Appendix

# 1. Study sites

## 1.1 Stevens Brook (SB, Pair 1)

The SB Project area is located in the Stevens Brook drainage in Rumney and Wentworth (Grafton County, NH) and spanning 400 ha of the WMNF ([Figure 1](#fig-sb)). A 2009 pre-management field survey showed a forested landscape with well-defined forest roads. In the past half a century, management on this area was carried out to retain wildlife habitat and forest products e.g., timber, which was last harvested in the early 1990s (Fuller 2009). Following the field survey, the Alternative 2 plan was written up by a group of interdisciplinary resource specialists to address wildlife habitat management, vegetation, as well as transportation objectives laid out in the WMNF Forest Plan (USDA Forest Service 2005). With regards to vegetation, three goals are specified: (1) to diversify habitat type and age class, (2) to achieve a sustainable yield of commercial forest products like high-quality sawtimber, and (3) to promote residual tree health and vigor through harvesting, timber stand improvement, and prescribed burns (Fuller 2009). More specifically, the Plan expected to perpetuate more of the oak-pine habitat type and proposed a shelterwood harvest and prescribed fire in stand 5-15 to reinforce oak dominance. Evidently, stand 3-16 was cut and burned instead while stand 5-15 only received a cut.

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| Figure 1: Map of Stevens Brook (SB, Pair 1) site. The burn stand is colored in red and the control stand in blue. Respective colored lines within the stands are transects establish for data collection. |

## 1.2 Hogsback (HOG, Pairs 2-3)

HOG is part of the 2100-ha Oliverian Stewardship Project area, which comprises the Benton Range southern half in Benton and Warren (Grafton County, NH) ([Figure 2](#fig-hog)). A pre-management survey showed a landscape dominated by hardwood, mostly mature with only a small area of young forest and no regeneration-age (0-9 years old) forest (Bayer 2010). Similar to the Stevens Brook project, this project aimed to produce a sustainable yield of commercial forest products and increase habitat diversity, especially for the regeneration age class, using timber harvesting. Unlike the SB area, however, the oak-pine forest type is less common. Prescribed burning was carried out on about 79 ha to maintain this forest type as well as reduce hazardous fuel loading. This management plan, officially called Alternative 3, was to ensure the provision of about 19300 m3 of forest products.

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| Figure 2: Map of Hogsback (HOG, Pairs 2-3) site, with 20/2B and 3/1C being the seed tree harvests and 28/2B and 12/2C being shelterwoods. Burn stands are colored in red and control stands in blue. Respective colored lines within the stands are transects establish for data collection. |

## 1.3 Crawford Notch State Park (CF, Pair 4)

This 2400-ha state park was acquired in 1913 by the State of New Hampshire, as a result of a bill passed in 1912 to protect the northern region of Hart’s Location from excessive timber harvest (NH State Parks 2010). Our study stand (CF) is specifically situated at the south end of the notch, through which a railroad has run since 1875. In May 2022, the Bemis Fire burned 106 acres uphill from the train tracks for 14 days (Angers 2022). Other than that, the stand has been unmanaged since its acquisition, with disturbance patches primarily formed by windthrow (Foster and Reiners 1983). The study vegetation zone is a northern hardwood-spruce phase forest at the lowermost portion of the slope up to an elevation of 700 m, dominated by *A. grandifolia*, *A. saccharum,* and *B. allenghensis*.

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| Figure 3: Map of Crawford Notch (CF, Pair 4) site. The burn stand is colored in red and the control stand in blue. Respective colored lines within the stands are transects establish for data collection. |

## 1.4 Bartlett Experimental Forest (BEF, Pairs 5-6)

1050 hectares were set aside by the US Forest Service in 1931 to conduct research on the ecology and management of northern forest ecosystems, including forest dynamics and structure as well as wildlife relationship with forest management ([Figure 4](#fig-bef)) (Gamal-Eldin 1998). The forest was chosen for its typical New England conditions in terms of soils, elevation gradients, climate, and tree species composition. It was selectively logged through the late 19th into the early 20th century for high-value timber, fuel, and building roads. At present, different silvicultural systems are implemented in different compartments to be studied over a long period of time (Leak and Yamasaki 2011). With regards to the even-aged silvicultural treatment, three compartments were clear-cut in 2018, and half of each also received prescribed fires in 2021. Whole tree harvesting as such promoted multi-species composition, especially allowing the successional paper birch and aspen to regenerate. The ultimate goal is to make Bartlett a mixed stand with multiple age classes, a diverse tree species composition, and appropriate levels of stocking.

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| Figure 4: Map of Bartlett (BEF, Pairs 5-6) site. The burn stand is colored in red and the control stand in blue. Respective colored lines within the stands are transects establish for data collection. |

# 2. Stand characterization

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| Table 1: Basal area per hectare of dead/alive overstory trees with DBH>=30 cm in 2023 by study stands, burn treatments, and genus.   | Pair | Disturbance | Genus | Condition | m2ha\_sum | | --- | --- | --- | --- | --- | | 1 | B | Acer | Alive | 4.9 | | 1 | B | Betula | Alive | 0.7 | | 1 | B | F. grandifolia | Alive | 0.5 | | 1 | B | Others | Alive | 6.6 | | 1 | B | Others | Dead | 0.1 | | 1 | B | P. strobus | Alive | 6.0 | | 1 | B | Q. rubra | Alive | 13.3 | | 1 | C | Acer | Alive | 2.0 | | 1 | C | F. grandifolia | Alive | 0.4 | | 1 | C | Others | Alive | 0.3 | | 1 | C | P. strobus | Alive | 3.9 | | 1 | C | Q. rubra | Alive | 16.3 | | 2 | B | Acer | Alive | 3.7 | | 2 | B | Acer | Dead | 0.7 | | 2 | B | Betula | Dead | 0.4 | | 2 | B | F. grandifolia | Alive | 0.5 | | 2 | B | F. grandifolia | Dead | 1.7 | | 2 | B | Q. rubra | Alive | 6.8 | | 2 | C | Acer | Alive | 5.7 | | 2 | C | Acer | Dead | 0.8 | | 2 | C | F. grandifolia | Alive | 0.3 | | 2 | C | F. grandifolia | Dead | 1.1 | | 2 | C | Others | Alive | 0.4 | | 2 | C | Q. rubra | Alive | 11.5 | | 2 | C | Populus | Alive | 0.7 | | 3 | B | Acer | Dead | 0.3 | | 3 | B | Betula | Alive | 0.9 | | 3 | B | P. strobus | Alive | 1.2 | | 3 | B | Q. rubra | Alive | 24.5 | | 3 | B | Q. rubra | Dead | 1.7 | | 3 | C | Acer | Alive | 4.3 | | 3 | C | F. grandifolia | Alive | 2.8 | | 3 | C | Q. rubra | Alive | 13.9 | | 4 | B | Acer | Alive | 1.5 | | 4 | B | Acer | Dead | 0.5 | | 4 | B | Betula | Alive | 0.5 | | 4 | B | Betula | Dead | 0.5 | | 4 | B | F. grandifolia | Alive | 0.2 | | 4 | B | F. grandifolia | Dead | 1.7 | | 4 | B | Q. rubra | Alive | 13.2 | | 4 | B | Q. rubra | Dead | 1.9 | | 4 | C | Acer | Alive | 3.5 | | 4 | C | Betula | Alive | 1.4 | | 4 | C | F. grandifolia | Alive | 1.3 | | 4 | C | Others | Alive | 4.4 | | 4 | C | Q. rubra | Alive | 9.8 | |

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| Figure 5: Q. rubra density per hectare in 2023 (y-axis) by percent bare soil (x-axis), error bars = ±1 SE. |

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| Figure 6: Q. rubra density per hectare in 2023 (y-axis) by microtopography (x-axis), error bars = ±1 SE. Six microtopography categories include concave (CCV), convex (CVX), flat (FLT), midslope (MDS), slight slope (SLS), and steep slope (STS). |

# 3. Soil sampling and analysis

## 3.1 Methods

Composite soil samples of the top 10 cm representing each study site were collected along study transects in fall 2023 to characterize soil parameters of relevance to seedlings.

Soil samples were air-dried, homogenized, and sieved to 2 mm. They were then sent to the University of New Hampshire Cooperative Extension in December 2023 to be tested for soil pH and concentrations of calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), lead (Pb), and organic matter (OM). In February 2025, more samples were sent to the Pennsylvania State University College of Agricultural Sciences’ Agricultural Analytical Services Laboratory to be tested for nitrate nitrogen (NO3) and ammonium nitrogen (NH4).

## 3.2 Results

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| Figure 7: Ammonium concetration in the soil (y-axis) by stand pairs (x-axis). |

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| Figure 8: Nitrate concetration in the soil (y-axis) by stand pairs (x-axis). |

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