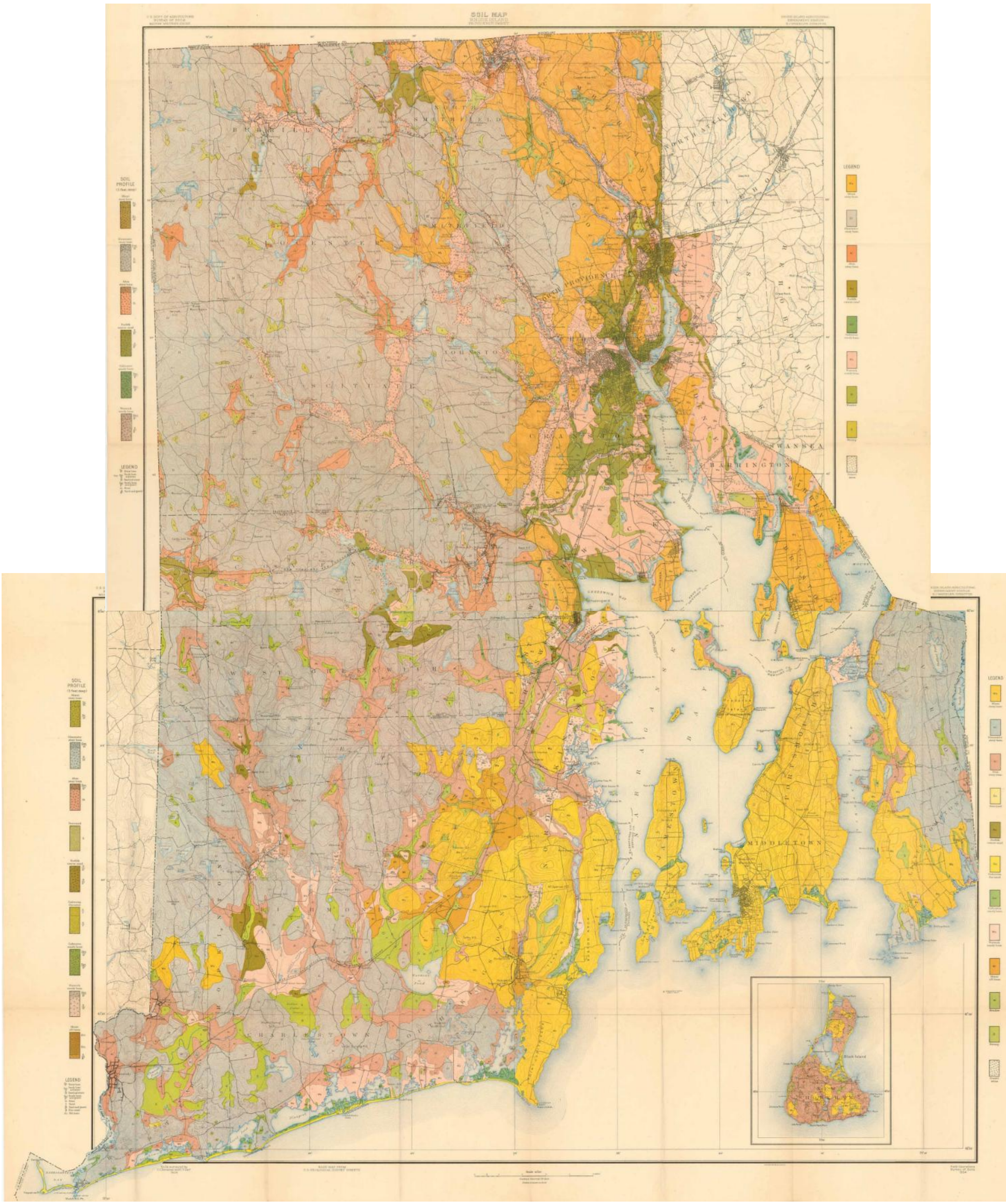
7/28/2025 –
7/30/2025

2025 Northeast Graduate Student Pedology Tour

Hosted by University of Rhode Island



1905 Soil Survey of Newport and Providence Counties

Contents

Acknowledgements

Thank you all for coming up to our tiny state that's often left off of maps to look at 30 piles of dirt. This tour would not be possible without help from many people, and we are grateful for their help. Specifically, we would like to thank Jim Turenne, Jacob Isleib, and Braden Fleming for their help and support in descriptions, tour planning, and support of URI's soil program. We would also like to thank Mark Stolt for hosting the tour as his "swan song" as Marty Rabenhorst put it. The University of Rhode Island and New England pedology is indebted to Mark's guiding hand during his career at URI and his leadership of SSSSNE through the years.

Notes

Many references, Tiny URLs, and QR codes are weaved in this guidebook; if you would like digital or hard copies of anything let Joe know (email or text). Looking for a place to eat and drink? Ask! We also have a list below. Driving around we will pass gas stations and coffee shops if you need a snack or drink. We will likely have water coolers available during the tour, but no promises.

We have ticks, deer flys, and mosquitoes to spare, and they carry some nasty bugs. Ticks in particular can be an issue, and it's been a bad year for them. Unless you're looking for a reason to go vegetarian, the Lone Star tick-transmitted Alpha-gal syndrome may cause you many issues including but not limited to a severe allergy to red meat. Lone Star ticks also move very quickly but are mainly only found on Conanicut Island… for now. Of course, we also have a standard assortment of tick-borne diseases including Lyme disease and Rocky Mountain Spotted Fever, and mosquito borne illnesses such as EEE (Eastern Equine Encephalitis) and West Nile Virus. We have tried to pull and or spray for poison ivy where we see it, but make sure you're not accidentally putting your stuff down or hand in a patch of it, otherwise you'll be making friends with Tecnu.

None of the above is any new information or outside the normal, but it does bear repeating. Thank you everyone for coming up to lil' Rhody for our pedology tour, we hope you enjoy our pits and our state.

Schedule

We will try our best to keep this schedule, but it is certainly approximate, and we may need to alter it.

Tour Map:

https://tinyurl.com/d4vn2pvm

Figure 1: QR code for tour map

Day 1.

Tuesday, July 29. National Chicken Wing Day:

Stop 0: 7:30 - 7:55 Meet at SK Land trust building for introductions and to condense. **Bathrooms and water bottle filling available after 9:00.**

Stop 1: 8:00 - 9:00. South Kingstown Beach HTM cut. **Bathrooms available.**

Stop 1.5: Drive through Charlestown Moraine.

Stop 2: 9:45 – 10:15. Kingston Kettle Hole

Stop 3: 10:30 – 1:00. Wood road Peckham Pits. Kettle Ortstein, Spodic Merrimac, Unplowed Bridgehampton.

Lunch: 1:00- 2:00. On campus, meet at URI botanical gardens, 41.488965, -71.525176. Park in URI Fine Arts Lot. If looking for a local joint we suggest Caliente, International Pocket, Simply Thai, or Krazy Fusion Café. **Bathrooms and water bottle filling available** in multiple campus buildings. Microwave available.

Stop 4: 2:15 – 5:30. Peckham Artesol, Merrimac, Sudbury, Walpole, Histosol. **Bathrooms available 5 minute drive away.**

Day 2.

Wednesday, July 30. National Cheesecake Day:

Stop 1: 7:30 – 9:30. East Farm. Rainbow North, Rainbow West, Rainbow Bees, Rainbow East. **Bathroom available.**

Stop 2: 9:50 – 11:20. Great Swamp. Merrimac, Ortstein.

Lunch: In vans on the way to deCoppet or Alton Jones. **Bathrooms available** (gas stations, coffee shops).

Stop 3: 11:45 – 1:15. deCoppet gravel pit. Hinckley, Discharge Pit, Artesol.

Stop 3.5: Drive along eastern edge of kame terrace to the next location.

Stop 4: 1:30 – 2:30. deCoppet Canton. Forestry study

Lunch and or bathroom break if needed: Truck stop off I-95 on the way to Alton Jones.

Stop 6: 2:50 – 5:00. Alton Jones. Esker, Floodplain, Kame Terrace Bridgehampton, Paxton, Woodbridge, Spodosol.

Social. 5:00. Environmental Education Center, Alton Jones Campus. Will have pizza, oysters, and. **Bathrooms available off site @ truck stop ~6 mins away.** Plenty of woods otherwise.

Day 3.

Thursday, July 31. National Raspberry Cake Day:

Stop 1: 8:00 – 9:30. Narrow River TLP Site. TLP Profile, Natural Marsh Profile.

Bathroom if needed: Dunkin, gas stations on way to Pumphouse Marsh.

Stop 2: 10:00 – 1:00. Pumphouse Marsh. Natural Marsh, GHG Measurements, Subaqueous Cores, Carbon Accounting, Organic Matter Accretion.

Lunch: 1:15 – 2:15. Fort Weatherill State Park. **Bathrooms available.** Grab lunch at a local joint on the drive there or pack a lunch. Swimming spot, porphyritic granite outcrop, old fort. Take a wander!

Stop 3: 2:30 – 3:30. Parker Farm.

Stop 4: 3:30 – 5:00. Godena Farm.

Optional stop 5: Narragansett Café in Jamestown has live music and fresh oysters.

Welcome to the little state of Rhode Island

A brief history

Historically known as “State of Rhode Island and Providence Plantations", the land currently known as Rhode Island (AKA Rhody or the Ocean State) has been continuously inhabited by Native Americans for at least 2,000 years and was first inhabited by European colonists approximately 400 years ago when Roger Williams, a religious refugee from Massachusetts, purchased land (which would become Providence) for a colony with a purely “secular” government in 1636. Originally, “Rhode Island” was the island now known as Aquidneck Island which earned the moniker “Rhode Island” for one of two reasons: one potential reason is Giovanni da Verrazzano noted the Island was reminiscent of the Greek island of Rhodes while the other reason is Dutch explorer Adrian Block may have named it "Roodt Eylandt" which means "red island". Meanwhile, the source of the name “Providence Plantations” is from the land around Providence and Warwick which was known as “Providence Plantations”; however, European colonization moved further south with the King Phillips War which began with the Great Swamp Massacre in 1675 and eventually “Providence Plantations” included the mainland of modern day Rhode Island. In 2020, state voters voted in favor of removing “Providence Plantations” from our official state title and we officially became “Rhode Island”.

Given the long history of land use and management, our landscape today is anything but natural. Nearly all of our state has been managed, developed, or farmed by either modern people, European colonists, or one of the five Native American tribes which have called this land home. No matter how stony or bouldery a landscape was, if the colonists could run a plow through it, you can be sure they did. There is evidence of this continuous habitation everywhere you turn from our historic stone walls denoting historic property borders, to prolific Ap horizons indicating plowing or pasturing, and even including Native American stone works which often include quartz as it was believed to hold the spiritual world. In modern times, Rhode Island, with a land area of ~1,000 square miles, is home to over 1.1 million people and is the second most densely populated state. Despite our dense population, forests now cover about 58% of Rhode Island. Although much of our landscape has historically been farmed, farm abandonment began in the mid to late 1800’s and plateaued in the 1950’s. Although forest cover has declined slightly since then, Rhode Island forests still contribute over $1 billion to the local economy through products and recreation.

Our forests and farms have to grow in something, and the importance of our soil was recognized early in soil survey history with Rhode Island being one of the first states to complete a soil survey in 1905. Of course, this was fairly broad, and thus a more detailed soil survey was completed in 1943 with the help of the nation’s first full-state aerial imagery project from 1939. These surveys, like most other at the time, were agriculturally oriented. As such, with the advent of Soil Taxonomy and recognition of soil survey’s worth outside of agriculture, field work for the state’s next soil survey was completed in 1977 and published in 1981. This survey was significant in that it contained the first mapped tidal wetland and coastal map unit, the Matunuck-Udipsamments-Beaches unit (Very broad!!).

We are known as the Ocean State for a reason - every Rhode Islander lives within ~30 minutes of the Atlantic Ocean or Narragansett Bay. As such, both modern and native peoples have used and managed our seascape as well as our landscape. There is a rich fishing history in Rhode Island, and all of New England. In total, Rhode Island lands over $100 million worth of fish and shellfish per year and the marine economy is worth over $3.3 billion. Thus, research into our subaqueous and tidal marsh soils has been a focus of URI and the RI/CT/MA NRCS for the last 25 years.

While mapped through a soil survey lens in the past few decades, tidal marshes of southern New England have been recognized for their unique ecology since the mid-1950's and utilized for salt marsh hay long before that. Many of our marshes have remnants of drainage altering systems from haying, and ditches dug by the Civilian Conservation Corps under FDR's New Deal. In modern times, stakeholders have opted to work to try and preserve our tidal marshes through digging runnels and thin layer placement (TLP), which we will discuss on the tour.

Fun facts

Selected from www.50states.com

1. Rhode Island was the last of the original thirteen colonies to become a state.
2. Rhode Island never ratified the 18th Amendment prohibition.
3. Judge Darius Baker imposed the first jail sentence for speeding in an automobile on August 28, 1904 in Newport.
4. St. Mary's, Rhode Island's oldest Roman Catholic parish was founded in 1828. The church is best known as the site of the wedding of Jacqueline Bouvier to John Fitzgerald Kennedy in 1953.
5. Rhode Island has no county government. It is divided into 39 municipalities each having its own form of local government.
6. George M. Cohan was born in Providence in 1878. He wrote, "I'm a Yankee Doodle Dandy," "You're a Grand Old Flag," and a wide variety of other musical entertainment.
7. At the Point Judith corrosion test site material samples sit exposed for years and are analyzed to determine the toll taken by ocean air and the sun.
8. Rhode Islanders were the first to take military action against England by sinking one of her ships in the Narragansett Bay located between Newport and Providence. The English ship was called "The Gaspee". *Joe's Note: Look for cars with a plate that has a burning ship on them – Rhode Islanders are quite proud of this action and celebrate it every year on Gaspee Day.*
9. Roger Williams, founder of Rhode Island, established the first practical working model of Democracy after he was banished from Plymouth, Massachusetts because of his "extreme views" concerning freedom of speech and religion.

10. Thomas Jefferson and John Adams publicly acknowledged Roger Williams, as the originator of the concepts and principles reflected in The First Amendment. Among those principles were freedom of religion, freedom of speech, and freedom of public assembly.
11. The era known as The Industrial Revolution started in Rhode Island with the development and construction in 1790 of Samuel Slater's water-powered cotton mill in Pawtucket.
12. The first British troops sent from England to squash the revolution landed in Newport.
13. The White Horse Tavern was built in 1673 and is the oldest operating tavern in the United States. *Joe's Note: Expensive and not actually a fun tavern.*
14. Rhode Island Red Monument in Adamsville pays homage to the world-famous poultry breed.
15. Since 1785 Bristol has the longest running, unbroken series of 4th of July Independence Day observances in the country.
16. The first Afro-American regiment to fight for America made a gallant stand against the British in the Battle of Rhode Island.
17. Jerimoth Hill is the state's highest point at 812 feet above sea level (2nd highest is the Johnston Central Landfill).

Food and beer recommendations:

Narragansett Brewery in Providence. Good bar food and can eat at other good food spots in Prov. Classic Narragansett Lager cans available everywhere, good with lime and salt. Other brews are a little harder to find in cans.

Long Live Beerworks in Providence. Good beer, near food spots. Unlikely to find cans.

Proclamation Brewing in Warwick. Maybe has a food truck. Most package stores with decent craft beer selection will have cans available.

Apponaug Brewing in Warwick. Good food, near the Warwick mall for other food options too. Unlikely to find cans in local stores.

Whalers Brewing in Wakefield. Typically has a food truck. Consistently voted best APA in U.S. Cans available everywhere.

Tilted Barn Brewing in Exeter. Usually has a food truck, owned and operated by former URI Soil Lab grad student, Matt Richardson.

Mews Tavern in Wakefield. Good food and beer. Possibly busy and crowded.

Olneyville New York System in Providence and Cranston. Classic RI food joint, get the NYS Weiner! No beer ☹️

Allie's Donuts in North Kingstown. Open early, delicious donuts. South County classic!

Belmont Market, Daves Marketplace, Roch's Fresh Foods. Locally owned supermarkets with good prepared food options. Dave's has free coffee! *Grocery stores do not sell beer in RI.*

Cafe Itri and Marchetti's in Cranston Classic Italian restaurants. Need reservations. Cafe Itri is more upscale, Marchetti's has huge portions.

Contacts:

Joe Manetta - 609-221-1787 - joemanetta@uri.edu

Jim Turrene - 401-490-1214 - jim.turenne@usda.gov, jimturenne@gmail.com

Mark Stolt – 401-218-2217 – mstolt@uri.edu

Tour Map:

Rhode Island Major Land Resource Areas (MLRAs)

The dominant MLRA in Rhode Island is 144A—New England and Eastern New York Upland, Southern Part, which encompasses most of the state. This MLRA is in Land Resource Region R—Northeastern Forage and Forest Region. Recently, changes to the USDA Agriculture Handbook 296 redefined Block Island and areas of Rhode Island on the south shore as MLRA 149B—Long Island-Cape Cod Coastal Lowland. This MLRA is in Land Resource Region S—Northern Atlantic Slope Diversified Farming Region.

MLRA 144A—New England and Eastern New York Upland, Southern Part

MLRA 144A has a mesic temperature regime and a udic, aquic, or peraquic moisture regime. The MLRA has four distinct seasons. Elevation dominantly ranges from sea level to about 2,000 feet, but subaqueous soils may be as much as 16 feet below sea level. The mean annual precipitation ranges from 45 to 54 inches, which exceeds potential evapotranspiration in most years. The mean annual air temperature is 44 to 54 degrees F. Freeze-free days range from 145 to 240 annually.

This area has been glaciated and consists of hills, drumlins, and ridges dissected by valleys. It has a thin to thick mantle of till and some glaciofluvial and glaciolacustrine deposits on terraces, kames, outwash plains, and depressions. The MLRA also includes areas of glaciomarine deposits along the coast north of Boston, Massachusetts. It is underlain by igneous, metamorphic, and sedimentary rock that is composed of various minerals ranging from carbonates to quartz and dates to the Paleozoic Era. Rhode Island dominantly is underlain by granitic rock, but an area of Pennsylvanian age sedimentary rock is in the Narragansett Basin and scattered areas of metamorphic rock are throughout the State.

The soils of MLRA 144A are dominantly Inceptisols and some Entisols, Histosols, Alfisols, Spodosols, and Mollisols. Most of the soils have mixed mineralogy. The parent material consists of dense subglacial lodgment till; friable melt-out till; variable flow till; glaciofluvial deposits; ice contact deposits; organic material; glaciolacustrine, glaciomarine, eolian, alluvial, and coastal/marine deposits; and human-transported material. The texture of the soils ranges from sand to clay, depending on the parent material. The most common great group is Dystrudepts. Eutrudepts are found in areas of carbonate-based parent material, and Sulfiwassents and Psammowassents are on subaqueous landforms. The depth to bedrock varies irregularly across the landscape, ranging to more than 100 feet below the surface in areas of thick till deposits. Rock outcrop is common in many areas of thin melt-out till. Subaqueous soils are in shallow water areas along the coast and in inland freshwater areas.

The soils commonly have a very low clay content, low pH, and sandy underlying material that may be capped by a silty or loamy eolian mantle of varying thicknesses. Soils on drumlins commonly have a densic contact at the interface with underlying lodgment till that restricts roots and water. Eolian deposits blanketed the landscape similar to drifting snow. The thickness of the deposits depends on the proximity to the source and the landscape position. These deposits provide a more favorable water-holding capacity and higher cation-exchange capacity for plant growth as compared to the sterile, impoverished, coarse-textured underlying material. Most of the soils have been cleared and used for agriculture in the past, but they now have reverted to forestland or have been converted to urban land. A relict Ap horizon is common.

MLRA 149B—Long Island-Cape Cod Coastal Lowland

MLRA 149B is in the low-lying coastal areas that consist dominantly of Wisconsin age terminal moraines and associated outwash plains, coastal dunes, salt marshes, and subaqueous areas. In Rhode Island the MLRA includes areas of the Charlestown Moraine and associated outwash plain and coastal barrier deposits and Block Island in southern Rhode Island. The Charlestown Moraine runs west to east from Watch Hill to South Kingston, Rhode Island, and it is similar in age to the Harbor Hill Moraine on the north fork of Long Island. Block Island is about 15 miles offshore. It is part of the Ronkonkoma Moraine complex on the south fork of Long Island and is similar in age to the moraine on the Island of Martha's Vineyard, south of Cape Cod. Areas of southeast Massachusetts also are included.

Elevation dominantly ranges from sea level to about 400 feet at the highest point on the moraines, but subaqueous soils may be as much as 16 feet below sea level. The moraines and dunes have complex slopes, and the outwash plains and salt marshes have simple slopes. The climate is moderated by marine influences. The mean annual air temperature is 49 to 54 degrees F, and the mean annual precipitation is 41 to 48 inches. Freeze-free days range from 195 to 240.

Terminal moraines are dominant on the landscape, and extensive nearly level outwash plains are down valley of the moraines in many areas. Bedrock commonly is at a great depth below the surface. Closed depressions and kettle ponds, common in parts of the MLRA, are a result of large remnants of glacial ice. Generally, the parent material has low base saturation and low pH and is sandy. Coastal dunes, barrier beaches, tidal marshes, and associated subaqueous landforms are extensive.

The soils on the moraines vary greatly within short distances because of the complexity of ice disintegration, meltwater, and eolian influences during the backwasting of the ice sheet. Entisols and Inceptisols are common in the MLRA. Histosols are in areas of salt marsh and freshwater wetland. Spodosols and spodic intergrades are also mapped in the MLRA, though there are no Spodosols mapped in Rhode Island. Quartzipsamments, Dystrudepts, and Sulfihemists are the most common great groups. Haplosaprists are in areas of freshwater wetland, and Sulfiwassents and Psammowassents are on subaqueous landforms.

Outwash plains are south of the moraines in many areas; they are a product of ice sheet meltwater transporting and depositing glacial debris into stratified layers of sand and gravel. The particle size in individual horizons is directly proportionate to the velocity of the meltwater. Finer textured eolian deposits overly the coarse textured glaciofluvial deposits in many areas.

This results in strongly contrasting particle-size classes in the control section of many soils, commonly coarse-loamy or coarse-silty over sandy or sandy-skeletal. The eolian mantle is not exclusive to areas of outwash or MLRA 149B; it is common in many till soils in MLRAs 144A and 145.

Kettle depressions, or kettle lakes, are common in areas of ice sheet disintegration. They formed in areas where glacial drift was deposited around large blocks of glacial ice and the ice subsequently melted, leaving a closed depression in the landscape. Kettle depressions range from lakes to vernal pools to dry basins depending on the depth to the water table.

Geology of Rhode Island

Bedrock Geology of Rhode Island

Although we are the smallest state, the bedrock geology of Rhode Island is surprisingly diverse with bedrock age ranging from Late Proterozoic igneous intrusions to Permian sedimentary rocks (Figure 1; Skehan, 2008). This comes from a long tectonic history between supercontinents and an ancient volcano arc known as Avalonia, also known as the Avalon Terrane. In present day, Avalonia is split between what is now Newfoundland, Nova Scotia, and England, but ~650 MYA it collided with the supercontinent of Gondwana and many of our oldest metamorphic rocks began to form. This bedrock is known as the Blackstone Series and is primarily metasedimentary and metavolcanic rocks including quartzite, schist, marble, and greenstone. The Blackstone Series occupies what is presently known as the Blackstone River Valley National Heritage Corridor which follows the Blackstone River along 25 cities and towns which were central to the early American Industrial Revolution. Although there is relatively little of this formation within our state, it does contain a small intrusion of what is called Cumberlandite – the state rock of Rhode Island. Cumberlandite is an incredibly dense porphyritic ultramafic igneous rock which contains high quantities of magnetite, ilmenite, olivine, and distinct clasts of plagioclase. Although there are only a few unimpressive acres of this rock exposed on the surface, it is very unique to Rhode Island; in fact, these few acres are the only exposure of this rock known about on the Earth's surface. There is a persistent myth

Age	Period	mya	Geological Events in Rhode Island and Connecticut
CENOZOIC	Holocene Epoch	0.01	Sea rises to near modern levels by 3,000 years ago
	Pleistocene Epoch Quaternary	1.8	Glacial Lake Hitchcock exists from 15,000 to 11,000 years ago Wisconsinan ice sheet deposits terminal moraine about 22,000 years ago then begins receding Wisconsinan ice sheet develops about 80,000 years ago and reaches Conn. and R.I. by 25,000 years ago Marine sediments deposited during Sangamon interglacial stage Illinoian ice sheet deposited till 140,000 years ago
	Tertiary	65	Tertiary rocks not exposed in southern New England
MESOZOIC	Cretaceous	145	Blocks of Cretaceous Raritan Formation enclosed by Pleistocene-age till on Block Island
	Jurassic	208	Pangea splits apart and Atlantic Ocean opens about 200 million years ago. Rift basins open along the margin of the North American continent, including Hartford Basin
	Triassic	248	
PALEOZOIC	Permian	286	Alleghanian mountain building event, between 300 and 250 million years ago, finalizes assembly of the Pangean supercontinent; Narragansett Pier Granite intrudes 275 million years ago.
	Pennsylvanian	320	Narragansett, North Scituate, and Woonsocket Basins fill with sediment
	Mississippian	355	
	Devonian	417	Rifting begins in Avalon Terrane, producing the 380- to 370-million-year-old Scituate Batholith Acadian mountain building event occurs 420 to 375 million years ago when Avalon microcontinent collides with Laurentia, sandwiching the Putnam-Nashoba, Merrimack, Central Maine, and Bronson Hill Terranes in between
	Silurian	443	Sediments deposited in Iapetus Ocean
	Ordovician	490	Taconic mountain building event occurs 485 to 440 million years ago as the Collinsville or Bronson Hill volcanic arc collides with Laurentia Island arcs form in Iapetus Ocean
	Cambrian	545	Sediments that will become the Cheshire Quartzite and Stockbridge Marble are deposited on Laurentian continental shelf Trilobite-bearing Jamestown Formation deposited on margin of Avalon microcontinent
PRECAMBRIAN	Late Proterozoic	900	Avalon volcanic chain forms on margin of Gondwana about 600 million years ago; magma forms Esmond Igneous Suite, southeastern R.I. granites, and Sterling Plutonic Suite Sediments of the Blackstone, Harmony, and Newport Groups and the Plainfield Quartzite deposited on continental shelf and shore of Gondwana Rodinia breaks up 750 million years ago, giving rise to Gondwana and Laurentia
	Middle Proterozoic	1,600	Grenvillian mountain building event forms Grenvillian gneisses about 1.2 to 1.1 billion years ago during assembly of the supercontinent Rodinia
	Early Proterozoic	2,500	
	Archean Eon		Earth forms 4.5 billion years ago

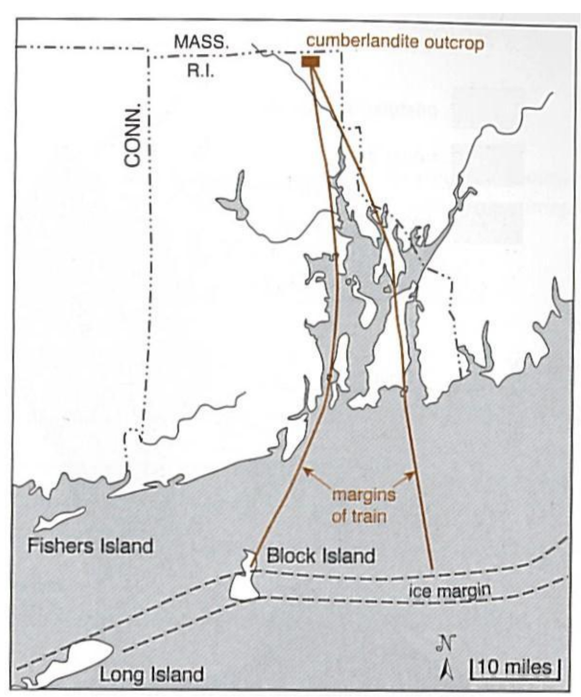
mya=millions of years ago

General timeline of bedrock geology of Rhode Island... and Connecticut because our state is too small to have its own that Cumberlandite was mined for use in Revolutionary era cannons and cannonballs, however this is likely a myth as the high amount of titanium in the rock makes the resulting iron quite brittle. This is not to say the rock is completely useless though as it has been used to help understand the extent and path of a specific boulder train within the Narragansett Bay Buzzards Bay ice lobe (Figure).

In the inland central and southern part of the state, massive Paleozoic plutonic batholiths including the Scituate Igneous suite, the Sterling Igneous suite, and Esmond Igneous suite underlie the majority of the state. The Scituate Igneous suite composes the majority of the Hope Valley subterrane. The Scituate Igneous Suite is further broken down into 2 granites with minor differences between the two with both being formed ~370 MYA. The granitic batholith underlies the central part of the state and is composed of a rather pretty granite that ranges from gray to pink and with and a fine to coarse grain containing plagioclase, quartz, biotite, hornblende, and some secondary muscovite. There are also minor inclusions of diorite and gabbro. Within the Sterling Igneous Suite is an alaskite gneiss with similar morphology and mineralogy to the granite in the Scituate Suite but with a greater ratio of plagioclase and orthoclase and with less biotite and muscovite. Finally, the Esmond Igneous suite is composed of a much older augen granite gneiss that is believed to have been formed as long as 1,000 MYA. This rock has a similar mineralogy to the Scituate Igneous Suite granite but has some chlorite. The extensive exposure of durable granite and gneiss in the western and central part of our state gives rise to our rather hilly terrain. Here in the western and central parts of the state we see a greater quantity of bedrock exposures, though our “cliffs” are still quite small compared to the mountains of Massachusetts and New Hampshire. Due to the relatively small size of our cliffs but large array of boulders across the state, the local climbing scene is dominated by bouldering and began with the “Rhody Loadies”. Read more about them here. https://tinyurl.com/53s7rhvj

Underneath our southern shoreline lies another plutonic suite of rocks within the Avalon Terrane deemed the Narragansett Pier Suite granite which is a younger (formed ~270 MYA) medium-grained granite primarily composed of microcline, orthoclase, quartz, and relatively little biotite, chlorite, and magnetite. This specific pluton was formed during a deformation of the Narragansett basin and underlies the Charlestown Moraine which will be discussed later.

Although the majority of the land in our state is underlain by durable igneous and metamorphic rocks, an extensive portion of the eastern half of Rhode Island is underlain by the Narragansett Bay



Cumberlandite boulder train.

Group. This group consists of the remnants of late Paleozoic rift resulting from the collision of the Avalon Terrane and the North American Plate. The Narragansett Basin was a sedimentary basin which included alluvial fans, deltas, and coal swamps (the source of Rhode Island coal). Rhode Island coal is a particularly difficult to burn form of Anthracite and it was said that “in the final great conflagration Rhode Island coal will be the last thing to take fire” (Ashley, 1915). Today, the primary rocks found within are a part of the Narragansett is the Rhode Island Formation which primarily consists of carboniferous shales, conglomerate, anthracite, meta-sandstone, schist, and graphite. As one would expect of carboniferous sedimentary and meta-sedimentary rocks, the bedrock in the Rhode Island Formation is quite dark and leads to dark till materials being found on Conicut and Aquidneck Islands. This can cause issues when determining hydric soil indicators as the Bw horizons may have colors as dark as 2/1 (Newport Series OSD). Plant fossils are somewhat common within the Narragansett Basin rocks, and the oldest known imprint of a flying insect was found behind a strip mall in Attleboro Massachusetts, just over the line from Rhode Island (Knecht et al., 2011). This same area produced the oldest known imprint of any insect at the time; however, this has been superseded by a find out of Scotland a few years ago (Brookfield et al., 2021). This group of rocks also records the late stages of the Appalachian and Alleghanian Orogeny with deformation in the Narragansett Bay Group rocks has been interpreted as being linked to the final collision between what is now North America and Africa (Mosher & Berryhill, 1991).

Of course, this overview of Rhode Island bedrock is both woefully incomplete but also likely too much detail for a pedology tour where all our soils have formed in transported material If there is something to take away from the general bedrock of Rhode Island (the source of our transported material) that most affects our soils today, it is that the majority of the rocks which glaciers scraped away and left behind pieces of are difficult to weather and generally quite durable. This results in low clays percentages (rarely exceeding ~8%) leading to low CEC and BS. Thus, we are the “Land of the Inceptisols” as one UC Davis student put it in 2008 during soil judging nationals.

Selected Bedrock Geology Readings:

Anderson, B. J. (1966). Cumberlandite and Bowenite of Rhode Island. *Rocks & Minerals*, *41*(7), 500. https://doi.org/10.1080/00357529.1966.11765675

Ashley, G. H. (1915). *Rhode Island Coal* (No. 615). US Government Printing Office.

Birger J. Anderson (1966) Cumberlandite and Bowenite of Rhode Island,

Rocks & Minerals, 41:7, 500-500, DOI: 10.1080/00357529.1966.11765675

Boothroyd, Jon C., and O. Don Hermes. "Guidebook to geologic field studies in Rhode Island and adjacent areas: The 73rd annual meeting of the New England Intercollegiate Geological Conference, October 16-18, 1981." (1981).

Brookfield, M. E., Catlos, E. J., & Suarez, S. E. (2021). Myriapod divergence times differ between molecular clock and fossil evidence: U/Pb zircon ages of the earliest fossil millipede-bearing sediments and their significance. *Historical Biology*, *33*(10), 2009-2013.

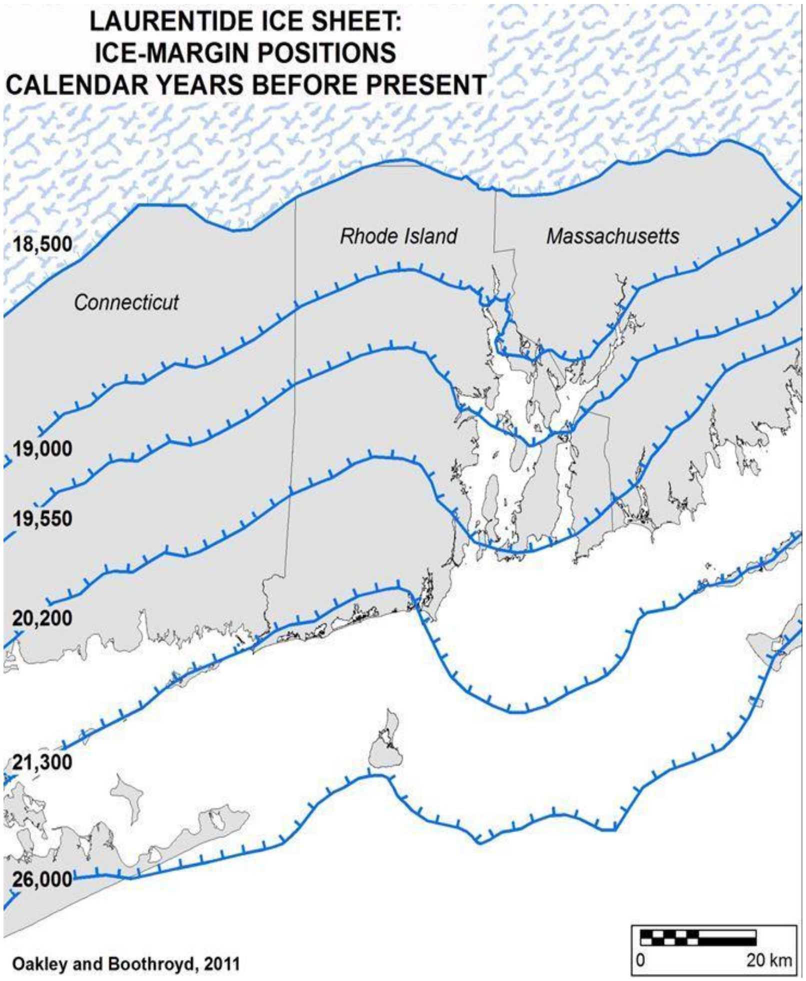
Knecht, R. J., Engel, M. S., & Benner, J. S. (2011). Late Carboniferous paleoichnology reveals the oldest full-body impression of a flying insect. *Proceedings of the National Academy of Sciences*, *108*(16), 6515-6519.

Mosher, S., & Berryhill, A. W. (1991). Structural analysis of progressive deformation within complex transcurrent shear zone systems: southern Narragansett Basin, Rhode Island. *Journal of Structural Geology*, *13*(5), 557-578.

Skehan, J. W. (2008). Roadside Geology of Connecticut and Rhode Island. Mountain Press Pub.

Quinn, Alonzo Wallace. *Bedrock geology of Rhode Island*. No. 1294-1295. US Government Printing Office, 1971.

Quaternary Surficial Geology of Rhode Island



Extent of ice sheet during the last deglaciation. Source: Oakley and Boothroyd, 2011.

Rhode Island's surficial geology is dominated by glacial drift (unconsolidated sediments moved by glacial ice or meltwaters) that mantle the underlying bedrock predominantly deposited by the Central Rhode Island eastern Connecticut (CRI) and Narragansett Basin (NB) lobe of the Laurentide Ice Sheet during the Wisconsian glaciation which reached its maximum extent approximately 21,000 BP (~25,400 calendar years BP; Figure; Oakley & Boothroyd, 2011). Retreat left proglacial lakes (e.g., Lake Narragansett) and locally glaciomarine muds, while periglacial conditions overprinted the drift with ice-wedge casts, involutions, and solifluction features. Holocene rivers, coastal barriers, tidal marshes, and widespread anthropogenic fill have since reworked this glacial template, creating sharp contrasts in hydrogeology and soil parent materials across very short distances; fitting for the smallest state.

The state is blanketed in till and glacial-fluvial materials (termed glacial drift) that were deposited directly by the ice (till), proglacial meltwaters (outwash), and ice-contact fluvial materials (stratified ice contact). There is also a blanket of loess which has its origins in a proglacial delta within what is now the Block Island Sound and Narragansett Bay when sea levels were still much lower than they are today. This loess cap tends to get thinner and finer the more north and west in the state you go. The mix of glacial landforms includes kames, kame terraces, eskers, outwash plains, kettle holes, moraines, drumlins, and till uplands. Additionally, we also have coastal features such as dunes and tidal marshes along our coastlines. Notably, we have very few if any large flood plains or river terraces due to the young age of our landscape and our hard bedrock, though we have may small floodplains (which we will discuss). Each of these landforms have associated parent materials which we have described below. Our small state also tends to have, relative to other parts of the country, small landforms. It is not difficult to walk across an esker, kame terraces, till upland, and kettle holes in a relatively short walk.

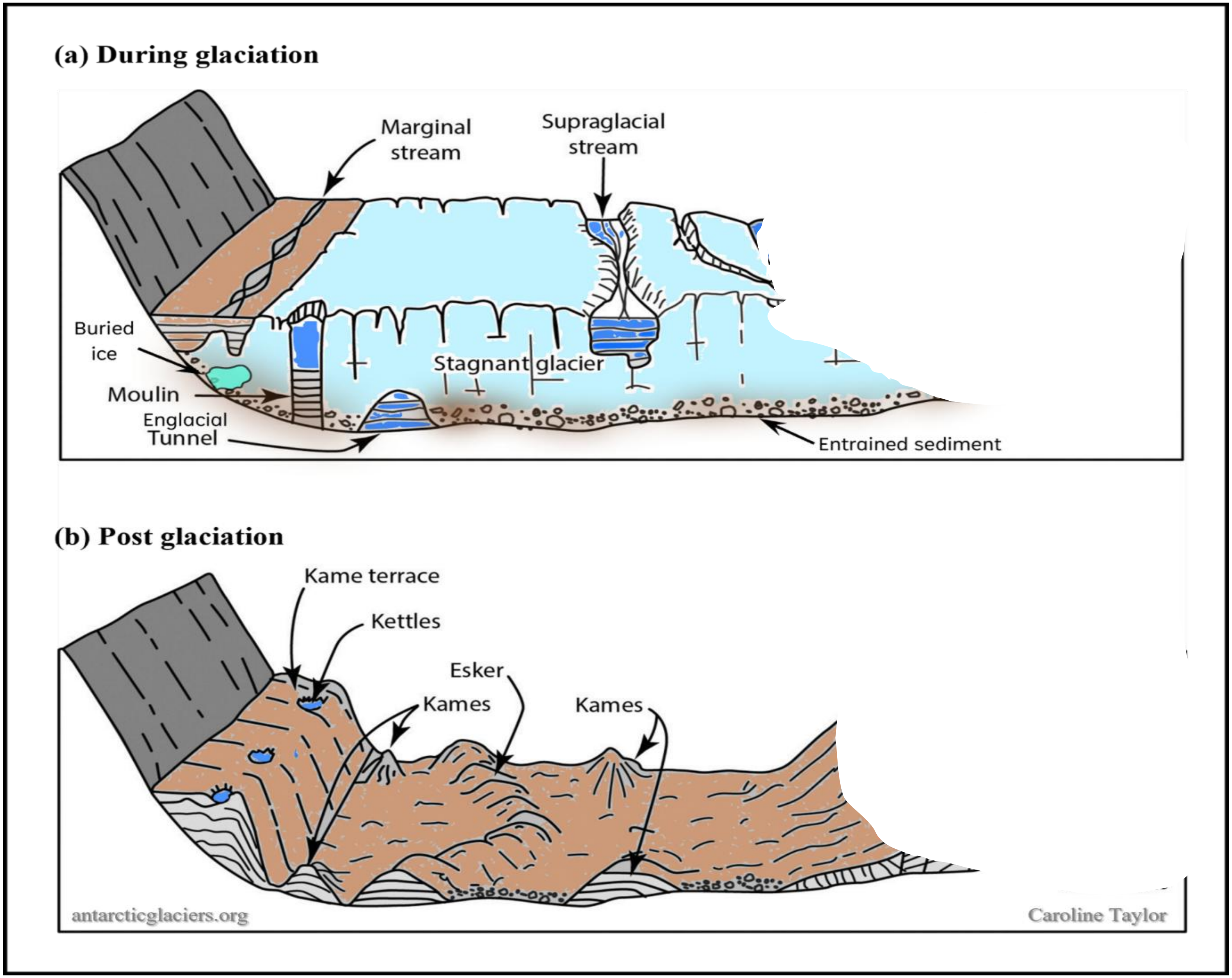


Diagram of formation of various ice-contact landforms. Figure modified from Taylor, 2024. Source: www.antarticglaciers.com

Glacial Landforms and Parent Materials:

Below is a list of Rhode Island's glacial landforms and their associated parent materials. Some landforms (including lacustrine plains, flood plains, etc. have been omitted for brevity and because we will not be visiting or discussing any examples.

Landforms:

Drumlins:

Associated parent material: dense till

Although described as "Nature's most graceful hills" (Charlesworth, 1957), the exact formation of drumlins is still debated to this day (see selected readings). These cigar-shaped hills are oriented with the flow of ice (North-South) and have dense basal till beneath a veneer of loose ablation till and or wind-blown loess.

Eskers:

Associated parent material: stratified ice-contact

Formed from fluvial deposits of subglacial or ice-walled water flows, eskers appear in modern times as elongated sinuous ridges on the surface of the landscape. Eskers may move uphill or downhill and may even occur under modern-day lakes (such as Eisenhower Lake in URI's Alton Jones Campus). Eskers are composed of stratified sands and gravels and thus most eskers in Rhode Island have been mined given their ease of excavation. Coarse fragment size is rarely larger than cobbles.

Kames:

Associated parent material: stratified ice-contact

Often described as a "Hershey's Kiss" on the landscape (See Figure above and below), kames are hills, ridges, or chains of hills that consist of stratified ice-contact material from supraglacial streams, ponds or moulins. Many of these features, similar to eskers, have been mined for sand and gravel. Coarse fragment size is rarely larger than cobbles.

Kames Terraces:

Associated parent material: stratified ice-contact

Although Rhode Island does not have large old river terraces, we do have a smaller version with similar morphology: kame terraces. These landforms are formed along the margins of ice sheets by systems of streams. These streams lay down sediment which forms flat surfaces with steep scarps. Some kame terraces in Rhode Island are found with multiple steps, though it's rarely more than 2 or 3. Many of these landscapes have borrow pits in them from localized sand and gravel mining operations. Given their proximity to bedrock ledges, kame terraces can have subrounded boulders larger than 2 m, though this is somewhat rare.

Kettle Holes:

Associated parent material: outwash, stratified ice-contact

Kettle holes form along outwash plains and other areas of meltwater, such as moraines. Kettle holes are depressions on the landscape which form from ice blocks being buried and/or surrounded by meltwater sediment (outwash typically). These often form small localized wetlands in otherwise flat landscapes.

Moraines:

Associated parent material: stratified ice-contact, till

Moraines are complex landscapes where the ice lobes stopped either in their advance (terminal moraines) or in their retreat (recessional moraines). Typically moraines have many hills and ridges formed from dense and loose till with stratified ice-contact material mixed in. Outwash plains are typically found to the south of moraines, which form from the meltwaters carrying and depositing coarse sediments.

Recessional Moraines:

Recessional moraines are formed where the ice briefly stalled in its retreat. Examples include the Charlestown Moraine, and the Wolf Rocks Moraine. These landscapes typically have complex landscapes and are difficult to map and develop due to their bouldery and stones surfaces.

Terminal Moraines:

Similar to recessional moraines, terminal moraines form where the ice stalled, but these are the furthest extent of a glaciation. Thus, the materials found in terminal moraines can vary even more than recessional moraines due to periods of retreat and advance which cause thrusting of various sediments the glacer picked up along it's retreat. In Rhode Island, or singular example of a terminal moraine is Block Island, which is in the same chain of moraines as Martha's Vineyard, Long Island, and Nantucket.

Outwash Plains:

Associated parent material: outwash

Typically a smooth plain with pattern-ground features, outwash plains were formed by glacial meltwaters as the glaciers melted to the north. These meltwaters formed braided streams and deposited staratified sands and gravels across the landscape. Typically our outwash plains are small, on the order of a few square miles. Outwash plains are typically found to the south of moraines.

Till Upland:

Associated parent material: till

A catch-all term for areas on the landscape which are not obvious drumlins, but also are formed in till. Till uplands may be bedrock controlled wherein their shape is influenced from the bedrock below. These bedrock controlled till uplands are typically found in areas of Rhode Island where the basement rock is especially hard and may be identified by locating bedrock outcrops and other large boulders. Till uplands may be formed in dense or loose till and often have a loess veneer. Till uplands may also have localized ice-contact features on them such as eskers, kames, or kame terraces. These can be differentiated on the ground from the till upland by locating more rounded surface stones, smaller coarse fragments (typically cobble-sized or smaller), and stratification in the substratum.

Parent Materials:

"Everything you're standing on was dumped here by a two-mile-thick conveyor belt of ice."
- paraphrasing Jon Boothroyd, 1975

Although specific landforms have associated parent materials, remember glaciers can be incredibly complex systems and it is very common to find multiple parent materials in a pit and across a landscape. Specifically, eolian materials are often found on the surface of soils. The late Jon Boothroyd once described the climate of the para-glacial environment as having winds on the order of hurricane force daily, thus it is expected to find at least some evidence of wind transported materials on top of many soils. See images in the discussion on sod farming to see modern day loess creation. Due to anthropogenic influence, a periglacial environment, and or thousands of years of freeze-thaw cycles, the eolian mantel may be thin and may be plowed or otherwise mixed into the underlying drift. Notably, you will not see residuum on the list of parent materials. Our landscapes are simply too young and our bedrock too difficult to weather to see meaningful development of saprolite. You may see, or we may point out bits and pieces of saprolite in some pits (especially stratified ice-contact materials), but this is assumed to have weathered during or prior to the most recent glaciation and then later deposited.

Outwash:

Outwash materials are typically well stratified, especially in the C horizons. These materials are formed from fine- to very coarse sands and commonly are gravelly or very gravelly. Typically, outwash does not have coarse fragments larger than a very coarse gravel (due to the relatively weak energy of outwash streams), though cobbles can be found, especially deep in the profile or in close proximity to a moraine. Common textures include sand, loamy sandy, and sandy loams. Most of the state's prime farmland occurs in outwash.

Outwash materials often exhibit what we term as "fining up" where coarser materials are found deeper in the profile and as you move upwards the sand fractions tend to get finer and the gravel content drops off. This is assumed to be caused by a decrease in the energy of the melt water stream that originally deposited the sediment due to the glacier melting further to the north.

Stratified Ice-Contact:

Stratified ice contact material can be thought of as alluvium that was deposited on top of or below the glacier. Stratified ice-contact materials are similar to outwash except that you may not see "fining up" and the coarse fragments may be much larger, up to boulder size. The streams and rivers that deposited ice-contact materials were moving with much greater speed and thus were able to transport or erode much larger coarse fragments than the streams that made up outwash plains which were generally weaker, especially as the glacier moved north.

Till:

Till can best be described as a consolidated mess of silts, sands, and rock fragments (in other areas of the world there is more clay), and is most often sandy loam with loamy sand textures in some of the ablation till. In areas of the Rhode Island Formation, loam can be found due to the higher clay percentages in the more easily weatherable bedrock which the glaciers scraped away. Usually, till has not been transported by liquid water and was only transported by ice, but some stratified materials can be found at contacts. Surface boulders and stones are common and make farming and developing in these areas very difficult. Don't tell the geologists, but we often simplify basal/lodgment till into "dense till", and ablation/melt-out till into "loose till". Dense till feels akin to concrete while loose till crumbles.

Dense till:

Also called basal or lodgment till, dense till is formed from material scraped away from bedrock and is transported beneath the ice sheet while being compacted by the weight of the ice above. This till is most often sandy loam and has poorly sorted coarse fragments of various sizes. Dense till in the Narragansett Basin often has a higher clay percent and SOC concentration due to the fine grained Carboniferous sedimentary and metasedimentary bedrock of the basin. Bulk density of dense till may be upwards of 2.1 g/cc. Typically, dense till is found in drumlins and may be found below loose till. Dense till can cause many issues for OWTS systems given its restrictive nature and similarly may form wetlands near summits where you otherwise might expect more well drained soils.

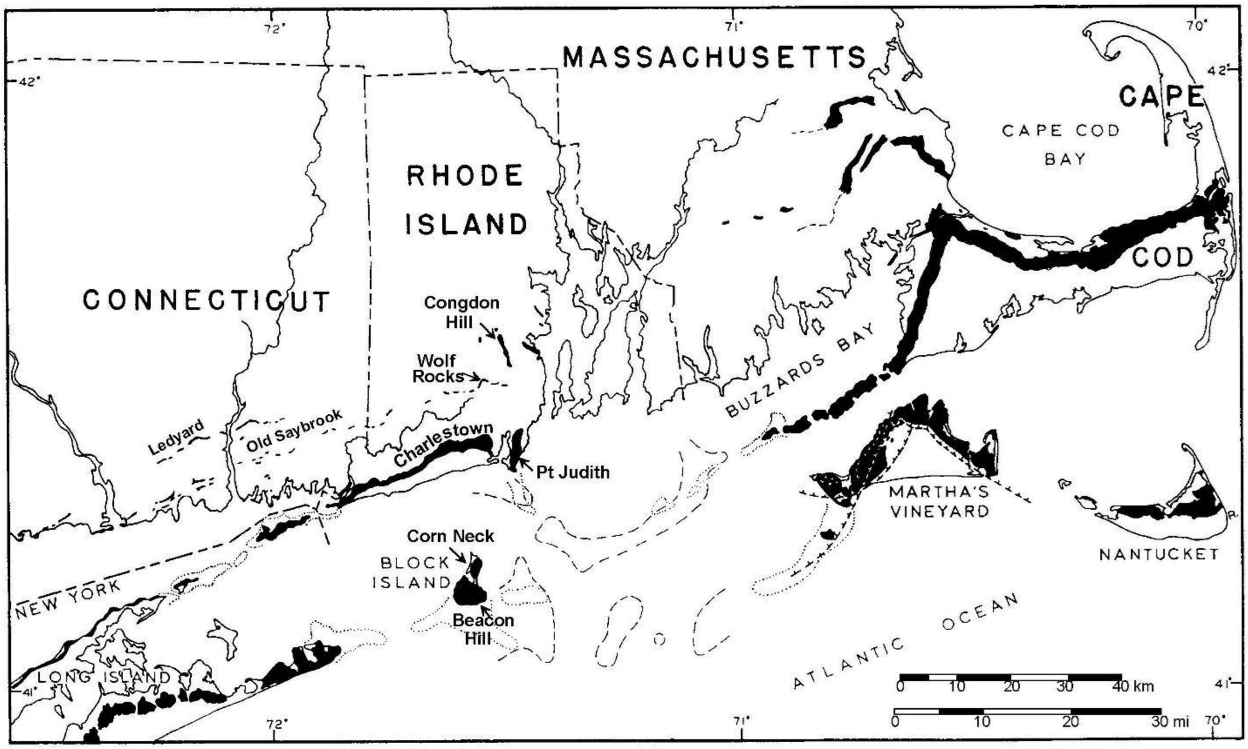
Loose till:

Also called ablation or melt-out till, loose till is formed from material that has been plucked and escaped away by the ice sheet and is then deposited on the ground surface as the ice melts away. Textures and coarse fragments are similar to that of dense till, in some cases sandier (loamy sands), and bulk density is typically lower as loose till has not been compacted.

Loess:

Much of the state is blanketed in a layer of eolian silt loam loess. Study of the loess cap across the state has found that the loess cap tends to decrease in depth and increase in fine silt the more north and west you travel. We interpret this as evidence that the loess originated from alluvial fans in the Block Island Sound soon after the glaciers moved north of Rhode Island (< 18.5 kyr BP).

During this period of time, sea level was ~100 m below its current level and broad outwash plains on the south of the Charlestown moraine and modern-day southern shore of RI dried out. Due to the proximity of the ice sheet to the unglaciated area, there was a massive atmospheric pressure difference with a low-pressure zone directly above the glaciers contrasted by the higher pressure zone in the barren land to the south. This pressure difference drove winds moving from the south to the north west that lifted clouds of very fine sand and silt. That dust settled as a blanket of loess that today mantles much of central southern Rhode Island, especially filling in low areas on the landscape. In modern times, evidence of this eolian cap has been eroded in some high slope areas of the landscape, or higher on the landscape. Additionally, it has been lost in outwash plains to turf farming.



Moraines of southern New England

Selected Quaternary Geology Readings

1. Boothroyd, J. C., Friedrich, N., & McGinn, S. R. (1985). *Geology of microtidal coastal lagoons, Rhode Island*. Marine Geology, 63(1-4), 485–506.sciencedirect.com
2. Boothroyd, J. C., & Sirkin, L. (2002). Quaternary geology and landscape development of Block Island and adjacent regions. P. W. Paton, LL Gould, P. V., August, and A. O. Frost, eds., The ecology of Block Island, The Rhode Island Natural History Survey, 13-27.
3. Melvin, R. L., De Lima, V., & Stone, B. D. (1992). The stratigraphy and hydraulic properties of tills in southern New England (No. 91-481). US Dept. of the Interior, US Geological Survey; Books and Open-File Reports Section [distributor],.
4. Ridge, J. C., Larsen, D. J., Ownby, S., Brochu, M., Cote, K., & Nicholson, R. S. (2012). The new North American varve chronology: A precise record of southeastern Laurentide Ice Sheet deglaciation and climate, 18.2–12.5 kyr BP, and correlations with Greenland ice core records. American Journal of Science, 312(7), 685–722.varves.as.tufts.edu
5. Skehan, J. W. (2008). Roadside Geology of Connecticut and Rhode Island. Mountain Press Pub..
6. Wright, W. R., & Sautter, E. H. (1988). *Soils of Rhode Island*. Kingston, RI: University of Rhode Island Agricultural Experiment Station (Bulletin 518).

New England Hydric Soil Indicator Cheat Sheet

Field Indicators for Identifying Hydric Soils in New England
For New England-wide use with *Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: North Central & Northeast (Version 2.0) ERDC/EL-TR-12-1*

User Notes & Definitions in Field Indicators for Identifying Hydric Soils in New England V4 May 2018 offer significant additions to address some soil forming factors that may be unique to our formerly glaciated region – those notes & definitions are not presented in this summary.

SOME EMPHASIZED CONCEPTS

***The Relevant* SOIL SURFACE --** The starting point for depth measurements when applying the hydric soil indicators. This point varies by the indicator and Land Resource Region (LRR). In LRR R, depth measurements start at the actual surface for indicators A1, A2, and A3; start at the muck or mineral surface for A11, A12, and start at the mineral surface for all other indicators. In LRR S, depth measurements start at the top of the muck or mineral surface (underneath any peat and/or mucky peat material), except for areas of indicators A1, A2, and A3, where measurements begin at the actual soil surface. Fresh litter is excluded from being part of the soil for any depth measurements.

***Layer(s)*:** A horizon, subhorizon, or combination of contiguous horizons or subhorizons sharing at least one property referred to in the indicators.

Mucky Modified Mineral Soil Material: -- See Page 2 Figure entitled "Thresholds—Organic & Mineral Soil Material.

Organic Masking Requirement – the relevant sandy layer is value ≤3 & chroma ≤1, and has at least 70% of the visible soil particles masked with organic material, when viewed through a 10x or 15x hand lens. Observed without a hand lens, the particles appear to be close to 100% masked.

Redoximorphic Features – Features associated with wetness formed by the processes of reduction, translocation, and/or oxidation of Fe and Mn. Formerly called mottling and low chroma colors. Redoximorphic features include: masses, pore linings, iron depletions, nodules and concretions, clay depletions, and reduced matrices. Nodules and concretions are not considered redox concentrations in these indicators, unless otherwise noted.

***Combining Indicators*:** http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/ (see Hydric Soil Technical Note 4) It is permissible to combine certain hydric soil indicators if all requirements of the individual indicators are met **except** thickness. The most restrictive requirements for thickness of layers in any indicators used must be met. Therefore, it is permissible to combine indicators for soils that have both loamy and sandy textures in the upper part if it meets all the requirements of matrix color, amount and contrast of redox concentrations, depth, and thickness for any single indicator or combination of indicators.

***Contrast -- Distinct or Prominent*:** Any feature above the upper threshold for faint features would be considered either distinct or prominent. If an indicator requires distinct or prominent features, then those features at or below the faint threshold do not count. See table below.

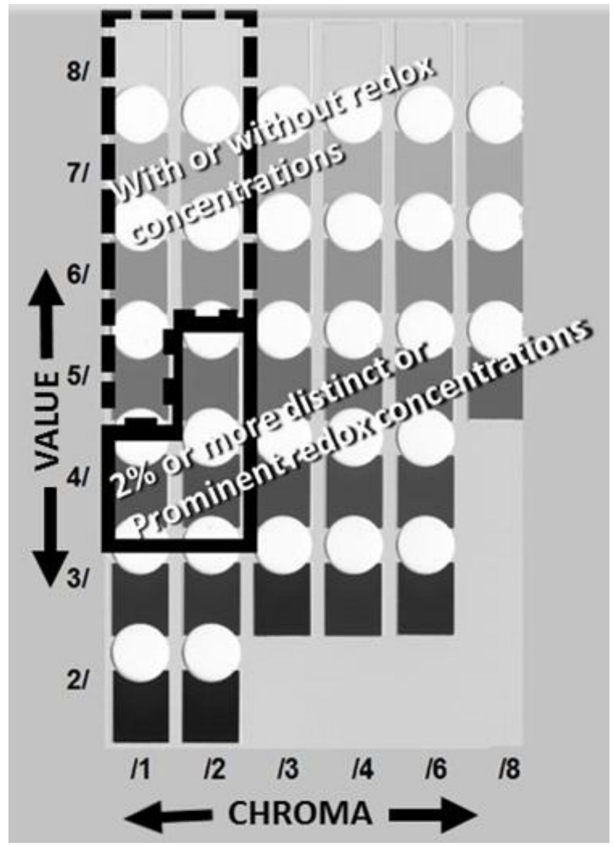
Upper Threshold for Faint		
Δ Hue	and Δ Value	and Δ Chroma
0	≤2	≤1
1	≤1	≤1
2	0	0
Any Δ Hue if BOTH hues have values ≤3 and chromas ≤2		

THRESHOLDS-- ORGANIC & MINERAL SOIL MATERIAL:

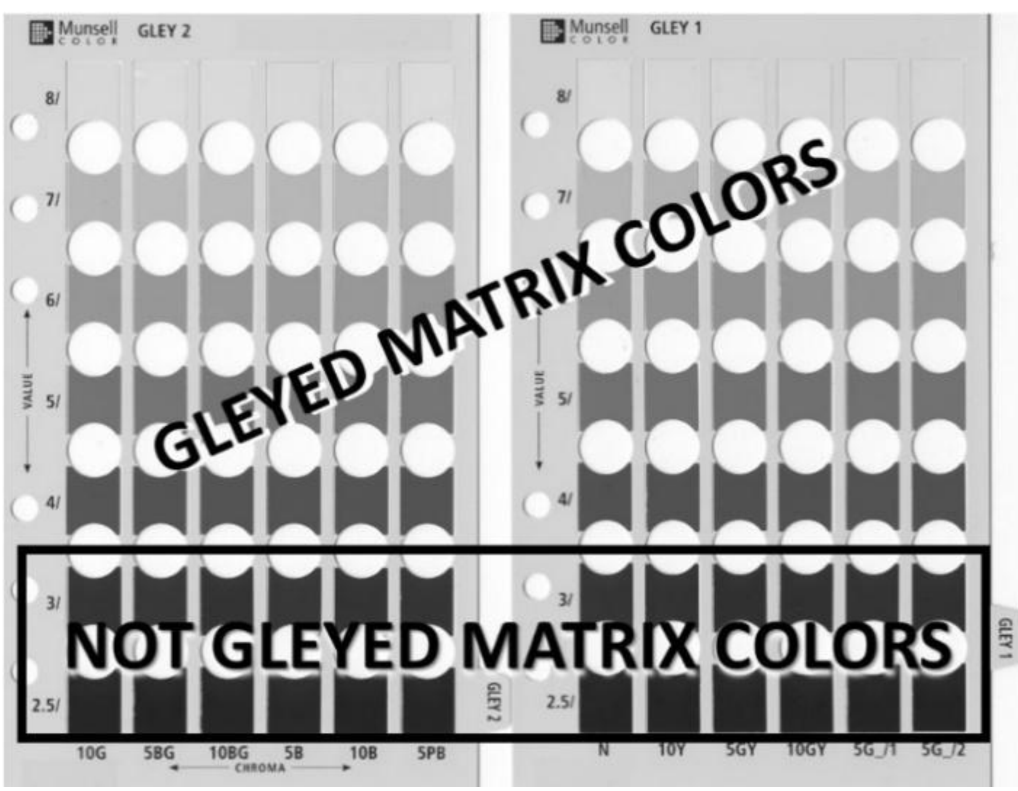
Organic soil materials have an organic carbon content (by weight percent) of at least 12%.

Mucky mineral materials have an organic carbon content (by weight percent) between 5 and 12%.

Depleted Matrix (Right):



Gleyed Matrix (Below):



ALL SOILS (A)

"All soils" refers to soils with any USDA soil texture. All mineral layers above any of the A Indicator(s), **except** A16, have a dominant chroma ≤2, or the layer(s) with a dominant chroma >2 is <15cm(6in) thick. Use the following indicators regardless of texture.

A1. Histosol. Classifies as a Histosol (except Folist).

A2. Histic Epipedon. A histic epipedon underlain by mineral soil material with chroma ≤2

A3. Black Histic. A layer of peat, mucky peat, or muck ≥20cm(8in) thick that starts ≤15cm(6in) from the soil surface; has hue of 10YR or yellower, value ≤3 & chroma ≤1; & is underlain by mineral soil material with chroma of ≤2.

A4. Hydrogen Sulfide. A hydrogen sulfide odor at a depth ≤30cm(12in) from the soil surface.

A5. Stratified Layers. Several stratified layers starting at depth ≤15cm(6in) of the soil surface. One or more of the layers has value of ≤3 & chroma ≤1, and/or it is muck, mucky peat, or peat or has a mucky modified mineral texture. The remaining layers have chroma ≤2. In sandy layer with value ≤3 see *Organic Masking Requirement*.

A11. Depleted Below Dark Surface. A layer with a depleted or gleyed matrix that has ≥60% chroma ≤2, starting at depth ≤30cm(12in) of the soil surface, & having a minimum thickness of either:

a. 15cm(6in), or

b. 5cm(2in) if the 5cm consists of fragmental soil material.

Above depleted or gleyed matrix, starting at a depth ≤15cm(6in) from the soil surface and extending to the depleted or gleyed matrix,

a. Organic, loamy, or clayey layer(s) must have value ≤3 and chroma ≤2
b. Sandy layers with value ≤3 & chroma ≤1 & fulfill *Organic Masking Requirement*.

A12. Thick Dark Surface. A layer ≤15 cm (6") thick with a depleted or gleyed matrix that has ≥60% chroma ≤2 starting at a depth more than 30 cm (12 ") of the surface. Layer(s) above depleted or gleyed matrix, and starting at a depth ≤15 cm (6") from the soil surface must have value ≤2.5 & chroma ≤1 to a depth of at least 30 cm (12"). Remaining layer(s) above depleted or gleyed matrix must have value ≤3 & chroma ≤1. Any sandy material must fulfill *Organic Masking Requirement.*

A17. – Mesic Spodic. A layer that is ≥5 cm (2 inches) thick, that starts at a depth ≤15 cm (6 inches) from the mineral soil surface, that has value of 3 or less and chroma of 2 or less, and that is directly underlain by either:

a. One or more layers of spodic materials that have a combined thickness of ≥8 cm (3 inches), that start at a depth ≤30 cm (12 inches) from the mineral soil surface, and that have a value and chroma of 3 or less; or

b. One or more layers that have a combined thickness of ≥5 cm (2 inches), that start at a depth ≤30 cm (12 inches) from the mineral soil surface, that have a value of 4 or more and chroma of 2 or less, and that are directly underlain by one or more layers that have a combined thickness of ≥8 cm (3 inches), that are spodic materials, and that have a value and chroma of 3 or less.

SANDY SOILS (S)

"Sandy soils" have a USDA texture of loamy fine sand & coarser. All mineral layers above any of the S Indicators, **except** for Indicator S6, have a dominant chroma ≤2, or the layer(s) with a dominant chroma >2 is less than 15cm(6in) thick. Use the following indicators in soil layers consisting of sandy soil materials.

All mineral layers above any of the layers meeting an S indicator, **except** for indicator S6, must have a dominant chroma of ≤2, or the layer(s) with a dominant chroma >2 must be <15cm(6in) thick to meet any hydric soil indicator.

S1. Sandy Mucky Mineral. A layer of *mucky modified* sandy soil material ≥5cm(2in) thick starting at a depth ≤15cm(6in) from the soil surface.

S4. Sandy Gleyed Matrix. A gleyed matrix that occupies ≥60% of a layer starting at a depth ≤15cm(6in) from the soil surface.

S5. Sandy Redox. A layer starting at a depth ≤15cm(6in) from the soil surface that is ≥10cm(4in) thick & has a matrix with ≥60% chroma ≤2 with ≥2% distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

S6. Stripped Matrix. A layer starting at a depth ≤15cm(6in) from the soil surface in which iron-manganese oxides and/or organic matter have been stripped from the matrix & the primary base color of the soil material has been exposed. The stripped areas & translocated oxides and/or organic matter form a faintly contrasting pattern of two or more colors with diffuse boundaries. The stripped zones are ≥10% of the volume & are rounded.

S7. Dark Surface. A layer ≥10cm(4in) thick starting at a depth ≤15cm(6in) from the soil surface & with a matrix value ≤3 & chroma ≤1, & fulfils *Organic Masking Requirement.*

S8. Polyvalue Below Surface. A layer with value ≤3 & chroma ≤1, starting at a depth ≤15cm(6in) from the soil surface, & fulfills *Organic Masking Requirement.* Immediately below this layer, ≥5% of the soil volume has value ≤3 & chroma ≤1, & the remainder of the soil volume has value ≥4 & chroma ≤1 to a depth ≥30cm(12in) or to the spodic horizon, whichever is less.

S9. Thin Dark Surface. A layer ≥5cm(2in) thick starting at a depth ≤15cm(6in) from the soil surface, & with value ≤3 & chroma ≤1, & fulfills *Organic Masking Requirement.* This layer is underlain by layer(s) with a value ≤4 & chroma ≤1 to a depth ≥12in. (30cm) or to the spodic horizon, whichever is less.

LOAMY & CLAYEY SOILS (F)

These soils have USDA textures of loamy very fine sand & finer. All mineral layers above any of the F Indicators, **except** for Indicator F8 must have a dominant chroma ≤2, or the layer(s) with a dominant chroma >2 must be ≤15cm(6in) thick to meet any hydric soil indicator. Use the following indicators in soil layers consisting of loamy or clayey soil materials.

F2. Loamy Gleyed Matrix. A gleyed matrix that occupies ≥60% of a layer starting at a depth ≤30cm(12in) from the soil surface.

F3. Depleted Matrix. A layer that has a depleted matrix with ≥60% chroma ≤2 & that has a minimum thickness of either:

a. 5cm(2in) if the 5cm is starts at a depth ≤10cm(4in) from the soil surface, or

b. 15cm(6in), starting at a depth ≤25cm(10in) from the soil surface.

F6. Redox Dark Surface. A layer ≥10cm(4in) thick, starting at a depth ≤20cm(8in) from the mineral soil surface, & has:

a. Matrix value ≤3 & chroma ≤1 & ≥2% distinct or prominent redox concentrations occurring as soft masses or pore linings, or

b. Matrix value ≤3 & chroma ≤2 & ≥5% distinct or prominent redox concentrations occurring as soft masses or pore linings.

F7. Depleted Dark Surface. Redox depletions with value ≥5 & chroma ≤2 in a layer that is at ≥10cm(4in) thick, starting at a depth ≤20cm(8in) from the mineral soil surface, & has:

a. Matrix value ≤3 & chroma ≤1 & ≥10% redox depletions, or

b. Matrix value ≤3 & chroma ≤2 & ≥20% redox depletions.

F8. Redox Depressions. In closed depressions subject to ponding, ≥5% distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is ≥5cm(2in) thick & starting at a depth ≤10cm(4in) from the soil surface.

Day 1

Tuesday, July 29. National Chicken Wing Day:

Stop 0: 7:30 - 7:55 Meet at SK Land trust building for introductions and to condense.
Bathrooms and water bottle filling available after 9:00.

Stop 1: 8:00 - 9:00. South Kingstown Beach HTM cut. **Bathrooms available.**

Stop 1.5: Drive through Charlestown Moraine.

Stop 2: 9:45 – 10:15. Kingston Kettle Hole

Stop 3: 10:30 – 1:00. Wood road Peckham Pits. Kettle Ortstein, Spodic Merrimac, Unplowed Bridgehampton.

<u>Lunch</u>: 1:00- 2:00. On campus, meet at URI botanical gardens, 41.488965, -71.525176. Park in URI Fine Arts Lot. If looking for a local joint we suggest Caliente, International Pocket, Simply Thai, or Krazy Fusion Café. **Bathrooms and water bottle filling available** in multiple campus buildings. Microwave available.

Stop 4: 2:15 – 5:30. Peckham Artesol and drainage catena pits. Artesol, Merrimac, Sudbury, Walpole, Aquasol, Histosol. **Bathrooms available 5 minute drive away.**

Overview:

To start the tour and the day, we will be observing the effects of sea level rise and coastal erosion at South Kingstown Town Beach. After this, we will make our way to the URI campus. During this drive to campus, we will pass through the Charlestown Moraine where you can observe the nature of a recessional moraine. You will notice multiple disjointed hills, and coarse fragments of all shapes and sizes from advance and retreat of ice. Right after the moraine, we will take a quick stop a deep Histosol in a kettle hole and compare it to a close-by dry kettle hole. Next, we will make our way to the final 3 pits before lunch. Although these pits are all on an outwash plain, nearly identical in elevation, and are within ~0.5 miles of each other, they are remarkably different and are characteristic of the small-scale variability in Rhode Island soils. After this, we will stop for lunch and enjoy the URI Master Gardeners' demonstration garden. Water bottle filling and restrooms are available.

After lunch, we will make our way back to Peckham Farm where we will see more pits on the outwash plain. Traditionally, the pits at Peckham have been used as a demonstration in drainage catenas for our Introduction to Soil Science classes. Here we will also see an Artesol which has likely been filled by turf farmers at some point in the last few decades. This second Peckham Farm site will also offer a place to discuss and see an example of ground penetrating radar (GPR) and its application in soil survey along with potential discussion on pattern ground and ice wedge casts.

Stop 0. SK Land Trust Building

7:30 am. Meet at for introductions and to condense vehicles. 17 Matunuck Beach Rd, South Kingstown, RI 02879. Restrooms available after 9:00.

Stop 1. Matunuck Beach

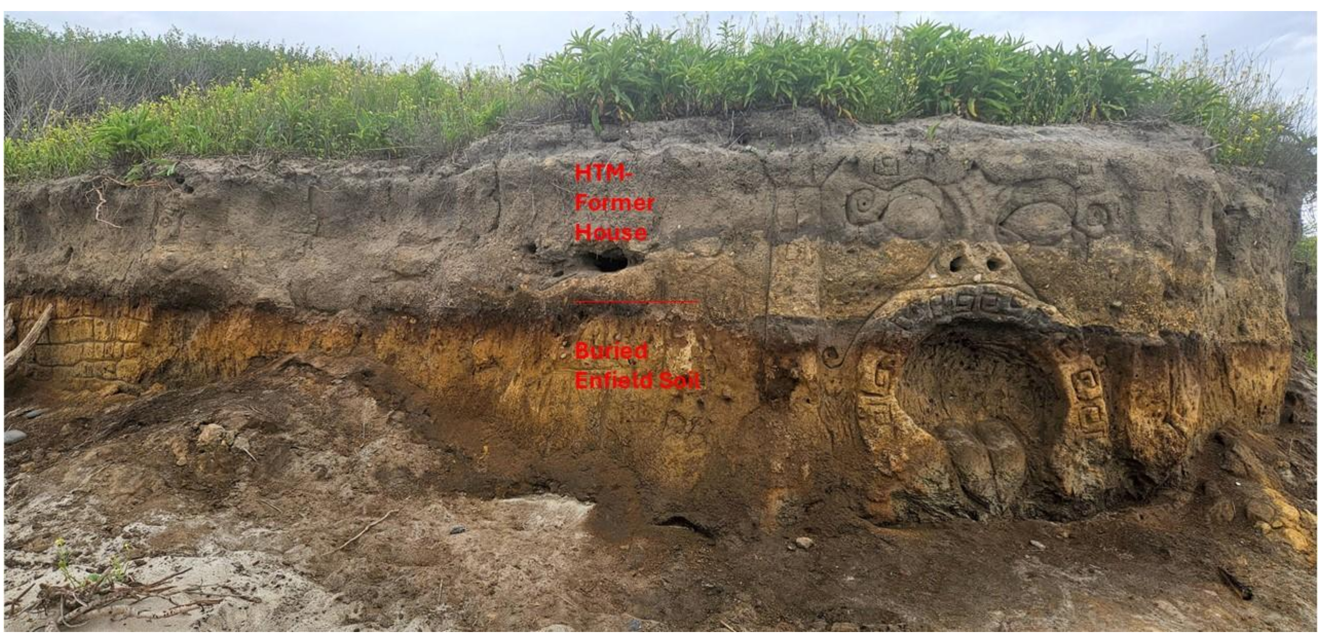
Parking: Lot 4.

Notes: Rest rooms available

Site Description: This site is a wave cut exposure of an eroding upland loess over outwash profile. In some areas along the cut there is storm-driven overwash deposits, and other areas HTM, over the original soil. This cut has moved back over the years as much as 100 meters or more. The aerial 2022 imagery below shows the location of the 2018 sampled pedon, and 1939 (Black line), 1985 (blue line), and 2008 (pink line) shoreline. 1939 Imagery shown with 2022 shoreline in red. To the East we can see the efforts of the town and private business to decrease erosion through sea-wall building as well as the famous surfing spot known as Carpenter's Bar in the 1939 B&W image.

Note Block Island (terminal moraine) and Block Island Wind Farm (30 MW). The wind farm powers 17,000 homes. 10% of this power is exported to power all of Block Island, and the rest is exported to the mainland. Although off shore wind is commonly seen as clean green energy, many local people have concerns related to the impact on wildlife. This is a complicated topic which we are not qualified to speak on. For discussion see: https://tinyurl.com/4r7dtcv6, https://tinyurl.com/ymk28ev7, and https://tinyurl.com/54fswhfu.

The description and lab report below are from pedon sampled nearby in 2018 at the cut. The sea-spray and waves have deposited enough salts to increase the base saturation of the epipedon to over 60% changing the classification of this soil to a Mollisol. Photo above by Jim Turenne 6/27/2025 showing foundation of former house.



CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)													
				(- - - cmol(+) kg^{-1} - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - % - - - -)		
				4B1a1a	4B1a1a	4B1a1a	4B1a1a		4B2b1a1				4B1a1a				
19N00314	0-7	A	S	2.4*	2.0	1.1	0.4	5.9	7.3			13.2	5.5			45	100
19N00315	7-28	2Ap1	S	2.6	1.5	3.8	0.8	8.7	19.9			28.6	12.0			30	73
19N00316	28-52	2Ap2	S	3.3*	3.0	8.1	0.8	15.2	19.9			35.1	12.5			43	100
19N00317	52-74	2Bw1	S	0.6*	1.7	7.5	0.5	10.3	6.2			16.5	2.1			62	100
19N00318	74-86	2Bw2	S	0.3*	0.8	4.9	0.4	6.4	3.3			9.7	1.8			66	100
19N00319	86-102	2BC	S	0.3*	0.2	1.2	0.2	1.9	0.9			2.8	0.6			68	100
19N00320	102-130	3C	S	0.2*	0.1	0.5	0.1	0.9	1.3			2.2	0.8			41	100

*Extractable Ca may contain Ca from calcium carbonate or gypsum., CEC7 base saturation set to 100.

Salt

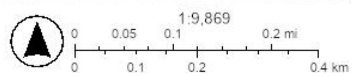
Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- 1:2 Elec Cond	-19- Exch Na	-20- SAR
				(- - - Water Extracted From Saturated Paste - - -)																			
				(- - - mmol(+) L^{-1} - - -)				(- - - mmol(-) L^{-1} - - -)										(- - % - -)		(- - dS m^{-1} - -)		%	
				4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2	4F2		4F2	4F1a1a1		
19N00314	0-7	A	S	0.5	1.5	9.4	0.7	--	3.5	--	4.8	0.1	--	tr	0.9	0.9	2.6	50.7		1.27	0.51	11	9
19N00315	7-28	2Ap1	S	0.4	1.3	21.3	0.6	--	0.7	--	17.9	--	--	--	2.9	0.3	--	60.6		2.53	1.03	21	23
19N00316	28-52	2Ap2	S	4.4	13.9	77.6	1.5	--	0.2	--	88.6	--	--	--	3.3	0.3	--	60.4		9.85	3.21	27	26
19N00317	52-74	2Bw1	S	4.9	35.4	122.9	2.0	--	--	--	151.4	--	--	--	5.4	--	2.2	43.8		15.98	4.25	100	27
19N00318	74-86	2Bw2	S	1.8	12.4	61.0	1.3	--	0.2	--	66.2	--	--	--	6.9	--	1.2	50.1		7.87	2.48	98	23
19N00319	86-102	2BC	S	2.3	4.9	31.2	0.4	--	--	--	30.9	--	--	--	5.5	--	0.9	29.4		4.08	0.63	56	16
19N00320	102-130	3C	S	0.9	1.9	12.6	0.2	--	1.7	--	12.7	--	--	--	2.5	--	0.3	36.0		1.76	0.33	2	11

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Lab Text-ure	-2- Total Clay < .002	-3- Total Silt .002 -.05	-4- Total Sand .05 -2	-5- Clay Fine < .0002	-6- Clay CO_3 < .002	-7- Silt Fine .002 -.02	-8- Silt Coarse .02 -.05	-9- Sand VF .05 -.10	-10- Sand F .10 -.25	-11- Sand M .25 -.50	-12- Sand C .5 -1	-13- Sand VC 1 -2	-14- Rock Fragments (mm) Weight 2 -5	-15- Weight 5 -20	-16- Weight 20 -75	-17- Weight .1- 75	-18- >2 mm wt % whole soil
					(- - - % of <2mm Mineral Soil - - -)												(- - % of <75mm - -)				
					3A1a1a					3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
19N00314	0-7	A	S	cos	2.0	10.4	87.6			4.7	5.7	2.4	13.6	43.1	25.4	3.1	1	tr	--	85	1
19N00315	7-28	2Ap1	S	sil	9.5	59.9	30.6			25.7	34.2	17.2	3.4	5.5	3.3	1.2	1	1	--	15	2
19N00316	28-52	2Ap2	S	sil	9.4	66.6	24.0			30.2	36.4	14.3	2.6	4.4	1.6	1.1	1	1	1	12	3
19N00317	52-74	2Bw1	S	sil	3.1	73.4	23.5			26.0	47.4	22.0	0.8	0.5	0.2	tr	--	--	tr	2	tr
19N00318	74-86	2Bw2	S	sil	1.8	65.1	33.1			21.3	43.8	27.4	1.7	1.5	1.4	1.1	1	2	1	9	4
19N00319	86-102	2BC	S	lcos	0.9	21.7	77.4			7.2	14.5	14.8	14.1	19.2	20.9	8.4	14	31	--	79	45
19N00320	102-130	3C	S	cos	--	6.5	93.5			3.2	3.3	4.5	9.7	22.4	37.0	19.9	14	32	--	94	47

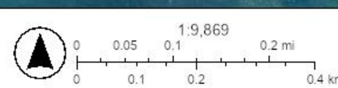
1939 shoreline with 2022 shoreline in red

7/24/2025



2022 shoreline previous shorelines

7/24/2025



IDENTIFIERS

Current Taxon Name (Soil Name): Enfield

OSD

Series Extent

User Site ID: S2018RI009007

User Pedon ID: S2018RI009007

Lab Information:

Certified Lab Pedon Description - no

Lab Source ID - KSSL

Lab Pedon # - 19N0058

User Project ID: 2019

Project Name: MLRA 144A - 2019 NCSS National Conference

Print Date: 7/24/2025

LOCATION

Location In Web Soil Survey

AOI is roughly a square mile and pedon is marked in the center.

Location in SoilWeb

Location in Google Maps

Std. Latitude: 41.3746130

Std. Longitude: -71.5531990

Datum: WGS84

Location Description: bluff cut on South Kingston Town Beach, Matunuck RI

Map Unit: BhB—Bridgehampton silt loam, 3 to 8 percent slopes

State: Rhode Island

County: RI009—Washington

MLRA: 149B—Long Island-Cape Cod Coastal Lowland

Regional Office: NE—Northeast

MLRA Soil Survey Area: NE-TOL—Tolland, Connecticut

Non-MLRA Soil Survey Area: RI600—State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

PEDON

Describers Name: Jacob Isleib, Jim Turenne, Milton Vega

Current Taxonomic Class: Coarse-silty over sandy or sandy-skeletal, mixed, active, mesic Typic Hapludolls

Current Taxon Kind: taxadjunct

Pedon Type: not classified to current taxon name

SITE

Parent Material: overwash sandy marine deposits and/or sandy eolian sands over silty loess over sandy and gravelly outwash

Landscape: coastal lowland

Landform: bluff on outwash plain

Geomorphic Component Terraces: riser

Drainage Class: well

Surface Fragments:

Benchmark Soil?: no

VEGETATION

SITE OBSERVATION

Observation Date: 10/17/2018 (actual site observation date)

Surface Cover Properties:

Site Obs. Cover Kind 1 - grass/herbaceous cover

Site Obs. Cover Kind 2 - other grass/herbaceous cover

Pedoderm Loose Cover Indicator - no

Drained? - no

Bedded Soil? - no

Forest Plantation? - no

A—0 to 7 centimeters (0.0 to 2.8 inches); very dark brown (10YR 2/2) coarse sand; structureless single grain; loose; 3.0 very fine roots and 3.0 medium roots and 3.0 fine roots; 1 percent by volume nonflat subrounded 2-10-20 millimeter mixed fragments observed by weighed method; slightly acid, pH 6.3, pH meter; abrupt smooth boundary. Lab sample # 19N00314; moist when described; observed in cut

2Ap1—7 to 28 centimeters (2.8 to 11.0 inches); very dark grayish brown (10YR 3/2), grayish brown (10YR 5/2), dry; silt loam; weak thin platy, and weak coarse subangular blocky parts to weak medium granular structure; friable; 3.0 very fine roots and 3.0 fine roots; 1 percent by volume nonflat subrounded 2-10-20 millimeter mixed fragments observed by weighed method; slightly acid, pH 6.1, pH meter; clear smooth boundary. Lab sample # 19N00315; moist when described; observed in cut

2Ap2—28 to 52 centimeters (11.0 to 20.5 inches); very dark grayish brown (10YR 3/2), grayish brown (10YR 5/2), dry; silt loam; weak coarse subangular blocky parts to weak medium granular structure; friable; 3.0 very fine roots and 3.0 fine roots; 1 percent by volume nonflat subrounded 2-10-20 millimeter mixed fragments observed by weighed method; moderately acid, pH 5.7, pH meter; abrupt smooth boundary. Lab sample # 19N00316; moist when described; observed in cut

2Bw1—52 to 74 centimeters (20.5 to 29.1 inches); 85 percent yellowish brown (10YR 5/6) and 15 percent brown (10YR 5/3) silt loam; weak coarse subangular blocky structure; friable; fragments; strongly acid, pH 5.4, pH meter; clear smooth boundary. Lab sample # 19N00317; moist when described; observed in cut

2Bw2—74 to 86 centimeters (29.1 to 33.9 inches); 70 percent light olive brown (2.5Y 5/4) and 30 percent brown (10YR 5/3) silt loam; weak coarse subangular blocky structure; friable; 2 percent by volume nonflat subrounded 2-10-75 millimeter mixed fragments observed by weighed method; moderately acid, pH 5.6, pH meter; clear smooth boundary. Lab sample # 19N00318; moist when described; observed in cut

2BC—86 to 102 centimeters (33.9 to 40.2 inches); olive brown (2.5Y 4/3) very gravelly loamy coarse sand; weak very coarse subangular blocky structure; friable; 15 percent coarse prominent dark yellowish brown (10YR 4/6), moist, masses of oxidized iron; 40 percent by volume nonflat subrounded 2-38-75 millimeter mixed fragments; moderately acid, pH 5.8, pH meter; clear wavy boundary. Lab sample # 19N00319; moist when described; observed in cut

3C—102 to 130 centimeters (40.2 to 51.2 inches); light olive brown (2.5Y 5/6) extremely gravelly coarse sand; structureless single grain; loose; 1 percent by volume nonflat subrounded 75-162-250 millimeter mixed fragments observed by visual inspection method and 70 percent by volume nonflat subrounded 2-38-75 millimeter mixed fragments observed by visual inspection method; moderately acid, pH 5.7, pH meter. Lab sample # 19N00320; moist when described; observed in cut

Stop 1.5

Charlestown Moraine

Parking: We will not be stopping here, just driving through.

Description: The moraine rises abruptly with a steep south slope and a gentler slope to the north. The moraine is characterized by irregular topography with many depressions. Unlike some moraines in the Midwest, moraines in southern New England, and specifically the Charlestown moraine is characterized by many thrusting events and retreats of ice which has caused a very complicated landscape to be formed. Given the dynamic nature of multiple thrust events and movement by water and ice, the moraine has multiple parent materials found within it and many soils are mapped as complexes. See image below for ice-thrust characteristics. This area was the CRI lobe’s first stop in its retreat where it stalled around 21 kyr BP. During this time alluvial fans were deposited to the south of the moraine (currently under Block Island Sound as a result of sea level rise since the end of the glaciation). The fine deposits at the surface of these previously exposed alluvial fans are likely one of the sources of the loess that blankets most of Rhode Island. See topographic map on the next page. Note the winding roads as you drive.

Multiple parent materials exposed in the moraine. A&B: Eolian. C: Till D: Glacial fluvial. Photo by Jon Boothroyd

USGS 7.5 minute topo map showing the Charlestown moraine and outwash plain. Blackberry and Green Hills are drumlins partially covered by outwash deposits. Contour interval is 10'.

Stop 2

Kingston URI Kettle Hole

Parking: Park in parking lot at 41.484087, -71.540368

Description:

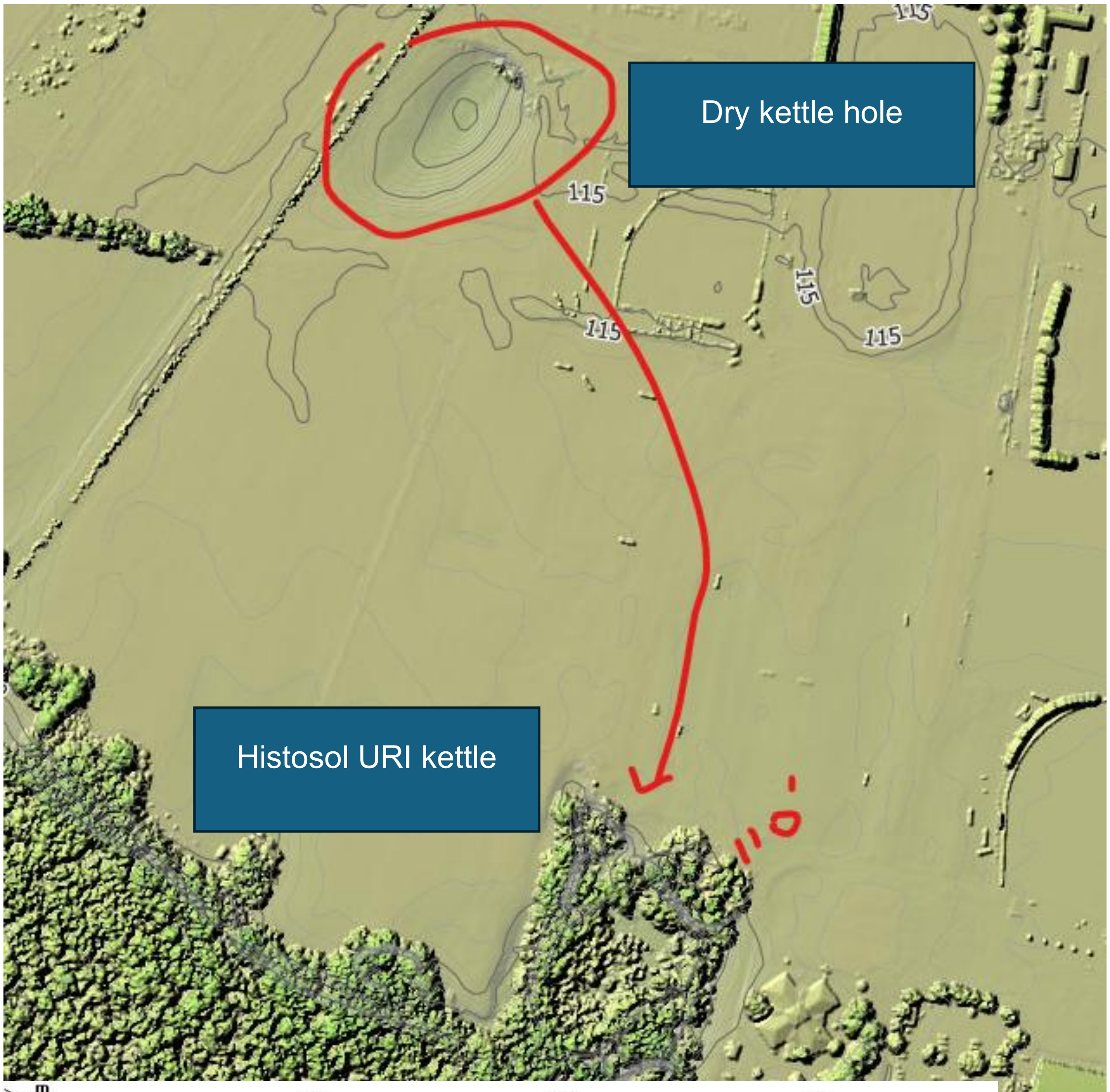
Davis et al. (2004) studied carbon stocks in three different kettle-hole Histosols in Rhode Island. Samples were collected with a Macaulay peat sampler at 50 cm increments except for the Oe horizon. We are visiting the URI site (see table below). Note the high soil organic carbon content of the organic materials. These kettle holes are typically mineral starved. We typically assume that the amount of organic matter is about twice that of the SOC content. These data suggest that in most cases most if not all the solids are organic soil materials. Jim Turenne ran GPR across the URI kettle hole and found the depth of organic soil materials were as much as 20 feet thick. GPR image below showing mineral contact.

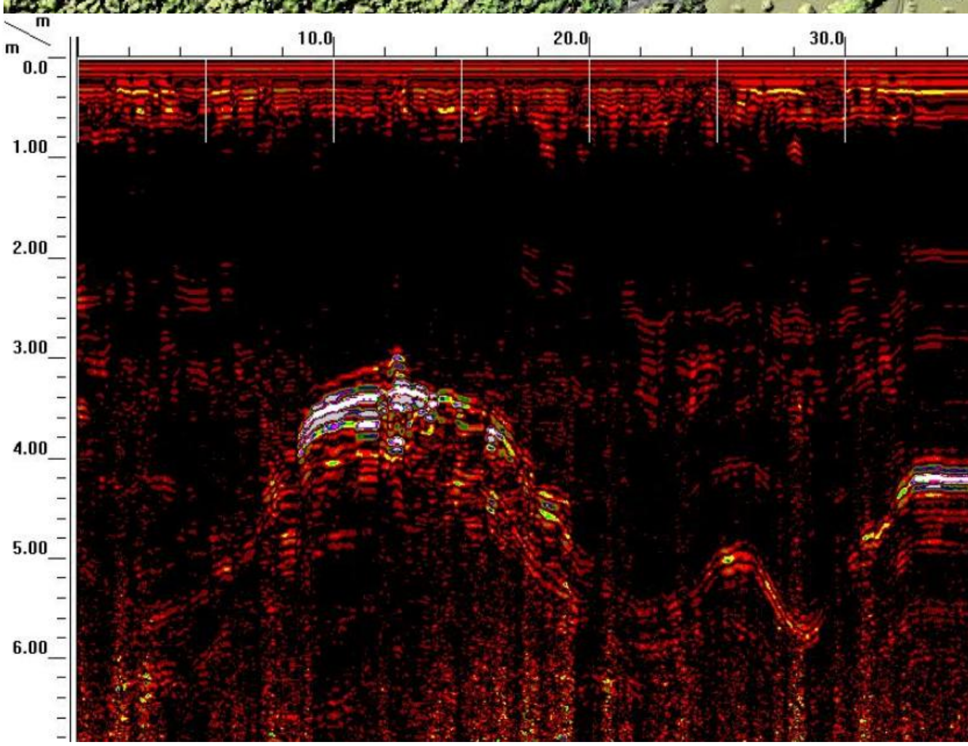
This specific kettle hole is about the same depth as a kettle hole a quarter mile to the north, and yet this one is inundated or saturated year-round while the one to the north is rarely if ever wet. See topographic map below.

Characterization of organic soil materials in 3 different kettle-hole Histosols. Statistical values are based on samples collected for 9 or 10 pedons for each site (Davis et al., 2004).

Site	Horizon	n	Thickness		Bulk density		SOC concentration		Total SOC content	
			Mean	CV	Mean	CV	Mean	CV	Mean†	CV
			cm	%	g cm^{-3}	%	g kg^{-1}	%	Mg ha^{-1}	%
URI	Oie	9	4	25	0.08	18	415	9	16	38
	Upper Oa	10	50	–	0.12	18	469	6	259	7
	Lower Oa	10	50	–	0.13	32	485	5	227	14
	Upper 1 m	10	100	–	–	–	–	–	494a	29
Rt110	Oie	10	8	10	0.08	5	490	1	31	11
	Upper Oa	10	50	–	0.11	5	524	1	292	4
	Lower Oa	10	50	–	0.13	5	498	2	323	4
	Upper 1 m	10	100	–	–	–	–	–	645b	9
CHTH	Oie	10	3	14	0.09	8	503	1	12	11
	Upper Oa	10	50	–	0.11	7	529	1	289	7
	Lower Oa	10	50	–	0.12	2	534	1	317	4
	Upper 1 m	10	100	–	–	–	–	–	618b	10

† Means for total SOC storage with different letters are significantly different at the 0.05 alpha level within each soil type.



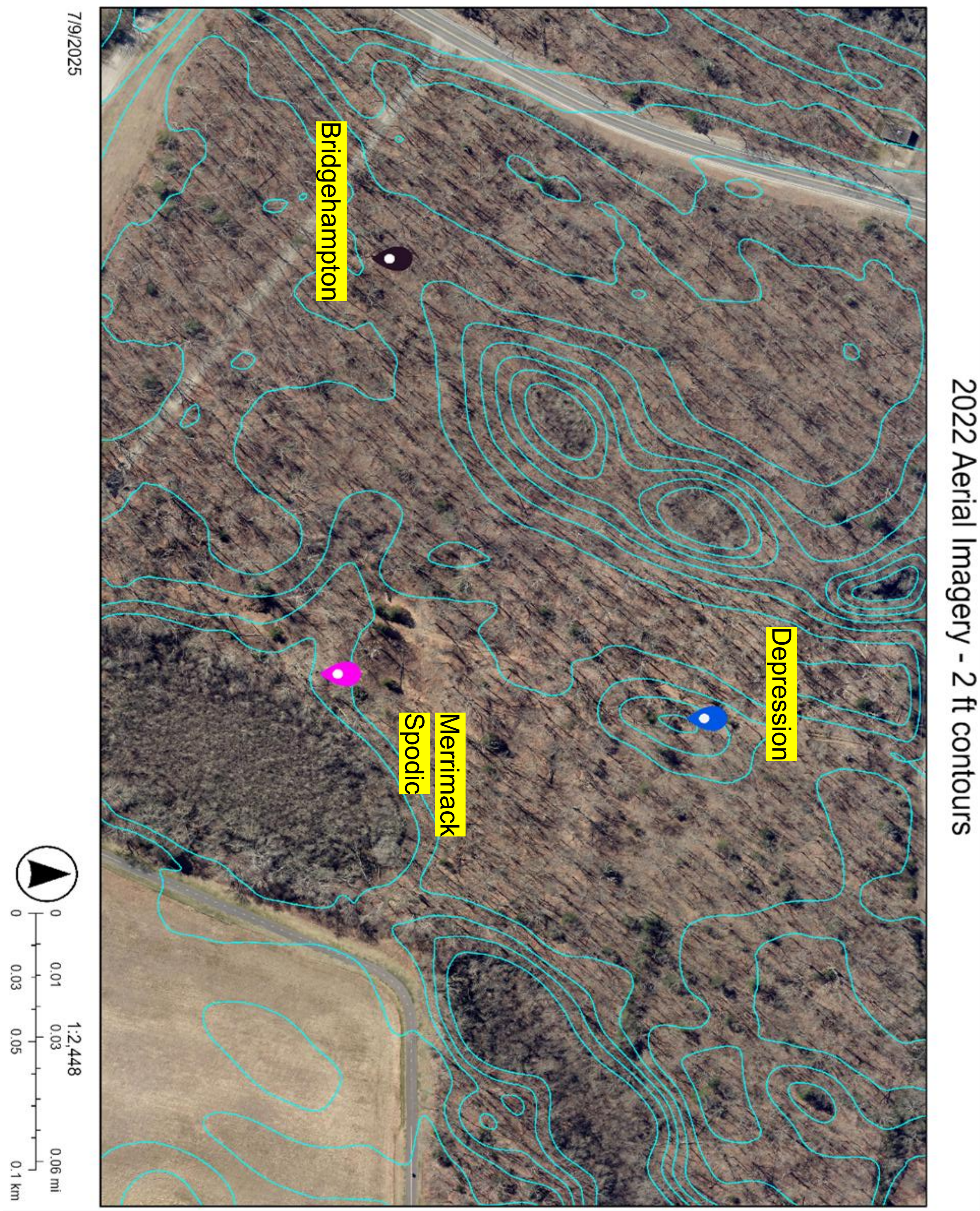


GPR image of organic deposits over mineral materials in URI kettle

Stop 3. Wood road at Peckham Farm

Parking: Park on the sides of the wood road off Ministerial road. Some spots along the road are wide enough to turn around on. Note the Bike path at the end of the wood road and beware of pedestrians or bikers if you drive up there to turn around.

Notes: We may split into multiple groups here. Paths to the pits will be obvious, but you also have a google map with all the pit locations.



Peckham Bridgehampton Pit

This pit is one of the few examples of soils in prime farmland in RI without an Ap horizon. In the 1939 imagery the area appears to be have more coverage than the surrounding area to the east.

Here we can observe what is termed a “hanging water table” where there are redox features in the finer-textured eolian mantle but no evidence of the water table in the coarser textured C horizons; the water table is likely ~4 meters below the soil surface here as evidenced by the wet kettle hole to the NE. This “hanging water table” is caused by the silt loam texture becoming nearly saturated before it releases water to the C horizon below.

Below are KSSL data and description from 2018 and a link to the series OSD. Note, the OSD shows a bisequeal horizon sequence. Since the OSD has been published, we no longer call bisequeal horizon sequences and opt instead to denote the “E” horizon as a Bw horizon.

Included below are excerpts from a 2018 description of this pit and the KSSL lab report. This shows the high silt content of the solum which has a much higher water holding capacity compared to the sands and gravels below. The solum of this profile Is dominated by coarse silts which would have been deposited during the periglacial environment and is likely sourced from ancient Block Island Sound alluvial fans.

Full 2018 KSSL Lab Report: https://tinyurl.com/2ufhj454

Full 2018 Description: https://tinyurl.com/b6t83b6m

Classification 2022 KST: Coarse-silty, mixed, superactive, mesic Oxyaquic Dystrudepts

User Pedon ID: S2008RI009020

Oe—0 to 6 centimeters (0.0 to 2.4 inches); very dark gray (7.5YR 3/1) moderately decomposed plant material; ; ; fragments; abrupt wavy boundary. Lab sample # 08N03447; moist when described; observed in pit, large or quarry

A—6 to 11 centimeters (2.4 to 4.3 inches); dark brown (7.5YR 3/2) silt loam; weak fine subangular blocky, and medium subangular blocky structure; friable; 3.0 very fine roots and 0.5 medium roots and 3.0 fine roots and 0.5 coarse roots; 3.0 very fine and 3.0 fine pores; fragments; abrupt wavy boundary. Lab sample # 08N03448; moist when described; observed in pit, large or quarry

Bw1—11 to 40 centimeters (4.3 to 15.7 inches); dark yellowish brown (10YR 4/4) silt loam; weak medium subangular blocky, and coarse subangular blocky structure; friable; 0.5 very coarse roots throughout and 3.0 medium roots and 3.0 fine roots throughout; 0.5 very fine tubular and 0.5 fine tubular pores; 1 percent by volume granite fragments; gradual wavy boundary. Lab sample # 08N03449; moist when described; observed in pit, large or quarry

Bw2—40 to 63 centimeters (15.7 to 24.8 inches); light olive brown (2.5Y 5/4) silt loam; weak medium subangular blocky, and coarse subangular blocky structure; friable; 3.0 very fine roots and 0.5 medium roots and 3.0 fine roots and 0.5 coarse roots; 0.5 medium and 0.5 fine pores; 1 percent by volume granite fragments; gradual wavy boundary. Lab sample # 08N03450; moist when described; observed in pit, large or quarry

BC1—63 to 92 centimeters (24.8 to 36.2 inches); light olive brown (2.5Y 5/3) silt loam; weak coarse subangular blocky structure; friable; 0.5 very fine roots and 0.5 medium roots and 0.5 fine roots; 0.5 fine pores; 1 percent fine grayish brown (2.5Y 5/2), moist, masses of reduced iron in matrix and 1 percent fine strong brown (7.5YR 4/6), moist, masses of oxidized iron in matrix; 1 percent by volume granite fragments; clear wavy boundary. Lab sample # 08N03451; moist when described; observed in pit, large or quarry

BC2—92 to 121 centimeters (36.2 to 47.6 inches); 60 percent yellowish brown (10YR 5/4) and 40 percent light olive brown (2.5Y 5/4) silt loam; weak medium subangular blocky, and weak coarse subangular blocky structure; friable; 0.5 very fine roots and 0.5 medium roots and 0.5 fine roots; 0.5 fine pores; 2 percent fine noncoherent cemented grayish brown (2.5Y 5/2), moist, masses of reduced iron in matrix and 5 percent fine noncoherent cemented strong brown (7.5YR 5/6), moist, masses of oxidized iron in matrix; fragments; abrupt boundary. Lab sample # 08N03452; moist when described; observed in pit, large or quarry

2C—121 to 200 centimeters (47.6 to 78.7 inches); olive brown (2.5Y 4/3) stratified stratified gravelly coarse sand; structureless single grain; loose; 40 percent by volume nonflat subrounded mixed fragments. Lab sample # 08N03453; moist when described; observed in pit, large or quarry

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
					(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - - Sand - - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Lab Text-ure	Clay < .002	Silt .002 -.05	Sand .05 -2	Fine < .0002	CO_3 < .002	Fine .002 -.02	Coarse .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(- - - - - - - - - Weight - - - - - - - - -) 2 -5	5 -20	20 -75	.1- 75	>2 mm wt % whole soil
					(- % of <2mm Mineral Soil											- -)	(- - - - - - - - % of <75mm - - - - - - -)				
					3A1a1a					3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
08N03447	0-6	Oe	S														--	--	--	--	--
08N03448	6-11	A	S	sil	9.3	64.5	26.2			22.6	41.9	10.8	3.5	6.0	3.8	2.1	2	1	--	18	3
08N03449	11-40	Bw1	S	sil	3.8	69.3	26.9			24.0	45.3	14.0	3.2	4.9	2.8	2.0	2	2	--	16	4
08N03450	40-63	Bw2	S	sil	3.8	76.2	20.0			26.1	50.1	15.1	1.9	1.9	0.9	0.2	tr	tr	--	5	tr
08N03451	63-92	BC1	S	sil	4.2	78.3	17.5			25.1	53.2	14.3	1.4	1.0	0.7	0.1	tr	--	1	4	1
08N03452	92-121	BC2	S	sil	4.1	76.3	19.6			20.8	55.5	17.8	0.7	0.5	0.4	0.2	--	--	--	2	--
08N03453	121-200	2C1	S	cos	2.9	3.6	93.5			0.6	3.0	2.7	8.5	35.5	32.4	14.4	12	40	--	96	52

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - - pH					- - - - - - - - - - - - - - - - - -)	(- - Carbonate - -) As $CaCO_3$		(- - Gypsum - - -) As $CaSO_4*2H_2O$		Resist
				KCl	$CaCl_2$ 0.01M 1:2	H_2O 1:1	Sat Paste	Oxid	NaF	<2mm	<20mm	<2mm	<20mm	ohms cm^{-1}
					4C1a2a	4C1a2a				(- - - - - - - - - - - - - %			- - - - - - - - - - - -)	
08N03447	0-6	Oe	S		3.4	4.3								
08N03448	6-11	A	S		3.9	4.5								
08N03449	11-40	Bw1	S		4.8	5.0								
08N03450	40-63	Bw2	S		4.8	5.1								
08N03451	63-92	BC1	S		4.9	5.2								
08N03452	92-121	BC2	S		5.0	5.3								
08N03453	121-200	2C1	S		5.4	5.3								

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- 33 kPa (Bulk Density) (- - - g cm^{-3} - - -) DbWR1	-2- Oven Dry (Bulk Density) DbWR1	-3- Cole Whole Soil	-4- 6 kPa (Water Content, pct of < 2mm)	-5- 10 kPa	-6- 33 kPa DbWR1	-7- 1500 kPa 3C2a1a	-8- 1500 kPa Moist	-9- (Air Dry-Oven Dry) Ratio 3D1	-10- Corrected	-11- WRD Whole Soil cm^3 cm^{-3}	-12- Aggst Stabl 2-0.5mm %	-13- (Ratio/Clay) CEC7	-14- (Ratio/Clay) 1500 kPa
08N03447	0-6	Oe	S							94.7		1.100					
08N03448	6-11	A	S							10.0		1.023				1.92	1.08
08N03449	11-40	Bw1	S	1.08	1.10	0.006			19.9	6.3		1.017		0.14		1.29	1.66
08N03450	40-63	Bw2	S	1.21	1.22	0.003			20.0	4.3		1.012		0.19		0.89	1.13
08N03451	63-92	BC1	S	1.43	1.44	0.002			20.2	3.3		1.009		0.24		0.67	0.79
08N03452	92-121	BC2	S	1.44	1.45	0.002			18.9	2.6		1.007		0.23		0.56	0.63
08N03453	121-200	2C1	S							0.6		1.001				0.28	0.21

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- Total C (% of <2 mm) 4H2a	-2- Total N 4H2a	-3- Total S 4H2a	-4- Est OC	-5- OC (WB)	-6- C/N Ratio	-7- Dith-Cit Ext Fe (% of < 2mm) 4G1	-8- Dith-Cit Ext Al 4G1	-9- Dith-Cit Ext Mn 4G1	-10- Ammonium Oxalate Extraction Al+½Fe	-11- ODOE 4G2	-12- Fe 4G2	-13- Al 4G2	-14- Si 4G2	-15- Mn mg kg^{-1} 4G2	-16- Na Pyro-Phosphate C (% of < 2mm)	-17- Fe	-18- Al	-19- Mn
08N03447	0-6	Oe	S	43.93	1.94	0.18	43.9		23													
08N03448	6-11	A	S	5.61	0.21	0.01	5.6		27	1.2	0.4	--	1.30	0.44	0.92	0.84	0.01	--				
08N03449	11-40	Bw1	S	1.19	0.06	0.01	1.2		20	1.1	0.6	--	1.83	0.07	0.54	1.56	0.12	1.0				
08N03450	40-63	Bw2	S	0.47	0.02	0.02	0.5		22	0.8	0.5	--	1.28	0.02	0.34	1.11	0.08	4.0				
08N03451	63-92	BC1	S	0.30	0.02	0.01	0.3		18	0.3	0.4	--	0.56	0.01	0.17	0.48	0.15	10.2				
08N03452	92-121	BC2	S	0.19	tr	0.01	0.2		46	0.5	0.3	--	0.49	0.01	0.23	0.37	0.11	3.1				
08N03453	121-200	2C1	S	0.21	0.04	tr	0.2		5	0.3	0.1	--	0.07	--	0.05	0.05	0.01	32.9				

*** Primary Characterization Data ***

Pedon ID: S2008RI009020

(Washington, Rhode Island)

Print Date: Jul 24 2025 10:04PM

Sampled As : Bridgehampton

Coarse-silty, mixed, mesic Typic Dystrudepts

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 08N0529

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca (NH_4OAC Extractable Bases) (cmol(+) kg^{-1}) 4B1a1a	-2- Mg 4B1a1a	-3- Na 4B1a1a	-4- K 4B1a1a	-5- Sum Bases	-6- Acid-ity 4B2b1a1	-7- Extr Al 4B3a1a	-8- KCl Mn mg kg^{-1} 4B3a1a	-9- CEC8 Sum Cats (cmol(+) kg^{-1})	-10- CEC7 NH_4 OAC 4B1a1a	-11- ECEC Bases +Al	-12- Al Sat (%)	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
08N03447	0-6	Oe	S	8.4	4.2	0.1	1.8	14.5	152.0			166.5	86.8			9	17
08N03448	6-11	A	S	0.1	0.1	--	0.2	0.4	29.0	6.1	0.1	29.4	17.9	6.5	94	1	2
08N03449	11-40	Bw1	S	0.1	--	--	0.1	0.2	13.8	1.6	--	14.0	4.9	1.8	89	1	4
08N03450	40-63	Bw2	S	0.1	--	--	tr	0.1	9.9	1.2	tr	10.0	3.4	1.3	92	1	3
08N03451	63-92	BC1	S	0.1	--	--	tr	0.1	7.6	0.9	tr	7.7	2.8	1.0	90	1	4
08N03452	92-121	BC2	S	0.1	--	--	tr	0.1	5.6	0.7	--	5.7	2.3	0.8	88	2	4
08N03453	121-200	2C1	S	0.1	--	--	tr	0.1	1.1	0.3	--	1.2	0.8	0.4	75	8	13

Peckham Merrimac Spodic Pit

Mapped as Hinkley but closer resembling a Merrimac series, this pit displays lateral podzolization (see Bourgault et al., 2015 for more information) from the adjacent wetland. Because the profile contains a sandy texture between the top of the "spodic horizon" and the mineral soil surface (Spodosol criteria 3.b.(2) in KST 13th edition), this soil nearly keys out to an Oxyaquic Haplorthod (we do not have aluminum or iron data). As this pit moves towards the wetland, the spodic horizon intermittently makes and fails to make the required criteria for spodic materials, thus we offer 2 potential classifications.

When attempting to analyze this pit through the lens of traditional vertical podzolization, this pit offers a conundrum: there is no apparent eluvial horizon in the profile which would supply the necessary organic material or sesquioxides. Additionally, the apparent spodic horizon is beneath a C horizon. Given that we are on an outwash plain in southern New England, it is exceptionally unlikely we are witnessing a buried horizon.

The top of the "spodic horizon" in this pit is approximately 62 cm below the organic soil surface of the adjacent kettle hole wetland, thus it can be inferred that water rich in humic and fulvic acids (and sesquioxides) leaches from the adjacent wetland during the drier months and is illuvially deposited in the surrounding soils, creating a deep spodic-like horizon beneath unaltered parent material without an apparent eluvial horizon.

Although not mapped on the landscape in Rhode Island, Spodosols are abundant in marginal areas adjacent to wetlands in the state. This particular example of lateral podzolization is uncommon (as far as we know) in RI but similar soils may be important in carbon accounting when considering the abundance of small kettle wetlands. See appendix for spodic material definition (KST, 2022), see below for field description and lab data.

Mineral soil surface: 31.58m.

Wetland organic soil surface: 31.19m

Classification 2022 KST: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Oxyaquic Dystrudepts

If lowest horizon meets spodic materials: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Oxyaquic Oxyaquic Haplorthods

Peckham Spodic Merrimack

Classification:

Field Morphology

Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes
Oe	0	3	AS	7.5YR 2.5/1	MPT	-	-	-	-	Leaf Litter	Somewhat discontinuous due to surface disturbance
A	3	6	AS	10YR 2/1	SL	5% F SR GR	1 M GR	VFR	N	Outwash	Somewhat discontinuous due to surface disturbance
Ap	6	22	AS	7.5YR 2.5/2 OR 10YR 2/2	SL	8% F/M SR GR	1 F SBK	FR	N	Outwash	-
Bw1	22	36	CS	10 YR 4/4	SL	8% F/M SR GR	1 M SBK	FR	N	Outwash	-
Bw2	36	54	CS	10 YR 5/4	SL	10% F/M SR GR	1 M SBK	FR	N	Outwash	-
BC	54	73	CS	10YR 4/6 OR 10YR 4/6	VGR SL	40% F/M SR GR	1 CO SBK	VFR	C D Masses and Depletions	Outwash	-
C	73	101	AS	10YR 4/6	EXGR COS	70% F/M SR GR)	0 SG	LO	N	Outwash	-
Bhs	101	139	-	55% 7.5YR 4/6 35% 2YR 2.5/2 10% 7.5YR 4/4	EXGR COS	60% F SR GR	0 MA / SG	FI / LO	N	Outwash	35% cemented, firm, lenses of cemented material 2.5YR 2.5/2 and has ODOE of 0.4, LOI 2.95%

Lab Data

Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk Density
Oe	-	-	-	4.35	-	-	-	-	-	-	-	-	52.37	26.19	0.12
A	45.31	47.9	6.79	4.42	0.22	2.27	9.6	13.05	11.41	8.98	39.4	8.5	6.71	3.36	0.99
Ap	46.9	49.92	3.18	4.37	0.17	3.075	7.36	18.04	8.68	9.74	43.71	6.21	5.21	2.61	1.12
Bw1	48.73	48.32	2.95	4.67	0.07	3	9.2	15.58	10.66	10.29	42.75	5.57	2.17	1.09	1.34
Bw2	66.37	28.17	5.46	4.55	0.06	8.31	4.08	13.33	18.8	21.84	26.21	1.96	1.97	1.0441	1.45
BC	69.29	27.63	3.08	4.49	0.05	8.7	22.17	20.45	10.19	7.77	26.13	1.5	1.32	0.6996	1.54
C	92.47	5.36	2.17	4.71	0.09	13.96	50.22	25.31	2.02	0.95	4.1	1.26	0.61	0.3233	1.43
Bhs	93.04	5.2	1.76	4.21	0.27	19.22	54.43	18.17	0.81	0.42	4.82	0.38	2.14	1.1342	1.41

Peckham Depression Pit

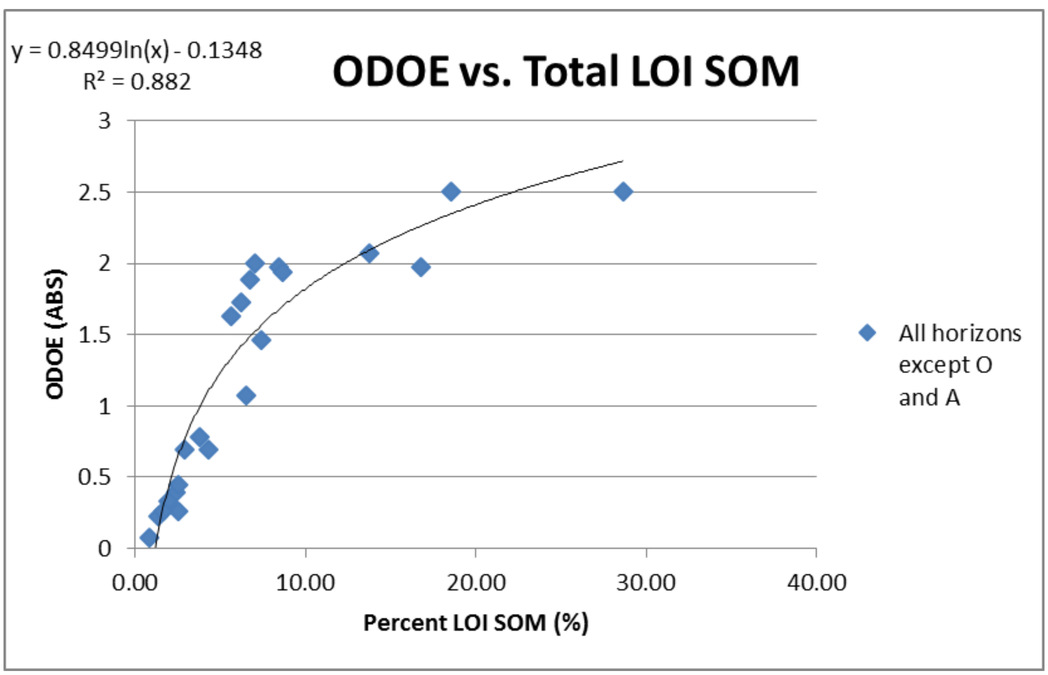
Notably lower than the surrounding landscape, this pit is situated in a small kettle hole and has evidence of slope-wash in the upper horizons. Additionally, there is apparent cementation in the bottom which indicates an ortstein horizon. This particular area has historically been farmed and the plowing along the kettle hole edges likely led to the slope wash which buried the original soil surface.

Take note of the dark inclusion below the Ap horizons. This is likely the original soil surface, though it is discontinuous and we did not separate it out as a separate horizon. The LOI is ~5.01%. See description below.

Mineral soil surface elevation: 31.02 meters. This is about a meter and a half below the surface of the wetland adjacent to the Merrimac pit, but nearly 6 meters above the surface of the wetland directly to the north, west, and east.

Andy Palucci studied the genesis of 7 similar Spodosols that have been described in southern New England, and developed a regression curve between ODOE and LOI (Figure below) for all horizons and the Bw3 horizon does not follow the regression model, which a modeled ODOE of 0.50 but an actual ODOE of 0.10. Meanwhile the Bhsm better follows the model with a modeled ODOE of 0.16 compared to the actual 0.19.

Classification 2022 KST: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Typic Durorthods



Optical density of oxalate extract (ODOE correlated with total loss on ignition soil organic matter (LOI SOM). O and A horizons were excluded from analysis to increase strength of prediction equation. Palucci 2013.

Peckham Kettle Ortstein

Classification:

Field Morphology

Horizon	Upper Depth	Lower Depth	BND	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes
Oe	0	4	AS	7.5YR 2.5/1	MPT	-	-	-	N	Organic material	-
A	4	7	AW	7.5YR 2.5/1	SIL	5 - SR M GR	1 F SBK	VFR	N	Slope Wash	-
Ap1	7	21	CW	90% 7.5YR 2.5/2 10% 5YR 2.5/1	SIL	5 - SR M GR	1 M SBK	FR	N	Slope Wash	-
Ap2	21	31	AW	7.5YR 2.5/2	SL	5 - SR M GR	1 M SBK	FR	N	Slope Wash	Original A intermittent beneath. 7.5YR 2.5/1 and Estimated C = 2.65%
Bw1	31	55	CS	7.5YR 4/4	SL	5 - SR M GR	1 CO SBK	FR	N	Outwash	-
Bw2	55	74	CS	7.5YR 4/4	GR SL	15 - SR M GR	1 CO SBK	FR	N	Outwash	-
Bw3	74	83	CS	7.5YR 4/5	GR LCOS	25 - SR M/CO GR	1 CO SBK	FR	C D Masses	Outwash	15% of horizon appears cemented
Bhsm	83	108+	-	85% 5YR 2.5/2 15% 7.5YR 4/6	XGR COS	75 - SR M/CO GR	0 MA	VFI	N	Outwash	90% cemented, makes requirement for spodic materials and ortstein

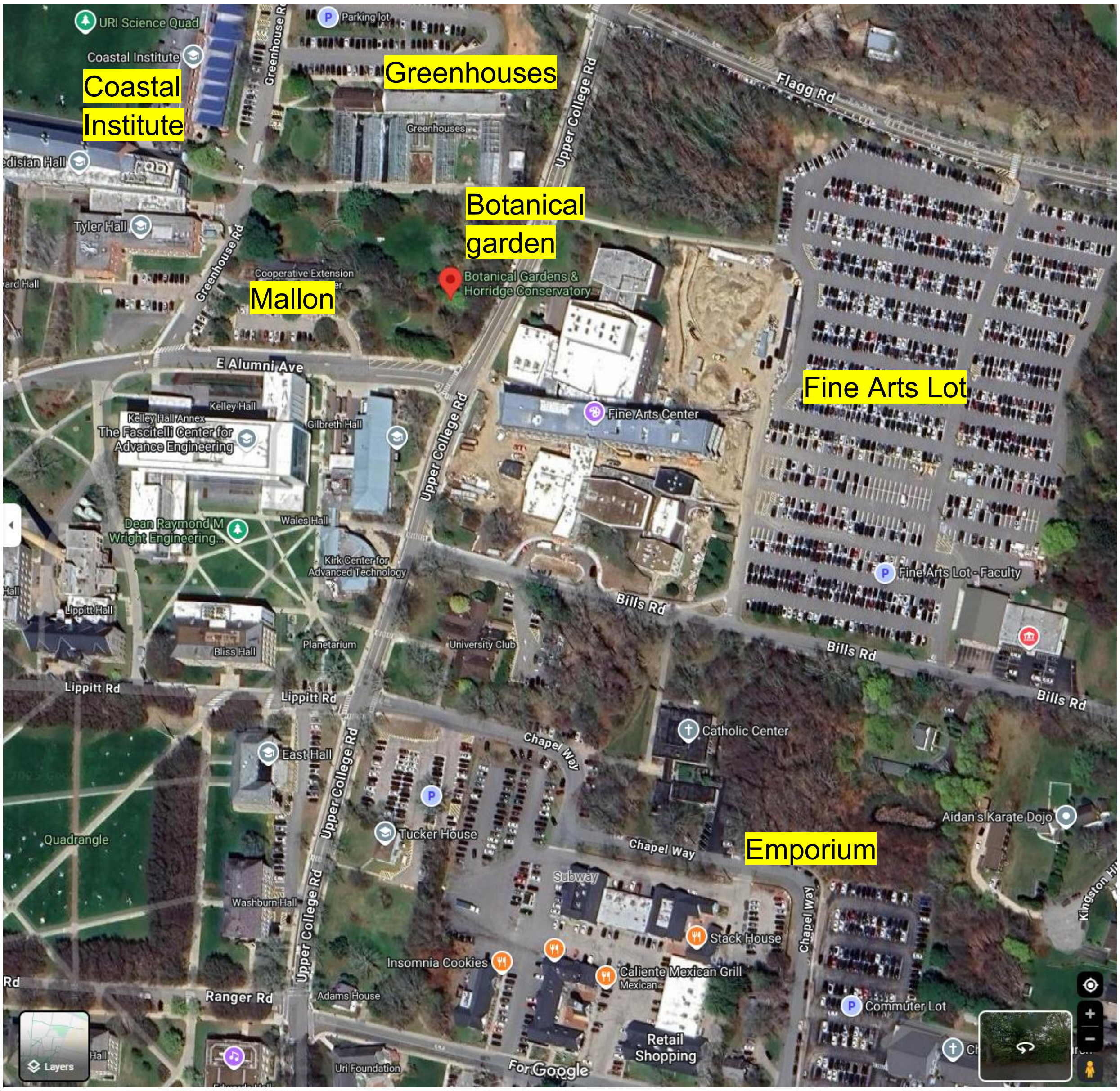
Lab Data

Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk Density
Oe	-	-	-	-	-	-	-	-	-	-	-	-	92.21	48.8713	-
A	35.72	59.88	4.4	3.32	0.41	3.5	6.23	12.03	9.84	4.12	50.8	9.08	17.43	9.2379	0.85
Ap1	38.27	54.47	7.26	3.04	0.23	3.88	9.59	11.43	7.55	5.82	47.43	7.04	11.73	6.2169	0.94
Ap2	57.61	36.37	6.02	3.18	0.22	7.42	16.08	17.92	9.26	6.93	30.08	6.29	8.15	4.3195	1.12
Bw1	73.6	22.28	4.12	3.72	-	23.6	7.7	10.6	18.5	13.2	-	-	3.52	1.8656	1.18
Bw2	72.8	23.15	4.05	3.3	-	3.2	16.5	24.2	20.7	8.2	-	-	2.65	1.4045	1.25
Bw3	73.5	22.96	3.54	3.07	0.1	2.7	8.5	25.5	22.4	14.4	-	-	2.13	1.1289	1.42
Bhsm	95.15	4.1	0.75	3.15	0.19	29.87	28.92	24.71	7.78	3.87	2.3	1.8	1.41	0.7473	1.46

Lunch

Lunch will be held at the URI Botanical Gardens & Horridge Conservatory (see map). Please park in Fine Arts Parking Lot. Do not park in the parking lot adjacent to the Kingston Coastal Institute, you may be ticketed. Restrooms and water bottle filling is available in nearby buildings (URI Greenhouses, Coastal Institute, Engineering Building, Avedisian, Mallon Outreach Center), ask a URI local if you don't know where to go. You may buy food at the Emporium which is a short/drive walk away. In the Emporium there is a CVS, multiple restaurants, a Dunkin, and a convenience store. Joe's favorite: International Pocket and Caliente (get the tres leche for a sweet treat, you deserve it!)

After lunch we will make our way back down to Peckham Farm. If we are running behind, we may need to leave lunch early.



Stop 4

<u>Parking:</u> Park on the path we take out to the field. If you do not want to take your vehicle through the field, you may park in the farm parking lot and carpool out. Note the path has tall grass and ridges that bottom out very low cars. Joe drives his lowish 4wd sedan out regularly without issue, though there is the potential for scratching the paint on your vehicle.

<u>Notes:</u> We may split into multiple groups here. Paths to the pits will be obvious. Beware of ticks in the field, especially the mugwort, it's been a bad year for them out here. We find multiple on us anytime we come out. Below are aerial images, contour lines, mapped soils, and hill shade images.

Peckham Farm History

Purchased in 1936 with additional land purchased in 1944, Peckham farm has historically been used for hay and pasture by the university and consists of approximately 160 acres of farmland. In the past few decades, the university has leased a number of the hay fields to sod farmers resulting in significant loss of the eolian mantle in some parts of the farm. Now, the southern field is being utilized for a silviculture/silvopasture experiment station. The central field is being leased by RI Mushroom company with plans to build a 50-acre production greenhouse, a contentious topic within the department! Included in the Peckham Farm area of campus is a ~28 acre area of woodland which is where this stop will take place. Below we have provided some historical imagery and topography of the area. Note the lack of apparent land clearing around the Bridgehampton pit.

Sod Farming in RI

Sod farming is the cultivation of turfgrass (grass and the underlying mat of roots and soil) for transplanting to lawns, sports fields, and other landscapes. In practice, farmers prepare fields by tilling and leveling soil, then seeding it with turfgrass varieties. At harvest, a sod-cutting machine slices under the grass to cut strips of sod with a thin layer of topsoil attached (often about 1–2 cm of soil). These sod strips (or rolls) are lifted, rolled up, and shipped out. The harvested field is left with some of its loess cap removed and is reseeded for the process to be repeated. This cycle means sod farming “mines” a portion of the soil with each harvest, unlike most farming where crops are removed but soil remains. Typically southern RI outwash plains are utilized in RI due to their flat or gentle rolling hill topography and thick loess cap

Sod is Rhode Island’s largest single agricultural commodity by sales. Although the Ocean State is tiny, sod farming plays an outsized role in its agriculture. About 2,600 acres of Rhode Island are devoted to turf farms (mostly in Washington County), which accounts for a substantial share of all sod grown in New England. Rhode Island even ranks about 26th in the nation for sod production, remarkable given it’s the smallest state. Rhode Island-grown sod has been used in high-profile locations like Fenway Park, the White House, and even the Olympics.

Economically, sod (often grouped with nursery and greenhouse products) makes up the largest slice of Rhode Island’s farm economy; in 2022, nursery/greenhouse/sod farms generated roughly 55% of the state’s agricultural sales. Farmers have found sod to be a reliable cash crop that can outperform food crops in revenue. As such, turf has production became a lifeline for many local farmers, especially on former potato farms, allowing them to stay in agriculture profitably given farmland preservation regulations. As Michael Sullivan, (former director of RI DEM) noted, sod farming “provided economic viability for farms that might have gone out of business” in Rhode Island.

Rhode Island’s sod farming industry expanded notably in the late 20th century, driven by both market demand and land-use policies. As suburban development spread after the

1950s, there was a spike in demand for turfgrass to carpet developments. At the same time, traditional crops like potatoes and dairy were in decline; many empty potato fields in Rhode Island were converted to sod farms by the 1970s and 80s. This shift was an economic decision, farmers in the state saw turf as more profitable and aligned with the needs of a suburbanizing region.

Critically, Rhode Island's land conservation policies also enabled this growth. In 1981 the state established the Farmland Preservation Program (sometimes called the Farmland Preservation Act) to purchase development rights from farmers and permanently protect agricultural land. Along with the Farm, Forest, and Open Space Act (which offers property tax incentives for keeping land in agriculture), these policies kept farmland from being lost to housing or commercial development. Since 1981, Rhode Island's Farmland Preservation program has preserved over 8,250 acres across 120+ farms. Sod farms have been major beneficiaries given their (short term) profitability. In total, roughly 1,400+ acres of turf farm land have been protected from development under these programs.

From a pedology perspective, sod farming in Rhode Island raises both interesting opportunities and concerns. Rhode Island's turf farms are generally situated on the state's best agricultural soils on Washington County's outwash plains. Many sod fields in South County sit on the same prime soil that once grew potatoes mid-century. These soils are ideal for turf: they drain well due to the coarse-textured outwash substratum yet have a fine enough solum hold nutrients and moisture for grass growth. The relatively flat, stone-free nature of these fields also makes it easier to harvest sod strips cleanly. Rhode Island is using its prime farmland to grow lawns, which is a point of local debate. Many argue that such soil should grow food instead of grass, given turf's low ecological biodiversity value. However, from the farmer's standpoint, they are unable to compete with large-scale agriculture of more productive areas of the country. Thus, they turn to specialized agricultural products such as sod which is grown locally and does not ship well.

A key issue with sod farming is the long-term removal of the loess cap. Harvesting sod inherently strips away part of the field's soil. Over time, this can lead to a significant loss of soil organic matter. Millar et al. (2010) quantified these losses and measured soil loss rates of about 74 to 114 metric tons per hectare per year on active sod fields in southern Rhode Island, equivalent to roughly 0.8 cm (a third of an inch) of topsoil removed annually. In practical terms, if no mitigation is done, a sod farm could lose an inch of topsoil in only around 3 years of continuous harvests. This contradicts some industry claims that sod farming causes no net soil loss.

Many of the agriculture fields that URI owns are leased to local sod companies for a fraction of their real value. Additionally, the sod companies have been known to strip the loess and leave the fields barren once their lease is up.

See below for some image showing plowing, harvesting, and eolian erosion of sod fields in nearby Slocum.

Above: Erosion while plowing a sod field. Dust cloud circled in red. Winds were < 5 mph.

Pattern ground and ice wedge casts:

Directly after glaciation, Rhode Island experienced a periglacial period wherein the climate was similar to that of modern-day Alaska and northern Canada. Soils/sediments in the area were subject to a number of intense freeze-thaw cycles and permafrost. Ice-wedge casts (IWCs) are the remnants of epigenetic ice wedges that once occupied contraction cracks in permafrost. During periglacial winters, tensile stresses opened polygonal networks of vertical fissures in the frozen active layer; spring meltwater infiltrated these cracks and refroze, building composite ice veins that widened episodically by a few mm each year. The result is a wedge-shaped body of ice, commonly 0.3-1.5 m wide at the palaeosurface and tapering to a point 2-6 m below it. When regional climate warms and the permafrost table descends or disappears, the ice melts out, and leaves open voids that collapse and are infilled by overlying loess. These sediment-filled voids now appear as V-shaped structures that sharply truncate underlying stratification yet retain an internal infill distinct from surrounding soil, making them reliable indicators of former permafrost rather than tectonic fracturing or liquefaction features.

Because freeze-thaw cracking repeats on a hexagonal grid, individual ice wedges meet at roughly 120-degree junctions, producing a surface mosaic known as non-sorted polygons, generally termed as patterned ground. The patterned ground suite thus provides a spatially coherent record of cryogenic processes that operated during and after ice-sheet retreat. Here, the polygon network is visible on aerial imagery and in ground-penetrating-radar profiles.

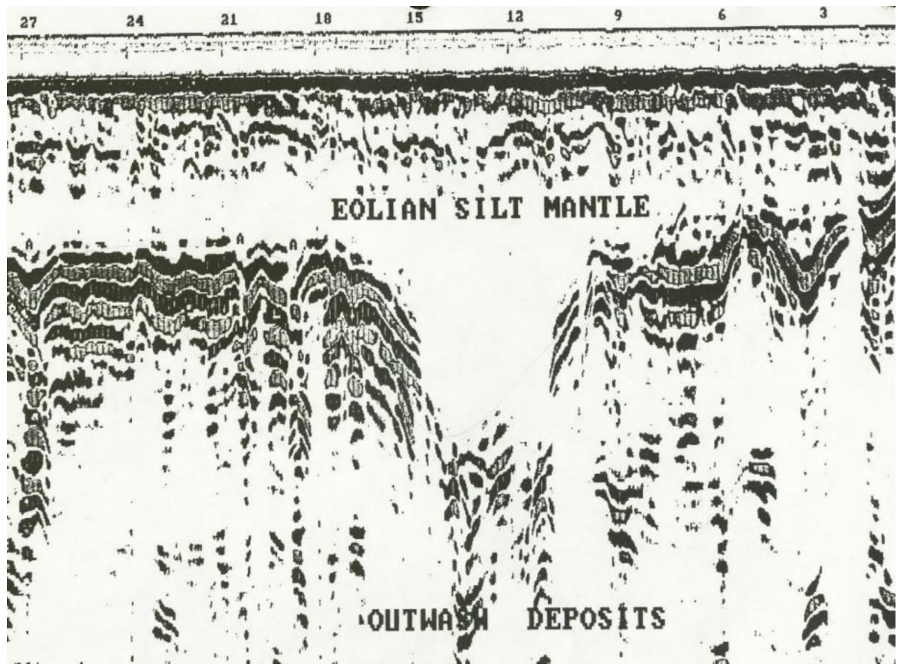
Pedologically, IWCs and other patterned-ground features disrupt horizon continuity, mix contrasting textures, and channel water and roots along wedge fills. Where loess blankets the polygon center more thickly than the rims, meter scale variations in bulk density, moisture regime, and nutrient availability develop, complicating soil classification and land-use interpretations. Cryoturbated zones may exceed a meter in thickness beneath polygon surfaces, overprinting original glaciofluvial bedding. Recognizing relict cryogenic structures is essential for accurate soil mapping. This can be seen in the soil maps of the Peckham Farm outwash plain where map-units follow these paleo river bars from the outwash streams. See Stone, J. R., & Ashley, G. M. (1992). Ice-wedge casts, pingo scars, and the drainage of glacial Lake Hitchcock. http://nesoil.com/upload/IceWedge1.pdf.

Patterned ground at Pekham Farm. The thin green lines were the relic fissure cracks that filled with loess.

The broad wavy and elongated areas were the braided outwash channels later covered with loess.

Use of ground penetrating radar in soil mapping:

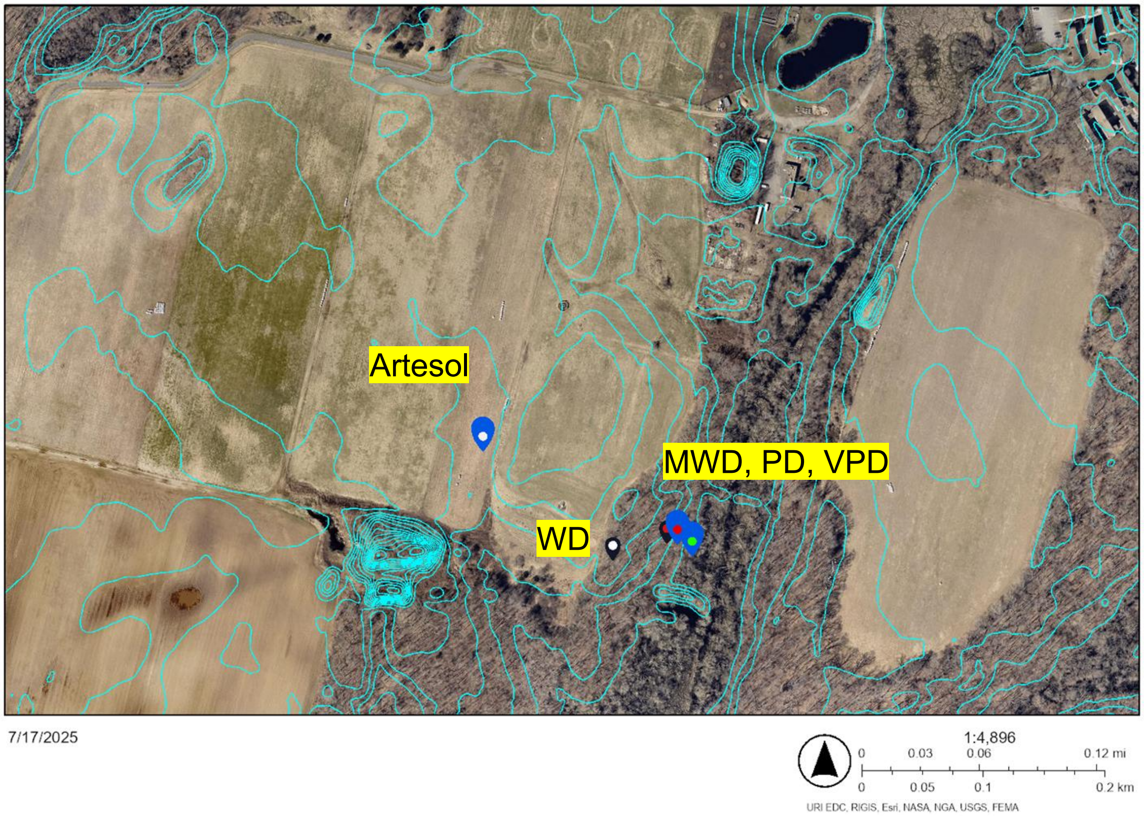
Ground-penetrating radar (GPR) transmits short electromagnetic pulses (typically in the 50 to 1000 MHz range) into the ground and records the travel time and amplitude of reflections generated where dielectric permittivity changes, such as at soil-horizon boundaries, textural contrasts, water tables, or stone lines. In pedologic surveys this allows non-invasive imaging of solum thickness, buried A or O horizons, changes in bulk density (dense till), and abrupt lithologic discontinuities with vertical resolutions on the order of a few centimeters. Because signal attenuation increases with electrical conductivity, penetration depths vary from >10 m in dry dune sands to <0.5 m in saline coastal marshes (why we can't use it to map peat thickness in tidal marshes); selecting lower antenna frequencies (e.g., 200 MHz) sacrifices resolution but extends depth, whereas higher frequencies (e.g., 900 MHz) resolve fine stratigraphy in loess, turfgrass root zones, or archaeological topsoil.



Above: GPR output showing IWC.

Below: Ice-wedge cast.

2022 aerial imagery and 2 ft contours



Aquasol proposal discussion:

The proposed Aquasol order classifies mineral soils that remain saturated within 30 cm of the mineral soil surface for a sufficient duration to become strongly biochemically reducing. These conditions lead to the development of clear morphological indicators of wetness, such as gleyed colors, redox depletions, and concentrations. Soils meeting this definition generally align with very poorly or poorly drained classifications and support hydrophytic vegetation while excluding most mesophytic crops unless artificially drained. (see the abbreviated proposal in the supplemental materials)

The proposal addresses a long-standing gap in Soil Taxonomy by formally recognizing soils where water moves so slowly that persistent saturation dominates their behavior, function, and appearance. Current classification systems capture some of these soils within "aquic" suborders, but the Aquasol concept requires stricter criteria, particularly shallower saturation and more definitive redox features. The classification criteria for Aquasols are based on established definitions of aquic conditions, morphological indicators like gleying and mucky textures, and additional qualifiers like histic or spodic horizons, sulfidic materials, or persistent surface inundation.

To test the proposal, over 160 soil series from aquic suborders were evaluated, specifically those classified as very poorly drained (VPD), poorly drained (PD), and somewhat poorly drained (SWPD). Of the 83 PD and VPD series examined, over 90% met the Aquasol criteria, confirming the the order's criteria's effectiveness in identifying soils with true aquic behavior. Only about 5% of the SWPD soils were falsely captured, and many of those may have been misclassified to begin with, given their shallow water tables and gleyed morphologies.

The proposed Aquasol order would include multiple suborders (e.g., *Frasaqs, Peraqs, Mollaqs, Vertaqs*) that reflect hydrology, mineralogy, and diagnostic horizons. Aquasols are positioned in the taxonomic key after Histosols and Gelisols and are intended to reflect both soil function and land-use limitations.

Given the contentious nature of the exact definition of an Aquasol, the Aquasol order proposal is currently tabled due to the on-going strife in NCSS caused by the mass layoffs and resignations of federal employees. The authors of the proposal believe it is more important to work together in this time of uncertainty than to butt heads over criteria definitions.

See supplemental information for proposed keys of Entisols and Inceptisols without the SMR at the suborder level. We hope to discuss how the classification of these pits would change given this proposed change. Paper copies will be available.

Peckham Artesol Pit

Originally, we expected to find a loess cap here (we didn't look at aerial imagery or LIDAR, silly us!), but when auguring down we found thick HTM over the original soil surface and had this pit dug in order for the tour. Although there is no direct evidence of when this area was filled, it was likely by sod farmers who were leasing this land from the university. As you see in the 1962 aerial imagery and 2022 hillshade image this area is part of a small drainageway, likely a remnant of the outwash plain. In the 2022 imagery we also see some patterned ground.

Given the morphology of the buried soil, we can assume this area was wetter than the sod farmers would prefer and so they filled the low area with fill, likely from a local source. This resulted in anthrodensic horizons which have perched the water table and has led to the formation of redox features in the HTM.

The buried soil resembles the moderately well drained pit in the woods, and the original soil surface at this pit is approximately 30 cm above the soil surface of the moderately well drained pit. Notably, there is no apparent loess cap in the moderately well drained pit nor this pit. This is likely caused by water erosion given that this would have been a drainageway. It is also possible that this soil's loess cap was mined and sold or used elsewhere by the sod company that leased the land.

Note: Not a densic contact @ ^Cd as we found roots in the matrix within and below the horizon.

Mineral soil surface: 32.24 m.

Classification 2022 KST: Coarse-loamy, mixed, active, mesic Anthroportic Udorthent

Classification proposed: Coarse-loamy, mixed, spolic, mesic, udic family of Typic Haplortharts

Peckham Artesol

Field Morphology

Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments	Structure	Consistence	Redox Features	Parent Material	Notes
^A	0	5	CS	10YR 3/4	SL	5 - F/M SR GR	1 M GR	FR	N	Local HTM	-
^Ap	5	25	CS	10YR 3/4	SIL	5 - F/M SR GR	1 M SBK	FR	N	Local HTM	-
^C	25	38	AS	10YR 4/4	SIL	5 - F/M SR GR	0 MA	FR/FI	C D Masses	Local HTM	Relic and active iron masses. Roots
^Cd	38	58	CS	10YR 5/4	SIL	10 - F/M SR GR	0 MA	FR/FI	C D Masses	Local HTM	Relic and active iron masses. Roots
^C'	58	88	AB	85% 10YR 5/4 10% 3/3 5% 10YR 6/4	L	3 - F/M SR GR	0 MA	FI	N	Local HTM	Roots.
Apb1	88	96	AB	7.5 YR 3/2	SL	3 - F/M SR GR	1 M SBK	FR	N	Outwash	Intermittent and sometimes mixed in with horizon below.
Apb2	96	104	AW	7.5YR 2.5/2	SL	3 - F/M SR GR	1 M SBK	FR	N	Outwash	Sometimes mixed with horizon above depending where you are in the profile.
Bwb1	104	125	CS	7.5YR 4/4	SL	5 - F/M SR GR	1 M SBK	FR	N	Outwash	-
Bwb2	125	142	CS	7.5 YR 5/4	SL	10 - F/M SR GR	1 CO SBK	FR	N	Outwash	-
BCb	142	147	AW	10YR 5/6	VGR LS	40 - F/M SR GR	1 F SBK	VFR	N	Outwash	Stone line
C1	147	179	CS	7.5YR 5/6	S	8 - F/M SR GR	0 SG	LO	C D Masses	Outwash	-
C2	179	179+	-	10YR 6/4	COS	8 - F/M SR GR	0 SG	LO	N	Outwash	-

Lab Data

Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk Density
^A	51.94	43.45	4.61	6.48	-	9.47	7.53	11.92	9.62	13.39	39.98	3.47	5.37	2.8461	1.14
^Ap	42.02	51.85	6.13	7.18	-	4.54	7.48	11.84	8.31	9.84	50.91	0.94	4.1	2.173	1.58
^C1	38.99	54.6	6.41	7.21	-	3.73	6.78	11.13	7.71	9.64	50.5	4.1	3.62	1.9186	1.61
^Cd	39.24	56.8	3.96	7.03	-	4.16	6.95	11.83	7.41	8.88	52.54	4.26	3.78	2.0034	1.68
^C`	49.11	43.6	7.29	6.32	-	5.51	10.72	16.06	8.63	8.19	40.04	3.56	4.38	2.3214	1.49
Apb1	47.85	46.09	6.06	6.29	-	4.94	11.88	17.55	8.9	4.59	40.13	5.96	6.11	3.2383	1.46
Apb2	56.34	35.56	8.1	6.28	-	5.1	16.05	20.78	10.2	4.21	28.49	7.07	9	4.77	1.31
Bwb1	53.36	39.46	7.18	6.32	-	4.73	9.52	24.63	9.24	5.25	33.3	6.16	2.79	1.4787	1.42
Bwb2	63.69	30.23	6.08	6.49	-	9.03	13.92	21.19	14.03	5.51	26.71	3.52	3.31	1.7543	1.45
BCb	78.28	17.4	4.32	6.56	-	6.67	42.73	22.42	5.11	1.36	-	-	1.09	0.58	-
C1	96.21	1.78	2.01	6.66	-	19.19	35.77	27.49	15.13	1.65	-	-	0.68	0.36	1.55
C2	96.49	1.69	1.82	6.58	-	7.92	48.88	38.22	1.47	0	1.2	0.49	0.71	0.3763	1.52

Peckham Well Drained Pit

Correlated as the Riverhead series, this pit does not appear to have been farmed in the last 90 years when looking at aerial imagery but there is evidence of plowing. See below for a description and lab data from 2018. Note this pit has likely moved ~10 feet since that description.

Mineral soil surface: 32.52 m

Discussion on classification without SMR. See keys.

Classification 2022 KST: Sandy, mixed, active, mesic Humic Dystrudept

2013 KSSL Lab Report: https://tinyurl.com/39t98fs8

2013 Description: https://tinyurl.com/4b3pna74

Oe—0 to 4 centimeters (0.0 to 1.6 inches); black (5YR 2.5/1) moderately decomposed plant material; many very fine roots throughout and many fine roots throughout; fragments; ultra acid, pH 3.4, pH meter; abrupt smooth boundary. Lab sample # RI1309171; observed in pit, small

Ap—4 to 19 centimeters (1.6 to 7.5 inches); very dark grayish brown (10YR 3/2) sandy loam; 50 percent sand; 47 percent silt; 3 percent clay; weak medium subangular blocky structure; friable; few medium roots throughout and common fine roots throughout; 1 percent by volume , 1 percent by weight nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by weighed method; extremely acid, pH 4.0, pH meter; abrupt smooth boundary. Lab sample # RI1309172; observed in pit, small. Small (0.5 cm) of A horizon overlying Ap. 10YR 2/1, fsl. 1mGR, Many VF roots

Bw1—19 to 34 centimeters (7.5 to 13.4 inches); brown (10YR 4/3) sandy loam; 55 percent sand; 43 percent silt; 2 percent clay; weak medium subangular blocky structure; friable; few medium roots throughout and few fine roots throughout; 1 percent by volume , 2 percent by weight nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by weighed method; extremely acid, pH 4.3, pH meter; clear smooth boundary. Lab sample # RI1309173; observed in pit, small

Bw2—34 to 70 centimeters (13.4 to 27.6 inches); yellowish brown (10YR 5/4) coarse sandy loam; 67 percent sand; 31 percent silt; 2 percent clay; weak medium subangular blocky structure; friable; few fine roots throughout; 1 percent by volume , 2 percent by weight nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by weighed method; very strongly acid, pH 4.5, pH meter; clear smooth boundary. Lab sample # RI1309174; observed in pit, small

Bw3—70 to 98 centimeters (27.6 to 38.6 inches); yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; 1 percent by volume nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by visual inspection method; clear smooth boundary.; observed in pit, small

Bw4—98 to 122 centimeters (38.6 to 48.0 inches); yellowish brown (10YR 5/4) loamy coarse sand; weak medium subangular blocky structure; very friable; 5 percent by volume nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by visual inspection method; clear wavy boundary.; observed in pit, small

C—122 to 200 centimeters (48.0 to 78.7 inches); dark grayish brown (2.5Y 4/2) coarse sand; structureless single grain; loose; 10 percent by volume nonflat subrounded indurated 2-39-75 millimeter unspecified fragments observed by visual inspection method.; observed in pit, small

Peckham Moderately Well Drained Pit

Note the dark inclusion to the bottom left of the pit. The LOI for the dark area is ~2.90% while the Bw directly above it is ~1.65% with no apparent difference in PSD. This pit may be on the line of the original plow line, as the wetland boundary is directly to the east by a few feet. Also note the very abrupt boundary of the Ap2 boundary to the left.

Mineral soil surface: 30.70 m

Discussion on classification without SMR. See keys.

Classification 2022 KST: Coarse-loamy, mixed, active, mesic, Oxyaquic Dystrudept

Classification proposed: Coarse-loamy, mixed, active, mesic, udic Oxyaquic Humidystrepts

Peckham Poorly Drained Pit

Discussion on Aquasols. See information and proposed keys below. Description below. E horizon is intermittent and some inclusions in and below E have higher ODOE than the surrounding area, on the line of making spodic materials.

The pits in this area have very intermittent morphology and horizons come and go, we hoped this profile would be more reliable but unfortunatly that is not the case. Observe both the main pit face but also the face to the left and right. Some areas have more prominent E horizons. This soil is fairly indicative of marginal soils found on the lines of wetlands in Rhode Island.

Although the surface of the White Horn Brook floodplain lies a few feet to the east, there are no buried soils in this profile (or on the flood plain). The surface of the flood plain is 10 - 20 cm lower than the mineral soil surface of this poorly drained pit.

Organic soil surface: 30.26 m

Discussion on Aquasols. See proposed keys and edited proposal.

Classification 2022 KST: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Aeric Alaquods

Classification proposed: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Aeric Alaspodaq

Peckham Sudbury

Classification:

Field Morphology

Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consis tence	Redox	Parent Material	Notes
Oe	0	3	AS	7.5YR 2.5/2	MPT	0	-	-	-	-	-
AE	3	6	AS	7.5YR 2.5/1	FSL	2 - F SR GR	1 F SBK	VFR	N	Outwash	-
Ap1	6	12	AB	7.5YR 3/2	SL	2 - F SR GR	1 M SBK	FR	N	Outwash	-
Ap2	12	23	AS	7.5YR 3/3	SL	2 - F SR GR	1 M SBK	FR	N	Outwash	Very Abrupt boundary to left. Intermitent.
Bw1	23	40	CS	10YR 5/6	SL	8 - F/M SR GR	1 CO SBK	FR	C D Masses	Outwash	-
Bw2	40	57	CS	10YR 5/6	LS	8 - F/M SR GR	1 CO SBK	FR	C D Masses, & Depletions	Outwash	Dark inclusion below. Estimated C% = 2.90%
BC	57	76	GS	2.5Y 4/4	S	8 - F/M SR GR	1 M SBK to 0 SG	VFR	M D Masses, & Depletions	Outwash	-
C1	75	105	GS	2.5Y 5/3	S	10 - F/M SR GR	0 SG	LO	M P Masses	Outwash	-
C2	105	105+	-	2.5Y 5/2	S	10 - F/M SR GR	0 SG	LO	M P Masses	Outwash	-

Lab Data

Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk Density
Oe	-	-	-	3.88	-	-	-	-	-	-	-	-	91.58	45.79	-
A	65.42	26.68	7.9	4.16	0.46	3.95	9.74	18.23	27.68	5.83	22.88	3.8	11.52	5.76	1.07
Ap1	62.41	29.63	7.96	4.8	0.43	4.04	14.44	20.05	19.62	4.26	25.65	3.98	9	4.5	1
Ap2	62.73	30.91	6.36	4.92	0.2	6.64	17.33	17.77	17.65	3.34	27.87	3.04	4.12	2.06	1.14
Bw1	75.62	15.99	4.98	5.05	0.42	3.14	11.29	38.59	18.67	3.92	15.22	0.77	4.09	2.05	1.21
Bw2	75.92	18.95	5.13	4.92	-	3.79	11.11	35.9	21.41	3.71	17.3	1.65	3.77	1.89	1.31
BC	89.53	5.43	5.04	4.97	-	1.42	6.67	54.73	23.46	3.25	5.06	0.37	1.87	0.94	1.5
C1	92.72	4.32	2.96	4.87	-	-	-	-	-	-	2.65	1.33	0.21	0.11	-
C2	94.69	3.12	2.19	4.76	-	-	-	-	-	-	2.18	0.94	0.19	0.1	-

Peckham PD

Classification:

Field Morphology

Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes
Oe	0	7	AS	10YR 2/1	MPT	-	-	-	-	-	-
A	7	20	AS	7.5YR 2.5/1	SL	5 - F SR GR	1 F SBK	CFR	F F Pore Linings	Outwash	-
A/E	20	25	CS	7.5YR 2.5/1 & 10YR 5/3	SL	5 - F SR GR	1 M SPK	FR	N	Outwash	Intermittent
Bhs	25	53	CS	7.5YR 4/4	SL	10 - F/M SR GR	1 F SPK	FR	N	Outwash	Intermittent
Bw	53	70	CS	7.5YR 5/4 OR 10YR 4/4	GR LS	20- F/M SR GR	1 M SPK	FR	C D Masses	Outwash	-
Cg	70	70+	-	10YR 4/2	GR S	20- F/M SR GR	0 SG	LO	C D Masses	Outwash	-

Lab Data

Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk density
Oe	-	-	-	-	-	-	-	-	-	-	-	-	93.92	49.7776	-
A	78.36	11.8	9.84	3.34	0.36	2.37	8.54	12.69	33.31	21.46	7.41	4.39	-	-	0.79
A/E	68.44	24.84	6.72	4.9	0.13	2.37	8.54	12.69	33.31	21.46	22.29	2.55	3.24	1.7172	1.27
Bhs	68.11	23.39	8.5	4.23	0.29	4.65	13.15	28.48	17.11	5.05	21.49	1.9	7.15	3.7895	1.29
Bw	85.79	12.12	2.09	3.54	0.15	4.49	14.73	27.03	17.11	4.75	-	-	2.01	1.0653	1.34
Cg	92.26	4.53	3.21	3.65	-	2.04	12.3	38.29	27.11	6.05	3.32	1.21	1.62	0.8586	1.47

Peckham VPD Trays

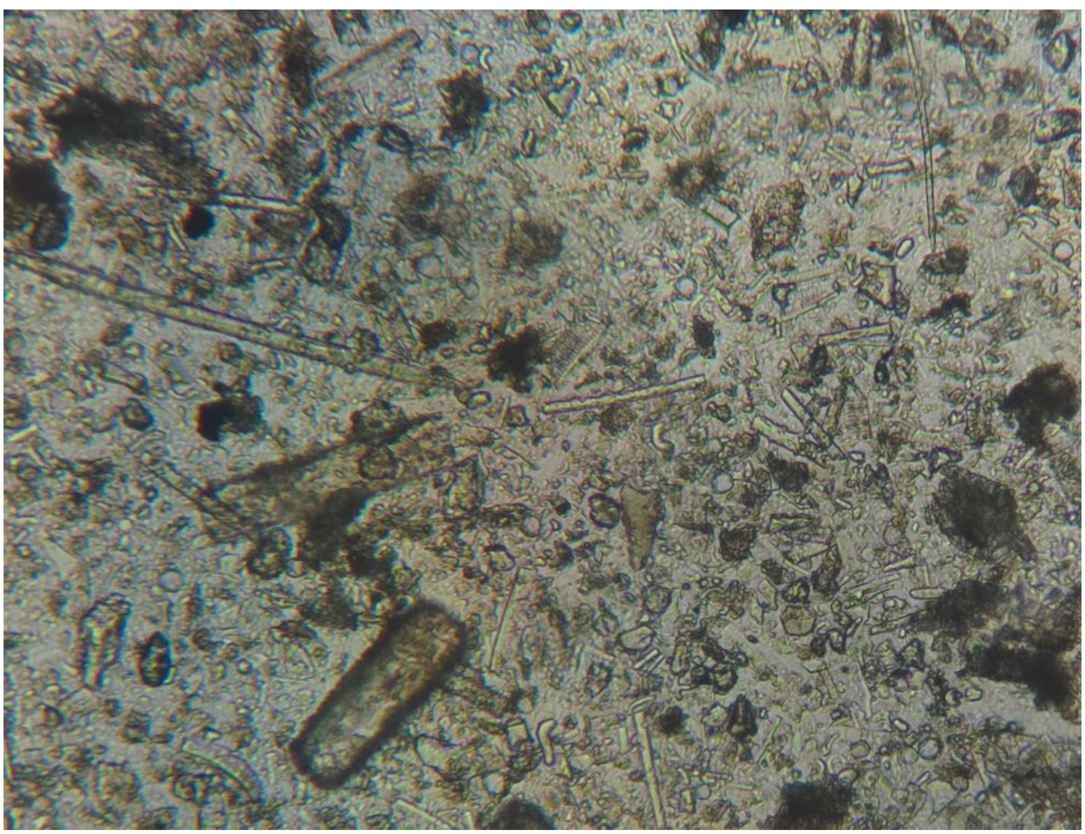
Note the thin horizon of higher clay material. When running PSA on it we got ~12% clay which is remarkably high for Rhode Island. We are interpreting this as alluvium from White Horn Brook. We have also found evidence of quasi-limnic materials incorporated into the lower portion of the histic epipedon. Diatomaceous earth appears to make up the majority of 5-10% of the 30-35 cm horizon in this soil. The brook was likely impounded by beavers for a period of time which allowed finer mineral material to settle out and created this peculiar horizon. Images below (200x) of some of the diatoms found in the mineral/organic contact. Pieces of the inclusions will be passed around. Matt Ricker found a continuous horizon of diatomaceous earth about a quarter mile upstream. Matt has provided us with SEM images of the diatoms he found, and we have also included a 220X image of the diatomaceous earth. Notes the high quantity of diatoms and their skeletons which make up the majority of the particles in the sample.

2 separate profiles shown here: a Terric Haplosaprist and a Histic Humaquept

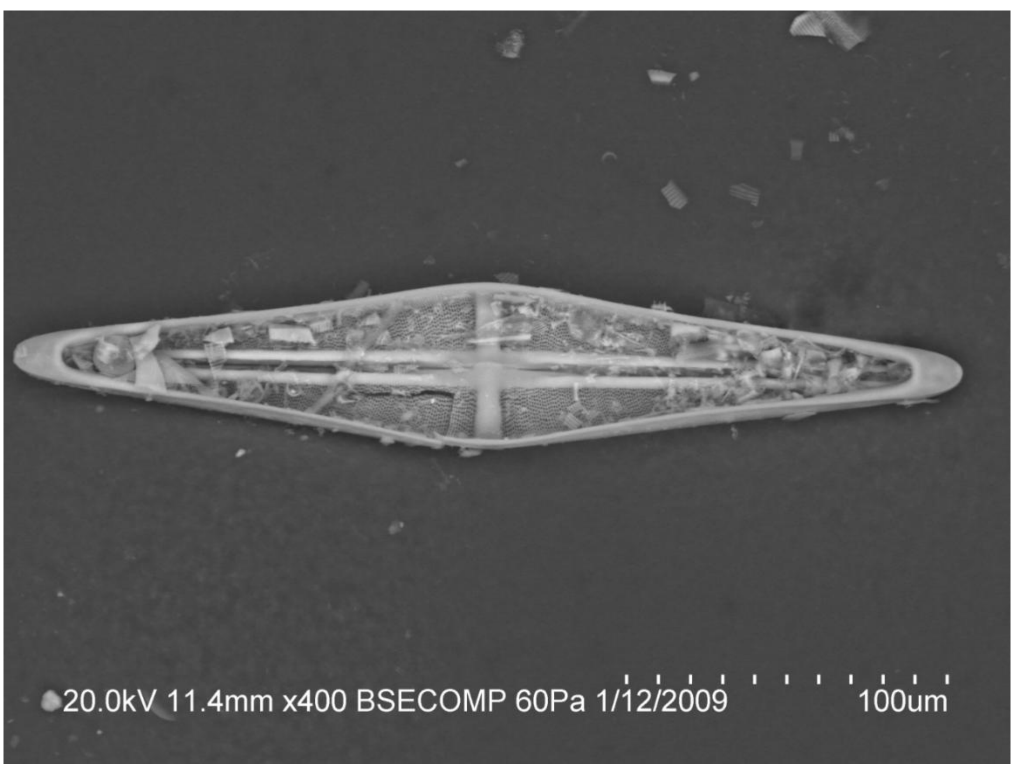
Proposed classification: Histic Humiperaq

Discussion on Aquasol. 35 cm organics would make Aquasol. We also have a tray of soil from closer to the brook that does make Terric Haplosaprist. See information and keys in the supplementals.

Organic soil surface: ~29.95 m




20.0kV 11.3mm x470 BSECOMP 60Pa 1/12/2009
100um


20.0kV 11.4mm x400 BSECOMP 60Pa 1/12/2009
100um

Peckham VPD											
Classification:											
Field Morphology											
Horizon	Upper Depth	Lower Depth	Boundary	Matrix Color	Texture	Coarse Fragments (Vol %)	Structure	Consistence	Redox	Parent Material	Notes
Oa	0	30	A	N 2.5/	MUCK	0	-	-	N	Woody herbaceous materials	Free water @ 10 cm
Oa/Ldi	30	35	C	90% N 2.5/ 10% 2.5Y 5/3	MUCK	-	-	-	N	Lacustrine deposit	10% apparent diatomaceous earth. Meets color requirements. Diatoms observed under microscope
Cg1	35	45	A	2.5Y 5/2	L	10 - F SR GR	0 MA	FR	N	Lacustrine deposit	Marked alluvium because of texture difference. Diatoms found at contact of Oa/Ldi and mineral soil surface
2Cg2	45	45+	-	2.5Y 5/1	GR SL	25 - F/M SR GR	0 SG	LO	N	Outwash	Stratified. Some stratifications are VGR.

Lab Data															
Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS%	CS%	MS %	FS %	VFS %	Coarse Silt %	Fine Silt%	550*C LOI %	Estimated C %	Bulk Density
Oa	-	-	-	-	-	-	-	-	-	-	-	-	64.37	34.11	-
Oa/Ldi	-	-	-	-	-	-	-	-	-	-	-	-	65.12	34.51	-
Cg1	41.74	45.39	12.87	3.89	-	10.72	11.45	12.81	5.13	1.62	43.3	2.09	9.61	5.1	-
2Cg2	61.05	34.99	3.96	3.53	-	7.61	13.67	20.85	11.99	6.92	32.28	2.71	1.55	0.82	-

Day 2.

Wednesday, July 30. National Cheesecake Day:

Stop 1: 7:30 – 9:30. East Farm. Rainbow North, Rainbow West, Rainbow Bees, Rainbow East. **Bathroom available.**

Stop 2: 9:50 – 11:20. Great Swamp. Merrimac, Ortstein.

Lunch: In vans on the way to deCoppet or Alton Jones. **Bathrooms available** (gas stations, coffee shops).

Stop 3: 11:45 – 1:15. deCoppet gravel pit. Hinckley, Discharge Pit, Artesol.

Stop 3.5: Drive along eastern edge of kame terrace to the next location.

Stop 4: 1:30 – 2:30. deCoppet Canton. Forestry study

Lunch and or bathroom break if needed: Truck stop off I-95 on the way to Alton Jones.

Stop 6: 2:50 – 5:00. Alton Jones. Esker, Floodplain, Kame Terrace Bridgehampton, Paxton, Woodbridge, Spodosol.

Social. 5:00. Environmental Education Center, Alton Jones Campus. Will have pizza, oysters, and. **Bathrooms available off site @ truck stop ~6 mins away.** Plenty of woods otherwise.

Overview

To start the day we will meet at East Farm, an 85-acre URI Agriculture Experiment Station Farm that is primarily used by the URI Master Gardeners, URI Entomology, and Commercial Fisheries Research Foundation. There are three separate pits which all mapped as the Rainbow series. The next stop is at Great Swamp Management Area to discuss climate change, SOM decomposition, and IRIS devices. In the late morning move over to Richmond where we will see a few pits in the deCoppet Estate: Artesol, discharge soil, a typical Hinkley series, and a Canton pit. Our discussion of climate change will switch to a forestry-oriented approach and discuss the ongoing forestry concerns in Rhode Island. After this, we will move north to the Alton Jones Campus of URI to see multiple pits typical of Rhode Island soils. We will have our social here as well.

Stop 1

Parking: Park in parking lot at 41.473435, -71.513816. If you are in a sedan, beware the speed bump may bottom you out. We will condense down and drive up to the pits.

Notes: There are active honey bee hives between the western and eastern pits (closest to the "Rainbow Bees" pit… hence the name). They typically do not care about people, but if you are allergic please be mindful not to walk too close to the hives.

East Farm History:

Colonial pasture became an agricultural station in 1928 when Rhode Island State College bought the land for orchard and poultry trials. After this purchase, McIntosh and Rhode Island Greening apple trees were planted, and multiple 200-foot chicken houses were built.

The farm continued expanding with freshwater aquaculture tanks in being added in 1971, fisheries labs in the 1990s. Today, East Farm is quieter than it once was but its 85 acres of meadows, woodlots, and wetlands are primarily used by the URI Entomology Department and the URI Master Gardeners.

East Farm Rainbow Series Catena

Given the hillslope positions of these pits it should come as no surprise that they progressively get wetter from east to west. The Eastern most pit is rarely if ever wet, the middle pit is often wet early in the season, and the western most pit is often wet until well after full leaf out. Below are descriptions and lab data from 2018.

All 4 of these pits currently classify as Coarse-loamy, mixed, active, mesic Humic Densiudepts but under our proposed classification without SMR Rainbow North and East would classify as Coarse-loamy, mixed, active, mesic, udic Densic Aquidystrepts while West and Bees would classify as Coarse-loamy, mixed, active, mesic, udic Densic Aquihumepts.

Silt Caps:

In till, you can often find coarse fragments which have an apparent "silt cap". These coatings are interpreted as having formed either during subglacial transport, where pressure and friction may cause matrix fines to smear or adhere to stone surfaces, or during post-depositional processes such as chemical weathering or soil formation. These thin layers are particularly common in dense tills and may act as a record of the depositional environment.

Some of these coatings are enriched in Fe and Al oxides, especially around clasts and along voids. Fluctuating redox conditions mobilize and reprecipitate these elements at clast boundaries. The resulting coatings resemble illuvial silt or Fe-oxide skins. See image and interpretation by Dr. Stone below.

https://www.youtube.com/shorts/DZIkRs4zdOU

Another interpretation (favored by us geologically inept pedologists) is that these stones were thrust up through the soil/sediment by frost heave and compacted fine material above the stone, which subsequently stuck to the top of the stone as we see today. This interpretation is supported when we find rocks like these on top of each other with silt caps, but no silt coatings on the side of either rock. Multiple examples will be available at Rainbow East and West.

Western Pit:

2018 KSSI Lab Report: https://tinyurl.com/4cpfsn2s

2018 Description: https://tinyurl.com/w4mstbmk

Middle Pit:

2018 KSSI Lab Report: https://tinyurl.com/mrcpmera

2018 Description: https://tinyurl.com/3nsccfh7

Eastern Pit:

2018 KSSI Lab Report: https://tinyurl.com/5dn6eu2c

2018 Description: https://tinyurl.com/yz9kahf6

No description of Northern Pit.

Rainbow North

This pit is consistently wetter than the 3 pits to the south.
Classification 2022 KST: Coarse-loamy, mixed, active, mesic Humic Densiudepts
Classification proposed: Coarse-loamy, mixed, active, mesic, udic Densic Aquidystrepts

HORIZONATION				BOUNDARY		COARSE FRAGMENTS AND TEXTURE			COLOR			STRUCTURE		CONSIST	REDOXIMORPHIC FEATURES						SCORE
Pre	Master	Sub	No	Depth (cm)	Dist.	Coarse Fragment Roundness	Coarse Fragment Modifier	Fine-Earth Class	Hue	Value	Chroma	Grade	Type	Moist	Depletions Y/N	Depletions Abun	Depletions Contr	Concentrations Y/N	Concentrations Abun	Concentrations Contr	
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(42)
–	A	p	–	25	A	SA 5	–	SiL	10YR	2	2	1	** SBK	fr	N	–	–	Y	C	P	
–	B	w	–	39	C	SA 3	–	SiL	10YR	5	4	1	SBK	fr	Y	C	P	Y	C	D	
–	B	g	–	55	C	SA 3	–	SiL	2.5Y	5	2	1	SBK	fr	N	–	–	Y	C	P	
–	B'	w	–	67	A	SA 5	–	SiL	7.5YR	5	6	1	SBK	fr	Y	C	P	Y	C	D or F	
–	B'	g	–	104	A	SA 20	CB	SiL	2.5Y	5	2	1	SBK	fi	N	–	–	Y	M	P	
2	C	–	–	116	A*	SA 40	VGR	CoSL	10YR	4	4	0	MA	fr	N	–	–	Y	M	D	

B. PROFILE CHARACTERISTICS * DENSIC CONTACT @ * UPPER PART HAS SOME GRANULAR

Rainbow East

*** Primary Characterization Data ***

Pedon ID: S2018RI009006 — (Washington, Rhode Island) — Print Date: Jul 25 2025 10:56AM

Sampled as on Oct 16, 2018: Rainbow ; Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
Revised to :

SSL
- Project C2019USRI012 2019 NCSS National Conference - MLRA144A
- Site ID S2018RI009006 Lat: 41° 28' 30.63" north Long: 71° 30' 49.48" west MLRA: 144A
- Pedon No. 19N0057
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
19N00308	A	A	0-3	S2018RI009006-1			HO-SIL	
19N00309	Ap	Ap	3-22	S2018RI009006-2			SIL	SIL
19N00310	Bw1	Bw1	22-35	S2018RI009006-3			SIL	SIL
19N00311	Bw2	Bw2	35-60	S2018RI009006-4			SIL	SIL
19N00312	BC	BC	60-92	S2018RI009006-5			SIL	SIL
19N00313	2Cd	2Cd	92-116	S2018RI009006-6			GRV-SL	LS

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	18	% wt
Volume, >2mm, Weighted Average	3	% vol
Clay, carbonate free, set 2, Weighted Average	4	% wt
Clay, total, set 2, Weighted Average	4	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 7	0.94	(NA)

Weighted averages based on control section: 25-92 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Lab Text-ure	-2- Total Clay < .002	-3- Total Silt .002 -.05	-4- Total Sand .05 -2	-5- Clay Fine < .0002	-6- CO_3 < .002	-7- Silt Fine .002 -.02	-8- Silt Coarse .02 -.05	-9- Sand VF .05 -.10	-10- Sand F .10 -.25	-11- Sand M .25 -.50	-12- Sand C .5 -1	-13- Sand VC 1 -2	-14- Rock Fragments Weight 2 -5	-15- Weight 5 -20	-16- Weight 20 -75	-17- Weight .1- 75	-18- >2 mm wt % whole soil
					(% of <2mm Mineral Soil) 3A1a1a					3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a	(% of <75mm)				
19N00308	0-3	A	S														--	--	--	--	--
19N00309	3-22	Ap	S	sil	6.1	61.1	32.8			25.2	35.9	16.7	5.4	4.5	3.3	2.9	2	1	8	25	11
19N00310	22-35	Bw1	S	sil	4.1	62.4	33.5			23.4	39.0	20.3	4.3	4.5	2.6	1.8	2	3	1	18	6
19N00311	35-60	Bw2	S	sil	3.4	58.3	38.3			23.3	35.0	25.7	5.2	4.0	2.6	0.8	2	2	tr	16	4
19N00312	60-92	BC	S	sil	3.4	63.1	33.5			23.2	39.9	18.7	5.2	4.3	2.9	2.4	3	3	--	20	6
19N00313	92-116	2Cd	S	ls	0.6	17.5	81.9			6.2	11.3	16.1	26.0	20.3	12.7	6.8	10	18	1	76	32

*** Primary Characterization Data ***

Pedon ID: S2018RI009006 — (Washington, Rhode Island) — Print Date: Jul 25 2025 10:56AM

Sampled As : Rainbow — Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 19N0057

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- Bulk Density 33 kPa	-2- Bulk Density Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Air Dry-Oven Dry Ratio	-10- Corrected	-11- WRD Whole Soil	-12- Aggst Stabl 2-0.5mm	-13- Ratio/Clay CEC7	-14- Ratio/Clay 1500 kPa
				($g\ cm^{-3}$) DbWR1	DbWR1		(pct of < 2mm)		DbWR1	3C2a1a		3D1		$cm^3\ cm^{-3}$	%		
19N00308	0-3	A	S							67.6		1.049					
19N00309	3-22	Ap	S							10.2		1.021				2.26	1.67
19N00310	22-35	Bw1	S	1.18	1.21	0.008			28.2	4.6		1.012		0.27		1.12	1.12
19N00311	35-60	Bw2	S	1.27	1.30	0.008			25.6	3.4		1.009		0.28		0.91	1.00
19N00312	60-92	BC	S	1.45	1.48	0.007			20.0	3.0		1.007		0.24		0.91	0.88
19N00313	92-116	2Cd	S	1.76	1.78	0.003			8.9	0.6		1.001		0.11		--	1.00

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- Total C	-2- Total N	-3- Total S	-4- Est OC	-5- OC (WB)	-6- C/N Ratio	-7- Dith-Cit Ext Fe	-8- Dith-Cit Al	-9- Dith-Cit Mn	-10- Ammonium Oxalate Extraction Al+½Fe	-11- ODOE	-12- Fe	-13- Al	-14- Si	-15- Mn	-16- Na Pyro-Phosphate C	-17- Fe	-18- Al	-19- Mn
				(% of <2 mm) 4H2a	4H2a	4H2a				(% of < 2mm)				4G4	4G4	4G4	4G4	mg kg^{-1} 4G4	(% of < 2mm)			
19N00308	0-3	A	S	27.08	1.76	0.22	27.1		15				0.58	0.43	0.30	0.43	0.02	273.0				
19N00309	3-22	Ap	S	4.74	0.30	0.05	4.7		16				0.99	0.35	0.56	0.71	0.10	36.6				
19N00310	22-35	Bw1	S	1.29	0.07	0.02	1.3		18				0.81	0.14	0.37	0.62	0.14	31.4				
19N00311	35-60	Bw2	S	0.44	0.02	0.01	0.4		22													
19N00312	60-92	BC	S	0.24	0.02	0.01	0.2		12													
19N00313	92-116	2Cd	S	--	--	--	--															

SITE
Parent Material: silty loess and/or sandy till

Oa—0 to 3 centimeters (0.0 to 1.2 inches); black (7.5YR 2.5/1) highly decomposed plant material; weak fine granular structure; very friable; 5.0 very fine roots and 5.0 medium roots and 5.0 fine roots; fragments; very strongly acid, pH 4.8, pH meter; abrupt smooth boundary. Lab sample # 19N00308; moist when described; observed in pit, small

Ap—3 to 22 centimeters (1.2 to 8.7 inches); very dark brown (10YR 2/2) silt loam; weak coarse subangular blocky parts to fine granular structure; friable; 3.0 very fine roots and 3.0 very coarse roots and 3.0 medium roots and 3.0 fine roots and 3.0 coarse roots; 6 percent by volume nonflat subangular indurated 2-10-75 millimeter mixed fragments observed by weighed method; very strongly acid, pH 4.7, pH meter; abrupt smooth boundary. Lab sample # 19N00309; moist when described; observed in pit, small

Bw1—22 to 35 centimeters (8.7 to 13.8 inches); dark yellowish brown (10YR 4/4) silt loam; weak coarse subangular blocky structure; friable; 3.0 very fine roots and 3.0 medium roots and 3.0 fine roots and 3.0 coarse roots; 3.0 medium tubular and 3.0 fine tubular pores; 3 percent by volume nonflat subangular indurated 2-10-75 millimeter mixed fragments observed by weighed method; 5 percent krotovinas (volume percent); strongly acid, pH 5.1, pH meter; clear smooth boundary. Lab sample # 19N00310; moist when described; observed in pit, small

Bw2—35 to 60 centimeters (13.8 to 23.6 inches); dark yellowish brown (10YR 4/4) silt loam; weak very coarse subangular blocky, and weak coarse subangular blocky structure; friable; 0.5 very fine roots and 0.5 medium roots and 0.5 fine roots and 0.5 coarse roots; 3.0 medium tubular and 3.0 fine tubular pores; 2 percent medium faint light olive brown (2.5Y 5/3), moist, iron depletions and 5 percent medium prominent strong brown (7.5YR 5/8), moist, masses of oxidized iron; 2 percent by volume nonflat subangular indurated 2-10-75 millimeter mixed fragments observed by weighed method; 3 percent krotovinas (volume percent); strongly acid, pH 5.1, pH meter; clear smooth boundary. Lab sample # 19N00311; moist when described; observed in pit, small

BC—60 to 92 centimeters (23.6 to 36.2 inches); dark yellowish brown (10YR 4/4) silt loam; weak very coarse subangular blocky structure; friable; 0.5 very fine roots and 0.5 medium roots and 0.5 fine roots; 15 percent coarse distinct dark grayish brown (2.5Y 4/2), moist, iron depletions and 20 percent coarse distinct strong brown (7.5YR 4/6), moist, masses of oxidized iron; 3 percent by volume nonflat subangular indurated 2-10-75 millimeter mixed fragments observed by weighed method; strongly acid, pH 5.5, pH meter; clear wavy boundary. Lab sample # 19N00312; moist when described; observed in pit, small

2Cd—92 to 116 centimeters (36.2 to 45.7 inches); grayish brown (2.5Y 5/2) very gravelly loamy sand; structureless massive; firm; 0.5 very fine roots top of horizon and 0.5 fine roots top of horizon; 5 percent coarse faint light brownish gray (2.5Y 6/2), moist, iron depletions and 20 percent coarse prominent yellowish red (5YR 4/6), moist, masses of oxidized iron; 1 percent by volume nonflat subrounded very strongly coherent cemented 250-425-600 millimeter mixed fragments observed by visual inspection method and 2 percent by volume nonflat subrounded indurated 75-162-250 millimeter mixed fragments observed by visual inspection method and 40 percent by volume nonflat subangular indurated 2-10-75 millimeter mixed fragments observed by visual inspection method; slightly acid, pH 6.3, pH meter. Lab sample # 19N00313; moist when described; observed in pit, small

Rainbow Bees

*** Primary Characterization Data ***

(Washington, Rhode Island)

Pedon ID: S2018RI009005

Print Date: Jul 25 2025 10:51AM

Sampled as on Oct 2, 2018: Rainbow ; Coarse-loamy, mixed, active, mesic Aquic Dystrudepts

Revised to :

SSL - Project C2019USRI012 2019 NCSS National Conference - MLRA144A
- Site ID S2018RI009005 Lat: 41° 28' 30.29" north Long: 71° 30' 50.30" west MLRA: 144A
- Pedon No. 19N0056
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
19N00301	A	A	0-12	S2018RI009005-1			SIL	SIL
19N00302	Ap	Ap	12-24	S2018RI009005-2			SIL	SIL
19N00303	Bw1	Bw1	24-34	S2018RI009005-3			SIL	SIL
19N00304	Bw2	Bw2	34-56	S2018RI009005-4			SIL	SIL
19N00305	Cdg	Cdg	56-96	S2018RI009005-5			SIL	SIL
19N00306	Cd1	Cd1	96-104	S2018RI009005-6			LVFS	VFSL
19N00307	2Cd2	2Cd2	104-110	S2018RI009005-7			GR-LVFS	LS

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	7	% wt
Volume, >2mm, Weighted Average	2	% vol
Clay, carbonate free, set 2, Weighted Average	4	% wt
Clay, total, set 2, Weighted Average	4	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 7	0.84	(NA)

Weighted averages based on control section: 25-56 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
					(----- Total ------)			(-- Clay ---)		(---- Silt -----)		(------------ Sand -----------)					(Rock Fragments (mm))				
				Lab Text-ure	Clay < .002	Silt .002 -.05	Sand .05 -2	Fine < .0002	CO_3 < .002	Fine .002 -.02	Coarse .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(-------- Weight --------) 2 -5	5 -20	20 -75	.1- 75	>2 mm wt % whole soil
Layer	Depth (cm)	Horz	Prep		(------------------------ % of <2mm Mineral Soil											------------------------)	(------- % of <75mm ------)				
					3A1a1a					3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
19N00301	0-12	A	S	sil	10.6	73.4	16.0			35.0	38.4	11.9	1.6	1.6	0.8	0.1	--	--	--	4	--
19N00302	12-24	Ap	S	sil	10.2	65.1	24.7			30.6	34.5	16.5	3.2	2.5	1.8	0.7	1	1	2	12	4
19N00303	24-34	Bw1	S	sil	4.8	61.4	33.8			26.2	35.2	28.6	2.2	1.8	0.8	0.4	1	1	1	8	3
19N00304	34-56	Bw2	S	sil	4.4	67.6	28.0			25.7	41.9	23.5	2.1	1.4	0.8	0.2	1	1	tr	6	6
19N00305	56-96	Cdg	S	sil	2.4	76.0	21.6			25.6	50.4	19.6	1.1	0.4	0.2	0.3	tr	tr	2	4	2
19N00306	96-104	Cd1	S	vfsl	1.7	43.2	55.1			12.5	30.7	40.9	7.6	4.1	1.8	0.7	1	2	tr	17	3
19N00307	104-110	2Cd2	S	ls	0.5	15.8	83.7			7.2	8.6	15.2	23.1	21.7	15.9	7.8	9	15	--	76	26

*** Primary Characterization Data ***

(Washington, Rhode Island)

Pedon ID: S2018RI009005

Print Date: Jul 25 2025 10:51AM

Sampled As : Rainbow

Coarse-loamy, mixed, active, mesic Aquic Dystrudepts

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 19N0056

Bulk Density & Moisture

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(Bulk Density) 33 kPa	Oven Dry	Cole Whole Soil	(----------- Water Content 6 kPa	10 kPa	33 kPa	1500 kPa	-----------) 1500 kPa Moist	(Air Dry-Oven Dry) (---- Ratio	----) Corrected	WRD Whole Soil	Aggst Stabl 2-0.5mm	(-- Ratio/Clay --) CEC7	1500 kPa
Layer	Depth (cm)	Horz	Prep	(--- g cm^{-3} ---)			(------------ pct of < 2mm				------------)			cm^3 cm^{-3}	%		
				DbWR1	DbWR1				DbWR1	3C2a1a		3D1					
19N00301	0-12	A	S	1.12	1.19	0.020			36.6	12.7		1.023		0.27		1.74	1.20
19N00302	12-24	Ap	S	1.05	1.10	0.015			41.5	9.3		1.018		0.33		1.28	0.91
19N00303	24-34	Bw1	S	1.22	1.25	0.008			22.2	5.1		1.010		0.21		1.00	1.06
19N00304	34-56	Bw2	S							4.2		1.009				0.77	0.95
19N00305	56-96	Cdg	S	1.53	1.55	0.004			19.3	2.4		1.005		0.26		0.63	1.00
19N00306	96-104	Cd1	S	1.55	1.57	0.004			18.1	1.5		1.004		0.25		0.41	0.88
19N00307	104-110	2Cd2	S							0.4		1.001				--	0.80

Carbon & Extractions

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-
				(----- Total C	N	-----) S	Est OC	OC (WB)	C/N Ratio	(--- Dith-Cit Ext Fe	Al	---) Mn	(------ Ammonium Oxalate Extraction Al+½Fe	ODOE	Fe	Al	Si	------) Mn	(--- Na Pyro-Phosphate C	Fe	Al	---) Mn
Layer	Depth (cm)	Horz	Prep	(---------- % of <2 mm				---------)		(------------------ % of < 2mm						----------------)	mg kg^{-1}	(------ % of < 2mm			-----)
				4H2a	4H2a	4H2a								4G4	4G4	4G4	4G4	4G4				
19N00301	0-12	A	S	4.96	0.40	0.06	5.0		12				0.91	0.29	0.49	0.66	0.12	153.8				
19N00302	12-24	Ap	S	3.03	0.23	0.04	3.0		13				0.84	0.25	0.46	0.61	0.10	118.0				
19N00303	24-34	Bw1	S	0.73	0.06	0.01	0.7		12				0.60	0.11	0.31	0.44	0.11	34.3				
19N00304	34-56	Bw2	S	0.46	0.04	0.01	0.5		12													
19N00305	56-96	Cdg	S	--	--	--	--															
19N00306	96-104	Cd1	S	0.01	--	--	--															
19N00307	104-110	2Cd2	S	0.06	--	--	0.1															

SITE
Parent Material: silty loess over lodgment till

A—0 to 12 centimeters (0.0 to 4.7 inches); very dark brown (10YR 2/2) silt loam; moderate medium granular structure; friable; many very fine roots throughout and many medium roots throughout and many fine roots throughout and many coarse roots throughout; fragments; very strongly acid, pH 4.8, pH indicator solutions; abrupt wavy boundary. Lab sample # 19N00301; moist when described; observed in pit, small

Ap—12 to 24 centimeters (4.7 to 9.4 inches); very dark brown (10YR 2/2) silt loam; weak coarse subangular blocky parts to weak medium granular, and weak medium subangular blocky parts to weak medium granular structure; friable; many very fine roots throughout and many very fine roots throughout and many medium roots throughout and many medium roots throughout and many fine roots throughout and many fine roots throughout and many coarse roots throughout and many coarse roots throughout; 2 percent by volume nonflat subangular indurated 2-39-75 millimeter mixed fragments observed by weighed method; very strongly acid, pH 4.8, pH indicator solutions; abrupt wavy boundary. Lab sample # 19N00302; moist when described; observed in pit, small. Pockets of Bw1 material mixed in the bottom of the horizon

Bw1—24 to 34 centimeters (9.4 to 13.4 inches); dark yellowish brown (10YR 4/6) silt loam; weak coarse subangular blocky structure; friable; moderately few very fine roots throughout and moderately few medium roots throughout and moderately few fine roots throughout; 1 percent by volume nonflat subangular indurated 2-39-75 millimeter mixed fragments observed by weighed method; 5 percent krotovinas (volume percent); very strongly acid, pH 5.0, pH indicator solutions; clear smooth boundary. Lab sample # 19N00303; moist when described; observed in pit, small. 5% pockets od unoxidized loess has color of 5Y 5/2

Bw2—34 to 56 centimeters (13.4 to 22.0 inches); dark yellowish brown (10YR 4/6) silt loam; weak coarse subangular blocky structure; friable; moderately few very fine roots throughout and moderately few fine roots throughout; 15 percent coarse prominent strong brown (7.5YR 5/8), moist, iron-manganese masses with diffuse boundaries throughout; 1 percent by volume nonflat subangular very strongly coherent cemented 2-39-75 millimeter mixed fragments observed by weighed method and 2 percent by volume nonflat subangular very strongly coherent cemented 75-163-250 millimeter mixed fragments observed by visual inspection method; strongly acid, pH 5.2, pH indicator solutions; abrupt wavy boundary. Lab sample # 19N00304; moist when described; observed in pit, small

Cdg—56 to 96 centimeters (22.0 to 37.8 inches); olive gray (5Y 5/2) silt loam; structureless massive; firm; 20 percent very coarse prominent iron-manganese masses with diffuse boundaries throughout; 1 percent by volume nonflat subangular very strongly coherent cemented 2-39-75 millimeter mixed fragments observed by weighed method; strongly acid, pH 5.4, pH indicator solutions; abrupt wavy boundary. Lab sample # 19N00305; moist when described; observed in pit, small

Cd1—96 to 104 centimeters (37.8 to 40.9 inches); olive brown (2.5Y 4/3) very fine sandy loam; structureless massive; firm; 15 percent coarse faint iron-manganese masses with diffuse boundaries throughout; 2 percent by volume nonflat subangular very strongly coherent cemented 2-39-75 millimeter mixed fragments observed by weighed method; moderately acid, pH 5.6, pH indicator solutions; abrupt wavy boundary. Lab sample # 19N00306; moist when described; observed in pit, small

2Cd2—104 to 110 centimeters (40.9 to 43.3 inches); 50 percent grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) very gravelly loamy sand; structureless single grain; friable; 2 percent by volume nonflat subrounded very strongly coherent cemented 75-163-250 millimeter mixed fragments observed by visual inspection method and 45 percent by volume nonflat subangular very strongly coherent cemented 2-39-75 millimeter mixed fragments observed by visual inspection method; slightly acid, pH 6.2, pH indicator solutions. Lab sample # 19N00307; moist when described; observed in pit, small. pockets of gravelly sand; silt coats on surface of fragments

Rainbow West

*** Primary Characterization Data ***

Pedon ID: S2018RI009004 (Washington, Rhode Island) Print Date: Jul 25 2025 10:44AM

Sampled as on Oct 3, 2018: Rainbow ; Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
Revised to :

SSL - Project C2019USRI012 2019 NCSS National Conference - MLRA144A
- Site ID S2018RI009004 Lat: 41° 28' 31.35" north Long: 71° 30' 53.77" west MLRA: 144A
- Pedon No. 19N0055
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Kellogg Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
19N00295	Ap	Ap	0-24	S2018RI009004-1			SIL	SL
19N00296	Bw1	Bw1	24-46	S2018RI009004-2			SIL	SIL
19N00297	Bw2	Bw2	46-70	S2018RI009004-3			SIL	SIL
19N00298	2Cd	2Cd	70-113	S2018RI009004-4			COSL	FSL
19N00299	2Cdg	2Cdg	113-144	S2018RI009004-5			COSL	SL
19N00300	3C	3C	144-166	S2018RI009004-6			GR-COS	COS

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	28	% wt
Volume, >2mm, Weighted Average	4	% vol
Clay, carbonate free, set 2, Weighted Average	4	% wt
Clay, total, set 2, Weighted Average	4	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 7	0.62	(NA)

Weighted averages based on control section: 25-70 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
					(- - - - - Total	- - - - - -	-)	(- - Clay	- - -)	(- - - - Silt	- - - - -)	(- - - - - - - - - - - - Sand				- - - - - - - - - - - -)	(Rock Fragments	(mm))			
				Lab Text-ure	Clay < .002	Silt .002 -.05	Sand .05 -2	Fine < .0002	CO_3 < .002	Fine .002 -.02	Coarse .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	(- - - Weight 2 -5	5 -20	20 -75	- - -) .1- 75	>2 mm wt % whole soil
Layer	Depth (cm)	Horz	Prep		(- % of <2mm Mineral Soil											- -)	(- - - - - - - % of <75mm			- - - - - -)	
					3A1a1a					3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
19N00295	0-24	Ap	S	sl	6.5	48.5	45.0			18.8	29.7	21.2	9.4	7.6	4.8	2.0	3	3	--	28	6
19N00296	24-46	Bw1	S	sil	4.2	57.4	38.4			22.3	35.1	17.1	7.4	6.6	4.0	3.3	3	3	4	29	10
19N00297	46-70	Bw2	S	sil	4.3	58.6	37.1			22.3	36.3	16.4	7.4	6.2	4.3	2.8	3	4	--	26	15
19N00298	70-113	2Cd	S	fsl	5.1	26.2	68.7			13.5	12.7	16.0	23.9	15.5	9.1	4.2	7	8	--	60	22
19N00299	113-144	2Cdg	S	sl	5.3	24.9	69.8			13.1	11.8	15.9	22.9	17.6	10.2	3.2	7	8	tr	61	18
19N00300	144-166	3C	S	cos	1.1	2.0	96.9			0.8	1.2	4.2	19.2	33.4	31.1	9.0	9	8	3	94	20

*** Primary Characterization Data ***

Pedon ID: S2018RI009004 (Washington, Rhode Island) Print Date: Jul 25 2025 10:44AM
Sampled As : Rainbow Coarse-loamy, mixed, active, mesic Aquic Dystrudepts
USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 19N0055

Bulk Density & Moisture

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(Bulk Density) 33 kPa	Oven Dry	Cole Whole Soil	(- - - - - - - - - - - Water Content 6 kPa	10 kPa	33 kPa	1500 kPa	- - - - - - - - - - -) 1500 kPa Moist	(Air Dry-Oven Dry) (- - - - Ratio	- - - -) Corrected	WRD Whole Soil	Aggst Stabl 2-0.5mm	(- - Ratio/Clay CEC7	- -) 1500 kPa
Layer	Depth (cm)	Horz	Prep	(- - - g cm^{-3}	- - -)		(- - - - - - - - - - - - pct of < 2mm				- - - - - - - - - - - -)			cm^3 cm^{-3}	%		
				DbWR1	DbWR1				DbWR1	3C2a1a		3D1					
19N00295	0-24	Ap	S							5.8		1.011				0.95	0.89
19N00296	24-46	Bw1	S	1.26	1.29	0.008			20.4	4.6		1.009		0.19		0.69	1.10
19N00297	46-70	Bw2	S							3.0		1.007				0.56	0.70
19N00298	70-113	2Cd	S	1.57	1.58	0.002			11.5	1.2		1.003		0.13		0.08	0.24
19N00299	113-144	2Cdg	S	1.83	1.85	0.003			6.5	1.4		1.002		0.08		--	0.26
19N00300	144-166	3C	S							0.4		1.001				--	0.36

Water Content

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(- - Atterberg - -) (- - - Limits - - -) LL	PI	(- - - - - Bulk Density Field	Recon 33 kPa	- - - - -) Recon Oven Dry	(- - - - - - - - - - - - Water Content Field	Recon 33 kPa	(- - - - - - Sieved Samples 6 kPa	10 kPa	33 kPa	100 kPa	200 kPa	- - - - - -) 500 kPa
Layer	Depth (cm)	Horz	Prep	pct <0.4mm		(- - - - - - - - g cm^{-3}		- - - - - - -)	(- - - - - - - - - - - - - - - - % of < 2mm							- - - - - - - - - - - - - - - -)
						3B7			3B7							
19N00300	144-166	3C	FCDB			1.80			6.3							

Carbon & Extractions

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-
				(- - - - - Total C	N	- - - - -) S	Est OC	OC (WB)	C/N Ratio	(- - - Dith-Cit Ext Fe	Al	- - -) Mn	(- - - - - - Ammonium Oxalate Extraction Al+½Fe	ODOE	Fe	Al	Si	- - - - - -) Mn	(- - - Na Pyro-Phosphate C	Fe	Al	- - -) Mn
Layer	Depth (cm)	Horz	Prep	(- - - - - - - - - - % of <2 mm			- - - - - - - - - -)			(- - - - - - - - - - - - - - - - - - % of < 2mm							- - - - - - - - - - - - - - - - -)	mg kg^{-1}	(- - - - - - % of < 2mm			- - - - -)
				4H2a	4H2a	4H2a								4G4	4G4	4G4	4G4	4G4				
19N00295	0-24	Ap	S	1.57	0.11	0.04	1.6		14				0.52	0.12	0.26	0.39	0.08	43.1				
19N00296	24-46	Bw1	S	0.43	0.04	0.01	0.4		11				0.55	0.06	0.22	0.44	0.13	19.0				
19N00297	46-70	Bw2	S	0.15	0.02	0.01	0.2		8				0.52	0.05	0.19	0.42	0.12	17.0				
19N00298	70-113	2Cd	S	--	--	tr	--															
19N00299	113-144	2Cdg	S	--	--	--	--															
19N00300	144-166	3C	S	--	--	--	--															

Parent Material: silty loess over silty flow till over sandy till

Ap—0 to 24 centimeters (0.0 to 9.4 inches); dark brown (10YR 3/3), light brownish gray (10YR 6/2), dry; sandy loam; weak medium subangular blocky parts to moderate medium granular structure; friable; 3 percent by volume nonflat subangular 2-39-75 millimeter granite fragments; abrupt wavy boundary. Lab sample # 19N00295; moist when described; observed in pit, small

Bw1—24 to 46 centimeters (9.4 to 18.1 inches); yellowish brown (10YR 5/6) silt loam; weak coarse subangular blocky, and weak medium subangular blocky structure; friable; 0.5 medium low-continuity vesicular pores; 5 percent by volume nonflat subangular 2-39-75 millimeter granite fragments; 10 percent krotovinas (volume percent); clear wavy boundary. Lab sample # 19N00296; moist when described; observed in pit, small

Bw2—46 to 70 centimeters (18.1 to 27.6 inches); yellowish brown (10YR 5/4) silt loam; weak coarse subangular blocky structure; friable; 0.5 medium low-continuity vesicular pores; 1 percent medium prominent strong brown (7.5YR 5/8), moist, masses of oxidized iron throughout and 1 percent coarse distinct grayish brown (10YR 5/2), moist, iron depletions throughout; 3 percent by volume nonflat subangular 2-39-75 millimeter granite fragments and 5 percent by volume nonflat subangular 75-162-250 millimeter granite fragments; 2 percent krotovinas (volume percent); abrupt wavy boundary. Lab sample # 19N00297; moist when described; observed in pit, small

2Cd—70 to 113 centimeters (27.6 to 44.5 inches); brown (10YR 5/3) fine sandy loam; structureless massive; firm; 15 percent coarse prominent strong brown (7.5YR 4/6), moist, masses of oxidized iron throughout and 20 percent coarse faint grayish brown (10YR 5/2), moist, iron depletions throughout; 5 percent by volume nonflat subangular 75-162-250 millimeter granite fragments and 9 percent by volume nonflat subangular 2-39-75 millimeter granite fragments; clear wavy boundary. Lab sample # 19N00298; moist when described; observed in pit, small

2Cdg—113 to 144 centimeters (44.5 to 56.7 inches); grayish brown (10YR 5/2) sandy loam; structureless massive; firm; 15 percent coarse distinct brown (7.5YR 4/4), moist, masses of oxidized iron and 20 percent coarse distinct gray (5Y 5/1), moist, iron depletions; 2 percent by volume nonflat subangular 75-162-250 millimeter granite fragments and 11 percent by volume nonflat subangular 2-39-75 millimeter granite fragments; abrupt wavy boundary. Lab sample # 19N00299; moist when described; observed in pit, small

3C—144 to 166 centimeters (56.7 to 65.4 inches); yellowish brown (10YR 5/4) coarse sand; structureless single grain; loose; 10 percent coarse distinct strong brown (7.5YR 4/6), moist, masses of oxidized iron throughout and 10 percent coarse prominent gray (2.5Y 6/1), moist, iron depletions throughout; 12 percent by volume nonflat subangular 2-39-75 millimeter granite fragments. Lab sample # 19N00300; moist when described; observed in pit, small

Stop 2

Great Swamp Ortstein and Merrimac Soils (Aka-- we learned a lot from a small vernal pool)

Parking: Park in parking lot indicated on map.

Notes: Likely to have lots of mosquitos and deer flys here, a bug suit, covered skin, and or copious amounts of bug spray would be helpful here.

Great Swamp History

Great Swamp management area is located within a low basin at the site of glacial Lake Worden. Today, Worden Pond rims the basin to the south.

Prior to the colonists' arrival, the Narragansett people wintered in these sheltered woods, harvesting fish and game. Their fort became the target of a 1,000-man colonial army during King Philip's War. On Dec 19, 1675, militia forces attacked the Narragansett people, torched the fort, and killed hundreds in what is known as the Great Swamp Massacre. Since then, nature has reclaimed the battlefield. Today the 3,349-acre Great Swamp Management Area is home to more than a hundred bird species, and the cedar swamp shelters regionally rare plants and amphibians.

Site History:

The Merrimac soil that is observed here was used as an individual contest pit in the 2008 National Collegiate Soils Contest hosted by the University of Rhode Island. The spodic pit, moved across the vernal pool from original location, was monitored to develop the criteria for A-17 Mesic-Spodic National Hydric Soils indicator (see "cheat sheet" for hydric soils of New England). The spodic pit we will see on Day 2 of this tour was another one of the monitoring sites. This work was in collaboration with the New England Hydric Soils Technical Committee (NEHSTC).

In 2014 the Northeast representatives to the National Cooperative Soil Survey (NCSS) began studying the hydropedology of vernal pools as part of Multistate Project NE-1438. Sites were established along three transects from the basin of the vernal pool (ponded in the winter and spring), across a transition area (considered a hydric soil), to the upland. Work presented here are results from Jim Turenne's (NRCS) soil temperature studies, NE-1438 and subsequent NE-1938 monitoring, and the master's thesis completed by Bianca Piexoto Ross (2017). Studies focused on hydrology, soil temperature at 30 cm, reaction of Fe and Mn IRIS tubes, decomposition of organic materials, greenhouse gas exchange, and carbon stocks.

Great Swamp Ortstein Pit

Attached is a short field description (below), and a description including lab data from 2013 (located on opposite end of vernal pool). Look at all sides of the pit, morphology is variable. If we have time we will auger down through the Cg. Note lack of gravels in this pit compared to elsewhere on outwash plain.

Classification 2022 KST: Sandy, mixed, mesic Aeric Alaquod

Proposed classification: Sandy, mixed, mesic, udic Allic Petraspodaq

2025 Horizons and Depths:

Oe 0-7 cm

Oa 7-9 cm

AE 9-15 cm

E 15-44 cm

Bhs 44-54 cm

Bhsm 54-61 cm

Bsm 61-69 cm

Bc 69-90 cm

Cg 90+ cm

2013 description with lab data by Andy Palucci:

Horizon	Depth (cm)	Matrix Color	Sand (%)	Texture	ODOE	Al (%)	Fe (%)	SOM (%)	HA (%)	FA (%)
Oe	0-5	7.5YR 2.5/2	---	MPT	---	---	---	91.1	15.7	6.9
Oa	8-12	10YR 2/1	---	M	0.35	0.2	0.14	29.6	13.3	1.8
EA	12-24	10YR 4/1	77	LS	0.69	0.28	0.04	4.3	2.3	0.2
Bhs1	26-31	5YR 2.5/1	79	LS	1.97	1.98	0.16	16.8	3.4	1.4
Bhs2	31-42+	5YR 2.5/1	82	LS	2.07	1.8	0.15	13.8	2.5	1.3

Great Swamp Merrimac Pit

Classification 2022 KST: Sandy, mixed, active, mesic Typic Dystrudepts

Classification proposed: Sandy, mixed, active, mesic, udic Typic Humidystrepts

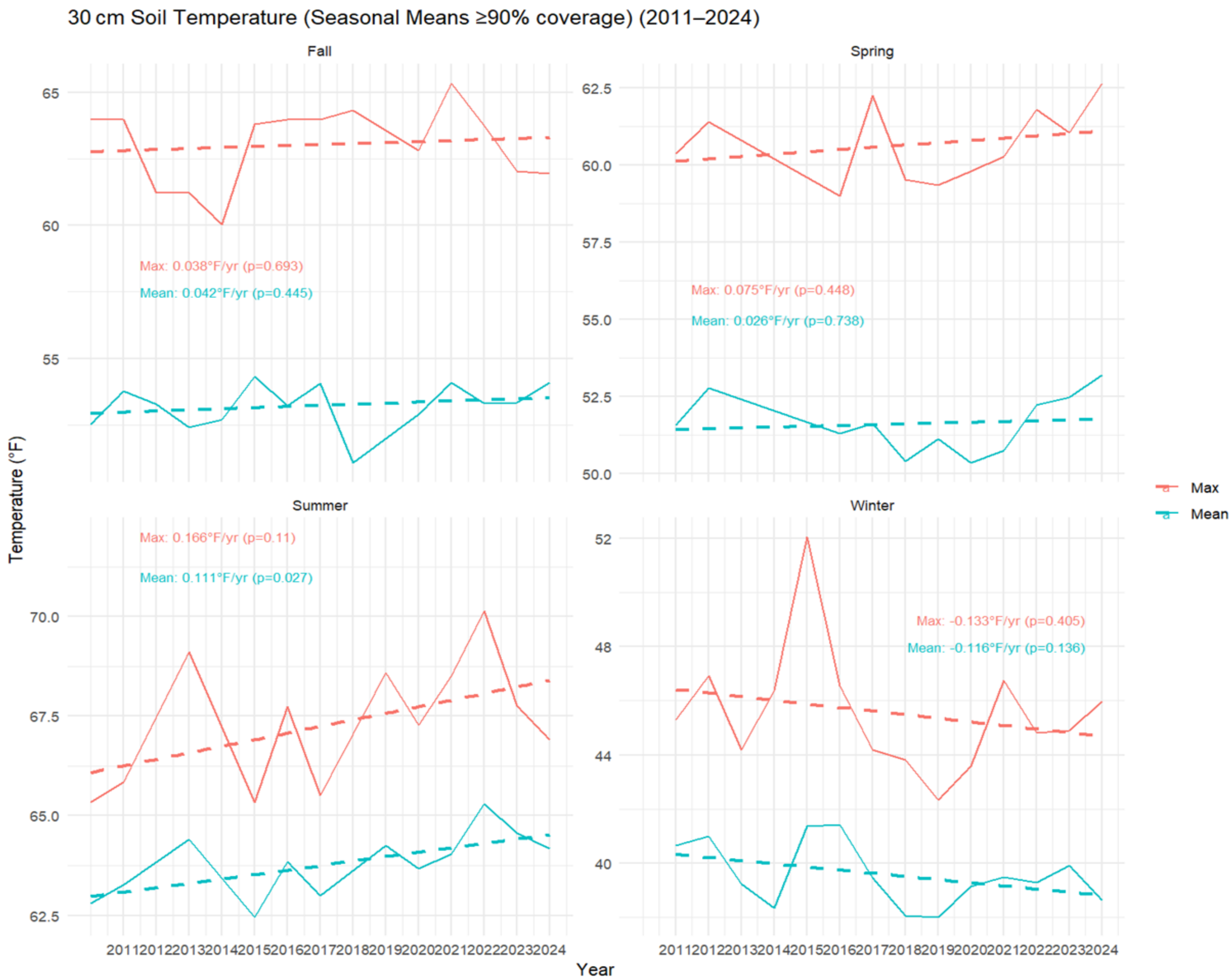
-	A	-	-	4-6 5	A	—	SL	10YR 7.5YR	2 OR 2.5	1 1	1	SBK	VFR	N	-	-	N	-	-	
-	A	P	-	14-16 15	A	—	SL	10YR	3	3	1	SBK	FR	N	-	-	N	-	-	
-	B	W	1	50-60 55	G	—	SL	10YR	4	4 OR 6	1	SBK	FR	N	-	-	N	-	-	
-	B	W	2	74-84 79	G	—	SL	10YR	5	4	1	SBK	FR	N	-	-	N	-	-	
-	BC	-	-	100-104 102	C	—	LS	10YR 2.5Y	5	3 OR 4	1	SBK	FR	N	-	-	N	-	-	
-	C	-	-	140+	-	—	LS	2.5Y	5	2	0	MA	FR	N	-	-	N	-	-	

Soil Temperature

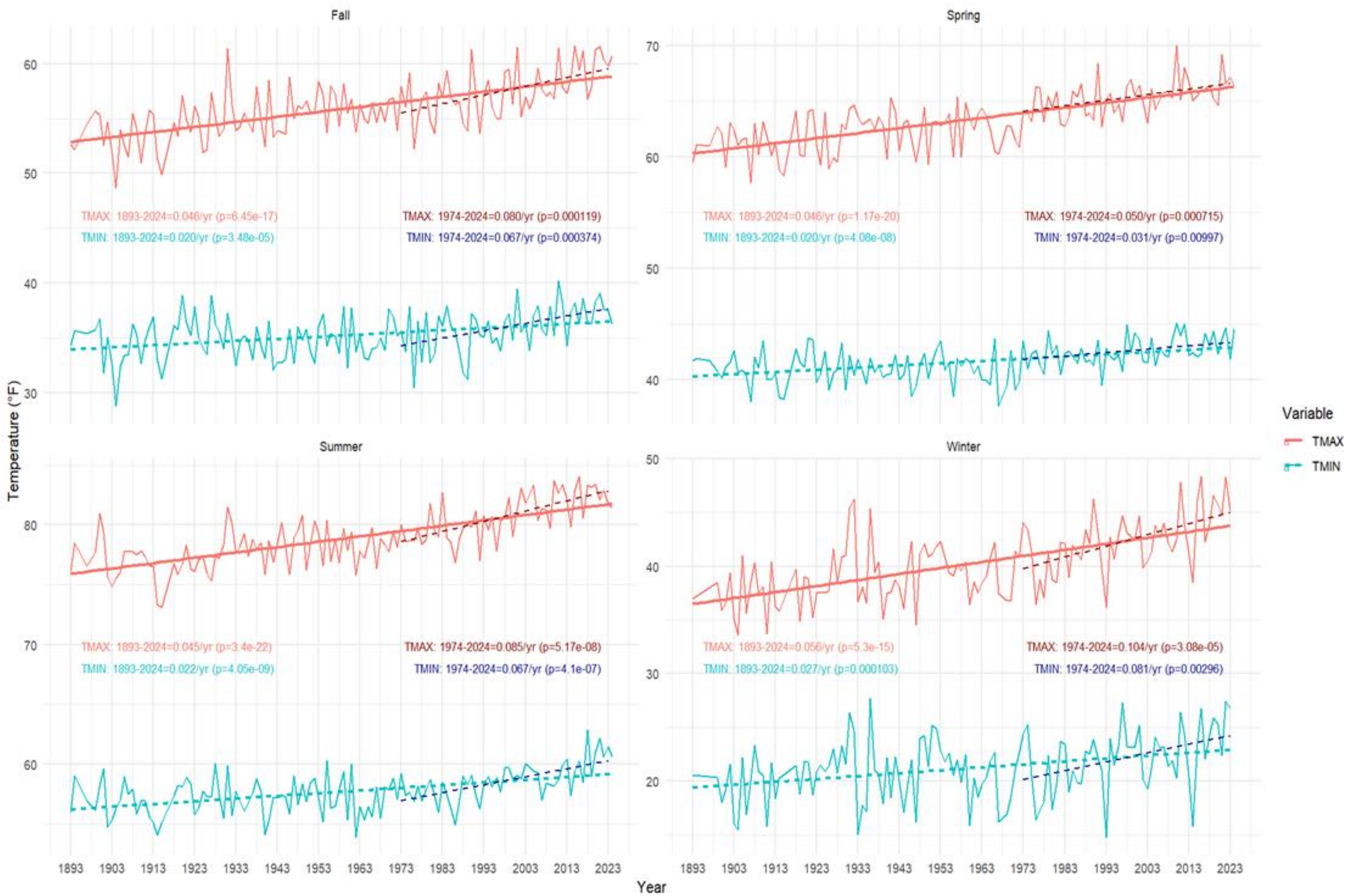
We have been (mostly) continuously monitoring soil temperatures at 30 cm depth for the past fifteen years at the spodic site. Long term trends show consistent soil warming. At 30 cm below the soil surface, where the soil's thermal inertia buffers short term swings, we have observed a mean increase in average soil temperature 0.10°F per summer season from 2010-2024, coupled with an average annual mean soil temperature increase of 0.16 °F per year and an average maximum temperature increase of 0.17 °F (See figure below). Over a fifteen year span, that amounts to a 1.5°F rise in mean soil temperature during the primary growing season (summer) and about a 60% greater increase over the course of the entire year. This warming at 30 cm indicates that the soil is systematically warming year over year during the growing season and the rest of the year as well.

During this same time period (2010-2024), summer minimum air temperatures have increased an average of 0.20°F yearly ($p=0.02$) while summer maximum temperatures have not significantly changed (Figure), indicating the mean summer air temperature has increased. Winter, fall, and spring minimum and maximum temperatures have not significantly changed between 2010-2024, though a yearly mean increase in observed air temperatures of 0.12°F has been observed ($p=0.029$) over the 2010-2024 period. Additionally, average daily minimum and maximum temperatures have increased by 0.20°F and 0.15°F, respectively, per year (Figure).

Utilizing the full period of the URI Agriculture Experiment Station's complete yearly weather observations (1883-2024) we observe a significant ($p<0.05$) mean yearly increase of summer minimum and maximum temperatures of 0.022°F and 0.045°F, respectively over the last 131 years and similar increases in the other three seasons. When we look at the last 50 summers (1974 – 2024) we see the average minimum temperature increase yearly by 0.067°F and maximum by 0.085°F, triple and double(respectively) the historic rates from 1893-2024. See figures below and on the next few pages.

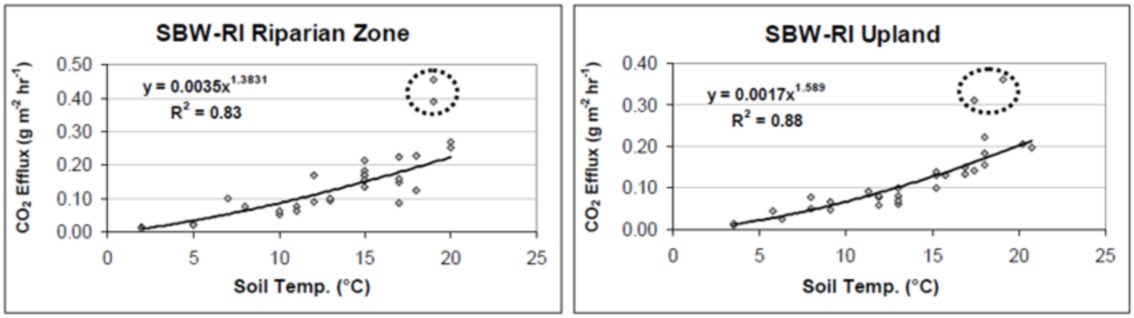


Above: Average daily maximum and mean seasonal temperatures of Great Swamp depression 30 cm below the mineral soil surface

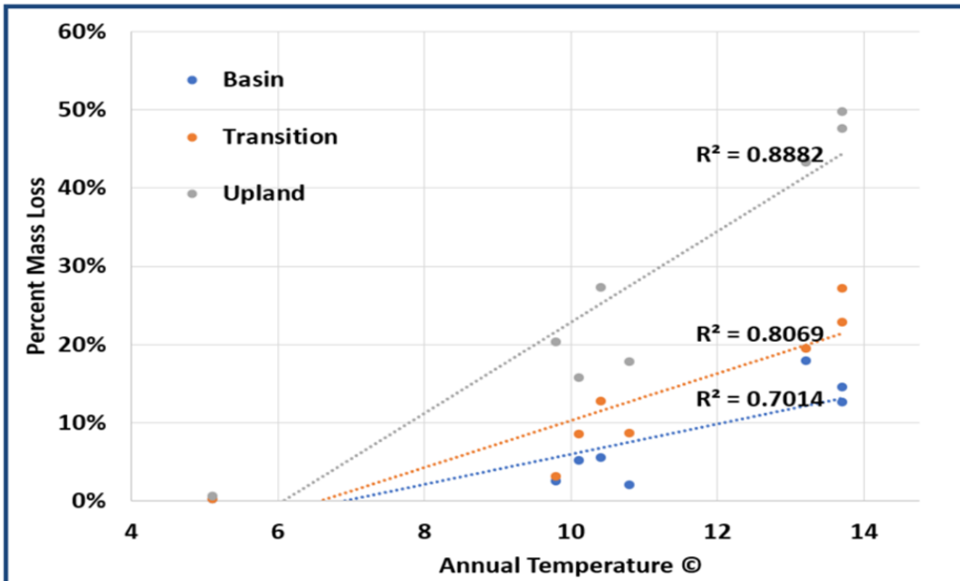


Above: Average minimum and maximum seasonal air temperatures from the Kingston Agriculture Experiment station. Continuous regression line for entire history of station (132 years) and regression line of past 50 years indicate acceleration in air temperature warming across all seasons.

Increasing soil temperatures increases microbial activity and thus increasing the rate of biogeochemical soil processes. As soil temperature increases, organic material decomposition increases leading to an increase in CO2 efflux.



Typical examples of power regression models predicting total CO_2 efflux based on measured soil temperature (n = 30). Circled data points are outliers with standardized residuals >2.0. (Ricker, 2010).

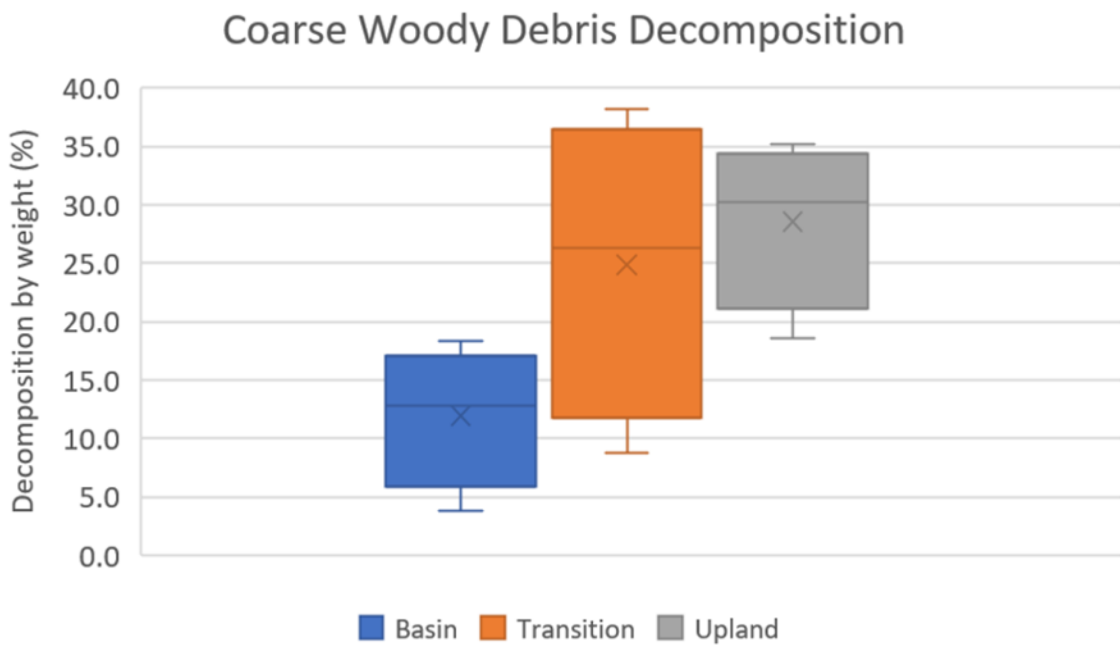


Percent mass loss from dowel rods inserted into the soil to 25 cm and removed one year later vs annual temperature for each study location. Upland areas had the greatest mass loss (on average 28%), followed by transition (mean = 13%), and basin (8%). There was a strong and significant relationship between annual temperature and mass loss with the colder the temperature the less decomposition.

In our multistate studies we examined rates of decomposition of several organic materials.

Coarse woody debris decomposition in Virginia, Maryland, West Virginia, and Rhode Island.

Average coarse woody debris weight loss due to decomposition among 4 vernal pools. Data are combined by station (n=60). Coarse woody debris was simulated with 3/8" birch dowel rods.



Leaf litter decomposition in Rhode Island:

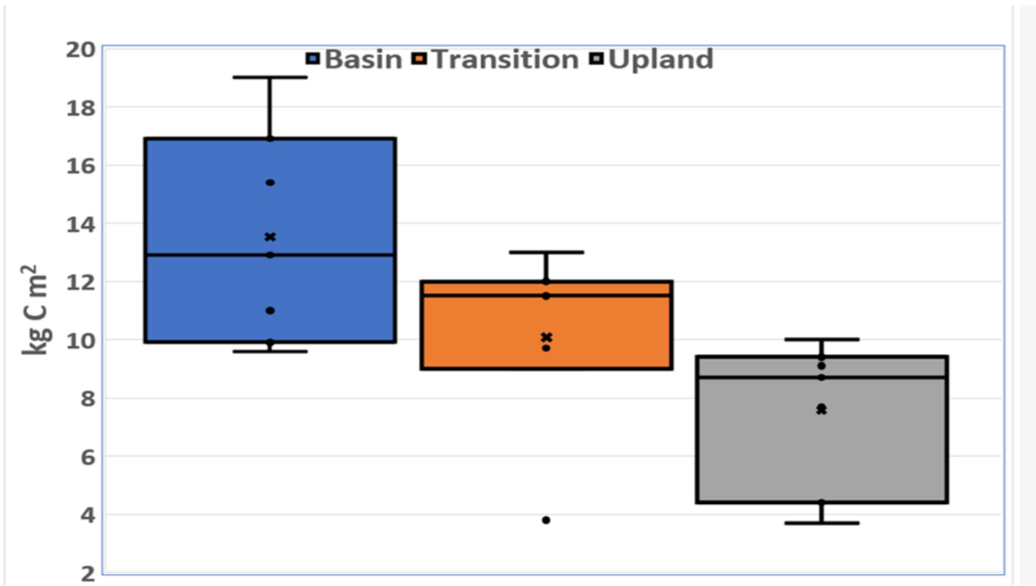
Average percent weight loss from decomposition in Rhode Island by station at the Great Swamp vernal pool. Oak leaves and both green and roibus tea were deployed for 5 and 3 months, respectively. Oak leaves were deployed in April 2021 and the tea in June of the same year. Retrieval was in September of 2021.

	Average percent weight loss (n=15)		
Station	**Oak Leaves**	**Green Tea**	**Roibus Tea**
Basin	7.3a*	67a	27a
Transition	20.0b	69a	28a
Upland	23.2b	69a	37b

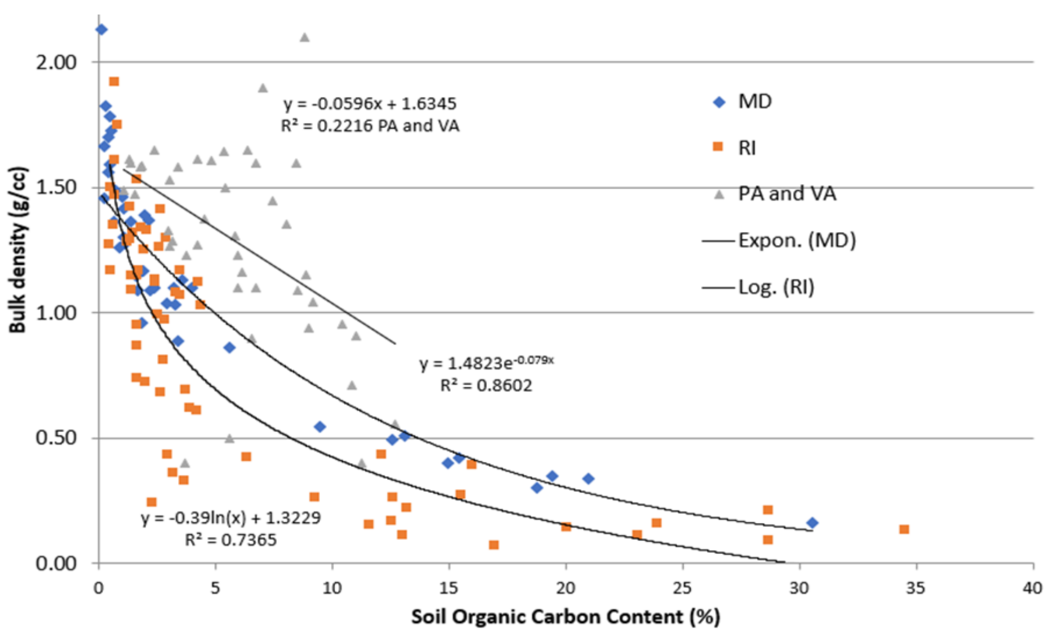
Means within columns with different letters are significantly different at the 0.05 level.

Clearly decomposition is also dependent upon the hydrology. In the basin the soils are saturated, ponded, and anaerobic for much of the year and the degree decreases from the basin to the upland leading to greater carbon stocks in the wetter soils.

Average arbon stocks for vernal pools in Maryland, Rhode Island, Virginia, Pennsylvania, and Delaware.



Calculating carbon stocks is dependent upon the amount of soil organic carbon (SOC) and the bulk density of the soil horizon. Because of the difficulty collecting undisturbed samples for measuring bulk density in saturated soils at depths deeper than 50 cm, a SOC: bulk density model is often used to estimate bulk density values based on the SOC content. Our studies of a range of vernal pools suggests that there are regional differences in the relationship between SOC and bulk density. Some of the



differences among sites may suggest that the amount of black carbon present is controlling some of the variability.

Ross (2017) measured methane flux in several months in 2015 and 2016 from 4 vernal pools including Great Swamp. The only time there was release of methane to the atmosphere was when the basin soil was ponded.

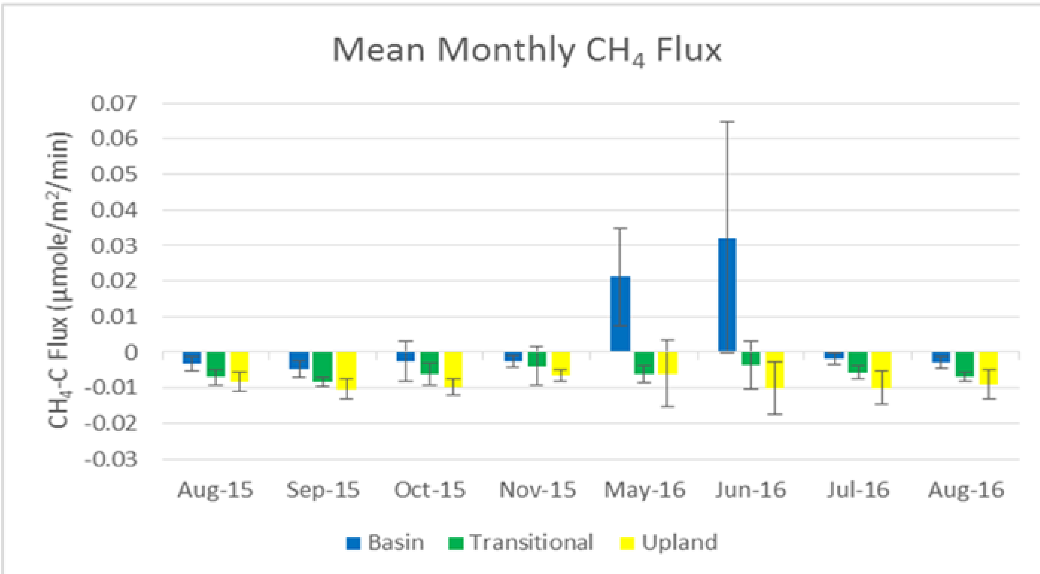


Figure 2.10. Mean monthly CH_4 fluxes across all vernal pools. A positive flux value indicates that the pools emitted CH_4 to the atmosphere, while a negative flux indicates a net absorption of CH_4. Each error bar represents +/- 1 standard deviation.

Understanding soil colors of Northeast Aquods

The Great Swamp Spodosol was one of 11 pedons we studied in our quest to understand why many Aquod spodic horizons had very red hues (often 5 or 6 YR). Our primary objective was to develop an understanding of why wet soil spodic horizons have such red hues. Our hypothesis was that humic (HA) and fulvic acids (FA), not Fe, are responsible for the red colors. In addition, we addressed questions related to hydric soil indicators, horizon designation, and soil classification of wet Spodosols. Of the 11 seasonally saturated Spodosols we studied, only the two soils with histic epipedons met criteria for Aquods. Almost all of the 24 Bh, Bhs, or Bhsm horizons we studied had 3 to 10 times more ammonium oxalate extractable (AOE) Al than Fe (mean AOE Fe was <0.15%); yet only 3 of the 11 pedons met the criteria to be in an "Al" great group, suggesting that criteria in Soil Taxonomy for Aquods need to be reconsidered. We found no consistently-applied color or sesquioxide content criteria for separating Bh from Bhs horizons, suggesting that criteria for these horizons need to be clarified. There were no relationships between extractable Fe and any soil color component of the spodic horizons, supporting our hypothesis that the red hues are not related to Fe. Our statistical analysis showed correlation coefficients of -0.40 and -0.39 (p-values >0.05) between hue and FA and HA, respectively. Thus, there is little statistical support for the red hues being a function of HA or FA. Our conclusion is that separating humified organic matter into HA and FA is not a fine enough approach to identify what is driving the red colors of the spodic horizons. On average, we found more than twice as much HA in the spodic horizons as FA. We conclude that FA is the precursor of HA in the northeast spodic horizons. Results of this study lead to changes in criteria for Aquods and Alaquods, and the definitions of Bh and Bhs horizons.

Table 4. Munsell color components; humic acid (HA), fulvic acid (FA), soil organic carbon (SOC), optical density of oxalate extract (ODOE); ammor oxalate extractable Fe and Al (AOE Al and AOE Fe) contents.

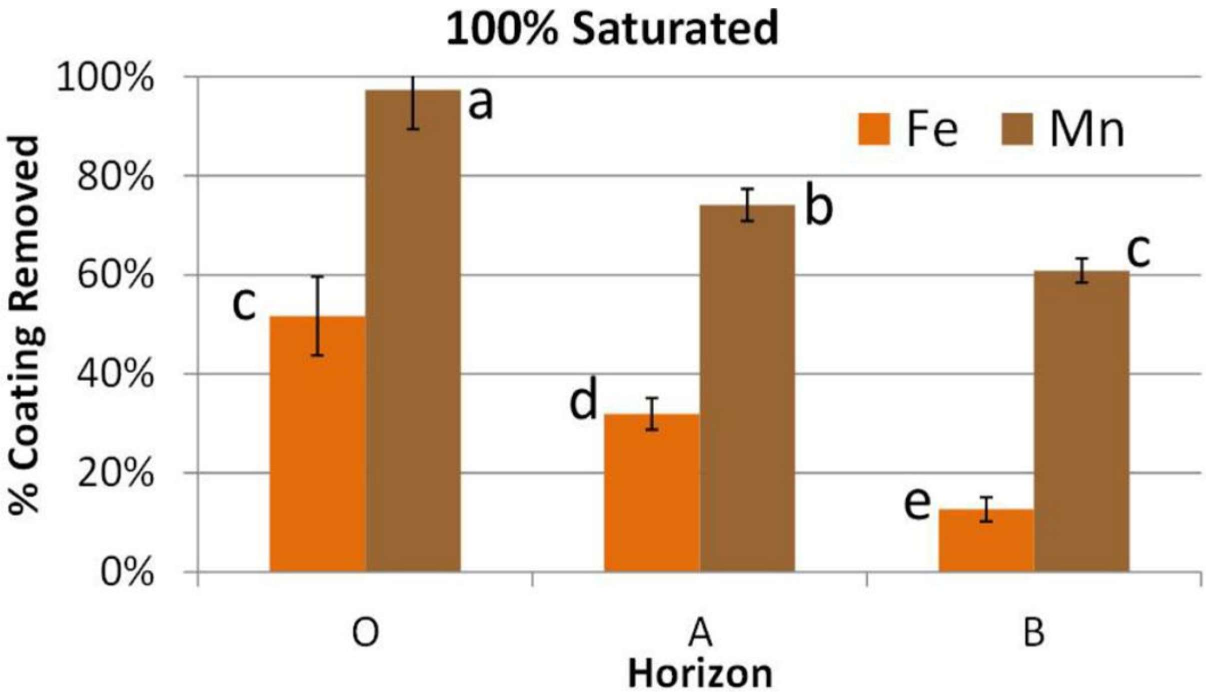
Pedon		Horizon	Hue (YR)	Value	Chroma	HA (%)	FA (%)	SOC (%)	ODOE	AOE Al (%)	AOE Fe (%)	HA:FA Ratios
EP		Bhsm1	6.4	1.7	1.0	2.24	1.15	2.94	1.73	0.67	0.08	1.95
EP		Bhsm2	5.5	1.6	1.7	1.62	1.07	3.01	1.97	0.85	0.10	1.51
SB		Bhs1	5.1	1.5	1.3	2.03	1.42	3.09	2.00	0.66	0.10	1.43
SB		Bhs2	4.4	1.5	1.9	0.89	0.89	4.43	1.46	0.63	0.14	1.00
AQ		Bhs	5.8	1.5	1.5	1.15	0.66	3.02	1.07	0.71	0.16	1.74
AQ		Bhsm	5.3	1.3	1.0	0.99	0.45	2.74	1.63	0.73	0.35	2.20
AJ		Bhs1	4.7	1.5	0.8	6.02	1.51	7.50	2.50	1.54	0.11	3.99
AJ		Bhs1	4.9	1.4	0.9	4.88	1.39	6.30	2.50	1.54	0.12	3.51
CP		Bhs1	5.4	1.1	0.7	7.92	3.24	10.1	2.50	2.16	0.13	2.44
CP		Bhs2	5.7	1.4	1.3	5.56	2.52	17.0	2.50	2.06	0.13	2.21
GS		Bhs1	5.0	1.3	1.0	3.42	1.41	8.90	1.97	1.98	0.16	2.43
GS		Bhs2	5.3	1.5	1.2	2.49	1.29	6.06	2.07	1.80	0.15	1.93
1,1		Bh	7.3	2.3	1.1	0.98	0.50	1.18	0.46	0.10	0.24	1.96
1,1		Bhs	7.6	2.2	2.1	1.13	0.50	1.94	0.44	0.28	0.16	2.26
1,3		Bhsm1	5.3	1.7	1.8	0.54	0.23	0.96	0.46	0.24	0.00	2.35
1,3		Bhsm2	5.9	1.7	1.0	0.56	0.44	0.87	0.81	0.21	0.00	1.27
1,3		Bhs	5.4	1.9	1.7	0.45	0.35	0.64	0.35	0.08	0.00	1.29
1,5		Bhsm	5.5	2.0	1.8	2.45	0.60	2.80	0.75	0.55	0.02	4.08
1,5		Bh2	5.8	1.9	1.0	0.77	0..62	0.95	0.22	0.08	0.00	1.24
1,5		Bhs	5.8	2.1	2.1	0.35	0.32	0.42	0.10	0.05	0.00	1.09
1,7		Bh	7.0	2.1	1.3	1.06	0.69	1.83	0.46	0.26	0.37	1.54
1,7		Bhs	8.5	2.7	2.4	0.64	0.24	0.82	0.13	0.43	0.14	2.67
2,5		Bh	6.2	1.8	1.3	2.00	0.85	3.42	1.13	0.59	0.02	2.35
2,5		Bhs	7.5	2.9	2.7	0.37	0.21	0.90	0.19	0.30	0.02	1.76
	NE Mean		5.3*	1.4*	1.2*	3.30*	1.40*	5.86*	1.99*	1.28*	0.14	2.36
	MD mean		6.5	2.1	1.7	0.90	0.50	1.39	0.46	0.26	0.08	1.80
	P value		0.001	0.001	0.018	0.008	0.001	0.003	0.001	0.001	0.186	0.405

*Note the significant differences in all criteria except Fe and HA:FA ratios between the two regions of the northeast. These differences are likely a function of soil temperature.

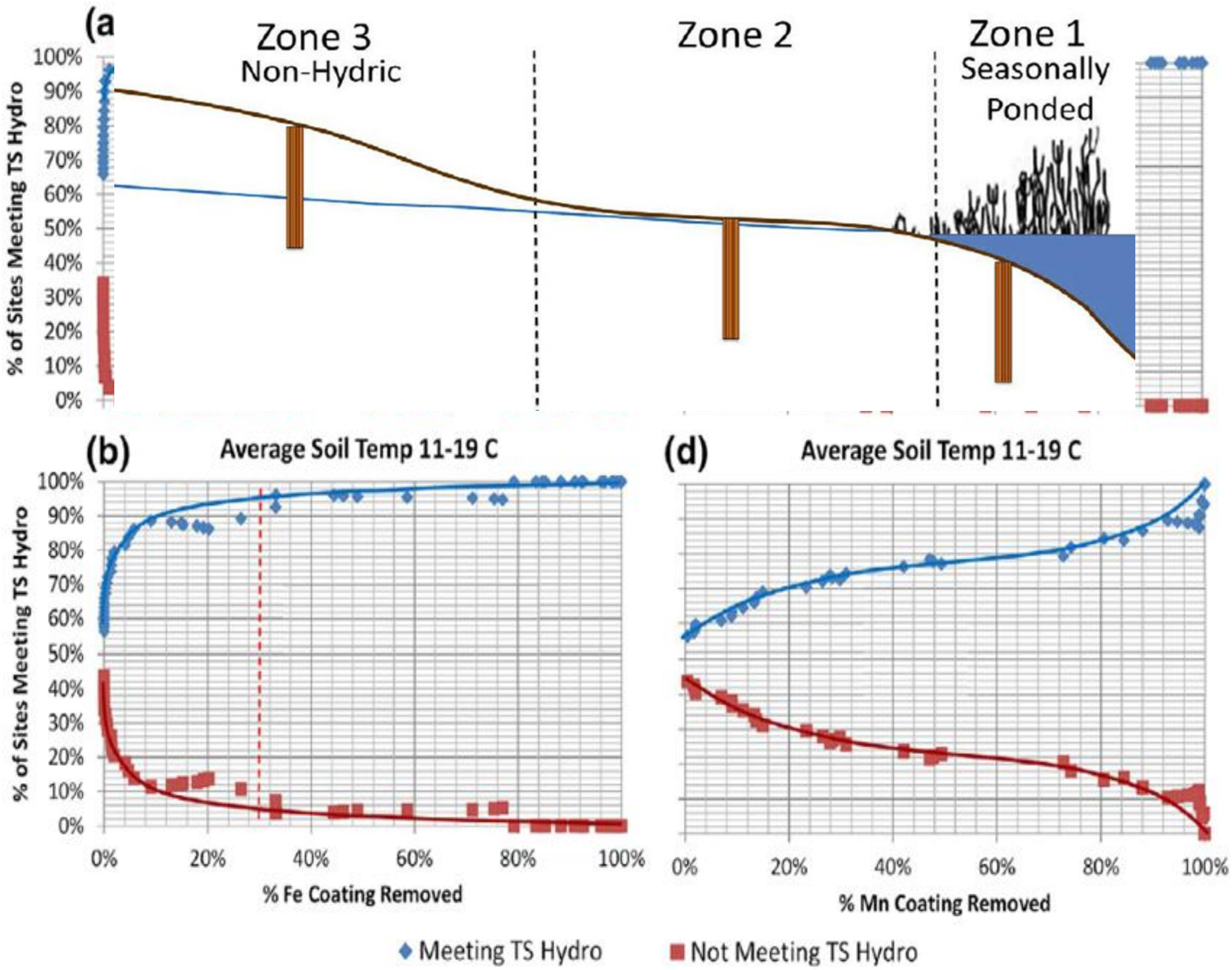
IRIS devices to document reducing soil conditions

Indicator of Reduction in Soil (IRIS), is a method for detecting reducing (anaerobic) conditions in wetland soils. Traditionally these have been coated with iron oxides, but more recently manganese-oxide coatings have become available. The greater amount of Gibb's free energy available to reducers from MnO_2 compared to $Fe(OH)_3$ allows for greater potential sensitivity to redox processes (e.g., nitrate reduction) that occur at higher soil potentials. Mn coated devices would also indicate reducing conditions faster than similarly coated devices with an Fe coating. As part of a multistate regional project, this vernal pool was one of 7 throughout the region used to compare Mn-coated and Fe-coated devices across the northeast US. This study directly compared Mn- versus Fe-coated IRIS performance across sites (including one in Wyoming) spanning hydric to non-hydric zones, under varying saturation and temperature regimes. Coating removal is primarily driven by (1) duration of soil saturation, (2) organic-matter content of the horizon, and (3) soil temperature. The time saturated, average temperature, and type of coating (Fe or Mn) were all significantly ($p<0.0001$) related to the amount of coating that was removed. If saturated for 28 days, removal of Mn from IRIS was almost 100%. For Fe for that same period of saturation, only 40% was removed. Horizons with greater amounts of organic carbon showed significantly more coating removal when horizons were saturated. For Mn coated IRIS, there was 95% (O horizons), 75% (A horizons), and 60% removal (B horizons). For Fe coated IRIS, saturated O, A, and B horizons had 50, 30, and 15% removal, respectively.

We tested if the period of the growing season impacted coating removal: early growing season conditions (soil temperatures 5–11 °C) and later growing season conditions (soil temperatures 11–19 °C). Of the 96 data sets, 43% were in the cooler group, and 57% were in the warmer group. Regardless of whether the soil temperatures were cool (<11 °C) or warm (>11 °C), there was significantly more Mn than Fe coating removed. Fe IRIS can be used to document reducing conditions for hydric soils according to the National Technical Standard. The standard is at least 30% removal from a contiguous 15-cm zone within the upper 30 cm of the soil. We found that when the soil temperature was 5 to 11 °C and saturated, only 5% of Fe coatings were removed. These data suggest that maintaining this current requirement for 30% removal during the early part of the growing season would likely result in many sites being miss diagnosed as not reducing. In contrast, the Mn IRIS showed during the early growing season window (5 to 11 °C) that 100% of the time when there was 30% removal from the Mn IRIS the soil was saturated. Our data suggest that Mn IRIS may be a better approach in the early growing season than Fe IRIS for documenting reducing conditions.



Percent of Fe or Mn coating removed from IRIS films in a 5 cm zone within O, A, and B horizons within 50 cm of the soil surface. All of the horizons were saturated during the 28 day deployment. There was significant difference in coating removal among horizons and on type of coating (Fe vs Mn). Horizons that are richer in carbon (O vs A vs B) have greater amounts of both Fe and Mn removed supporting the importance of labile carbon in the depletion of the Mn and Fe minerals. There was significantly more removal of Mn coatings than Fe.



Percentage of sites meeting National Technical Committee for Hydric Soils (NTCHS) standards for hydrology vs percent Fe and Mn coating removed from a 15 cm zone in the upper 30 cm of the soil. For Fe (a and b), data from the lower temperature (<11 degree C) deployment suggest that as little as 5% removal is indicative of complete saturation. Only 13 of the 41 data points at the lower temperature met the (NTCHS) standard of 30% of the Fe coating removed suggesting early in the growing season Fe IRIS are likely identifying few of the soils as both saturated and reducing. For Mn (c and d), data from the lower temperature (<11 degree C) deployment suggest that 30% removal is indicative of complete saturation. Thus, early in the growing season Mn is much more reactive to saturation and reduction and may be a better indicator of such conditions than Fe IRIS.

Lunch

On the road either between Great Swamp Management Area and deCoppet or between deCoppet and Alton Jones. If you need to use the restroom or want to grab food, there are a few pizza places, a subway, Starbucks, a taco joint, and a grocery store in Hope Valley, right before you get on I95. After you get off 95 there is a truck stop with a Popeyes and TA Travel Center. Restrooms will not be available on Alton Jones campus, but the truck stop is a short drive away.

Stop 3

deCoppet Gravel Pit

<u>Parking:</u> Park in the small parking area by the gate. Park close to each other, there is not much space. If we need to find overflow parking there is a small lot to the north.

deCoppet Estate History:

The deCoppet Estate began as a 19th-century mill village on the Beaver River before financier Theakston de Coppet merged the abandoned farms into a private sporting estate. His 1937 will ordered the 1,825-acre property to be "forever preserved as a Forest and Wildlife Reservation," and after the last life tenant died, Rhode Island accepted the gift in 2014. Today the state manages old stone-mill foundations, second-growth oak-pine forest, and a stretch of the Beaver River.

The western part of the management area is dominated by bedrock-controlled glacial till (dense and loose). The central part of the estate was formed by a glacial stream which deposited stratified ice-contact materials. Some of this kame terrace has a thick layer of wind-blown silt. The geology of the area is predominantly underlain by late Permian intrusive rocks. In the western third of the property, there are common bedrock outcrops, however in the eastern two thirds there are nearly no bedrock outcrops. The landscape is hilly in the western half of the property with slopes ranging from 1% to 25+%. Researchers from URI and partners at the USDA and USFS have begun to test climate-resilient forestry plots on the property. We will discuss that at the Canton pit.

deCoppet Hinckley cut

<u>Note:</u> Beware of loose ground. We tried to make as secure of a standing area as possible but you are on a pile of sand.

Small pocket of clean sand to bottom right.

Classification 2022 KST: Sandy-skeletal, mixed, active, mesic Typic Udiorthents
Classification proposed: Sandy-skeletal, mixed, active, mesic, udic Dystric Haplorthents

deCoppet Hinkely								
Classification: Sandy-skeletal, mixed, mesic Typic Udorthents								
Horizon	Upper Depth	Lower Depth	Coarse Frag %	Texture	Color	Structure	Consistence	Redox
Oe	0	2	0	MPT	7.5YR 2.5/2	-	-	-
AE	4	14	30	GR SL	7.5YR 3/4	1 SBK	VFR	N
Ap	14	24	50	VGR COSL	7.5YR 5/4	1 SBK	VFR	N
Bw1	24	48	70	XCB LCOS	10YR 5/4	1 SBK	VFR	N
C	48	72+	70	XCB COS	10YR 4/4	0 SG	LO	N

deCoppet Discharge Pit

Located at the base of the scarp of the kame terrace, this pit is nearly always wet below the solum but still has high chroma colors. We assume this is because the water is fairly oxygen rich and thus does not promote reducing conditions. See map and field description below.

Classification 2022 KST: Sandy, mixed, active, mesic, Oxyaquic Humudepts

Classification proposed: Sandy, mixed, active, mesic, udic Oxyaquic Humidystrepts

deCoppet Discharge								
Classification:								
Horizon	Upper Depth	Lower Depth	Coarse Frag %	Texture	Color	Structure	Consistence	Redox
Oe	0	4	0	MPT	10YR 2/1	-	-	-
AE	4	13	5	LS	10YR 2/2	1 GR	VFR	N
Ap	13	35	2	MK LS	10YR 2/1	1 SBK	FR	N
Bw1	35	50	7	SL	10YR 4/3	1 SBK	FR	N
Bw2	50	66	10	COSL	10YR 4/4	1 SBK	FR/VFR	Common prominent concentrations
2C	66	76+	55	VGR COSL	10 YR 5/4	0 SG	LO	Common prominent concentrations

deCoppet Gravel Pit Artesol

This gravel pit was actively mined from the 1950's through at least the 1980's, but aerial imagery makes it difficult to tell if it was actively mined more recently. Note to the north you see a large hill of sands, gravels, and cobbles where we have a Hinckley soil profile cut. Kame terraces such as this one have been extensively mined throughout Rhode Island for local building projects.

The soil pit is located in a spoil pit of the mining operation. See field description and map below.

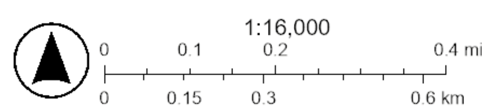
Classification 2022 KST: Coarse-loamy, mixed, active, mesic, udic Anthropotic Udorthent

Classification proposed: Coarse-loamy, mixed, spolic, mesic, udic family of Typic Haplortharts

deCoppet Artesol								
Classification:								
Horizon	Upper Depth	Lower Depth	Coarse Frag %	Texture	Color	Structure	Consistence	Redox
^CA	0	35	25	GR SL	10YR 4/6	1/0 SBK/MA	VFR	N
^Ab	35	42	2	SL	10YR 2/2	1 SBK	FR	N
^C1	42	52	17	GR SL	10YR 4/4	0 MA	VFR	N
^C2	52	121	20	GR COSL	7.5YR 5/6	0 MA	VFR	N
^A'b	121	130	5	COSL	7.5YR 3/2	1 SBK	FR	N
Bwb	130	160	2	SL	7.5YR 4/6	1 SBK	FR	N

Position of gravel pit on the landscape.

7/28/2025



Stop 3.5

Note the steep slope to your east in the hillshade and contour images above as driving north to the Hinkley pit. This is the scarp of the kame terrace. See map above.

To the west of Hillsdale Road, on the other side of the kame terrace, is bedrock controlled upland dominated by loose and dense till. Similarly, to the east, on the other side of Beaver River is a bedrock controlled till upland.

Stop 4

Parking: In the clearing area BEWARE OF BOULDERS COVERED BY GRASS. You don't want to damage your precious university or rental vehicle.

Notes: This sight is being utilized for a long term climate resilience project with RI DEM and URI. Beware of flags or plots if you wander off and please try not to disturb vegetation.

Climate Smart Forestry (ASCC)

Beginning in 2023, the Rhode Island Department of Environmental Management (RI DEM) launched a climate-adaptation forestry project on a 45-acre parcel in the Hillsdale/deCoppett Preserve in Richmond. This site, already experiencing stress from repeated spongy-moth outbreaks and prolonged drought, saw the removal of dead or declining oak trees. Crews planted a mix of tree species expected to thrive in Rhode Island's hotter, drier future such as American chestnut, chinkapin oak, shellbark hickory, and southern pines. Select healthy trees were also harvested to create canopy gaps that encourage natural regeneration. While no clear-cutting was conducted, low shrubs and standing dead trees were left in place to provide habitat for wildlife.

This is Rhode Island's first partnership with the Adaptive Silviculture for Climate Change (ASCC) Network, a collaborative, long-term study testing forest management strategies across North America. The Hillsdale site, dominated by oak-hickory forest and managed by RI DEM, is part of a broader Southern New England Exurban Oak ASCC affiliate project, which includes multiple replicate sites in Rhode Island and Connecticut. At Hillsdale, three climate-adaptive forest management approaches (resistance, resilience, and transition) are being implemented and compared to an unmanaged control. Each strategy differs in its level of intervention and planting. From preserving current conditions using shelterwood harvests, to actively introducing species adapted to projected climate conditions.

Ongoing monitoring includes detailed collection of forest and soil data, including forest productivity, dominant tree species, and below-ground soil organic carbon (SOC) stocks within the upper meter of soil. Researchers are examining SOC distributions and pools in benchmark forest soils and analyzing how climate, geography, and management practices affect carbon storage. At fixed plots, researchers (McWilliams and Riely) are conducting annual vegetation surveys and planting trials to study the survival and growth of both native and climate-adapted oak species.

The project is led by Scott McWilliams, Brett Still, and Christopher Riely of the University of Rhode Island, and it is collaboratively supported by RIDEM, the USDA, the University of Connecticut, and other regional and national partners. Riely called the initiative "a leading-edge opportunity" to showcase forest treatments that private landowners can replicate to increase ecological resilience, carbon sequestration, and habitat value. Ultimately, the goal is to create a healthier, more diverse forest capable of withstanding extreme weather and long-term shifts in species composition.

deCoppet Canton Pit

This pit is mapped as a Canton and Charlton complex which is typical for till uplands with loose till. Canton soils, such as this pit, are classified as as Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Dystrudepts while Charlton soils are classified as Coarse-loamy, mixed, superactive, mesic Typic Dystrudepts. Due to the unpredictable nature of ablation till, it is often difficult to know exactly what lies beneath the surface in a particular area without test pits or other descriptions.

In this pit note the pockets of silt to the left of the profile. We assume these are desiccation or permafrost cracks formed in the periglacial period where eolian loess blew down and filled the space between chunks of frozen soil. This loess remained relatively undisturbed given their depth in the profile. There are areas of the silt inclusion that are redder and greyer, both of these areas were sampled and no apparent difference in PSD. LOI, or pH was found. The BD of the silt inclusion was very high compared to the C horizon around it.

Classification KST 2022: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Typic Dystrudepts

Classification proposed: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic, udic, Typic Haplodystrepts

IDENTIFIERS

Current Taxon Name (Soil Name): Canton

OSD

Series Extent

User Site ID: 2025RI009001

User Pedon ID: 2025RI009001

Lab Information:

Certified Lab Pedon Description - no

User Project ID: 2025_2026 DTW

Project Name: MLRA 144A - Forest Soil Study in RI600 - Dirt-Trees-Wildlife Initiative

Print Date: 7/23/2025

LOCATION

State: Rhode Island

County: RI009—Washington

MLRA: 144A—New England and Eastern New York Upland, Southern Part

Non-MLRA Soil Survey Area: RI600—State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties

PEDON

Describers Name: Jim Turenne, Joe Manetta, Brett Still

Current Taxonomic Class: Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Typic Dystrudepts

Current Taxon Kind: series

Pedon Type: classifies to current taxon name, full description

Pedon Purpose: soil survey inventory

Pedon Record Orgin: NASIS

SITE

Parent Material: supraglacial till

Landscape: glaciated upland

Landform: moraine

Hill Slope Profile: footslope

Slope Complexity: simple

Slope Shape Across: convex

Slope Shape Down: concave

Runoff: very low

Drainage Class: well

Surface Fragments: 3.00 percent

Benchmark Soil?: no

VEGETATION

SITE OBSERVATION

Observation Date: 7/1/2025 (actual site observation date)

Data Collector: Jim Turenne, Joe Manetta, Brett Still

Surface Cover Properties:

Site Obs. Cover Kind 1 - tree cover

Site Obs. Cover Kind 2 - hardwoods

Pedoderm Loose Cover Indicator - no

Drained? - no

Bedded Soil? - no

Forest Plantation? - no

Current Weather - sunny

Correlated Information:

Soil Name - Canton
PSC - 27 to 100 cm.
Classificaton Date - 7/23/2025
Classifier - Geraldine Vega Pizarro
Soil Taxonomic Edition - thirteenth edition
Moisture Class - udic
Moisture Subclass - typic

Dynamic Soil Properties:

Pedoderm Loose Cover Indicator - no

Hydric: no

Pedon Diagnostic Features

Feature Kind	Feature Depth L-H	Feature Thickness L-RV-H
	cm	
ochric epipedon	0—19	—19—
cambic horizon	19—82	—63—

Setting and Climate

Slope	Slope Length USLE	Upslope Length	Elev.	Corr. Elev	Aspect	MAP	REAP	FFD	MAAT	MSAT	MWAT	MAST	MSST	MWST	MFFP	PE Index	Climate Station ID	Climate Station Name	Climate Station Type
%	*m*				*degrees*	*mm*	*mm*		*C*						*mm*				
4	—	—	—	—	270	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Oi—0 to 2 centimeters (0.0 to 0.8 inches); slightly decomposed plant material; many very fine roots throughout and many very coarse roots throughout and many medium roots throughout and many fine roots throughout and many coarse roots throughout; fragments; abrupt smooth boundary.; observed in pit, small

A/E—2 to 4 centimeters (0.8 to 1.6 inches); gray (10YR 6/1) interior and black (7.5YR 2.5/1) interior fine sandy loam; weak fine granular structure; nonsticky, nonplastic; many very fine roots throughout and many medium roots throughout and many fine roots throughout; fragments; abrupt smooth boundary.; observed in pit, small

Ap—4 to 19 centimeters (1.6 to 7.5 inches); dark brown (10YR 3/3) interior fine sandy loam; weak medium subangular blocky structure; friable, nonsticky, nonplastic; common very fine roots throughout and common medium roots throughout and common fine roots throughout; fragments; clear smooth boundary.; observed in pit, small

Bw1—19 to 64 centimeters (7.5 to 25.2 inches); yellowish brown (10YR 5/4) interior gravelly fine sandy loam; weak fine subangular blocky structure; friable, nonsticky, nonplastic; common very fine roots throughout and common medium roots throughout and common fine roots throughout; 2 percent by volume flat subrounded 75-?-250 millimeter granite fragments observed by visual inspection method and 15 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method; clear smooth boundary.; observed in pit, small

Bw2—64 to 82 centimeters (25.2 to 32.3 inches); yellowish brown (10YR 5/6) interior gravelly fine sandy loam; weak fine subangular blocky structure; friable, nonsticky, nonplastic; common very fine roots throughout and common medium roots throughout and common fine roots throughout and common coarse roots throughout; 2 percent by volume flat subrounded 75-?-250 millimeter granite fragments observed by visual inspection method and 15 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method; clear wavy boundary.; observed in pit, small

C_—82 to 110 centimeters (32.3 to 43.3 inches); grayish brown (2.5Y 5/2) interior extremely gravelly loamy sand; structureless massive; very friable, nonsticky, nonplastic; few very fine roots throughout and few fine roots throughout; 25 percent distinct silt coats on top faces of peds; 5 percent by volume flat subrounded 75-?-250 millimeter granite fragments observed by visual inspection method and 43 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method; clear wavy boundary.; observed in pit, small

Lab Data																
Horizon	Sand %	Silt %	Clay %	1:1 H2O pH	ODOE	VCS %	CS %	MS %		FS %	VFS %	Coarse Silt %	Fine Silt %	550* C LOI %	Estimated C %	Bulk Density
Oe	-	-	-	3.91	-	-	-	-		-	-	-	-	65.23	32.62	-
Ap	54.2	40.4	5.42	4.12	-	5.4	6.8	10.8		17.1	14.1	21.01	19.4	6.25	3.13	1.01
Bw1	68.67	27.7	3.6	4.23	-	5.5	9.4	15.1		22.2	16.5	16.5	11.2	197.08	98.54	1.25
Bw2	45.21	50.9	3.86	4.1	-	5.3	0.02	8.8		17.9	13.24	47.89	3.04	3.09	1.55	1.32
C	83.5	14.9	1.6	4.16	-	11.3	14.3	33.2		12.4	12.3	5.1	9.8	1.98	0.99	1.38
C silt inclusion	11.75	86	2.3	4.43	-	0.63	0.8	1.43		1.95	6.95	82.35	3.6	2.19	1.1	1.82

Stop 6

Parking: Along the road at individual pit sites.

Notes: Some light offroading on a narrow wood road will take place when we look at the esker. There is a turn around site up the road, but we can carpool and park some of the vans along the paved road.

You may hear (very loud and unsettling) explosions. This is normal. Part of the campus is used by the URI Chemistry Department for explosives research.

Alton Jones Campus History:

The 2,300 acres of till upland, kame terraces, and eskers emerged from relative obscurity when oil executive W. Alton Jones purchased the land and, known at the time as “Hianloland Farms”. Here, he stocked pheasants and trout, and hosted President Eisenhower on trout-fishing weekends (image below) that inspired the design of Camp David. After Jones’s 1962 death in a plane crash, his widow gifted the estate to URI; a year later the university opened the Whispering Pines Conference Center and launched an Environmental Education Center that eventually welcomed thousands of Rhode Island schoolchildren to study vernal pools and night skies with an observatory. At one point, the campus hosted over 20,000 people a year.

Unfortunately, the campus closed to the public due to the pandemic in 2020 but in June of this year, URI and the DEM announced a new partnership: DEM will handle forest and dam work while the university revives camps and field courses.

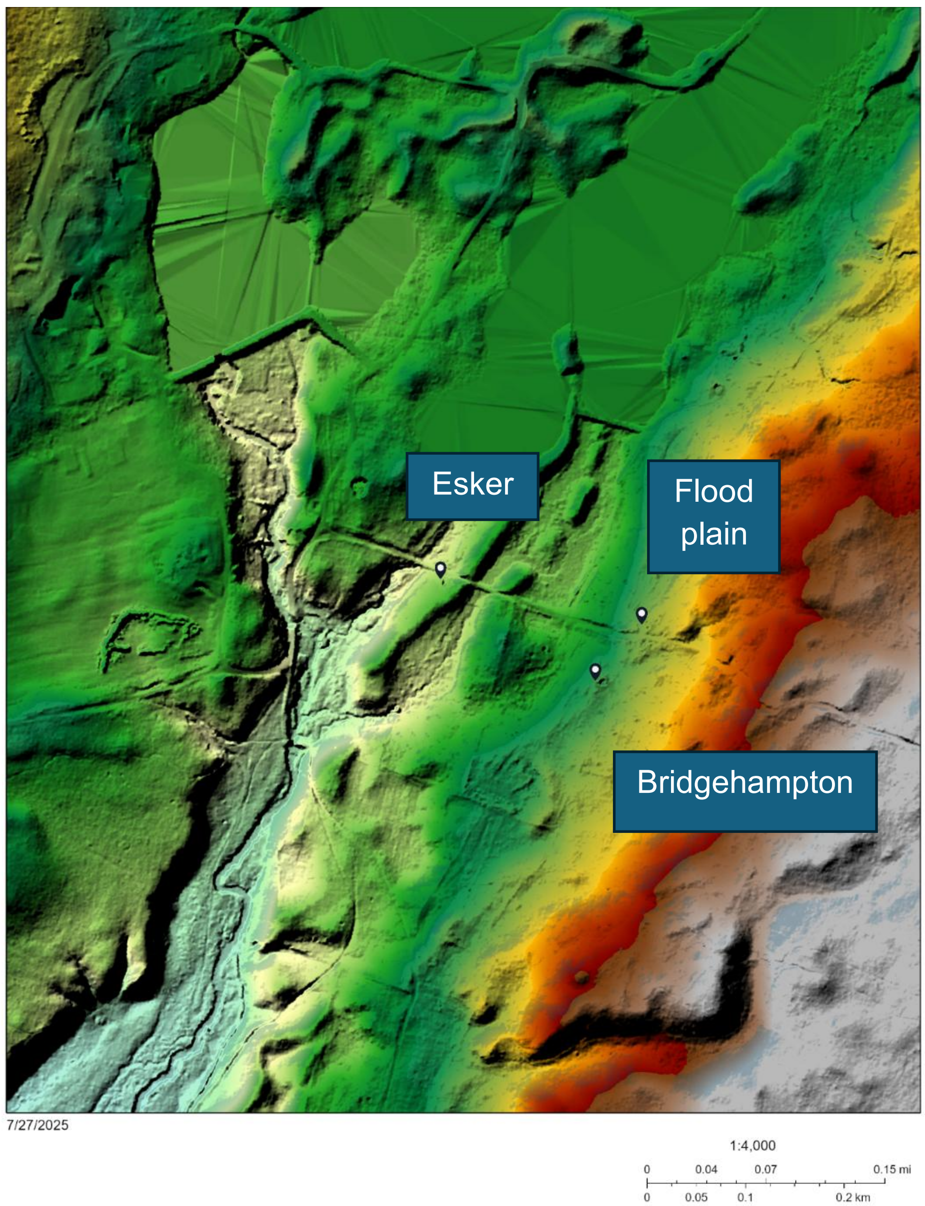
Alton Jones Esker

Unfortunately we do not have a current description of this pit, but the pit is on a wonderful example of an esker. In fact, this esker can be followed through the woods and even underneath the man-made lake that we drove over to get here. If you walk to the top of the hill the pit is on you will be able See below for hillshade and topo maps. Also take note of apparent fine stratification in the lower left-hand corner of the pit.

On either side of this valley are bedrock controlled till uplands. Directly after this pit we will travel to the Bridgehampton and flood plain pits which are situated on a kame terrace at the base of the till upland.

Classification KST 2022:Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Dystrudepts

Classification proposed: Coarse-loamy over sandy or sandy-skeletal,, mixed, active, mesic, udic Typic Haplodystrepts



7/27/2025

1:4,000

0 0.04 0.07 0.15 mi

0 0.05 0.1 0.2 km

URI EDC, RIGIS, Esri, NASA, NGA, USGS, FEMA, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community

Alton Jones Floodplain

Classification KST 2022: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Thapto-Humic Fluvaquept

Classification proposed: Coarse-loamy over sandy or sandy-skeletal, mixed, active, mesic Thapto-Humic Fluviperaq

HORIZONATION				BOUNDARY		COARSE FRAGMENTS AND TEXTURE			COLOR			STRUCTURE		CONS IST	REDOXIMORPHIC FEATURES						SCORE
															Depletions			Concentrations			
Pre	Master	Sub	No	Depth (cm)	Dist.	Coarse Fragment Roundness	Coarse Fragment Modifier	Fine-Earth Class	Hue	Value	Chroma	Grade	Type	Moist	Y/N	Abun	Contr	Y/N	Abun	Contr	
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(42)
–	A	–	–	9	A	–	–	mk SiL	7.5YR	2.5	1	1	SBK	fr	N	–	–	Y	m	P	
–	B	g	–	25	A	–	–	SiL	2.5Y	4	2	1	SBK	fr	N	–	–	Y	C	P	
–	A	b	–	50	C	SA 5%	–	SiL	10YR	2	1	1	SBK	fr	N	–	–	Y	C	P	
–	C	g	–	60+	–	SA 20%	GR	SL	2.5Y	5	2	0	MA	fr	N	–	–	Y	C	P	

Carbon accounting in riparian wetland soils.

Development and application of multi-proxy indices of land use change for riparian soils of southern New England, USA. Ecological Applications 22:487-501.

Ricker, M.C., S.W. Donohue, M.H. Stolt, and M.S. Zavada. 2012.

Understanding the effects of land use on riparian systems is dependent upon the development of methodologies to recognize changes in sedimentation related to shifts in land use. Land use trends in southern New England consist of shifts from forested precolonial conditions, to colonial and agrarian land uses, and toward modern industrial–urban landscapes. The goals of this study were to develop a set of stratigraphic indices that reflect these land use periods and to illustrate their applications. Twenty-four riparian sites from first- and second-order watersheds were chosen for study. Soil morphological features, such as buried surface horizons (layers), were useful to identify periods of watershed instability. The presence of human artifacts and increases in heavy metal concentration above background levels, were also effective indicators of industrial–urban land use periods. Increases and peak abundance of non-arboreal weed pollen (Ambrosia) were identified as stratigraphic markers indicative of agricultural land uses. Twelve 14C dates from riparian soils indicated that the rise in non-arboreal pollen corresponds to the start of regional deforestation (AD 1749 6 56 cal yr; mean 6 2 SD) and peak non-arboreal pollen concentration corresponds to maximum agricultural land use (AD 1820 6 51 cal yr). These indices were applied to elucidate the impact of land use on riparian sedimentation and soil carbon (C) dynamics. This analysis indicated that the majority of sediment and soil organic carbon (SOC) stored in regional riparian soils is of postcolonial origins. Mean net sedimentation rates increased ;100-fold during postcolonial time periods, and net SOC sequestration rates showed an approximate 200-fold increase since precolonial times. These results suggest that headwater riparian zones have acted as an effective sink for alluvial sediment and SOC associated with postcolonial land use.

492 M. C. RICKER ET AL. Ecological Applications Vol. 22, No. 2

TABLE 3. Accelerator mass spectrometry ^{14}C dating results of soil horizons corresponding to the peak (peak ragweed), start (ragweed rise) of colonial–agrarian land use, and precolonial riparian surfaces.

Site	Depth (cm)	Sample type	^{14}C yr BP ± 1σ	Median 2σ age (cal yr BP)†	Median 2σ age (AD cal yr)†	CPRAV†
Peak ragweed: maximum agriculture						
URI-RI	60	plant fragments	105 ± 30	80 ± 67	1870 ± 67	0.70
Slocum	32	plant fragments	modern (≤50)	n/a	n/a	n/a
Tuskatucket	57	plant fragments	220 ± 30	180 ± 35	1770 ± 35	0.48
Mean‡	50	n/a	125 ± 35	130 ± 51	1820 ± 51	n/a
Ragweed rise: start of agriculture						
AMA-RI	44	wood	220 ± 35	180 ± 40	1769 ± 40	0.48
HSP-RI	82	wood	70 ± 45	80 ± 67	1869 ± 67	0.70
HVS-RI	60	charcoal	130 ± 30	104 ± 47	1846 ± 47	0.44
SBF-MA	60	wood	170 ± 25	180 ± 43	1769 ± 43	0.57
URI-RI	90	charcoal	200 ± 30	180 ± 39	1769 ± 39	0.56
Nasucket	139	plant fragments	150 ± 25	200 ± 32	1751 ± 32	0.35
Pippin Orchard§	77	plant fragments	modern (≤50)	n/a	n/a	n/a
Slocum	80	plant fragments	95 ± 105	157 ± 157	1793 ± 157	1.00
Tuskatucket	107	plant fragments	485 ± 30	521 ± 21	1428 ± 21	1.00
Mean‡	82	n/a	175 ± 40	201 ± 56	1749 ± 56	n/a
Precolonial riparian surfaces						
HVS-RI	87	charcoal	510 ± 40	530 ± 30	1420 ± 30	0.85
NWC-MA	180	wood	9730 ± 55	11 160 ± 89	n/a	0.88
POW-CT	100	sediment	3340 ± 35	3558 ± 83	n/a	0.96
RCB-RI	50	charcoal	2470 ± 30	2527 ± 94	n/a	0.61
TVW-RI	65	charcoal	9990 ± 40	11 446 ± 178	n/a	0.98
URI-RI	110	plant fragment	800 ± 30	720 ± 45	1230 ± 45	1.00
WSP-MA	30	charcoal	800 ± 35	724 ± 50	1226 ± 50	1.00
Mean‡	89	n/a	3950 ± 4170	4380 ± 81	n/a	n/a

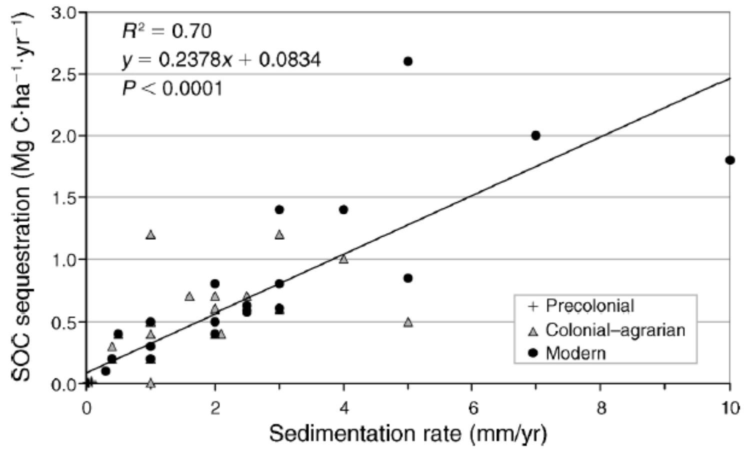
Notes: The 1σ and 2σ age ranges correspond to 68.2% and 95.4% confidence levels of the raw and calibrated ^{14}C dates, respectively. An entry of "n/a" indicates "not applicable."

† Calibrated ^{14}C ages reported are those chosen with the highest CPRAV (calibration peak area value), determined using Calib 5.0.2 (version 5.0; Stuiver and Reimer 1993).

‡ Arithmetic mean of individual ^{14}C dates for ragweed rise, peak ragweed, and precolonial surfaces.

§ Corresponding ^{210}Pb (0–21 cm) and ^{137}Cs (0–11 cm) data from the Pippin Orchard site indicate ages from AD 1865 to present in the upper 21 cm of soil.

FIG. 6. Overall linear relationship between riparian zone sedimentation and soil organic carbon (SOC) sequestration (n = 72). Similar linear trends existed for the precolonial (20 400 yr BP to AD 1650), colonial–agrarian (AD 1650–1900), and modern (AD 1900–present) time periods.



Soil organic carbon pools in riparian landscapes of southern New England.

Soil Science Society of America Journal 77:1070-1079.

Ricker, M.C., M.H. Stolt, S.W. Donohue, Blazejewski, G.A., and M.S. Zavada. 2013.

Wetland riparian soils typically have greater C pools than adjacent uplands, yet quantifying soil organic C (SOC) sequestration in riparian systems remains difficult. Quantification of major inputs and losses of autochthonous SOC through process-based measurements would allow for better comparisons between riparian and upland systems. In this study, we quantified major soil C fluxes within five paired headwater riparian and upland sites in Rhode Island. The difference between total C inputs and losses were used to construct net annual landscape-scale SOC sequestration rates. Annual SOC inputs were statistically similar between landscapes, with the exception of those from understory herbaceous vegetation, which were significantly greater ($p < 0.001$) in riparian zones than uplands. Mean annual C losses via soil respiration were also statistically similar between landscapes, but estimates of microbial respiration (actual loss of SOC) were significantly less ($p < 0.01$) in riparian ecosystems. Thus, riparian forests had greater net annual SOC sequestration (range 2.4–3.4 Mg C ha−1 yr−1) than paired upland sites (range 0.4–2.1 Mg C ha−1 yr−1). Our results suggest that process-based SOC sequestration measures can yield similar results to traditional methods, such as chronosequences, but our averaged estimates (2.0 Mg C ha−1 yr−1) were greater than those typically reported using alternate approaches.

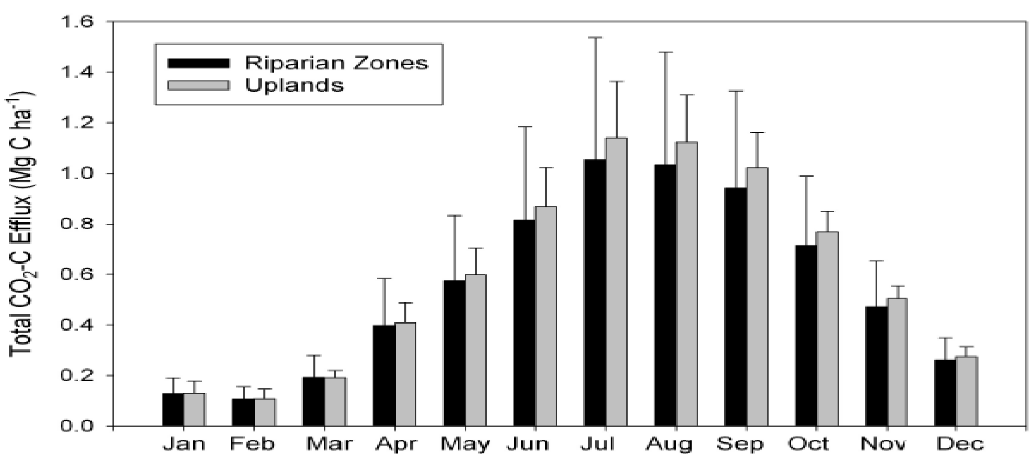


Fig. 3. Mean monthly total soil respiration C losses for riparian and upland monitoring plots, error bars represent one standard deviation. There were no statistically significant differences in total soil respiration between riparian and upland plots.

Table 3. Mean annual inputs and losses of soil organic C (SOC) from riparian zone and upland settings. Means were calculated from 2 yr of data. Coefficient of variation (%) are shown in parentheses.

Site†	AMA‡	EGA‡	HSP‡	SBW‡	WKC‡
Riparian zone plots					
Carbon inputs (Mg C ha^{-1} yr^{-1})					
Leaf litter	2.0 (30)a	2.4 (8)a	1.9 (16)a	3.5 (6)a	2.1 (29)a
Total roots§	0.4 (25)a	0.6 (17)a	2.8 (84)a	0.3 (93)a	1.1 (99)a
Deadfall	3.5 (140)a	1.0 (90)a	1.4 (130)a	3.3 (145)a	2.6 (130)a
Herbaceous vegetation	0.3 (67)ac	0.6 (50)ab	0.9 (33)b	0.2 (50)c	0.2 (40)c
Total	6.2	4.6	7.0	7.3	6.0
Carbon losses (Mg C ha^{-1} yr^{-1})					
Total CO_2–C efflux	6.3 (2)a	2.5 (4)b	9.4 (1)a	8.7 (1)a	6.4 (2)a
Microbial CO_2–C efflux	3.3 (14)a	2.2 (13)a	4.3 (11)a	3.9 (9)a	3.1 (10)a
Total carbon sequestration (Mg C ha^{-1} yr^{-1})¶					
Total	2.9	2.4	2.7	3.4	2.9
Upland plots					
Carbon inputs (Mg C ha^{-1} yr^{-1})					
Leaf litter	2.7 (22)a	2.0 (5)ab	4.1 (15)ac	4.2 (5)c	2.5 (4)ab
Total roots§	2.3 (105)a	1.2 (8)a	2.0 (58)a	0.4 (75)a	1.5 (64)a
Deadfall	1.4 (29)a	3.3 (121)a	1.7 (47)a	1.4 (71)a	0.6 (83)a
Herbaceous vegetation	0.1 (100)a	0.08 (38)ab	0.02 (45)b	0.02 (50)b	0.07 (14)ab
Total	6.5	6.6	7.8	6.0	4.7
Carbon losses (Mg C ha^{-1} yr^{-1})					
Total CO_2–C efflux	7.4 (2)a	7.0 (3)a	8.1 (1)a	7.3 (1)a	6.0 (2)a
Microbial CO_2–C efflux	5.3 (13)a	5.2 (11)a	5.7 (19) a	5.1 (16)a	4.3 (12)a
Total carbon sequestration (Mg C ha^{-1} yr^{-1})¶					
Total	1.2	1.4	2.1	0.9	0.4

† AMA, Arcadia Management Area; EGA, East Greenwich Apartments; HSP, Haines State Park; SBW, Spring Brook Westerly; WKC, West Kingston Chickasheen.

‡ Means by row with different letters are significantly different (α = 0.05).

§ Fine root production, plus estimated 32% coarse root inputs to a depth of 1 m.

¶ Total C sequestration is the sum of total C inputs minus microbial CO_2–C losses.

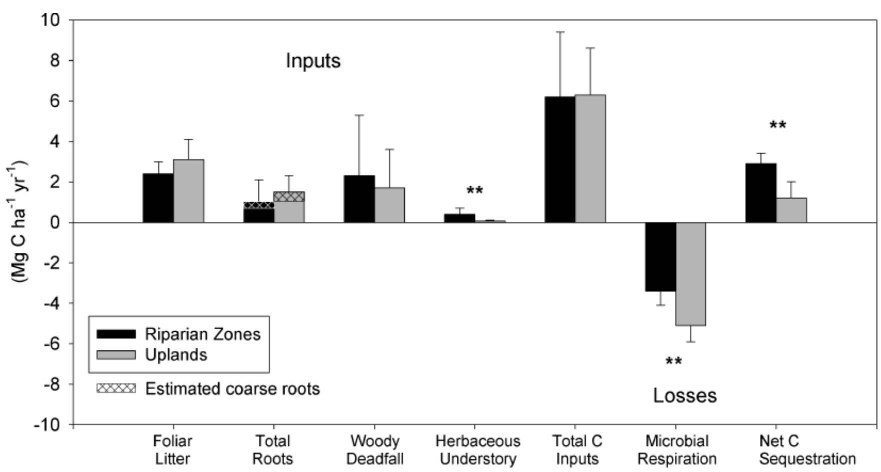


Fig. 6. Total mean annual inputs and losses of soil organic C (SOC) in riparian zone and upland landscapes. Means represent combined measures from five monitoring plots in both riparian and upland landscapes. Note that only microbial respiration was used in calculating total net SOC sequestration. Error bars represent one standard deviation, ** indicates significant differences ($p < 0.01$) between riparian zones and uplands. All other SOC inputs and losses were not statistically different (α = 0.05).

Alton Jones Bridgehampton

Classification 2022: Coarse-loamy, mixed, superactive, mesic Typic Humudepts

Classification proposed: Coarse-loamy, mixed, superactive, mesic, udic, Typic Dystrihumepts

-	A	p	-	21	C	-	SiL	10YR	3	3	1	SBK	fr	N	-	-	N	-	-	
-	B	w	1	31	C	-	SiL	10YR or 7.5YR	4	4	1	SBK	fr	N	-	-	N	-	-	
-	B	w	2	52	C	-	SiL	10YR	4 or 5	6	1	SBK	fr	N	-	-	N	-	-	*
-	BC	-	-	66	C	-	SiL	10YR or 2.5Y	5	4	1	SBK	fr	N	-	-	Y	F	P	**
-	C	-	1	99	C	-	SiLT	2.5Y	5	2	0	MA	fr	N	-	-	Y	C	P	**
-	C	-	2	119+	-	-	SiL	10YR	5	3	0	MA	fr	N	-	-	Y	C or M	P	**

Alton Jones Paxton

Classification KST 2022: Coarse-loamy, mixed, active, mesic Typic Densiudepts

Classification proposed: Coarse-loamy, mixed, active, mesic, udic Typic Densidystrepts

-	A	-	-	5	A	-	fSL	7.5YR	2.5	1	1	SBK	vfr	N	-	-	N	-	-	
-	A	p	-	13	A	-	fSL	10YR	4	4	1	SBK	fr	N	-	-	N	-	-	
-	B	w	1	32	G	GR or	fSL	10YR	4	6	1	SBK	fr	N	-	-	N	-	-	*
-	B	w	2	54	G	GR or	fSL or SL	10YR	5	6	1	SBK	fr	N	-	-	N	-	-	
-	B	w	3	80	C	-	fSL or SL	10YR	5	6	1	SBK	fr	N	-	-	N	-	-	
-	C	-	-	124+	-	-	fSL or SL	2.5Y	6	2 or 3	0	MA	fr	N	-	-	N	-	-	**

Alton Jones Woodbridge

Classification KST 2022: Coarse-loamy, mixed, active, mesic Typic Densiudepts

Classification proposed: Coarse-loamy, mixed, active, mesic, udic Densic Aquidystrepts

HORIZONATION				BOUNDARY		COARSE FRAGMENTS AND TEXTURE			COLOR			STRUCTURE		CONSIST	REDOXIMORPHIC FEATURES						SCORE
															Depletions			Concentrations			
Pre	Master	Sub	No	Depth (cm)	Dist	Coarse Fragment Abundance (%)	Coarse Fragment Modifier	Fine-Earth Class	Hue	Value	Chroma	Grade	Type	Moist	Y/N	Abun	Contr	Y/N	Abun	Contr	
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(42)
-	A	p	-	13-15 14	A	1-10 5	-	SL	7.5YR	2.5	3	1	SBK	vfr	N	-	-	N	-	-	
-	B	w	1	30-34 32	C	2-12 7	-	SL	10YR	4	6	1	SBK	fr	N	-	-	N	-	-	
-	B	w	2	46-50 48	C	4-14 9	-	SL	10YR	5	4 or 6	1	SBK	fr	N	-	-	Y	F	P or D	
-	B	w	3	61-67 64	G	5-15 10	-	SL	10YR	5	6	1	SBK	fr	Y	M or C	P	Y	M	D	
-	BC	-	-	72-76 74	C	7-17 12	-	SL	10YR or 2.5Y	5	3 or 6	1	SBK	fr	Y	M or C	D	Y	M	D	
-	C	dg	-	98+	-	11-21 16	GR	SL	2.5Y	5	2	0	MA	firm	N	-	-	Y	C	P	

Moving SMR to family level:

Soil Taxonomy was designed as a shared language for interpreting and describing soils, yet its current hierarchy gives too little useful information at the point many end users need: the suborder. Right now that level is dominated by just five broad soil-moisture regimes--SMR -(ustic, xeric, udic, aridic, aquic). Nationwide SCAN sensor data show those mapped regimes often fail to match the actual moisture conditions throughout the year. The classification of most soils outside of those with udic moisture regimes is actually wrong. AS such, literally thousands of monitoring stations across the nation have been established to identify soil moisture conditions (National Moisture Monitoring Network).

A proposed restructuring of the suborder categories that use SMR would move readily observed morphological features up to the suborder category. The moisture regime would shift down to the family category, where many more classes could be defined using continuous sensor networks, remote-sensing products, and climate-model projections. It has been demonstrated that this change markedly increases “information gain” between order and suborder, allowing for more effective communication about a soil’s morphology without potentially incorrectly assigning a moisture regime.

For our Rhode Island that means a soil now classified as a Aquic Dystrudept could instead classify as a Densic Aquidystrept. Such a system would make field discussions tie profile morphology more directly to land-use decisions, and keep the classification flexible as climate-driven shifts in soil moisture continue to accelerate.

Alton Jones Alaquod

Classification KST 2022: Coarse-loamy, mixed, active, mesic Aeric Alaquod

Classification proposed:

HORIZONATION				BOUNDARY		COARSE FRAGMENTS AND TEXTURE			COLOR			STRUCTURE		CONSIST	REDOXIMORPHIC FEATURES						SCORE
Pre	Master	Sub	No	Depth (cm)	Dist.	Coarse Fragment Abundance (%)	Coarse Fragment Modifier	Fine-Earth Class	Hue	Value	Chroma	Grade	Type	Moist	Depletions			Concentrations			
															Y/N	Abun	Contr	Y/N	Abun	Contr	
(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(42)
-	A	-	-	4-6 5	A	1-7 2	-	SL	7.5 YR	2.5	1	1	GR	vfr	N	-	-	N	-	-	
-	E	-	-	14-16 15	A	1-7 2	-	LS	7.5 YR	5	2	1	SBK	vfr	N	-	-	N	-	-	
-	B	hs	1	22-26 24	C	2-12 7	-	SL	5YR	2.5	2	1	SBK	fr	N	-	-	N	-	-	
-	B	hs	2	32-36 34	C	5-15 10	-	SL	2.5 YR	2.5	2	1	SBK	fr	N	-	-	N	-	-	
-	B	w	-	51-53 52	A	7-17 12	-	SL	10YR	4	6	1	SBK	fr	N	-	-	Y	C	P or D	
-	C	dcg	-	98+	-	7-17 12	-	fSL	2.5Y	5	2	0	MA	vfirm	N	-	-	Y	C	P	

Social

BYOB. $10 for pizza and oysters. We will have lawn games. Restrooms available a short drive away, we will go over how to access the road.

Please be respectful of the area and remember to throw out all trash in trash bags.

Day 3.

Thursday, July 31. National Raspberry Cake Day:

Stop 1: 8:00 – 9:30. Narrow River TLP Site. TLP Profile, Natural Marsh Profile.

Bathroom if needed: Dunkin, gas stations on way to Pumphouse Marsh.

Stop 2: 10:00 – 1:00. Pumphouse Marsh. Natural Marsh, GHG Measurements, Subaqueous Cores, Carbon Accounting, Organic Matter Accretion.

Lunch: 1:15 – 2:15. Fort Weatherill State Park. **Bathrooms available.** Grab lunch at a local joint on the drive there or pack a lunch. Swimming spot, porphyritic granite outcrop, old fort. Take a wander!

Stop 3: 2:30 – 3:30. Parker Farm.

Stop 4: 3:30 – 5:00. Godena Farm.

Optional stop 5: Narragansett Café in Jamestown has live music and fresh oysters.

Overview:

To start the last day we will meet at John Chafee National Wildlife preserve to discuss thin layer placement (TLP), natural tidal marshes, carbon stocks, and green house gas monitoring. We will then head over to Jamestown (Conicut Island) and meet at the town water pumphouse for more marsh fun. We will then head to lunch at Fort Weatherill, a historic fort turner state park with gorgeous granitic outcrops. After lunch we will finish the day at Parker Farm and Godena Farm to observe dark till and local eolian sand mantles.

Stop 1

John Chafee National Wildlife Refuge

Parking: Park along left side of the road.

Notes: Please stay on the sanded surface of the marsh so as to not disturb (or step on!) salt marsh sparrows - FWS will be upset, and we want to be allowed back!

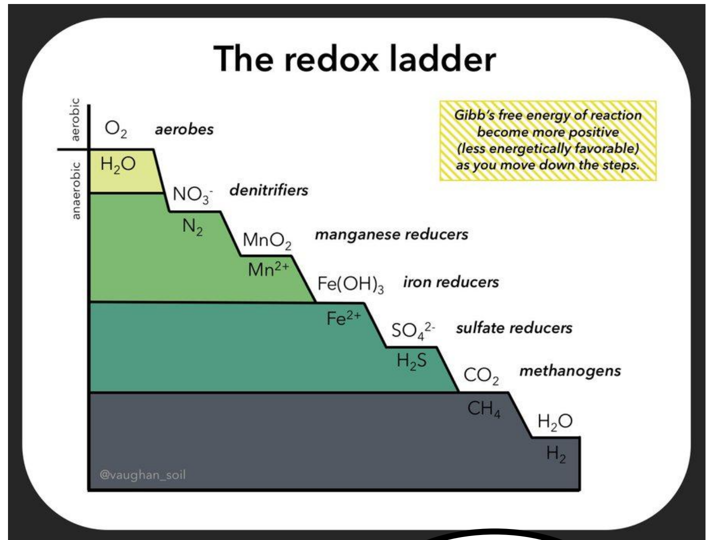
Pettaquamscutt River:

The Pettaquamscutt River, also known as the Narrow River is divided into two distinct regions, (upper and lower) each shaped by glacial processes and defined by different geomorphological and hydrological characteristics. The valley in which the river lies was formed during the Tertiary and further deepened by Pleistocene glacial erosion. At the northern end, melting glacial ice blocks created two deep kettle lakes and deposited sediments southward, forming meltwater channels and a flood delta in the lower estuary. As a result, the lower river is relatively shallow, averaging about two meters in depth, and includes a large cove (to the south of where we are for this stop) that absorbs roughly one-third of the incoming tide. This section behaves as a well-mixed estuary, with consistent salinity and water circulation.

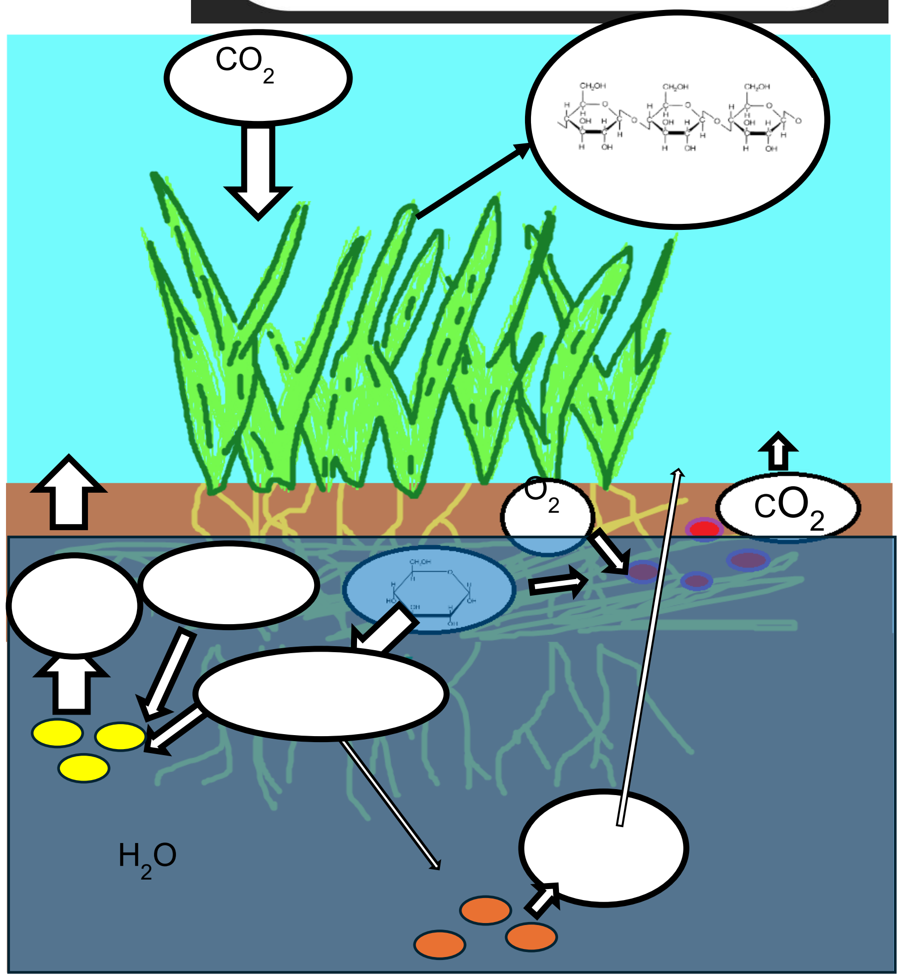
In contrast, the upper river is dominated by the two deep kettle lakes, Upper and Lower Ponds, with depths of 15 and 19 meters, respectively. These lakes are separated from the lower river by shallow sills that restrict water flow and reduce tidal influence. The upper river behaves more like a fjord-type estuary, with strong vertical stratification in the water column. Typically, the lakes feature a surface layer of oxygenated water with low to moderate salinity, a middle hypoxic layer with increasing salinity, and a bottom layer that is stagnant, anoxic, and most saline. Overturn events in the deep ponds of the Narrow River occur every few years under specific weather conditions, typically in the fall. A dry season reduces freshwater input from sources, while king tides bring an influx of cold, salty seawater. This denser seawater sinks upon entering Upper Pond, displacing the stagnant, anoxic bottom water and forcing it upward. Strong winds further aid in mixing the water column. When the anoxic bottom water reaches the surface and is exposed to air, sulfur compounds oxidize, creating a milky appearance and a distinctive rotten egg smell. These conditions can persist for several hours to weeks. Notably, there was an overturn event in November of last year, see here for some gorgeous footage: https://youtu.be/ddyUlytnuto

Greenhouse Gas Monitoring:

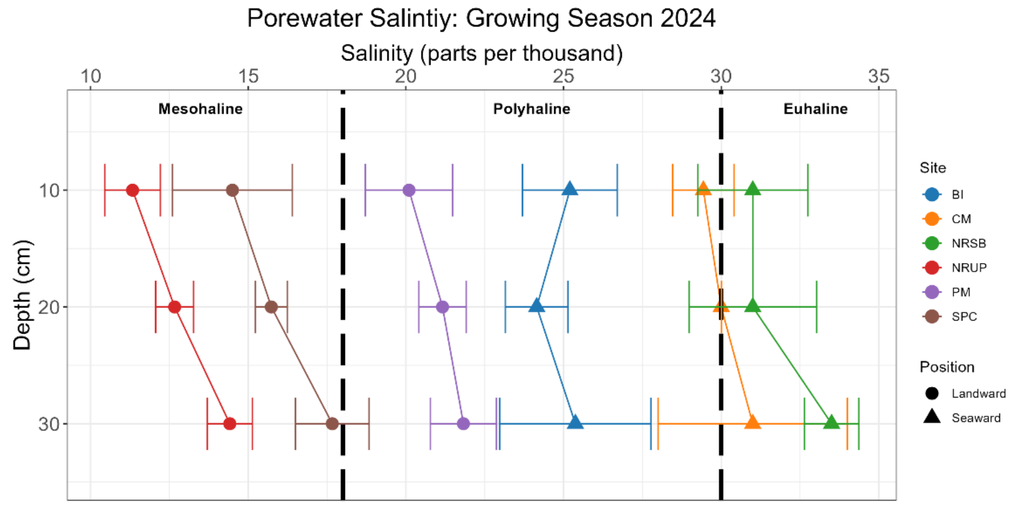
In order to more accurately quantify present-day carbon fluxes in tidal marshes, Michael Norton's research focuses focuses on, CH_4 & CO_2 emissions from tidal marshes in Connecticut and Rhode Island. These ecosystems play a crucial role in carbon sequestration, but they can also release potent greenhouse gases like methane under anoxic conditions. Mike's research addresses the high variability and uncertainty surrounding methane emissions from salt marshes with a goal of understanding how salinity and other environmental factors influence these GHG fluxes.



While it's widely assumed that higher salinity (and thus sulfate availability) suppresses methane production by favoring sulfate-reducing bacteria over methanogens (see redox ladder and figure to right) (Poffenbarger et al., 2011), empirical evidence suggests that this relationship is not always reliable (Capooci et al., 2024). Some high-salinity marshes still exhibit elevated methane emissions, potentially due to alternate methanogenic pathways like methylotrophy or limited sulfate availability due to sulfate reducers utilizing all available sulfate faster than it can be replenished.



The hypothesis of the study is that methane emissions increase as salinity and sulfate concentrations decrease. Additionally, factors like SOC content, ammonium, and sulfide levels in porewater are expected to influence emissions. CO_2 flux is predicted to rise with temperature and ammonium levels. The study examines six Spartina alterniflora-dominated marshes along salinity gradients in three estuaries: the Narrow River (Rhode Island), and the Mystic and Wequetequock Rivers (Connecticut).

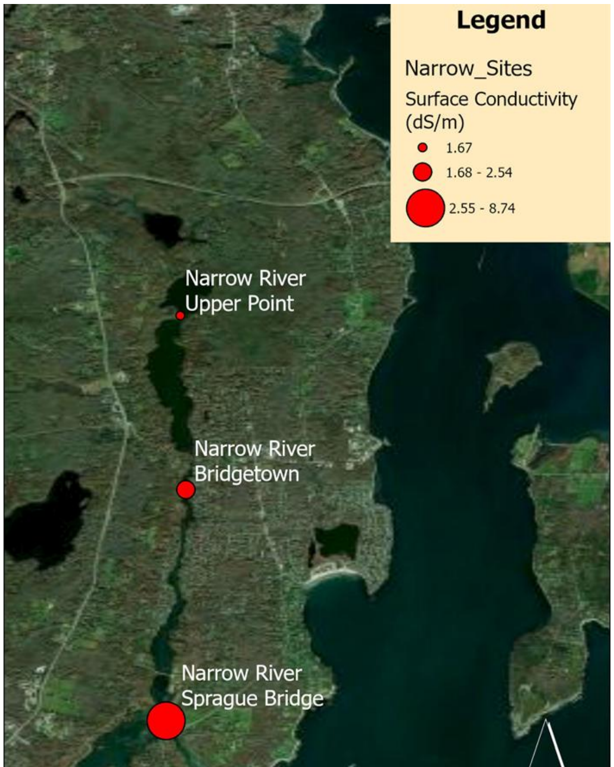


Using static chambers and monthly gas sampling, fluxes of CH_4 and CO_2 are measured at 20 minute timed increments to determine GHG flux from time 0. Porewater chemistry (sulfate, sulfide, ammonium, and salinity) is measured during each sampling event. Gas chromatography and spectrophotometry Is used to quantify gas concentrations and porewater solutes.

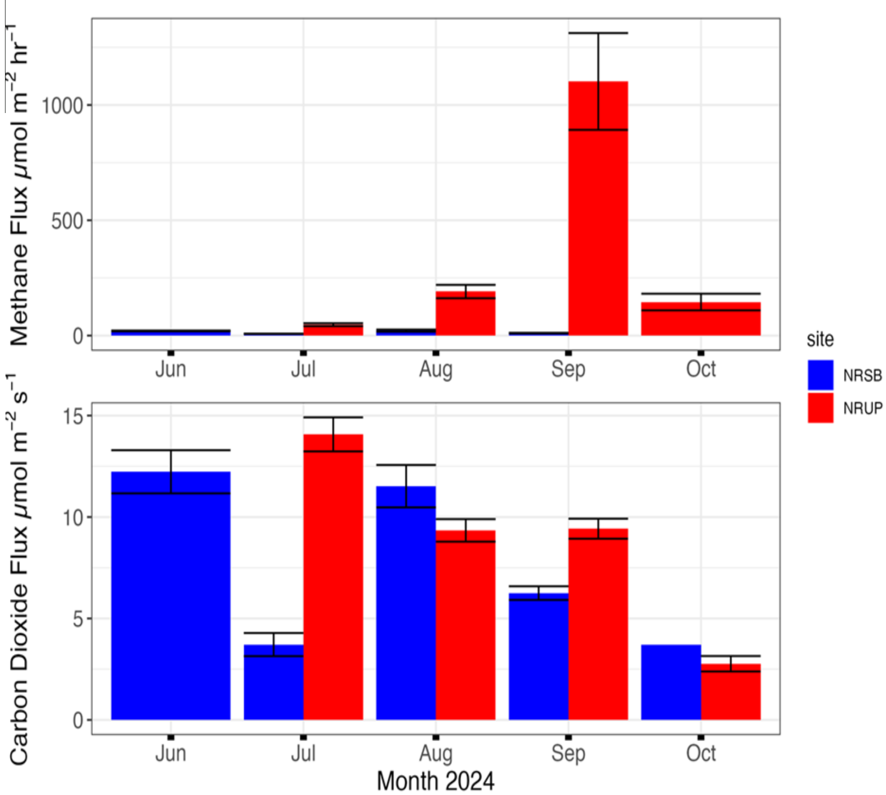
This work contributes to refining regional and global carbon budgets and improving models for coastal wetland restoration and management. By considering complex and sometimes contradictory biogeochemical interactions, the study aims to produce site-specific and seasonally sensitive insights into the greenhouse gas dynamics of New England tidal marshes. The findings are expected to inform conservation efforts and guide the implementation of blue carbon strategies as nature-based solutions to climate change.

In order to quantify methane flux and analyze its relationship with environmental variables such as salinity, sulfate, ammonium, and soil properties we utilize closed chamber methods at six sites across three estuarine systems (Narrow River, Wequetequock Cove, and Mystic River) in order to collect and analyze gas flux samples for for CH_4 and CO_2 concentrations. Methane emissions are inversely correlated with salinity. Fresher, more landward marshes have significantly higher CH_4 flux, while more saline, seaward marshes showed reduced methane emissions. A linear model shows that salinity explains about 51% of the variation in methane flux ($R^2 = 0.51$, $p = 0.0006$).

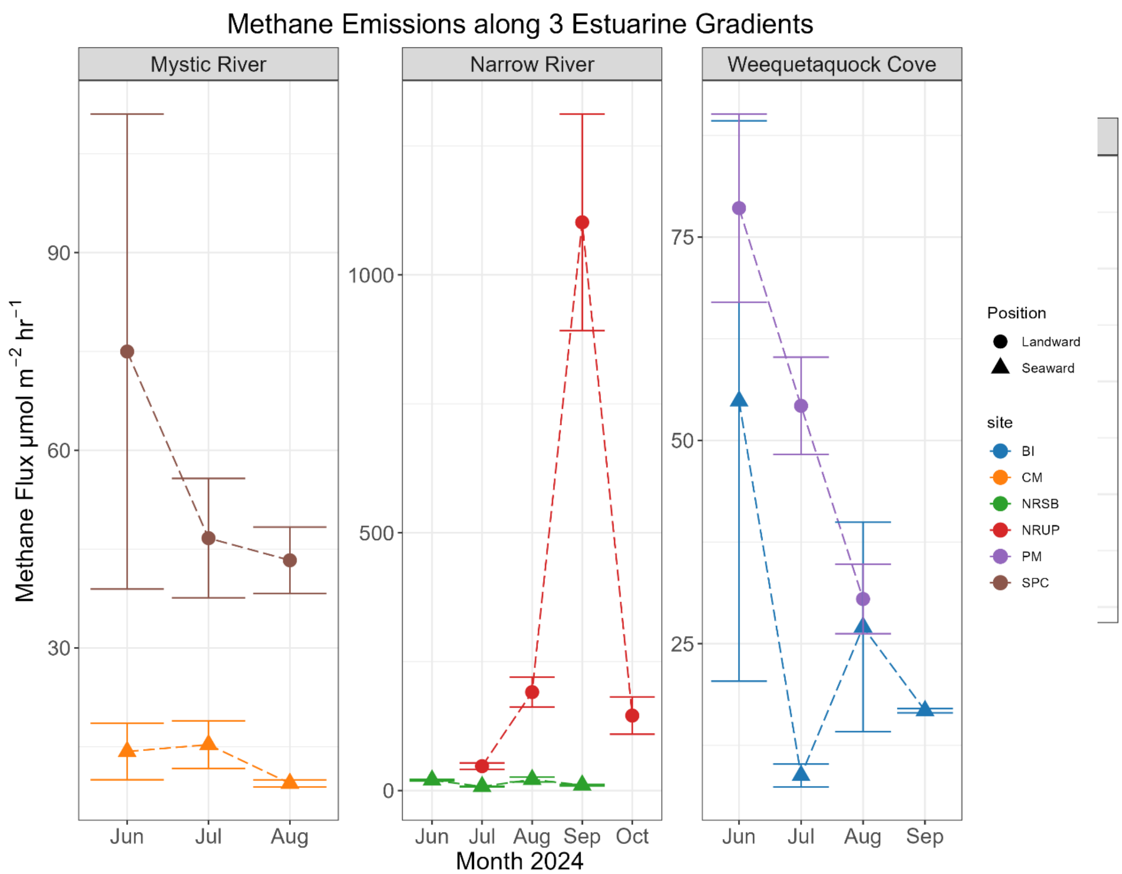
CH_4 emissions tend to decline across the growing season as salinity increases. However, some anomalies occur. Specifically, at the Narrow River Upper Pond site, methane emissions spiked in late summer 2024 despite increased salinity. his was attributed to a decrease in sulfate concentration, suggesting sulfate-reducing bacteria had depleted the pool of available sulfate, allowing methanogens to dominate. See figures below.



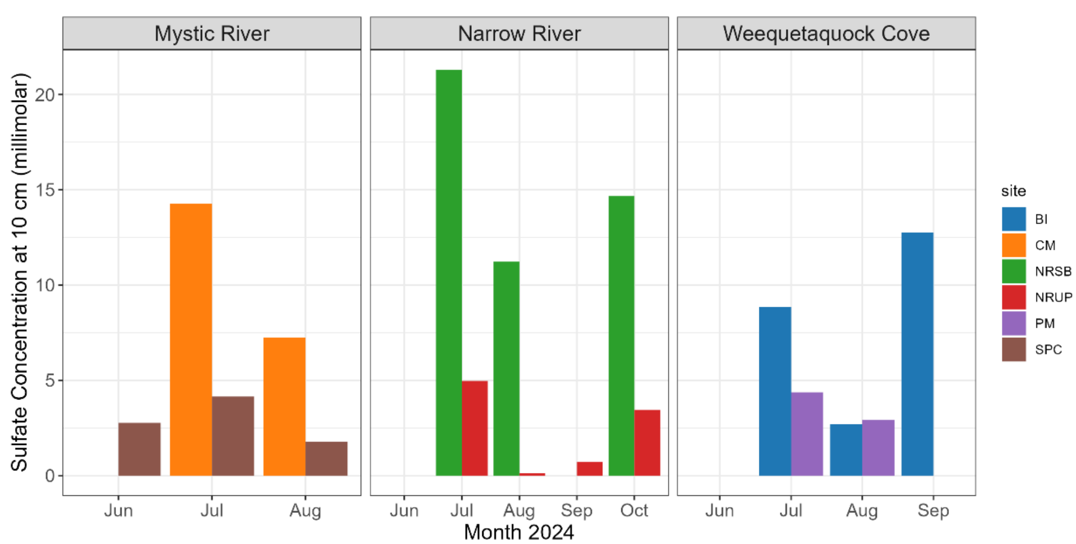
Electric Conductivity (1:5 soil-DI water slurry by volume) at three tidal marsh sites along the Narrow River. Soil EC decreases with increasing distance from the tidal inlet, representing an estuarine salinity gradient.

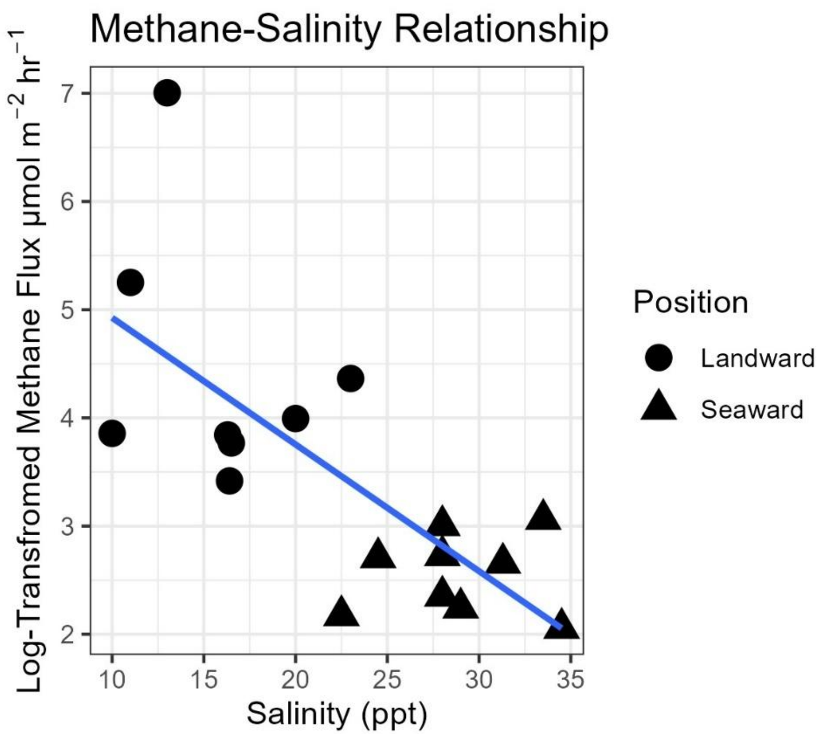


Greenhouse gas fluxes measured during 2024 at seaward (NRSB) and landward (NRUP) sites in the Narrow River estuary. Mean values (+/- standard error of the mean) for each monthly sampling event are displayed. NRUP displayed notable higher methane emission, but similar CO2 emissions to NRSB.



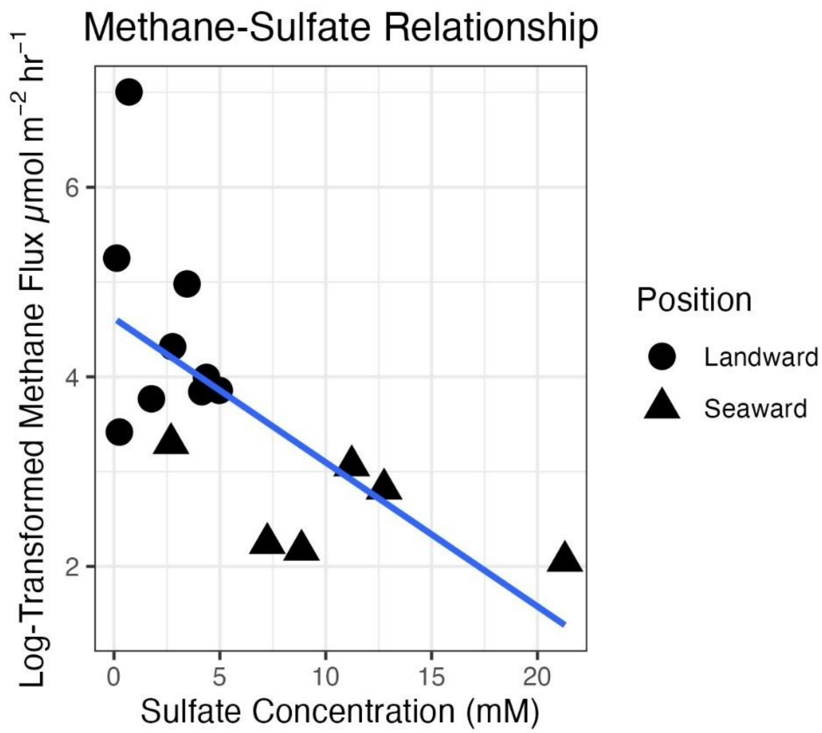
Mean methane flux +/- standard error at each site visit. NRUP, Upper Narrow River, has a mean flux 2 magnitudes of order higher than other marshes. Note below the near total depletion of sulfate at NRUP in August and September.





Relationship between methane flux (log-transformed) and salinity. $p<0.0001$, $R^2=0.55$.

Log(Methane Flux) = -(0.13*Salinity)+6.52



Relationship between methane flux (log-transformed) and sulfate concentration. $p<0.0001$

Thin Layer Placement:

Thin-layer placement (TLP) is an emerging marsh restoration technique that involves adding a “thin” layer of sediment (typically locally dredged material) onto the surface of a tidal marsh to help it maintain its elevation relative to rising sea levels. This strategy is supposed to mimic natural sediment deposition during storms and is designed to bolster marsh resilience by offsetting elevation loss from subsidence and sea level rise.

TLP is particularly relevant in areas where marsh migration is limited by steep slopes or nearby development (look at either side of this river channel!) leaving wetlands with little room to shift landward. The method has been used for decades in Louisiana and is now being studied in a broader range of ecosystems through coordinated research by the National Estuarine Research Reserve System (NERRS).

The addition of sediment through TLP can significantly alter soil properties and ecological processes. Positively, it can increase soil surface elevation, reduce inundation stress on vegetation, promote plant productivity, and maintain marsh hydrology. In the short term, it may also cap contaminated or degraded soils, improving conditions for root development and soil microbial activity.

However, TLP also comes with potential drawbacks. If not properly deposited, the addition of too much sediment too quickly can smother vegetation, disrupt root zones, and compact underlying soil layers. These effects can reduce pore space, limit oxygen diffusion, and inhibit microbial decomposition. With burying of the native vegetation, total primary productivity can be significantly lowered to the point that organic matter accumulation may cease and alter carbon cycling. Some applications have led to increased bulk density and changes in soil texture that negatively impact plant recovery. There is also the potential for altering salinity gradients and nutrient availability, which can shift plant community composition or reduce diversity.

TLP Site Pedons:

2018 KSSL Lab Data (Pedon 1): https://tinyurl.com/47kr8cba

2018 Description (Pedon 1): https://tinyurl.com/4vk5xz4m

2018 KSSL Lab Data (Pedon 2): https://tinyurl.com/44y5anbx

2018 Description (Pedon 2): https://tinyurl.com/4herj9f8

^Cse1—0 to 2 centimeters (0.0 to 0.8 inches); dark greenish gray (10Y 4/1) fine sand; moderate thin platy structure; nonfluid; 7 percent coarse prominent brown (7.5YR 4/4), moist, masses of oxidized iron at top of horizon; fragments; moderate sulfurous odor; very strongly acid, pH 4.9, pH meter; very abrupt smooth boundary. Lab sample # 19N00281; moist when described; observed in pit, small

^Cse2—2 to 30 centimeters (0.8 to 11.8 inches); dark greenish gray (10Y 4/1) oxidized and dark gray (N 4/), reduced fine sand; structureless massive; nonfluid; fragments; moderate sulfurous odor; moderately alkaline, pH 8.0, pH meter; abrupt smooth boundary. Lab sample # 19N00282; wet, satiated when described; observed in pit, small

2Oiseb1—30 to 61 centimeters (11.8 to 24.0 inches); dark gray (10YR 4/1) broken face and very dark gray (10YR 3/1) rubbed peat; nonfluid; fragments; moderate sulfurous odor; moderately alkaline, pH 8.2, pH meter; gradual boundary. Lab sample # 19N00283; wet, satiated when described; observed in pit, small

2Oiseb2—61 to 93 centimeters (24.0 to 36.6 inches); dark gray (10YR 4/1) broken face and very dark gray (10YR 3/1) rubbed peat; slightly fluid; fragments; slight sulfurous odor; slightly alkaline, pH 7.7, pH meter; gradual boundary. Lab sample # 19N00284; wet, satiated when described; observed in macaulay sampler

2Oeseb1—93 to 117 centimeters (36.6 to 46.1 inches); very dark gray (10YR 3/1) broken face and black (10YR 2/1) rubbed mucky peat; slightly fluid; fragments; slight sulfurous odor; slightly alkaline, pH 7.6, pH meter; gradual boundary. Lab sample # 19N00285; wet, satiated when described; observed in macaulay sampler

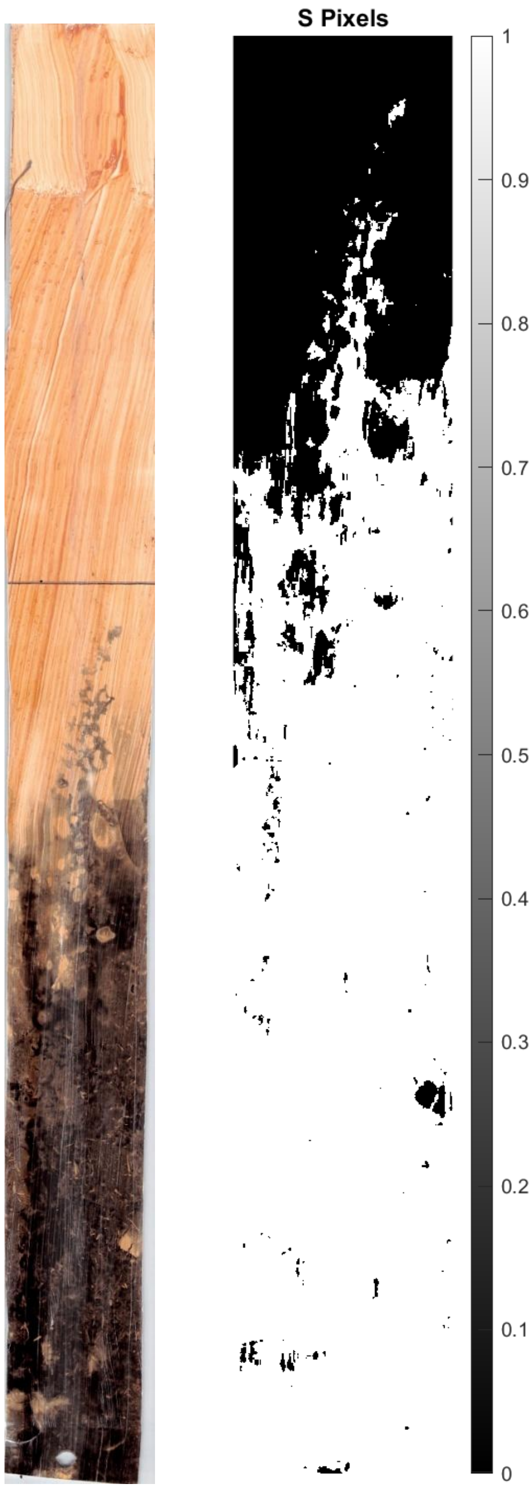
2Oeseb2—117 to 145 centimeters (46.1 to 57.1 inches); black (10YR 2/1) broken face and black (10YR 2/1) rubbed mucky peat; moderately fluid; fragments; slight sulfurous odor; slightly alkaline, pH 7.5, pH meter; gradual boundary. Lab sample # 19N00286; wet, satiated when described; observed in macaulay sampler

3CAse—145 to 158 centimeters (57.1 to 62.2 inches); 60 percent very dark gray (5Y 3/1) and 40 percent black (10YR 2/1) sandy loam; massive; friable; nonfluid; fragments; slight sulfurous odor; slightly alkaline, pH 7.5, pH meter; clear boundary. Lab sample # 19N00287; wet, satiated when described; observed in macaulay sampler

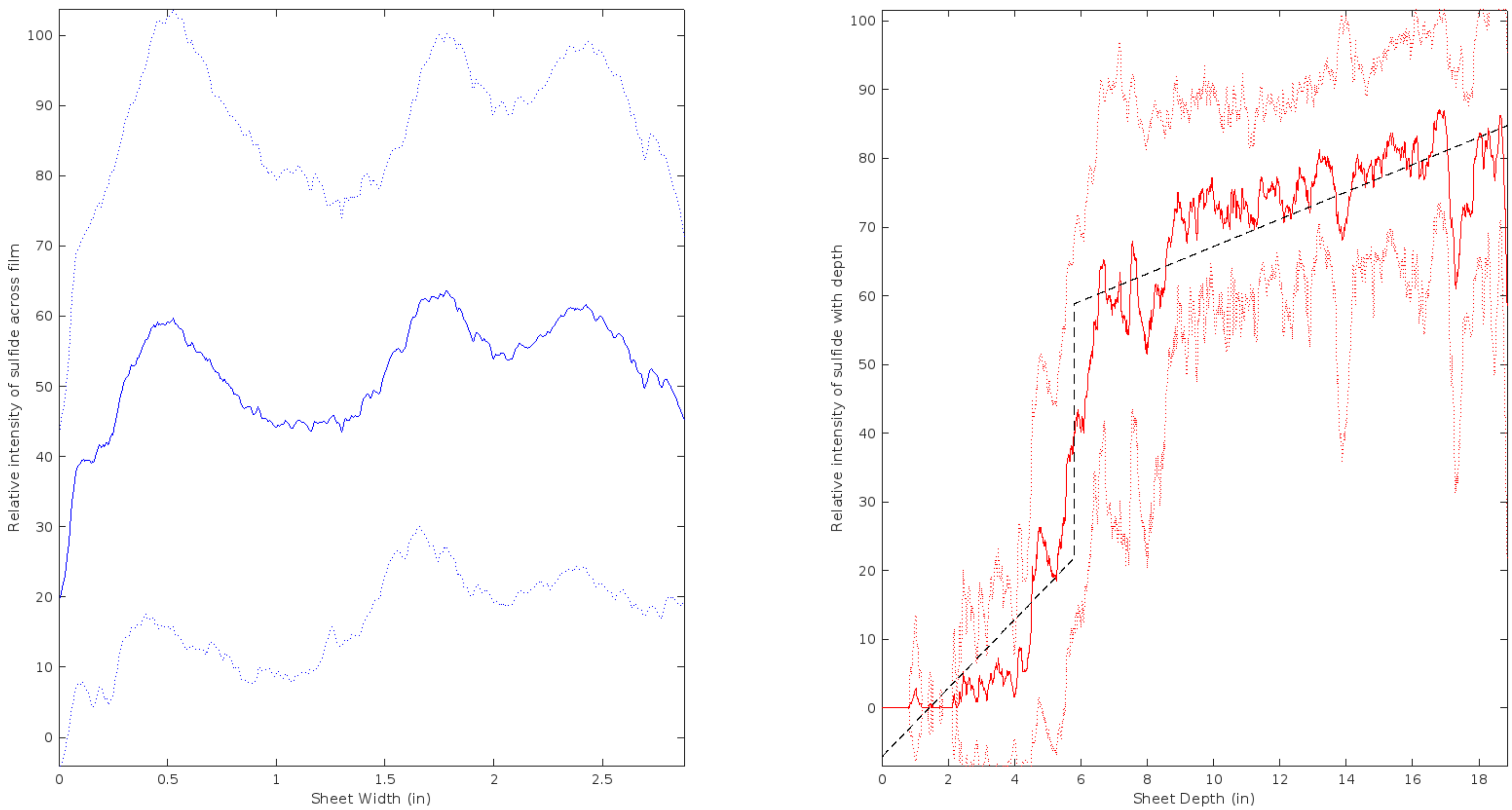
3Cse—158 to 196 centimeters (62.2 to 77.2 inches); 10Y 2.5/2 (10Y 2.5/2) sandy loam; structureless massive; friable; nonfluid; fragments; slight sulfurous odor; slightly alkaline, pH 7.5, pH meter. Lab sample # 19N00288; wet, satiated when described; observed in macaulay sampler

IRIS in marshes:

Soluble sulfide is highly toxic to many plants and animals, especially in brackish coastal zones like tidal marshes and benthic habitats. As mentioned above, sulfate-reducing bacteria are also more energetically favorable than methanogens. Measuring sulfide in pore water has traditionally been difficult, requiring extraction techniques using suction or diffusion-based samplers, followed by lab analysis. These methods often involve chemical stabilization and provide low spatial (vertical) resolution. IRIS (Indicator of Reduction In Soils) devices, which use iron oxide coatings, were found to react with sulfide to produce black FeS stains which offers a way to visualize and quantify sulfide concentrations. This can be coupled with GHG flux data in order to better understand correlations between sulfate distribution in soils and GHG flux.



Black Iron sulfide precipitated on an IRIS film (left) and Binary identification of sulfide-bearing pixels on scanned film (0 - no sulfide, 1- sulfide) utilizing Limmer, M. A., Evans, A. E., & Seyfferth, A. L. (2021). The IRIS Imager: A freeware program for quantification of paint removal on IRIS films. Soil Science Society of America Journal, 85(6), 2210-2219.



Relative intensity of sulfide-bearing pixels across the width (left) and depth (right) of the strip

Native Veg Site Pedon:

Located to the south, in a natively vegetated area. Adjacent to GHG monitoring rings.

Pedon ID:	JCW2	Date:	6/16/2022	Location:	John Chafee Wildlife Preserve, RI	Dominant vegetation: S. patens			Pedogeomorphic Unit:	TR	
Classification:	Coarse-loamy, Mixed, Active, Mesic Histic Sulfaquent			Latitude:	41.450767	Secondary vegetation: S. alterniflora			1 meter carbon stock (kg C m^{-2}): 43		
Pore water halinity (ppt):	20	Open water halinity:	30	Longitude:	-71.450531	Tertiary vegetation:			2 meter carbon stock (kg C m^{-2}): 51.2		
Distance to open water (m):	25	Sampled:	Yes	Site notes:	Marsh disected by small creek. Open water meauserment to creek.						
Horizon	Texture	Munsell Color	Lower Depth (cm)	Bulk Density (g*cm⁻3)	SOC (%)	5:1 EC (µS/m)	Sulfidic odor presence	Course Fragment %	Fluidity	Von Post	Notes
Oise	NA	7.5YR 3/4	13	0.21	34.01	5.39	Strong	0	NA	H3	
Oese	NA	7.5YR 3/1	23	0.21	22.75	6.2	Strong	0	NA	H5	
A	FSL	10YR 3/1	49	0.46	10.96	7.76	Mod	0	MF	NA	
Oab	NA	2.5Y 3/1	59	0.52	12	8.16	No	0	NA	H8	
Cse1	FS	N 4/	69	1.21	1.47	8.15	No	12 SR GR	NF	NS	Dark M-CO SR gravels
Cse2	SL	10YR 4/1	91	0.97	3.34	6.87	No	30 SR/R GR	NF	NS	Dark M-CO SR/R gravels
Cse3	LFS	N 5/	103+	1.9	0.75	6.42	No	30 SR/R GR	NF	NS	Dark M-CO SR/r gravels

Stop 2

Pumphouse Marsh

Parking: Park on left hand side of road/driveway

Notes: Careful, don't fall in the marsh

Marsh soil classifications: Typic Sulfisaprists, Typic Sulfihemists, and Terric Sulfihemists

Subaqueous soils

Below are the links to the SAS cores we will show you. We will have paper descriptions of each.

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI005005

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI005001

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI001018

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI001019

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI005003

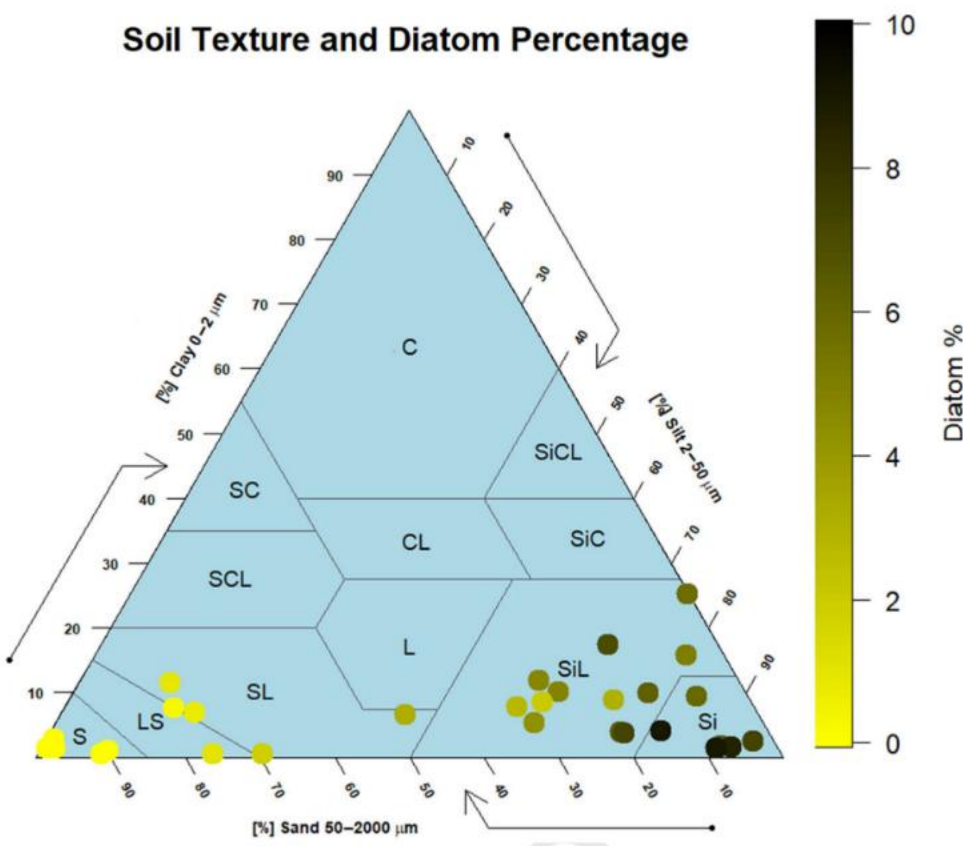
https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI001013

https://nasis.sc.egov.usda.gov/NasisReportsWebSite/limsreport.aspx?report_name=Pedon_Site_Description_usepedonid&pedon_id=2025RI001016

Given the challenges of PSA in estuarine subaqueous soils (SAS) where salt and sulfide contents complicate traditional analyses, we wanted to find a way to potentially model PSD based on sand contents to eliminate the salt-washing necessitated for silt and clay analysis. Accurate PSD data is essential for the Coastal Zone Soil Survey (CZSS) led by NRCS, especially given the growing need to understand coastal soil behavior under climate stressors like sea-level rise and shoreline erosion. Traditional PSD measurement methods (pipette, hydrometer, and laser diffraction) are accurate but time-intensive, particularly because salt removal requires multiple washings or dialysis to remove haline and sulfide salts which would otherwise disrupt particle settling and by mistakenly measured as clay.

To streamline SAS analysis for large-scale surveys, we developed and validated a simple regression model to predict silt content based solely on total sand content. A total of 257 mineral soil horizons from vibracored SAS pedons across a 15,000-hectare region of Long Island Sound were analyzed for PSD using the pipette method after salt and organic matter removal. The study found a highly significant inverse relationship between sand and silt content ($r^2 = 0.975$), enabling accurate silt prediction for samples with >40% sand, which represented 70% of the total dataset. For this sand-rich subset, the average absolute residual of silt predictions ranged from 0.80–3.58%, within acceptable error margins defined by intra-method variability.

In contrast, accuracy diminished significantly for finer-textured soils (≤40% sand), especially those <20% sand, likely due to the presence of diatom frustules (low-density, silica-based skeletons) that skew sedimentation dynamics and disrupt the expected sand-silt relationship. Diatom counts reached up to 9% of total particles in silt-dominated samples. Randomized iterative subsampling (10,000 iterations) revealed that only 50 representative samples (20% of the dataset) were needed to construct a predictive model with <4% average error for the >40% sand subset. These findings support the use of total sand content as a proxy for broader PSD analysis in sandy SAS, offering a cost-effective, scalable approach for large soil survey efforts across coastal U.S. estuaries. However, traditional methods remain necessary for finer-textured sediments where biological material and salinity effects reduce modeling accuracy. This work is particularly relevant for ongoing CZSS projects across Southern New England and elsewhere, where efficient data collection is critical for supporting land use planning, habitat conservation, and resilience in coastal zones.



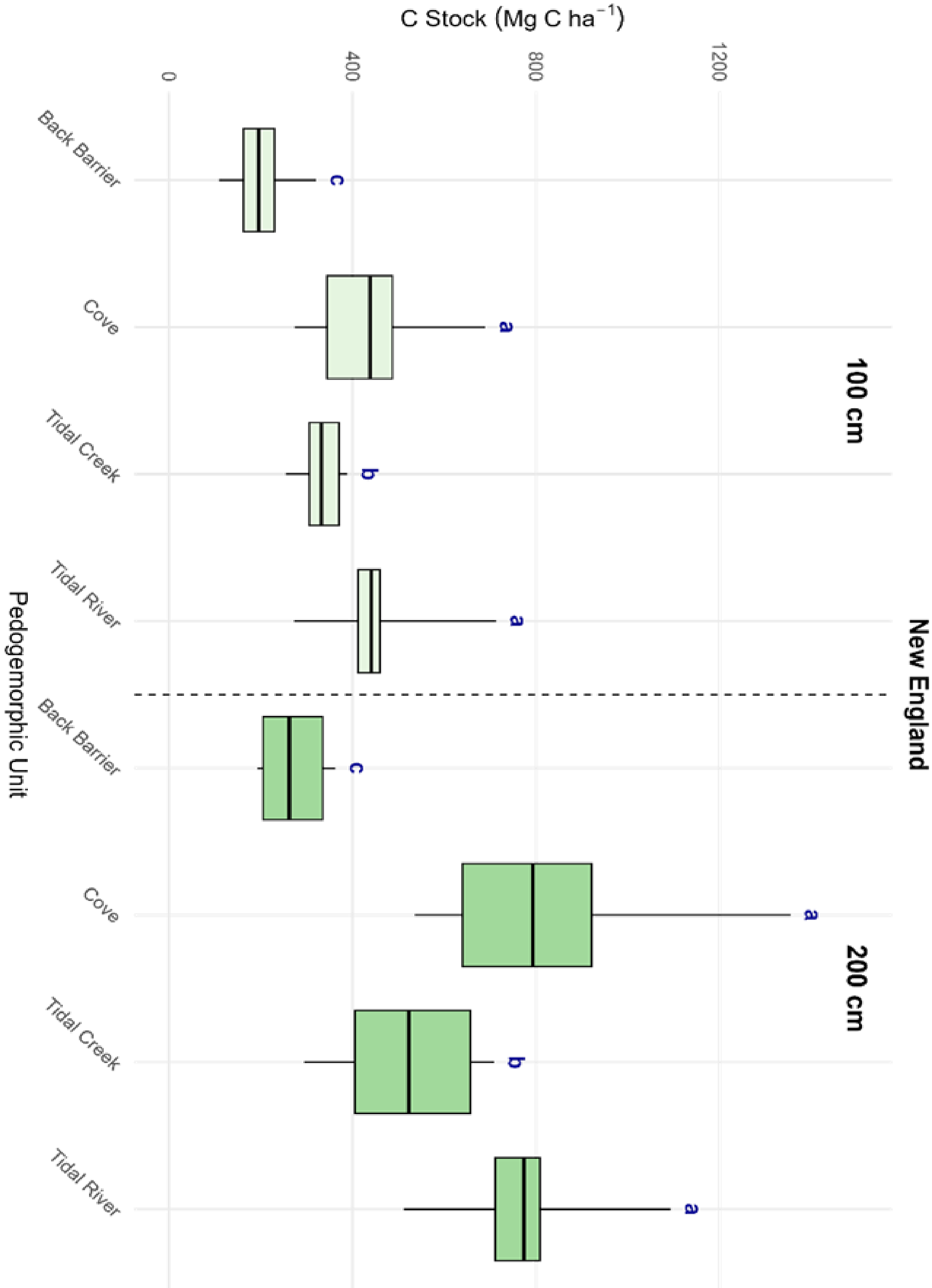
Carbon Stocks, Sequestration, and Accretion Rates:

Tidal salt marshes are dynamic blue carbon systems that are shaped by frequent inundation and prolonged soil saturation, creating unique conditions that favor organic matter accumulation. In these environments, decomposition is constrained by reducing conditions, limited oxygen availability, high sulfide concentrations, and periodic acidification in rhizospheres, particularly around *Spartina alterniflora*. These processes slow microbial activity, allowing marsh soils to store large amounts of carbon. However, anthropogenic sea level rise and continued coastal development are threatening marsh longevity and function, increasing the urgency of accurate carbon accounting to inform restoration, protection, and policy efforts.

As a part of a multi-regional study, Joe's thesis focused on applying a pedogeomorphic framework to estimate carbon stocks across southern New England (SNE) tidal marshes by identifying dominant pedogeomorphic units (PGUs) (tidal rivers, tidal creeks, coves, and back barrier marshes) and quantifying soil organic carbon (SOC) to depths of 1 and 2 meters. Traditional methods for blue carbon inventories often limit sampling depth to 1 meter, yet nearly 40% of carbon in these systems resides below that threshold, underscoring the need for deeper, pedon-based inventories. A total of 46 pedons were sampled across 32 marshes using transect-based field surveys. Samples were analyzed using bulk density, loss-on-ignition (LOI), and high-temperature combustion. Spatial extents of PGUs were mapped using SSURGO data and aerial imagery to upscale carbon stock estimates regionally.

Results showed significant variability in carbon stocks across PGUs. Back barrier marshes, shaped by overwash processes and episodic sand deposition during storm events, had the lowest carbon stocks due to thin organic horizons and coarse-textured, low-carbon sandy overwash sediments. In contrast, tidal rivers and coves held the highest stocks, attributable to protected geomorphic settings, stable sedimentation patterns, and thicker organic layers. Carbon density values were highest in organic horizons of tidal rivers and coves (over 1,000 Mg C ha^{-1} at 2 meters in depth), with coves displaying mean organic thicknesses over 150 cm. Across PGUs, mean carbon stocks ranged from 84 to 430 Mg C ha^{-1} for the upper meter and 140 to 790 Mg C ha^{-1} to 2 meters, see image on next page.

Further integration revealed that single-value national models (e.g., Holmquist et al., 2018) can significantly under or overestimate regional carbon stocks. In SNE, such models underestimated carbon stocks by 35% on average. Comparisons to Maxwell et al. (2024)'s global carbon stock model showed similar trends, particularly where model resolution and predictor variables failed to capture local-scale pedogeomorphic variability. These findings highlight the importance of using PGU-level data and deep sampling for effective carbon estimation.


C Stock (Mg C ha⁻¹)
0
400
800
1200
New England
100 cm
200 cm
Back Barrier
Cove
Tidal Creek
Tidal River
Back Barrier
Cove
Tidal Creek
Tidal River
c
a
b
a
c
a
b
a
Pedogemorphic Unit

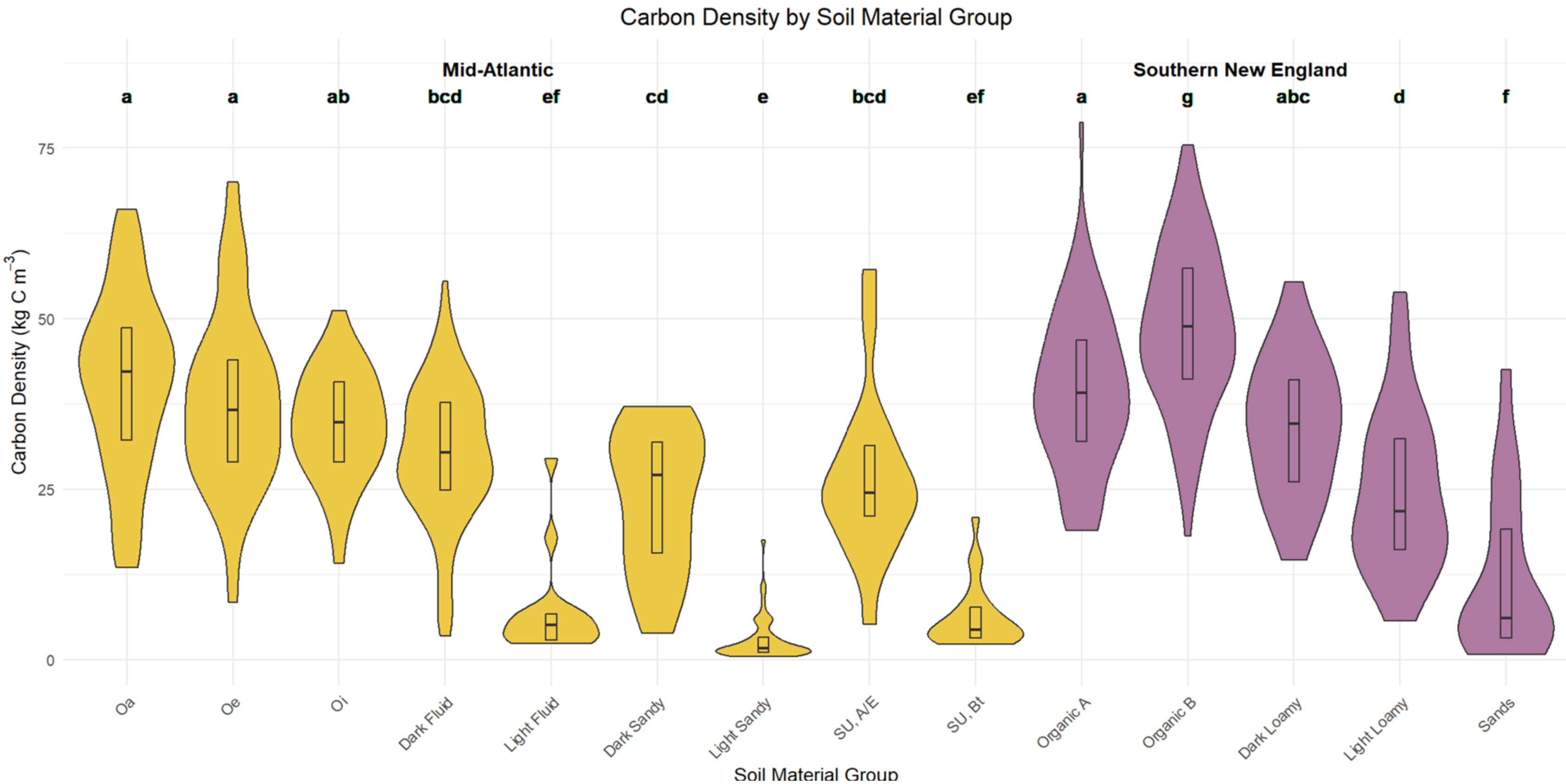
While back-barrier marshes generally exhibit lower total carbon stocks, research by Stolt and Hardy (2022) demonstrates that these systems in Southern New England contribute meaningfully to carbon sequestration. Findings also indicate that soil organic carbon (SOC) accumulation is closely tied to elevation within these marshes. To investigate this, SOC sequestration was quantified across an elevation gradient at three back-barrier sites that had been affected by overwash sediment deposition from Hurricane Sandy in 2012. Across the 52 sampling points established, plant recolonization ranged from 55% to 94% after eight years, and soils had begun forming thin A horizons atop sandy overwash layers (C horizons). Sequestration rates spanned from 52 to 637 grams of carbon per square meter per year (three to four times higher than typical rates reported for New England forests). A clear inverse relationship between elevation and SOC sequestration was observed, with lower elevation areas showing significantly higher accumulation rates (296 and 326 g C m^{-2} yr^{-1}) compared to higher elevation zones (186 g C m^{-2} yr^{-1}), with statistical significance at two of the three sites ($p = 0.006$, 0.020, and 0.16, respectively). These findings underscore that elevation is a key control on carbon sequestration in back barrier marsh environments and that applying a uniform rate across similar marsh types may overlook important spatial variability.

We attempted further investigate this elevation relationship utilizing feldspar marker horizons and litter decomposition bags (*Spartina patens*) in 4 cove marshes, but we found no significant relationship between organic matter accretion and elevation nor decomposition and elevation over the course of 2 years. We found organic matter accretion ranged between 3 and 23 mm over the course of 2 years (1.5-11.5 mm per year) with an average accretion rate of ~12-13 mm over 2 years (~6-6.5 mm per year). Over this same time period, average sea level rose by approximately 12.2 mm (based on an average rate of ~4.6 mm yr^{-1} and a spike from 2022-2023 of ~7.6 mm yr^{-1} due to effects from El Nino). This indicates that organic-based in southern New England may be able to keep pace, and potentially out pace sea level rise when they are in relatively protected areas such as coves (like Pumphouse Marsh). See image to the right of 21 mm of accretion over a feldspar horizon. Image on next page shows marker horizon 1 year after deployment.

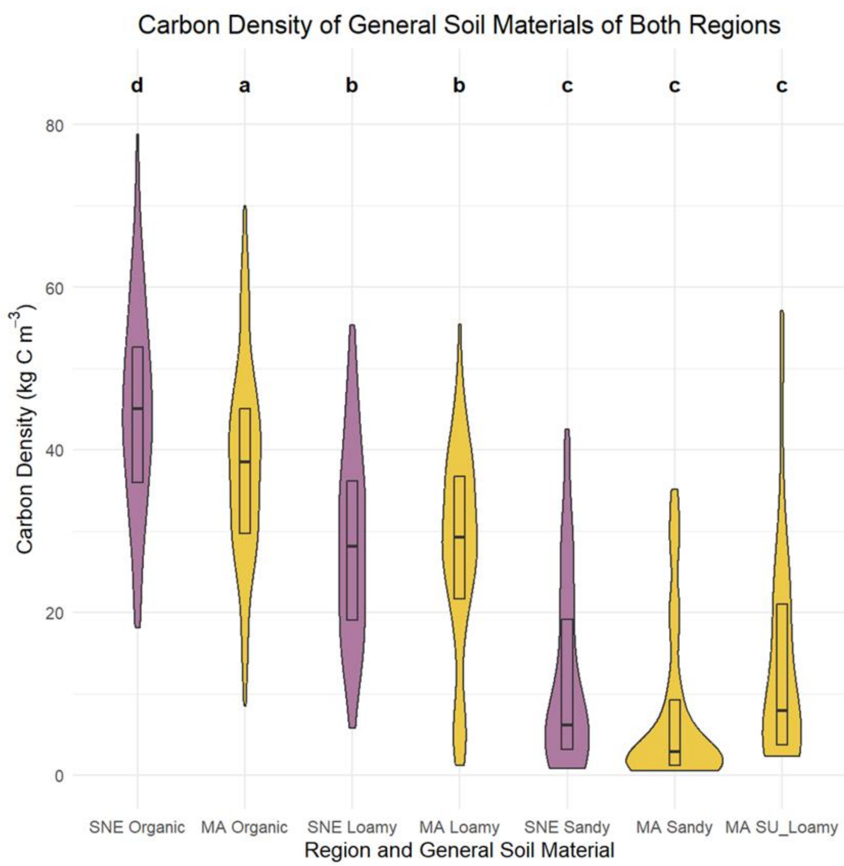
Another way to quantify soil organic carbon stocks in tidal marshes is through the use of prior descriptions and utilizing morphology to model carbon density in described horizons. Jordan Kim began this in his master's work, as did Joe Manetta. Combing their data, we evaluated the carbon density of soil materials in 60 tidal marshes across Southern New England (SNE) and the Mid-Atlantic (MA), morphologically defined Soil Material Groups (SMGs) to improve carbon stock modeling without extensive lab analysis.

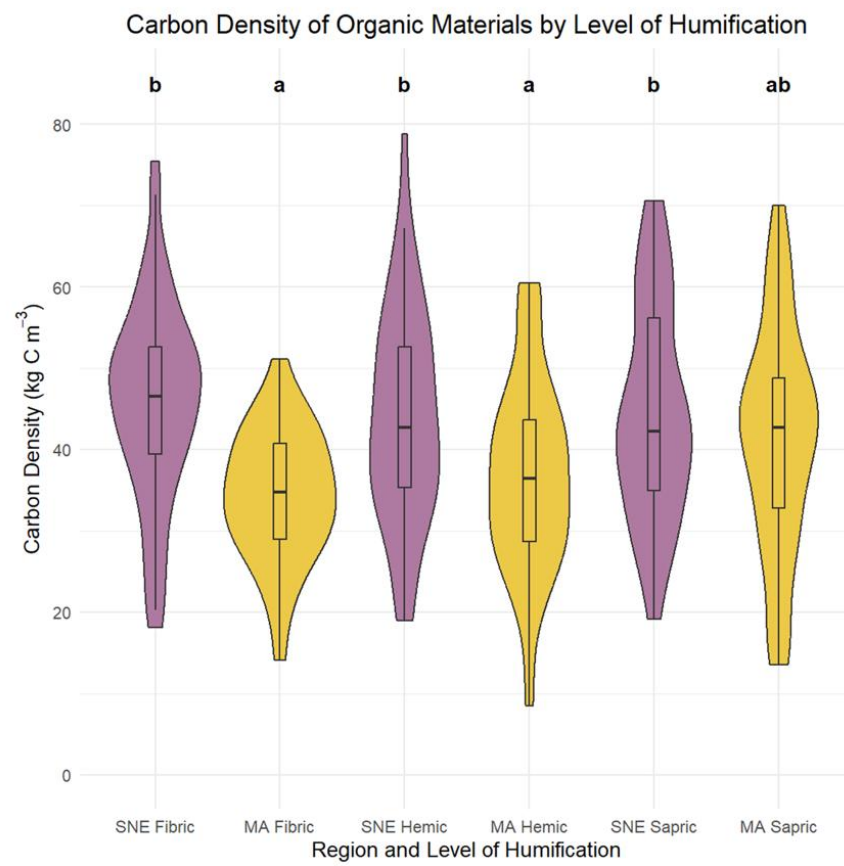
Soils were sampled and analyzed for carbon density, and then classified into SMGs based on texture, color, horizon type, fluidity, and pedogeomorphic setting Carbon densities were compared using ANOVA and Tukey HSD tests, with region-specific SMG groupings developed to assess predictability in C stock estimation.

Findings showed that carbon density varied significantly by horizon type, texture, and region. SNE soils, especially O horizons, had significantly higher average carbon densities than those in the MA region, thought to be reflecting the lower average soil temperatures in SNE marshes. Organic soils consistently had the highest carbon densities, with darker-colored and loamy textures associated with greater C content compared to non-fluid light-colored sands. Strong linear correlations (R^2 = 0.74–0.79) between modeled and measured carbon stocks demonstrate the effectiveness of SMGs as predictive tools. Using region-specific SMG groupings tailored to PGU and soil morphology allowed for accurate estimation of carbon stocks at depth (up to 200 cm), bypassing the need for extensive lab work. See figures on the next pages.



Violin plot of carbon density for SMGs of each region (yellow MA and purple SNE). Letters above each violin indicate statistically significant groupings ($p < 0.05$). The Mid-Atlantic marshes showed higher variability in carbon density, particularly in SU-dominated environments leading to PGU-specific SMGs for SU environments. In contrast, Southern New England marshes showed significant differences in the carbon density of O horizons in different PGU's which necessitates PGU specific organic SMGs for SNE marshes





Comparison of mineral (left) and organic (right) carbon density values of soil material groupings by region (yellow MA and purple SNE). Letters above each violin indicate statistically significant groupings ($p < 0.05$) within each plot. . SNE organic materials have a significantly higher carbon density than MA organic materials; SNE fibric and hemic materials both have a higher mean carbon density than their MA counterparts. Average soil temperatures are lower in SNE than the MA, and thus, these temperature differences may explain differences in organic materials among the groups. Notably, there is little intra-region variation in carbon density of organic horizons. Average carbon density for loamy or sandy materials were not significantly different between the regions.

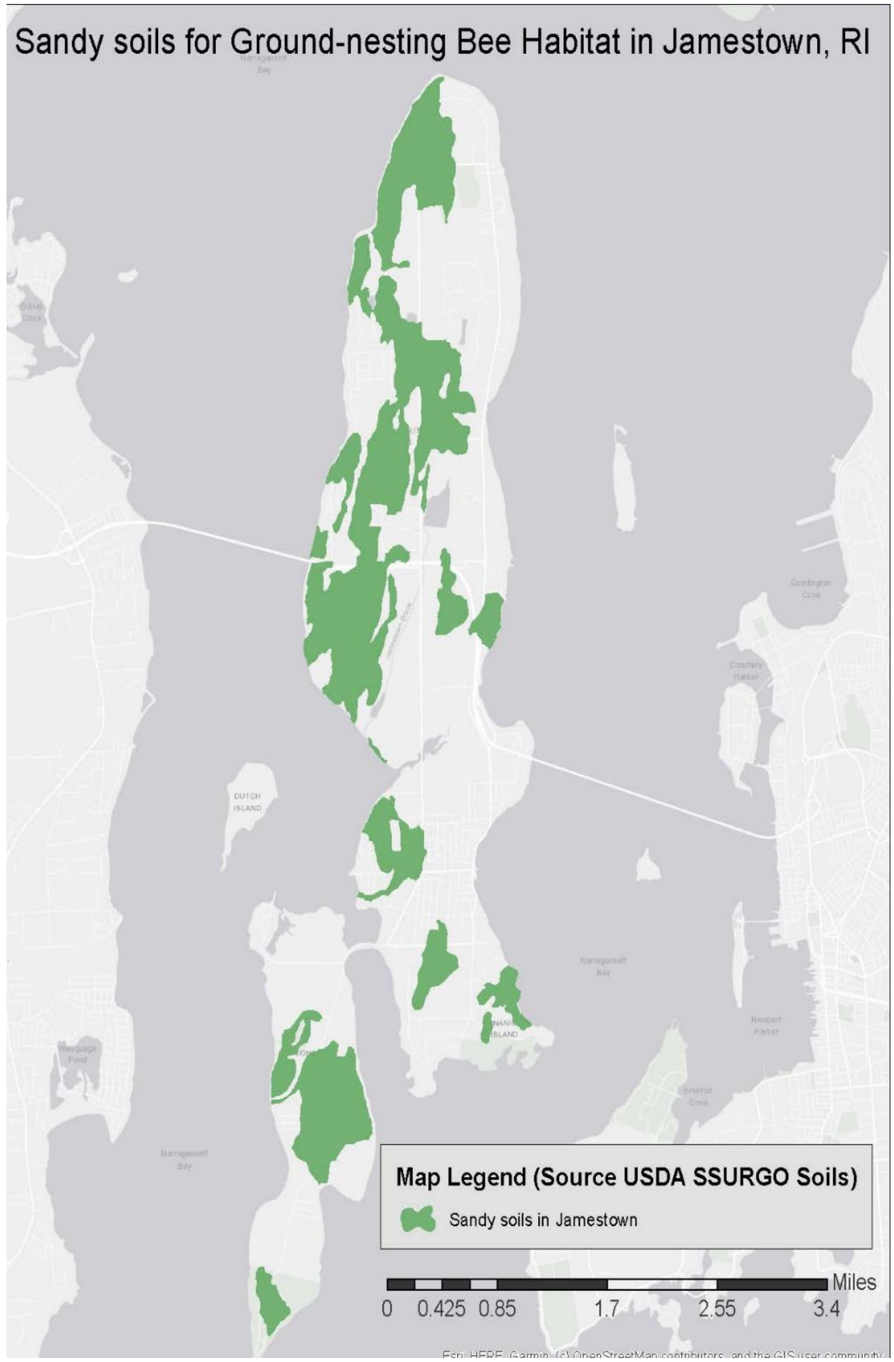
Stop 3

Parker Farm

Parking: Park inside gate along road on grass. We will have the gate open for you. If it is not open the code is “3124#”

Eolian Sand Cap of Jamestown

As noted above, during the periglacial period Rhode Island experienced incredibly strong Katabatic Winds which transported massive quantities of silt and fine sand sized particles across the Rhode Island landscape. You can see the affects of this in Jamestown where thick eolian sand deposits are common on the western sides of Jamestown, but much less common to the east, indicating the winds here would have been traveling from the west to the east. The source of this sand is unknown, but it is speculated that it may have blown from dunes that borded the glacial drainage way to the east in what is now Narragansett Bay.



Parker Farm Pit

Note: The Cd1 horizon should be Cd/C as due to the sand inclusions in the desiccation cracks. Also check the stones that were dug up for remnants of Pennsylvanian plant fossils. Well data shows this soil is frequently wet near the surface.

Classification KST 2022: Coarse-loamy, mixed, active, mesic Aquic Humudepts

Classification proposed: Coarse-loamy, mixed, active, mesic, udic Densic Aquihumepts

Oi—0 to 2 centimeters (0.0 to 0.8 inches); slightly decomposed plant material; many very fine roots throughout and many very coarse roots throughout and many medium roots throughout and many fine roots throughout and many coarse roots throughout; fragments; clear smooth boundary.; observed in pit, small

Oe—2 to 4 centimeters (0.8 to 1.6 inches); very dark brown (7.5YR 2.5/2) rubbed moderately decomposed plant material; low excavation difficulty; many very fine roots throughout and many very coarse roots throughout and many medium roots throughout and many fine roots throughout and many coarse roots throughout; fragments; abrupt wavy boundary.; observed in pit, small

A—4 to 9 centimeters (1.6 to 3.5 inches); black (7.5YR 2.5/1) interior fine sandy loam; weak fine subangular blocky structure; friable, slightly sticky, nonplastic; low excavation difficulty; common very fine roots throughout and common medium roots throughout and common fine roots throughout; fragments; abrupt wavy boundary.; observed in pit, small

Ap—9 to 25 centimeters (3.5 to 9.8 inches); 95 percent very dark grayish brown (2.5Y 3/2) interior fine sandy loam; weak medium subangular blocky structure; friable, nonplastic; low excavation difficulty; common medium roots throughout; 5 percent medium prominent irregular very weakly coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries in matrix; 5 percent by volume nonflat subrounded 2-?-75 millimeter gneiss fragments observed by visual inspection method; clear smooth boundary.; observed in pit, small

Bw1—25 to 40 centimeters (9.8 to 15.7 inches); 92 percent brown (10YR 4/3) interior sandy loam; weak medium subangular blocky structure; friable, nonplastic; low excavation difficulty; few fine roots throughout; 8 percent medium prominent irregular very weakly coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries in matrix; 1 percent by volume flat angular 2-?-150 millimeter shale, unspecified fragments observed by visual inspection method and 10 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method; clear smooth boundary.; observed in pit, small

Bw2—40 to 61 centimeters (15.7 to 24.0 inches); 85 percent dark brown (10YR 3/3) interior fine sandy loam; weak fine subangular blocky structure; friable, nonplastic; low excavation difficulty; few fine roots throughout; 15 percent coarse prominent irregular very weakly coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries in matrix; 3 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method and 5 percent by volume nonflat subrounded 75-?-250 millimeter granite fragments observed by visual inspection method; clear wavy boundary.; observed in pit, small

C—61 to 77 centimeters (24.0 to 30.3 inches); light olive brown (2.5Y 5/3) interior sand; structureless massive; very friable, nonplastic; low excavation difficulty; few very fine roots throughout; 20 percent very coarse prominent irregular moderately coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries in matrix; 5 percent by volume flat subangular 150-?-380 millimeter shale, unspecified fragments observed by visual inspection method; abrupt irregular boundary.; observed in pit, small

2Cd1—77 to 160 centimeters (30.3 to 63.0 inches); 70 percent N 3/1 (N 3/1) interior and 30 percent light olive brown (2.5Y 5/3) interior sand, loam; structureless massive; very firm, slightly plastic; very high excavation difficulty; few very fine roots throughout; 25 percent distinct silt coats on top faces of peds; 5 percent very coarse distinct irregular very weakly coherent cemented gray (N 5/), moist, iron depletions with clear boundaries throughout and 10 percent coarse prominent irregular very weakly coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries in matrix and 25 percent coarse prominent irregular moderately coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries throughout; 5 percent by volume nonflat subrounded 2-?-75 millimeter granite fragments observed by visual inspection method and 7 percent by volume flat angular 2-?-150 millimeter shale, unspecified fragments observed by visual inspection method; clear wavy boundary.; observed in pit, small. horizon was described as 70% Cd and 30% C. The horizon is interpreted as Cd with dessication cracks filled with C material from the horizon above. The color of this C material is 2.5Y 5/3 with sandy texture and 10% coarse, prominent and irregular masses of oxidized iron in matrix.

2Cd2—160 to 200 centimeters (63.0 to 78.7 inches); N 3/1 (N 3/1) interior loam; structureless massive; very firm, slightly plastic; very high excavation difficulty; 25 percent distinct silt coats on top faces of peds; 5 percent very coarse distinct irregular very weakly coherent cemented gray (N 5/), moist, iron depletions with clear boundaries throughout and 25 percent coarse prominent irregular moderately coherent cemented strong brown (7.5YR 4/6), moist, masses of oxidized iron with clear boundaries throughout; 2 percent by volume nonflat subrounded 75-?-150 millimeter granite fragments observed by visual inspection method and 10 percent by volume flat angular 2-?-150 millimeter shale, unspecified fragments observed by visual inspection method.; observed in pit, small

Godena Farm

<u>Parking:</u> Park just within the gate on the grass and then either condense into as few vehicles as possible or just walk (about 0.35 miles, but lots of ticks.

<u>Note:</u> We dug these pits Monday and all 3 of us found multiple ticks on ourselves. Please be wary of tall grass here. Use bug spray and or tuck the pants!

West Pit:

Sandy eolian mantle over Narragansett Bay Group dark till. We did not quite hit dense till here. Description below is a 5 minute field description.

Horizon	Bottom Depth	Color	Texture	Structure	Consistence	Redox	Notes
Ap1	4	10YR 3/2	LFS	1 F SBK	VFR	N	-
Ap2	14	10YR 3/2	LFS	1 M SBK	VFR	N	-
Bw	47	10YR 5/6	LFS	1 M SBK	VFR	N	-
BC	70	10YR 5/4	LFS	1 M SBK or 0 SG	VFR or LO	N	-
C1	94	10YR 6/4	LFS or FS	0 SG	LO	F P Masses	Some small plates. Stratification, maybe water sorted?
2C2	120	10YR 6/4 & 10YR 4/1	FSL	0 MA	FR	F P Masses	-
2C3	138+	N 3/ & 10Y6 4/1	CB FSL	0 MR	FR	F P Masses	-

East pit:

Sandy eolian mantle over Narragansett Bay Group dark dense till. We dug a pit here slightly to the north that met a hydric indicator (F6) but was not a hydric soil (high chroma Bw).

Horizon	Bottom Depth	Color	Texture	Structure	Consistence	Redox	Notes
A	4	7.5YR 3/2	SL	1 M GR	FR	C F Pore linings	-
Ap	13	7.5 3/2	SL	1/2 M SBK	FR	C F Pore linings	-
Bw	34	7.5YR 4/4	SL	1 CO SBK	FR	C F masses	-
BC	60	7.5YR 4/5	SL	1 CO SBK	FR	C D Masses	-
Cd	75+	N 3/	SL	0 MA	VFR	N	~5% 2.5Y 6/3 sand pockets.

Supplemental Soil Taxonomy Materials

Below we have added a small appendix of supplemental materials related to spodosol classification, the proposed Artesol order, Aquasols, and moving of the SMR from the suborder.

Spodosols and Soil Taxonomy

Our studies of soil colors of Northeast Aquods led to changes in the criteria for Aquods, Alaquods, and the definitions of Bh, Bs, and the combination of those two horizons (Bhs).

Keys to Soil Taxonomy 2014

h *Illuvial accumulation of organic matter*

This symbol is used with B horizons to indicate the accumulation of illuvial, amorphous, dispersible complexes of organic matter and sesquioxides. The sesquioxide component is dominated by aluminum and is present only in very small quantities. The organo-sesquioxide material coats sand and silt particles. In some horizons these coatings have coalesced, filled pores, and cemented the horizon. The symbol h is also used in combination with s (e.g., Bhs) if the amount of the sesquioxide component is significant but the value and chroma, moist, of the horizon are 3 or less.

s *Illuvial accumulation of sesquioxides and organic matter*

This symbol is used with B horizons to indicate an accumulation of illuvial, amorphous, dispersible complexes of organic matter and sesquioxides if both the organic matter and sesquioxide components are significant and if either the value or chroma, moist, of the horizon is 4 or more. The symbol is also used in combination with h (e.g., Bhs) if both the organic matter and sesquioxide components are significant and if the value and chroma, moist, are 3 or less.

Keys to Soil Taxonomy 2022

h *Illuvial accumulation of organic matter*

This symbol is used with B horizons to indicate the accumulation of illuvial, dispersible humic materials. The illuvial humic material coats sand and silt particles, resulting in a dark-colored horizon having a value and chroma, moist, of 3 or less. The symbol h is used in combination with s (e.g., Bhs) if the illuvial humic materials are complexed with metals such as aluminum and/or iron. In some horizons, the humic coatings have bridged, coalesced, or filled pores and cemented the horizon (Bhsm).

s *Illuvial accumulation of metals complexed with organic matter*

This symbol is used with B horizons to indicate the accumulation of illuvial, dispersible humic materials complexed with significant Fe and Al metal components (organo-metal). The horizons have either a color value or chroma, moist, of greater than 3. The symbol h is used in combination with s (e.g., Bhs) if the moist value and chroma are 3 or less.

KST 2014. Key to Spodosol Suborders

Spodosols that have aquic conditions for some time in normal years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface and have *one or both* of the following:

1. A histic epipedon; *or*

2. Within 50 cm of the mineral soil surface, redoximorphic features in an albic or a spodic horizon.

Aquods

KST 2014. Key to Aquod Great Groups

CAB. Other Aquods that have less than 0.10 percent iron (by ammonium oxalate) in 75 percent or more of the spodic horizon.

Alaquods

KST 2022. Key to Spodosol Suborders

Spodosols that have aquic conditions for some time in normal years (or artificial drainage) in one or more horizons within 50 cm of the mineral soil surface and have *one or both* of the following:

1. A histic epipedon; *or*

2. Within 50 cm of the mineral soil surface, aquic conditions in an albic or a spodic horizon.

Aquods

KST 2022. Key to Aquod Great Groups

CAB. Other Aquods that have less than 0.10 percent iron (by ammonium oxalate) or at least 3 times as much ammonium oxalate extractable aluminum as iron in 75 percent or more of the spodic horizon.

Alaquods

Definitions of Spodic Materials, Spodic Horizons and criteria for Spodosols

During the tour we will see at least four soils with spodic morphologies. Two of the soils have spodic materials deep in the profile and no relative horizon to consider as an illuvial horizon. Since not everyone will have a copy of the Keys to Soil Taxonomy (KST, 2022), we have included the current definitions of spodic materials, spodic diagnostic horizons, and requirements to meet the Spodosol soil order classification here.

Spodic Materials

Spodic materials form in an illuvial horizon that normally underlies a histic, ochric, or umbric epipedon or an albic horizon. In most undisturbed areas, spodic materials underlie an albic horizon. They may occur within an umbric epipedon or an Ap horizon.

A horizon consisting of spodic materials normally has an optical density of oxalate extract (ODOE) value of 0.25 or more, and that value is commonly at least 2 times as high as the ODOE value in an overlying eluvial horizon. This increase in ODOE value indicates an accumulation of translocated organic materials in an illuvial horizon. Soils with spodic materials show evidence that organic materials and aluminum, with or without iron, have been moved from an eluvial horizon to an illuvial horizon.

Definition

Spodic materials are mineral soil materials that do not have all of the properties of an argillic or kandic horizon; are dominated by active amorphous materials that are illuvial and composed of organic matter and aluminum, with or without iron; and have *both* of the following:

1. A pH value in water (1:1) of 5.9 or less and an organic carbon content of 0.6 percent or more; *and*

2. *One or both* of the following:

a. An overlying albic horizon that extends horizontally through 50 percent or more of each pedon and, directly under the albic horizon, colors, moist (crushed and smoothed sample), as follows:

(1) Hue of 5YR or redder; *or*

(2) Hue of 7.5YR, value of 5 or less, and chroma of 4 or less; *or*

(3) Hue of 10YR or neutral and value and chroma of 2 or less; *or*

(4) A color of 10YR 3/1; *or*

b. With or without an albic horizon and one of the colors listed above or hue of 7.5YR, value, moist, of 5 or less, and chroma of 5 or 6 (crushed and smoothed sample), and *one or more* of the following morphological or chemical properties:

(1) Pedogenic cementation by organic matter and aluminum, with or without iron, in 50 percent or more of each pedon and a very firm or firmer rupture-resistance class in the cemented part; *or*

(2) 10 percent or more cracked coatings on sand grains; *or*

(3) Al plus 1/2 Fe percentages (by ammonium oxalate) totaling 0.50 or more, and half that amount or less inoverlying umbric epipedon (or subhorizon of an umbric), ochric epipedon, or albic horizon; *or*

(4) An optical density of oxalate extract (ODOE) value of 0.25 or more, and a value half as high or lower in an overlying umbric epipedon (or subhorizon of an umbric), ochric epipedon, or albic horizon.

Spodic Horizon

A spodic horizon is an illuvial layer with 85 percent or more spodic materials (defined above) in a layer 2.5 cm or more thick that is not part of any Ap horizon.

Spodosol Soil Order

Spodosols do not have a plaggen epipedon or an argillic or kandic horizon above a spodic horizon, *and* have *one or more* of the following:

1. A spodic horizon, an albic horizon in 50 percent or more of each pedon, and a cryic or gelic soil temperature regime; *or*

2. An Ap horizon containing 85 percent or more spodic materials; *or*

3. A spodic horizon with *all* of the following characteristics:

a. *One or more* of the following:

(1) A thickness of 10 cm or more; *or*

(2) An overlying Ap horizon; *or*

(3) Cementation in 50 percent or more of each pedon; *or*

(4) A texture class that is finer than coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand in the fine-earth fraction *and* a frigid temperature regime in the soil; *or*

(5) A cryic or gelic temperature regime in the soil; *and*

b. An upper boundary within the following depths from the mineral soil surface: *either*

(1) Less than 50 cm; *or*

(2) Less than 200 cm if the soil has a texture class of coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand, in the fine-earth fraction, in some horizon between the mineral soil surface and the spodic horizon; *and*

c. A lower boundary as follows:

(1) *Either* at a depth of 25 cm or more below the mineral soil surface or at the top of a duripan or fragipan or at a densic, lithic, paralithic, or petroferric contact, whichever is shallowest; *or*

(2) At any depth,

(a) If the spodic horizon has a texture class that is finer than coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand in the fine-earth fraction *and* the soil has a frigid temperature regime; *or*

(b) If the soil has a cryic or gelic temperature regime; *and*

d. *Either*:

(1) A directly overlying albic horizon in 50 percent or more of each pedon; *or*

(2) No andic soil properties in 60 percent or more of the thickness *either*:

(a) Within 60 cm either of the mineral soil surface or of the top of an organic layer with andic soil properties, whichever is shallower, if there is no densic, lithic, or paralithic contact, duripan, or petrocalcic horizon within that depth; *or*

(b) Between either the mineral soil surface or the top of an organic layer with andic soil properties, whichever is shallower, and a densic, lithic, or paralithic contact.

Fundamental Changes in Soil Taxonomy

In 2015 the Soil Science Society of America (SSSA) established the Fundamental Changes to Soil Taxonomy Task Force to address the growing number of issues with using and teaching Soil Taxonomy. The objective of the task force is to facilitate an open and transparent process to develop a suite of fundamental changes to Soil Taxonomy leading to a more user-friendly product that can and will be used by more than just trained pedologists and soil scientists. The task force identified and discussed many fundamental changes. Proposals to redefine organic soil materials and reducing the complexity of the oxic and kandic diagnostic horizons were the first to be approved and incorporated into the Keys to Soil Taxonomy (KST) in 2022. Other fundamental changes have gone through many, sometimes heated, discussions. There is an apparent considerable resistance and reluctance to make fundamental changes. These stem from local and individual bias, misunderstandings, individual paradigms for Soil Taxonony (e.g. is soil genesis more important than soil interpretations in defining classes?), and the linkage between Soil Taxonomy and the USDA-NRCS programs which is independent of the science. The areas that have developed the most attention and work have been the alteration of the definition of the mollic epipedon. John Galbraith has done a lot of work on this but will be of limited discussion during the tour because we will only see one pseudo Mollisol. Abbreviated proposals for a soil order for anthropogenic soils (Artesols), a soil order for wet soils (Aquasols), and moving all soil climate data (soil moisture and temperature regimes to the family level) are presented below. John Galbraith has done the majority of the work on the Artesol proposal along with the USDA-NRCS Urban Soils Focus Team with Randly Riddle (NRCS). The Aquasol proposal was developed by the International Committee for Subaqueous and Aquic Soils (ICOMSAS). Mark Stolt is the chair. The proposal to move soil climate information to the family level was supported by a grant from the National Soil Survey Center (NSSC) to the University of Rhode Island. There is also a working group with charges to edit *Soil Taxonomy: A basic system of soil classification for making and interpreting a soil survey* into the 3rd Edition.

Artesol Soil Order Proposal – HAHT Soils (Artesols) 43rd Draft Abbreviated (Not to be Shared)

John M. Galbraith, Virginia Tech March 31, 2025

Most soil on Earth in gently sloping areas with favorable climates have been modified for conventional agricultural use (commercial growing of plant products, such as crops or improved pasture) in some way. Most soils likely to be used for conventional agricultural need more detailed interpretations, management, and recommendations for use than would be possible through the family level in a new soil order, and so they were excluded from this proposal. Even soils used for conventional agriculture that have been profoundly modified in place for agricultural purpose beyond conventional tillage, such as the deep plowed soils of the Central Valley in California, artificially drained soils, flood-irrigated rice soils with Anthraquic conditions, those formed on conservation terraces and on broad, gently sloping hillslope terrace treads (defined below) would be better left in existing taxa, or their alteration recognized at the subgroup, series or phase level, because of their suitability for conventional mechanized agriculture and need for detailed interpretations. While agricultural manipulation alone is not enough to classify a soil as an Artesol, commercial agricultural soils are not excluded from Artesols if they meet other criteria (e.g., 50 cm or more of HTM). Many of the areas with anthropic, plaggic, or pretic epipedons would be in ancient fields, steep hillslope terraces, middens, or soils in gardens and family-scale non-commercial plant production. Deeply-excavated soils such as road-cuts, quarries, and pit areas can be identified by the Anthrocavic subgroups in existing orders using GIS, Lidar, and existing soil survey. A unique set of subgroups such as Anthroportic, Anthraltic, or Anthropic can be used within other soil orders for soils with limited thickness of HTM. Other soils with human influences can be recognized at the soil series level or through mapping phases.

New Differentiae used:

A. Epipedons: Anthropic, Plaggic, and Pretic.

B. Diagnostic horizons and characteristics: Artifacts, human-transported material, human- altered material, and manufactured layers.

Name: Artesols (from Latin phrase *arte factum* made with skill). Formative element: art. Reason: Soils in the Artesols order form in human-transported material. They are *made with skill* and many contain artifacts that are also *made with skill*. The *art* formative element starts with a vowel and fits well linguistically with the suborder formative elements. The *art* formative element is different enough from existing formative elements to avoid confusion in pronunciation.

Order

B. Soils with human-transported material from the soil surface to 50 cm or more thick or to a root-limiting layer if one is less than 50 cm below the soil surface.

Artesols

SUBORDER

BA. Artesols that have a positive water potential at the soil surface for more than 21 hours of each day in all years.

Wassarts

BB. Other Artesols that have either:

1. A histic epipedon, or
2. Have organic soil materials that are saturated with water for 30 days or more per year in normal years (or are artificially drained) and make up at least 40 of the 80 cm below the soil surface; *or*
3. Within 50 cm of the soil surface, aquic conditions for some time in normal years (or artificial drainage) and *one or more* of the following:
   a. In more than half of each pedon, either on faces of peds or in the matrix if peds are absent, 50 percent or more chroma of *either*:
      (1) 2 or less if redox concentrations are present; *or*
      (2) 1 or less; *or*
   b. *One or more* of the following:
      (1) Enough active ferrous iron to give a positive reaction to alpha, alpha-dipyridyl at a time when the soil is not being irrigated; *or*
      (2) Removal of 5% or more Fe paint from a 10-cm section of an IRIS device inserted to 50 cm and left in the soil for 6 weeks or less in a three-month season when rainfall is not above normal; *or*
      (3) Saturation for 20 or more consecutive days or 30 or more cumulative days. **Aquarts**

BC. Other Artesols that contain a concentration of artifacts, either:

1. 10% or more (weighted average by volume or weight) artifacts in a layer ≥ 15 cm thick starting ≤ 30 cm of the soil surface; *or*
2. 10% or more (weighted average by volume or weight) artifacts in the particle size control section; or
3. 10% or more (weighted average by volume or weight) artifacts throughout the human-transported material below 30 cm.

Factarts

BD. Other Artesols.

Ortharts

Table 1. Suborder through Great Groups of Soil Order B. Artesols.

BA. Wassarts – subaqueous soils	**BB. Aquarts** – have aquic conditions within 50 cm (or artificial drainage)	**BC. Factarts** – have 10% or more artifacts in some part	**BD. Ortharts** – other Artesols
BAA. Sulfiwassarts - contain sulfidic materials > 15 cm thick within 50 cm	**BBA. Histaquarts** – have ≥ 40 cm of the top 80 cm organic soil materials	**BCA. Wastifactarts** – contain systematic deposits of household, nonhazardous, industrial, or hazardous waste	**BDA. Sulfortharts** – have a sulfuric horizon or sulfidic materials within 50 cm
BAB. Psammowassarts - sandy particle-size class	**BBB. Sulfaquarts** – have a sulfuric horizon or sulfidic materials within 50 cm	**BCB. Combustifactarts** – contain a significant amount of coal combustion by-products (fly ash, bottom ash, etc)	**BDB. Gypsiortharts** – have > 5% (weight) gypsum in a layer > 15 cm thick or have a gypsic or petrogypsic horizon
BAC. Haplowassarts – other Wassarts	**BBC. Factaquarts** - have 10% or more artifacts in some part	**BCC. Sulfifactarts** - contain a significant amount of sulfur	**BDC. Halortharts** – have a product of the EC, in dS/m, and thickness, in cm, equal to > 450
	BBD. Psammaquarts - sandy particle-size class	**BCD. Gypsifactarts** – contain a significant amount of gypsum	**BDD. Vertortharts** – have shrink-swell properties in or beneath the HTM
	BBE. Epiaquarts – episaturation	**BCE. Vertifactarts** - have a linear extensibility > 6.0 cm in or beneath the HTM	**BDE Leptortharts** – root-limiting layer, an abrupt textural change, or strongly contrasting particle-size class
	BBF. Endoaquarts – other Aquarts	**BCF. Leptofactarts** - have a root-limiting layer, an abrupt textural change, or strongly contrasting particle- size class	**BDF. Psammortharts** – sandy particle-size class
		BCG. Psammofactarts – sandy particle-size class	**BDG. Humortharts** – stable, long-term OC additions such as terra preta
		BCH. Humifactarts – stable, long-term OC additions, high OC content (pretic, plaggic, mollic, melanic, umbric, etc.)	**BDH. Haplortharts** – other Ortharts
		BCI. Haplofactarts – other Factarts.	

Aquasol Classification Proposal Abbreviated

International Committee for Subaqueous and Aquic Soils (ICOMSAS)

Wetland soils serve as the foundation and structure of a range of unique and valued ecosystems. Creating a wet soil order explicitly recognizes the values and functions of these soils which serve as the core of all soil interpretations. This aim is clear in the title of the classification system: "Soil Taxonomy: A Basic System for Making and Interpreting Soil Surveys". Identifying the wettest soils is one of the most important uses of a soil classification system. Of the 10 most requested interpretations on the Web Soil Survey, 6 of these are dependent upon the depth of the seasonal high water table (SHWT). Adopting a wet soil order would therefore emphasize the importance of soil interpretations at the highest level in Soil Taxonomy while also recognizing the most important driver of soil morphology (hydrology). In the current classification, Aqu suborders identify soils with a SHWT within 50 cm. This is insufficient since it doesn't differentiate between soils with wetland hydrology and those that don't. Nor does it identify if the soils are peraquic vs those with a fluctuating water table.

Wet soils classification in ST continues to follow the system that was developed in 1960. In 1960, environmental science as we know it did not really exist; hydric soils and wetland delineation were not part of our everyday language or soils activities; subaqueous soils and salt marshes were considered miscellaneous areas (even waste lands); and wet soils were considered to have little value. Not until 1985, under the Swampbuster Provisions of the Farm Bill, did the USDA-SCS stop providing incentives for farmers to drain wetlands for agriculture. Identifying actual wet soils is critical in today's world.

Aquasols include mineral subaqueous soils, peraquic soils, and those soils where water is removed so slowly that the soil is wet at shallow depths (<30 cm from the soil surface) for sufficient duration to become strongly biochemically reducing and to express this morphologically. Free water is at or near the surface long enough during the growing season that hydrophytic vegetation are predominant and most mesophytic crops cannot be grown, unless the soil is artificially drained. These soils would correspond to those that are poorly-drained or wetter as defined in the Soil Survey Manual and in general have morphologies similar to those used to identify hydric soils.

Aquasols would key out after the proposed order Artesols, and after Gelisols and Histosols.

An Aquasol meets one or more of the following criteria:

1) A Histic epipedon, or

2) Aquic conditions within 30 cm of the mineral soil surface for some time in normal years (unless artificially drained), and one or more of the following:

a. A mollic or umbric epipedon that has within 30 cm of the mineral soil surface, or bottom of the epipedon if it is shallower, a chroma <=2, and one or more of the following:

1. Contains distinct or prominent redox concentrations, or

2. Contains mucky modified textures, or

3. Is immediately underlain by a horizon where >50% of the soil (on ped faces or within the matrix) has one of these combinations of Munsell hue, value, chroma and redox concentrations if noted and extends to a depth of 75 cm or a lithic, paralithic or densic contact.

Hue	Value	Chroma	Redox Concentrations Required
10YR or redder*	>=4	1 or 2	Yes
2.5Y or yellower**	>=4	1	No
2.5Y or yellower	>=4	2	Yes
5Y or yellower	>=4	3	Yes
Neutral (N)	>=4	0	No
Any color if it results from uncoated mineral grains due to saturation; (e.g. g subscripts, representing strong gleying)			

*10YR or redder includes 10YR, 7.5YR, 5YR, 2.5YR, and 10R
**2.5Y or yellower includes hues of 2.5Y, 5Y, or those on the Gley page.

b. Starting within 30 cm of the mineral soil surface, and extending to a depth of 75 cm or lithic, paralithic or densic contact, soil horizons with textures finer than loamy fine sand and >50% of each horizon as one of these combinations of Munsell hue, value, chroma and redox concentrations (on ped faces or within peds):

Hue	Value	Chroma	Redox Concentrations Required
10YR or redder	>=4	1 or 2	Yes
2.5Y or yellower	>=4	1	No
2.5Y or yellower	>=4	2	Yes
5Y or yellower	>=4	3	Yes
Neutral (N)	>=4	0	No
Any color if results from uncoated mineral grains due to saturation; (e.g. g subscripts, representing strong gleying)			

c. Starting within 30 cm of the mineral soil surface, and extending to a depth of 75 cm or lithic, paralithic or densic contact, soil horizons with textures of loamy fine sand or coarser and >50% of the soil has one of these combinations of Munsell hue, value, chroma and redox concentrations (on ped faces or within peds):

Hue	**Value**	**Chroma**	**Redox Concentrations Required**
10YR or redder	>=4	1	No
10YR or redder	Any	2	Yes
2.5Y or yellower	Any	1	No
2.5Y or yellower	Any	3	Yes, distinct or prominent
Neutral	Any	0	No
Any color if results from uncoated mineral grains due to saturation; (e.g. g subscripts, representing strong gleying)			

d. Sulfidic (hyper or hypo) materials within 30 cm of the soil surface; or

e. A spodic horizon with a moist color value 3 or less and chroma 3 or less that is at least 10 cm thick, and within 30 cm of the mineral soil surface aquic conditions within the spodic horizon or an overlying albic horizon; or

3) Inundation with 2 cm or more of water for at least 21 hours per day, for every day of the year; or

4) Peraquic conditions (within 30 cm of the mineral soil surface).

Aquasols: Key to Suborders for Rhode Island

DA. Aquasols that have a field observable water table 2 cm or more thick above the soil surface for more than 21 hours of every day in all years, and in all horizons within 100 cm of the mineral soil surface, have an electrical conductivity of less than 0.6 dS/m in a 1:5 (soil:water), by volume.

Frasaqs

DB. Other Aquasols that have a field observable water table 2 cm or more thick above the soil surface for more than 21 hours of every day in all years.

Wassaqs

DC. Aquasols that have a water table within 30 cm of the soil surface for every day in all years.

Peraqs

DD. Other Aquasols that have a spodic horizon at least 10 cm thick.

Spodaqs

DE. Other Aquasols that have an mollic, umbric, melanic, or histic epipedon, or have buried O and/or dark-colored A horizons (moist value of 3 or less), within 200 cm of the soil surface and with combined thickness of 20 cm or more, that have 1.0 percent or more Holocene-age organic carbon, or has at least 20 kg/m^2 organic carbon in the upper meter.

Humaqs

DF. Other Aquasols that have less than 35 percent (by volume) rock fragments and a texture of loamy fine sand or coarser in all layers (sandy loam lamellae are permitted) within the particle-size control section, and don't have an argillic horizon (unless buried).

Psammaqs

DG. Other Aquasols.

Orthaqs

Frasaqs: Key to the Great Groups

Fluifrasaqs: between 20 and 50 cm below the mineral soil surface, a fluidity class of slightly fluid or greater;
Humifrasaqs: a color of 3/3 or darker) in the upper 18 cm of the mineral soil surface and at least 0:6% SOC;
Psammifrasaqs texture class of loamy fine sand or coarser in all layers within the particle-size control section;
Fluvifrasaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth
Haplofrasaqs: Other Frasaqs.

Wassaqs: Key to the Great Groups

Sulfiwassaqs: have horizons thickness of at least 15 cm within 50 cm that contain hypersulfidic materials;
Psammowassaqs a texture class of loamy fine sand or coarser in all layers within the particle-size control section;
Fluiwassaqs: in all horizons at a depth between 20 and 50 cm a fluidity class of slighty fluid or greater;
Humiwassaqs: have that have a histic epipedon, or at least 20 kg m^2 SOC in the upper 100 cm, or both;
Fluviwasaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth;
Haplowassaqs: Other Wassaqs.

Peraqs: Key to the Great Groups

Sulfoperaqs: have a sulfuric horizon within 50 cm of the mineral soil surface (identified by pH below 4:0);
Sulfiperaqs: have horizons thickness of at least 15 cm within 50 cm that contain hypersulfidic materials;
Fluiperaqs: in all horizons at a depth between 20 and 50 cm a fluidity class of slighty fluid or greater;
Humiperaqs: have a histic epipedon or at least 20 kg m^2 soil organic carbon in the upper 100 cm, or both;

Psammoperaqs: have a texture class of loamy fine sand or coarser within the particle-size control section;
Fluviperaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth;
Haploperaqs: Other Peraqs.

Spodaqs: Key to the Great Groups

Humispodaqs: have a histic or umbric epipedon or have at least 20 kg/m^2 organic carbon in the upper meter;
Petraspodaqs: have a ortstein within 100 cm of the mineral soil surface;
Placispodaqs: have a placic horizon within 100 cm of the mineral soil surface;
Fragispodaqs: have a fragipan within 100 cm of the mineral soil surface;
Alaspodaqs: have <0:10% Fe (by NH4OX), or at least 3x as much NH4OX Al as Fe in the spodic horizon;
Epispodaqs: have episaturation;
Endospodaqs: Other Spodaqs.

Humaqs: Key to the Great Groups

Umbrihumaqs: have an umbric epipedon;
Histohumaqs: have a histic epipedon;
Psammihumaqs: have a texture class of loamy fine sand or coarser within the particle-size control section;
Fluvihumaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth;
Epihumaqs: have episaturation;
Endohumaqs: Other Humaqs.

Psammaqs Key to the Great Groups

Fluvipsammaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth;
Quartzipsammaqs: have >90% resistant minerals in the 0:02 to 2:0 mm fraction of the particle-size control section;
Epipsammaqs: have episaturation;
Endopsammaqs: Other Psammaqs.

Orthaqs: Key to the Great Groups

Humorthaqs: have a surface horizons $\geq$15 cm thick that meet all the criteria for histic, mollic, or umbric epipedon;
Fluviorthaqs: have $\geq$0:6% SOC at a depth of 125 cm or an irregular decrease in organic carbon with depth;
Epiorthaqs: have episaturation;
Endorthaqs: Other Orthaqs.

Proposal to change hierarchical placement of soil moisture regime to the family level

Soil moisture and temperature are soil properties linked to climate and incorporated into Soil Taxonomy through the broad classes of moisture and temperature regimes. The application of soil moisture regime (SMR) has evolved over the various versions of ST through the 7th Approximation to the current 2022 version of KST. The initial concepts in US classification likely started with Marbut's (1935) highest level classifications: Pedocals and Pedalfers. The break between these two classes essentially aligns with the break between the humid east (udic SMR) and the xeric, aridic, and ustic SMR in the western US. In the 7th Approximation there were four SMRs: aquic, aridic, ustic, and udic. When ST was published in 1975 xeric was added. In addition, some soils were given intermediate SMRs where they bordered on either end of aridic -- ustic or xeric, or bordering between ustic and udic. In 1994 a new SMR map for the US was published which included 9 SMRs. The use of the intermediate soil moisture regimes has expanded so much over time that there are over 100 examples of its use in Aridisols alone. Where SMR classes fit within the classification taxa vary widely. For example, at the order level Aridisols represent the extreme end of the soil moisture regime. Yet, aridic (or torric in some taxa) are also applied at the suborder (Torox), great group (Torrifluvent), and subgroup (Aridic Haplustoll) levels. In most cases, however, SMR is applied at the suborder level (e.g. Udults) or suborder for dual classes (Udic Argiustolls). With the exception of cryic and gelic, the other 8 soil temperature regime (STR) classes are presented at the family level or in some cases series level. The aim of this proposal is to increase the amount of information provided in a soil classification by moving soil climate information to the family level. Aligning both soil moisture and temperature climate information at the family level provides consistency in the classification system. Classification of extremely dry (Aridisols), cold (Gelisols), and wet (Aquasols) soils will not be affected by the proposed changes. This change has many advantages over the present structure used to apply soil climate information in Soil Taxonomy.

The primary advantage is that the change provides more information to the user by presenting diagnostic soil property information at higher levels in the classification system and by increasing the amount of climate information that can be potentially detailed. Valid reasons for the current approach of mostly applying SMR at the suborder level is that it provides a way to group soils on a broad scale at a high level in the classification system; and secondly, since soil formation is a function of soil climate (one of the 5 soil forming factors; Jenny,1941)

In support of this proposal, we examined the effectiveness of using maps (climate maps) or vegetative communities to predict soil moisture regime as defined. In this we looked at the data from 93 SCAN and NEON (mostly SCAN) from the western US (west of the Mississippi). Each of the SCAN sites has a soil moisture curve that presents percent moisture at various potentials with depth. From these, we recorded the moisture content at 1500 kPa for the upper and lower boundary of the moisture control section as defined in Soil Taxonomy. Moisture content is recorded at least daily at each SCAN site. We matched the Soil Taxonomy soil moisture regime (SMR) definitions with the SCAN and NEON data and assigned the SMR. Some sites had soil series data, some just locations. If the soil series was given we looked up the SMR for that series. If only location was recorded, the SMR was assumed to be what the soil was mapped at that location. On average over 90% of the soils classified as either aridic, xeric, and ustic SMR are incorrect. **This means that classifications at the suborder level using SMR, with the exception of udic are incorrect most of the time!!!**

Here is a summary of the results for sites west of the Mississippi River:

SMR	Total Years Checked	Total Years Failed	% Total Years Failed
Aridic	156	113	72
Udic	176	12	7
Ustic	195	142	73
Xeric	127	111	87
Xeric Aridic	100	72	72
Aridic Ustic	147	96	65
Aridic Xeric	37	13	35
Udic Ustic	44	13	30
Ustic Aridic	157	94	60

SMR	Total Stations Checked	Total Stations Failed	% Stations Failed
Aridic	16	11	69
Udic	12	1	8
Ustic	23	22	97
Xeric	8	8	100
Xeric Aridic	8	6	75
Aridic Ustic	9	8	89
Aridic Xeric*	2	0	0
Udic Ustic	3	0	0
Ustic Aridic	12	8	67

*For aridic-xeric, it should be noted that only 4 of those 37 years were Xeric.

The soil moisture information provided in Soil Taxonomy is essentially useless. This why the NCSMMN was established https://www.drought.gov/documents/national-coordinated-soil-moisture-monitoring-network

In 2022 there were over 2000 stations across the nation with the goal of having as many as 3000 stations.

Abbreviated Proposed key to the classification of Inceptisols where soil moisture and temperature regimes are recorded in the family category of Soil Taxonomy

(Draft April 2024, edited format Jan 2025)

Abbreviated Proposed key to the classification of Inceptisols where soil moisture and temperature regimes are recorded in the family category of Soil Taxonomy

(Draft April 2024, edited format Jan 2025)

KEY TO SUBORDERS

KA. Inceptisols that have one or more of the following: 1. in a layer at a depth between 40 and 50 cm from the mineral soil surface aquic conditions for some time in normal and either: a. A layer directly under the epipedon, or within 50 cm of the mineral soil surface, that has, on faces of peds or in the matrix 50 percent or more chroma of either 2 or less if there are redox concentrations; or 1 or less; or b. Within 50 cm of the mineral soil surface, enough active ferrous iron to give a positive reaction to alpha,alpha-dipyridyl at a time when the soil is not being irrigated;

Aquepts

KB. Other Inceptisols that have a sulfuric horizon within 50 cm of the mineral soil surface.

Sulfepts

KC. Other Inceptisols that have a duripan within 100 cm of the mineral soil surface.

Durepts

KD. Other Inceptisols that have a fragipan within 100 cm of the mineral soil surface.

Fragepts

KE. Other Inceptisols that have a calcic or petrocalcic horizon within 100 cm of the mineral soil surface.

Calcepts

KF. Other Inceptisols that have an umbric or mollic epipedon, or at least 16 kg m^{-2} organic carbon in the upper meter of the soil.

Humepts

KG. Other Inceptisols that have either free carbonates or a base saturation (by NH4OAc) of $\geq$60 percent between 25 and 75 cm from the mineral soil surface.

Eutrepts

KH. Other Inceptisols.

Dystrepts

Key to Aquept Great Groups in Rhode Island

KAA. Aquepts that have a sulfuric horizon within 50 cm of the mineral soil surface.

Sulfaquepts

KAB. Other Aquepts that have a lithic contact within 100 cm of the mineral soil surface.

Lithiaquepts

KAC. Other Aquepts that have a geogenic densic contact within 100 cm of the mineral soil surface.

Densiaquepts

KAD. Other Aquepts that have an umbric epipedon, or at least 16 kg m^{-2} organic carbon in the upper meter of the soil.

Humaquepts

KAE. Other Aquepts that have episaturation.

Epiaquepts

KAF. Other Aquepts.

Endoaquepts

Key to Sulfaquept Subgroups

KAAA. Other Sulfaquepts that have a fluidity class of slightly fluid at a depth between 20 and 50 cm

Hydraquentic Sulfaquepts

KAAB. Other Sulfaquepts.

Typic Sulfaquepts

Key to Lithiaquept Subgroups

KAEA. Lithiaquepts that have: 1. A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) either throughout the upper 15 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 15 cm after mixing; and 2. Free carbonates throughout; or 3. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface or directly above a root-limiting layer that is at a shallower depth.

Eutric Humic Lithiaquepts

KAEB. Lithiaquepts that have both: 1. A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) either throughout the upper 15 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 15 cm after mixing;

Humic Lithiaquepts

KAEC. Other Lithiaquepts that have one or more of the following:1. Free carbonates throughout; or 2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface or directly above a root-limiting layer that is at a shallower depth.

Eutric Lithiaquepts

KAED. Other Lithiaquepts:

Dystric Lithiaquepts

Densiaquepts

Key to Subgroups

KAGA. Densiaquepts that have an umbric epipedon.

Humic Densiaquepts

KAFB. Other Densiaquepts that have one or more of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface.

Eutric Densiaquepts

KAFC. Other Densiaquepts that have a base saturation (by sum of cations) of less than 60 percent in some horizon between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and a depth of 75 cm

Dystric Densiaquepts

Humaquepts

Key to Subgroups

KAHA. Humaquepts that have an n value of either: 1. a fluidity class of slightly fluid or higher (and less than 8 percent clay) in one or more layers at a depth between 20 and 50 cm from the mineral soil surface; or 2. a fluidity class of moderately fluid or higher in one or more layers at a depth between 50 and 100 cm.

Hydraquentic Humaquepts

KAHB. Other Humaquepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); and4. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Humaquepts

KAHC. Other Humaquepts that have one or more of the following:1. Free carbonates throughout; or 2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface or directly above a root-limiting layer that is at a shallower depth.

Eutric Humaquepts

KAHD. Other Humaquepts that have a base saturation (by sum of cations) of less than 60 percent in some horizon between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Dystric Humaquepts

Key to Epiaquept Subgroups

KAIA. Other Epiaquepts that have both: 1. A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) either throughout the upper 15 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 15 cm after mixing; and 2. A base saturation (by NH4 OAc) of less than 50 percent in some part within 100 cm

Humic Epiaquepts

KAIB. Other Epiaquepts that have one or more of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface

Eutric Epiaquepts

KAIC. Other Epiaquepts that have a base saturation (by sum of cations) of less than 60 percent in some horizon between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Dystric Epiaquepts

Key to Endoaquept Subgroups

KAJA. Other Endoaquepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. In one or more horizons between the A or Ap horizon and a depth of 75 cm below the mineral soil surface, one of the following colors: a. Hue of 7.5YR or redder in 50 percent or more of the matrix; and (1) If peds are present, either chroma of 2 or more on 50 percent or more of ped exteriors or no redox depletions with chroma of 2 or less in ped interiors; or (2) If peds are absent, chroma of 2 or more in 50 percent or more of the matrix; or b. In 50 percent or more of the matrix, hue of 10YR or yellower; and either (1) Both a color value, moist, and chroma of 3 or more; or (2) Chroma of 2 or more if there are no redox concentrations; and 4. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Endoaquepts

KAJB. Other Endoaquepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. In one or more horizons within 60 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage); and 4. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluvaquentic Endoaquepts

KAJC. Other Endoaquepts that have both: 1. A color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) either throughout the upper 15 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 15 cm after mixing; and 2. A base saturation (by NH4 OAc) of <50% in some part within 100 cm

Humic Endoaquepts

KAJD. Other Endoaquepts that have one or more of the following:1. Free carbonates throughout; or 2. A base saturation (by NH4OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface

Eutric Endoaquepts

KAJE. Other Endoaquepts that have a base saturation (by sum of cations) of less than 60 percent in some horizon between either an Ap horizon or a depth of 25 cm from the mineral soil surface, whichever is deeper, and either a depth of 75 cm

Dystric Endoaquepts

Key to Sulfept Great Groups
KBA. All Sulfepts.

Haplosulfepts

Key to Haplosulfept Subgroups
KBAA. All Haplosulfepts

Typic HaploSulfepts

Key to Humept Great Groups

KFA. Humepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquihumepts

KFB. Other Humepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithihumepts

KFC. Other Humepts that have a geogenic densic contact within 100 cm of the mineral soil surface.

Densihumepts

KFD. Other Humepts that have one or both of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4 OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface

Eutrihumepts

KFE. Other Humepts.

Dystrihumepts

Key to Aquihumept Subgroups

KFAA. Other Aquihumepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface

Fluventic Aquihumepts

KFAB Other Aquihumepts that have one or both of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4 OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface

Eutric Aquihumepts

KFAC. Other Aquihumepts

Dystric Aquihumepts

Key to Lithihumept Subgroups

KFBA Other Lithihumepts that have one or both of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4 OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface.

Eutric Lithihumepts

KFBB. Other Lithihumepts

Dystric Lithihumepts

Key to Densihumept Subgroups

KFCA Other Densihumepts that have one or both of the following: 1. Free carbonates throughout; or 2. A base saturation (by NH4 OAc) of 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface

Eutric Densihumepts

KFFB. Other Lithihumepts

Dystric Densihumepts

Key to Eutrihumept Subgroups

KFEA. Other Eutrihumepts.

Typic Eutrihumepts

Key to Dystrihumept Subgroups

KFFA. Other Dystrihumepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for either or both: 1. 20 or more consecutive days; or 2. 30 or more cumulative days

Oxyaquic Dystrihumepts

KFFB. Other Dystrihumepts that have a sandy particle-size class throughout the particle-size control section.

Psammentic Dystrihumepts

KFFC. Other Dystrihumepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. An umbric or mollic epipedon that is 60 cm or more thick; and 4. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content between a depth of 25 cm and a depth of 125 cm below the mineral soil surface

Cumulic Dystrihumepts

KFFD. Other Dystrihumepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Dystrihumepts

KFFE. Other Dystrihumepts that have an umbric epipedon that is 50 cm or more thick.

Pachic Dystrihumepts

KFFF. Other Dystrihumepts that do not have a cambic horizon and do not, in any part of the umbric epipedon, meet the requirements for a cambic horizon, except for the color requirements.

Entic Dystrihumepts

KFFG. Other Dystrihumepts.

Typic Dystrihumepts

Key to Eutrept Great Groups

KGA. Eutrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquieutrepts

KGB. Other Eutrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithieutrepts

KGC. Other Eutrepts that have a geogenic densic contact within 100 cm of the mineral soil surface.

Densieutrepts

KGD. Other Eutrepts that have an umbric or mollic epipedon.

Humieutrepts

KGE. Other Eutrepts.

Haploeutrepts

Key to Aquieutrept Subgroups

KGAA. Other Aquieutrepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Aquieutrepts

KGAB. Other Aquieutrepts that do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

Dystric Aquieutrepts

KGAC. Other Aquieutrepts.

Typic Aquieutrepts

Key to Lithieutrept Subgroups

KGBA. Lithieutrepts that have an umbric epipedon.

Humic Lithieutrepts

KGBB. Other Lithieutrepts.

Typic Lithieutrepts

Key to Densieutrept Subgroups

KGCA. All Densieutrepts.

Typic Densieutrepts

Key to Humieutrept Subgroups
KHEA. Humidystrepts that have sandy particle-size class in all subhorizons throughout the particle-size control section.

Psammentic Humidystrepts

KHEB. Other Humidystrepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Flueventic Humidystrepts

KHEC. Other Humidystrepts.

Typic Humidystrepts

Key to Haploeutrept Subgroups
KGGA. Other Haploeutrepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for either or both: 1. 20 or more consecutive days; or 2. 30 or more cumulative days

Oxyaquic Haploeutrepts

KGGB. Other Haploeutrepts that do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface, and have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Dystric Fluventic Haploeutrepts

KGGC. Other Haploeutrepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Haploeutrepts

KGGD. Other Haploeutrepts that have a texture class (fine-earth fraction) of coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand in all horizons within 50 cm of the mineral soil surface.

Arenic Haploeutrepts

KGGE. Other Haploeutrepts that do not have free carbonates throughout any horizon within 100 cm of the mineral soil surface.

Dystric Haploeutrepts

KGGF. Other Haploeutrepts

Typic Haploeutrepts

Key to Dystrept Great Groups
KHA. Dystrepts that have, in one or more horizons within 75 cm of the mineral soil surface, redox depletions with chroma of 2 or less and also aquic conditions for some time in normal years (or artificial drainage).

Aquidystrepts

KHB. Other Dystrepts that have a lithic contact within 50 cm of the mineral soil surface.

Lithidystrepts

KHC. Other Dystrepts that have a geogenic densic contact within 100 cm of the mineral soil surface.

Densidystrepts

KHD. Other Dystrepts that have an umbric or mollic epipedon.

Humidystrepts

KHE. Other Eutrepts.

Haplodystrepts

Key to Aquidystrept Subgroups

KHAA. Other Aquidystrepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Fluventic Aquidystrepts

KHAB. Other Aquidystrepts that have a histic, mollic, or umbric epipedon.

Humic Aquidystrepts

KHAC. Other Aquidystrepts.

Typic Aquidystrepts

Lithidystrepts

Key to subgroups

KHBA. Lithidystrepts that have an umbric or mollic epipedon.

Humic Lithidystrepts

KHBB. Other Lithidystrepts.

Typic Lithidystrepts

Key to Densidystrept Subgroups

KHCA. All Densidystrepts.

Typic Densidystrepts

Key to Humidystrept Subgroups

KHEA.

Humidystrepts that have sandy particle-size class in all subhorizons throughout the particle-size control section.

Psammentic Humidystrepts

KHEB. Other Humidystrepts that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface or a densic, lithic, or paralithic contact, whichever is shallower.

Flueventic Humidystrepts

KHEC. Other Humidystrepts.

Typic Humidystrepts

Key to Haplodystrept Subgroups

KHFA. Other Haplodystrepts that in normal years are saturated with water in one or more layers within 100 cm of the mineral soil surface for either or both: 1. 20 or more consecutive days; or 2. 30 or more cumulative days

Oxyaquic Haplodystrepts

KHFB. Other Haplodystreptss that have all of the following: 1. A slope of less than 25 percent; and 2. A total thickness of less than 50 cm of human transported material in the surface horizons; and 3. One or both of the following: a. At a depth of 125 cm below the mineral soil surface, an organic carbon content (Holocene age) of 0.2 percent or more and no densic, lithic, or paralithic contact within that depth; or b. An irregular decrease in organic carbon content (Holocene age) between a depth of 25 cm and a depth of 125 cm below the mineral soil surface

Fluventic Haplodystrepts

KHFC. Other Haplodystrepts that have a horizon 5 cm or more thick that has one or more of the following: 1. 25 percent or more of the horizon in each pedon is extremely weakly coherent or more coherent due to pedogenic cementation by organic matter and aluminum, with or without iron; or 2. Al plus ½ Fe (by ammonium oxalate) of 0.25 percent or more and half that amount or less in an overlying horizon; or 3. An ODOE value of 0.12 or more and a value half as high or lower in an overlying horizon.

Spodic Haplodystrepts

KHFD. Other Haplodystrepts

Typic Haplodystrepts

References:

Capooci, M., Seyfferth, A. L., Tobias, C., Wozniak, A. S., Hedgpeth, A., Bowen, M., ... & Vargas, R. (2024). High methane concentrations in tidal salt marsh soils: Where does the methane go?. Global Change Biology, 30(1), e17050.

Hino, K. J. Romero, J. Loffredo, M.H. Stolt, J. Amador, S. Moseman-Valtierra, C. Wigand, and B. Pellock. 2023. Birnessite films are sensitive indicators of microbial manganese reduction in soil. Soil Science Society of America Journal 87:196–201.

Kim, J. D. S. (2022). Distribution and Variability of Carbon Stocks in Mid-Atlantic Tidal Marsh Soils (Master's thesis, University of Maryland, College Park).

Loffredo J.A., M.C. Rabenhorst, M.H. Stolt, and J.A. Amador. 2023. Potential Interference of Organic Acids and Ferrous Iron in the Interpretation of Fe- and Mn-Indicators of Reduction in Soil (IRIS). Soil Science Society of America Journal, 86:1165-1173.

Manetta, J. V. (2023). Distribution and Variability of Blue Carbon in Tidal Marsh Soils of Southern New England. Master's thesis, University of Rhode Island.

Manetta, J. V., & Stolt, M. H. (2025). Modeling particle size distribution for subaqueous soil survey applications. Soil Science Society of America Journal (Preprint)

Manetta, J. V., Dellinger, M., Ricker M. C., & Stolt, M. H. A pedogeomorphic strategy for blue carbon accounting of tidal marsh soils. Soil Science Society of America Journal (In review)

Poffenbarger, H. J., Needelman, B. A., & Megonigal, J. P. (2011). Salinity influence on methane emissions from tidal marshes. Wetlands, 31(5), 831-842.

Rabenhorst, M.C., and M.H. Stolt. 2012. Field Estimations of Soil Organic Carbon. Soil Science Society of America Journal. 76:1478-1481.

Rabenhorst, M.C., P.J. Drohan, J.M. Galbraith, C. Moorberg, L. Spokas, M.H. Stolt, J.A. Thompson, J. Turk, B.L. Vasilas, and K.L. Vaughan. 2021. Manganese-coated IRIS to document reducing soil conditions. Soil Science Society of America Journal. doi.org/10.1002/saj2.20301

Richardson, M., and M.H. Stolt. 2013. Measuring soil organic carbon sequestration in aggrading temperate forests. Soil Science Society of America Journal 77:2164-2172.

Ricker, M.C., M.H. Stolt, and M.S. Zavada. 2014. Comparison of Soil Organic Carbon Dynamics in Forested Riparian Wetlands and Adjacent Uplands. Soil Science Society of America Journal 78:1817-1827.

Ricker, M.C., M.H. Stolt, and M.S. Zavada. 2019. Pollen preservation in alluvial soils: implications for paleoecology and land use studies. Soil Science of America Journal 83:1595-1600. doi:10.2136/sssaj2019.01.0025

Ricker, M.C., M.H. Stolt, S.W. Donohue, Blazejewski, G.A., and M.S. Zavada. 2013. Soil organic carbon pools in riparian landscapes of southern New England. Soil Science Society of America Journal 77:1070-1079.

Ricker, M.C., S.W. Donohue, M.H. Stolt, and M.S. Zavada. 2012. Development and application of multi-proxy indices of land use change for riparian soils of southern New England, USA. Ecological Applications 22:487-501.

Romero, J., K. Hino, J. Loffredo, M.H. Stolt, S. Moseman-Valtierra, J. Amador, and B. Pellock. 2021. Abiotic soil properties affecting interpretation of IRIS sensors in tidal and freshwater soils. Soil Science Society of America Journal, 85:2234-2239.

Stolt, M.H, and J. Bakken. 2014. Inconsistencies in terminology and definitions of organic soil materials. Soil Science Society of America Journal 78:1332-1337.

Stolt, M.H., A.T. O'Geen, D.E. Beaudette, P. J. Drohan, J.M. Galbraith, D.L. Lindbo, H.C. Monger, B.A. Needelman, M.D. Ransom, M.C. Rabenhorst, and J.N. Shaw. 2021. Changing the hierarchical placement of soil moisture regimes in Soil Taxonomy. Soil Science of America Journal 85:488-500 https://doi.org/10.1002/saj2.20219

Stolt, M.H., and A. Hardy. 2022. Carbon sequestration in back-barrier tidal marsh soils. Soil Science Society of America Journal, 86:1368-1377.

Stolt, M.H., and B.A. Needelman. 2015. Fundamental Changes in Soil Taxonomy. Soil Science Society of America Journal 79:1001-1007.

Stolt, M.H., M.C. Rabenhorst, E.A. Ghabbour, and G. Davies. 2016. Soil Color and US Northeast Aquods. Soil Science Society of America Journal 80:1001-1007.