

PAXTON

Massachusetts State Soil



SOIL SCIENCE SOCIETY OF AMERICA



Introduction

Many states have a designated state bird, flower, fish, tree, rock, etc. And, many states also have a state soil – one that has significance or is important to the state. The Paxton is the official state soil of Massachusetts. Let's explore how the Paxton is important to Massachusetts.

History

The Paxton soil series is named for the town of Paxton in Worcester County Massachusetts where it was first described. The series was established in 1922, described in the Soil Survey of Worcester County in 1927, and then in 1991 it was designated as the official state soil of Massachusetts. Created by the movement of glaciers thousands of years ago, Paxton soils can be found throughout New England and are exemplified by scenic rolling hills dotted with dairy farms. It is considered one of the most productive soils for agriculture in New England.

What is Paxton Soil?

Paxton soil is made of well drained loamy soils formed on wind deposited material that sits on top of rock deposited by glaciers. Classified as a coarse-loamy soil, Paxton soils possess soil particles that are at the larger end of the textural spectrum. Being composed of material scraped from the surface of the landscape over which glaciers traveled, its mineral composition is varied. The rocks contributing to Paxton soils include schist, gneiss, and granite. The clays in its composition have good cation-exchange capacity, although the *pH* of these soils is low. A cation is a positively charged ion (such as an atom or molecule) which influences the soil's ability to hold onto essential nutrients and provides a buffer against soil acidification. These soils can be very deep but can have a horizon where the soils become very dense and quite impermeable.

Every soil can be separated into three separate size fractions called *sand*, *silt*, and *clay*, which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil.

Paxton soils are young in terms of soil forming processes. In Paxton soils, the horizons are just starting to form and become distinct (**Figure 1**). The A horizon is relatively thin, just 0 to 5 inches, composed of a fine sandy loam, and possesses weak structure. The B horizon can exceed 20



Figure 1. An example of a Paxton series soil profile. Credit: USDA-NRCS

Photo Soil Monolith: Chip Clark/Smithsonian Institution



Figure 2. Location of the Paxton soil series in Massachusetts and surrounding states. Credit: Smithsonian Institution's Forces of change.



Figure 3. Massachusettes apple orchard.

inches and is also made up of fine sandy loam. Different from the A horizon, the B horizon increases in yellow color and in rock fragments. There is some blocky structure as the clay content increases. The C horizon is very significant and can reach a thickness of over 30 inches. It has a firm, brittle, and *platy* structure. There can be dense impermeable layers that can lead to perched seasonal water tables.

Where to dig Paxton

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile*. The different horizontal layers of the soil are called *soil horizons*. This does not mean that other types of soil cannot be found there but that the Paxton is the most common. Paxton soils are associated with glacier related landforms such as *till plains*, ground moraines, and *drumlins*. Paxton soils will predominantly occur on slopes which puts them in higher areas on the landscape. Paxton soils occur throughout New England but is concentrated in the southern portion (**Figure 2**). Of the more than 5 million acres in Massachusetts, 400,000 of them belong to the Paxton soil series.

Importance

What makes the Paxton soil so important is its use and prevalence in the State. Considered one of the most productive soils of New England whose formation is tied to the movement of glaciers thousands of years earlier, its importance comes from the favorable climate and the lack of steep slopes making it ideal for agriculture, even it requires significant effort to clear the land of stones present on the surface and the upper soil profile. In 2012 Massachusetts produced about \$500 million in agricultural products, almost \$150 million coming areas with Paxton soils. Considering that Massachusetts is the 3rd highest state in terms of population density, it is significant that 3 to 10% of available land is dedicated to agriculture.

When the soil has steep slopes, woodlands offer a large selection of trees that include red, white, and black oak, history, sugar maple, red maple, gray and black birch, white pine, and hemlock.

Uses

In general, soils can be used for agriculture (growing foods, raising animals, stables); engineering (roads, buildings, tunnels); ecology (wildlife habitat, wetlands), recreation (ball fields, playground, camp areas) and more. Paxton soils, with high water holding capacity, are very productive agricultural soils once stones have been cleared. The major crops on Paxton soils are apples (**Figure 3**), corn, and silage. These soils are also well-suited for pastureland. Besides agriculture Paxton soils are suited for light construction, like suburban housing, and lumber, offering a variety of different desirable tree species.

Limitations

When a soil cannot be used for one or more of the described functions, it is referred to as a limitation. Soil experts, called *Soil Scientists*, studied Paxton soil and identified that it has **varied** limitations, from a classification of IIe (moderate limitations that limit choice of plants or require moderate conservation practices) to VII (soils with severe limitations that make them unsuitable for cultivation). It has limited use as a construction material due to excess of fine sands, can have moisture issues where excess water in the profile can lead to piping over a pan layer that has a very slow percolation rate. The slow percolation rate has an impact on the construction of septic fields and sanitation facilities. A seasonal high *water table* and a frost-action potential are also problems that can affect developing a site for housing and roadways.



Figure 4 Example of erosion. Credit: Adobe Stock.

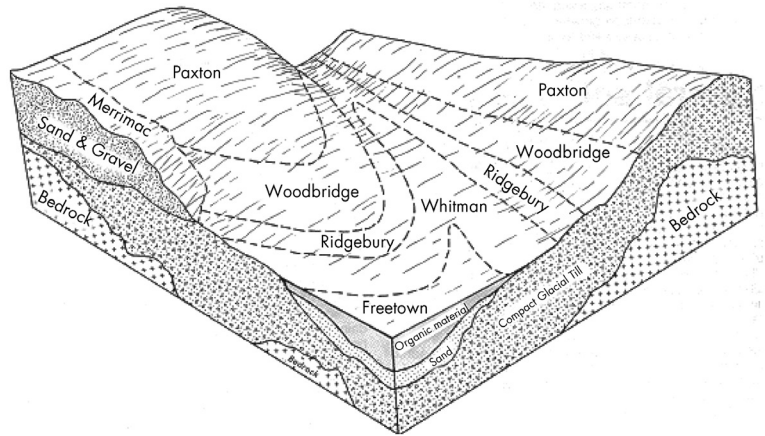


Figure 5 Diagram of where to find Paxton soils in the landscape. Credit: <http://nesoil.com/images/paxtonblock.gif>

Management

Paxton soils are very productive for agriculture, but there could be a significant number of stones and cobbles that need to be removed prior to planting. Since erosion is a hazard (**Figure 4**), managers should employ conservation tillage, use cover crops, or stripcrop to help reduce erosion potential.

Paxton Formation

Before there was soil there were rocks and in between, CLORPT. Without CLORPT, there will be no soil. So, what is CLORPT? It is the five major factors that are responsible for forming a soil like the Downer series. It stands for **C**limate, **O**rganisms, **R**elief, **P**arent material and **T**ime. CLORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Paxton (and all other soils) are determined by the influence of CLORPT. Weathering takes place when environmental processes such as rainfall, freezing and thawing act on rocks causing them to dissolve or fracture and break into pieces. CLORPT then acts on rock pieces, marine sediments and vegetative materials to form soils.

Climate – Temperature and precipitation influence the rate at which parent materials weather and dead plants and animals decompose. They affect the chemical, physical and biological relationships in the soil. According to its taxonomic classification, Paxton soils are in an udic suborder, which means they are in a region that gets a fair amount of precipitation during the year. Average precipitation ranges from 37 to 49 inches which is adequate for all crops grown on these soils. Winters can be cold, but summers are moderately warm with an occasional hot period. The average annual temperature of 45 to 52 F. Paxton soils have a growing season of 115 to 180 days.

Organisms – This refers to plants and animal life. In the soil, plant roots spread, animals burrow in, and bacteria break down plant and animal tissue. These and other soil organisms speed up the breakdown of large soil particles into smaller ones. Plants and animals also influence the formation and differentiation of soil horizons. Plants determine the kinds and amounts of *organic matter* that are added to a soil under normal conditions. Animals breakdown complex compounds into small ones and in so doing add organic matter to soil. Pax-

ton soils have a variety of trees growing on them such as red, white, and black oaks, hickory, sugar and red maple, gray and black birch, white pine, and hemlock.

Relief – Landform position or relief describes the shape of the land (hills and valleys), and the direction it faces which makes a difference in how much sunlight the soil gets and how much water it keeps. Deeper soils form at the bottom of the hill rather than at the top because gravity and water move soil particles downhill. Paxton soils are found on hillslopes that have their origins tied to glacial activity (**Figure 5**). The continental ice sheet pushed material across the landscape and stopped its progress southward in the area Paxton soils formed. Meltwater from the glaciers also contributed to moving materials to their final destination.

Parent material (C horizon) – Just like people inherit characteristics from their parents, every soil inherits some traits from the material from which it forms. Some parent materials are transported and deposited by glaciers, wind, water, or gravity. Four major glaciers contributed material to the areas where Paxton soils can be found. Features such as drumlins were created by glaciers pushing up loose material over firm areas that did not yield to the enormous force of the glaciers. As glaciers melted, material carried by the grinding action of glaciers were washed along and sorted by size creating glacial till. These events had a significant impact on the type of parent material that can be found in the area of Paxton soils.

Time – All the factors act together over a very long period of time to produce soils. As a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined horizons than younger soils. Less time is needed for a soil profile to develop in a humid and warm area with dense vegetative cover than in a cold dry area with sparse plant cover. More time is required for the formation of a well-defined soil profile in soils with fine textured material than in soils with coarse-textured soil material. Paxton soils, according to their taxonomic classification, are “young” soils. These are soils who are just starting to experience *horizonation* (Bw labeling of deeper horizons in official description). In terms of geologic time, the glacial activity that had a huge impact on the parent material and relief of the landscape where Paxton soils can be found happened quite recently.

USEPA Ecoregions

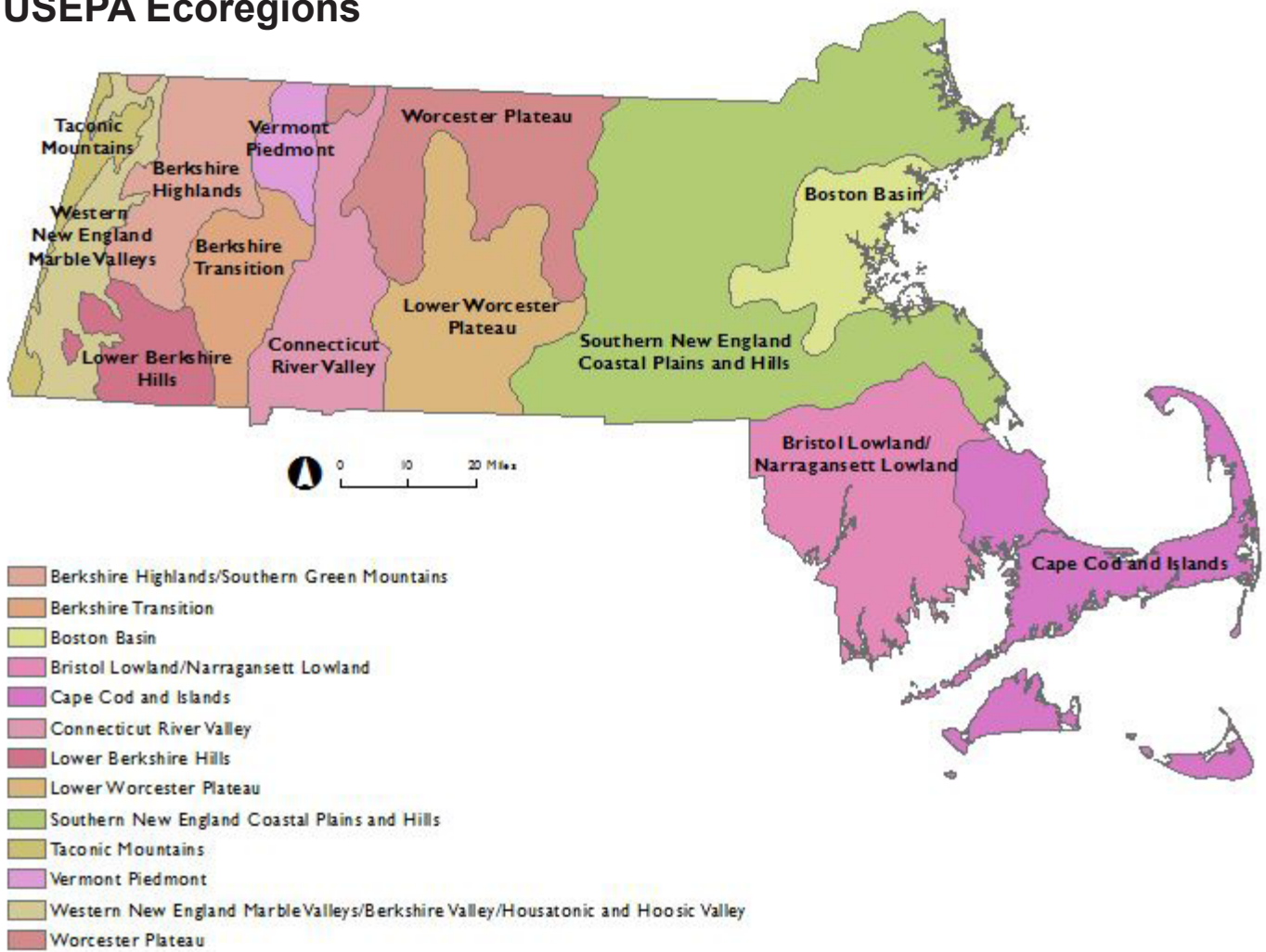


Figure 6. Ecoregions of Massachusetts Credit: www.massaudubon.org

Ecoregions, Soils and Land Use in Massachusetts

While the above map (Figure 6) shows more than a dozen discreet ecoregions as listed by the EPA and the Massachusetts Audubon Society, they can be put into three major region categories.

The first category is the Northeastern Highlands which occupy a good portion of western Massachusetts. The areas included from the above map are the Taconic Mountains, the Western New England Marble Valleys, the Berkshire Highlands, the lower Berkshire Hills, the Vermont Piedmont, and the Berkshire Transition. Sparsely populated hills are covered with a mix of boreal and deciduous forests. The soils are nutrient poor and frigid much of the year. Recreation and logging are the major industries of this region, although there are a few dairy, fruit tree and potato farms.

The second category is the Northeastern Coastal Zone. The areas included here are the lower Worcester Plateau, the southern New England Coastal Plains and Hills, the Boston Basin, and the

Bristol/Narragansett Lowland. Here are plains with hills covered with forests of oak and pine, a mix of Appalachian and northeastern US vegetation types. The soils are nutrient poor and support little agriculture, whether pasture or cropland. While there is greater population density in this region, what isn't urban and suburban development is forest and woodland.

The last category is the Atlantic Coastal Pine Barrens, which includes Cape Cod and the islands. A continental glacial ice sheet deposited nearly 400 feet of gravel, sand, and silt on a bedrock of granite, gneiss, and schist. Terminal moraines and outwash plains are the major features of this region. There is a maritime climate, unique salt and freshwater marsh habitats in close proximity of stunted pine and oak forests. Dotting the landscape are kettle ponds, swamps, bogs,

Glossary

Clay: A soil particle that is less than 0.002 mm in diameter. Clay particles are so fine they have more surface area for reaction. They hold a lot of nutrients and water in the soil. A clay soil is a soil that has more than 40% clay, less than 45% sand and less than 40% silt.

Drumlin: a low oval mound or small hill, typically one of a group, consisting of compacted boulder clay molded by past glacial action.

Ecoregion: Represents areas with similar biotic and abiotic characteristics which determine the resource potential and likely responses to natural and man-made disturbances. Characteristics such as climate, topography, geology, soils, and natural vegetation define an ecoregion. They determine the type of land cover that can exist and influence the range of land use practices that are possible.

Horizon: see Soil horizons

Horizonation: The development of horizons in soil as a result of a soil forming process or a combination of soil forming processes.

Moraine: a mass of rocks and sediment carried down and deposited by a glacier, typically as ridges at its edges or extremity.

Organic matter: Material derived from the decay of plants and animals. Always contains compounds of carbon and hydrogen.

pH: pH is the measurement of acidity or alkalinity. In chemistry terms, pH is the negative logarithm of hydrogen ion (H⁺) activity. In all cases, it is measured on a scale of 0 to 14 of which 7 is considered to be neutral. If it falls below 7 it is acidic and if it is above 7 it is alkaline or basic.

Platy: Consisting of soil aggregates that are developed predominantly along the horizontal axes; laminated; flaky.

Sand: A soil particle between 0.05 and 2.0 mm in diameter. Sand is also used to describe soil texture according to the soil textural triangle, for example, loamy sand.

Silt: A soil particle between 0.002 and 0.05 mm diameter. It is also used to describe a soil textural class.

Soil Horizon: A layer of soil with properties that differ from the layers above or below it.

Soil Profile: The sequence of natural layers, or horizons, in a soil. It extends from the surface downward to unconsolidated material. Most soils have three major horizons, called the surface horizon, the subsoil, and the substratum.

Soil Scientist: A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties; distribution, genesis and morphology; and biological components. A soil scientist needs a strong background in the physical and biological sciences and mathematics.

Soil Texture: The relative proportion of sand, silt, and clay particles that make up a soil. Sand particles are the largest and clay particles the smallest. Learn more about soil texture at www.soils4teachers.org/physical-properties

Till Plain: An extensive flat to undulating surface underlain by till. (unsorted and unstratified earth material, deposited by glacial ice, which consists of a mixture of clay, silt, sand, gravel, stones, and boulders in any proportion).

Water table: The top layer of ground water where the soil is filled with standing water. It can move up or down during different seasons.

Additional Resources

Soil! Get the Inside Scoop. David Lindbo and others. Soil Science Society of America, Madison, WI.

Know Soil, Know Life. David L. Lindbo, Deb A. Kozlowski, and Clay Robinson, editors. Soil Science Society of America, Madison, WI.

Web Resources

Soils for Teachers—www.soils4teachers.org

Soils for Kids—<http://www.soils4kids.org/>

Have Questions? Ask a Soil Scientist—<https://www.soils.org/ask>

Soil Science Society of America—<https://www.soils.org/>

References

Snapshot of Massachusetts Agriculture. <http://www.mass.gov/eea/docs/agr/facts/snapshot-of-ma-agriculture.pdf>, retrieved Dec. 7, 2017

Fact Sheet Cations and Exchange Capacity. <http://www.soilquality.org.au/factsheets/cation-exchange-capacity>, retrieved Nov. 27, 2018,

Griffith, G.E., Omernik, J.M., Bryce, S.A., Royte, J., Hoar, W.D., Homer, J.W., Keirstead, D., Metzler, K.J., and Hellyer, G. 2009. Ecoregions of New England (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,325,000)

Hill, David Easton, and Walter N. Gonick. The Paxton Soils. Connecticut Agricultural Experiment Station, 1963.

Turenne, Jim. "Paxton, Fine Sandy Loam The Official State Soil of Massachusetts." NEsoil.com. 1996. Web. 21 Sept. 2016.

Taylor, William H., and C. F. Hotz. "Soil survey of Worcester County, Massachusetts, northeastern part." (1985).

"USEPA Ecoregions." MassAudubon.org. Mass Audubon. 2016. Web. 21 Sept. 2016.

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This state soil booklet was developed under the auspices of the Soil Science Society of America's K-12 Committee—their dedication to developing outreach materials for the K-12 audience makes this material possible.