Comparison of *Tsuga canadensis* and *Pinus strobus* Population Structure at the Smith College MacLeish Field Station, Whately, MA

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Introduction

The goal of this study was to compare the population structure and growth of two conifer species, Hemlock (*Tsuga canadensis*) and White Pine (*Pinus strobus*), in secondary forests at the Smith College MacLeish Field Station in Whately, MA.

The MacLeish Field Station property was acquired by Smith College in the 1960s (Fig. 1). The area is mostly forested today, but was extensively cleared for pasture and farmland in the 1800s (Fig. 2). Stone walls marking the edges of these former fields can be seen throughout the property (Fig. 3). These fields were abandoned in the early twentieth century, which allowed secondary- growth forests to develop. The secondary-growth forests are primarily Hemlock, but White Pine is also present.

We hypothesized that the differing ecological strategies of Hemlock and White Pine would lead to differing population age structures. In particular, we predicted that White Pine population would be found to have established in a brief period soon after abandonment of agriculture, because it is known to establish in disturbed areas with high light. We predicted that the Hemlock population would include trees of a broader range of ages and would have established several decades after the White Pine population because Hemlock needs a cool, moist environment to establish. Therefore, the initial establishment of White Pine in the abandoned fields might allow Hemlock to establish subsequently.

Currently, Hemlock is threatened by hemlock woolly adelgid, a pest against which the trees cannot defend themselves. This insect does not seem to have attacked the hemlock stands at the field station yet, but has been found locally and will likely spread to these forests. Therefore, this study will also provide a baseline record of Hemlock population structure before the anticipated adelgid infestation.

Methods

Tree core samples were collected from Hemlock and White Pine trees in an area on the western portion of the MacLeish Field Station (Fig. 4). Twenty-three Hemlock cores and nine White Pine cores were obtained. The diameter at breast height (DBH) was also recorded for each tree. The rings were counted in each core to determine each tree's approximate age, which was used to determine the approximate year of establishment.

Fig. 1. The MacLeish Field Station in Whately,, MA Study site marked with red star. Aerial photo from 2007; base map by R. W. Bertone-Johnson.

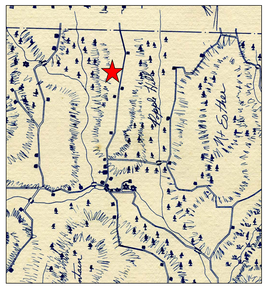


Fig. 2. Portion of 1830 map of Whately, MA showing approximate location of study site. Note absence of tree cover on hill top where MacLeish Field Station is located today.

Fig. 3. Stone wall marking boundary of 19th century pasture in present-day forest.

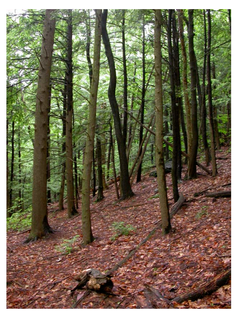
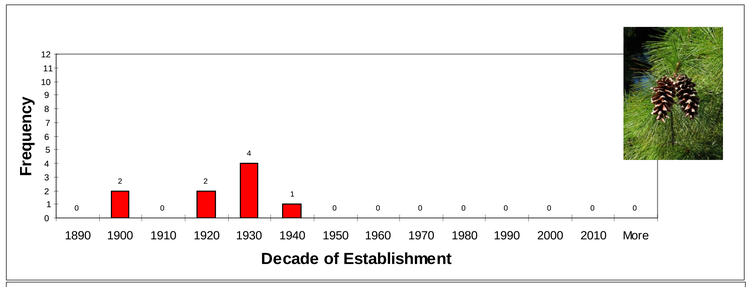


Fig. 4. Hemlock forest at the MacLeish Field Station, Whately, MA.

Results

It was found that both the Hemlock and White Pine populations established during the same time period (1900-1940; Fig. 5); there was no significant in mean age between the two species (Hemlock = 91 years ± 2.1 SE; White Pine = 92 years ± 4.4 SE; t-test p >> 0.05). Peak recruitment of both species occurred between 1900-1930. No trees recruited after 1943; even the smallest hemlocks (6-8 cm diameter) were 66-94 years old. A significant positive correlation between age and diameter was observed in the Hemlock population, but not in the White Pine population (Fig. 6).



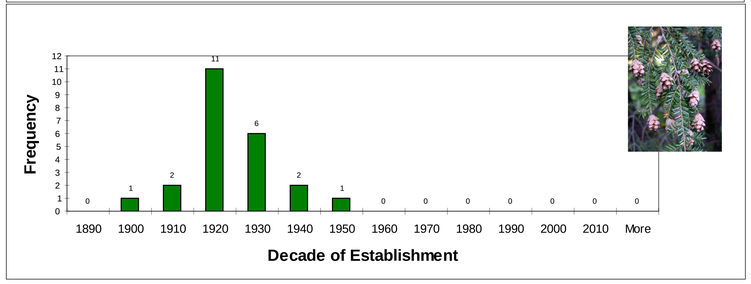


Fig. 5: Establishment of White Pine (top) and Hemlock (bottom) in secondary forest at the MacLeish Field Station.

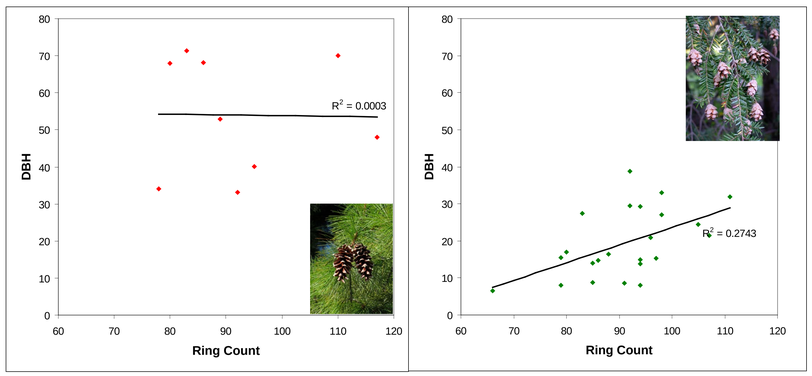


Fig. 6: Correlation between tree age and diameter (cm) for White Pine (left) and Hemlock (right). The correlation between age and diameter was significant for Hemlock ($p < 0.05$).

Conclusions

- The secondary forests at the MacLeish Field Station appear to have initiated following cessation of active land use on the property between 1910-1930. This corresponds to the time period when the owner of the property at the turn of the century, Victor Bardwell, died (1932).
- Both Hemlock and White Pine populations were found to have established almost simultaneously during this period. This pattern contrasts with our expectation of a series of protracted successional events leading to the formation of these forests. It appears that the Hemlock trees were able to establish in the abandoned fields along with White Pine, an environment that we had expected to be unsuitable for Hemlock.
- The positive correlation between age and diameter in the Hemlock population suggests that intra-specific competition exists in this dense population; the trees that established first are larger and more successful than those that established later.
- The absence of a correlation between age and diameter in White Pine could result from the lower density of this population and less competition between individuals.
- Additionally, because Hemlock is more stress-tolerant, its population includes more small, suppressed trees. In contrast, for light-demanding White Pine, only the large, successful trees may still be alive to be surveyed.

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