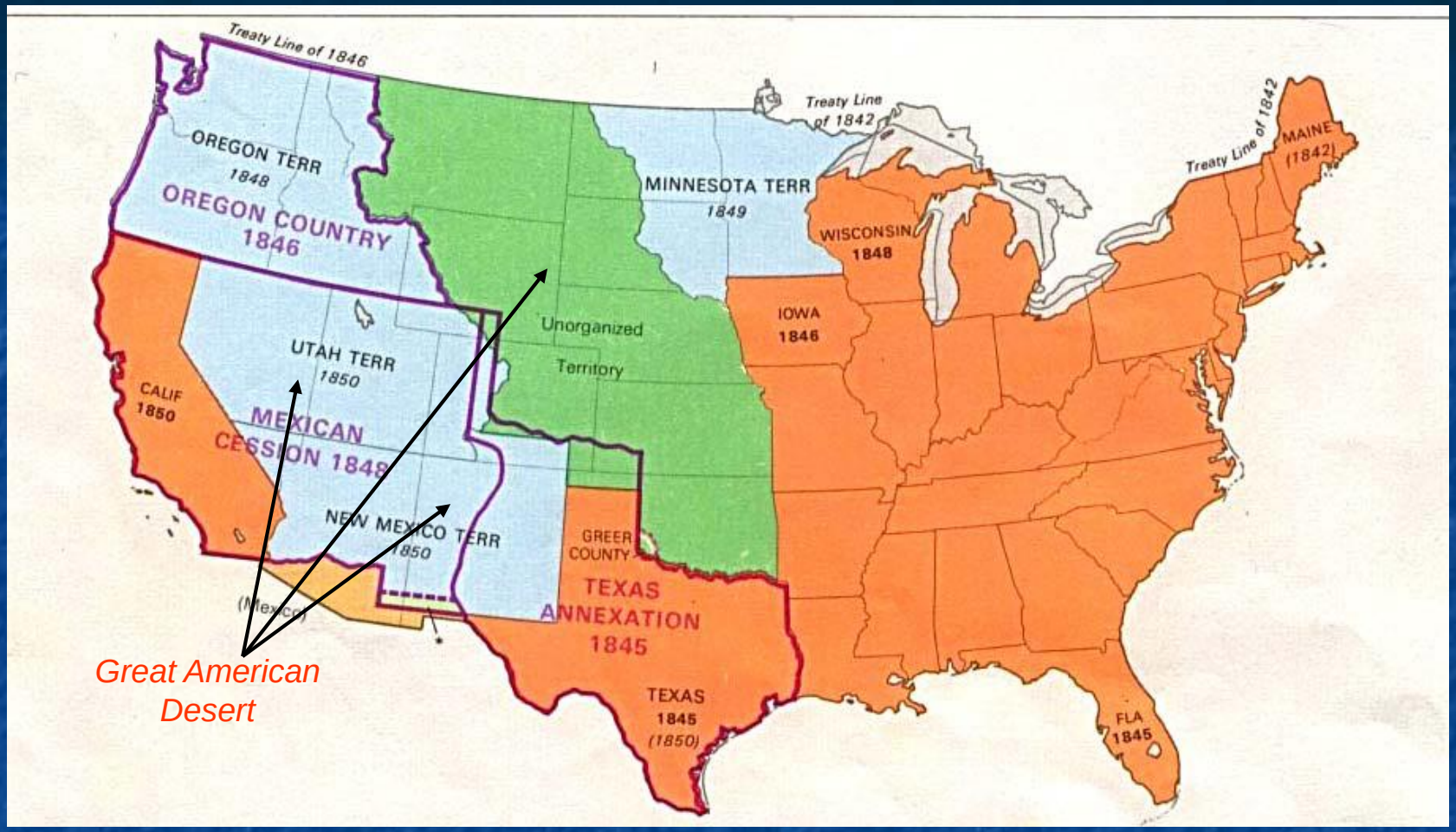

MISSOURI
1821
CORPS OF DISCOVERY
1804
2004
2003
E PLURIBUS UNUM

“I do not hesitate in giving the opinion, that it is almost wholly unfit for cultivation, and of course, uninhabitable by a people depending upon agriculture for their subsistence.” *Geographer Edwin James, 1823*



1850 Map of the United States

Courtesy of the University of Texas Libraries, University of Texas at Austin

Late 1800's: "Homestead Act"

160 acres (1/4 section) given to homesteaders who-live on the land, build a home, make improvements, and farm it for a minimum of five years.

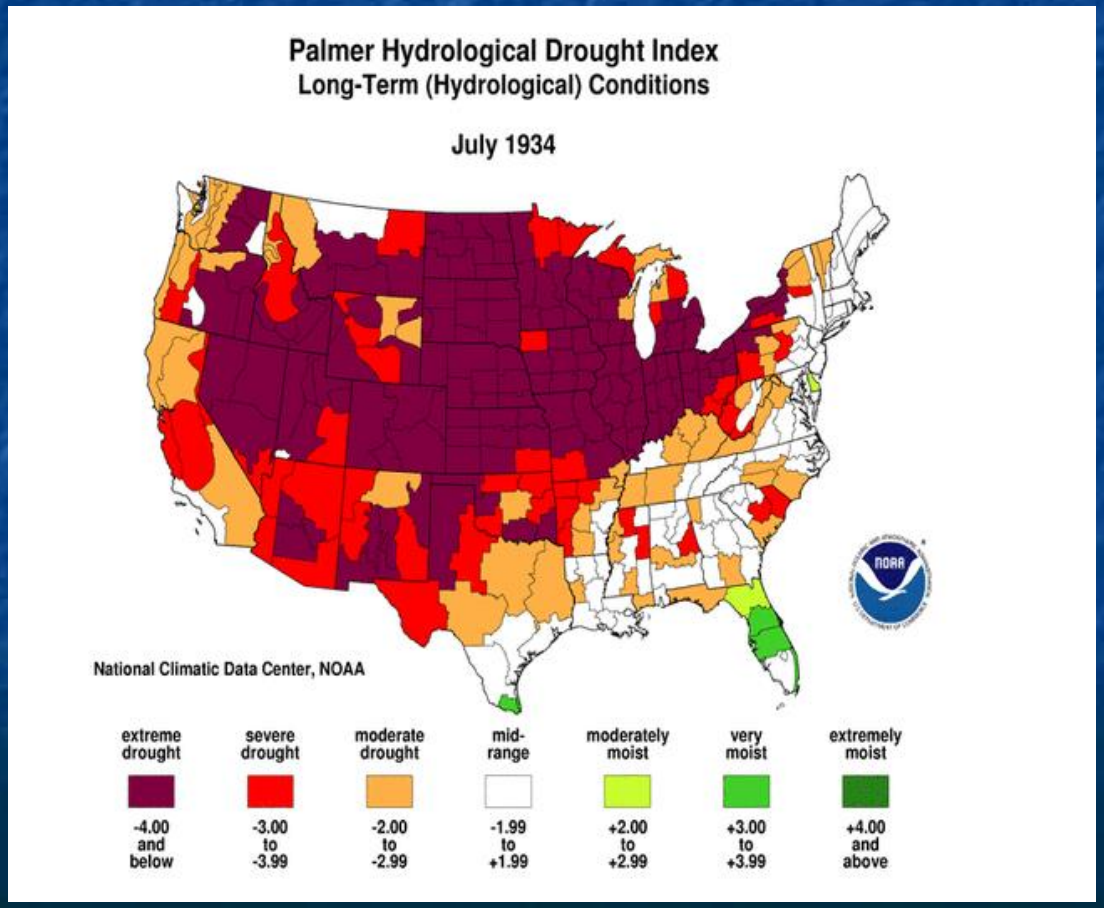
"Rain follows the plow"

1900-1920s

- Enlarged Homestead Act of 1909 (320 ac of marginal lands that could not be irrigated-encouraged dryland farming)
- World War I increase in agricultural prices
- Increase in immigration
- Increased mechanization of agriculture
- Unusually wet weather
- Led to major increases in land under cultivation in Great Plains

The 1930s

- Wet weather ends



1930-36: The Dust Bowl

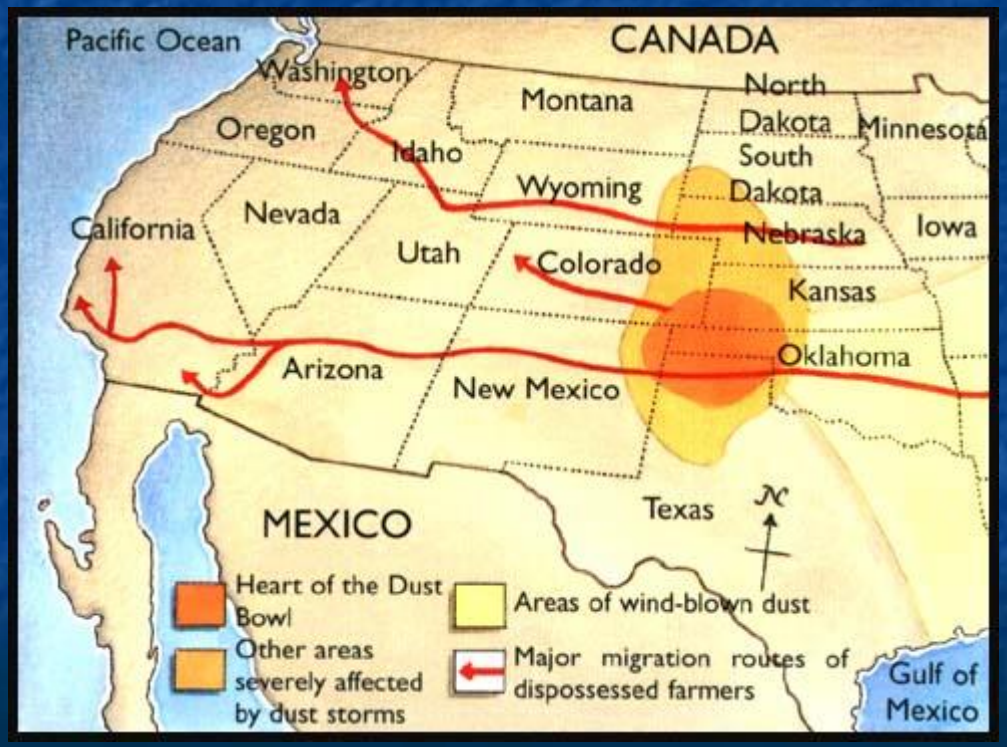
Dust clouds from the Great Plains reach Buffalo, Boston, NYC

Human Impact

- 500,000 Americans left homeless
- Some Kansas & Oklahoma residents died of dust pneumonia or malnutrition

Human Impact

- By 1940, 2.5 million people moved out of the plains states (200,000 moved to California)



Map courtesy: www.spartacus.schoolnet.co.uk

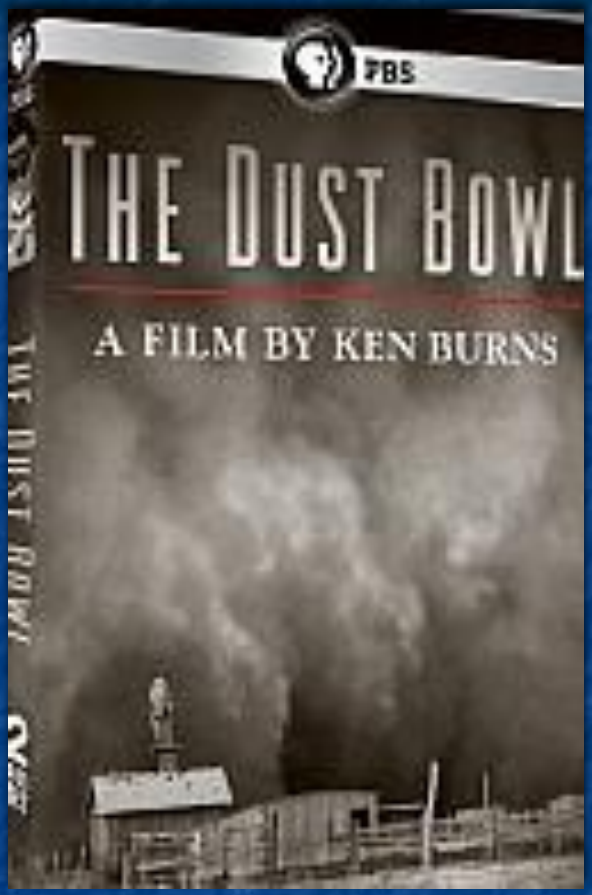
Responses

- August 1933: Soil Erosion Service
- 1935: Renamed Soil Conservation Service
- 1937: First Soil Conservation District in US

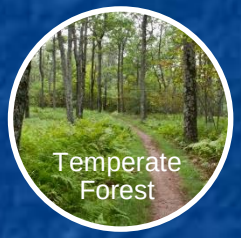
  Education of farmers on soil conservation and anti-erosion techniques

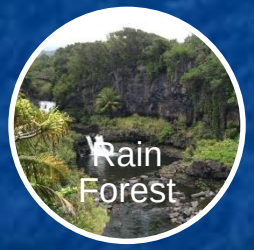
Lessons from the Dust Bowl

- Climate patterns fluctuate over time
- Soils can be severely damaged if treated improperly
- Agricultural practices need to be adapted to both climate and soils


PBS
THE DUST BOWL
A FILM BY KEN BURNS

Soils and U.S. Landscapes



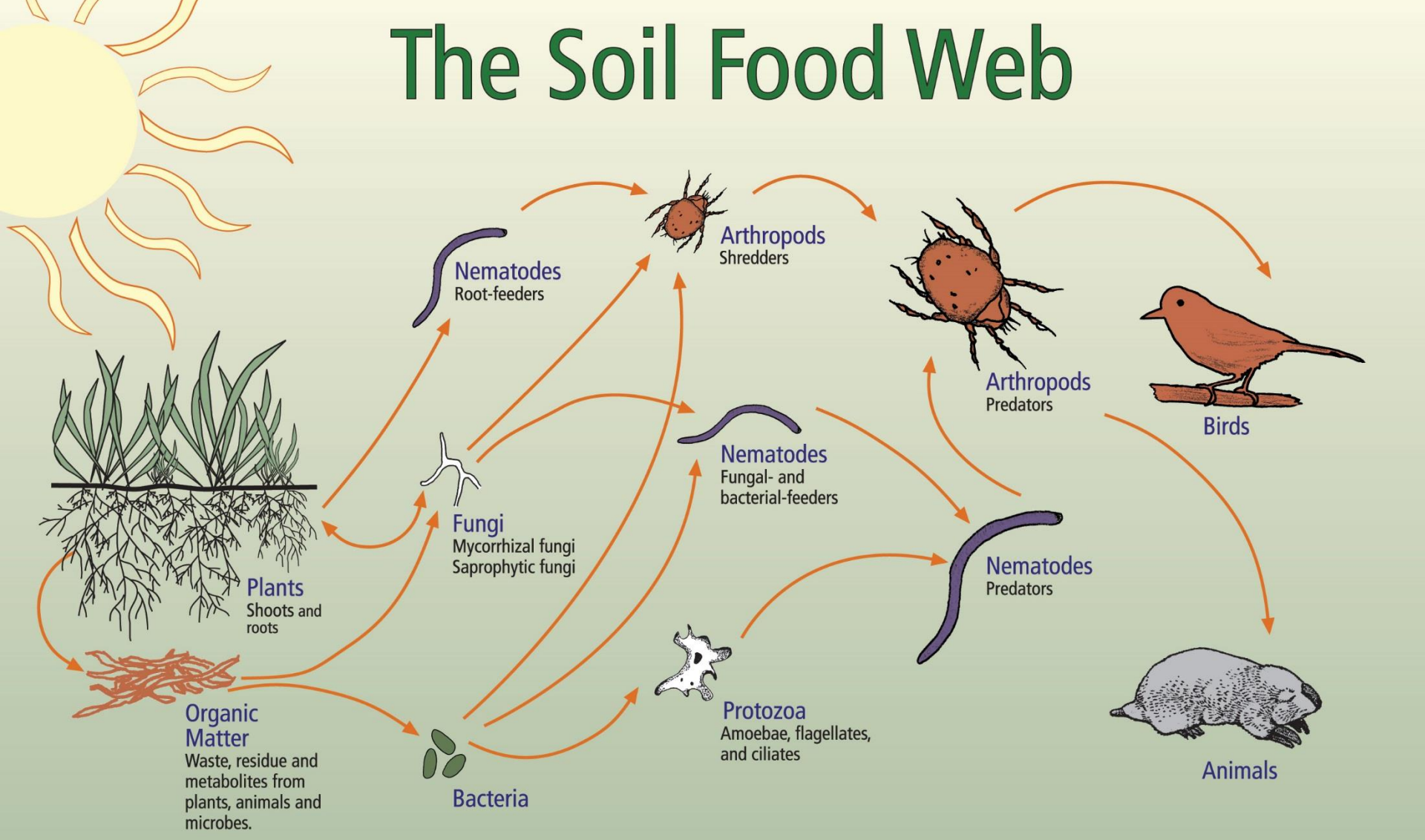


Ecosystem

"The interacting system of biologic community and its nonliving environment; a community together with its environment; an ecological system."

Soils are *part of* an ecosystem. At the same time, soils *are* an ecosystem.

The Soil Food Web



First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, Parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

Fourth trophic level:
Higher level predators

Fifth and higher trophic levels:
Higher level predators

Chenango gravelly loam
Portland, New York

Soil- *a natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthly parent material, as conditioned by relief over periods of time.*

(From the Chautauqua County Soil Survey Glossary)

Soil-A Limited Resource

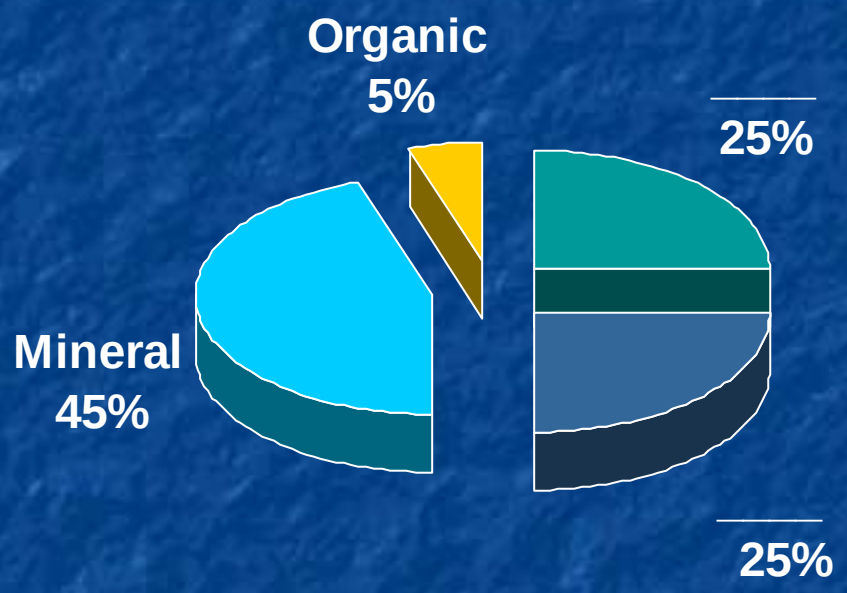
- 74% of the earth's surface is ocean
- Only 25% of the land area is arable soil

Soil Properties Vary

- Differences in soil properties result in differences in their capabilities & uses

Building on high shrink-swell clay

Soil Components



Soils are dynamic

Formation affected by:

- Parent material
- Climate
- Organisms
- Topography
- Time

Parent Material

Geologic

Biologic

Human Created

Parent Material-Geologic

- Alluvium: material deposited by-

Camp Creek
San Bernardino National Forest
California

Parent Material-Geologic

- Colluvium: material deposited at the base of steep slopes

Mt. San Antonio
Angeles National Forest
California

Parent Material-Geologic

- Eolian Deposits:

  moved by-

  _____

Parent Material-Geologic

- Glacial Till: unsorted, nonstratified material deposited by glacial _____

Parent Material-Geologic

- Glaciofluvial deposits: moved by glaciers, then sorted & deposited by melting ice.

  (*Examples-kames, eskers, deltas, outwash plains)*

ESKER

Other Geologic Parent Materials

- Deltaic and Beach Deposits
- Lacustrine and Marine Sediments
- Volcanic Deposits

Biologic Parent Materials

- Muck soils: primarily organic matter (decayed and decaying _____ and _____)

Human Created Parent Materials

- Brownfields, fill, excavated areas, or landfills

Chautauqua County Landfill
Town of Ellery, New York

Soil Formation: Climate

- Which region has a faster rate of soil development?
- *(Rainfall quantities and temperature affect rate of soil development)*

Amazon Basin

Gobi Desert

Soil Formation: Organisms

- accumulate and cycle organic matter, make soils more porous
- *Macro*organisms: plant roots, burrowing animals

- *Micro*organisms: fungi, bacteria, nematodes, etc.

Soil Formation: Topography

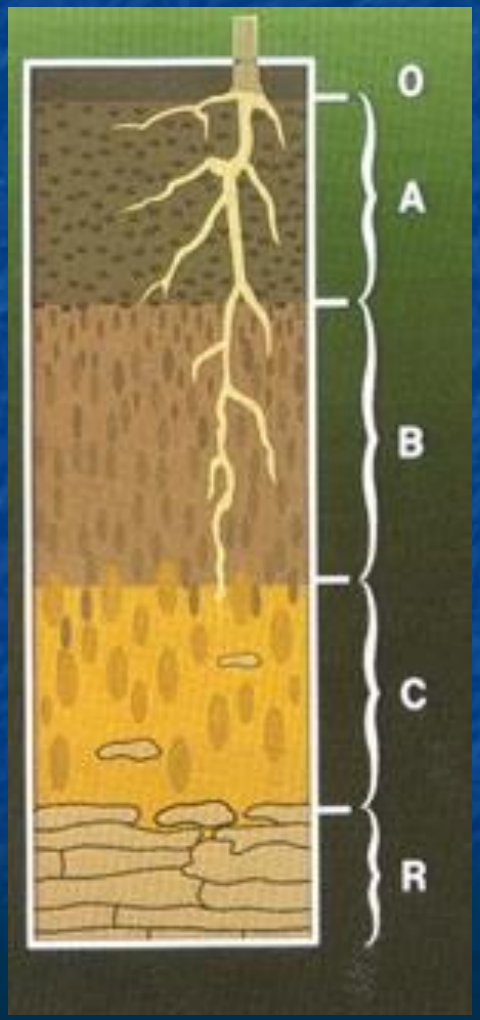
- Water movement-erosion/deposition
- Aspect-temperature

Soil Formation: Time

- Similar to a chemical reaction: *longer reaction time, greater change*
- 1-3cm soil takes 100 years to form in some situations

Mosses, Lichens, Organic Matter
Allegheny National Forest, Pennsylvania

Soil Profile:



- Horizons=horizontal layers
- “O”=organic
- “A”=mixture of organic & mineral soil
- “B”=accumulation of organic matter & sesquioxides (i.e. alumina)
- “C”=unconsolidated, unweathered material
- “R”=rock (not always present in the soil profile, i.e. flood plains)

Soil Characteristics

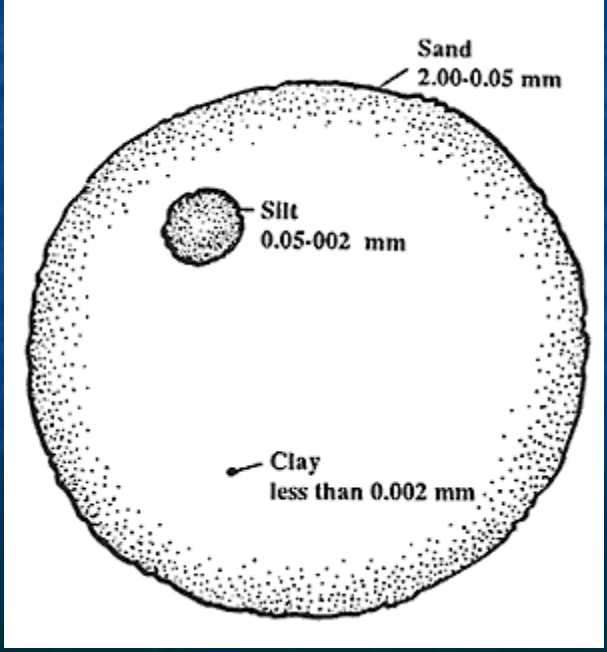
(Properties that describe the soil)

- Color
- Thickness or Depths
- Redox features
- Bedrock

- Texture
- Structure
- Consistence
- Permeability

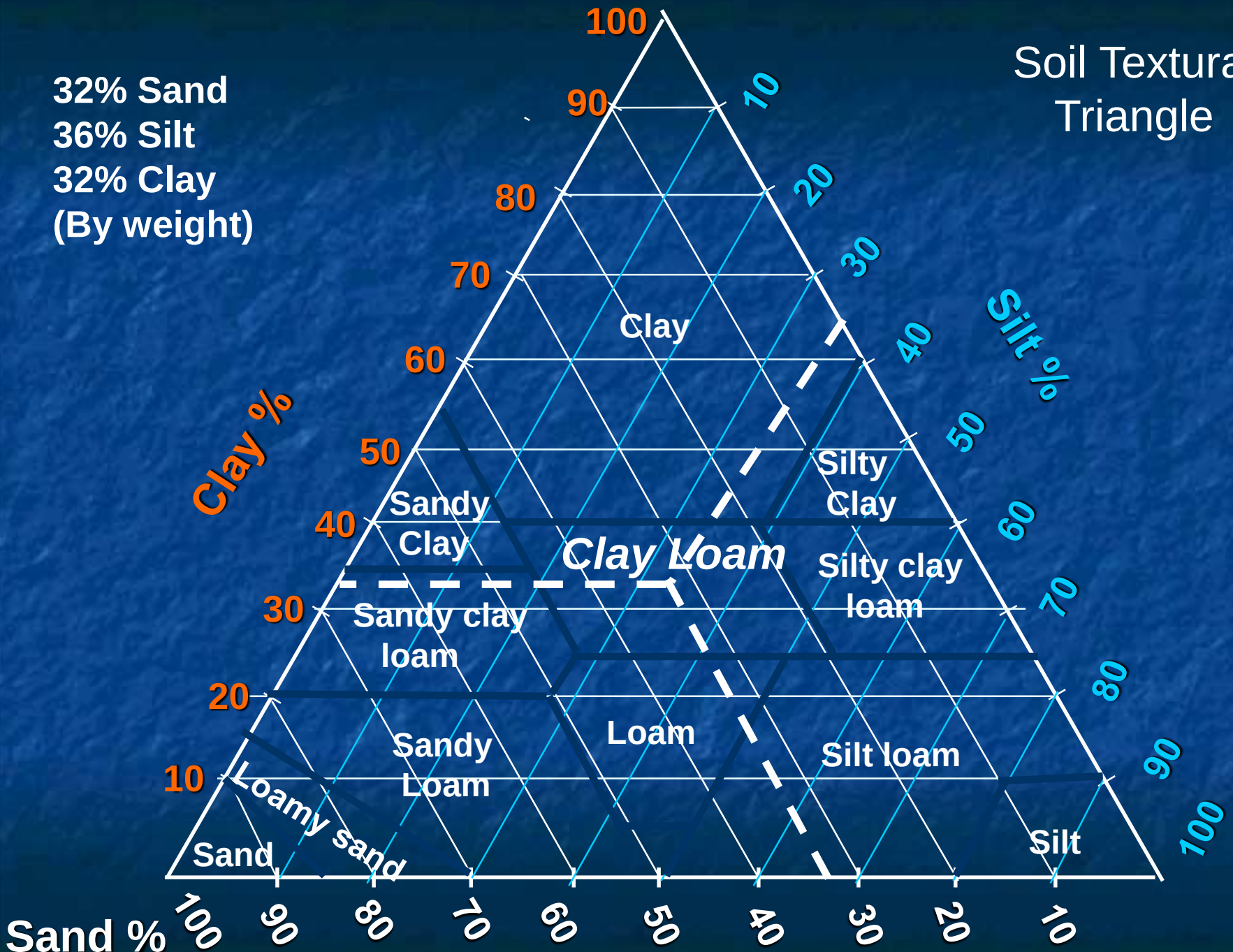
Soil Characteristics: Texture

- *Texture*-relative proportion of sand, silt, and clay (by weight)
- Sand: 2-0.05mm
- Silt: 0.05-0.002mm
- Clay: <0.002mm

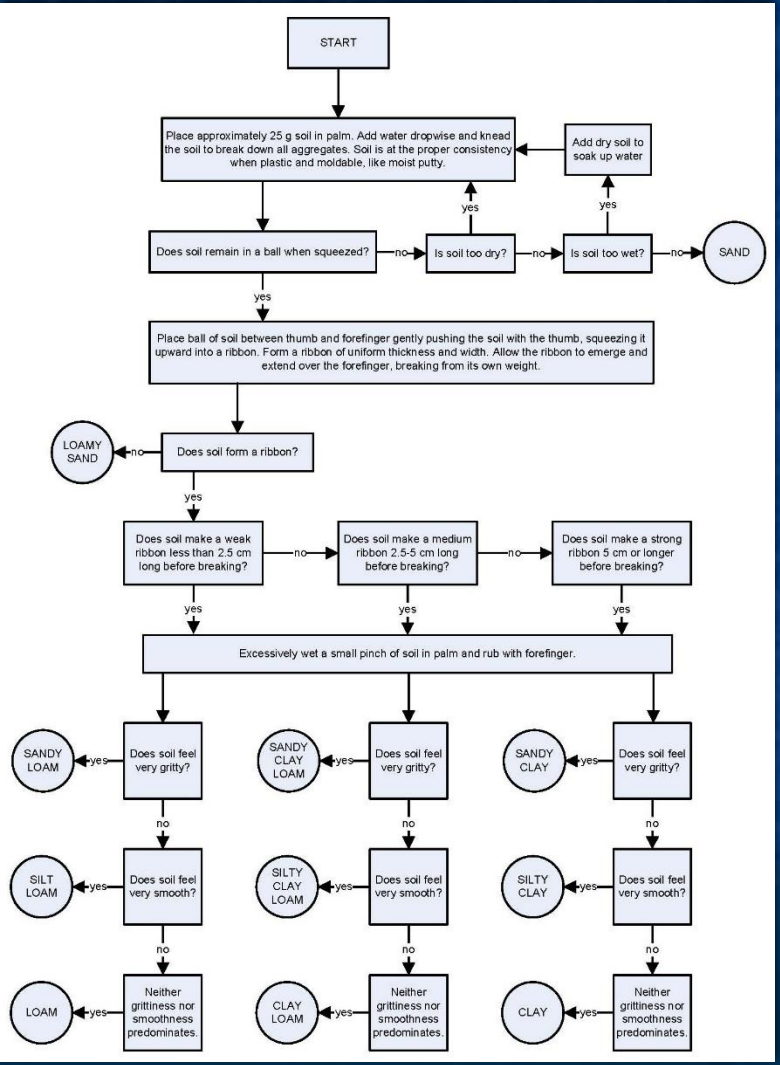


Soil Textural Triangle

32% Sand
36% Silt
32% Clay
(By weight)

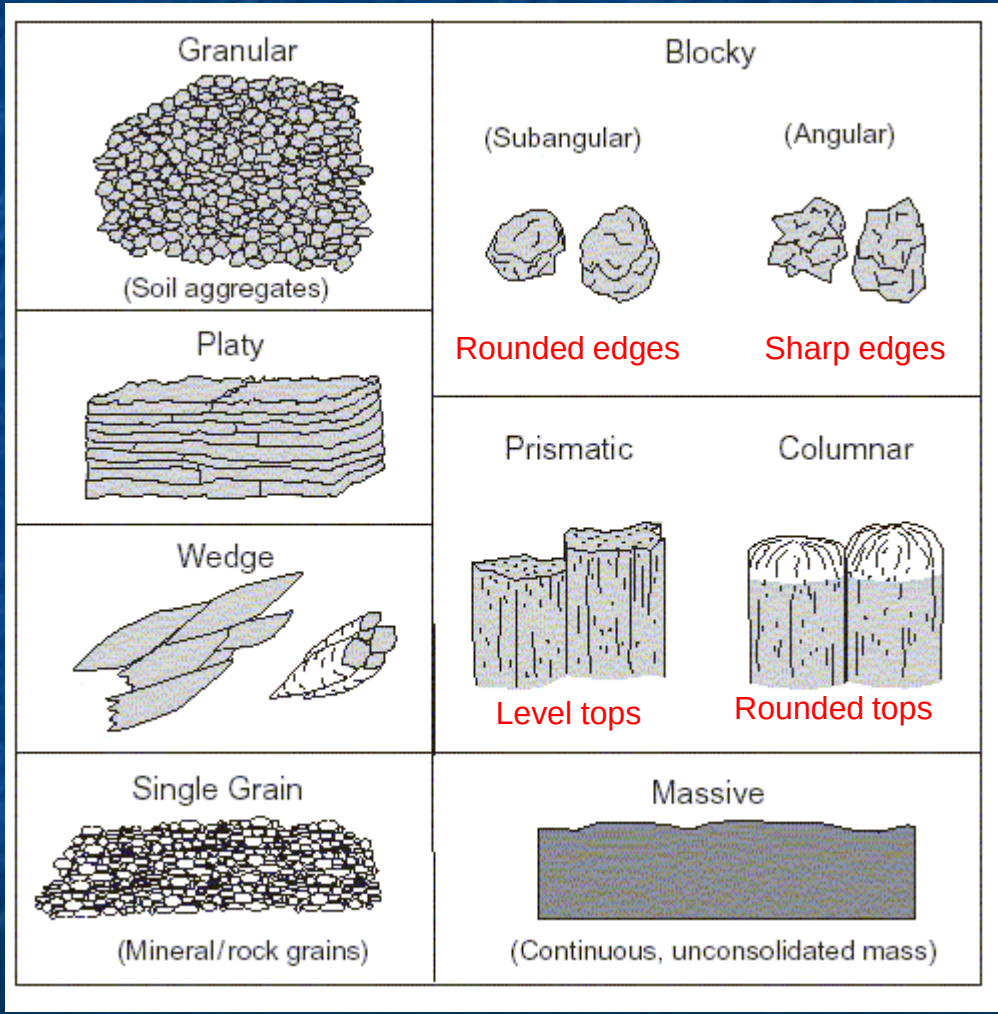


Guide to Texture by Feel



https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=nrcs142p2_054311

Soil Characteristics: Structure



Courtesy: http://nesoil.com/

Soil Characteristics: Consistence

"The feel of the soil and the ease with which a lump can be crushed by the fingers"

- Sticky
- Hard
- Soft
- Cemented

- Loose
- Friable
- Firm
- Plastic

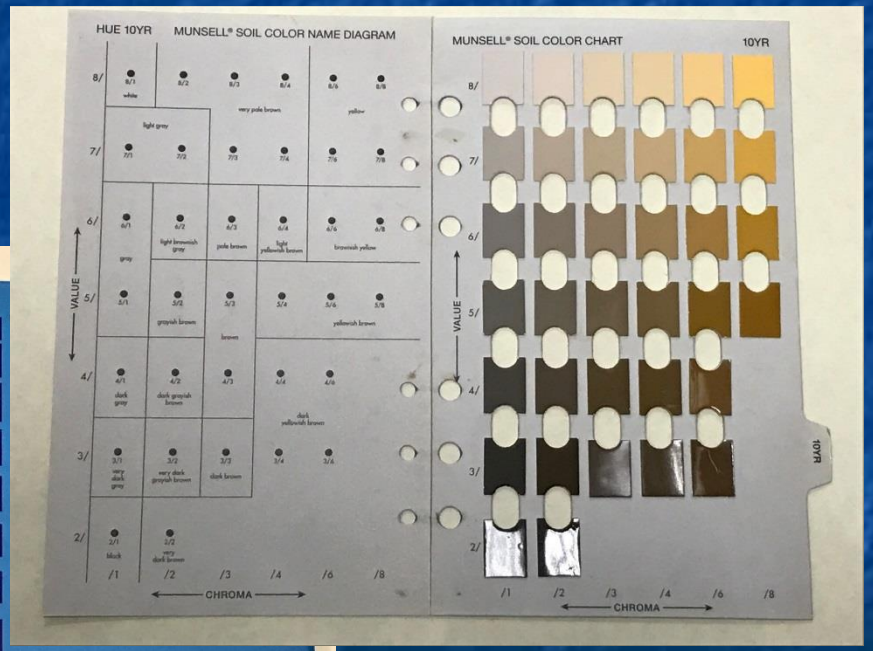
Soil Characteristics: Permeability

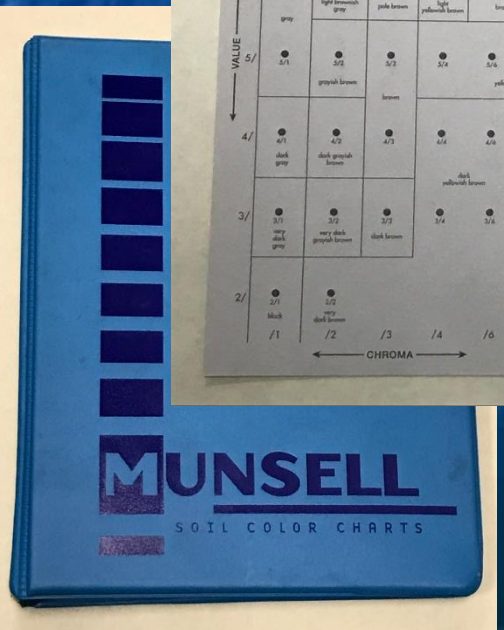
"The ease with which fluids or gasses can flow through the soil profile"

(Inches per hour of water movement downward through saturated soil)

Soil Characteristics: Color

- *Munsell* soil color charts used as a standard worldwide





Soil Characteristics: Color

- *Hue:* dominant spectral color
- *Value:* darkness/lightness
- *Chroma:* relative purity of strength of color

10YR 3/2 = Hue 10YR; Value 3; Chroma 2

Soil Characteristics: Redoximorphic Features

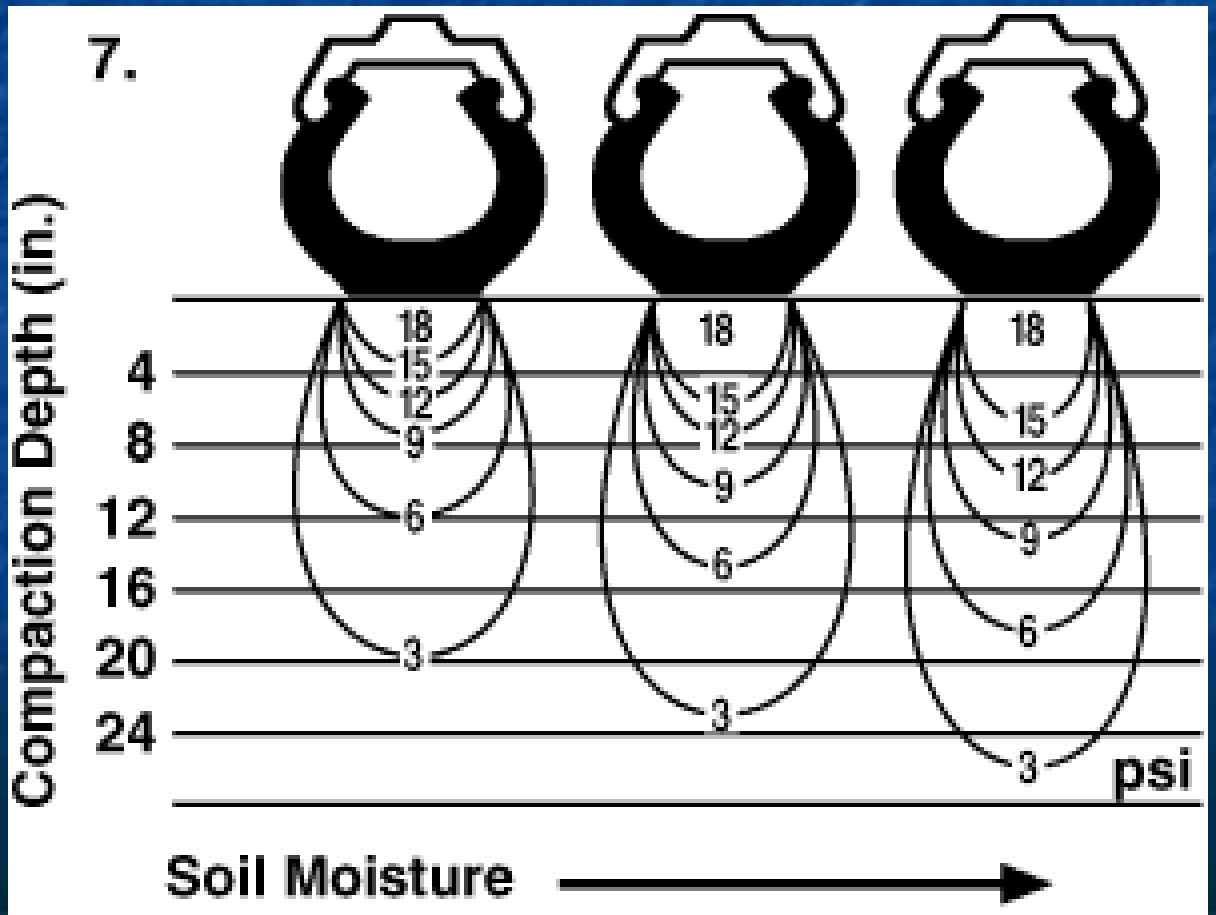
- Mottled soil colors caused by a fluctuating water table

Bulk Density

- Weight of a given volume of dry, undisturbed soil
- Measured in g/cc

Compaction

- The reduction of pore space, increasing the bulk density



Compaction

- Effects:
  - ✓ root growth & development
  - ✓ water & air movement

5 row cotton picker weighs

37,100 lbs empty (18 ½ tons)

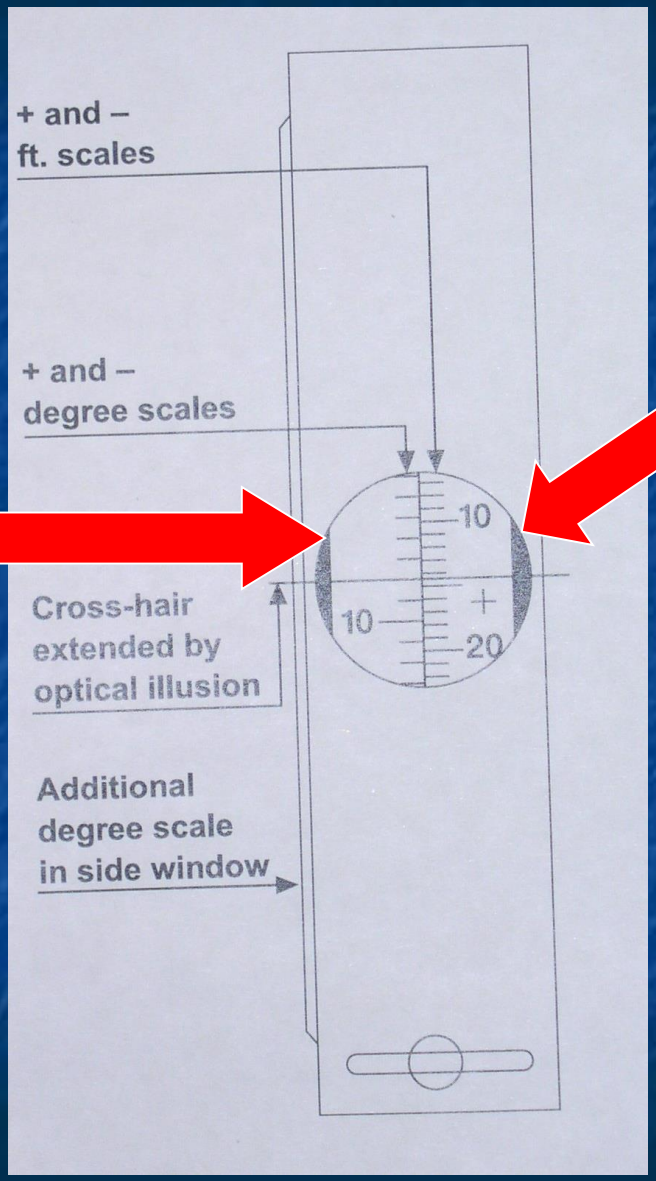
Infiltration

- The process of water entering the soil from the surface
- *(Good infiltration reduces erosion, runoff, and ponding)*

Slope

- The gradient of the soil surface, expressed as a percentage
- A commonly used measuring device for slope is a *clinometer*

Clinometer



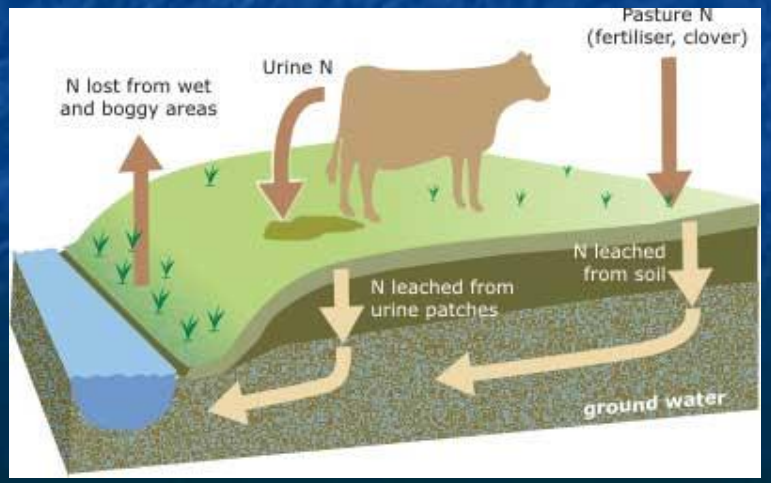
degree scale

% slope scale

(Soil map units expressed in % slope)

Plant Nutrients

- Soils *store and cycle* plant nutrients such as *N, P, K, C, S*, and others
- *Cation exchange capacity* (CEC) is a measure of the quantity of nutrients that a soil can hold
- *> soil organic matter leads to > CEC*

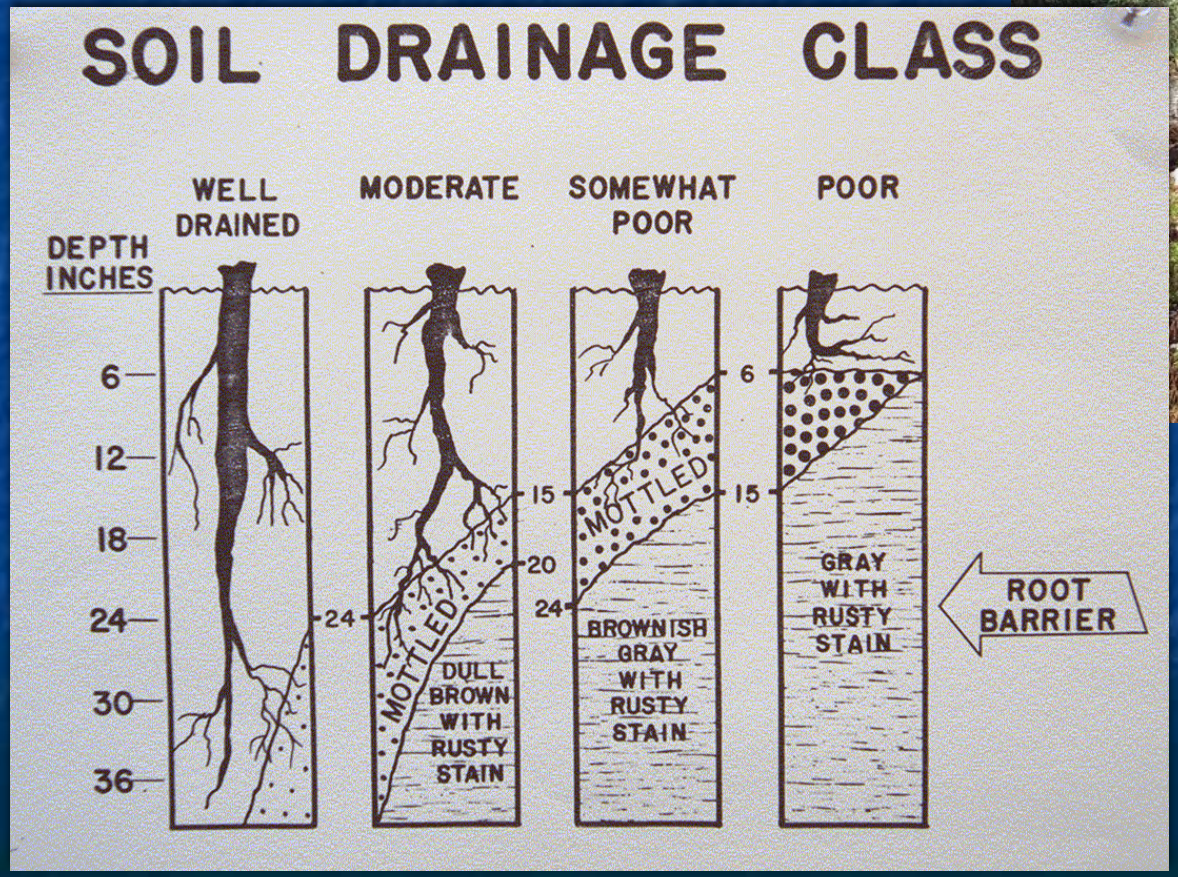


Nitrogen cycle

Plant Nutrients:
The effect of pH

- *pH* = a measure of acidity or alkalinity of a soil
- Optimum pH for plant growth = 6.0 to 7.5
- Plant nutrients may become unavailable outside of this range

Soil Drainage Classes



Windthrow
Allegheny National Forest
Pennsylvania

Hydric Soils

- “a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part”

Wetlands

- Wetlands generally have 3 components:
  1. *hydric* soils
  2. *hydrophytic* vegetation
  3. *saturated hydrology* during a portion of the growing season

Wetlands Easement
Town of Stockton, NY

Soil Water-Terms

FIELD MOISTURE CAPACITY: moisture content of soil after the free water has drained away.

WILTING POINT: moisture content of soil at which a plant wilts so much that it does not recover.

Soil Water-Terms

AVAILABLE WATER CAPACITY:

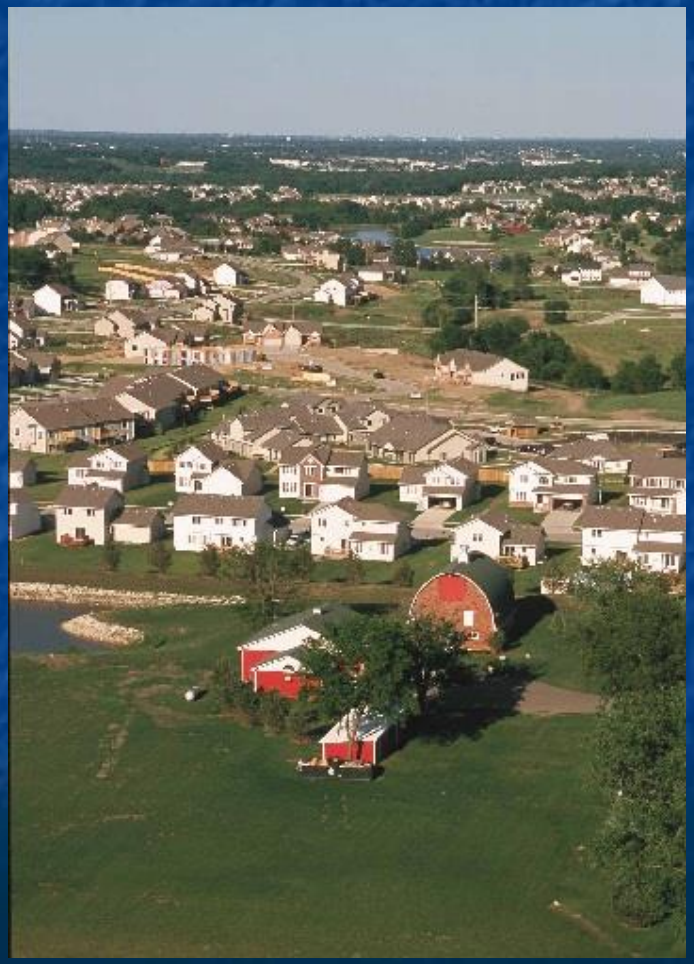
capacity of soils to hold water available for use by most plants. (inches of water per inch of soil)

Available Water Capacity =

Field Moisture Capacity – Wilting Point

Land Use Affects Soil Productivity

Agricultural practices



Development

Non-Point Source Pollution:

(soils may act as a treatment system)

Organic & Inorganic materials

soil

Filters

Detoxifies

Buffers

Immobilizes

Degrades

watertable

Example:_____?

Non-Point Source Pollution

- soils may become contaminated beyond their ability to treat pollutants

Non-Point Source Pollution

Soils may *become* the pollutant

Term:_____?

Soil Erosion

Wind

Water

Soil Erosion:
the Universal Soil Loss Equation

A = R x K x LS x C x P

where A = *average annual soil loss* from sheet & rill erosion in *tons per acre per year* (by *water*)

- Later Models: RUSLE2 and Water Erosion Prediction Project (WEPP)
- similar equation exists for *wind* erosion

Universal Soil Loss Equation

- R = Rainfall factor

  higher rainfall amounts or intensity results in higher R factor

Universal Soil Loss Equation

- K = soil erodibility factor
  determined by soil texture,
  and other properties

Universal Soil Loss Equation

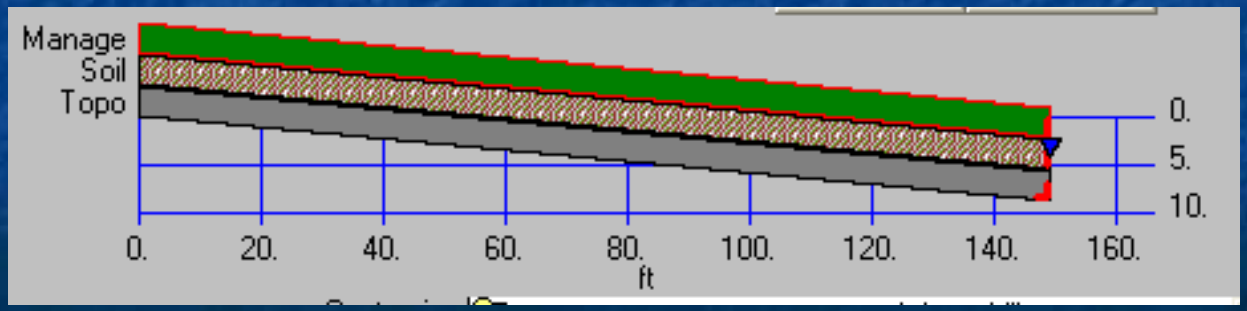
- L = slope length (feet)

  starts where overland flow begins

  ends where deposition begins

- S = slope gradient (percent)

  average slope over the slope length



Universal Soil Loss Equation

- C = cover & management factor

  crop canopy and residue protection

"Soil is meant to be covered!"

Universal Soil Loss Equation

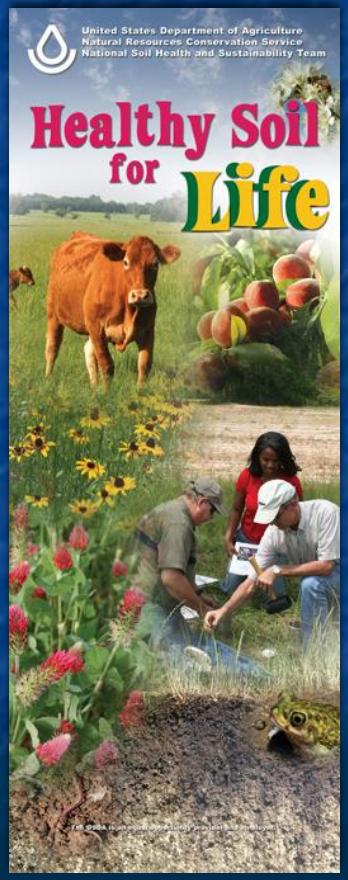
- P = support practice factor

  up & down hill tillage vs. contour tillage *(what is wrong with this picture?)*

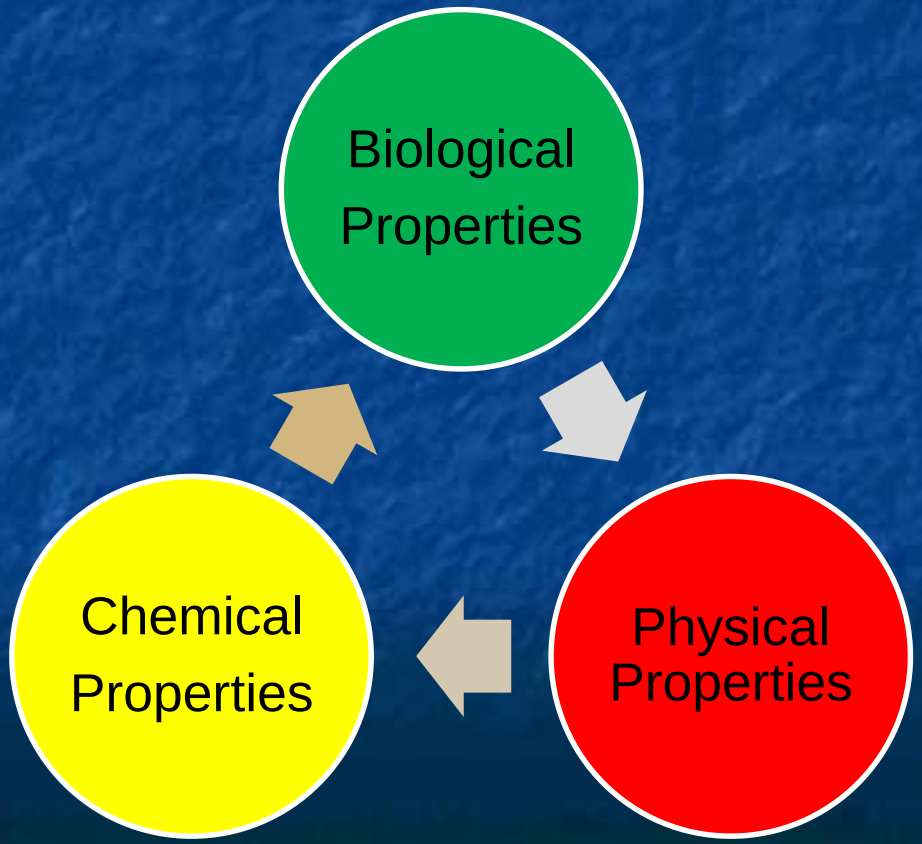
Soil Health

Soil health = soil quality

- *how well soil does what we want it to do:*
  - *sustain plant and animal productivity*
  - *maintain or enhance water and air quality*
  - *support human health and habitation*



Soil Health


Biological Properties
Physical Properties
Chemical Properties

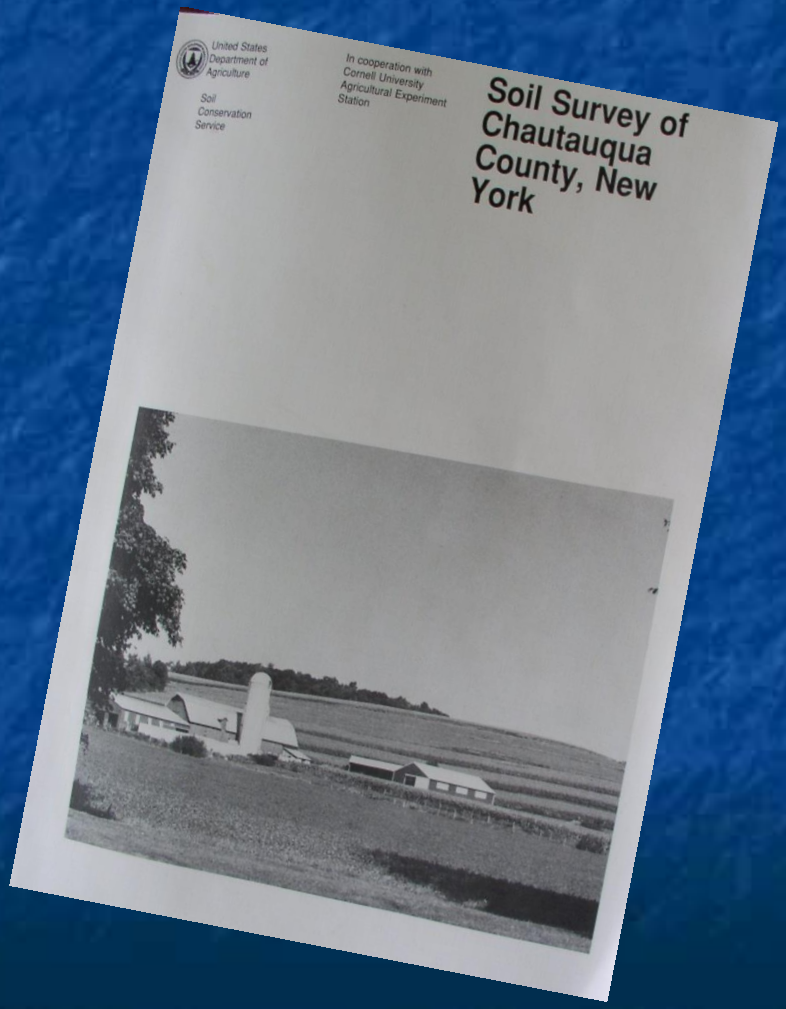
Soil Classification

Order	Suborder	Great Group	Subgroup	Family	Series
Inceptisol	Aquept	Haplaquepts	Aeric	Coarse-loamy, mixed, nonacid, mesic	Busti
soils that exhibit minimal horizon development	Aqu=water, ept=Incepti-sols	Hapl=minimal horizonation	Aeric=better drained than the typical subgroup	Physical and chemical properties and other characteristics that affect management	Soils with similar horizons in their profile

Reference County Soil Survey pages 171 and 331.

Soil Survey

Published survey:
- Mapping & interpretations
- Glossary of terms


United States Department of Agriculture

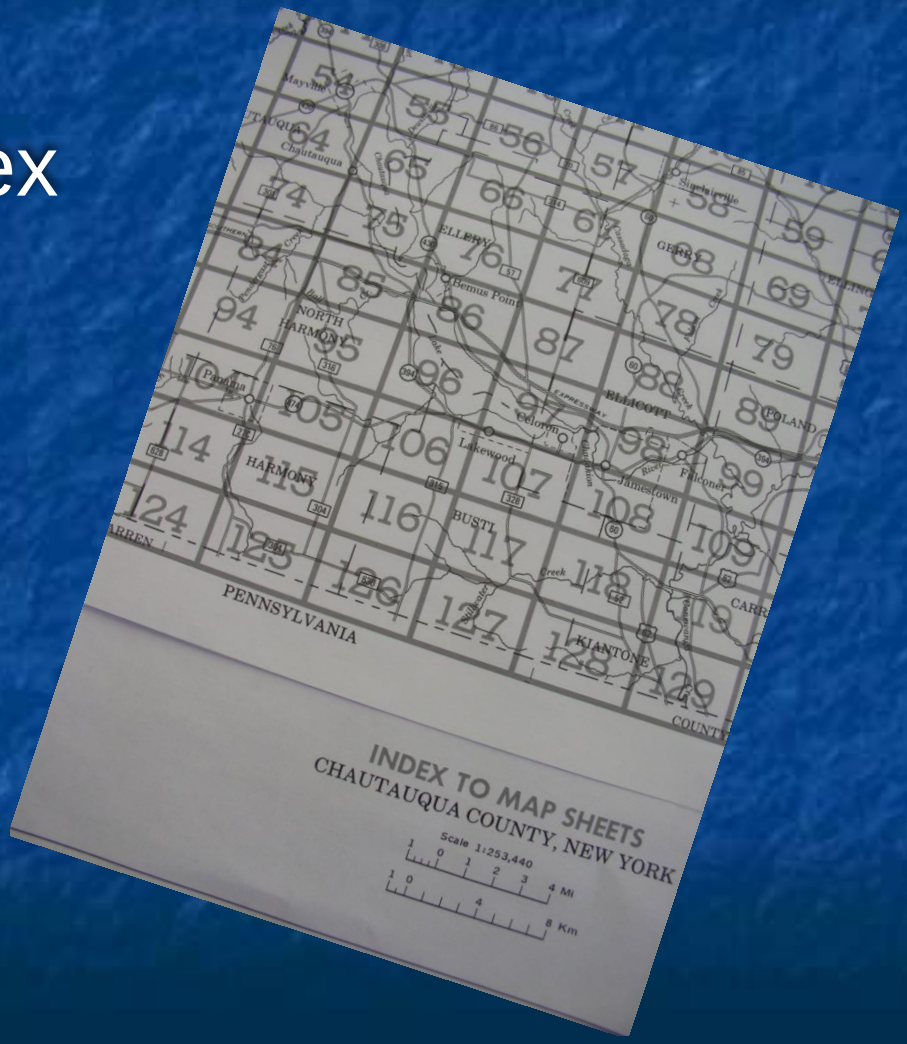
Soil Conservation Service

In cooperation with Cornell University Agricultural Experiment Station

Soil Survey of Chautauqua County, New York

Soil Survey

- Map Index



Soil Survey

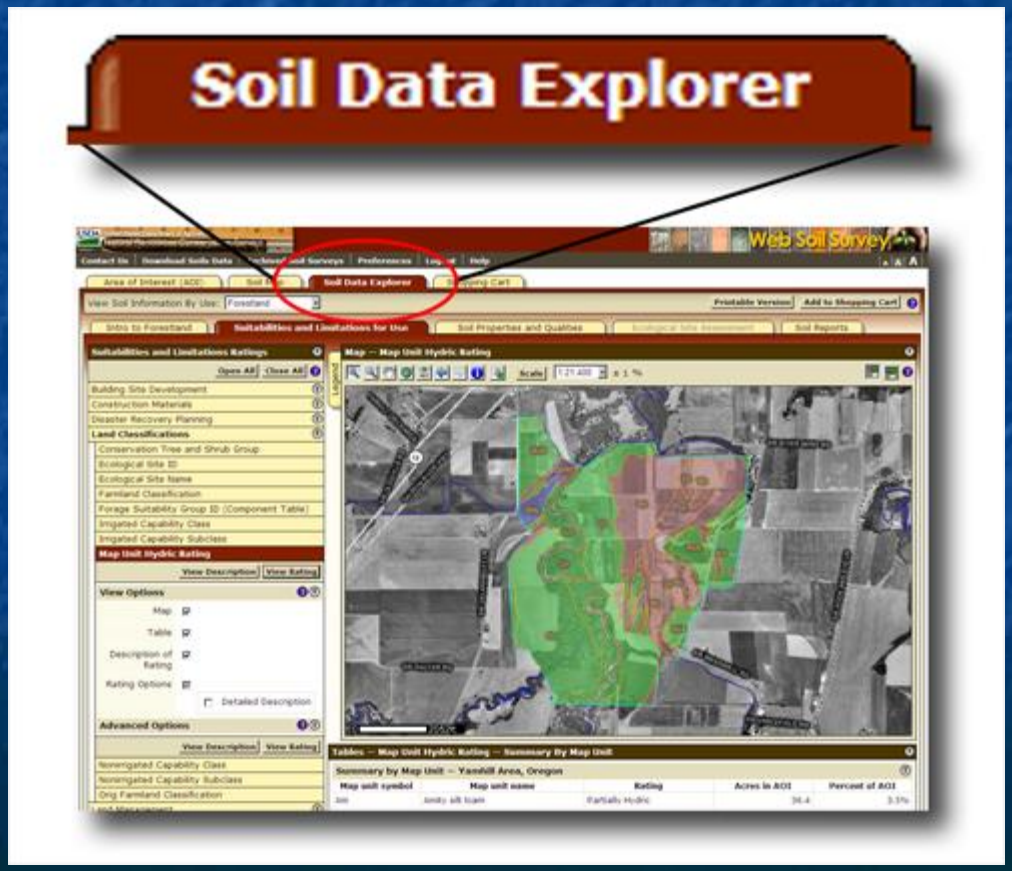
CkC:
Chautauqua silt loam
8-15% slopes

There are 131 different map units in the Chautauqua County Soil Survey!

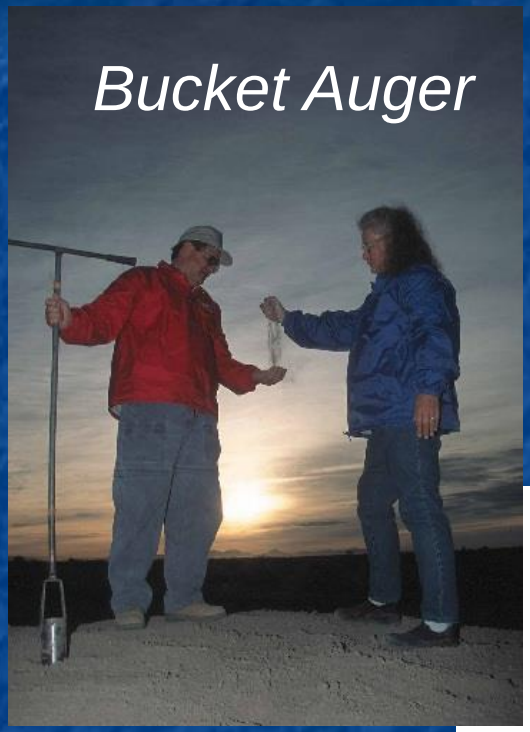
Soil Survey

- Also available online at:

  http://websoilsurvey.nrcs.usda.gov/app/



Soil Sampling Tools

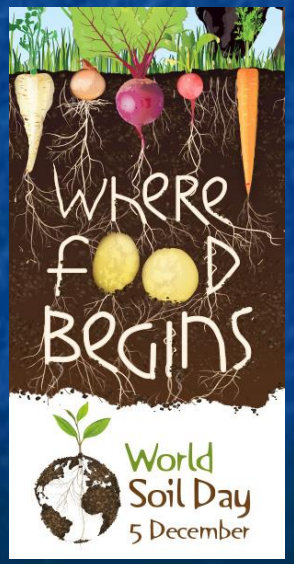


Resources:

- http://www.nrcs.usda.gov/
- http://websoilsurvey.nrcs.usda.gov/app/

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

CHAUTAUQUA COUNTY
SOIL & WATER
CONSERVATION DISTRICT



World Soil Day-2015
UN-FAO

"We know more about the movement
of celestial bodies than about the soil underfoot.“
- Leonardo Da Vinci, circa 1500's