The Brief Emergence of a Nineteenth-Century White Pine Forest from a Massachusetts Reservoir

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Abstract - The draining of a reservoir in eastern Massachusetts for dam repairs revealed dozens of stumps and several segments of stone walls. We mapped and measured the diameters of all stumps in a 0.1-ha study plot and collected and analyzed tree-ring and wood-anatomy samples from 5 of the stumps. These analyses reconstructed a dense stand of young (<50 years old) *Pinus strobus* (Eastern White Pine) that recruited during 1826–1848, likely establishing after the site was logged or when the area was no longer used as pasture. Historical accounts indicate that the trees were cut in the fall/winter of 1873–1874, just prior to the inundation of the reservoir. This opportunistic study provides a snapshot of the mid-19th-century landscape of southern New England.

Introduction. Landscapes of southern New England experienced dramatic ecological changes over the last 5 centuries. Prior to European arrival, the region was dominated by closed-canopy forests of long-lived trees (Cogbill et al. 2002, Oswald et al. 2018, Thompson et al. 2013). European colonists cleared forests for agriculture, starting at the coast in the 1620s and proceeding inland over the 17th and 18th centuries (e.g., Hall et al. 2002). Agriculture reached its peak in the early to mid-19th century, with >60% of the landscape in cultivation or pasture and remaining woodlots utilized intensively (e.g., Foster 2002). In this opportunistic study, we reconstructed the establishment of a stand of trees in eastern Massachusetts during this time period, providing a brief glimpse into the 19th-century landscape afforded by the recent draining of a reservoir while repairs to its dam were underway.

Study area. The Middlesex Fells Reservation (hereafter "the Fells") is a ~1400-ha public conservation property located in an area of uplands in suburban Boston, MA, spanning parts of the Towns of Malden, Medford, Melrose, Stoneham, and Winchester (Fig. 1a). This area of eastern Massachusetts, which is part of the ancestral homelands of Algonquian Peoples (Chilton and Hardy 2014), was colonized by English settlers in the early 17th century, and the river valleys and other lowland areas surrounding the lands that would become the Fells were occupied by farms over the next 2 centuries. The steep, rocky terrain and thin soils that occur across much of the Fells made farming difficult, and thus the area remained mostly forested during the agricultural era, serving primarily as a source of timber (Kittredge 2013). However, some farming occurred within the Fells, concentrated on the north and west sides of Spot Pond (Fig. 1b; Levin and Mahlstedt 1990). In 1894, the Fells was preserved as part of the Metropolitan Park System. Present-day forests feature a variety of hardwood and conifer species, including *Quercus rubra* L. (Northern Red Oak), *Quercus coccinea* Münchh. (Scarlet Oak), *Quercus velutina* Lam. (Black Oak), *Quercus alba* L. (White Oak), *Carya ovata* (Mill.) K. Koch (Shagbark Hickory), *Fraxinus americana* L. (White Ash), *Betula alleghaniensis* Britton (Yellow Birch), *Acer rubrum* L. (Red Maple), *Fagus grandifolia* Ehrh. (American Beech), *Pinus strobus* L. (Eastern White Pine), *Tsuga canadensis* (L.) Carrière (Eastern Hemlock), and *Pinus rigida* Mill. (Pitch Pine) (Hamlin et al. 2012).

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In the 19th century, several reservoirs were impounded by the construction of earthen dams, including 3 reservoirs—North, Middle, and South Reservoirs—built by the Town of Winchester on the west side of the Fells. The ~240-m-long North Reservoir Dam was built in 1873–1874; it dammed a northward-flowing stream called Sawmill Brook, creating a reservoir with a surface area of ~22 ha (Fig. 1b) in what had been an area of wetlands known as the Long Meadow (Chapman 1975, Skillings et al. 1873). North Reservoir was partially drained between the fall of 2022 and spring of 2023 so that repairs could be performed on the dam.

Methods. In November of 2022, while the water level of North Reservoir was lowered for the dam-repair project, we encountered dozens of stumps and several segments of stone walls in a previously submerged area at the southern end of the reservoir (Fig. 1). The

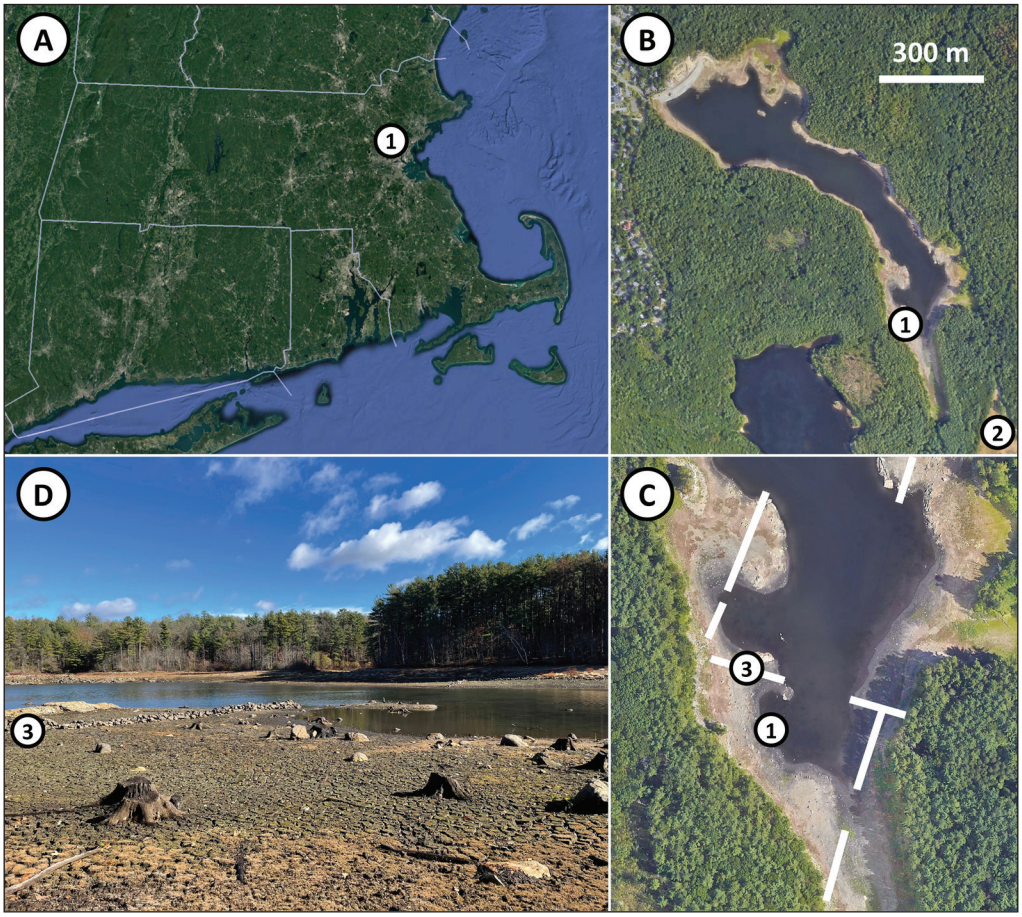

Figure 1. Maps and photo of the study area. (A) GoogleEarth® image of southern New England showing location of study area in the Middlesex Fells Reservation, eastern Massachusetts. (B) GoogleEarth® image of North Reservoir, Middlesex Fells Reservation, from June 2022; exposed lake bottom is visible along the shoreline. (C) Southern end of North Reservoir; white lines show the locations of stone walls on the exposed lake bottom. (D) Photo of stumps and stone walls at the southern end of North Reservoir. In panels (A), (B), and (C), the location of the study area is marked with (1). In panel (B), the location of the Sheepfold grassland is marked with (2); in 1875, the Tufts and Emerson farmsteads occurred just east of this location (Levin and Mahlstedt 1990). In panels (C) and (D), the stone wall visible in both images is marked with (3).

shapes of the stumps suggest the trees were felled with "scarf" cuts, horizontal saw cuts on opposite sides of the trees, with the back-cut slightly higher than the other, creating a hinge to determine the direction in which the tree would fall. We mapped the locations and measured the diameters of all stumps within an approximately 25 m x 40 m (0.1 ha) study plot centered on 42°27'31"N, 71°6'41"W (Fig. 2).

We used an increment borer to collect tree-ring cores from 5 stumps of various sizes distributed across the study area (Fig. 2). These stumps had intact outer rings, and the cores reached the pith. We glued the samples to core mounts and sanded them to produce a flat surface. We counted the annual rings with a light microscope and measured the ring widths to the nearest 0.001 mm using a Velmex measuring stage (Velmex Inc, Bloomfield, NY) controlled using MeasureJ2X software (VoorTech Consulting, Holderness, NH). We calculated annual basal area increment (BAI, cm^2/year; e.g., Smith et al. 1990) based on the ring widths. We also collected small samples of exterior wood from the 5 stumps cored for tree-ring analysis. We used an Olympus BH-2 light microscope to examine thin sections of the wood along radial, transverse, and tangential planes, with the determination of species following standard wood-identification protocols (Panshin and de Zeeuw 1980). We also examined the wood samples for fungal decay or other deterioration (Daniel 2003). We consulted various historical accounts (Chapman 1975, Levin and Mahlstedt 1990, Skillings et al. 1873) for information on the land-use history of the Fells and the construction of the North Reservoir Dam.

Results. We mapped and measured the diameters of 33 stumps (including 1 with 2 stems) in our study area (Fig. 2). A variety of size classes was represented: 10 stumps were <20 cm in diameter, 7 stumps were 20–40 cm, 10 stumps were 40–60 cm, and 7 stumps were >60 cm, with the largest measuring 76 cm (Fig. 3b). The density of the stand was ~330 trees ha^{-1}. All 5 stumps sampled for wood anatomy were identified as Eastern White Pine based on microscopic features including: (1) softwood structure with gradual-transition growth rings; (2) large, regular resin canals; and (3) large window pits (fenestriform pitting) in the rays. The wood samples were in some cases friable, but in good condition overall. Sample #23 was somewhat more degraded than the other samples, with more inclusions within some of the wood cells, and with parenchyma cells missing, likely due to degradation by bacteria over years of submersion. Blue stain fungal hyphae were not observed.

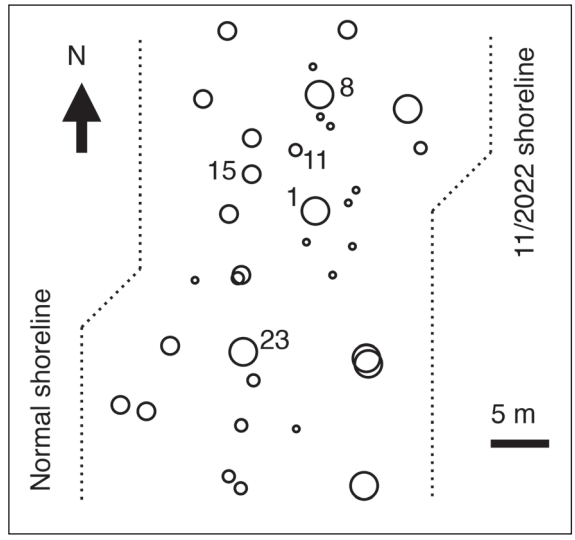

Figure 2. Map of the study area at the southern end of North Reservoir, Middlesex Fells Reservation, eastern Massachusetts. Dotted lines show the normal shoreline and the shoreline at the time of sampling in November 2022 when the water level of the reservoir was drawn down. Circles show the locations of stumps, with symbol size reflecting stump diameter (not to scale). Numbered stumps were sampled for tree-ring analysis and wood identification.

The 5 stumps sampled for tree-ring analysis had 25–47 annual rings, and there was a strong relationship between age and diameter (Fig. 3a). Given that the trees were most likely felled in 1873, the year that the construction of the North Reservoir Dam began, the tree ages yield recruitment years of 1826–1848 (Fig. 3a). Average ring widths varied from 3.3 mm to 6.4 mm. For the 4 older trees, BAI values increased steadily during the first ~20 years of growth (Fig. 3d), reaching ~60–130 cm^2/year by ~1850 (trees #1, 8, and 23)

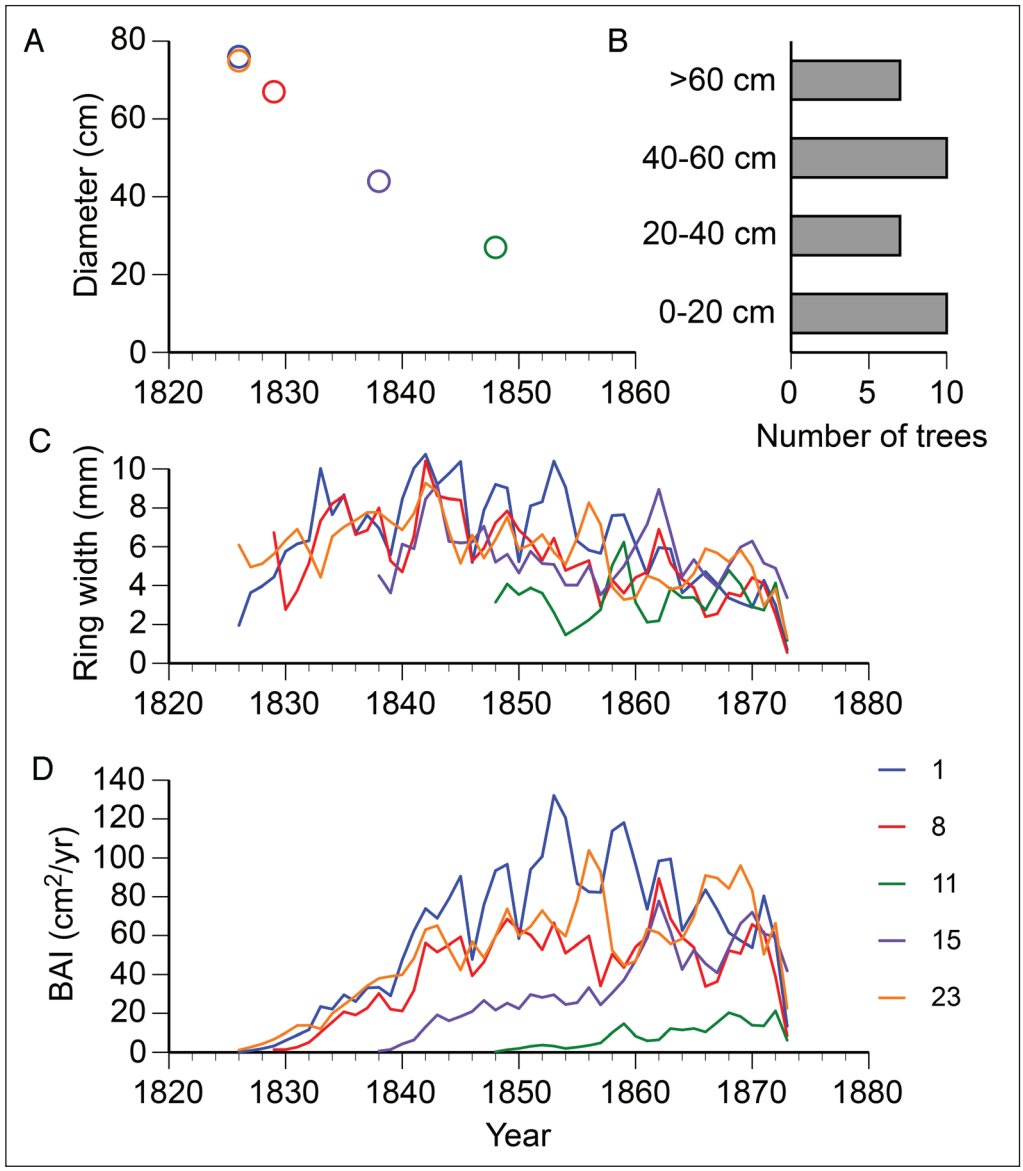

Figure 3. Analysis of stumps at the bottom of North Reservoir, Middlesex Fells Reservation, eastern Massachusetts. (A) Diameters and estimated ages (assuming trees were felled in fall/winter of 1873–1874) of 5 selected stumps. (B) Histogram of diameters for 33 stumps (including 1 with 2 stems) in the study area. (C) Measurements of tree-ring widths for 5 selected stumps (years shown on *x*-axis are based on assumption that the trees were felled in fall/winter of 1873–1874). (D) Basal area increment (BAI) values for the 5 selected stumps.

or ~1860 (tree #15). The youngest tree (#11) featured a more gradual increase in growth, reaching BAI of ~20 cm^2/year by the late 1860s. One of the older trees (tree #1) had declining BAI after the early 1850s.

Discussion. In the 18th and early-19th centuries, eastern Massachusetts, like most of southern New England, was an agricultural landscape. While much of the Fells was steep and rocky and thus used primarily for wood harvesting (Kittredge 2013), some areas were used as farmlands, as evidenced by the presence of stone walls in some locations, including those that emerged at the southern end of North Reservoir (Fig. 1c).

In 1875, the west side of Spot Pond was occupied by 2 farmsteads, owned by the Tufts and Emerson families (Levin and Mahlstedt 1990). The stone walls at the southern end of the Long Meadow likely enclosed pastures and/or hayfields that were associated with these farms. While lower parts of the Long Meadow, along Sawmill Brook, were probably too wet for trees, this stand of Eastern White Pine was able to establish on a slope above the wetland where the soil was better-drained. The stand may have established after the site was logged or when that area was no longer used as pasture. Recruitment of Eastern White Pine began in the late 1820s and continued for ~2 decades. For some trees, radial growth stabilized or declined after ~1850, probably due to increasing stand density and greater competition for light. The establishment of this stand of Eastern White Pine predates the regional abandonment of agriculture across southern New England (e.g., Foster 2002). In the towns that neighbor the Fells, farming declined between 1850 and 1870 (Fig. 4).

An historical account of the creation of North Reservoir at the site of the Long Meadow explains: "The land which was to be flooded had first to be cleared of the trees, stumps and underbrush. … Most of the tree growth was small and scattered, but at the southern end of the meadow there was a stand of good-sized timber. Everything was cut down; the larger trees were cut up and sold for firewood, and the stumps, the small trees and the brush were

Figure 4. Mid-nineteenth-century decline in agricultural activity in eastern Massachusetts illustrated by changes in the number of cattle in the towns of Malden and Medford, both of which border the Middlesex Fells Reservation (Foster et al. 2023).

piled and burned" (Chapman 1975:214). We believe the Eastern White Pine stumps we encountered are the remnants of this stand of trees; perhaps they were spared from burning because they were along the edge of the area to be inundated.

The construction of North Reservoir Dam began in fall of 1873, but the project was paused in November due to cold weather. The dam was far enough along at that point that the gate was able to be closed in December, and over the next 6 weeks the reservoir was flooded, reaching a depth of ~4 m at the gatehouse on the dam (Chapman 1975). The absence of fungal deterioration and the lack of fungal stain in the sapwood of the stumps suggest they were inundated during the winter of 1873–1874, even though the dam was not completed until September 1874. In Eastern White Pine sapwood, the wood will develop blue stain fungal hyphae if exposed to the air for more than a few days during summer months (i.e., June–August). But if the trees were felled in the fall/winter and the stumps were submerged by the rising waters of the reservoir before the arrival of summer weather, blue stain hyphae would not have been able to form.

Conclusions. The Eastern White Pine stumps that emerged from North Reservoir provide a snapshot of the mid-19th-century landscape of southern New England. Our serendipitous finding allowed us to reconstruct the species, density, ages, and growth rates of a young forest establishing on the periphery of a farmstead in eastern Massachusetts.

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