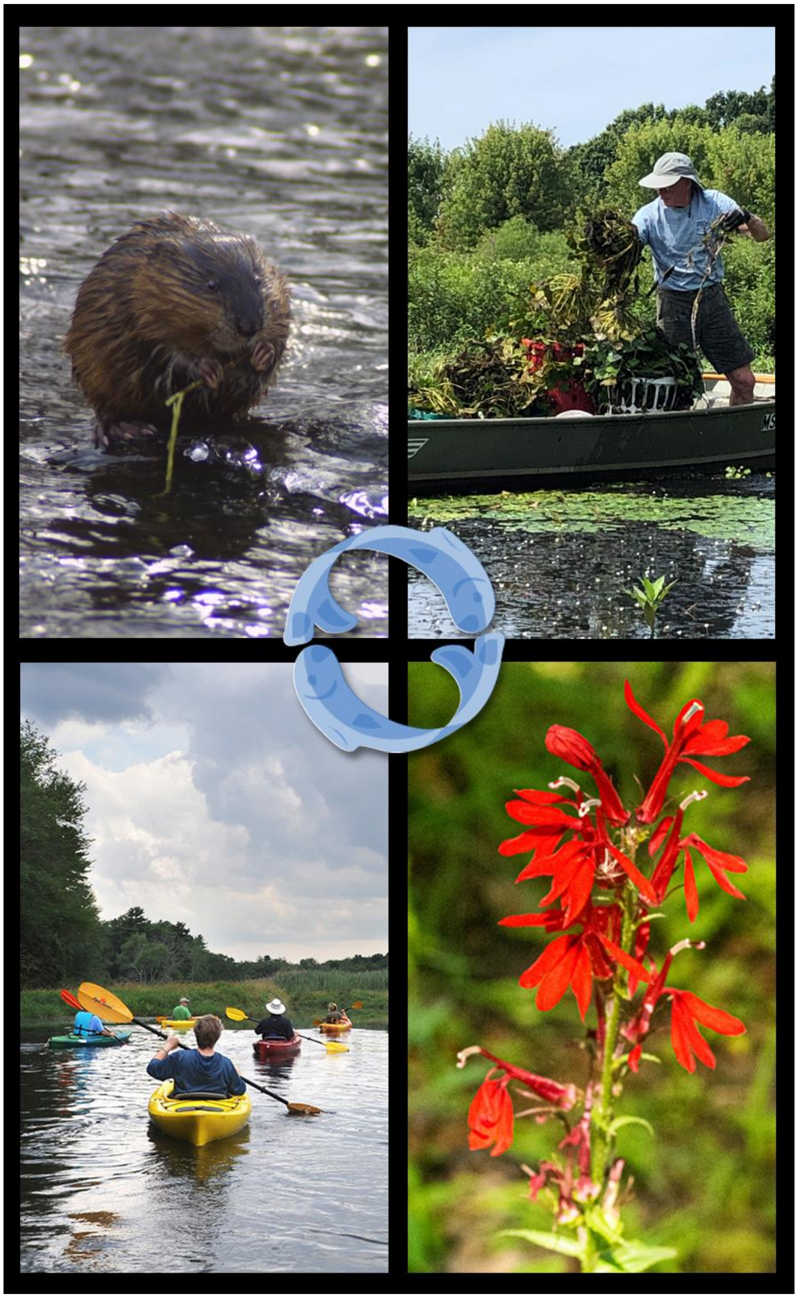
OARS

FOR THE ASSABET SUDBURY & CONCORD RIVERS



Water Quality Monitoring Program Final Report: 2018-2019 Field Seasons

March 2020

Abstract

This report covers the water quality and streamflow data collected between March 2018 and November 2019, summarizes the findings of a trends analysis between 1993 and 2019, presents aquatic plant biomass data collected in 2018 and 2019, and presents bacteria data collected in 2019 in our new bacteria monitoring program.

Water quality reports for 1999–2017 (OAR, 2000b; OAR, 2001; OAR, 2002; OAR, 2003b; OAR, 2004; OAR, 2005; OAR, 2006b; OAR, 2007; OAR, 2009; OARS, 2011; OARS, 2013; OARS, 2015; OARS, 2016; OARS, 2017; OARS, 2018) and 2005 biomass sampling project (OAR, 2006a) are available on OARS' website (http://www.oars3rivers.org/river/waterquality/reports). Full data is available upon request.

Introduction

OARS is a 501(c)(3) non-profit organization whose mission is to protect, improve, and preserve the Assabet, Sudbury, and Concord Rivers, their tributaries, and watersheds, for public recreation, water supply, and wildlife habitat. Established in 1986 as the Organization for the Assabet River by a group of concerned citizens, OAR added the Sudbury and Concord Rivers to its mission in 2011, becoming OARS. Currently the organization has approximately 750 individual and family memberships, a 9-member Board of Directors, and 2 full-time and 6 part-time staff. Together with our volunteers and partners, OARS has made significant progress over the past 30 years towards achieving our mission.

The combined Assabet, Sudbury, and Concord River watershed comprises about 399 square miles in eastern Massachusetts and is within EPA's Nutrient Ecoregion XIV subregion 59, the Eastern Coastal Plain. The mainstem rivers, particularly the Assabet, have suffered from cultural eutrophication caused by excess nutrients coming from point and non-point sources and from the soft sediments. During the growing season excess nutrients, phosphorus in particular, fuel nuisance algal and macrophytic plant growth that interferes with recreational use of the rivers and causes large daily variations in dissolved oxygen concentrations and pH, making poor habitat for aquatic life. When the algae and plants decay (which occurs when they are exposed on the river banks and/or at the end of the growing season) they generate strong sewage-like odors, can dramatically lower dissolved oxygen levels in the water column, and impair aesthetics and use of the rivers.

Under the federal Clean Water Act (Section 305b), states are required to evaluate the condition of the state's surface and ground waters with respect to their ability to support designated uses (such as fishing and swimming) as defined in each of the state's surface water quality standards. In their 2016 assessment (2016 Integrated List, approved 1/2/20), Massachusetts Department of Environmental Protection lists all sections of the Assabet and Concord Rivers, from the Assabet River Reservoir (A1 Impoundment) in Westborough to the confluence with the Merrimack River in Lowell, on the Impaired Waters List (Category 5, "Waters Requiring a TMDL") for a variety of impairments, including *E. coli* in most sections of the Assabet and Concord Rivers (Mass DEP, 2019). A Total Maximum Daily Loading Study (TMDL) for total phosphorus on the Assabet River was completed in 2004. The most significant change in the 2016 Integrated List was the removal of total phosphorus as an impairment from three sections of the Concord River (MA82A-07, MA82A-08, and MA82A-09). OARS' data suggest that this change was reasonable.

The Sudbury River upstream of the Fruit Street bridge in Hopkinton/Westborough is listed as Category 2, "Attaining some uses; other uses not assessed," attaining uses for aesthetic, primary and secondary contact recreation. All sections of the Sudbury River from Fruit Street downstream to the confluence with the Assabet in Concord (including the Framingham Reservoirs) are listed as Category 5, impaired for mercury in fish tissue; most sections are also listed for *E. coli*. Eleven of the tributaries in the basin are also listed as Category 5 Waters: Coles Brook (*E. coli*), Beaver Brook (*E. coli*), Eames Brook (aq. macroinvertebrate bioassessment, taste/odor, excess algal growth), Hop Brook in Marlborough/ Sudbury (total phosphorus, *E. coli*, dissolved oxygen, and noxious aquatic plants), Pantry Brook (fecal coliform), Elizabeth Brook (aq. macroinvertebrate bioassessment and *E. coli*), Nashoba Brook (*E. coli*, fisheries bioassessment), and River Meadow Brook (fecal coliform, *E. coli*). Mill Brook in Concord is listed as Category 4c Waters, "Impairment not caused by a pollutant." Other tributaries are listed as either Category 2 ("Attaining some uses; other uses not assessed") or Category 3 ("No Uses Assessed").

The findings of the *Assabet River Total Maximum Daily Load for Total Phosphorus* study (ENSR, 2001; Mass DEP, 2004) confirmed that the majority of the nutrients entering the Assabet were coming from the wastewater treatment plants that discharge treated effluent to the river. In particular, treatment plants were the major source of ortho-phosphorus (the bioavailable form of phosphorus) throughout the year. While non-point sources (e.g., stormwater) contributed nutrients, they contributed significantly less than point sources over the growing season. The 2004 study concluded that reductions in nutrient loads from both point and non-point sources would be required to restore the Assabet River to Class B conditions. Mass DEP and EPA adopted a two-phased adaptive management plan to reduce phosphorus loads in the Assabet. In Phase I, lower total phosphorus discharge limits were required at the four major wastewater treatment plants (WWTPs). As a part of Phase I, ways of limiting nutrient flux from the nutrient-rich sediments which accumulate in the slower moving and impounded river sections were studied. The *Assabet River, Massachusetts, Sediment and Dam Removal Study* (ACOE 2010) examined sediment dredging, dam removal, and lower winter phosphorus discharge limits as ways of controlling the annual phosphorus loading from the sediments. The study concluded that: (1) dredging would achieve, at best, short-term improvements; (2) phosphorus discharge from the WWTPs in the winter contributes to the annual phosphorus budget for the Assabet and, therefore, decreased winter phosphorus discharge limits would be another way to control phosphorus loading to the system; and (3) dam removal plus the Phase 1 WWTPs' phosphorus discharge reductions would almost meet the goal of reducing the sediment phosphorus contribution by 90 percent (Mass DEP, 2004), achieving an estimated 80% overall reduction.

Upgrades to the four municipal wastewater treatment plants that discharge to the Assabet River were completed as of the spring of 2012: Hudson in September 2009, Maynard in spring 2011, Marlborough Westerly and Westborough in the spring of 2012. The Marlborough Easterly plant, discharging to Hop Brook (tributary to the Sudbury River), finished required upgrades by spring 2015. With the upgrades complete, all the treatment plants meet a summer total phosphorus discharge limit of 0.1 mg/L and a winter limit of 1.0 mg/L. As of 2019, a new NPDES winter phosphorus discharge limit of 0.2 mg/L has been set for Hudson and Maynard. Hudson is already meeting this limit, but Maynard will need to implement operational changes to meet it (Figure 38).

A natural streamflow regime (i.e., range, duration, and timing of streamflows) throughout the year is critical to supporting fish and other aquatic life. Baseflow, the flow of groundwater into the streams, is particularly critical during the summer and is essential to diluting the effluent discharged to the river. For the nutrient load reductions proposed in the state's TMDL to be effective in restoring water quality in the mainstem, the existing baseflow in the river and its tributaries must be preserved and, if possible, augmented. The water resources of the area are under the strain of an increasing demand for water supply and centralized wastewater treatment, which results in the net loss of water from many sub-basins and reduced baseflow in the mainstem and tributaries.

Invasive aquatic plants are also a problem throughout the watershed. The Sudbury River has a long history of invasive water chestnut (*Trapa natans*) problems and efforts to remediate those problems. Significant water chestnut infestations are also on the Concord River, particularly in the Billerica impoundment, and the Assabet River sections downstream of Hudson. Other invasive aquatic plants include Eurasian milfoil, fanwort, curly leaf pondweed, and European water clover.

Because of these issues, OARS conducts water quality, streamflow, and aquatic plant biomass monitoring on the mainstems and large tributaries of the Assabet, Sudbury, and Concord Rivers. Without the support and work of its volunteers, OARS would not be able to conduct such an extensive monitoring program. The summer of 2019 was OARS' 28th consecutive summer collecting data at mainstem Assabet River sites, including the longest standing sites below each major wastewater treatment plant, its 18th year collecting data at tributary sites, its 16th year collecting data at mainstem Concord River sites, its 10th summer collecting Sudbury River data, its 15th year assessing aquatic plant biomass in the large impoundments of the Assabet River, its 2nd year collecting chloride data, and its 1st year collecting fecal indicator bacteria data. Water quality data, collected under OARS' *Quality Assurance Project Plan for OARS' Water Quality and Quantity Monitoring Program* (OARS, 2018b) (approved May 2016 to cover the 2016-2018 field seasons and renewed December 2018 to cover the 2019-2021 field seasons) and previous Quality Assurance Project Plans, and bacteria data, collected under OARS' *Quality Assurance Project Plan for OARS' Bacteria Monitoring Program* (OARS, 2019) (approved June 2019 to cover the 2019-2021 field seasons), may be used by EPA and DEP in making regulatory decisions. The goals of OARS' monitoring program remain: to understand long-term trends in the condition of the rivers and their tributaries, provide sound scientific information to evaluate and support regulatory decisions that affect the rivers, and to promote stewardship of the rivers through volunteer participation in the project.

Aquatic Plant Biomass Sampling

Three large impoundments of the Assabet River were visually surveyed for aquatic plant biomass using a grid-based system between mid-August and early September each year starting in 2005. Goals of the ongoing project are to assess the nature and extent of aquatic plant biomass in the major impoundments of the Assabet River to add to the multi-year database to assess changes in the river's condition and assess progress in achieving the TMDL goal: "a substantial reduction in total biomass of at least 50% from July 1999 values is considered a minimum target for achieving designated uses." (Mass DEP, 2004)

Biomass Survey Methods

These surveys have focused on three large impoundments as the most eutrophic areas of the river. Impoundment locations include:

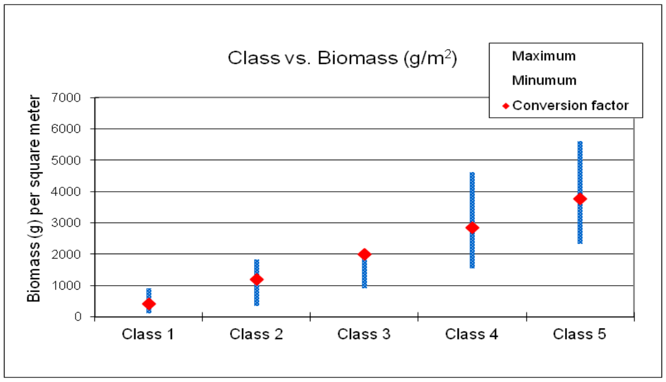
(1) Hudson impoundment, Hudson, about 0.5 miles upstream from the dam at Route 85;
(2) Gleasondale impoundment, Stow, about 0.6 miles upstream from the dam near Route 62;
(3) Ben Smith impoundment, Maynard, about 0.7 miles upstream from the dam near Route 62/117.

The rivers are divided into observation grids, extending the grid system originally developed by USGS for MassDEP duckweed monitoring in 2007 (Zimmerman et al., 2011). Using this method, visual observations were conducted by OARS staff from a kayak or canoe at the peak of the growing season each summer starting in 2007. Observations were recorded in the field using hand-held GIS/GPS devices. A viewing tube ("Aquascope") and/or plant rake was used in some locations to help with identification of species and to help estimate the percent volume of the water column filled with plants. At each grid cell the following observations were recorded:

- water depth (measured with weighted tape or pole)
- visual assessments of
    - total percent coverage of floating plants
    - percent coverage of duckweed (*Lemna minor*) ignoring the other floating plants
    - percent volume of the grid's water column filled with submerged plants
    - percent coverage of emergent plants
- dominant and other species in each category (floating, submerged, and emergent)
- presence of invasive species

To compare conditions between years and between impoundments, total wet weight of the floating plant biomass was calculated for each impoundment. Field estimates of total floating plant cover were converted to consistent classes (0 = 0% coverage, 1 = 1–25% coverage, 2 = 25–50% coverage, 3 = 50–75% coverage, 4 = 75–99% coverage, 5 = 100% coverage); the total grid surface area (from GIS) for each class was summed for each impoundment; and total floating biomass wet weight was calculated using conversion factors developed by OARS (Figure 56). Caveat: these conversion factors were developed on a mixture of floating and rooted aquatic plants, so biomass is relative (i.e. comparable within this analysis but not with analyses done in other water bodies).

Figure 56: Class vs. Biomass Wet Weight



Biomass Results

The calculated wet weight of total floating biomass for the Hudson, Gleasondale, and Ben Smith impoundments from 2005 to 2019 is shown in Figure 57. Because aquatic plant growth is strongly affected by summer weather conditions, the mean of the monthly mean air temperatures for May to August (from the Worcester Regional Airport NWS station) are also shown. A correlation analysis of biomass wet weight and temperature or rainfall for Hudson and Ben Smith shows a weak positive correlation between biomass and temperature and a weak to strong negative correlation between biomass and rainfall (Table 19). Interestingly, Gleasondale has no statistical correlation and even biases in the opposite direction. For duckweed, the data are similar to biomass (Figure 59), with slightly stronger correlations (Table 20).

This survey is subjective, depending on estimates by the surveyor. The OARS aquatic scientist conducting the survey changed between 2018 and 2019. The survey is also subject to changes in dominant vegetation type that are not adequately accounted for in the general bio-volume to biomass conversion. Note also that these surveys are conducted in late August, after water chestnut (*Trapa natans*) has been removed.

Maps showing floating plant biomass in the Ben Smith, Gleasondale, and Hudson impoundments in 2019 are shown in Figure 60, Figure 61, and Figure 62 respectively. These maps show percent floating plant coverage for all species, and in the inset show which species were the dominant species in sectors with more than 20% coverage. The camera icon indicates the approximate position of the inset photo. One major takeaway from this survey was that the Hudson impoundment had the least diverse floating species (mostly filamentous green algae (FGA)), while the Ben Smith impoundment had the most diverse floating species (with very little FGA). Low species diversity can be a sign of eutrophication.

Figure 57: Total floating aquatic plant biomass (2005-2019)

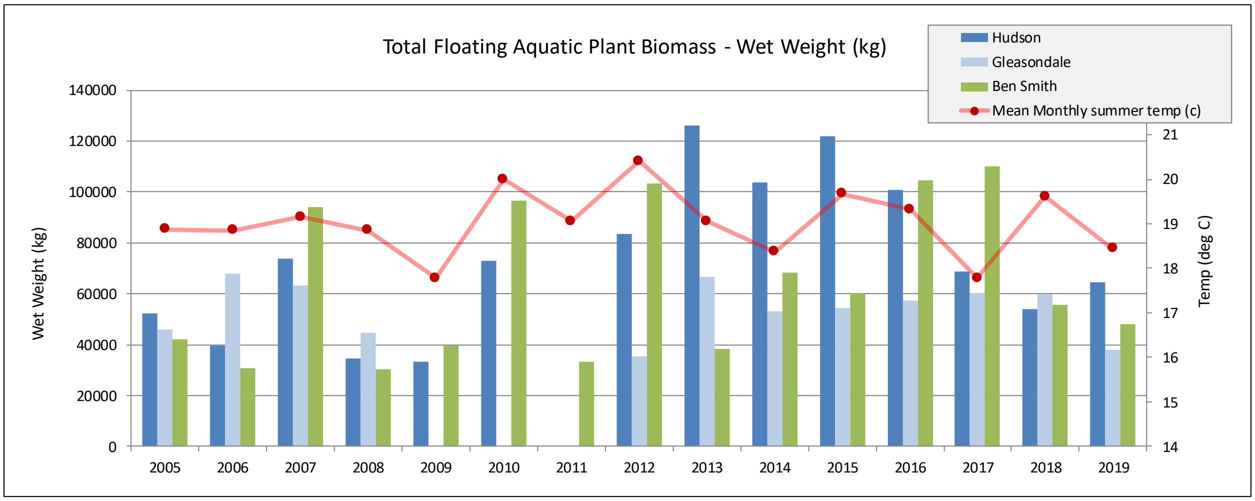


Table 19: Pearson Correlation Coefficients - Biomass vs Temperature and Rainfall

	Hudson	Gleasondale	Ben Smith
Temperature Correlation	0.33	-0.21	0.28
Precipitation Correlation	-0.36	0.05	-0.64

Figure 58: Mean summer temperature and rainfall (2005-2019)

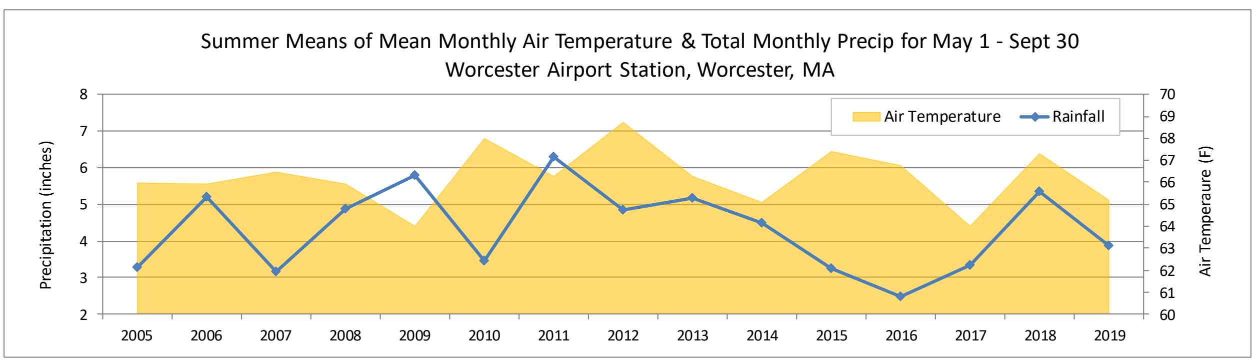


Figure 59: Total duckweed coverage (2007-2019)

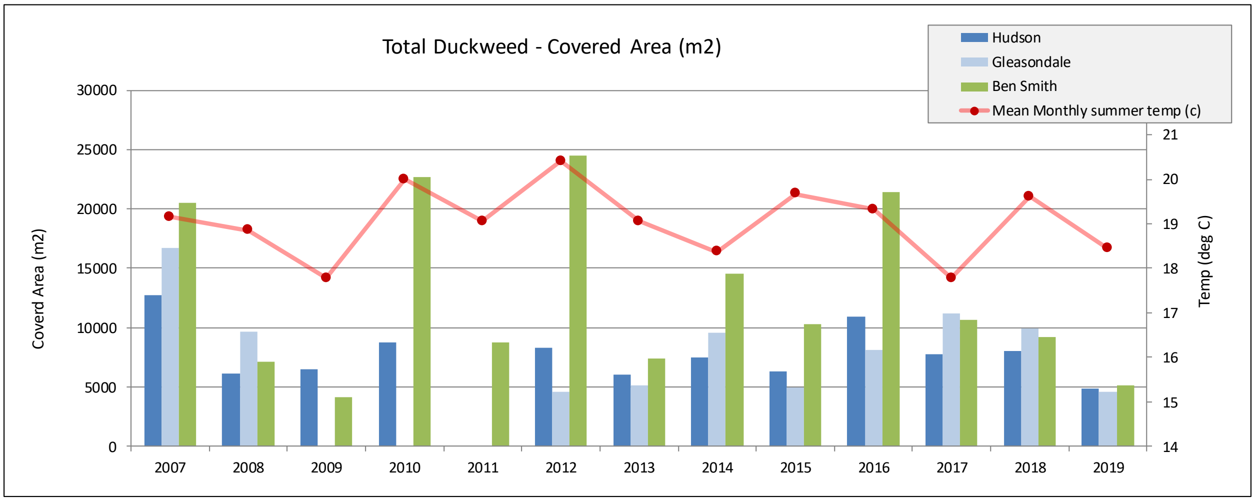


Table 20: Pearson Correlation Coefficients - Duckweed vs Temperature and Rainfall

	Hudson	Gleasondale	Ben Smith
Temperature Correlation	0.30	-0.30	0.64
Precipitation Correlation	-0.52	-0.26	-0.51

Figure 60: Total Floating Biomass - Ben Smith

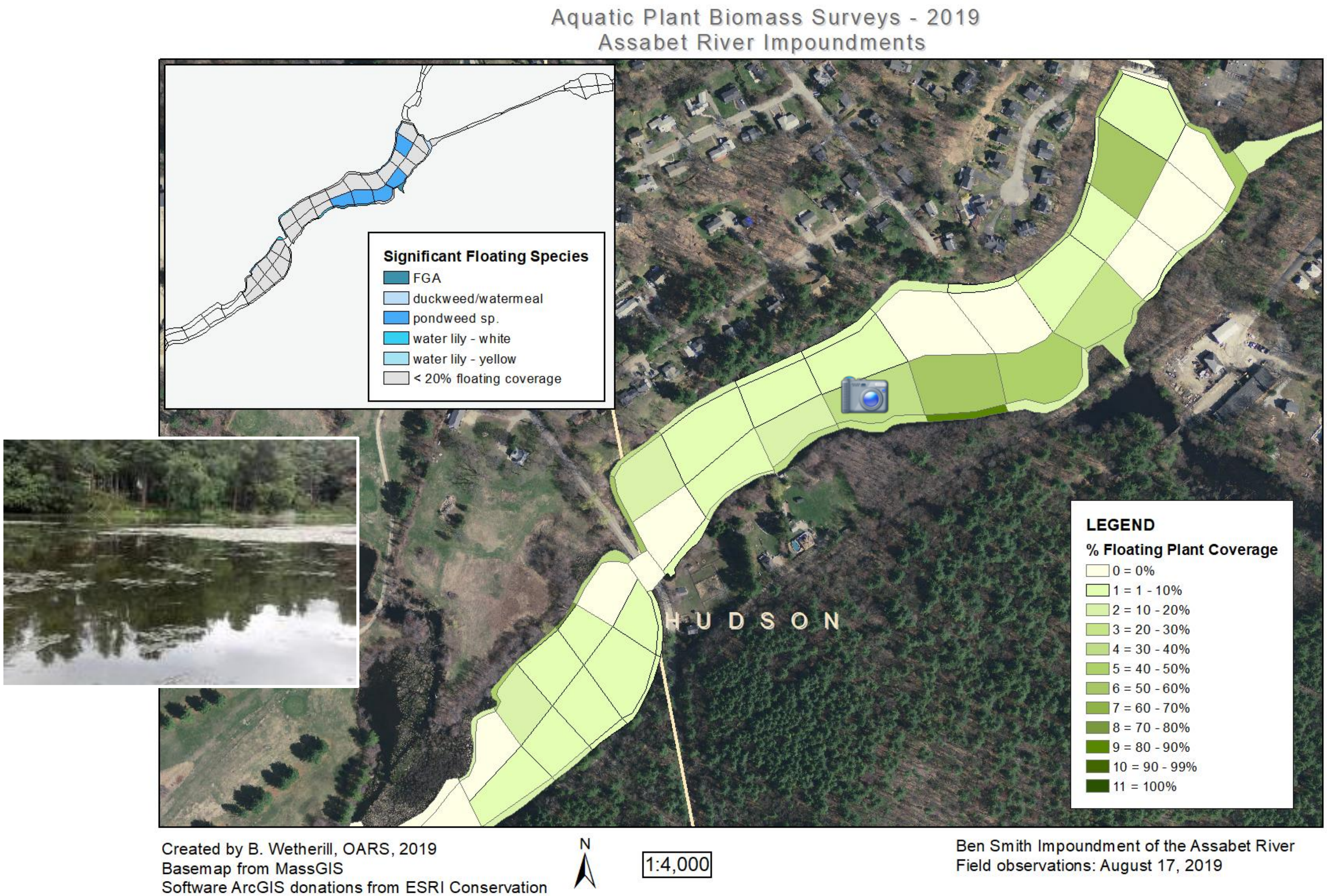


Figure 61: Total Floating Biomass - Gleasondale

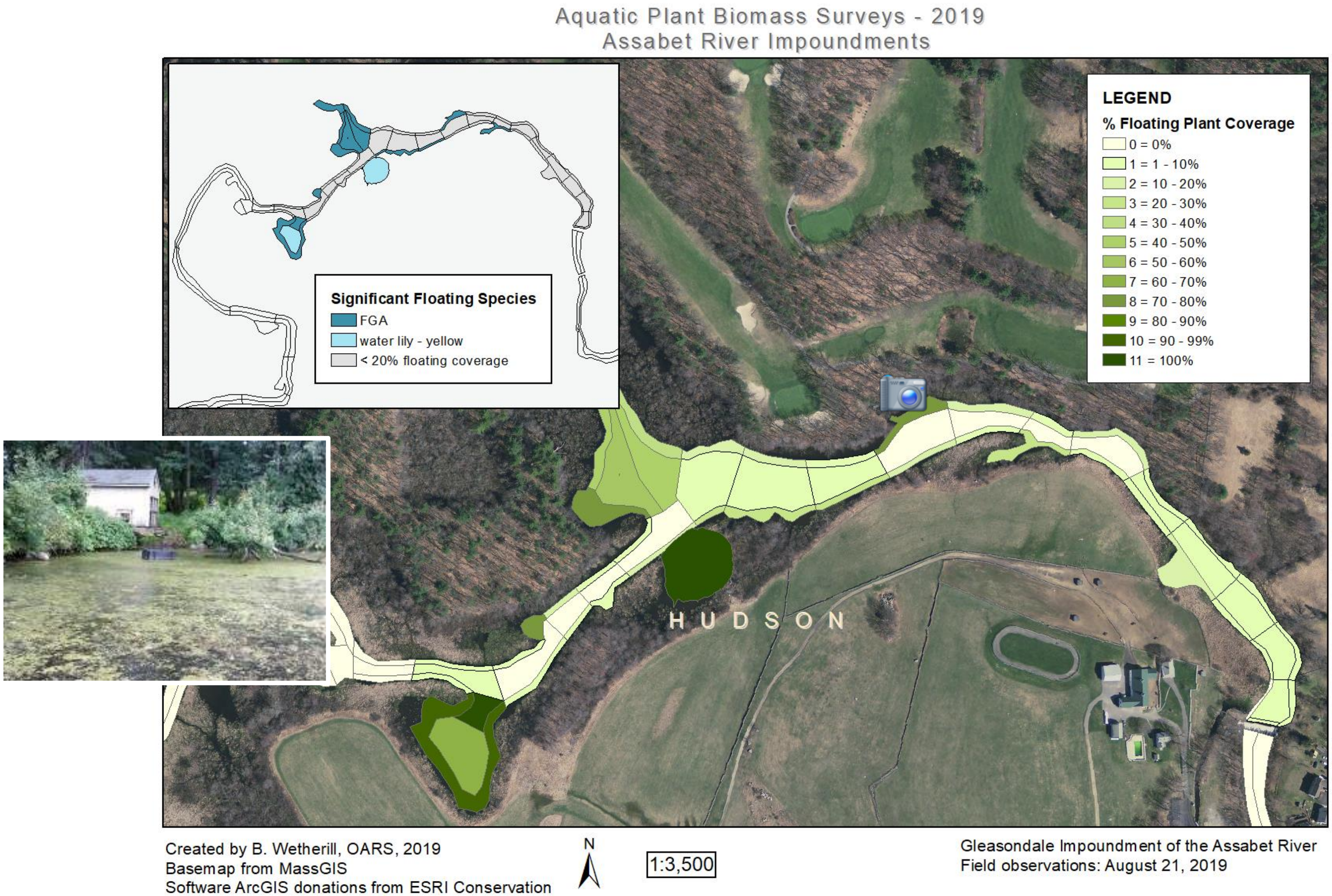


Figure 62: Total Floating Biomass - Hudson