Wet	Decontamination	
□	□	□	Tow Vehicle hitch area
□	□	□	Trailer structure, railings, rollers, carpeted bunks (Y/N), fenders, spare tire
□	□	□	Vessel hull
□	□	□	Transom
□	□	□	Motor –prop, shafts and all water contact areas
□	□	□	Outside motor
□	□	□	Trim tabs
□	□	□	Transducers
□	□	□	Bilge plug pulled – no fluid or debris
□	□	□	Bilge
□	□	□	Bait tank/live wells/compartments
□	□	□	Through hull fittings
□	□	□	Anchor/fenders and line
□	□	□	Trolling Motor
□	□	□	Down riggers
□	□	□	Flush Motor
□	□	□	Flush transom
□	□	□	Interior
		□	Additional review needed by R.D. or A.B.
		□ Samples collected (circle)	PLANT BIOLOGICAL

□ Pass: Seal # ______________________________________ Color_________________

Seal boat and inform owner that tampering with seal will result in a permanent ban at Quabbin Reservoir.

□ Fail

a. Owner refused decontamination procedure
b. Motor won't start
c. Plant fragments present
d. Biological contamination found

Comments: ____ Inspector:_____

Appendix E
2010 Quabbin Warm Weather Decontamination Protocol

Purpose
To prevent all AIS from colonizing Quabbin reservoir through the boat fishing program. All Aquatic Invasive Species, including zebra mussels, are of concern. In 2009, DCR staff collected five AIS of plants during the inspection process. These species included Eurasian Milfoil, Fanwort and Curly Pond weed. This program is designed to minimize vector risks from zebra and Quagga mussels, spinney water flea, Eurasian milfoil, fanwart and curly pond weed transported on boats/trailers/engines launching at the three boat launch ramps.

Program Components
The general components of the program are visual inspection, hot water pressure wash of 140° F or above, and flushing of motors with a chemical rinse (Vinegar) or hot water of 140° F. Physical flushing of cold water will also happen. The overall protocol components will be pre-arranged appointments, pre-survey before decontamination, visual inspection with data collection, boat and equipment decontamination, motor decontamination, tagging, and fee collection. All data collected will be entered into a database.

Appointments:
The Interpretative Services staff will be the lead for coordinating the inspection schedule and providing necessary information. See the information below for details.

Location: House of Wax, Orange:
Bill has tried to locate another location in the south but no location has surfaced with the 140° F hot water temperature, right equipment, space, manpower, connected to sewer, etc..

Dates 2010:
119 time appointment slots are provided on these 7 days; Seventeen boats may be cleaned per day. Additional days may be scheduled if needed.

Thursday 4/1, Saturday 4/3, Thursday 4/8, Saturday 4/10, Sunday 4/11, Thursday 4/15, Wednesday 4/14

Time:
Scheduled 8:00AM-12:00 and 1:00-4:30PM, every 30 minutes
(Lunch is 12:30 -1:00 no cleanings.)

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Additional Dates:
May dates are: Saturdays 5/1,5/15 and back up 5/22.
June dates are: Saturdays 6/5, 6/19 and backup 6/26.

Cost:
$30.00. We conducted **over 30** days of free decontaminations in 2009 and February 2010. The free program was conducted last summer, fall and this past winter. Additional decontamination days will be scheduled after the fishing season opens. The frequency and dates need to be established, but it will only be a day or two a month.

Trailers:
All carpeting needs to be removed, including the wheel wells, supports, bunks and any other areas. The trailer structural members must be in good condition - free from extensive rust, corrosion, holes. Wood must sealed, non-absorbent and free from mold or fungi.

Owner cleaning before decontamination:
All surfaces of the trailer, boat, motor, live wells, bilge that may come in contact with the reservoir water shall be cleaned by the owner before the decontamination appointment. There shall be no dirt, grease, oil, leaves, rust, fungi or other material that may mask the inspection and decontamination of the boat. All compartments must be accessible along with all lines, bumpers and anchors.

Decontamination:
All areas of the boat that will be exposed to reservoir water will be sprayed with 140° F hot water. This includes all areas of the trailer, the exterior of the motor, the exterior of the boat, the interior bilge, live wells, trolling motors, and anchor line.

Motor flushing:
The motor will be run and 140 ° F water or a vinegar solution will be flushed thru the motor. The motor must start and will either be flushed with hot water or a vinegar solution. Boats and trailers will have a pre-survey at the car wash and will be turned away if they are not the clean and in good standard condition. No charge will be assessed, if they are turned away. Rejected boat owner will be responsible for scheduling a future inspection appointment, if desired.

Initial intake/ pre-survey:
The Watershed Rangers will be responsible for the initial intake information, checking appointment time, checking current boat registration (required) and filling out name address, etc. The ranger will also do a pre-survey to check for carpeting or rusty trailers. Any questions will be referred to the EQ person.

Environmental Quality staff:
EQ staff will conduct the inspection, interview the boat owner; fill out the inspection check-list; collect any plant fragments, time the motor chemical decontamination, direct the 140° F spray and approve the tagging of the boat/motor. EQ will also monitor water temperature and vinegar pH.

Sub-contractors (e.g., House of Wax):
Staff will provide 140°F water on the boat and in the motor. They will spray the boat and associated equipment. They will collect the fee.

Sealing:
Rangers will secure the Quabbin Boat Seal (QBS) after EQ approves process. EQ has also developed a database for seals and will monitor the data base for functionality. DCR Administrative staff will input data weekly or more often based upon work load.

Evaluation:
EQ staff will perform spot checks by way of database queries and visits to fishing areas etc. Quality control procedures will be instituted for the temperature monitoring, pH levels, employee safety, inspections, and questionnaires.

Appendix F
Mass Wildlife Fishing Stocking Truck Decontamination Memo

Field Visit to Fish Hatcheries
3/12/10

Attendees: Bill Pula, Bob Bishop, Paula Packard, Yuehlin Lee

We met Dr. Ken Simmons, Chief Fish Culturist for Massachusetts Division of Fisheries and Wildlife (Mass Wildlife) at the McLaughlin Hatchery in Belchertown. Ken described protocols Mass Wildlife takes to prevent cross-contamination of waterways as they distribute fish statewide under the fish stocking program. Mass Wildlife is very concerned about introducing pathogens into their hatcheries by way of equipment or water. The primary efforts focus on preventing vehicles and equipment from contacting the different waters being stocked, washing/sterilizing vehicles or equipment that do contact water, and scheduling sites appropriately to minimize potential cross-contamination. Mass Wildlife has recently formalized standard operating procedures (SOPs) to reduce the risk of spreading aquatic nuisance species, a copy of which was provided for DCR's internal use at this time. Protocols specific to Quabbin and Wachusett Reservoirs are outlined in the SOPs, including steam-cleaning the tires and underbody of their stocking trucks (comparable to what is required for boat trailers) and the use of well water only to transport fish to stock these sites. The trucks will be decontaminated at the House of Wax in Orange under DCR guidance prior to stocking Quabbin Reservoir. Only well water from McLaughlin Hatchery will be used to transport fish to both reservoirs. When stocking Wachusett Reservoir, no truck contact will occur with water. Fish will be emptied from the truck at bridges and over passes.

Jim Hahn is the manager at the McLaughlin Hatchery, which raises brook trout, brown trout, and rainbow trout. The McLaughlin Hatchery draws water from the Swift River and their on-site wells, and raw water is not currently treated before use. Wastewater is treated in on-site lagoons.

We also visited the salmon hatchery in Palmer. Dan Marchant is the manager at the Palmer Hatchery, which raises Atlantic and landlocked salmon. This hatchery draws water from an on-site surface water reservoir and on-site wells, and the raw water (both surface water and groundwater) is treated using high-pressure sand filters and ultraviolet disinfection.

Rainbow trout and salmon are stocked at Quabbin and only rainbow trout at Wachusett Reservoir.

Staff reviewed the Mass. Wildlife protocol for stocking and feel it sufficiently reduces the risk of AIS being introduced from the stocking operation. In addition, the motivation for the SOP is to prevent the introduction of pathogens into the hatchery so staff feel Mass Wildlife has an institutional goal which is common to DCR's and believe that implementation is a high priority for Mass. Wildlife. DCR staff believe the S.O.P. will reduce AIS risks for Quabbin and Wachusett Reservoirs from fish stocking operations and that Mass Wildlife should be allowed to proceed with its yearly stocking.