**The soils at the GMNF Long-term Ecosystem Monitoring Project plots sampled in 2009**

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**Plot Number 6**

**Plot Name: Lake Brook**

**Town of Mount Tabor in Rutland County**

**Elevation range (handheld GPS): 2270-2300 ft**

The soils at this sloping, west-facing hardwood site all are underlain by dense basal till, noted by the Cd horizon at the bottom of each soil profile description. However, one soil also has bedrock on one side of the bottom of the pit. It is unclear if it is the bedrock contact or just a large boulder. None of the soils have E (albic) horizons. The spodic horizons are comprised of medium-thick dark Bhs horizons underlain by reddish Bs horizons. Redoximorphic feature indicative of seasonal saturation are present in the lower horizons of each of the three soils sampled.

Soil series that best fit the three pits are: X-10, Worden series (Aquic Haplorthods); Y-7, Worden series (Aquic Haplorthods); and Z-3, Worden series (Aquic Haplorthods) if the R horizon is actually just a boulder, or Rawsonville series (Typic Haplohumods) if the R horizon at 68 centimeters is indeed the bedrock contact.

Note that for soil classification, depth to bedrock and redoximorphic features is measured from the mineral soil surface, not the soil surface (which for all of the soils sampled is the top of the Oi horizon).



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| Lake Brook X-10 | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Very friable |  |
| Oe | 2-7 |  |  | Very friable |  |
| Oa | 7-12 | black |  | Very friable |  |
| A | 12-15 | 7.5YR 2.5/2 | silt loam | Very friable |  |
| Bhs | 15-23 | 7.5YR 3/3 | Silt loam-very fine sandy loam | friable |  |
| Bs | 23-36 | 7.5YR 4/4 | Silt loam-very fine sandy loam | friable |  |
| Bw | 36-48 | 10YR 4/4 | Very fine sandy loam | friable | c-red & f-grey |
| Cd | 48-70 | 2.5Y 5/4 | Silt loam-very fine sandy loam | Very firm | c-red & c-grey |



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| Lake Brook Y-7 | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Very friable |  |
| Oe | 2-5 |  |  | Very friable |  |
| Oa/A | 5-9 | 10YR 2/1 | Very fine sandy loam | Very friable |  |
| Bhs | 9-23 | 7.5YR 3/3 | Very fine sandy loam | Friable |  |
| Bs | 23-63 | 7.5YR ¾ | Fine sandy loam | Friable |  |
| Cd | 63-70 | 2.5Y 5/4 | very fine sandy loam | Very firm | c-grey & c-red |
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| Lake Brook Z-3 | | Series: see narrative | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-3 |  |  | Very friable |  |
| Oe | 3-6 |  |  | Very friable |  |
| A | 6-9 | Black N 2/ | Silt loam | Very friable |  |
| Bhs | 9-17 | 7.5YR 3/3 | Silt loam | Friable |  |
| Bs | 17-42 | 7.5YR3/4 | Silt loam | Friable |  |
| Bw | 42-64 | 10YR ¾ | Very fine sandy loam | Friable | Few-5/3 depletions |
| Cd | 64-68 | 2.5Y 4/3 | fine sandy loam | firm | c-grey & c-red |
| “R” | 68 |  |  |  |  |

**Plot Number 7**

**Plot Name: Three Shanties Knoll**

**Town of Mount Tabor in Rutland County**

**Elevation range (handheld GPS): 2500-2570 feet**

The soils at this sloping hardwood site directly upslope from the Lake Brook site have varying depths to bedrock. Pit Z-10 is greater than 70 centimeters to bedrock and is underlain by dense basal till, noted by the Cd horizon at the bottom of the soil profile description. The other two pits have bedrock at 54 and 65 centimeters. They have sporadic E horizons, being seen at only one of the three pits. The spodic horizon varies in thickness and color. All three pits have dark Bhs horizons, with total thicknesses ranging from 15 to 30 centimeters. Redoximorphic features were only seen in the deeper soil that was underlain by dense basal till.

Soil series that best fit the three pits are: X-1, Hogback series (Lithic Haplohumods); Y-9, Hogback series (Lithic Haplohumods); and Z-10, Worden series (Aquic Haplorthods).



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| Three Shanties Knoll X-1 | | | Series: Hogback | | | |
| Horizon | Depth, cm | Matrix color | | Texture | Consistence | Redox features |
| Oi | 0-2 |  | |  | Loose |  |
| Oe | 2-5 |  | |  | Very friable |  |
| Oa/A | 5-8 | 7.5YR 2.5/2 | | OM | Very friable |  |
| Bhs | 8-23 | 7.5YR 3/2 | | Very fine sandy loam | Friable |  |
| Bw | 23-54 | 10YR 3/3 | | very fine sandy loam | friable |  |
| R | 54 |  | |  |  |  |
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| Note: The orange glow in photo is a reflection of camera flash off orange nylon drop cloth. | | | | | | |



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| Three Shanties Knoll Y-9 | | | Series: Hogback (bedrock is 49 cm below mineral soil surface) | | | |
| Horizon | Depth, cm | Matrix color | | Texture | Consistence | Redox features |
| Oi | 0-2 |  | |  | Loose |  |
| Oe | 2-5 |  | |  | Very friable |  |
| Oa/A | 5-16 | Black (N 2/) | | (some mineral) | Very friable |  |
| Bhs1 | 16-23 | 7.5YR 3/3 | | Fine sandy loam | Very friable |  |
| Bs | 23-42 | 7.5YR ¾ | | Fine sandy loam | Friable |  |
| Bhs2 | 42-65 | 5YR 3/3 | | fine sandy loam | friable |  |
| R | 65 |  | |  |  |  |
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| Three Shanties Knoll Z-10 | | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | | Texture | Consistence | Redox features |
| Oi | 0-2 |  | |  | Loose |  |
| Oe | 2-6 |  | |  | Very friable |  |
| Oa/A | 6-10 | Black | |  | Very friable |  |
| E | 10-14 | 5YR 4/2 | | Very fine sandy loam | Friable |  |
| Bhs1 | 14-24 | N 2/ to 5YR 2.5/2 | | Fine sandy loam | Friable |  |
| Bhs2 | 24-41 | 7.5YR 3/3 | | Fine sandy loam | Friable |  |
| Bw | 41-56 | 10YR 4/4 & 3/4 | | Fine sandy loam | Friable | Few grey |
| Cd | 56-70 | 2.5Y 5/4 | | fine sandy loam | Very firm | m-grey & c-red |

**Plot Number 8**

**Plot Name: Mad Tom**

**Town of Peru in Bennington County**

**Elevation range (handheld GPS): 2800-2920 feet**

The soils at this hummocky, south-facing mixed hardwood/softwood site are all underlain by bedrock, noted by the R horizon at the bottom of the soil profile descriptions. A thin veneer of dense basal till directly overlies the bedrock in a couple of the pits, which contributes to the presence of redoximorphic features in those soils at lower depths. All of the soils sampled have E (albic) horizons. This may be due to the higher elevation and presence of more softwood at this site compared to some of the other LEMP sites. Total thickness of the dark Bhs horizons is impressive, ranging from 24 to 36 centimeters. The total thickness of the organic horizons (O horizons) is also relatively thick, ranging from 14 to 17 centimeters.

Soil series that best fit the three pits are: X-8, Hogback series (Lithic Haplohumods); Y-1, Rawsonville series – moderately well drained variant (Typic Haplohumods); and Z-5, Rawsonville series – moderately well drained variant (Typic Haplohumods).

Note that in the photo of Pit Y-1, the identification flag says Y-9. That is incorrect. The pit that was sampled was confirmed to be Y-1.



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| Mad Tom X-8 | | Series: Hogback | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-3 |  |  | Very friable |  |
| Oe | 3-10 |  |  | Very friable |  |
| Oa | 10-17 | Black |  | Very friable |  |
| E | 17-21 | 7.5YR 5/2 | Fine sandy loam | Friable |  |
| Bhs1 | 21-24 | 5YR 2.5/1 | Very fine sandy loam | Friable |  |
| Bhs2 | 24-34 | 5YR 3/3 | Fine sandy loam | Friable |  |
| Bhs3 | 34-55 | 7.5YR 3/3 | fine sandy loam | friable |  |
| R | 55 |  |  |  |  |



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| Mad Tom Y-1. Note: pit number Y-9 on flag in photo is incorrect. | | | Series: Rawsonville moderately well drained variant | | | |
| Horizon | Depth, cm | Matrix color | | Texture | Consistence | Redox features |
| Oi | 0-2 |  | |  | Very friable |  |
| Oe | 2-6 |  | |  | Very friable |  |
| Oa | 6-14 | Black (N 2/) | |  | Very friable |  |
| E | 14-17 | 5YR 4/2 | | Very fine sandy loam | Friable |  |
| Bhs1 | 17-21 | N 2/ to 5YR 2.5/1 | | Very fine sandy loam | Friable |  |
| Bs | 21-31 | 5YR 4/6 & 4/4 | | Very fine sandy loam | Friable |  |
| Bhs2 | 31-63 | 7.5YR 2.5/2 & 3/2 | | Very fine sandy loam | Friable |  |
| Cd | 63-80 | 2.5Y 5/4 & 5/3 | | very fine sandy loam | firm | c-red & f-grey |
| R | 80 |  | |  |  |  |



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| Mad Tom Z-5 | | Series: Rawsonville moderately well drained variant | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Very friable |  |
| Oe | 2-8 |  |  | Very friable |  |
| Oa | 8-14 | Black (N 2/) |  | Very friable |  |
| E | 14-20 | 7.5YR 5/2 & 4/2 | Fine sandy loam | Friable |  |
| Bhs1 | 20-30 | 7.5YR 2.5/2 | Silt loam | Friable |  |
| Bhs2 | 30-44 | 7.5YR 3/3 | Silt loam | Friable |  |
| Bw | 44-55 | 10YR 4/4 | Fine sandy loam | Slightly firm | c-grey |
| Cd | 55-84 | 10YR 4/6 | fine sandy loam | firm | c-grey & c-red |
| R | 84 |  |  |  |  |

**Plot Number 9**

**Plot Name: Maple Hill**

**Town of Woodford in Bennington County**

**Elevation range (handheld GPS): 2600 – 2650 feet**

The soils at this relatively gently sloping, north-facing hardwood sitehave varying depths to bedrock. Two of the soils are deeper than 70 centimeters to bedrock, and the third has bedrock at 57 centimeters from the soil surface. All three soils, however, are underlain by dense basal till. The soil with bedrock at 57 centimeters has a 4 centimeter veneer of dense basal till above the bedrock. Two of the soils have thin E (albic) horizons. The dark Bhs horizon ranges in thickness from 16 to 40 centimeters. All three soils have a non-spodic colored Bw horizon between the spodic horizon and the underlying Cd horizon. Perhaps because of the Cd horizon, all three soils exhibit redoximorphic features at lower depths, ranging from 45 to 53 centimeters from the soil surface.

On the weekend of August 21-23, heavy rains fell in the area. When visiting the site on August 24th, standing water was found in all three soil pits at the following depths:

* X-8 @ 55 centimeters;
* Y-4 @ 43 centimeters;
* Z-12 @ 30 centimeters (see photos).

Soil series that best fit the three pits are: X-8, Worden series (Aquic Haplorthods); Y-4, Hogback series (Lithic Haplohumods); and Z-12, Worden series (Aquic Haplorthods).

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| Maple Hill X-8 | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Loose |  |
| Oe | 2-4 |  |  | Very friable |  |
| Oa | 4-10 | Black |  | Very friable |  |
| E | 10-13 | 2.5YR 5/1 | Fine sandy loam | Friable |  |
| Bhs | 13-29 | N 2/ to 5YR 2.5/2 | Fine sandy loam-very fine sandy loam | Friable |  |
| Bs | 29-45 | 7.5YR ¾ | Fine sandy loam | Friable |  |
| Bw | 45-58 | 10YR ¾ | Fine sandy loam | Slightly firm | f-grey |
| Cd | 58-72 | 2.5Y 4/4 & 4/3 | fine sandy loam | Very firm | f-grey & c-red |

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| Maple Hill Y-4 | | Series: Hogback | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Loose |  |
| Oe | 2-5 |  |  | Very friable |  |
| Oa/A | 5-10 | Black |  | Very friable |  |
| E | (10-12) | 7.5YR 4/2 & 5/2 | Very fine sandy loam | Friable |  |
| Bhs1 | 10-19 | 7.5YR 2.5/2 & 3/2 | Very fine sandy loam | Friable |  |
| Bhs2 | 19-44 | 7.5YR 3/3 | Very fine sandy loam | Friable |  |
| Bw | 44-53 | 10YR 4/3 | Fine sandy loam | Slightly firm |  |
| Cd | 53-57 | 2.5Y 4/4 | very fine sandy loam | Firm | c-grey & f-red |
| R | 57 |  |  |  |  |

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| Maple Hill Z-12 | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-3 |  |  | Loose |  |
| Oe | 3-6 |  |  | Very friable |  |
| Oa | 6-13 | Black (N 2/) |  | Very friable |  |
| Bhs1 | 13-27 | 7.5YR 2.5/2 | Fine sandy loam-very fine sandy loam | Friable |  |
| Bhs2 | 27-53 | 7.5YR 3/2 | Fine sandy loam-very fine sandy loam | Friable |  |
| Bw | 53-65 | 10YR 4/4 | Fine sandy loam | Slightly firm | f-grey |
| Cd | 65-75 | 2.5Y 4/3-4/4 | fine sandy loam | firm | c-red & f-grey |

**Plot Number 10**

**Plot Name: Camp Meadows**

**Town of Woodford in Bennington County**

**Elevation range (handheld GPS): 2480 – 2500 feet**

The soils at this gently sloping mixed hardwood/softwood site are all deeper than 70 centimeters to bedrock. I think all three soils are underlain by dense basal till, but it was observed at only one pit within the depth of the soil pit. I think it is deeper than 70 centimeters at the other two pits. None of the three soils have E (albic) horizons. All three do have quite impressive thick dark Bhs horizons directly underlying the surface organic horizons. The Bhs horizons vary in thickness from 39 to 50 centimeters. Redoximorphic features were observed in the soil pit where the Cd was within 70 centimeters. They were not seen in the other two pits, although I also think they might be in those soils below the depth of the pits.

One question is the true nature of the uppermost Bhs horizons. To me, it is somewhat unusual to have a Bhs horizon directly below the O horizon, so I have a question whether that Bhs1 horizon could actually be an old Ap horizon. Diane Burbank was at the site one day when I was there and she remarked on how the area looked like it could have been under some sort of agricultural use many years ago. Indeed, the soil surface in the plot is quite smooth and there are some old stone walls along the Old Stage Road trail used to access the site. Lab analysis may help to answer this question, but for now, those horizons will be considered to be the uppermost spodic horizons.

Soil series that best fit the three pits are: X-4, Mundal series (Oxyaquic Haplorthods); Y-1, Mundal series (Oxyaquic Haplorthods); Z-6, Worden series (Aquic Haplorthods).



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| Camp Meadows X-4 | | Series: Mundal | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Loose |  |
| Oe | 2-5 |  |  | Very friable |  |
| Oa | 5-10 | black |  | Very friable |  |
| Bhs1 | 10-34 | 5YR 2.5/2 | Very fine sandy loam | Very friable |  |
| Bhs2 | 34-60 | 7.5YR 2.5/2 | Very fine sandy loam | Friable |  |
| Bw | 60-70+ | 2.5Y 4/4 | fine sandy loam | Slightly firm | Not seen above 70cm |
| (Cd) | (believe it is just a little deeper than 70cm | | |  |  |



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| Camp Meadows Y-1 | | Series: Mundal | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Loose |  |
| Oe | 2-4 |  |  | Very friable |  |
| Oa | 4-8 | Black |  | Very friable |  |
| Bhs1 | 8-30 | N 2/ to 5YR 2.5/1 | Fine sandy loam | Very friable |  |
| Bhs2 | 30-49 | 5YR 2.5/1 | Fine sandy loam | Very friable | (fewer roots in this layer than Bhs1) |
| Bs | 49-60 | 7.5YR 4/4 | Fine sandy loam | Friable |  |
| Bw | 60-70+ | 2.5Y 4/4 | fine sandy loam | Slightly firm |  |
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| Camp Meadows Z-6 | | Series: Worden | | | |
| Horizon | Depth, cm | Matrix color | Texture | Consistence | Redox features |
| Oi | 0-2 |  |  | Loose |  |
| Oe | 2-5 |  |  | Very friable |  |
| Oa | 5-12 | Black (N 2/) to 5YR 2.5/2 |  | Very friable |  |
| Bhs1 | 12-25 | 7.5YR 2.5/1 & 2.5/2 | Fine sandy loam | Friable |  |
| Bhs2 | 25-51 | 7.5YR 3/3 | Fine sandy loam | Friable |  |
| Bw | 51-67 | 10YR 4/3 | Fine sandy loam | Slightly firm |  |
| Cd | 67-70+ | 2.5Y 4/3 | fine sandy loam | firm | c-grey & c-red |
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**Final note on soil classification – Humods or Orthods?**

Four soil series are mostly represented in the soil pits sampled in 2009. They are the Hogback, Rawsonville, Mundal, and Worden series. In reviewing their current soil classification, the Hogback and Rawsonville series are Humods, while the Mundal and Worden series are Orthods. The primary difference between Humods and Orthods is that Humods have 6.0 percent or more organic carbon in at least 10cm of the spodic horizon, while Orthods have less than that amount. Typically in Vermont, the Bhs horizon has the highest amount of organic carbon in the spodic horizon. Given that almost all of the soils sampled at the 5 LEMP sites this year have well developed Bhs horizons, I wonder if the Mundal and Worden soils are actually Humods and not Orthods.

Since one of the bulk samples collected at each soil pit is for the upper 10 centimeters of the B horizon, I am very curious to see what the amount of organic carbon is in those bulk samples. If the Forest Service lab does not plan on running that analysis, I would be willing to look into seeing if the NRCS National Soil Survey Lab could run that analysis. Knowing the percent of organic carbon in these pedons in southern Vermont could be very helpful in refining the classification of the Mundal and Worden series.

One final comment regards the taxonomic subgroups listed under Haplohumods. There are only four subgroups listed in the 10th edition of Keys to Soil Taxonomy, and none of them deal with Haplohumods that have redoximorphic features within the soil profile. If the Mundal and Worden pedons do end up having 6.0 percent or more organic carbon in the B horizon, then possibly one or two new subgroups under Haplohumods may need to be proposed to capture their combination of soil characteristics.

**Soil Pit hand-held GPS UTM Coordinates**

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| Lake Brook X-10 | 4800195 - 0668153 |
| Lake Brook Y-7 | 4800149 – 0668153 |
| Lake Brook Z-3 | 4800197 – 0668174 |
| Three Shanties Knoll X-1 | 4800078 – 0668502 |
| Three Shanties Knoll Y-9 | 4800030 - 0668502 |
| Three Shanties Knoll Z-10 | 4800064 – 0668532 |
| Mad Tom X-8 | 4793352 – 0665890 |
| Mad Tom Y-1 | 4793304 – 0665921 |
| Mad Tom Z-5 | 4793338 – 0665920 |
| Maple Hill X-8 | 4751203 – 0655603 |
| Maple Hill Y-4 | 4751160 – 0655633 |
| Maple Hill Z-12 | 4751205 – 0655634 |
| Camp Meadows X-4 | 4745058 – 0658813 |
| Camp Meadows Y-1 | 4745053 – 0658851 |
| Camp Meadows Z-6 | 4745076 - 0658881 |