Downer
New Jersey 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 "Downer" is the state soil of New Jersey. Let's explore how the Downer is important to New Jersey.

History

Downer soil is the New Jersey State Soil. In 1955, G. A. Quackenbush of the New Jersey Agricultural Experiment Station was the first to use the name Downer to represent some yellowish, sandy and somewhat droughty soils of the Pine Barrens of New Jersey. However, it was first established as a soil series in 1960 in Gloucester County, in the southern part of the State.

What is Downer Soil?

Downer soil is a deep well-drained soil developed from acid, loamy Coastal Plain sediments **(Figure 1)**. Originally, the land area had developed from older rock formations before the coastal sands were deposited over it. The coastal deposits become soil as they weathered (see ClORPT below) and plants, animals and microorganisms began to add organic matter to the top layer over thousands of years. They are found on rolling landscapes, terraces and uplands with up to 30% slope in some places, but less than 5% slope is most common. Every soil can be separated into three separate size fractions called sand, silt, and clay, which make up the soil texture. They are present in all soils in different proportions and say a lot about the character of the soil. In Downer soil, the topsoil or A horizon (the layer of soil that we plow or plant seeds in) is loamy sand in its feel, has a dark grayish-brown color and could be up to 28 cm (11 inches) thick **(Figure 2)**. The subsoil or B horizon (the layers below the topsoil) can be loose loamy sand that progressively becomes sandy loam as you go deeper from the 28 cm mark down to 76 cm (30 inches) mark in the soil. The subsoil has a yellowish-brown color. The topsoil and subsoil are mixed with as much as 15% gravel. In the lower layers, the amount of gravel can be as much as 25% which makes the layers feel like gravelly sandy loam.

Where to dig a Downer

Yes, you can dig a soil. It is called a soil pit and it shows you the soil profile **(Figure 1)**. The different horizontal layers of the soil are called soil horizons. Downer soil covers a wide area of the State. This does not mean that other types of soil cannot be found there but that the Downer is the most common **(see map in Figure 3)**. Downer series covers 291,319 acres of land in 11 counties of New Jersey. It is the most extensive soil in the portion of New Jersey referred to as the Pine Barrens. In all, there are a total of 195 named soils (series) in New Jersey (see the web link list on Page 5, Important New Jersey Soils for more information).

Photo: Chip Clark/Smithsonian Institution

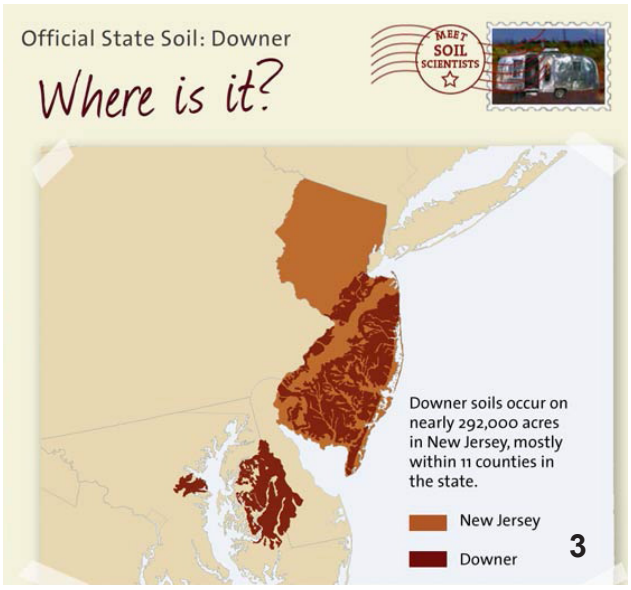

Fig. 1 Soil profile of a Downer soil formed in loamy or gravelly fluvio-marine deposits. Credit: USDA-SCS. Soil Survey of Gloucester County.

Fig. 2 The Downer soil plowed for planting. Credit: USDA-NRCS. ftp://ftp-fc.sc.egov.usda.gov/NSSC/StateSoil_Profiles/nj_soil.pdf

Fig. 3 Location of the Downer soil in New Jersey (and parts of Delaware and Maryland). Credit: Smithsonian Institution's Forces of change. http://forces.si.edu/soils/interactive/state-soils/index.html

Importance

What makes the Downer soil so important is it's use and prevalence in the State. Most of Downer soils are used as woodlands. Common tree species consist of mixed oaks of chestnut, blackjack, white, black, scarlet and post oaks, hickory, and scattered pines such as pitch pines, shortleaf pines, and Virginia pines. Blueberry and bracken fern provide the bush or shrub layer under the trees. These forests are home to white-tailed deer, opossum, mushrooms, lichens and much more. It is also important for putting "garden" in New Jersey's nickname, the "Garden State." About 40% of the soil is used for cultivation of high-value vegetable and fruit crops **(Figure 4 and 5)** such as peppers, tomatoes, cabbage, apples, asparagus, and sweet potatoes.

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. Most Downer soil is found in woodlands (forest) and many of the Garden State's vegetables and crops are grown on Downer soil. Hay, pasture, nursery stock and sod production when irrigated, are also grown on this soil. In addition, some of the soil has been used for sand mining and some towns are settled on Downer soil.

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 Downer soil and identified that it has moderate limitation. Because of this, only some types of plants can be grown on this soil and it must be monitored for erosion. Drought can be a problem too so irrigation (providing water for plants) may be necessary. Since Downer soil can have a loose sandy surface, it is not suitable for construction of recreation facilities. In some locations, Downer is not good for building a house with a basement or onsite sewage treatment and dispersal field because of the high water table.

Management

Downer soils are low in organic matter and clay, and have medium natural fertility but are productive with added fertilizer. If soils can be sweet or sour, Downer soil is strongly sour, or, as Soil Scientists like to put it, they are extremely to strongly acidic. As a result, lime needs to be added to make the soil less acidic. Since these are somewhat sandy soils, added fertilizer and lime can easily leach from the soils. The soil has a seasonal high water table at a depth of 183 cm or less (6 ft) below the surface. Again, drought is the main limitation to the use of this soil so, irrigation is necessary to increase productivity in some locations.

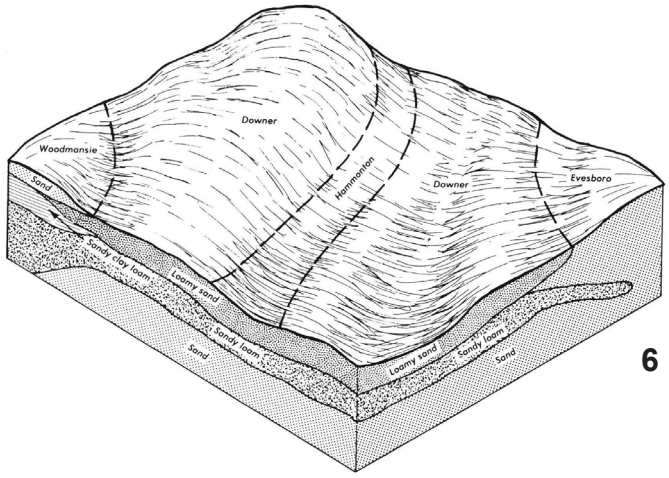

Fig. 4 The Downer soil grows some of the best fruits and vegetables in the Garden State.

Fig. 5 Downer soil series on gentle slopes of 0 to 2 percent is used to grow cabbage in Gloucester county. Credit: USDA-SCS. Soil Survey of Gloucester County.

Fig. 6 Relationship of soils, landform position (relief) and parent material. Downer soil is located on the slopes, slightly higher than other soils that could be poorly drained or have a high water table. Credit: USDA-NRCS. Soil Survey of Gloucester County.

Downer Soil 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 **Cl**imate, **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 Downer soil (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. The Downer soil developed under a warm humid climate with mild temperatures and abundant rainfall. The influence of the two resulted in the depletion of organic matter and leaching of soluble bases.

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. Downer developed under hardwood or pine forests which deposit leaves, twigs, roots and other plant remains on the surface and these readily degrade and leach through the sandy soil. Downer soils have little accumulation of organic matter.

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. Downer soil is well drained because it is formed on the higher position of the landscape **(Figure 6)**.

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. Downer soils developed from water-transported materials and fluviomarine deposits.

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 where the Downer soil is 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.

Ecoregions, Soils and Land Use in New Jersey

The State of New Jersey has a complex geology made up of about 65 geologic formations. These formations lie in four regions or physiographic provinces **(Figure 7)**. Although, there are different levels of ecoregions, in New Jersey they fit very well within the boundaries of the 4 physiographic provinces. The soil type and characteristics depend on the type of rock from which the soil was formed.

Coastal Plain: The Downer formed in this ecoregion which is the largest physiographic province in New Jersey. It has a generally flat topography dominated by deposits from oceans and seas on top of older metamorphosed rocks. Due to the ocean influence, the soil texture is dominated by sand but can also have textures with considerable silt and clay fractions. The sediments consist of layers of sand, silt and clay that were deposited alternately in river deltas, and marine environments as the sea level fluctuated. The soil is rather unproductive and acid. Some areas in this region have an important type of soil mineral called glauconite (greensand) which has been mined in the past for use in fertilizer. Greensands are rich in iron, phosphoric acid, and/or calcium carbonate. The Coastal Plain sediments have been mined for bog iron, glass sand, foundry sand, ceramic and brick clay, and titanium from the mineral, ilmenite, in sand deposits. It continues to supply sand for glass, and sand and gravel for construction. A large expanse of the region comprises the Pine Barrens, a vast area covered mainly by pines, several species of oak trees and sandy acidic soil. The Pine Barrens are adapted to occasional fires that periodically spread in a mosaic pattern across large areas. The remaining part of the Coastal Plain is characterized by sphagnum bogs, coastal salt ponds, cedar swamps, mixed forests, croplands and urban development along the Atlantic coast. Most of the crop cultivation is done in the south and southwest portion. The sand formations are productive aquifers and important ground water reservoirs.

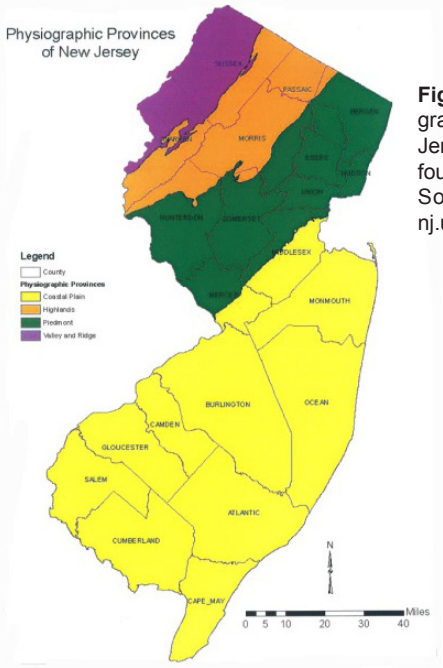

Fig. 7 The four physiographic regions of New Jersey. Downer soil is found in the Coastal Plains. Source:http://www.state.nj.us/dep/njgs/index.html

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.

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.

Fluviomarine deposits: Marine deposits that have been reworked and transported from their original place by river or stream action.

Geology: The study of the physical earth, its composition (materials), history and processes (physical and chemical) that act on it.

Geologic formation: A body of rock of considerable extent with distinctive characteristics that allow geologists to map, describe, and name it.

Geomorphology: A branch of geology and geography that studies the development of landforms.

Horizon: see Soil horizons

Leaching: The removal of soluble material from soil or other material by percolating water.

Loamy sand: Soil material that is a mixture of between 70-90% sand, up to 30% silt, and less than15% clay. It has more sand than sandy loam.

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

Physiographic province: Broad-scale subdivisions based on terrain texture, rock type, and geologic structure and history.

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.

Sandy Loam: Soil material that contains between 43-85% sand, 0-50% silt and 0-20% clay. It has less sand than 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 Management: The sum total of how we prepare and nurture soil, select type of crops that suitable for a type of soil, tend the crop and the soil together, and determine fertilizer types and other materials to be added to soil to maintain productivity and preserve soil.

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, slit, 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

Soluble bases: Elements (calcium, magnesium, sodium and potassium) that are present in soil as ions and form what is called Cation Exchange Capacity. The amount in the soil can be reduced through leaching.

Subsoil: (B horizon) The soil horizon rich in minerals that eluviated, or leached down, from the horizons above it. Not present in all soils.

Topography: The shape of the land surface. (Relief: refers to differences in elevation of different points in a region.)

Topsoil: (A horizon) The horizon that formed at the land surface. Mostly weathered minerals from parent material with a little organic matter added.

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

Lindbo, D. et al. 2008. *Soil! Get the Inside Scoop.* Soil Science Society of America, Madison, WI.

Lindbo, D. L., D. A. Kozlowski, and C. Robinson (ed.) 2012. *Know Soil, Know Life*. Soil Science Society of America, Madison, WI.

Web Resources

Soil Science Links

Soils for Kids —www.soils4kids.org/

Resources for Teachers— www.soils4teachers.org

Have Questions? Ask a Soil Scientist—www.soils.org/ask

Soil Science Society of America—www.soils.org/

NRCS Links

Important New Jersey Soils (list of additional soils)— www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/soils/?cid=nrcs141p2_018874

Natural Resources Conservation Service, NJ Homepage— www.nrcs.usda.gov/wps/portal/nrcs/site/nj/home/

Natural Resources Conservation Service—www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/

Natural Resources Conservation Service, Educational Resources—www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/

New Jersey Links

New Jersey Agricultural Experiment Station, Rutgers, The State University of New Jersey—http://njaes.rutgers.edu/extension/

NJ Association of Conservation Districts (Envirothon & other programs)**—**www.njacd.org/

NJ Dept. of Agriculture, State Soil Conservation Districts— www.nj.gov/agriculture/divisions/anr/nrc/conservdistricts.html

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