Onota Lake Invasive Species Management Plan

Prepared for:
The City of Pittsfield

By
ENSR Corporation
&
Berkshire Regional Planning Commission

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ENSR INTERNATIONAL

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Invasive Species Management Plan for Onota Lake

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and

Berkshire Regional Planning Commission

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1.0 INTRODUCTION

Onota Lake is a large waterbody located entirely within the City of Pittsfield in Berkshire County, Massachusetts. The lake is a local amenity and regional attraction for recreational uses such as swimming, fishing, and boating, as well as its designated uses such as supporting healthy aquatic life. These uses have been impacted by the extensive growth of aquatic vegetation, particularly the exotic invasive Eurasian watermilfoil (*Myriophyllum spicatum*) in the more shallow portions of the lake, particularly in the North Basin. A series of recommendations and management options for controlling this nuisance aquatic vegetative growth have evolved from rather extensive limnological and watershed investigations. Application of these vegetation management options have raised concerns regarding possible impacts to rare or endangered plant and animal species residing in the lake (MA DFW, 2004); resulting in a need for an comprehensive approach to aquatic vegetation management which is effective in reducing nuisance growth but protective of protected species.

ENSR Corporation (ENSR) was selected by the City of Pittsfield for development, evaluation and refinement of an *Invasive Species Management Plan for Onota Lake*. Through this project, the City, the Lake Onota Preservation Association (LOPA), and the Berkshire Regional Planning Commission (BRPC) (acting as the administrator for this project on behalf of the City) will implement a critical recommendation of the *Long Range Management Plan for Onota Lake*, prepared by BRPC and LOPA for the City of Pittsfield in 2004. While the Onota management plan considers many aspects of watershed and lake management, a key recommendation (Management Goal #1) is to develop and implement a plan to protect and restore native aquatic plants and minimize the impacts of non-native, invasive plants (Pittsfield/BRPC/LOPA/BRPC/LOPA, 2004). Specifically, the comprehensive aquatic plant management is intended to:

- maintain and improve healthy, native aquatic plants;
- address the extent of the re-growth of milfoil in Onota Lake that is reaching nuisance levels for the current uses of the lake;
- provide quality fish and wildlife habitat;
- minimize the ecological and recreational impacts of nuisance aquatic plants;
- effectively coordinates with other ongoing management efforts; and
- address Onota Lake's recent designation as rare and endangered species habitat.

To achieve the aims of Management Goal #1, a Technical Advisory Group (TAG) was established to help create and refine the *Invasive Species Management Plan* and address potential concerns regarding protection of rare and endangered species habitat. The Technical Advisory Group is composed of experts in the fields of lake management (Dr. David Mitchell and Dr. Kenneth Wagner; ENSR International), aquatic botany (George Knocklein; Northeast Aquatic Research), ichthyology (Dr. Robert Schmidt; Simon's Rock College), hydrology (Charles Steven Howe; ENSR Corporation), and environmental law (to be determined).

ENSR is serving as the expert in lake management and has developed this initial *Draft Invasive Species Management Plan for Onota Lake*. ENSR reviewed existing data and relevant technical reports for Onota Lake provided by BRPC, as well as drawing on previous work conducted at the lake. In addition, ENSR considered experiences with past vegetation management techniques employed at Onota Lake. The Invasive Species Management Plan took into consideration the presence of rare and endangered species as determined by the Natural Heritage and Endangered Species Program. The initial draft plan and other relevant information was distributed to the Technical Advisory Group, who participated in a site visit to Onota Lake and a TAG Meeting at Springside Park House, Pittsfield MA on April 27, 2005 to review and critique the plan. BRPC revised the draft plan based on the site visit and TAG meeting discussions. BRPC submitted the revised Final Plan to ENSR and other TAG members for review and final approval.

The BCRP Project Manager was Melissa Jette (413-442-1521 ext. 22; mjette@berkshireplanning.org). The TAG member and senior technical reviewer for ENSR were, respectively, Dr. Dave Mitchell (978-589-3077; dmitchell@ensr.com) and Dr. Kenneth Wagner (860-429-5323; kwagner@ensr.com).

Following a similar approach to that adopted for the *Long-Term Management Plan* (Pittsfield/BRPC/LOPA, 2004), the *Invasive Species Management Plan for Onota Lake* will summarize to avoid duplication of material and maintain consistency with the relevant studies and policies. To the greatest extent possible the Plan will summarize and integrate the individual findings and recommendations of these existing documents.

2.0 PAST AND CURRENT CONDITIONS

This section provides an overview and summary of the current conditions in Lake Onota, particularly those that may be critical for aquatic vegetation control evaluation. Due to the rather extensive bibliography of work on Onota Lake, no attempt will be made to comprehensively report on each subject; rather a short summary is provided, with further detail and data available in the referenced source documents. Much of the material presented below is taken from the *Long-Range Management Plan* (Pittsfield/BRPC/LOPA, 2004), supplemented with findings from other studies.

The *Housatonic River Basin 1997/1998 Water Quality Assessment Report* classified Onota Lake as mesotrophic (MA DEP, 1998). This trophic state assignment appear warranted based on the information presented above, particularly with regard to nutrients, SDT depths, and chlorophyll *a* values, and is consistent with previous studies (IT, 1991; ALWS,1997) and recent observations (LOPA 2003, 2004. In general, the lake water quality is achieving its designated water uses for fishing, swimming and support of aquatic species.

While the water quality at Onota Lake appears to be appropriate to its uses, the excessive growth of exotic aquatic plants threatens recreational options and other current uses of the lake. Onota Lake is listed on the *Massachusetts Year 2004 Draft Integrated List of Impaired Waters* as being impaired by exotic species (EOEA, 2004). Onota Lake's eutrophication can be attributed to watershed urbanization and subsequent increases in sediment and nutrient loading. The most all-encompassing causes of Onota Lake's problems appear to be a result of excessive sediment and nutrient loading (IT, 1991). Management and mitigation of non-point source pollution, including erosion, is a major priority.

2.1 Lake and Watershed Setting

Onota Lake is a 617-acre (250 hectares) lake located entirely within the City of Pittsfield (Figure 1) with a watershed approximately 6,345 acres (25.7 km^2) in area. Onota Lake is located at an elevation of 1086 feet (331m) according to USGS topographic maps. However, the dam spillway is located at 1078.9 ft (IT, 1991). The outlet of Onota Lake, Onota Brook, flows southeast entering the West Branch of the Housatonic River, in Pittsfield (IT, 1991).

A variety of land uses are found within the watershed. These land uses include, among others, commercial, participation recreation, urban open land, agriculture, mining, and low, moderate, and high density residential (MassGIS 1997 Land use Data). Although the majority of the watershed is not highly developed, the northeastern section of the lake is the most densely developed (Figure 2-1). The vast majority of the development within the watershed has occurred around the shoreline of the lake, limiting forested and open land to the periphery of the watershed. A significant number of residences have converted from seasonal to year round occupancy with the average residence time currently eleven months per year.

Residential development in the Onota Lake watershed consists primarily of lots greater than ½ acres, with the exception of the northeastern section of the watershed, which includes the densely developed Thomas Island and a commercial marina. Several summer camps are also operated within the watershed some of which maintain lakefront property with lake access. Public access is provided through Burbank Park, a municipally owned park that includes a public boat launch, fishing pier, restrooms, and parking areas. Burbank Park serves as the primary access point for lake users that do not live on the lake.

Located along the lake's periphery are approximately twelve wetland systems. Most of these wetlands are along the northern half of the lake, and five of them are associated with inlet streams (Figure 2-1). These habitat systems include forested swamps, emergent shrub swamps, and freshwater marshes.

Figure 2-1. Onota Lake and Watershed, Pittsfield, MA (from BRPC et al., 2004)

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Based on vegetation inventories and habitat evaluations performed on the area, three major wetland systems provide moderate to high quality wildlife habitat (Fugro, 1996)

2.2 Basin Morphometry and Circulation

The configuration of the lake and its bathymetric contours are provided in Figure 2-2 (taken from IT, 1991), with associated morphometric data provided in Table 2-1. As can be seen in the bathymetric map, the deeper portion of the lake is located in the larger South Basin (419 ac), where the maximum depth of 67 ft is reached. Onota Lake is often described as “two lakes in one” because of the minimal water exchange between the North and South basins due to the old roadway that marked the north end of the original lake prior to the building of the dam (Pittsfield/BRPC/LOPA, 2004). The average depth of the lake has been estimated at 21 ft (Souza et al, 1991), although much of the North Basin is less than 8 ft. These differences in basin depth (and presumably light availability) are important in determining the observed patterns of aquatic vegetation growth (see below).

Investigation of the hydrologic budget of Onota Lake indicates an overall hydraulic residence time (HRT) in Onota Lake of 0.78 yr (285 days) with an average 1.3 flushings per year (IT, 1991). However, there are very different flushing rates for the two internal basins. North Basin has a HRT of 0.116 yr (42 days) with 8.6 flushings per year, while the South Basin has a HRT of 2.82 yr (1029 days) with 0.36 flushings per year (IT, 1991).

2.3 Temperature and Dissolved Oxygen Profiles

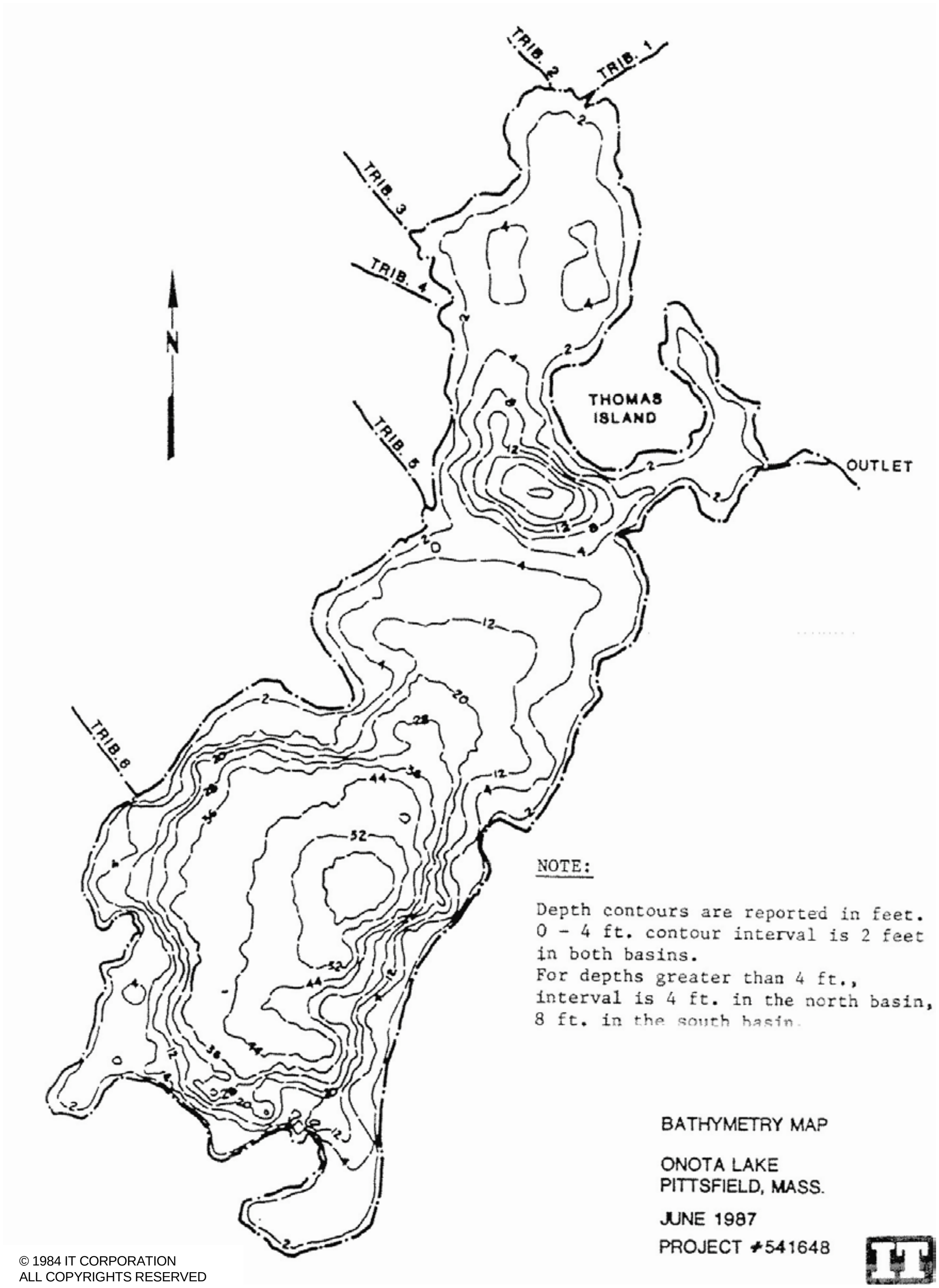
Onota Lake is a temperature, dimictic lake exhibiting two periods of mixing - vernal (spring) and autumnal turnovers, ice-bound winter conditions and a thermally stratified summer condition (separating the lake profile into epilimnion and hypolimnion). A typical mid-summer thermocline depth in the South Basin is approximately 20 ft while that in the shallower North Basin is closer to 12-15 ft. (IT, 1991; LOPA, 2003; 2004).

Onota Lake exhibits a seasonal pattern in which concentrations of oxygen in the metalimnion are in excess of saturation. This phenomenon (metalimnetic oxygen maxima) has occurred typically each year during stratification, and is suspected to be caused by algae production. As stratification intensifies Onota Lake experiences a decrease in the oxygen concentration of the hypolimnion. The oxygen deficit is sufficient to cause anoxic conditions to persist towards the bottom of the lake in both basins. Under anoxic conditions changes in sediment chemistry allow phosphorus to become remineralized. The soluble phosphorus, which has been remineralized can potentially be circulated in the water column and available for algae and macrophytes (IT, 1991).

Table 2.1. Morphometric Data of Onota Lake, Pittsfield MA (from IT, 1991)

Lake Area	617 ac(250 ha)
North Basin	198 ac (80 ha)
South Basin	419 ac (170 ha)
Lake Maximum Depth	67.6 ac (20.6 m)
Lake Mean Depth	21 ft (6.4 m)
Lake Volume	$5.66*10^8 ft^3$ ($15.98*10^6 m^3$)
Watershed Area	6,345 ac (25.7 km^2)
Shoreline Length	10.1 mi (16.3 km)
Maximum Length	2.1 mi (3.4 km)
Maximum Width	0.62 mi (1.0 km)

Figure 2-2. Bathymetric Map of Onota Lake, Pittsfield, MA (from IT, 1991)



2.4 Water Quality

The water quality of Onota Lake supports its present designated uses. Water quality data indicates that the water quality of the deeper South Basin is more desirable than that in the shallower North Basin. (LOPA Annual Report, 2003) This is not surprising since the two largest subwatersheds drain into the north basin. With minimal water exchange between the two basins, due to the shallow depth contour near Thomas Island, the water quality is expected to be better in the South Basin (IT, 1991).

Secchi disc transparency

Secchi disc transparency (SDT) tests are regularly conducted by LOPA volunteers from spring to late fall. Recent SDT depths have averaged between 3 meters depth to 6 meters depth in the deeper South Basin (LOPA Annual Report, 2003; 2004). According to SDT tests conducted by LOPA volunteers, the water clarity was reduced after the 1999 SONAR treatment (LOPA Annual Report, 1999). One cove has exhibited reduced water clarity on rare occasions falling below the state mandated 1.4 meters for swimming.

Nutrients and Sources

Total phosphorus (TP) levels in Onota Lake reported in the 1991 monitoring program ranged from < 10 ug/L to 630 ug/L (i.e., due to anoxic hypolimnion) but were generally characterized as < 50 ug/L (IT, 1991). Recent (2004), and perhaps more sensitive detection limits, indicate TP levels in the North Basin from between 5-8 ug/L in surface waters with deep maximum of 36 ug/L and in the South Basin between 4-10 ug/L in the epilimnion with a deep sample maximum of 13 ug/L (LOPA, 2004). Nitrogen levels were generally moderate (e.g., NH_3-N < 0.1 mg/L; NO_3-N < 0.2 mg/L) except for anoxic hypolimnetic and spring runoff samples (IT, 1991). Nitrogen fractions are not regularly monitored by LOPA volunteers. It should be noted that the P-budget of the 1991 Study indicated the following relative phosphorus inputs: direct runoff/tributary loading, 50%; direct precipitation and dryfall, 5%; septic loading, 15%; and internal loading, 30%. Since that period, sewering of a major portion of the watershed has likely significantly decreased contributions from septic loadings.

A pollutant load analysis summarizes the kilograms per year of total phosphorus, total nitrogen, and total suspended solids entering the lake from each of the ten subwatersheds for the entire Lake Onota Watershed (See Figure 1). The results of that analysis show that sub-watersheds VI, VII and VIII are responsible for the bulk of the lake's nutrient and sediment loading (IT, 1991). These watersheds correspond respectively to the Parker/Lulu Brook, Churchill and Daniels Brook watersheds. Further analysis based on land use, loading coefficients and potential attenuation in transport indicate that sub-watersheds I, II, and IX are more problematic in terms of producing higher than expected levels of TP and total suspended solids (TSS) (Princeton Hydro., 2004).

2.5 Sediments

Sediments may be derived from natural sources, anthropogenic sources, or a combination of these sources. In the case of Onota Lake, there are no known point sources of pollutants. The major vectors of nutrients and sediments are tributaries and runoff (nonpoint sources), atmospheric contributions and internal sources. The North Basin of Onota Lake has an appreciable accumulation of sediment (> 0.3 meters appreciable accumulation). In the South Basin, limited areas along the southwest shore were found to have deposits of organic sediments, primarily confined to the shoreline parallel to Blythewood Drive and ranging from 0.3 to 1.0 meters in depth. Deep deposits (1.8 – 2.0 m) of sediment accumulation were measured in the northwestern shoreline of the lake. Along the northwestern shore of Thomas Island and within Thomas Island Cove approximately 1 – 1.2 m of sediment were observed (IT, 1991).

2.6 Plant communities

Phytoplankton

Phytoplankton levels (as indicated by chlorophyll *a* values) are generally indicative of mesotrophic conditions in Onota Lake. Chlorophyll *a* values reported in the range of 0.1 to 7.5 ug/L in 1991 (IT, 1991). Recent monitoring indicates total chlorophyll levels of 2.5 to 9.4 ug/L in the North Basin and 1.5 to 7.7 ug/L in the South Basin (LOPA, 2004). Phytoplankton community composition in Onota Lake exhibits a typical temperate lake seasonal succession between algal groups including winter dinoflagellates (*Dinobryon, Ceratium*), spring diatoms (*Fragilaria*), summer greens, and some late-summer blue-green algae (BGA). Nuisance blooms of BGA do not seem to be a common phenomenon at Onota Lake.

Aquatic Macrophytes

Aquatic macrophytes have been surveyed as part of lake investigations over the past two decades (IT, 1991; Fugro, 1996; ALWS, 1997; LOPA, 1999; ACT, 2000; ACT, 2002; GeoSyntec, 2003a; LOPA, 2003; 2004). Most of these surveys were in conjunction with evaluating and potential management or treatment of the Eurasian watermilfoil (EWM) (*Myriophyllum spicatum*). Several of the aquatic plant maps generated by these studies are included in Appendix B along with some of the aquatic plant inventories and coverage data generated by the surveys. Rather than go through the entire chronology of surveys, it may be instructive to look at the chronology of the EWM expansion during the late 1980s-1990's, the effect of chemical treatments in the 1999-2002 period, and some of the more recent surveys.

In August of 1986, IT Corporation investigated Onota Lake for macrophyte distribution (IT, 1991). The shallow North Basin contained five major plant species and several less common forms. The deeper

South Basin had only one abundant species. A total of ten plant species were reported in the August 1986 plant survey of the entire lake area, although this would be an unusually low number of species for a Berkshire County lake. It seems more likely that additional species were simply too uncommon to be detected at the level of resolution achieved in that study.

EWM grew to nuisance densities in 1986 in the north basin, but was rare in the south basin. *Potamogeton perfoliatus* (identified in 1996 *as P. richardsonii*) was also considered dominant in some areas of the north basin, and was the most common plant of the south basin in 1986. *Elodea* sp. (waterweed) and *Vallisneria americana* (water celery) were listed as abundant but not dominant in 1986, again based mainly on North Basin populations. *Potamogeton crispus* (curly-leaf pondweed) was listed simply as present in 1986. A third *Potamogeton* species, *P. robbinsii (*ribbonleaf pondweed)*,* was also listed as present, and two green macroalgae, *Chara* and *Nitella*, were observed. *Nuphar advena* (yellow water lily) and *Heteranthera (Zosterella) dubia* (water stargrass) were the other species listed. In 1986, only the north basin contained high densities of rooted aquatic plants, with coverage of 70 to 80% noted. Apparent southward migration of some species was suggested in the IT report, but emphasis was *Potamogeton perfoliatus* and *Elodea* sp. as the major threats.

In late June and early July of 1996 Fugro East, Inc. investigated Onota Lake for macrophyte distribution (Fugro, 1996). The timing and methods varied somewhat from those of the 1986 survey, mainly due to a need to provide repeatable quantitative measures for future comparisons. However, the focus of the survey was on 10 transects from shore to deep water or the opposite shore, depending upon depth, with habitat data recorded at up to 17 stations along each transect. Overall, 25 macrophyte species were identified for the lake, many more than in 1986, but including all species found in 1986. Again, this is more likely a methodological artifact than a plant community change. The plant list includes 9 species of *Potamogeton*, which is typical for Berkshire County lakes, but only 2 non-native species, the EWM and curly-leaf pondweed. Ten species with distinct nuisance potential were observed, including the two non-native species. All but two of the potential nuisance species are susceptible to drawdown effects, while only two native, non-nuisance species (two species of *Potamogeton*) were likely to be adversely affected by drawdown.

Based on the Fugro survey, macrophyte cover appeared to have increased dramatically since the IT Corporation survey, especially in the South Basin (IT, 1991; Fugro, 1996). Both EWM and curly-leaf pondweed had expanded their ranges substantially. *Potamogeton richardsonii* or *P. perfoliatus* (the taxonomy of these is troublesome, and both could occur in Onota Lake) had nearly been eliminated from the north basin, but is dense in several areas of the South Basin and the outlet cove. Aquatic plant cover and biomass ranged from 75 to 100% in the North Basin with large patches of curly-leaf pondweed which were matted near the north shore of the north Basin. While there were no plants below depths of about 15 ft in the South Basin, cover approached 100% in many shallow areas and the volume of the water column filled by milfoil or curly-leaf pondweed was between 75 and 100% in areas where these species occurred.

While the increase in distribution and density of curly-leaf pondweed was attributable to seasonal differences in the surveys; the expansion of EWM was of greater concern. Its greater distribution and density in early summer of 1996, compared to mid-summer of 1986, suggested an alarming but not atypical increase in the dominance by this species. As a non-native plant capable of achieving high densities and reducing the diversity and abundance of native species, EWM is a primary target of plant management in New England lakes.

Based on this information and subsequent monitoring (ALWS, 1997) and in accordance with the Onota Lake Management Plan (LOPA, 1999a), Aquatic Control Technologies (ACT) was commissioned in 1999 to develop a Comprehensive Aquatic Management Program, obtain necessary permits and conduct a whole-lake Sonar® (fluridone) herbicide treatment. Maintenance spot-treatments were performed during the 2000 and 2001 growing seasons with Reward ® (diquat) or Navigate ® (2,4-D) herbicides. Details on the management planning and herbicide applications are provided elsewhere. Aquatic vegetation maps indicating the results of the herbicide treatments are provided in Appendix B (ACT, 2000-2002)

Of recent efforts, macrophyte surveys of Onota Lake were conducted in 2002 and 2003 by Aquatic Control Technology (ACT) and GeoSyntec Consultants, respectively, and have documented a relatively diverse macrophyte community with a minimum of twenty-two (22) species observed (ACT, 2002; GeoSyntec, 2003a) (Appendix B). These twenty-two species include four species designated as non-native, invasive species by the Massachusetts Natural Heritage and Endangered Species Program (NHESP). These noxious aquatic plants are EWM, curly-leaf Pondweed, European Naiad (*Najas minor),* and Water Chestnut (*Trapa natans*). Unfortunately, EWM and Curly-leaf Pondweed are clearly the dominant species found in the lake based on early season 2003 findings. By mid-August of 2003, problematic densities made up primarily of EWM covered the majority of the northern portion of the lake (GeoSyntec, 2003a). An aquatic plant survey conducted by LOPA in 2004 found a significant expansion in the spatial coverage of EWM (LOPA, 2004).

2.7 Animal Communities

The following information is provided on fauna of Onota Lake. The fishery discussion is drawn largely from the Fugro (1996) report in the discussion regarding fishery concerns associated with a potential lake-level drawdown.

Onota Lake Fish Community

Onota Lake supports a diverse and important recreational fishery. Based on historic Massachusetts Division of Fisheries and Wildlife (MA DFW) survey data, approximately 18 species of fish maintain naturally reproducing populations in the lake (Table 2-2). A subsequent fishery survey also added redbreast sunfish (*Lepomis auritis*) to the species list (ALWS, 1997). Additionally, three species of trout have been stocked annually during the spring and fall, and broodstock Atlantic salmon are stocked on a periodic basis. Onota Lake is primarily managed for put-and-take trout fishing, trophy brown trout, and trophy northern pike. Onota Lake also serves as the principal water supply for its outlet stream, Pecks Brook. This small perennial stream supports a naturally reproducing population of brook trout (Daly. 1996 cited in Fugro, 1996).

According to the MA DFW, three naturally reproducing species of fish were of primary concern in the proposed drawdown. These include the brown trout, northern pike, and rainbow smelt. The potential concerns included potential aeration/stranding of eggs deposited in shallow shoals and accessibility to feeder streams (brown trout, smelt) and accessibility of vegetation spawning habitat and attraction to the outlet pipe (northern pike). Additionally, the success of the trout stocking program in the lake and the maintenance of a naturally reproducing population of brook trout in the outlet stream (Pecks Brook) are also both closely linked to the drawdown (Daly 1996). The principal concern regarding the success of the stocking program is that both rainbow trout and Atlantic salmon are known to follow strong water currents and could potentially exit the lake via the outlet pipe. For Peck's Brook, adequate flows must be maintained in order to sustain suitable conditions for brook trout and other aquatic life. Details on these requirements are further described in Fugro (1996). More recently, MA DFW has identified a species of Special Concern, the Bridle Shiner (*Notropis bifrenatus*) as being present in Onota Lake (MADFW, 2004).

Amphibians

Reptiles and amphibians have not been extensively surveyed by many of the previous lake investigations, but observations regarding these groups have been included in some of the adjacent wetland habitat evaluation (Fugro, 1996; ALWS, 1997). Reptiles and amphibians have become focal points of many wetlands conservation efforts, and one of the concerns regarding water-level drawdown relates to the potential for impact to hibernating populations. However, little data are available for comparisons before and after drawdown events. Qualitative surveys of basking turtles on logs are regularly monitored by LOPA volunteers.

Table 2-2. Fishes of Onota Lake (Daly, 1996 from Fugro, 1996)

Common Name	Scientific Name	Status
Brown trout	*Salmo trutta*	stocked/natural reproduction
Brook trout	*Salvelinus fontinalis*	stocked
Rainbow trout	*Oncorhynchus mykiss*	stocked
Atlantic salmon (brood stock)	*Salmo salar*	stocked
Kokanee salmon	*Oncorhyncus nerka*	probably not present anymore
Rainbow smelt	*Osmerus mordax*	natural reproduction
Largemouth bass	*Micropterus salmoides*	natural reproduction
Smallmouth bass	*Micropterus dolomieui*	natural reproduction
Rock bass	*Ambloplites rupestris*	natural reproduction
Black crappie	*Pomoxis nigromaculatus*	natural reproduction
Pumpkinseed	*Lepomis gibbosus*	natural reproduction
Bluegill sunfish	*Lepomis macrochirus*	natural reproduction
Northern pike	*Esox lucius*	natural reproduction
Chain pickerel	*Esox niger*	natural reproduction
Channel catfish	*Ictalurus punctatus*	natural reproduction
White catfish	*Ameiurus catus*	natural reproduction
Brown bullhead	*Ameiurus nebulosus*	natural reproduction
Yellow perch	*Perca flavescens*	natural reproduction
White sucker	*Catostomus commersoni*	natural reproduction
Common carp	*Cyprinus carpio*	natural reproduction
Common shiner	*Luxilus cornutus*	natural reproduction
Golden shiner	*Notemigonus crysoleucas*	natural reproduction

2.8 Natural Heritage and Endangered Species

A major challenge to potential lake and aquatic vegetation management programs in Onota Lake is the presence of protected species. In September 2003, the Massachusetts Natural Heritage and Endangered Species Program (NHESP) of the Massachusetts Division of Fisheries and Wildlife (MA DFW) designated three areas within the Onota Lake watershed (Theodore Pomeroy Pond, a small wetland/pond area southwest of the Dan Casey Causeway known as Dunn's Grove, and the embayment north of Dan Casey Causeway which receives flow from Churchill and Daniels Brooks) as Priority Habitat (see figure entitled "Priority Habitat in the Vicinity of Onota Lake Pittsfield, Appendix C). This listing stems from the presence of two state-protected (status: endangered) macrophyte species, the Comb watermilfoil (*Myriophyllum verticillatum*), and Ogden's Pondweed (*Potamogeton ogdenii*). The latter is a hybrid species formed by a cross of Flatstem Pondweed (*Potamogeton zosteriformis*) and Hill's Pondweed (*Potamogeton hillii*). The MA DFW letter (dated November 22, 2004) expresses concern that some lake management techniques may result in "take" (defined as collecting, picking, killing, transplanting, cutting, or processing of a plant) of the state-protected species.

In addition to these two endangered aquatic macrophyte species, the Bridle Shiner (*Notropis bifrenatus*) is listed as "special concern" pursuant to the Massachusetts Endangered Species Act (M.G.L. 131A). MA DFW (2004) has identified Onota Lake as direct habitat for the watermilfoil and shiner species, but not the hybrid Pondweed. Correspondence from the MA DFW and City of Pittsfield regarding concerns and fact sheets on these three state-protected species are provided in Appendix C. A Nature Conservancy conservation plan for *P. ogdenii* is also included in Appendix C.

3.0 PREVIOUS LAKE PLANNING AND MANAGEMENT EFFORTS

The City of Pittsfield and the many stakeholders of Onota Lake have been very active in their attempts to manage the lake and watershed. This excellent summary of previous lake planning and management efforts is drawn from the Long-Range Management Plan (Pittsfield/BRPC/LOPA, 2004) as is listed in Table 3-1 which provides a concise summary of various methods to manage aquatic vegetation.

Onota Lake is a well-characterized lake system with an extensive bibliography of documents relating to a significant history of lake and watershed investigation, monitoring and management. The list presented below (see Pittsfield/BRPC/LOPA, 2004), denotes the long, active interest and commitment of the City of Pittsfield, BRPC, LOPA and other lake stakeholders in improving the lake water quality and recreational usage of Onota Lake. The important documents include:

- *Diagnostic /Feasibility Study for Onota Lake*, Pittsfield, MA IT Corporation, March 1991.
- *Environmental Impact Review and Managerial Implications for a Proposed Drawdown of Onota Lake, Pittsfield, MA*. Fugro East, Inc., July 1996.
- *Onota Lake Monitoring Program, 1997.* American Lakes & Wetlands Services, Inc.
- *Onota Lake Management Plan, 1999*. LOPA.
- Quality Assurance Project Plan, 1999 (Rev. 2003) BPRC & LOPA.
- *Long-range Aquatic Vegetation Management Plan – Onota Lake – Pittsfield, Massachusetts, December 2000*. Aquatic Control Technology, Inc. Sutton, MA
- *LOPA Annual Report Years 1999 – 2004.*
- Aquatic Control Technology Macrophyte Survey Report, 2002
- *2003 Lake Onota Aquatic Vegetation Assessment.* GeoSyntec Consultants, 2003.
- *Field Guide to the Plants of Onota Lake*. GeoSyntec Consultants, 2003.
- *Watershed Survey Final Report & Action Plan.* Prepared by Riverways Program of the Massachusetts Department of Fish and Game, 2003.

- *The Evaluation of Hypolimnetic Withdrawal and Deep-Water Aeration Management Alternatives for Lake Onota, Pittsfield, MA.* Princeton Hydro, LLC, July 2003,

- *Lake Onota Milfoil Weevil Project – First Monitoring Report.* GeoSyntec Consultants, September 2003.

- *Housatonic River Watershed Five Year Action Plan 2002-2007*. Executive Office of Environmental Affairs, 2003.

- *Final Report Eurasian Watermilfoil Re-growth Control Project* at Onota Lake. BRPC & LOPA.

- *Storm Drain & Erosion Assessment at Burbank Park.* BRPC and Foresight Land Services, Fall 2003.

- *An Integrated Approach to the Management of Stormwater Water Quality Within the Sub-Watersheds of Onota Lake Pittsfield, Massachusetts.* Princeton Hydro, LLC., BRPC, and LOPA, 2004.

- *Onota Lake Long-Range Management Plan Spring 2004.* Prepared for the City of Pittsfield by BRPC & LOPA (A copy of this is included in Appendix A).

3.1 Chronology of Lake Management Efforts

A comprehensive Diagnostic/Feasibility Study of Onota Lake was completed by International Technology Corporation for the Massachusetts Department of Environmental Protection in 1991 to identify and quantify causes of lake degradation and recommend mitigation strategies. The study identified excessive macrophyte growth as a primary problem of the lake. Since that study, the dramatic increase in Eurasian watermilfoil throughout both basins of the lake in the early-mid nineties has been documented in two studies. The first was the *Environmental Impact Review and Management Implications for a Proposed Drawdown of Onota Lake* conducted by Dr. Ken Wagner, then of Fugro East, Inc. in 1996 (Fugro, 1996). Based on that EIR, the City of Pittsfield instituted an annual 3 foot drawdown. This was followed by a post drawdown monitoring program analysis by Sean Lonergan of American Lakes and Wetlands Services (ALWS) in 1997.

The City, in partnership with LOPA, reviewed the above studies and recommendations and then generated the *Onota Lake Management Plan* (LOPA, 1999a) which documents short term and long term plans for both watershed and in-lake preservation actions. The primary goal of the restoration/management plan was to decrease nutrient and sediment loading through a comprehensive, well-coordinated watershed management program. Elements of the plan included the installation of a culvert at Thomas Island, nutrient rich sediment removal, continued volunteer monitoring, the identification and remediation of erosion problems, winter drawdown, the installation of stormwater best management practices, public education and outreach, and herbicide treatment. This plan has provided basic guidance in the management of the lake since then.

The City of Pittsfield, LOPA, and BRPC have worked to implement several mitigation strategies identified in the D/F study and the management plan. Due to the recreational importance of Onota Lake, the City determined that an intensive in-lake restoration and management program be implemented. Through such a program, immediate, user orientated improvements in lake quality could be realized.

In 1998, monitoring by the City and volunteers from LOPA showed that approximately one-third of the lake was so choked with milfoil as to be virtually unusable for recreational purposes. In 1999 due to the critical need to combat the milfoil, the City contracted Aquatic Control Technology, Inc. to implement a whole lake treatment with the herbicide SONAR, a primary action recommended in the management plan. Follow-up spot treatment was conducted in 2000. The City of Pittsfield undertook the task of financing and managing the SONAR treatment at a total expense of $125,000 without the support of any state funding or grant funds. This program successfully "eliminated" well over the contractually required 90% of the milfoil and resulted in a final report, *Long-range Aquatic Vegetation Management Plan – Onota Lake – Pittsfield, Massachusetts, December 2000* prepared by Aquatic Control Technology, Inc (ACT, 2000).

The City of Pittsfield, LOPA, and BRPC have recently completed several management activities under the Lake Onota Preservation Strategy. This particular project has employed a multi-faceted approach involving biological and mechanical techniques, along with limited herbicide treatment to attempt to control milfoil re-growth after successful whole lake application of SONAR. Following the recommendations of the D/F Study and the Lake Onota Management Plan, a comprehensive assessment of bank stabilization, erosion control and storm drain treatment needs for Burbank Park has been conducted. This has resulted in the preliminary design of best management practices to be implemented at the park. Based on the recommendations of the D/F Study to install macrophyte barriers, a 21 x 200 foot benthic barrier has been installed at the Burbank Park public swimming beach and monitored for usefulness in creating clear swimming areas over multiple years. GeoSyntec Consultants has been contracted to manage the introduction of milfoil-eating weevils into Onota Lake. Weevils were introduced in the summer of 2003. GeoSyntec Consultants completed the first monitoring survey in September 2003 (GeoSyntec, 2003a). A follow-up monitoring survey was conducted in July 2004. This project represents the first time in Massachusetts that a lake has been treated with aquatic weevils in response to the re-growth of Eurasian milfoil after a whole-lake herbicide treatment. The D/F Study listed biological controls, such as milfoil predators, as an in-lake management option for Onota Lake. Through this project a limited experiment of diver hand-pulling and spot suctioning that was conducted in the summer of 2001 was expanded.

In 2004, the City of Pittsfield, BRPC, LOPA and other lake stakeholders including the Berkshire Rowing and Sculling Society (BRASS) and Housatonic Valley Association (HVA) developed the *Long*

Range Management Plan for Onota Lake (Pittsfield/BRPC/LOPA, 2004). The goals of this plan are summarized in Section 3.2 and provided in full in Appendix A. However, as noted earlier, application of proposed vegetation management options have raised concerns regarding possible impacts to rare or endangered plant and animal species residing in the lake (MA DFW, 2004) resulting in a need for an comprehensive approach to aquatic vegetation management which is effective in reducing nuisance growth but protective of state-protected species.

Table 3-1. Summary of Recent Aquatic Vegetation Management Techniques in Onota Lake.

Year	Activity	Funding Source
Annual through mid-1980s; reinstituted in 2000	3 ft Drawdown	City of Pittsfield
Annual through 1998	Mechanical Harvesting	City of Pittsfield
1999	Whole-lake Herbicide Treatment	City of Pittsfield
2001	Spot-suctioning	LOPA
2002	Benthic barrier	DEM
2002	Diver hand-pulling	DEM
2002	Spot-herbicide	DEM/LOPA
2002	Spot-suctioning	DEM/LOPA
2003	Milfoil-eating weevils	DEM

3.2 Integrated Lake Goals of Onota Lake Long-Range Management Plan

The *Onota Lake Long-Range Management Plan* (Pittsfield/BRPC/LOPA, 2004) was the product of the Technical Advisory Group (City of Pittsfield, BRPC, LOPA, BRASS, HVA and others). The TAG did not limit their considerations of Onota Lake concerns to strictly water quality concerns, but rather identified concerns relative to the aesthetics, environmental quality and overall condition of the lake, both presently and projecting into the future These problems and concerns formed the basis for the development of management goals and objectives, which in turn form the basis for specific recommended management actions. The five identified areas of concern and/or interest and associated goals are listed below.

Nuisance Aquatics

Goal #1: Conduct sound, comprehensive aquatic plant management that a) maintains and improves healthy native aquatic plants; b) addresses the extent of the re-growth of milfoil in Onota Lake that is reaching nuisance levels for the current uses of the lake; c) provides quality fish and wildlife habitat; d) minimizes the ecological impacts and recreational impacts of nuisance aquatic plants; e) effectively coordinates with other ongoing management efforts; and f) addresses the recent designation as rare and endangered species habitat. This goal will be expanded on it Section 5.0

Drawdown

Goal #1: Manage water level to the maximum extent feasible to control flooding, reduce shoreline property damage, and control nuisance aquatic species while minimizing negative impacts on emergent wetlands, native flora, and fauna.

Watershed Management

Goal #1: Manage nonpoint source pollution through such items as stormwater management, including structural best management practices to prevent the deterioration of present in-lake water quality conditions in the lake and downstream receiving waters.

Goal #2: Minimize the negative impact on lake, the lake watershed, and downstream receiving waters from nonpoint source pollution through non-structural best management practices, such as through land use regulation.

Goal #3: Manage the internal recycling of phosphorus within the lake.

Education & Outreach

Goal #1: Increase public awareness and knowledge through enhanced education and outreach effort.

Recreation & Regulations

Goal #1: Increase the City's commitment to both lake management and enforcement of City regulations within the watershed.

Goal #2: Work with the proper local and state authorities to increase the enforcement of existing safety and environmental protection regulations to a) reduce user conflicts; b) minimize nonpoint source pollution resulting from use do not add to shoreline erosion.

Summary of Onota Lake Long-Range Management Plan Goals

The *Onota Lake Long-Range Management Plan* goals indicate the holistic approach that the City of Pittsfield and lake stakeholders have used to consider management of Onota Lake and its watershed. Since the focus of this plan is on control of aquatic plants, the remaining technical sections will deal principally with this goal, but will also need to comply or at least not adversely impact the other identified goals for the lake.

4.0 AQUATIC VEGETATION MANAGEMENT TECHNIQUES

While the presence of aquatic plants is necessary to a variety of desirable lake functions, native or non-native plants may cause problems if plant growth becomes excessive. Non-native plants may be incorporated into an assemblage with no major negative impacts, and may in fact provide increased habitat value in some cases. The general rule in ecology and lake management, however, is that the introduction of new species to which the lake is not adapted as a system usually means the reduction of other species and an increased potential for nuisance conditions. In the case of introductions of species not native to the area and highly invasive by evolutionary design, as is the case for EWM in Onota Lake, impairment of habitat value and human uses of the lake can be severe, resulting in the need for the *Invasive Species Management Plan for Onota Lake.*

As part of the development of the *Invasive Species Management Plan,* the initial step was a review of potential candidate aquatic vegetation treatment options, mostly for invasive EWM, but cognizant of the other exotic invasive species present in the lake. An excellent general compendium of techniques, project experiences, advantage and disadvantages, permitting requirements, etc. is presented in the *Eutrophication and Aquatic Plant Management in Massachusetts. Final Generic Environmental Impact Report* (GEIR) (Mattson et al., 2004). In addition to the Massachusetts GEIR, aquatic vegetation management options are also covered in *The Practical Guide to Lake Management in Massachusetts* (Wagner, 2004), a companion guide to the GEIR (Mattson et al., 2004), available on-line at http://www.mass.gov/dcr/waterSupply/lakepond/lakepond.htm and supplied to all towns in the Commonwealth by the DCR in 2004.

Rather than review all the potential options available for aquatic macrophyte control (e.g., see Chapter 4 and Table 4-1 in Mattson et al., 2004) and taking advantage of previous recommendations (LOPA, 1999; GeoSyntec, 2003; Pittsfield/BRPC/LOPA, 2004), a select number of potential control options were considered. These are discussed in Section 4.1 with a concise summary of their attributes is provided in Appendix D. Section 4.2 discusses how these options can be refined by consideration of lake-specific features.

4.1 Candidate Aquatic Vegetation Control Options for Onota Lake

As Section 3 indicates (see Table 3-1), a number of various aquatic vegetation control methods have been envisioned or enacted at Onota Lake. As indicated by the aquatic plant maps provided in Appendix C, application of fluridone had an immediate impact on the distribution of EWM in the lake. While application of chemicals will be further considered, other methods are available as well. A recent review by GeoSyntec (2003a) identified the following methods as potential non-chemical aquatic plant management techniques considered for Onota Lake: artificial circulation and aeration; dredging; drawdown; mechanical harvesting; hand-harvesting; hydro-raking; biological control (by macroinvertebrates); and benthic barriers. Of these, GeoSyntec identified artificial circulation and aeration, dredging, mechanical harvesting, and hydro-raking as either ineffective, unfeasible (too costly), or otherwise inappropriate (GeoSyntec, 2003a). We would concur with most of these conclusions but feel that mechanical harvesting should be retained for the following reasons – in the absence of other control methods, harvesting provides a means to directly remove biomass from the lake and the City of Pittsfield owns and operates harvesters on nearby Pontoosuc Lake. Mechanical harvesting may also be effective in the control of Curly-leaf Pondweed, but has the disadvantage of potentially impact weevil effectiveness.

Based on the available control techniques and past experiences of management at Onota Lake, we would recommended that the following options be further considered as part of the *Invasive Species Management Plan for Onota Lake:*

- **Drawdown** – this technique is currently being practiced (3 ft drawdown, with proposed deep 5.5 ft test drawdown still to be evaluated) in the Lake. Due to the lake morphometry and susceptibility of the aquatic invasive species, this method has been shown to reduce EWM in the drawdown zone.

- **Benthic Barriers** – these have been installed at Burbank Park and have shown limited success for suppressing growth in selected high use areas, such as swimming beaches. Regular maintenance of benthic barriers is the key to their continued effectiveness.

- **Hand-Harvesting** – this is an appropriate means to attack small infestation of nuisance invasive species, such as the water chestnut (*T. natans*) found in the isolated basin at the north of the lake.

- **Mechanical Harvesting / Hydroraking** – to be further considered, for reasons described above.

- **Biological Control** – milfoil weevils were stocked in July 2003 along western shore as part of long-term control management plan. A follow-up survey in July 2004 found only modest activity in selected places (LOPA, 2004). Further evaluation is required regarding this technique.

- **Herbicide Treatment** – chemical treatment has provided an effective means to reduce EWM and Curly-leaf Pondweed but needs to be considered with regards to impacts to non-target organisms, including state-protected species.

Each of these management techniques were further evaluated as to their effectiveness, duration, impact to non-target organisms, costs, and integration with other techniques.

4.2 Deciding Which Technique(s) to Apply

A good starting point is to evaluate those techniques which are particularly effective against EWM and see how lake-specific characteristics may guide such a decision. The following decision tree (Figure 3) is taken from the *Massachusetts Rapid Response Plan for Eurasian Watermilfoil in Massachusetts* (ENSR, 2005) and is provided as a general aid to evaluating potential control options. Thresholds for application are given as guidelines, not rigid rules. Individual circumstances may affect the choice of approach and outcome. Follow up monitoring is considered essential, and follow up control after an initial application is considered likely to be necessary.

Unlike a case where EWM infestation is relatively recent, Onota Lake represents a well-colonized lake and thus will be mostly considered options arising out of the right portion of the figure. This figure also indicates the importance of two factors – the presence of sensitive or protective species and the ability to flush the lake – keys to potential options. For Onota Lake, the presence of protected species has an important qualifier, in that they appear to be in locations where potential protective mitigation is possible. These factors will be considered furthered in the next section. Some general considerations are given below.

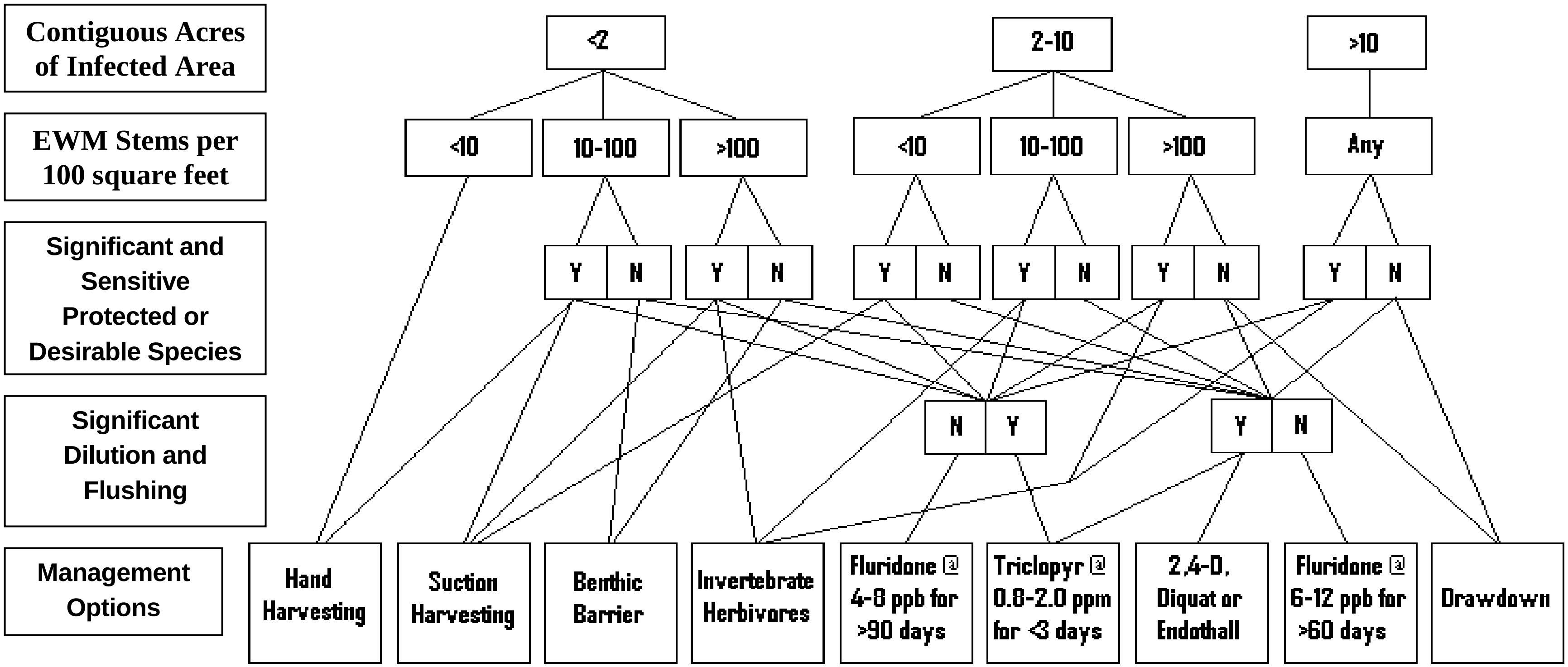
Drawdown, where applicable, is perhaps the most widely effective preventive control in cases where repeated invasion is documented, but is not applicable in all cases. Protection of the endangered aquatic macrophytes indicates that this technique should be carefully evaluated with some guarantee of water level control in areas of protected species. Fortunately, there seems to be good opportunities to protect the areas of concern (embayment southwest of the Casey Causeway and northernmost embayment) in a manner which is consistent with drawdown goals.

Benthic barriers and hand-pulling are the least intrusive of the methods considered and both are effective only in relatively small areas. Benthic barriers provide a cost-effective solution for maintaining relatively modest (e.g. < 1.0 ac) of recreational areas open, but have demanding maintenance requirements. Hand-pulling is the least spatially effective and is usually limited to attempts to control an invading nuisance species.

The use of aquatic herbicides has also been effective previously but needs to consider protection of endangered species. The herbicides 2, 4-D and fluridone are very effective but difficult to use on a small scale and the decision not to use 2,4-D further on Onota Lake has previously been made due to the reclassification of the lake as a Zone II Wellhead Protection Area (ACT, 2002). However, where EWM growths are too widespread, dense or deep for other methods, or where detection and removal of all growths in an area is impeded by low light or other vegetation, fluridone may represent the preferred approach. On a localized basis, the herbicide triclopyr has great potential for control of EWM where exposure times are limited and with limited impacts on other native species; more experience is needed to make a more definitive recommendation.

Timelines for necessary action with regard to EWM populations should also consider the season phenology of this plant. Root crown expansion occurs throughout the growing season, so the sooner controls are implemented, the smaller the area that must be addressed. As plants fragment in the late summer and early autumn, emphasis should be placed on removing plants before the end of August to limit dispersal of propagules by that mechanism. Once the growing season is over (about October), plants are largely dormant and many collapse or are otherwise reduced in biovolume until the following spring. Detecting and effectively removing EWM plants by physical means will therefore be more difficult outside the growing season.

Figure 4-1. Decision Tree for the Control of Eurasian Watermilfoil (*Myriophyllum spicatum*)



Notes: Hand harvesting and suction harvesting must include root system removal. Benthic barrier should remain in place for 30 to 60 days. Herbivorous insect use is limited by fish predation; where appropriate, expect a 5 year process with multiple stockings. Fluridone use may include liquid, pellets, sequestration and repeat (boost or bump) treatments to maximize exposures. Triclopyr approved for use in MA in late 2004; experience is limited in MA. Choice of 2,4-D, diquat or endothall is linked mainly to water uses. Drawdown use is dependent on many factors, including hydrology and use as a water supply. Moderate to dense growth over an extensive area (>10 acres) may not be appropriate for rapid response consideration.

5.0 ELEMENTS OF INVASIVE SPECIES MANAGEMENT PLAN FOR ONOTA LAKE

Control of invasive nuisance aquatic plants in Onota Lake is a critical element to restoring recreational uses and better supporting designated ones. However, it is important to recall that the *Invasive Species Management Plan* is only one part of the *Onota Lake Long-Range Management Plan* (Pittsfield/BRPC/LOPA, 2004). A large measure of is ultimate success will depend on integration with the other elements of the integrated lake and watershed management actions recommended by that latter document. The major elements and goals of the Plan have been previously reviewed in Section 3.2, but we revisit the criteria with regard to the nuisance vegetation goal in 5.1. The primary motivating factor necessitating this plan and TAG meeting review is to address NHESP and MA DFW concerns regarding state-protected plant and wildlife species in Onota Lake (Section 5.2). Each of the six methods being considered is briefly evaluated in Section 5.3, since extensive descriptions, discussions of short-term and long-term benefits, impact analyses, regulatory requirements, etc. have already been conducted on these methods, both for their general usage in Massachusetts (Mattson et al., 2004; Wagner, 2004 – see relevant portions of Appendix D) as well as for Onota Lake (IT, 1991; Fugro, 1996; LOPA, 1999a; ACT, 2000; GeoSyntec, 2003a). Emphasis will be on addressing specific NHESP and MA DFW concerns for application of aquatic vegetation management techniques and integration with overall lake and watershed management plans.

5.1 Goals of Invasive Species Management Plan

The *Invasive Species Management Plan* is to provide a sound, comprehensive aquatic plant management to address the six criteria of Nuisance Vegetation Goal #1 (Pittsfield/BRPC/LOPA, 2004), with special attention to the last criterion raised by NHESP and MA DFW:

The last point is a particularly important one for any invasive aquatic plant management program in Onota Lake. As indicated by the letter from NHESP (MA DFW, 2004), concerns have been raised regarding the potential impact or "take" of protected species by several of the whole-lake treatments previously used in the lake (drawdown, chemical treatments, weevils). Therefore, any aquatic vegetation management plan will need to incorporate measures to avoid, minimize or mitigate the potential adverse impacts to state-protected species to the greatest extent practicable as well as provide long-term net benefit to the conservation of the local population of the impacted species. As noted by the NHESP (MA DFW, 2004) this may involve an aquatic vegetation management plan that "avoids the areas where the rare plants are known to occur, or includes some type of protection and enhancement for the rare species." In the absence of an aquatic management plan, it is important to note that a "no-action" alternative could have equally or worse adverse effects on native plant species.

5.2 Aquatic Vegetation Management Plan Concerns/Comments from NHESP and MA DFW

The suite of aquatic vegetation management options considered (see Section 4.1) has been previously reviewed and extensively discussed with regard to benefits and impacts (e.g., Fugro, 1996; LOPA, 1999a; ACT, 2000; GeoSyntec, 2003a; Mattson et al., 2004; Wagner, 2004). All of the options considered have been previously conducted in Onota Lake so there is previous site-specific history with regard to potential benefits and impacts. However, the finding of state-protected species in September 2003 has significantly changed the importance given to non-target organisms. In review of the proposed annual drawdown of Onota Lake for 3 to 5 feet in 2004 (NHESP File No. 04-16742; MA DEP File No. 263-819), a number of specific agency comments / recommendations were identified (MA DFW, 2004). These are listed below.

- As documented by the MA GEIR (Mattson et al., 2004), a deep winter drawdown usually results in the decrease in the relative abundance of *Myriophyllum* species. NHESP is concerned that a deep drawdown at Onota Lake could result in the related desiccation and freezing of the non-target Comb Water-Milfoil (*M. verticillatum*);

- Similarly, the introduction of milfoil-eating weevils is aimed at reduction in populations of *Myriophyllum* species. Therefore, the weevils could potential relocate from target stands and impact the non-target Comb Water-Milfoil (*M. verticillatum*);

- A drawdown of 3-6 ft will potentially impact the habitat of the Bridle Shiner in Onota Lake by exposing a significant portion of the aquatic vegetation in the littoral zone. Bridle Shiner spawn in vegetated areas and the larvae in their early stages adhere to the plants. The MA DFW has determined that a deep drawdown will adversely affect rare wildlife habitat by altering the vegetative community within the littoral zone;

- Any drawdown must be done in accordance with the performance guidelines outlined in the MA GEIR Drawdown Section. The Department of Environmental Protection has issued a document (MA DEP, 2004) entitled "Guidance for Aquatic Plant Management in Lakes and Ponds as it relates to the Wetlands Protection Act" (Policy/SOP/Guideline# BRP/DWM/WW/GO4-1, effective April 8, 2004) which provides additional guidance;

- MA DFW recommends that the City of Pittsfield monitor the status of fish populations in the lake through use of a variety of fish sampling techniques (seining, electrofishing); and

- MA DFW recommends water quality monitoring during the year of drawdown (temperature, dissolved oxygen (DO) and for three years following the drawdown event to evaluate potential impacts to coldwater fisheries habitat.

The TAG took these comments into consideration when developing the recommendations presented in this plan. It is believed by the TAG that the recommendations adequately address the above comments and provide necessary measures to protect rare and endangered species.

6.0 RECOMMENDATIONS

BRPC, LOPA and the City of Pittsfield facilitated a Technical Advisory Group (TAG) to develop this invasive species management plan. The TAG was composed of experts in the fields of lake management, botany, ichthyology, and hydrology. Building upon its existing partnership with LOPA and the City, BRPC facilitated the development of an Advisory Group to work along with the TAG to assist in creating the plan. The Advisory Group was representative of the interests of Onota Lake at the local level and was guided by the TAG. The TAG identified alternative management approaches and assessed each approach for feasibility of application at Onota Lake. The TAG and the Advisory Group worked together to assure that this Invasive Species Management Plan is a technically sound plan, is sensitive to MA DFW and NHESP concerns, and will be feasible to implement based upon both economic considerations and permit requirements.

The TAG was composed of experts in the fields of lake management (Dr. David Mitchell and Dr. Kenneth Wagner; ENSR Corporation), aquatic botany (Dr. George Knoecklein; Northeast Aquatic Research), ichthyology (Dr. Robert Schmidt; Simon's Rock College), and hydrology (Charles Steven Howe; ENSR Corporation). The TAG and the Advisory Group met on April 27, 2005 to conduct a site visit, review the draft plan, and develop recommended actions. The Advisory Group was composed of LOPA volunteers and people from local agencies and municipal departments who are familiar with Onota Lake as well as technical and regulatory matters. The members were as follows; Bob Race (LOPA/LAPA-West), Dorothy Mara (LOPA), Dick Laureyns (BRASS/LOPA), Jim McGrath (City of Pittsfield), and Melissa Jette (BRPC).

The primary focus of the invasive species management plan is the control of EWM, however Curly-leaf Pondweed and Water Chestnut must also be controlled, due to their potential impacts to rare and endangered species habitat, and to the current uses of the lake. The other exotic invasive species present in Onota Lake, European Naiad (*Najas minor)*, is considered a secondary nuisance and has less tendency to impact habitat and lake use due to its lower growth form. The TAG considered cumulative environmental impacts to ensure that environmentally sound methods are deployed, as recommended by the National Invasive Species Council for vulnerable areas.

When invasive species appear to be permanently established the most effective action may be to prevent their spread or lessen their impacts through control measures (The National Invasive Species Council Management Plan - *Meeting the Invasive Species Challenge*, 2001). Control and management of invasive species encompasses diverse objectives such as eradication within an area of initial colonization, population suppression, limiting spread, and reducing effects. The TAG utilized an approach to invasive species management that flexibly considered available information, technology, methods, and environmental effects. The TAG developed recommendations that incorporate measures to avoid, minimize or mitigate the potential adverse impacts to state-protected species. The TAG ruled out the "no-action" alternative for Onota Lake, as it could have equally or worse adverse effects on the habitat compared to the management alternatives. The aquatic vegetation control techniques that were considered by the TAG and the Advisory Group can be divided into those which are applied to the entire lake (water level drawdown), are applied to a variable portion of the lake surface (herbicide treatment, harvesting, biological control), and those which are suited for small localized treatments (hand-harvesting, benthic barriers). As noted in the previous section, the TAG developed recommended actions specifically for Onota Lake with due regard to concerns for state-protected species. Supporting information is drawn from relevant sections of Fugro (1996) and GeoSyntec (2003a, b, c) reports on Onota Lake and the MA GEIR and accompanying Practical Guide (Mattson et al., 2004; Wagner, 2004).

6.1 Water Level Drawdown

General Description - Drawdown is a multipurpose lake management tool that can be used for aquatic plant control (Mattson et al., 2004; Wagner 2004; see summary in Appendix D). The water level is lowered by pumping, siphoning, or opening a pipe or gate in the dam. Until a few decades ago, drawdowns of recreational lakes were primarily for the purpose of flood control and allowing access for near-shore clean ups and repairs to structures, with macrophyte control as an auxiliary benefit. However, lake drawdown can provide inexpensive and effective control of certain macrophytes. Lake drawdown decreases abundance of some of the chief nuisance species, particularly those which rely on vegetative propagules for overwintering and expansion (Cooke et al., 1993), and is known to be effective against EWM and Curly-leaf Pondweed (Mattson et al., 2004). While this technique is not effective on all submergent species, it does decrease the abundance of some of the chief nuisance species, particularly those that rely on vegetative propagules for overwintering and expansion, and allows for repopulation by native species (Cooke et al., 1993). If there is an existing drawdown capability, lowering the water level provides an inexpensive means to control some macrophytes. Additional benefits may include opportunities for shoreline maintenance and oxidation or removal of nutrient-rich sediments.

Feasibility for Onota Lake - An annual drawdown of 3 feet has been conducted historically (up until 1986) and from 2000 until the current period. The existing dam and outlet structure are capable of drawing down the lake to approximately 8 ft, although 6 ft is probably the practical limit (Fugro, 1996). The current 3 foot drawdown exposes approximately 180 acres, mostly in the North Basin. A 4 ft drawdown would expose 257 acres, while a 6 ft drawdown would expose 290 acres (Fugro, 1996). An 8 ft drawdown would expose 324 acres but is probably not practicable with the current outlet pipe. It may be possible to enhance drawdown to 6 - 8 feet with additional modification to the dam or installation of a temporary siphon device.

Effectiveness in Controlling Aquatic Vegetation - As presented in the MA GEIR (Mattson et al., 2004), drawdown has been applied to many lakes in the Berkshire region since the 1960s or earlier, and plant composition and density in the drawdown zone clearly indicates that species such as Eurasian watermilfoil can be controlled at the lake periphery by this technique. In Stockbridge Bowl there is little milfoil out to a water depth of 3 to 4 ft, owing to an 18-inch drawdown and about 2 ft of ice contact (ENSR, 2002b). Drawdown kept areas of Richmond Pond <6 ft deep largely free of milfoil for over 30 years (BEC, 1990a). Lake Buel, by comparison, has no water level controls and has dense milfoil growth right to the shoreline.

Drawdown in Onota Lake has been effective in controlling macrophyte levels within the limited littoral zone exposed (LOPA observations as cited in GeoSyntec, 2003). These authors noted that, due to the North Basin's shallow depths and gradual bathymetry, a 5 ft drawdown would expose a significant area of the most densely vegetated portion of the lake (GeoSyntec, 2003).

Impacts to Non-Target State-Protected Species – The two principal concerns expressed by NHESP and MA DFW are associated with the direct impact of drawdown adversely affecting non-target populations of Comb Water-Milfoil (and possibly Ogden's Pondweed) and the indirect effect of reduced littoral zone vegetation on Bridle Shiner populations. Although no species-specific responses have been recorded, the probability for drawdown impacts on the Comb Water-Milfoil may be considered somewhat greater than for Ogden's Pondweed, based on the presumption that, in general, the water-milfoils are more susceptible to freezing and desiccation than the pondweeds.

Based on available reports (Pittsfield, 2004; photographs) and from observations during the TAG site visit of April 27, 2005, it appears that the wetland/pond area southwest of the Dan Casey Causeway becomes naturally impounded (i.e., shallow sill at edge of lake emerges) at a depth of -22" (relative to the dam spillway elevation). Similarly, Pomeroy Pond (location of Ogden's Pondweed) becomes naturally impounded at elevation of <6" below the spillway (this site was also visited by the TAG). Thus, the two areas have not been dewatered by the current 3 ft drawdown and have been able to maintain the populations of the state-protected species. As the MA GEIR indicates, the nature of the wetland soils will significantly influence wetland response to a drawdown (Mattson et al., 2004). Where a substantial layer of decomposing organic matter underlies the wetland, as is expected in the identified wetlands associated with Onota Lake, dewatering will be very slow and impacts from winter drawdown will be minimized.

The remaining wetland/pond area north of the Dan Casey causeway can be artificially impounded at a depth of 33" +/- 3" by installation of sandbags placed upstream of the culverts under the road (Pittsfield, 2004). The timing of this isolation will be careful timed to prevent interference with stream flows and seasonal fish spawning habitat. Impacts will be minimized by conducting a drawdown in late fall and removing sandbags, if necessary, during the spring refilling stage. If these measures are employed, then all three areas of Priority Habitat are unlikely to be completely dewatered by a 5 or even 6 ft drawdown. The pooled water contained by the natural or artificial impounding features should mitigate and minimize potential effects to state-protected species. Reduction of invasive species will provide long-term net benefit to the conservation of the local population of these species.

Relatively little is known about Bridle Shiner, a native minnow species, which is on state "watch lists" in Vermont, Massachusetts, and Connecticut (Whittier et al., 2000). The US EPA Environmental Monitoring and Assessment Program (EMAP) collected it at seven lakes with fairly undisturbed watersheds; six of these lakes were <250 m in elevation and six were oligotrophic (Whittier et al., 2000). A recent review of the environmental factors associated with this species decline in Massachusetts indicated that none of the following factors was significantly correlated: (1) lake trophic status; (2) lake acidification; (3) introduced species; (4) change in land use; and (5) catastrophic water quality event (e.g., rotenone) (Chandler, 2000). Instead, it appears that a combination of these factors was responsible. The influence of annual stocking of piscivorous game fish in Onota Lake has not been evaluated, but is unlikely to be advantageous to minnow species.

The Bridle Shiner prefer sites with high coverage of submerged aquatic vegetation along the bottom 25 cm and tend to prefer vegetation with feather-like leaves such as *Ceratophyllum*. Spawning sites are generally clearings surrounded by dense submerged vegetation, such as *Myriophyllum* or *Chara*. (NHESP Fact Sheet; April 2003) There is no evidence that this species of shiner is dependent upon *Myriophyllum*. A reduction in aquatic vegetation or a change in the dominant species from an exotic invasive to a native dominant species or assemblage should not significantly impact this species. The species typically inhabits sluggish warm backwater eddies of low gradient streams, rivers, and ponds containing dense vegetation (*Potamogeton, Sparganum, Elodea*) over mud, sand, or gravel. (Harrington, 1947; Criswell and Shervinskie, 1998) According to the Canadian Wildlife Service, invasion by EWM may create unsuitable spawning habitat, by reducing the clear area of water above the plants that is necessary for mating activities. While invasive milfoils are not viewed as a major threat to the Bridle Shiner, it is apparent that this species is not dependent upon it and may in fact fare better with native vegetation at a lower density.

The timing of the fall-winter drawdown will not impact the spawning period (mid-summer). In the long run, replacement of EWM or Curly-leaf Pondweed with a native assemblage would not likely impact this species. The fish species is believed to have persisted in Onota Lake during periods of annual 3 ft drawdowns as well as occasional deep drawdowns and through chemical herbicide treatments. Due to the large size of Onota Lake and diversity of littoral zone areas, it may be anticipated that the Bridle Shiner completes its life cycle in the large wetlands on the western side of the lake or in sluggish areas such as isolated coves. Presently there is no population data which indicate that a sustainable population of Bridle Shiner is found within the lake proper or whether their numbers are increasing, maintaining or decreasing.

Mitigation of Impacts – Impacts to endangered plant species in Priority Habitat areas should be mitigated by installing water detention structures to isolate and protect endangered plant species and to ensure that these areas do not dewater during drawdown. Mitigation measures will minimize undesirable environmental impact from this method and focus on maintaining the water level in non-target areas and adjusting the timing and duration of drawdown to minimize impacts on sensitive organisms (Mattson et al., 2004). For Onota Lake, this is translated into isolating areas where Comb Water-Milfoil or Ogden's Pondweed are located (see Priority Habitat Map in Appendix C). It appears that at two of the three presumed areas are hydrologically isolated from the main lake basin during a drawdown event greater than 2 ft.

Impacts to the Priority Habitat of Pomeroy Pond can be mitigated by defining the protective water depth, establishing a temporary outflow berm if needed, and monitoring the water level. Additions of water pumped from lake could be made if the water level were to drop below the protective water depth before ice cover or snow forms, after which water can be absent. Impacts to the Priority Habitat north of Dan Casey Causeway can be mitigated by defining the protective water depth, establishing an outflow berm/sandbag barrier at the culvert, monitoring water level and mitigating with flow from tributaries and reduced lake outflow if necessary. Impacts to the Priority Habitat of Dunn Grove Pond can be mitigated by defining the protective water depth, establishing an outflow berm if needed, and monitoring the water level. Additions of water pumped from across Dan Casey Causeway could be made if the water level were to drop below the protective water depth before snow or ice covers the area.

Mitigation of the indirect effects of reduced aquatic littoral vegetation to the population of Bridle Shiner (*N. bifrenatus*) was also considered. The species seems to prefer sites with high coverage of submerged aquatic vegetation along the bottom 25 cm along with open areas in which they can school (NHESP Fact Sheet; April 2003). Hartel et al. (2002) report that this species of shiner is typically found in well-vegetated, quiet waters where schools often swim in and out of vegetation along the edge of ponds. Spawning occurs in July in shallow water depth (2 ft) in clearings surrounded by dense vegetation such as *Myriophyllum* or *Chara*. The fish species has persisted in Onota Lake during periods of annual 3 ft drawdowns. Since the annual 3 ft drawdowns currently impact the shallowest portions of the littoral zone of the lake, a 5-6 ft drawdown is not expected to significantly impact additional Bridle Shiner habitat. Native plants can be expected to repopulate areas exposed by drawdown. Impacts to spawning associated with the 5-6 ft drawdown option will be mitigated by conducting drawdown during the months of October through April to avoid impacts during the spawning months of May through August. In addition, impacts to Bridle Shiner will be minimized by maintaining the water levels in Dunn Grove, Theodore Pomeroy Pond and area north of Dan Casey Causeway, which appear to be preferable habitat for this species. Quantitative fishery sampling should be conducted as recommended by MA DFW to establish the population database to make a more informed decision in future years.

Recommended Action – The TAG agreed that the preferred method of invasive plant management is to supplement the current 3 ft drawdown with a 5½ ft (+/- ½ ft) drawdown every two to three years for increased plant control at greater depths. It is recommended that in 2005 the current program of annual drawdown (3 ft) is modified to a stepped or phased drawdown of 5½ ft +/- ½ ft. The 2005 drawdown will be conducted using a stepped approach in which a 3 ft drawdown will be maintained over a two day period. After which, the lake level will continue to be drawn down. The lake level will be held for 2 days at each additional foot of drawdown until reaching a 5½ ft drawdown. An evaluation of Priority Habitat areas will be conducted during each hold (i.e., at 3, 4, and 5ft below spillway level). Failure to achieve drawdown criteria to maintain protective water depth in the Priority Habitat areas will lead to re-evaluation of situation and/or ceasing drawdown. Drawdown to this level is expected to provide effective control of EWM in the littoral zone while protecting Priority Habitat. A detailed drawdown plan is outlined in Appendix E. Records of bridle shiner in Onota Lake extend from 1972 to the present. This species has persisted through all previous efforts at invasive plant control and therefore will probably continue to persist in the main lake. The proposed efforts to protect the listed aquatic plant species will also provide protection for bridle shiner, particularly in the area north of the causeway which appears to be the best habitat for bridle shiner.

While the GEIR suggests concerns for drawdowns of >3 ft, a drawdown of >3 ft is allowable as long as it meets the goals of the program and does not unreasonably impact the interests of the Wetlands Protection Act (WPA). The TAG finds no indication that a drawdown >3 ft in Onota Lake will have adverse impact on the interests of the WPA, but may indeed benefit several of those interests, including flood control and enhancement of habitat for many aquatic organisms.

Monitoring – Macrophyte distribution and biomass will be monitored pre- and post-drawdown for effectiveness, applying the methods used for the last few years to assess the plant community, supplemented as necessary to cover areas of specific interest (e.g., Priority Habitat, target treatment areas). Fish populations will be surveyed to evaluate the Bridle Shiner population. Fishery monitoring will be conducted according to MA DFW recommendations (MA DFW, 2004). Monitoring will be conducted for both fish and state-protected plants in subsequent years after deep drawdown (2 year minimum) to evaluate impacts. Based on the evaluation of the data the 5½ ft drawdown will be conducted every two or three years, following the procedures, protocols, timing and duration outlined in the Deep Drawdown Plan Summary contained in Appendix E and in accordance with the MA DEP (2004) policy document. The annual program of 3 ft drawdown will continue in the alternate years. LOPA volunteers will continue to conduct water quality monitoring following established protocols. Water quality monitoring will be conducted for temperature and dissolved oxygen during the year of drawdown and for three years following the drawdown event to evaluate potential impacts to coldwater fisheries habitat, in accordance with the recommendations of MA DFW.

6.2 Herbicide Treatment

General Description – Treatment of aquatic vegetation by chemicals (herbicides) is a commonly used method in many parts of the United States for reducing large expanses of nuisance aquatic vegetation. They are an effective means to rapidly reduce unwanted biomass and promote recreational use. However, it can be costly and there may be significant concerns with direct and indirect effects on non-target organisms of poorly planned or inappropriate applications. Therefore, any treatment must be carefully thought out and monitored. While a herbicide treatment can often be an effective short-term management procedure to produce a rapid reduction in algae or vascular plants for periods of weeks to months (Mattson et al., 2004: see Appendix D), it should be integrated with other forms of lake management for the long term management of the lake, as has been the case at Onota Lake.

Currently there are seven active ingredients (2,4-D, fluridone, glyphosate, diquat, endothall, triclopyr, and copper sulfate and related mixtures) that are approved for use in aquatic herbicides in Massachusetts. Neither glyphosate (not effective on submerged macrophytes) nor copper sulfate (used primarily as an algaecide) is appropriate for Onota Lake.

With regard to the major invasive species of concern in Onota Lake, four active ingredients (diquat, endothall, 2,4-D, and fluridone) have been found to be effective for consistent control of EWM (Table 4-5, Mattson et al., 2004). Triclopyr is expected to be effective for consistent control of EWM. [Note: diquat and endothall are contact herbicides while 2, 4-D, fluridone, and triclopyr are systemic herbicides]. Both Curly-leaf Pondweed and spiny naiad are consistently controlled by diquat, endothall, fluridone, and triclopyr but only partially controlled by 2,4-D. Water chestnut shows the least susceptibility to chemical control of the invasives with consistent control only by 2,4-D and partial control by fluridone.

A critical consideration for a successful application is the ability to maintain effective dosage of herbicides in the water column over sufficient time to maximize the effect. For example, with fluridone (i.e., Sonar ®), the probability of successful control of EWM is greatly increased when an adequate dose (>6 ppb, preferably >10 ppb) and exposure time (60-120 days) are maintained (ENSR, 2005). This has proven difficult to achieve, however, particularly in partial lake treatments where dilution from other areas can occur. Use of slow release pellet formulations or sequestration of the target area with impervious curtains maximizes exposure time and limits dilution of the dose.

Feasibility for Onota Lake – Chemical treatment was conducted in Onota Lake during the period 1999-2002 with significant but temporary reductions in EWM (see below). The whole-lake fluridone treatment in 1999 was funded by the City of Pittsfield at approximately $125,000 (Pittsfield/BRPC/LOPA, 2004). Reclassification of the lake as a Zone II Wellhead Protection Area

(2001) has led to the elimination of the use of 2,4-D as an herbicide option. If a whole-lake treatment is desired, fluridone (Sonar ® A.S. at 41.7% fluridone) appears to be the herbicide of choice due to it's past performance in other lakes, most notably when exposure to about 6 ppb can be maintained for >60 days. With regard to application in Onota Lake, the large watershed and relatively rapid flushing rate of the North Basin indicates that there may be a need for a partial drawdown to increase the detention of the water in the Lake, some containment structure (e.g., curtains), or additional secondary treatment applications to "bump up" herbicide concentrations to desired dosage. Additional concerns have been raised about state-protected species (discussed below).

Effectiveness in Controlling Aquatic Vegetation – A three year program of a whole-lake treatment with fluridone in 1999 (applied as Sonar ®) and spot-treatments of problem areas with 2,4-D in 2000 (applied as Navigate ®) and diquat (applied as Reward ®) in 2001 and 2002 was conducted for the City of Pittsfield by Aquatic Control Technologies (ACT, 2002). This series of treatments was successful in significantly reducing the EWM (see Appendix B, Exhibits B6 – B15) and control was considered adequate through the 2002 growing season. Control of curly-leaf pondweed was less effective and its distribution has reportedly increased since the 1999 treatment (ACT, 2002). Since that time, EWM has successfully reestablished itself in most shallow areas of the lake to levels equal to or exceeding pre-treatment conditions (see Appendix B, Exhibits B15 – B19; LOPA, 2004). The overall performance of the herbicide treatments seems to be typical for the expected duration (Mattson et al., 2004), but over the last decade we have learned much about how to maximize treatment effects.

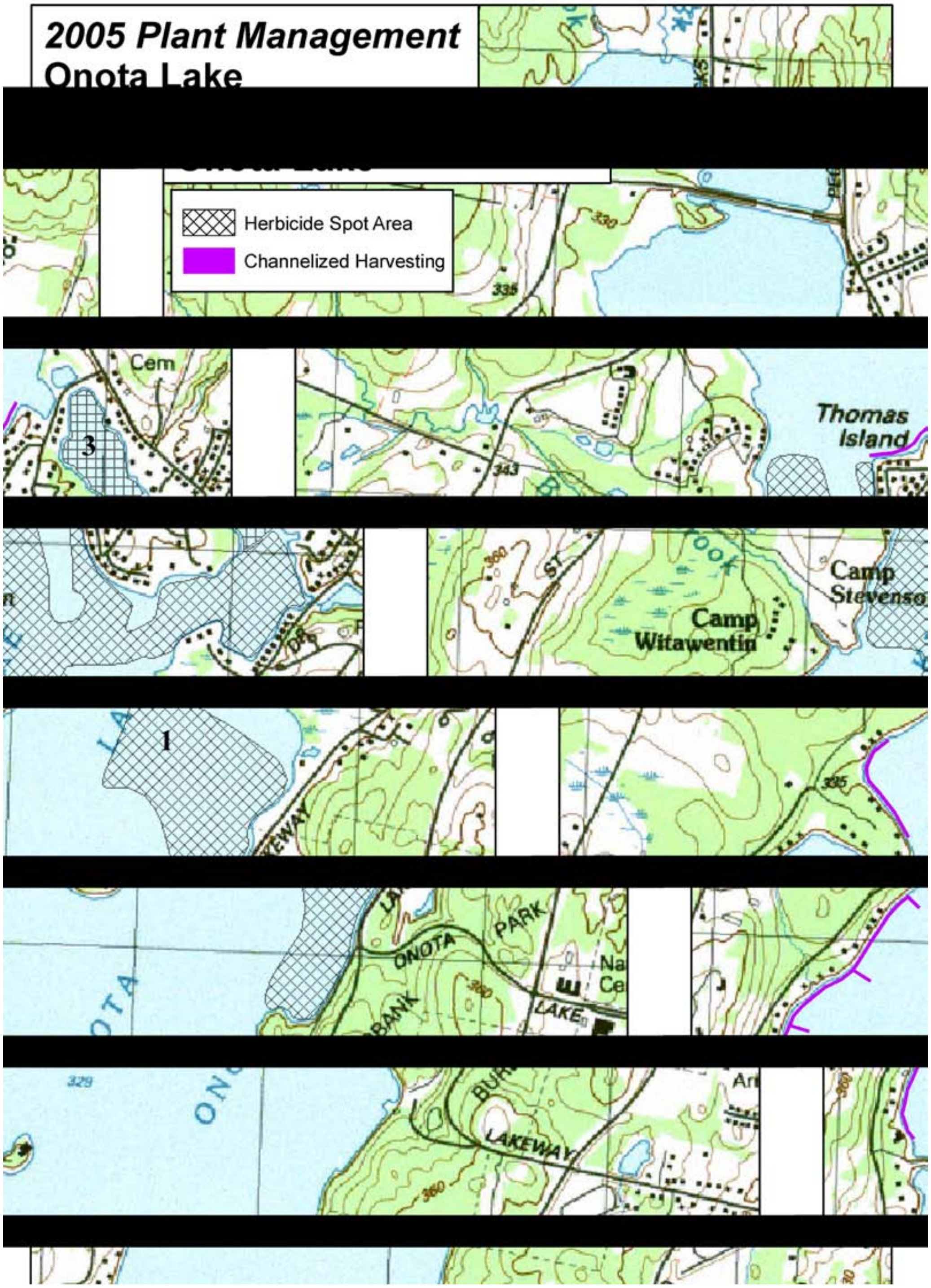
Impacts to Non-Target State-Protected Species - The MA DFW Fact Sheets for Comb Water-Milfoil and Ogden Pondweed (Appendix C) identifies "broad-scale herbiciding" as a potential threat to these species. This is consistent with the concept that while an application of herbicide is usually intended to reduce the abundance of a specific nuisance plant species, it may cause a reduction in other macrophytes, at least on a temporary basis, as well as have an indirect impact on species dependent upon the affected plants for food or cover. The specific response of protected macrophytes in Onota Lake to various herbicides is not specifically documented, but it is reasonable to assume that both comb water-milfoil and Ogden's pondweed would be negatively affected if exposed directly to the herbicides under consideration, at least during the year of treatment. It is believed that Comb-watermilfoil and Ogden's Pondweed were present in the lake and survived the 1999 – 2002 herbicides treatments. Susceptibility of plants to fluridone varies widely, and lowering the dose can maintain much of the native community. However, doses less than 6 parts per billion (ppb) are unlikely to control EWM, and complete control is not typically achieved at much less than 10 ppb unless exposure times are long (>60 days, preferably >90 days). The preferred approach is therefore to maintain an adequate concentration of fluridone (>6 ppb) for a long enough time (>60 days) to kill the target milfoil without overly damaging the native community. Recovery of natives is expected within 2-4 years. If less damage is mandated, lower doses or lower exposure times can be applied, but recovery of EWM is likely to be faster. Without follow-up controls, the lower dose approach could result in the resurgence observed in Onota Lake, which is also considered a negative impact on protected species.

Mitigation of Impacts – Mitigation is largely based on avoidance of exposure of the Priority Habitat areas to herbicides in concentrations that lead to toxic responses. This can be more easily achieved in the case of so-called "spot treatments", which are directly targeted to a specific weed bed or location and rely on a contact herbicide. More problematic is a whole-lake application using a systematic herbicide such as fluridone, where elevated water column concentrations are held for considerable periods (weeks to months) and are much more likely to reach non-target submerged plants. Mitigation for a whole-lake application could be based on (a) avoidance of the portion of the North Basin where the Priority Habitats are located; (b) hydrologic isolation of the Priority Habitat areas via partial drawdown or sandbagging (as was discussed in the discussion of drawdown) and (c) installation of some impervious sheets or curtains at the sills to provide additional protection from exposure.

Recommended Action – In the absence of deep drawdown in 2004 affecting the growing season of 2005, a herbicide application is the only available technique to rapidly reduce biomass and coverage of EWM. The use of herbicides to control a major plant nuisance is a valid element of long-term management when other means of keeping plant growths under control are then applied. A whole lake herbicide application is a costly option (>$150K) and poses significant challenges to the protection of Priority Habitat. It is recommended that localized nuisance populations of EWM are controlled through spot treatments using appropriate herbicides (i.e., diquat and triclopyr) and application location avoidance to act as a mitigative measure to isolate and protect endangered plant species in Priority Habitat areas as well as Bridle Shiner. Figure 6-1 displays the areas planned for spot treatment in 2005. Spot treatments are planned for areas at a great enough distance so that location avoidance is sufficient and no impacts will be made to Priority Habitat areas. The large watershed and relatively rapid flushing rate of the North Basin indicate that mixing and dilution do not pose a threat to the Priority Habitat areas. Areas selected for spot treatment will be surveyed for Bridle Shiner by seining prior to the application of herbicides and again before any additional treatments are applied in subsequent years, allowing an assessment of any impacts on this species. It is believed that the areas selected are not the preferred habitat of this minnow species. Impacts to the Bridle Shiner will be minimized by limiting impacts to localized areas and avoiding preferred habitat areas, such as Dunn Grove, Theodore Pomeroy Pond, and the area north of Dan Casey Causeway.

If the planned 2005 deep drawdown combined with spot herbicide treatment fails to significantly reduce EWM, a single whole-lake application of fluridone (as Sonar ® A.S. at 41.7% fluridone) should be considered for 2007. Application location avoidance, partial drawdown (as feasible and/or permittable) and possibly limno-curtains should be employed to act as mitigative measures to isolate and protect endangered plant species in Priority Habitat areas. Care should be taken to make sure the dosage levels are maintained at effective concentrations for sufficient time (e.g., 8-10 ppb for 60 days or

Figure 6-1. Plant Management 2005


2005 Plant Management
Onota Lake
Herbicide Spot Area
Channelized Harvesting
Cem
3
Thomas
Island
Camp
Witawentin
1
ONOTA
PARK
LAKE
LAKEWAY
329
335
343
360

longer). The maximum benefit should be derived by making sure that the concentration and exposure time are sufficient to effectively attack the EWM (it appears that a minimum of 6 ppb for 60 days is required – K. Wagner, pers. comm.). A partial drawdown (to increase detention time) and a series of secondary treatments to keep concentrations above the critical threshold appear likely to be necessary. As noted above, herbicides are a powerful tool in invasive and nuisance plant control, but should be supplemented with other techniques to prolong benefits and minimize adverse effects.

Monitoring – Macrophytes and fish populations will be surveyed following the same protocols as or as part of the monitoring described under drawdown. LOPA volunteers will continue to conduct water quality monitoring following established protocols.

6.3 Mechanical Harvesting / Hydroraking

General Description - Mechanical plant removal operations are successful in producing at least temporary relief from nuisance plants and in removing organic matter and nutrients without the addition of a potentially deleterious substance (Mattson et al., 2004; see summary in Appendix D). Harvesting can be an effective short-term treatment to control the growth of aquatic plants. With repeated application at appropriate intervals, it can produce long-term shifts in the plant community, but it is unlikely to reduce long-term plant density substantially. Harvesting is generally used seasonally to remove vegetation that limits lake uses such as boating and swimming.

Feasibility for Onota Lake – Harvesting has been previously conducted on Onota Lake until 1998 to control milfoil and other nuisance plants, but was discontinued in favor of SONAR treatment in 1999. It is understood that harvesters owned by the City of Pittsfield could be made available to Onota Lake in the future. Hydroraking was employed in limited areas in 2004 on a fee for service basis. The effectiveness of this technique has yet to be determined, but has not resulted in lasting relief from EWM in other lakes. However, it is planned to offer hydroraking of shorelines to property owners on a fee for service basis in 2005 as was done in 2004.

Effectiveness in Controlling Aquatic Vegetation – Mechanical harvesting has variable success depending on the nature of the dominant species and its means of reproduction. If properly conducted and timed, it can be effective in reducing biomass and seeds for next year's growth (e.g., water chestnut). Unfortunately, it has a poor record with EWM due to the rapid plant biomass regrowth (days or weeks) and the potential for spreading through rerooting of plant fragments. Harvesting is somewhat more effective in removing Curly-leaf Pondweed if the timing of the harvesting coincides with early summer growth and is conducted at a moderate depth (e.g., 3-7 ft). At best, it provides a predictable if somewhat ineffective means to reduce biomass in areas of Onota Lake heavily used for recreation.

Impacts to Non-Target State-Protected Species – Harvesting was not identified specifically as a threat to non-target populations of Comb Water-Milfoil possibly due to the ineffectiveness of harvesting in eliminating water milfoils. Harvesting is unlikely to be conducted in the Priority Habitat Areas due to shallow depth and poor access for machinery. Harvesting could potentially impact Bridle Shiner populations if conducted during spawning season. While the noise and disturbance of the harvester could startle and disperse the adults, it is also possible that harvested material would crop some portion of adhered eggs. However, by harvesting in areas with a depth of 3 ft or greater the spawning areas should not be disturbed.

Mitigation of Impacts – No mitigation is necessary with regard to the state-protected plant species, other than avoidance of the Priority Habitat areas. For the Bridle Shiner, avoidance of the spawning areas will be accomplished by limiting harvesting to depths of 3 ft or greater. Since limited areas will be harvested, sufficient refuge for this fish will remain. As noted in the drawdown evaluation, very little is known about the ecology of this fish to suggest a more definitive protection plan. The preferred approach is to conduct the quantitative fishery sampling recommended by MA DFW to establish the population ecology and database to make even more informed decisions in the future.

Recommended Action – Harvesting should not be considered a primary means of aquatic plant control in Onota Lake. However, it can be integrated with other measures (e.g., drawdown, herbicide) to control plant biomass and increase recreational usage. The most effective use of this method may be to create boating lanes (see Figure 6-1). It is also an alternative to be considered in the event that the recommended herbicide spot treatments are not able to be conducted. Once the dominance of EWM has been reduced by other means, harvesting may be an effective tool to control Curly-leaf Pondweed. Conducting a deep cut in late spring (late May to early June) at 3 to 7-ft depth should prove effective in significantly reducing Curly-leaf Pondweed biomass and reducing its adverse effect on summer recreational uses. It is critical in such an effort that the winter buds be collected, meaning that harvesting must be conducted before the winter buds are dropped later in June. Even so, with a reserve of winter buds already in place, it will take several years to reduce the annual growth of this species.

Monitoring – Macrophytes and fish populations will be surveyed following the same protocols as or as part of the monitoring described under drawdown.

6.4 Biological Controls

General Description - Biological control has the objective of achieving control of plants without introducing toxic chemicals or using machinery (Mattson et al., 2004; see summary in Appendix D). This may include biomanipulation of upper level trophic species or the stocking of herbivorous fish (e.g., grass carp – not legal to stock in MA) or macroinvertebrates (e.g., milfoil weevil*, Euhrychiopsis lecontei*) to reduce nuisance populations. Most methods are still somewhat experimental in nature and have a limited degree of documented effectiveness.

Feasibility for Onota Lake – GeoSyntec stocked 10,000 EWM-eating weevils (*E. lecontei*) at a location in the littoral zone of Onota Lake's western shore. For comparison, a control plot was established in the southwest portion of the lake. These populations were monitored in August 2003 and July 2004 to evaluate population and effectiveness of control. A 2003 monitoring survey report was completed by GeoSyntec (Pittsfield/BRPC/LOPA, 2004).

Effectiveness in Controlling Aquatic Vegetation - The introduction of the herbivorous insects, including the milfoil weevil, moth and midge, has the potential to reduce EWM growths, but is unlikely to eliminate them as a function of classic predator-prey interactions, which usually result in cycles of abundance and scarcity. As fish eat the insects but few herbivores eat the EWM, constant inputs of herbivorous insects appear necessary to bolster populations to a level at which they can control EWM.

LOPA (2004) reported that GeoSyntec conducted the July 2004 survey and found "modest activity" (not defined) in several places (southwest cove, near Parker Brook where originally stocked, near unnamed tributary at Blythewood Drive) in Onota Lake. LOPA (2004) reported that "there is no evidence that the weevil population is flourishing." Based on the vegetation survey of that year, there does not seem to be evidence of significant decline of EWM in areas of application (or elsewhere in the lake). The primary limitation on weevil effectiveness appears to be predation by fish, especially sunfish, and this may be an important factor in Onota Lake.

Impacts to Non-Target State-Protected Species – Application of weevils was mentioned by NHESP and MA DFW as potentially adversely affecting non-target populations of Comb Water-Milfoil (MA DFW, 2004). It is presumed by NHESP that the weevils will attack the taxonomically-related Comb Water-Milfoil, if EWM is not available, since the insect may not discriminate between these two species as hosts. MA DFW indicates that due to this concern, they would not be able to permit their intentional introduction into Onota Lake. There is evidence that the weevils are species specific and will not transfer to other milfoil (Pers. Comm., R. Hartzel, 2005). Given that the weevils occur naturally in many lakes and are not known to impact comb water-milfoil in those lakes, it seems unwarranted to assume that there is a threat from weevils to comb water-milfoil in Onota Lake, but the desire to be protective is understood. Certainly there is no threat from this technique to any other protected species.

Mitigation of Impacts – At this point, no mitigation is needed or proposed since the introduced weevils do not seem to be making a significant impact on EWM populations and are unlikely to pose a threat to the Comb Water-milfoil. Weevils that have persisted from the 2003 stocking appear to be located fairly distant from the Priority Habitat areas. If this aquatic vegetation control method is continued (i.e., re-stocking of additional weevils), the insects should not be stocked in the Priority Habitat areas or in their immediate vicinity. Since little is known about how far these weevils will emigrate in search of milfoil, further investigation may be necessary to establish a sufficiently protective buffer zone from the Priority Habitat areas. However, as stated previously, there is no evidence that weevils make any use of any milfoil species other than EWM and northern milfoil (*M. sibiricum*), so there is no clear threat to comb water-milfoil.

Recommended Action – Biological control efforts by weevils do not seem promising based on the first introduction. It is recommended that further monitoring be conducted in 2005 and 2006 to determine if residual control has been achieved before considering restocking. Additional surveys for surviving weevil populations and evidence of attacks on EWM should be conducted to further evaluate this method prior to any restocking. Based on lack of control of EWM evidenced so far, it is doubtful that additional stocking will be beneficial in controlling EWM at Onota Lake. This option will be reevaluated in 2007.

Monitoring –The City of Pittsfield intends to hire GeoSyntec Consultants to monitor stocking sites in 2005 and 2006 to determine if residual control has been achieved. Surveys will be conducted for surviving weevil populations and evidence of attacks on EWM to further evaluate this method.

6.5 Hand-Harvesting

General Description – Hand-harvesting is the selective removal of unwanted plants on an individual basis (Mattson et al., 2004; see summary in Appendix D). It is very labor-intensive (usually conducted by divers) but may be appropriate for efforts to keep out invasive species that have not yet become established in the lake or area of concern. Hand pulling can also effectively address non-dominant growths of undesirable species in mixed assemblages, or small patches of plants targeted for removal. This technique is not suited to large-scale efforts, especially when the target species or assemblage occurs in dense or expansive beds.

Feasibility for Onota Lake - Hand-harvesting has been used by volunteers to control and limit as much as possible invading water chestnut from the north side of Dan Casey Causeway. Reportedly 90 gallons of water chestnut were removed in 2004 by volunteers from infested areas (LOPA, 2004). Hand-harvesting of the dense expanse of EWM in Onota Lake is impractical, and may even be counterproductive, creating fragments that could spread this plant further.

Effectiveness in Controlling Aquatic Vegetation - Hand pulling of localized populations can be extremely effective in removing small populations of nuisance plants provided the plant fragments are removed from the water (Mattson et al., 2004). This method is impractical for application to most large areas, although it is useful to control newly arriving invasive species. In areas where just a few plants are established, pulling those plants by hand can be an effective approach with minimal impact to any non-target organisms. Repetition of this approach is likely to be needed, as not all targeted plants may be found during the initial effort, or in the case of water chestnut, to harvest plants growing from seed deposits.

Impacts to Non-Target State-Protected Species – Due to the selective nature of hand-harvesting and obvious morphological differences between water chestnut and state-protected species, there are no impacts associated with the use of hand-harvesting.

Mitigation of Impacts – No impacts will result and no mitigation is needed.

Recommended Action – It is recommended that LOPA coordinate volunteer efforts to continue hand-pulling and removal of the water chestnuts in the North Basin. The area should be surveyed in 2005 to determine whether this species is increasing its range despite removal activities. Hand-harvesting of water chestnut should be continued in the areas of initial infestation. Additional surveys of the extent and coverage of plants in lake should be conducted. If hand-harvesting is not effective and/or spatial extent of water chestnut is increasing, additional aquatic plant control measures should be considered since this pioneer infestation must be controlled. Mechanical harvesting over several years has been effective elsewhere. Herbicide are of limited effectiveness in controlling water chestnut, while 2,4-D is effective it cannot be used in Onota Lake, fluridone is less effective, and although triclopyr may be effective more data is needed.

Monitoring – Macrophytes will be surveyed following the same protocols as or as part of the monitoring described under drawdown.

6.6 Benthic Barriers

General Description - Manufactured benthic barriers are negatively buoyant materials, usually in sheet form, including polyethylene, polypropylene, fiberglass, and nylon, which can be applied on top of plants to limit light, physically disrupt growth, and allow unfavorable chemical reactions to interfere with further development of plants (Perkins et al., 1980). Benthic barriers can be an effective treatment for the control macrophytes in small, localized areas of a lake like a dock, boat launch or a swimming beach, but are generally not practical for use in large areas (greater than several acres) as a consequence of cost and maintenance requirements (Mattson et al., 2004; see summary in Appendix D). This method is usually considered a low impact treatment and is easily permitted under the Massachusetts Wetland Protection Act (WPA).

Feasibility for Onota Lake – A trial benthic barrier was installed at Burbank Park swimming area and its effectiveness without maintenance was monitored for two years.

Effectiveness in Controlling Aquatic Vegetation - Barriers are an effective and fairly rapid method to achieve a plant free water column in localized areas. They are more effective if applied early in the season and maintained by removal and cleaning on a regularly basis. If no maintenance is performed, sediment accumulates on top of the barriers, allowing rooting of aquatic macrophytes. At Burbank Park, LOPA volunteers noted that within two years of installation, redeposited silt had covered the test benthic barrier panel and EWM had quickly colonized it, making it almost impossible to detect by visual means (LOPA, 2004).

Impacts to Non-Target State-Protected Species – Since benthic barriers are proposed for use only in the area around Burbank Park and none are to be located in the areas of Priority Habitat for plants, there are no impacts associated with their use for protected plant species. Benthic barriers create patches among aquatic plants that should favor the Bridle Shiner.

Mitigation of Impacts – None needed.

Recommended Action – The status of the existing benthic barriers at Burbank Park should be evaluated by inspection (snorkeling) to determine the level of silt and plants which have accumulated. If possible, remaining barriers should be pulled in late spring, cleaned, and re-installed prior to prime recreational period (typically before the end of June). Additional, benthic barriers should not be installed at Burbank Park unless there is commitment to regularly retrieve and clean them. Otherwise, the limited duration of effective plant control without maintenance (<2 years) is not cost-effective.

Monitoring – Visual surveys will be conducted of the benthic barriers to determine if weed growth is occurring on or through the barrier(s).

7.0 ACTION PLAN

The Lake Onota Preservation Association, Inc. (LOPA) will work with the City of Pittsfield and will share responsibility for the administration, coordination and oversight of this plan. In order to simply and effectively assure that the management actions are implemented the partners in this effort have developed a Five Year Action Plan that summarizes the proposed management actions, identifies the agency responsible for taking the lead in implementing each action, identifies partners and cooperators, and identifies funding needs or requirements (Table 7-1).

The success of this plan will require coordination among those programs as well as special watershed wide initiatives. A major component of success will require engaging local government, whose authority and local decision making collectively have a significant impact on the natural resources and sustainability of communities throughout the Onota Lake watershed. All of these steps require institutionalized coordination and strong communication among government agencies and stakeholders. Therefore, the Action Plan presents an implementation process and roles for not only participating governmental agencies, but also LOPA, other basin stakeholders, and the general public. The Five Year Action Plan will further enable the City, LOPA, and other basin stakeholders to monitor the results of various action items to guide the continued management of this valuable natural and recreational resource.

Table 7-1 Five Year Action Plan

ACTIONS	TIME PERIOD					PARTICIPANTS	APPROXIMATE COST
	2005	2006	2007	2008	2009		
Drawdown						**City of Pittsfield & LOPA**	
5 ½ foot drawdown	×			×			TBD
3 foot drawdown		×	×		×		
Herbicide						**City of Pittsfield & LOPA**	
Spot treatment with Reward® (Diquat)	×	×	TBD	TBD	TBD		+ $20,000/yr
Spot treatment of S.E. Cove with Renovate ® (Triclopyr)	×		TBD	TBD	TBD		$3,000
Whole lake treatment with SONAR® (Fluridone)			TBD				$175,000
Harvesting & Hydroraking						**City of Pittsfield & LOPA**	
Harvest boat channels on western shore and northern shore of Thomas Island	×	×	×	×	×		
Hydrorake individual shorelines on fee for service basis	×	×	×	×	×		
Weevils						**City of Pittsfield & LOPA**	
Professional monitoring by GeoSyntec Consultants	×	×	TBD	TBD	TBD		$2,000/yr
Hand Pulling						**LOPA**	
Thoroughly search for Water Chestnuts and hand pull Water Chestnuts annually	×	×	×	×	×		$0
Benthic Barrier						**City of Pittsfield & LOPA**	
Install and remove benthic barrier in swimming area	×	×	×	×	×		TBD
Install and remove benthic barriers on individual shorelines as fee for service		×	×	×	×		
Monitoring						**City of Pittsfield & LOPA**	
Volunteer water quality monitoring	×	×	×	×	×		$2,000/yr
Volunteer macrophyte surveys	×	×	×	×	×		$0
Monitor water levels	×	×	×	×	×		$0
Conduct fisheries surveys with electroshocking and seining	×	×	×	TBD	TBD		+/- $2,000/yr

8.0 REFERENCES

ACT. 2000. *Long-range Aquatic Vegetation Management Plan – Onota Lake – Pittsfield, Massachusetts, December 2000*. Aquatic Control Technology, Inc. Sutton, MA

ACT. 2002. *Aquatic Control Technology Macrophyte Survey 2002 Report*. Sutton, MA.

ALWA. 1997*. Onota Lake Monitoring Program, 1997.* American Lakes & Wetlands Services, Inc.

BRPC and Foresight Land Services. 2003 *Storm Drain & Erosion Assessment at Burbank Park.*, Fall 2003.

BPRC & LOPA. 1999. Quality Assurance Project Plan, 1999 (Rev. 2003). Berkshire Regional Planning Commission and Lake Onota Preservation Association, Inc.

BPRC & LOPA. 2004. *Final Report Eurasian Watermilfoil Re-growth Control Project* at Onota Lake Berkshire Regional Planning Commission and Lake Onota Preservation Association, Inc.

Chandler, M. 2000. Acidification, Exotic Species, Habitat Alteration and Loss of Bridle Shiner. Presented at New York Natural History Conference. VI. New Yorl

City of Pittsfield, BRPC and LOPA. 2004. *Onota Lake Long-Range Management Plan Spring 2004.* Prepared for the City of Pittsfield by Berkshire Regional Planning Commission and Lake Onota Preservation Association, Inc.

Cooke, G.D., Welch, E.B., Peterson, S.A., and P.R. Newroth. 1993. Restoration and Management of Lakes and Reservoirs. 2nd ed. Lewis Publishers. Boca Raton, FL.

ENSR Corporation. 2005. Draft Rapid Response Plan for Eurasian Watermilfoil (*Myriophyllum spicatum*) in Massachusetts. Prepared for Massachusetts Department of Conservation and Recreation, Boston, MA.

Executive Office of Environmental Affairs (EOEA). 2003. *Housatonic River Watershed Five Year Action Plan 2002-2007*. Boston, MA.

Executive Office of Environmental Affairs (EOEA). 2004. *Massachusetts Year 2004 Draft Integrated List of Impaired Waters.* Boston, MA.

Fugro. 1996. *Environmental Impact Review and Managerial Implications for a Proposed Drawdown of Onota Lake, Pittsfield, MA*. Fugro East, Inc., July 1996.

GeoSyntec. 2003a. *2003 Lake Onota Aquatic Vegetation Assessment.* GeoSyntec Consultants, Boxborough, MA.

GeoSyntec. 2003b. *Field Guide to the Plants of Onota Lake*. GeoSyntec Consultants, Boxborough, MA.

GeoSyntec. 2003c. *2003 Lake Onota Milfoil Weevil Project – First Monitoring Report.* GeoSyntec Consultants, Boxborough, MA.

Hartel, K.E., Halliwell, D,B. and A.E. Launer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society. Lincoln, MA.

IT Corporation. 1991. *Diagnostic /Feasibility Study for Onota Lake*, Pittsfield, MA IT Corporation, March 1991.

LOPA. 1999a. *Onota Lake Management Plan, 1999*. Lake Onota Preservation Association, Inc.

LOPA (1999b – 2003). *LOPA Annual Report Years 1999 – 2003.* .Lake Onota Preservation Association, Inc.

Massachusetts Department of Environmental Protection. 1998. *Housatonic River Basin 1997/1998 Water Quality Assessment Report.* Boston, MA.

Massachusetts Department of Environmental Protection. 2004. *Guidance for Aquatic Plant Management in Lakes and Ponds*. Bureau of Resource Protection and Wetlands/Waterways Program. April 2004.

Massachusetts Division of Fish and Game (MA DFW) 2003. *Watershed Survey Final Report & Action Plan.* Prepared by Riverways Program.

Massachusetts Division of Fish and Game (MA DFW) 2004. Letter from Thomas French, Assistant Commissioner to Pittsfield Conservation Commission date November 22, 2004. Comments on approved Notice of Intent (NOI) regarding annual drawdown of Onota Lake, 3 feet and 6 feet (MA DEP File No. 263-819, Westborough, MA.

MassGIS. 1997. Land Use Data for Berkshire County.

Mattson, M.D., P.J. Godfrey, R.A. Barletta and A. Aiello. (K.J. Wagner Editor) 2004. Eutrophication and Aquatic Plant Management in Massachusetts Final Generic Environmental Impact Report. Edited by Kenneth J. Wagner. Department of Environmental Protection and Department of Conservation and Recreation, Executive Office of Environmental Affairs, Commonwealth of Massachusetts.

NHESP Fact Sheet. 2003a. Bridle Shiner (*Notropis bifrenatus*). Natural Heritage and Endangered Species Program. Division of Fisheries & Wildlife, Westborough, MA. April 2003.

NHESP Fact Sheet. 2003b. Comb Water-Milfoil (*Myriophyllum verticllatum)*. Natural Heritage and Endangered Species Program. Division of Fisheries & Wildlife, Westborough, MA. September 2003.

NHESP Fact Sheet. 2003c. Ogden's Pondweed (*Potamogeton ogdenii*). Natural Heritage and Endangered Species Program. Division of Fisheries & Wildlife, Westborough, MA. September 2003.

New England Plant Conservation Program. 2002. *Potomogeton ogdenii* (Ogden's Pondweed). *Conservation and Research Plan for New England*. Prepared by C. Barre Hellquist and T. Mertinooke-Jongkind, Massachusetts College of Liberal Arts for New England Wild Flower Society, Framingham, MA. December, 2002.

Princeton Hydro. 2003. *The Evaluation of Hypolimnetic Withdrawal and Deep-Water Aeration Management Alternatives for Lake Onota, Pittsfield, MA.* Princeton Hydro, LLC, July 2003,

Princeton Hydro, LLC, BRPC, and LOPA, 2004. An Integrated Approach to the Management of Stormwater Water Quality Within the Sub-Watersheds of Onota Lake Pittsfield, Massachusetts. Princeton Hydro, LLC, Berkshire Regional Planning Commission and Lake Onota Preservation Association, Inc.

Wagner, K.J. 2004. The Practical Guide to Lake Management in Massachusetts. A companion to the Final Generic Environmental Impact Report on Eutrophication and Aquatic Plant Management in Masssachusetts. Commonwealth of Massachusetts. Executive Office of Environmental Affairs, Boston, MA.

Whittier, T. R., Halliwell, D. B., and R.A. Daniels, 2002. Distributions of Lake Fishes in the Northeast – II. The Minnows (Cyprindae). Northeastern Naturalist 7:131-156

APPENDIX A

Onota Lake Long-Range Management Plan

(Pittsfield/BRPC/LOPA, 2004)

APPENDIX B

Recent Onota Lake Macrophyte Distribution Maps

and Coverage Data

APPENDIX C

Correspondence from NHESP and MA DFW

and Protected Species Information

APPENDIX D

Information Summaries of Aquatic Vegetation Control Methods

from *The Practical Guide to Lake Management in Massachusetts*

(Wagner, 2004)

APPENDIX E

Onota Lake Deep Drawdown Plan Summary

(NOI application; City of Pittsfield, 2004)