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October 27, 2017

Ms. Judy Colaluca
Sand Dam Reservoir Association
61 Wood Road
Chepachet, Rhode Island 02814

Re: 2017 Sand Dam Reservoir Aquatic Plant Survey Report
ESS Project No. S442-003

Dear Ms. Colaluca:

ESS Group, Inc. (ESS) is pleased to present the Sand Dam Reservoir Association (SDRA) with results of the aquatic plant survey conducted at Sand Dam Reservoir (also known as Smith and Sayles Reservoir) in mid-September. The primary purpose of the survey was to assess the current extent and density of exotic variable-leaf milfoil (*Myriophyllum heterophyllum*) beds in the pond, as well as to look for pioneer infestations of new invasive or nuisance species, if present.

AT-A-GLANCE SUMMARY OF FINDINGS

- Invasive variable-leaf milfoil was present at a substantially increased extent (compared to 2015) in Sand Dam Reservoir.
  - Overall, these beds extended across 46 acres of the pond.
  - Several large beds of dense, contiguous growth were documented, primarily in deeper portions of the pond (typically greater than 5.0 feet).
  - Sparse to patchy beds were documented in a number of additional locations, including shallow waters.
- Swollen bladderwort (*Utricularia inflata*) was observed for the first time (by ESS) in the Smith and Sayles Reservoir this year. Swollen bladderwort is considered to be an exotic species in Rhode Island.
- No other readily apparent changes (compared to prior years) were observed in the remainder of the aquatic plant community.
- The following management options are recommended for consideration by SDRA:
  - Winter drawdown is recommended to control variable-leaf milfoil down to 54 inches (4.5 feet). Deeper drawdown or optimization of drawdown timing are additional options to consider.
  - Systemic herbicide application is recommended for short-term control of the extensive variable-leaf milfoil beds in deeper water.
  - Diver assisted suction harvesting (DASH) is recommended for controlling smaller patches of variable-leaf milfoil.
  - Hand harvesting may be used to control remaining variable-leaf milfoil in wadeable areas near the shoreline. This may also be useful for control of swollen bladderwort.

METHODS

ESS completed an aquatic plant survey at Smith and Sayles Reservoir on September 14, 2017. For consistency with prior mapping, aquatic plants were mapped along the same transects as previously. However, additional off-transect observations were also made to supplement the dataset, as needed, and delineate the edges of aquatic invasive plant beds with greater detail.

Depending on the depth and type of plant growth at each location a pole rake, throw rake, view tube, and/or underwater camera were used to assess the aquatic plant community. A Trimble Geo7x DGPS with sub-meter accuracy was used to collect position and record species composition at selected locations. As in previous years, particular focus was given to mapping major invasive species beds.

RESULTS

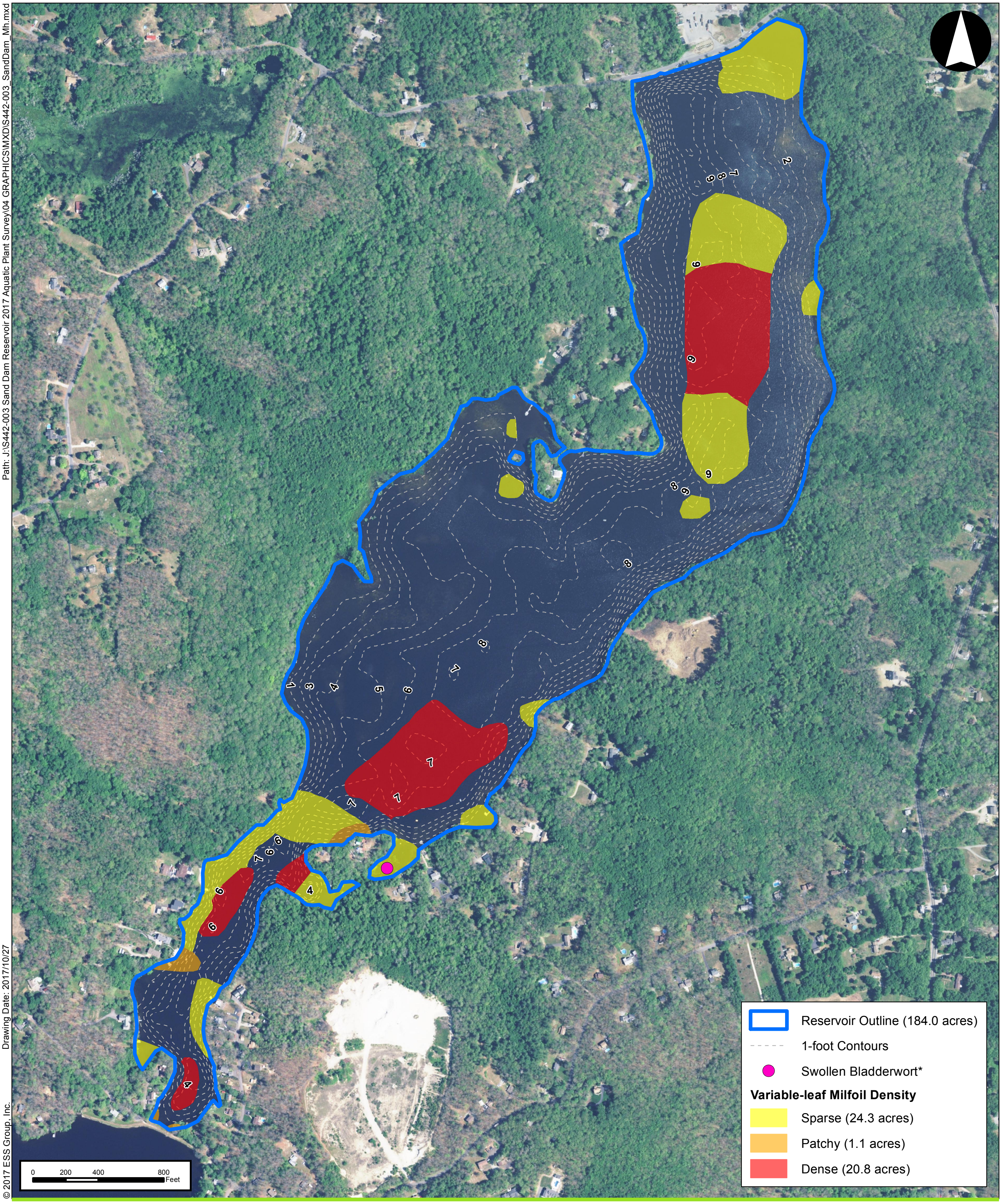
Aquatic Invasive Plants

Based on this year's aquatic plant survey, variable-leaf milfoil is both the primary invasive species and overall dominant aquatic plant in Smith and Sayles Reservoir. The total extent of variable-leaf milfoil in the pond was 46.2 acres (25% of the pond). Almost half of this acreage (20.8 acres) consisted of dense beds, including large areas of growth reaching the top of the water column. Most of the remaining area of variable-leaf milfoil growth – particularly the portion in shallower waters – was characterized as sparse (i.e., milfoil stems only occasionally observed).

Variable-leaf milfoil topped out, with flowering bracts emerging from the water, creating a lawnlike effect. Dense beds like this were observed in nearly 21 acres of the pond.

Path: J:\S442-003 Sand Dam Reservoir 2017 Aquatic Plant Survey\04 GRAPHICS\MXD\S442-003_SandDam_Mh.mxd

Drawing Date: 2017/10/27



ess group
environmental consulting
& engineering services

Sand Dam Reservoir Association
Glocester, Rhode Island

1 inch = 800 feet

Source: 1) ESRI/USDA/, NAIP, 2017
2) ESS, GPS Locations, 2017

***Swollen bladderwort detection. Species could migrate to other locations due to its free-floating nature.**

Invasive Species Cover
September 14, 2017

Figure 1

This year's observations represent the largest overall extent of variable-leaf milfoil growth observed by ESS at Smith and Sayles Reservoir, exceeding 2010 by several acres (Figure 2). Furthermore, the extent of dense variable-leaf milfoil growth observed far exceeded that of prior years.

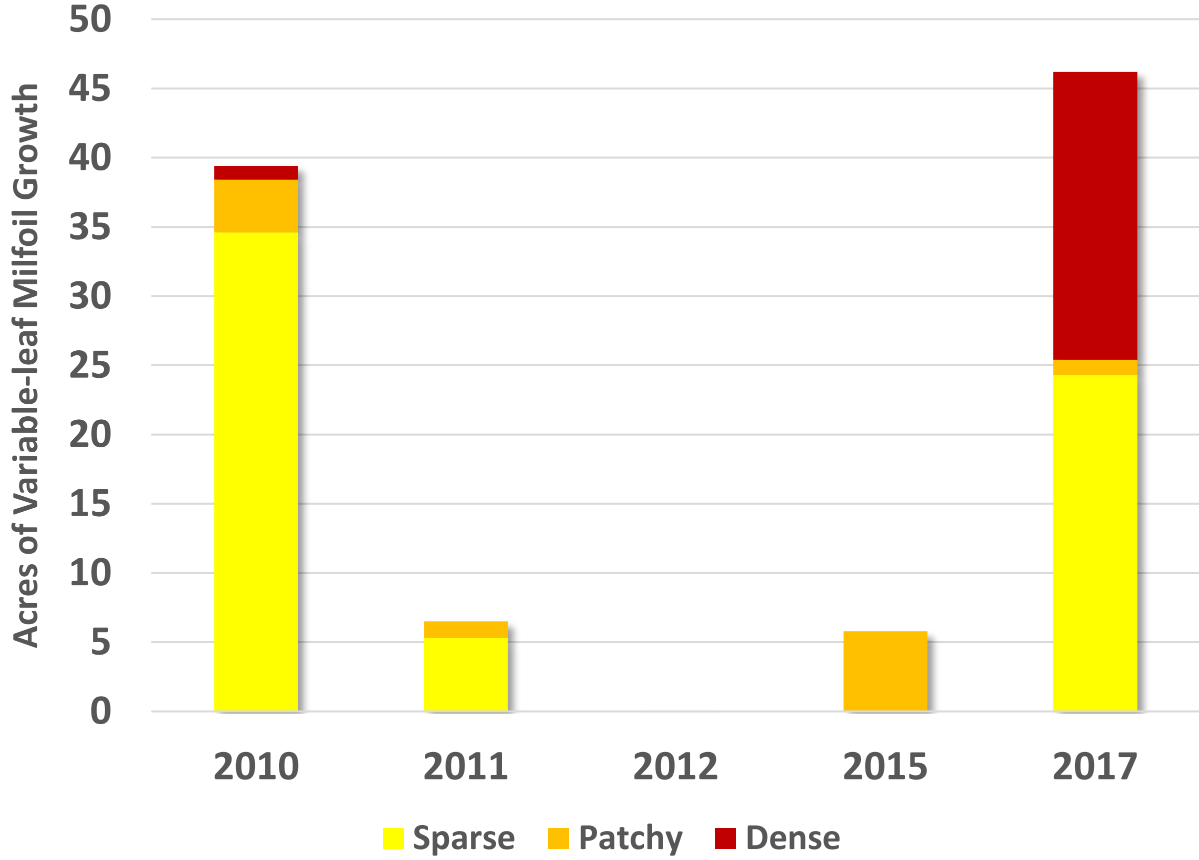


Figure 2. Acreage of Variable-leaf Milfoil Observed by ESS from 2010 to 2017

ESS also documented one new aquatic invasive species at Smith and Sayles Reservoir: swollen bladderwort (*Utricularia inflata*). At Smith and Sayles Reservoir, swollen bladderwort was observed in limited numbers in just one cove, near Evelyn's Way (Figure 1). Therefore, it is believed that this is a new infestation.

Swollen bladderwort is conspicuous at the water's surface when in flower

This species is native to the southeastern United States but has been introduced to New England and now thrives in a number of lakes and ponds across the region, including several in Rhode Island (RIDEM 2015). Due to its large size and aggressive growth habits, this species may quickly expand to cover significant portions of a waterbody. Additionally, because swollen bladderwort is a floating plant, it may shade out other aquatic plants that are rooted in bottom sediments. This species tends to concentrate in quiescent coves or among other aquatic plants in areas of high plant biovolume. Swollen bladderwort reproduces through a variety of means, including fragmentation, tubers, winter buds (turions), and seeds.

Although it was not the focus of this study, ESS is aware that SDRA recently identified common reed (*Phragmites australis*) growing along the shoreline of the pond and has initiated efforts to control its spread.

Species Composition

Seventeen aquatic plant species were present in Smith and Sayles Reservoir at the time of survey (Table A). One macroalgal species, six emergent plant species and small growths of filamentous green algae (Chlorophyceae) were also found in the pond. Most of the shallow shoreline waters of Smith and Sayles Reservoir are inhabited by low-growing, inconspicuous native plants, including pipewort (*Eriocaulon aquaticum*), spikerush (*Eleocharis* spp.), and golden hedge-hyssop (*Gratiola aurea*). Stonewort (*Nitella sp.*), is similarly inconspicuous but is typically found in deeper water near the center of the pond.

Table A. Aquatic and Emergent Plant species observed at Smith and Sayles Reservoir

Scientific Name	Common Name	2010	2011	2012	2015*	2017
Aquatic Plants						
Brasenia schreberi	Watershield	X	X	X		X
Eriocaulon aquaticum	Sevenangle pipewort	X	X	X	X	X
Eleocharis sp.	Spikerush	X	X	X	X	X
Elatine sp.	Waterwort	X	X	X	X	X
Gratiola aurea	Golden hedge-hyssop	X	X	X	X	X
Isoetes sp.	Quillwort	X	X	X	X	X
Myriophyllum heterophyllum	**Variable-leaf milfoil**	**X**	**X**	**X**	**X**	**X**
Nymphoides cordata	Little floating heart	X	X	X	X	X
Nuphar lutea variegata	Yellow water lily	X	X	X	X	X
Nymphaea odorata	White water lily	X	X	X		X
Potamogeton bicupulatus	Snailseed pondweed	X	X	X		X
Potamogeton natans	Floating pondweed	X	X	X	X	X
Proserpinaca palustris	Mermaid weed		X			X
Utricularia gibba	Humped bladderwort	X	X	X	X	
Utricularia inflata	**Swollen bladderwort**					**X**
Utricularia macrorhiza	Common bladderwort	X	X	X	X	X
Utricularia purpurea	Purple bladderwort	X	X	X		X
Utricularia radiata	Little floating bladderwort	X	X	X	X	X
Attached Algae						
Chara sp.	Muskwort (macroalgae)	X				
Chlorophyceae	Filamentous green algae	X	X	X	X	X
Nitella sp.	Stonewort (macroalgae)	X	X	X	X	X
Key Emergent Plants						
Dulichium arundinaceum	Three-way sedge	X	X	X	X	X
Pontederia cordata	Pickerelweed	X	X	X	X	X
Sagittaria sp.	Arrowhead	X	X	X	X	X
Scirpus cyperinus	Wool-grass		X	X	X	X
Sparganium americanum	Burreed	X	X	X	X	X
Typha latifolia	Cattail		X	X	X	X

Note: Species in **bold red text** are exotic

*Survey conducted early in the season (late May). Some species may not have been detected by the survey due to early stage of development.

MANAGEMENT OPTIONS FOR 2018

A summary of recommended actions for the management of aquatic plant growth at Smith and Sayles Reservoir is presented below. Each of the recommended options for consideration is consistent with the 2010 *Lake Management Plan for Smith and Sayles Reservoir* (Lake Management Plan), completed by ESS on behalf of the Northern Rhode Island Conservation District.

Additional permitting may be required for some of the options included in this report. Generally speaking, aquatic herbicide applications require submission of an Application for Permit to Control Aquatic Nuisance Species Using Pesticides and management actions that impact wetlands more than 15 feet from shore or a permitted dock may need to file a Request for Preliminary Determination with RIDEM. Additional study or design may also be required to provide RIDEM with the information required for these filings. However, the filing fee itself may be reduced for SDRA if the requested action is recommended in its Lake Management Plan.

Winter Drawdown
Recommended for Milfoil Control in Shallow Waters

Winter drawdown has been successfully used by SDRA as a management technique for many years. Historically, SDRA has targeted a maximum drawdown depth of 54 inches (4.5 feet). This technique relies on repetition over many years, as the degree of control achieved by drawdown in any given year will vary, depending on the timing and duration of freezing weather and snow cover. In general, long periods of freezing weather combined with minimal snow cover will provide the best results. The winter of 2016-2017 was the fifth warmest on record in Rhode Island (Northeast Regional Climate Center 2017). Although temperatures were significantly below freezing on occasion, these cold periods were generally short-lived and interspersed with extremely mild weather, allowing soils to thaw. This likely prevented the development of a deep freeze in exposed sediments and may have resulted in reduced effectiveness of the 2016-2017 drawdown at Smith and Sayles Reservoir.

ESS is aware that SDRA is interested in potentially conducting a deeper drawdown or modifying the drawdown schedule to improve control of variable-leaf milfoil in the future. To help SDRA identify the potential benefits of a deeper target drawdown depth, ESS considered two alternative scenarios.

Under the first scenario, drawdown depth would be increased by 2 inches to 56 inches (4.7 feet). Based on the bathymetric contours presented in the 2010 Lake Management Plan, this would result in approximately ***3.1 acres*** of additional sediment exposure beyond the current winter drawdown program. This scenario may provide a marginal increase in variable-leaf milfoil control but would be unlikely to impact the densest beds, as most of these currently occupy waters deeper than the 56 inches.

Under the second scenario, drawdown depth would be increased by 6 inches to 60 inches (5 feet). This would result in approximately ***11.1 acres*** of additional sediment exposure beyond the current winter drawdown program and 8.0 acres beyond a 56-inch drawdown. This scenario may provide a further increase in variable-leaf milfoil control but would still be unlikely to impact the densest beds, as most of these currently occupy waters deeper than the 60 inches (Figure 1).

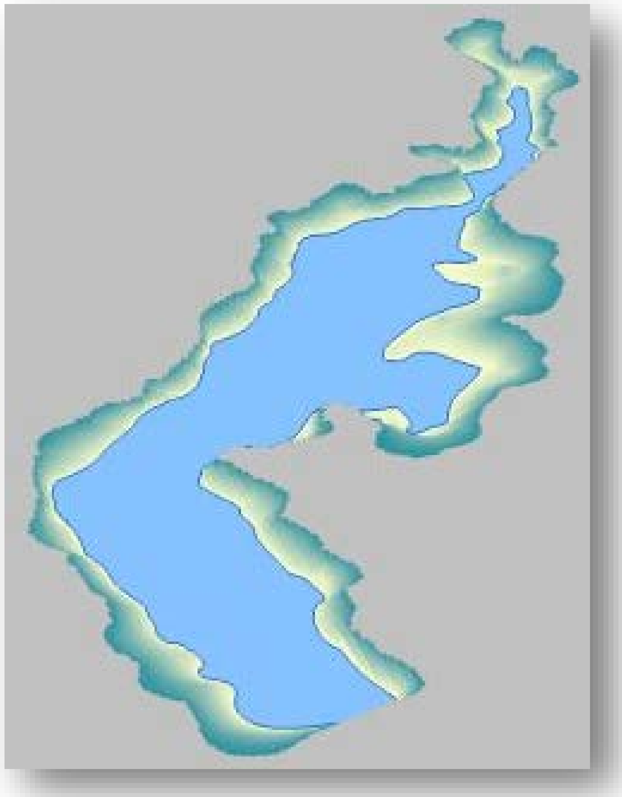
All three of these drawdown depths are expected to retain a contiguous water surface in Smith and Sayles Reservoir. This is important because it maintains connectivity between shallow and deep aquatic habitats during the drawdown period, allowing aquatic organisms to seek refuge from frozen or hypoxic (low oxygen) conditions over the winter. Even though measurements by SDRA indicate dissolved oxygen levels are sufficient to support aquatic life (i.e., 5.0 mg/L or higher) in the pond over the winter, pockets of low dissolved oxygen may sometimes develop, even in adequately oxygenated ponds, due to micro-scale conditions.

Therefore, maintaining connectivity between aquatic habitats throughout the pond is helpful for preventing fish kills or other undesirable outcomes during drawdown.

Regarding modification of the drawdown schedule, winter drawdown may be optimized by drawing the pond down earlier in the season and refilling earlier in the spring, as weather conditions allow. Drawdown has typically been initiated during Columbus Day weekend in October, reaching the target level by late November. Refill of the pond is usually complete by the end of March, depending on weather conditions.

It may sometimes be desirable to begin drawdown earlier in the autumn. This would allow maximum drawdown to be achieved earlier in the season, thereby maximizing the opportunity for desiccation and freezing of exposed variable-leaf milfoil plants in late autumn/early winter, when snow cover is typically not present.

Likewise, earlier refill of the pond may provide benefits in some years, as it would reduce light intensity in deeper waters, thereby slowing early-season milfoil growth. This may also be beneficial when ongoing drought or a forecast for warmer than normal late winter weather make early refill desirable.



Predicted water surface (blue) under a 5.0-ft drawdown scenario. Although minor ponding would be expected in isolated areas that poorly dewater, most of the aquatic habitat within the pond would remain connected. Figure provided by SDRA.

RIDEM will need to be consulted prior to significant modification of the drawdown operations plan, particularly regarding earlier commencement of drawdown or increased target depth, as this could potentially increase the risk of impacts to non-target species. Should SDRA desire to optimize winter drawdown through modification of the drawdown schedule, additional study is also recommended to develop a systematic decision-making framework based on actual and predicted weather and hydrologic conditions.

Herbicide Treatment
Recommended for Milfoil Control in Deep Waters

As presented in prior annual monitoring reports and the original 2010 Lake Management Plan, appropriately selected and applied herbicides are typically considered the most effective option for controlling large areas of dense milfoil growth. Should SDRA desire to significantly reduce the now extensive beds of variable-leaf milfoil growth in deeper waters (i.e., below the depth of winter drawdown), herbicide treatment is the surest way to achieve this over the short term.

Given its track record of effective control when applied in previous years, 2,4-D (trade name Navigate) would likely achieve large-scale, multi-season control of variable-leaf milfoil, were it to be reapplied to Smith and Sayles Reservoir in 2018. This would open a window for SDRA to more effectively use alternative management techniques (e.g., DASH – see below) for control of variable-leaf milfoil regrowth. As a systemic herbicide, uptake of Navigate results in the death of the entire milfoil plant, which typically provides two to three years of control. Additionally, Navigate is a relatively selective herbicide, resulting in less impact to non-target plants that provide habitat for aquatic life (e.g., native pondweeds).

Hand Harvesting
Recommended in Wadeable Waters

Newly rooted fragments of variable-leaf milfoil may be effectively controlled through hand harvesting in shallow water as long as those performing the work are careful to remove the entire plant (including the roots) and prevent further fragmentation.

Hand harvesting may also be effective on swollen bladderwort. Because this is a rootless floating plant, it can be effectively harvested from the pond surface without the need for dive gear. However, extreme care should be taken to gently remove the plant and prevent fragmentation, which is one of the primary modes of reproduction for this species. Ideally, a floating fragment barrier should be used to prevent fragments from escaping the managed area.

In all cases, harvested plant material should be composted or disposed of in upland areas away from wetlands, streams, lakes, and ponds in order to prevent introduction into new waterbodies.

Diver-Assisted Suction Harvesting
Recommended for Smaller Beds of Variable-leaf Milfoil

Diver Assisted Suction Harvesting (DASH) is the most efficient method of hand harvesting in non-wadeable waters, where diving is required. SDRA implemented DASH to control selected beds of variable-leaf milfoil in 2017 and continued use of DASH is recommended on an ongoing basis, primarily for smaller beds. Although DASH becomes substantially more efficient with increased crew experience and optimized equipment, successful harvesting of extensive or very dense beds of variable-leaf milfoil is very difficult. Typically, this is only achievable by use of professional crews with sustained effort over multiple weeks or months. Therefore, most DASH efforts are best focused on control of regrowth following drawdown or an herbicide treatment, or on smaller peripheral beds that pose a significant recreational impediment (e.g., near swimming areas).

As with all manual harvesting efforts, care should be taken to remove the entire milfoil plant (i.e., roots and stems) and to avoid releasing fragments during DASH operations.

Aquatic Invasive Species Education, Boat Launch Monitoring, and Annual Aquatic Plant Surveys
Recommended as a Preventative Measure

Curtailing the spread of aquatic invasive species is critical to preventing the emergence of new management issues at Smith and Sayles Reservoir. Furthermore, most pioneer infestations can be successfully eradicated for minimal cost, as long as they are quickly identified and contained. Therefore, education about aquatic invasive species and monitoring of the public boat launch and overall pond is highly recommended.

At least once a year, a systematic aquatic plant survey should be conducted to assess the status of variable-leaf milfoil growth, as well as the presence of new infestations. Pond residents should also be encouraged to continue to learn how to identify and report potentially invasive plants, as they are the most likely to notice a change in the plant community along their shoreline or in their favorite recreational areas on the pond.

Inversion Oxygenation
Not Currently Recommended

Although inversion oxygenation is not currently recommended as a management action, a brief discussion and evaluation of the approach is included here at SDRA's request.

Inversion oxygenation is a management method that induces circulation of oxygen-rich water from the pond surface to the pond bottom (inversion), typically by means of a bottom diffuser system. The mechanical inversion of water in the pond may be accompanied by addition of microbial agents (bioaugmentation) to stimulate biodegradation of bottom muck and a variety of other biogeochemical processes that are assumed to be advantageous to aquatic environments.

Vendors of inversion oxygenation systems suggest that the process provides a number of benefits. Among these are claims that inversion oxygenation will result in oxygenation of the entire water column throughout the pond, improvement of water clarity, binding of nutrients in the sediment, removal of heavy metals, reduction of unpleasant pond odors, depletion of disease organisms, and removal of organic sediments through enhanced activity of aerobic microorganisms. Inversion oxygenation is also sometimes promoted as an approach for reducing the growth of aquatic plants.

Unfortunately, the peer-reviewed research regarding this approach is primarily associated with its use in wastewater treatment processes. Evaluations concerning the effectiveness of this approach in lakes and ponds, particularly with respect to the control of rooted aquatic plants (like variable-leaf milfoil), are almost entirely limited to studies conducted directly by the vendor or vendor partners and have not been published in the peer-reviewed literature. Furthermore, artificial circulation of water in a natural pond has potential to generate or worsen water quality problems, if not properly studied, engineered, and operated. Therefore, the risk of failure of this approach at Smith and Sayles Reservoir is currently considered too significant to recommend its use.

If you have any questions regarding this report or the future management of Smith and Sayles Reservoir, please feel free to contact the undersigned at (401) 330-1204.

Sincerely,

ESS GROUP, INC.

Matt Ladewig, CLM
Senior Scientist