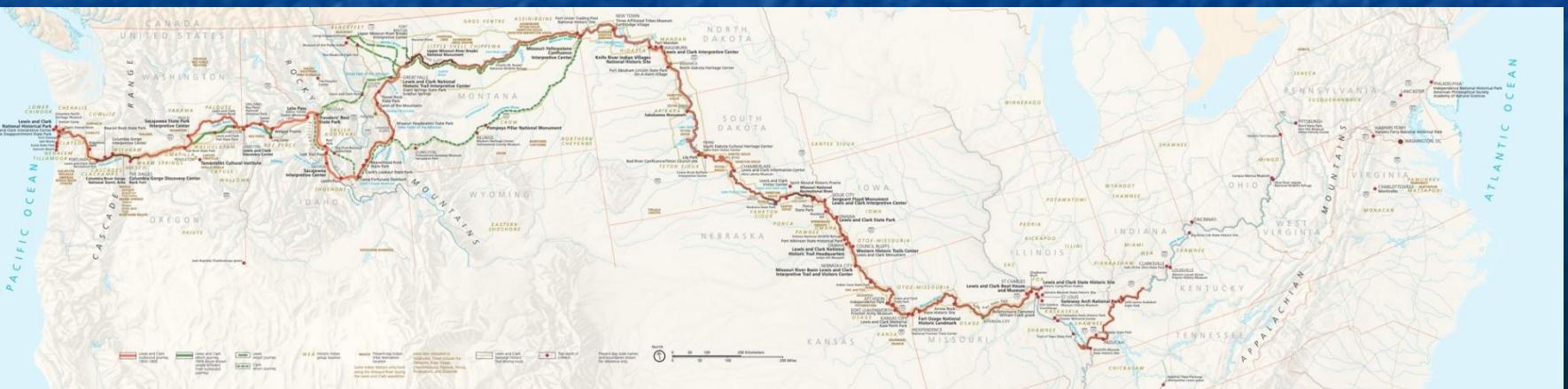






# Lewis & Clark Expedition

## 1803-1806



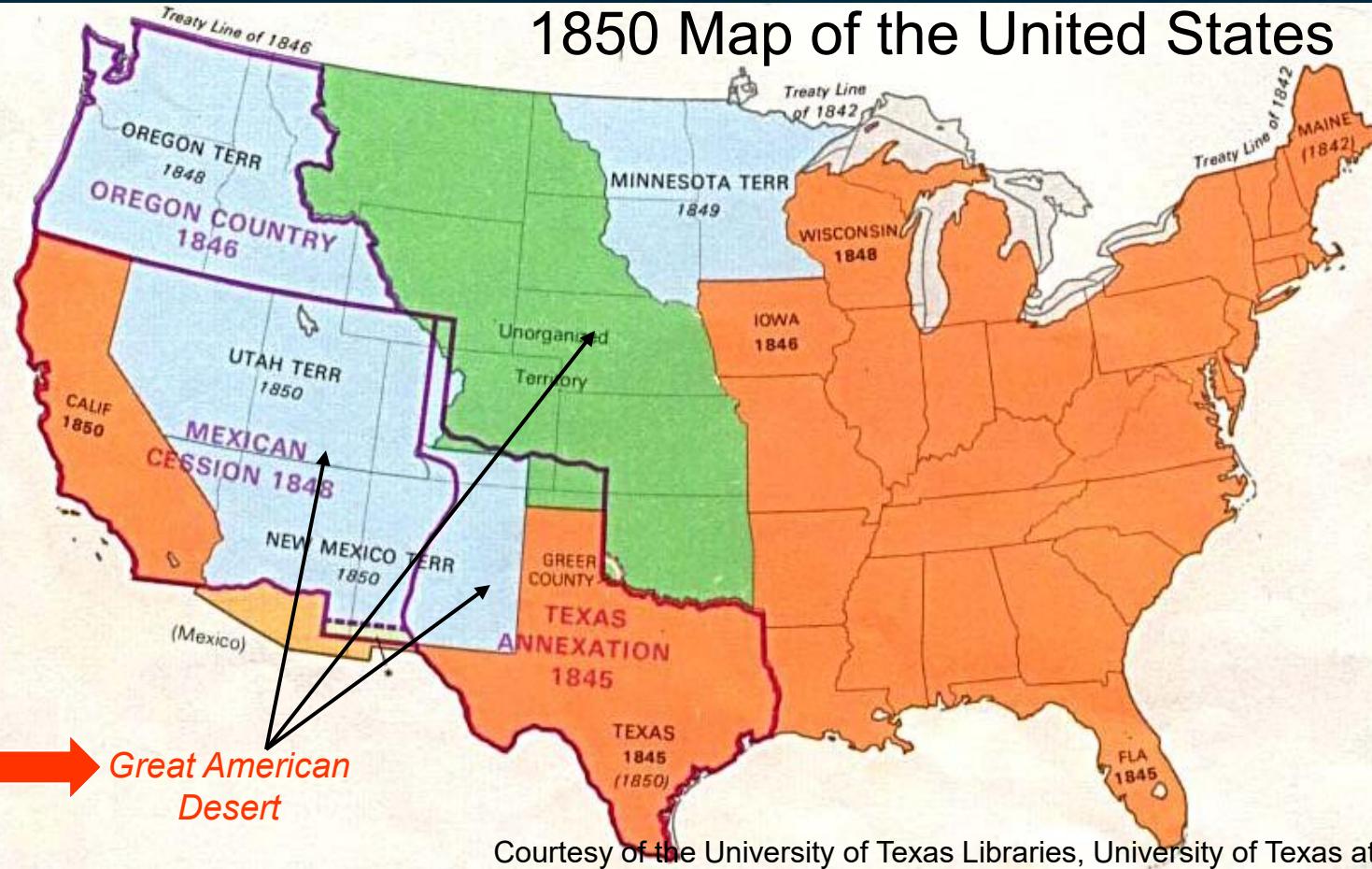


Painting by Carl Rungius

*Prior to the mid-1800's,  
the Great Plains bison  
herd may have contained  
30-60 million head.*



# 1850 Map of the United States



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

"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*



## Homestead Act of 1862

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”

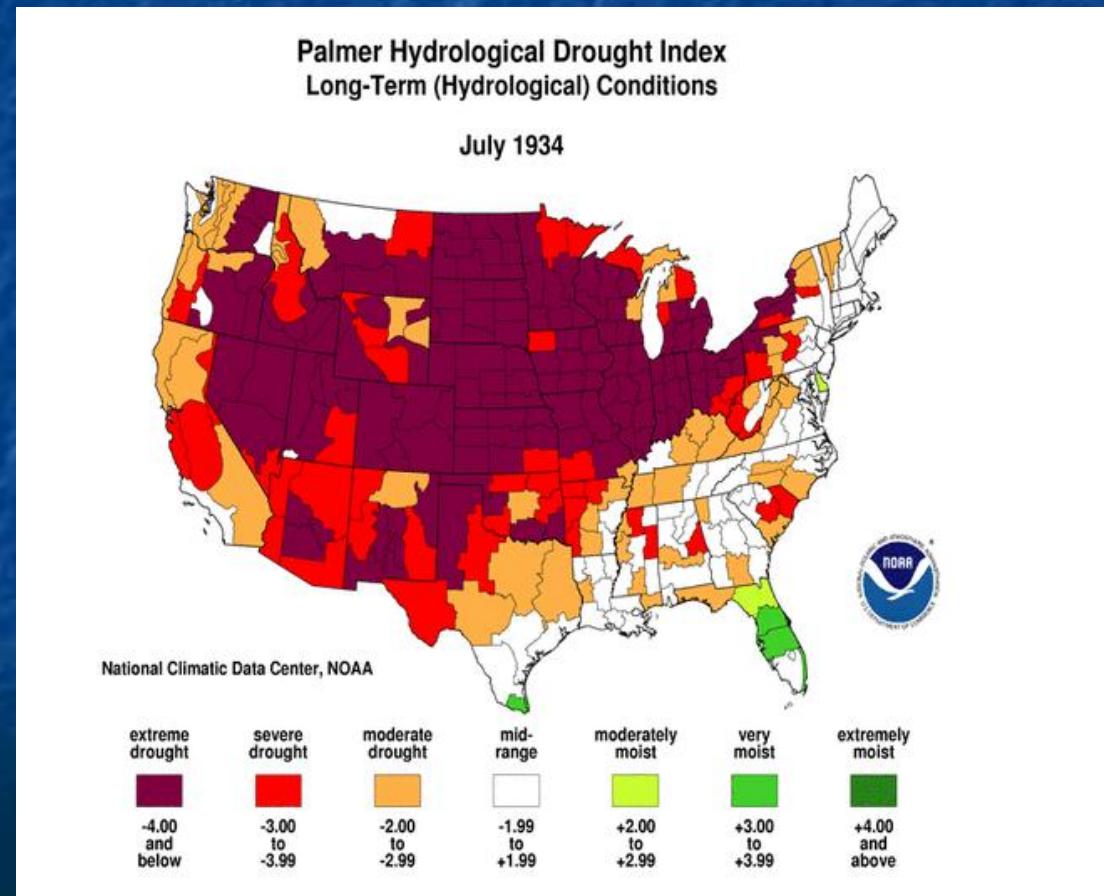
# 1900-1920s

- 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



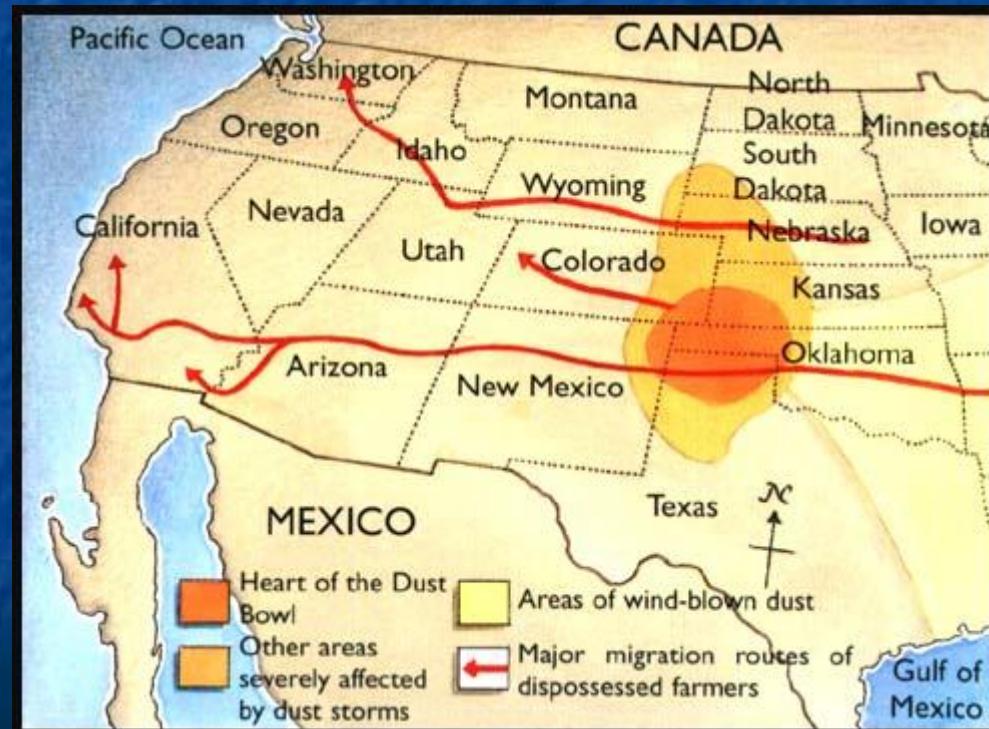
# Human Impact

- 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](http://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



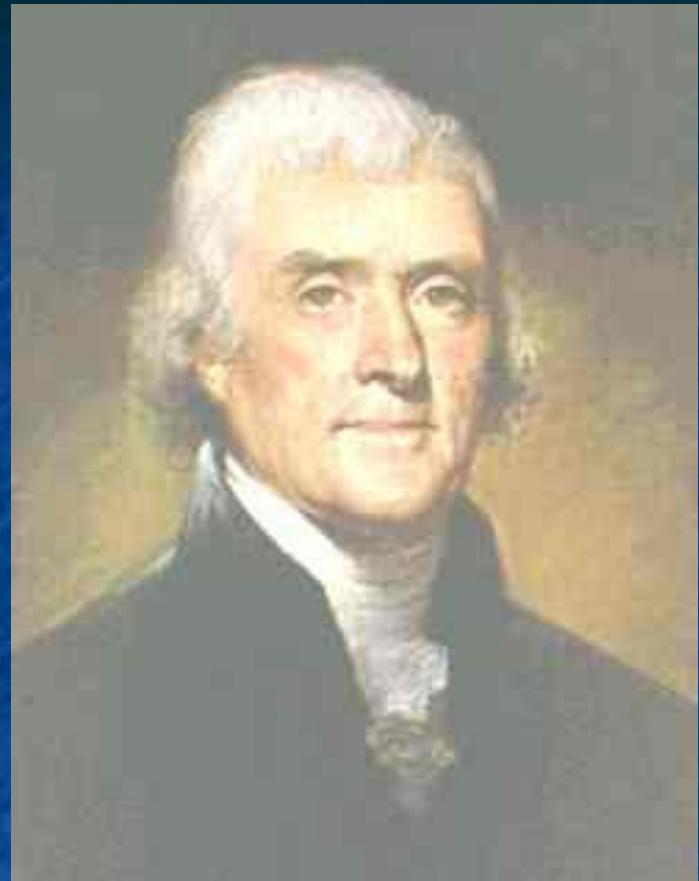
# Lessons from the Dust Bowl



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



Gardens at Monticello



"While the farmer holds the title to the land, actually it belongs to all the people because civilization itself rests upon the soil." - Thomas Jefferson (1743-1826)

# Soils and U.S. Landscapes

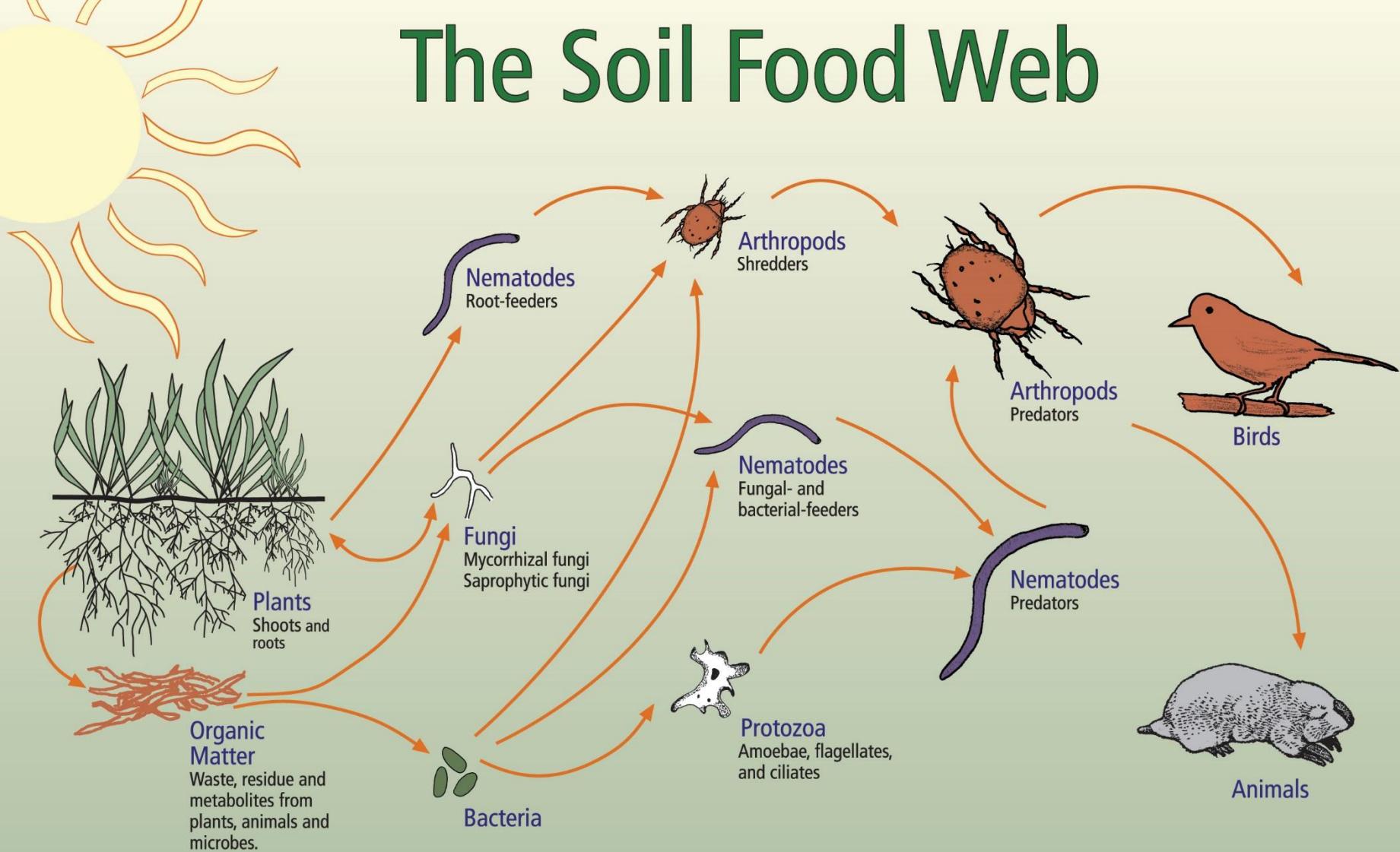


# Ecosystem

“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  
Parasites  
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



- ❖ 71% of the earth's surface is ocean
- ❖ Only 25% of the land area is arable soil

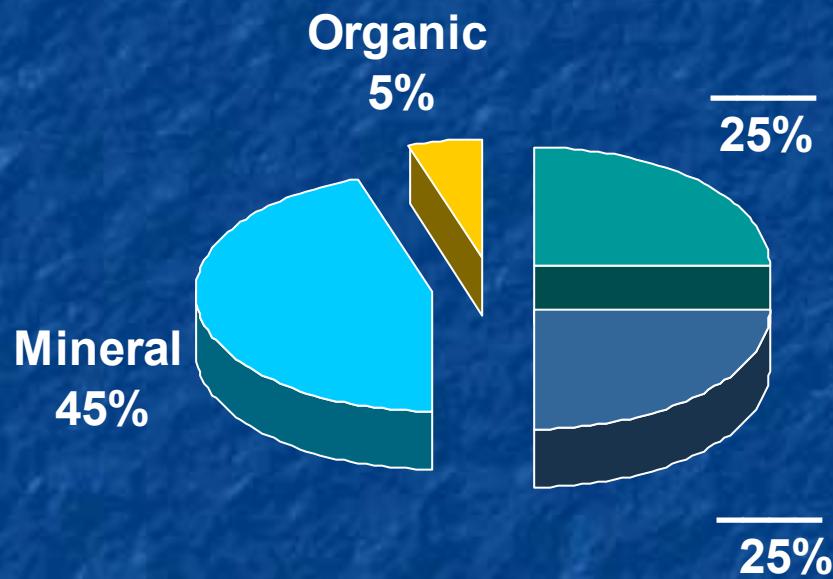
# Soil Properties Vary

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



*Building on high  
shrink-swell clay*

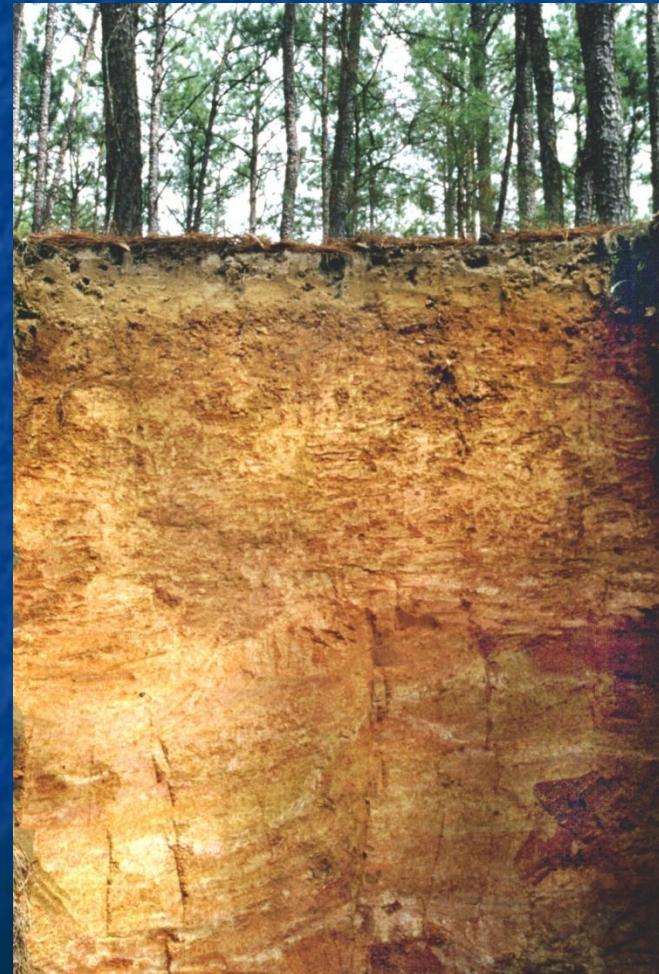
# Soil Components



# 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-

---

Mt. Rainier National Park  
Washington



# 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 \_\_\_\_\_



Image courtesy National Park Service

# 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



Oak Harbor, WA

- Lacustrine and Marine Sediments
- Volcanic Deposits



Mt. Saint Helens, WA

# 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

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

*Amazon Basin*



*Gobi Desert*



# Soil Formation: Organisms

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



- Microorganisms: fungi, bacteria, nematodes, etc.



# Soil Formation: Topography

- Water movement-erosion/deposition
- Aspect-temperature



Pilot Mountain, NC

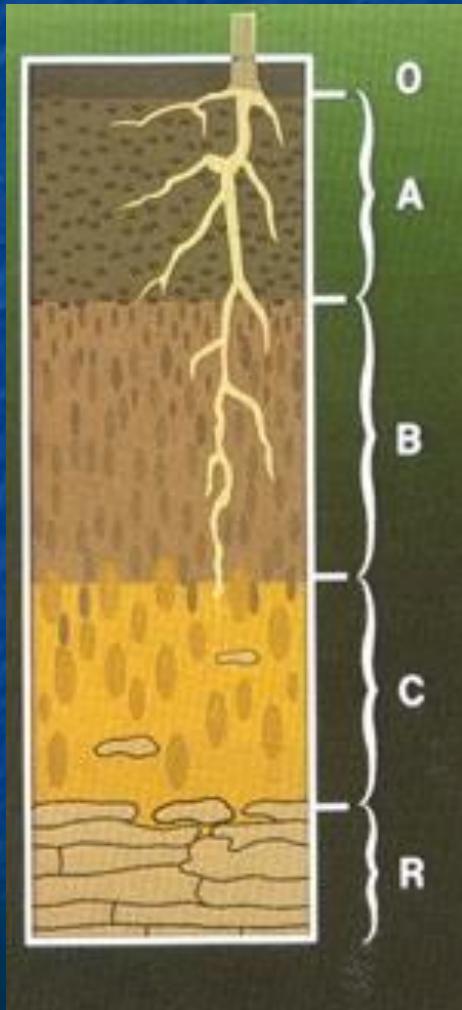
# Soil Formation: Time

- As in many chemical reactions, a *longer reaction time results in greater change*
- 1-3cm soil takes 100 years to form depending on climate and other factors



Canyonlands National Park, Utah

# 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

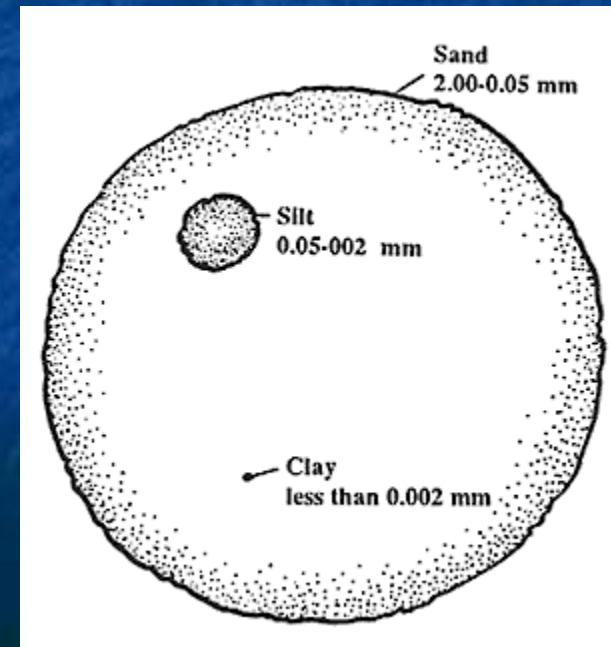
*(Properties that describe the soil)*

- Texture
- Structure
- Consistence
- Permeability
- Color
- Thickness or Depths
- Redox features
- Bedrock



# 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



Example:

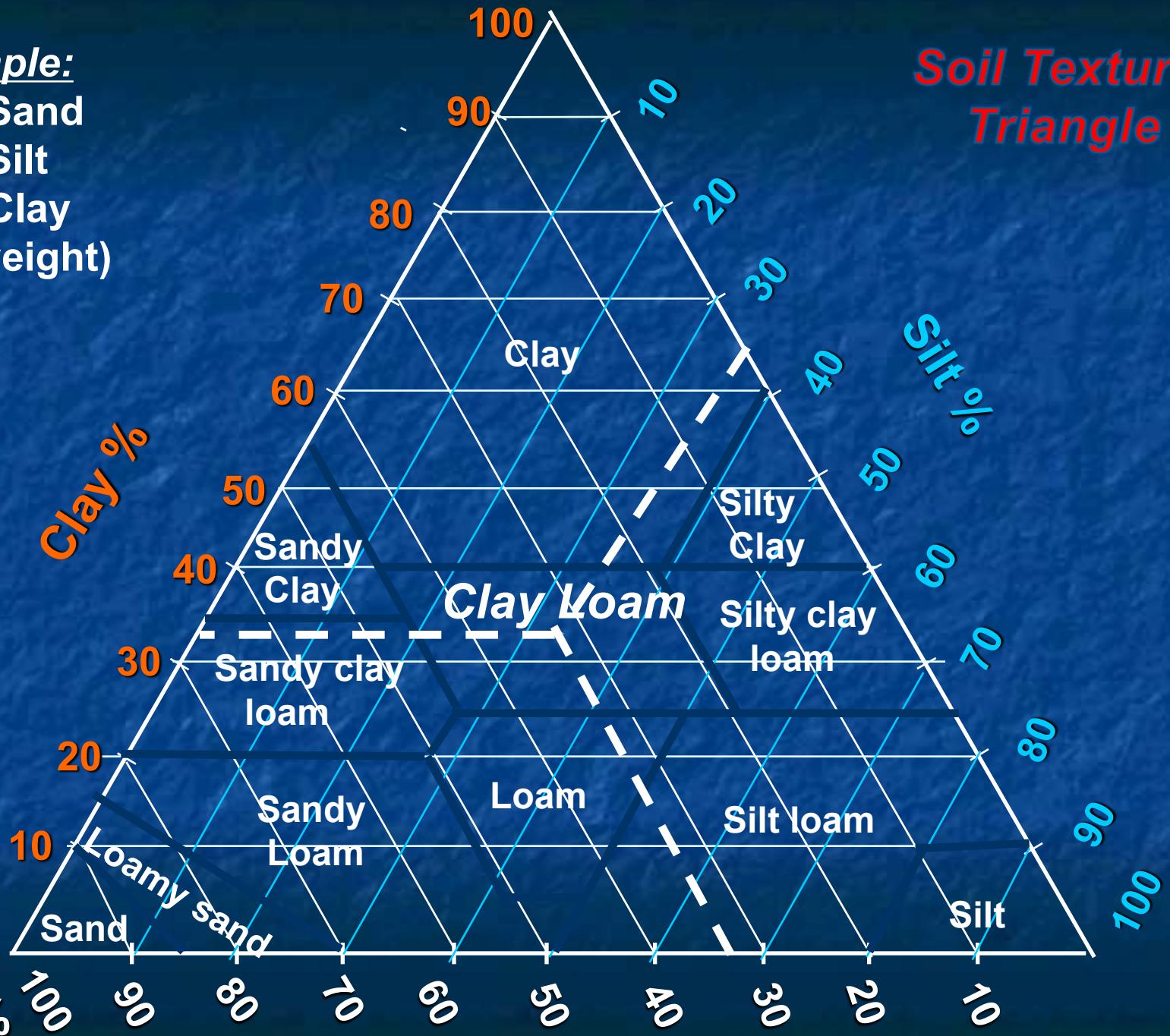
32% Sand

36% Silt

32% Clay

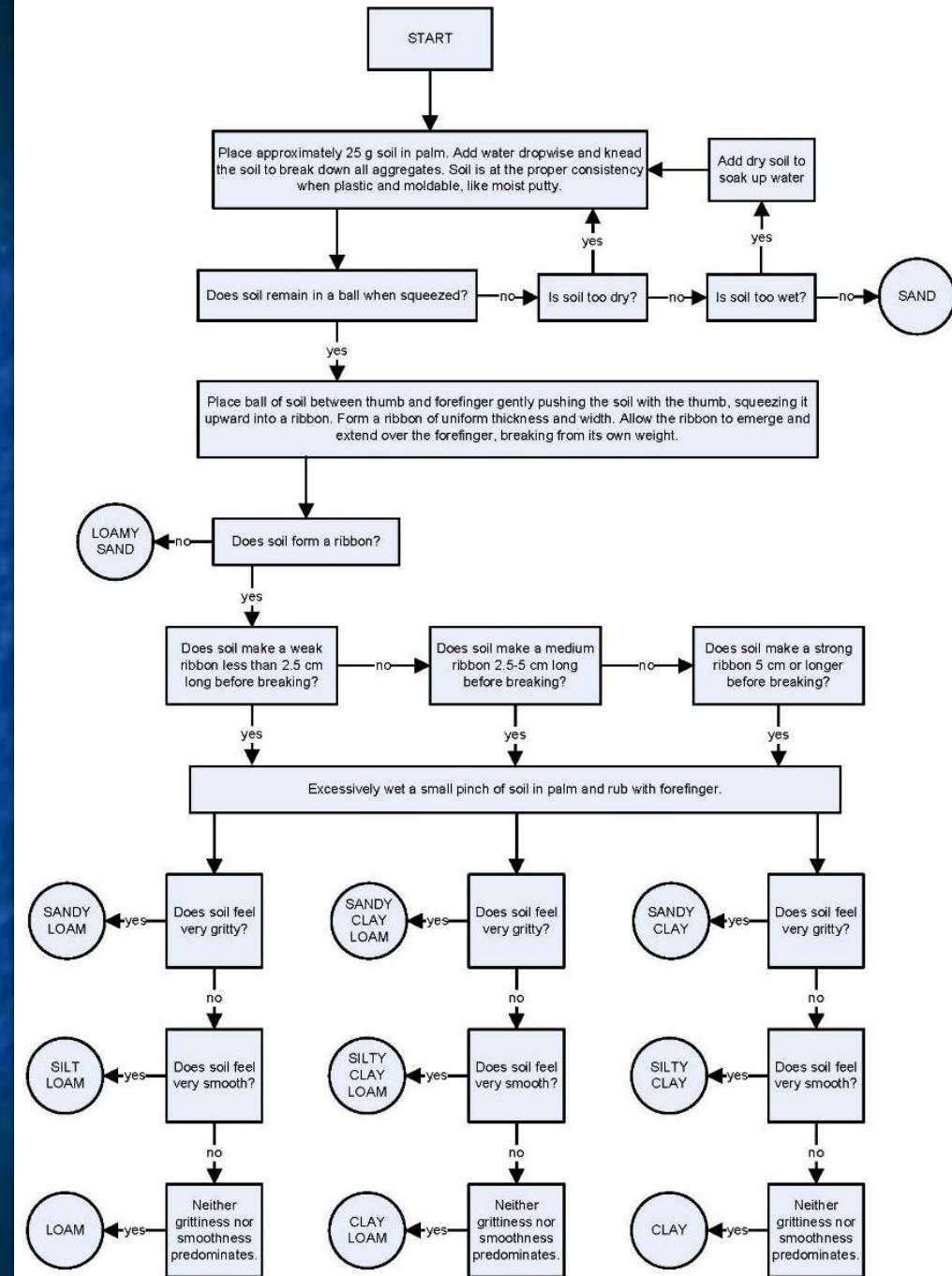
(By weight)

*Soil Textural Triangle*

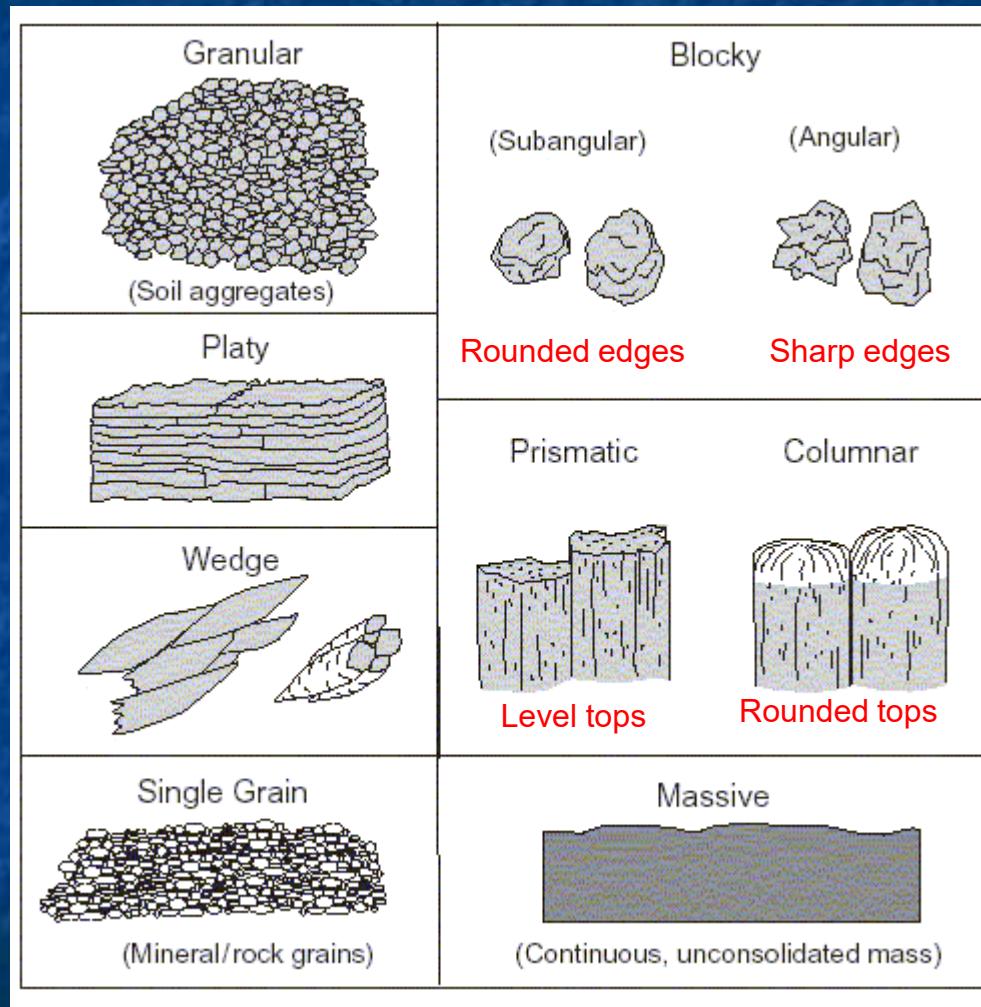


# Guide to Texture by Feel

<https://www.nrcs.usda.gov/sites/default/files/2022-11/texture-by-feel.pdf>



# Soil Characteristics: Structure



# Soil Characteristics: Consistence

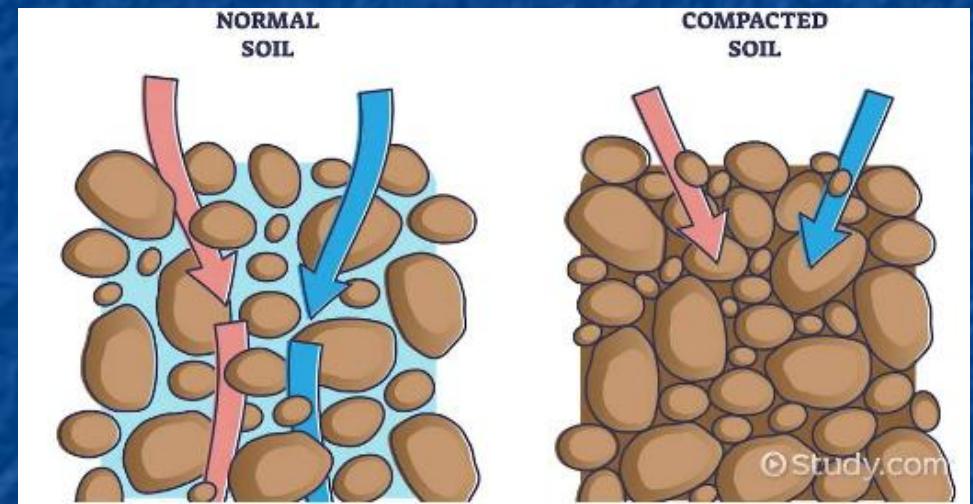
“The feel of the soil and the ease with which a lump can be crushed by the fingers”

- Sticky
- Hard
- Soft
- Loose
- Friable
- Firm
- Plastic
- Cemented



# Soil Characteristics: Permeability

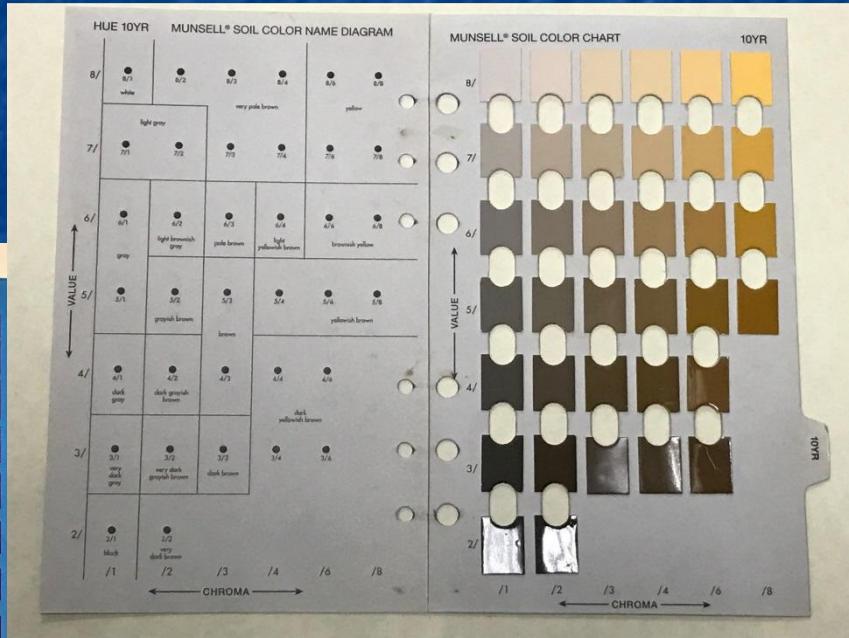
“The ease with which fluids or gasses can flow through the soil profile”



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

# Soil Characteristics: Color

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



**MUNSELL**  
SOIL COLOR CHARTS



# 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



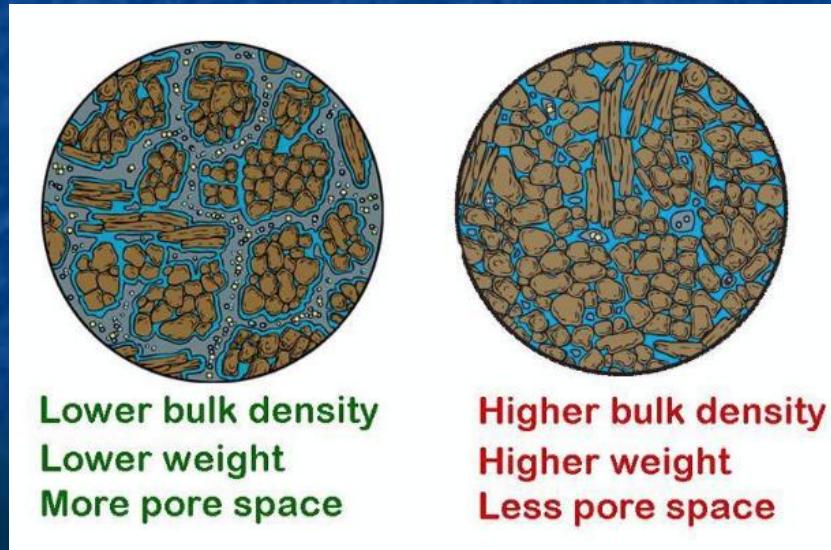
# Soil Characteristics: Redoximorphic Features

- Mottled soil colors caused by a fluctuating water table



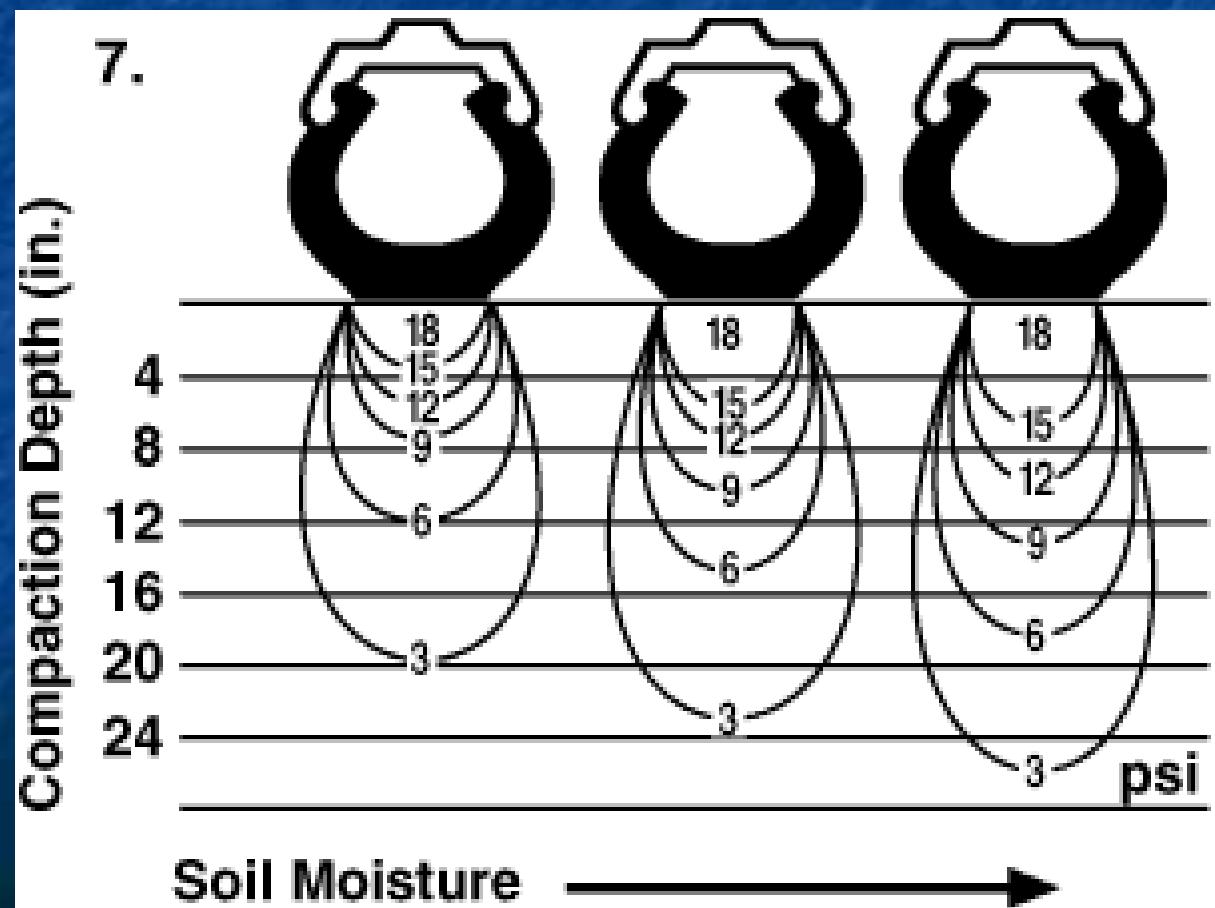
# Bulk Density

- 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)



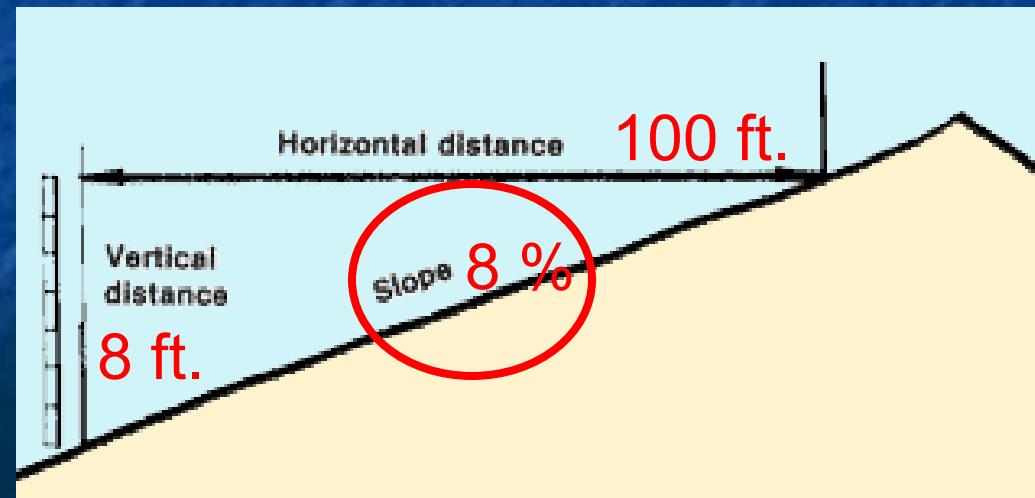
# Infiltration

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



# Slope

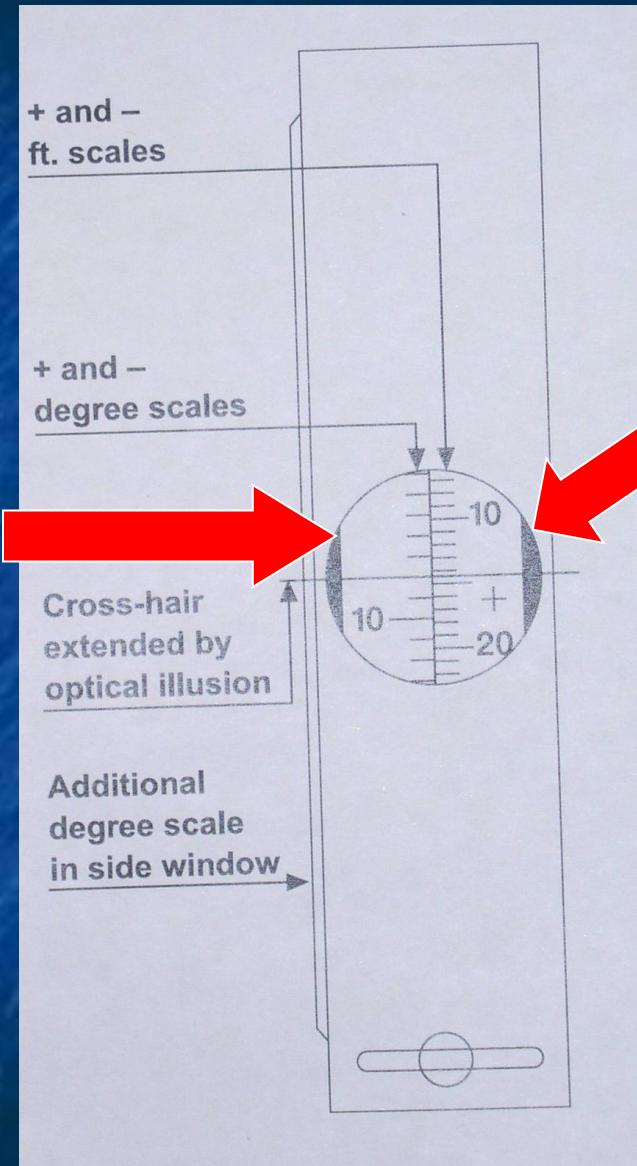
- The gradient of the soil surface, expressed as a percentage
- A commonly used measuring device for slope is a *clinometer*



# Clinometer



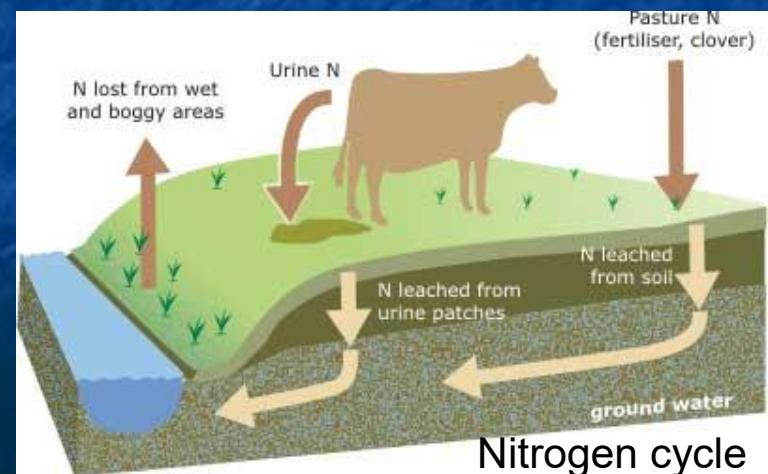
degree scale



% 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



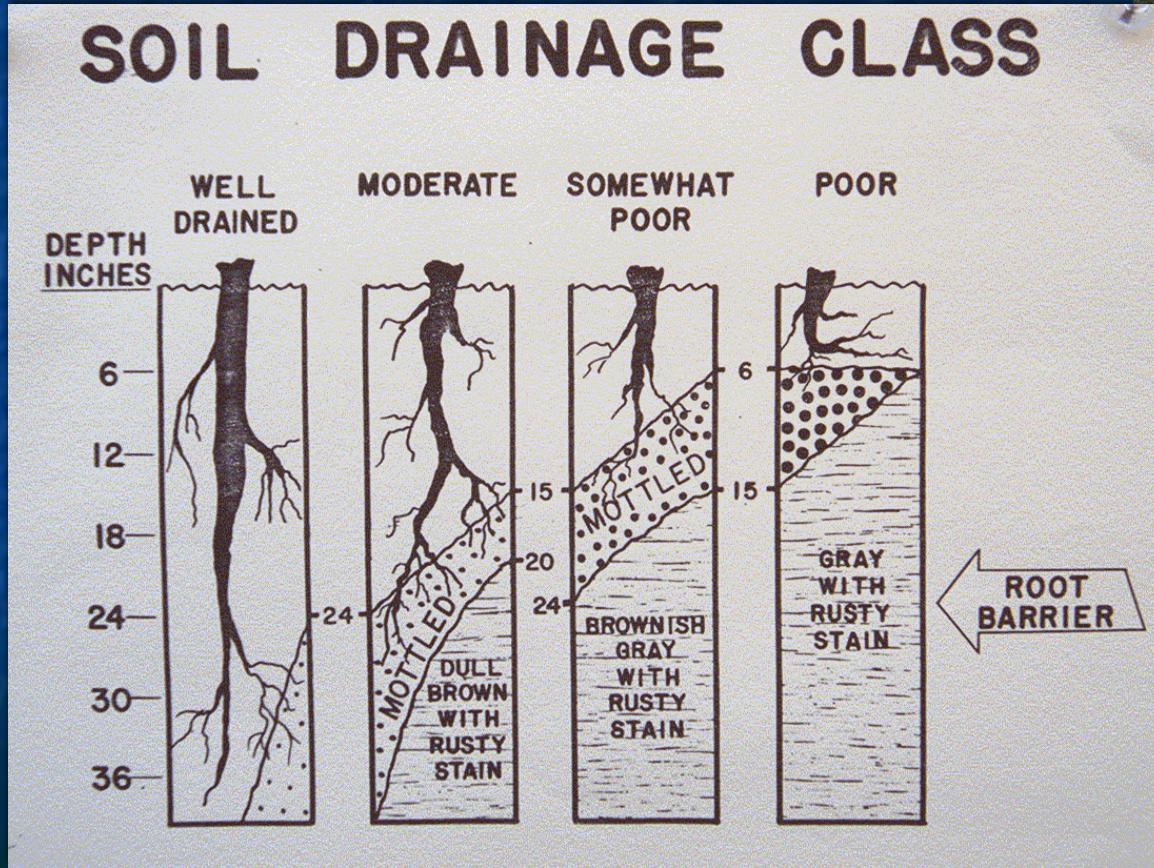
# Plant Nutrients:

## 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  
Deception Pass, WA

# 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”



Photo: USDA

# 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, or ml/cc)*

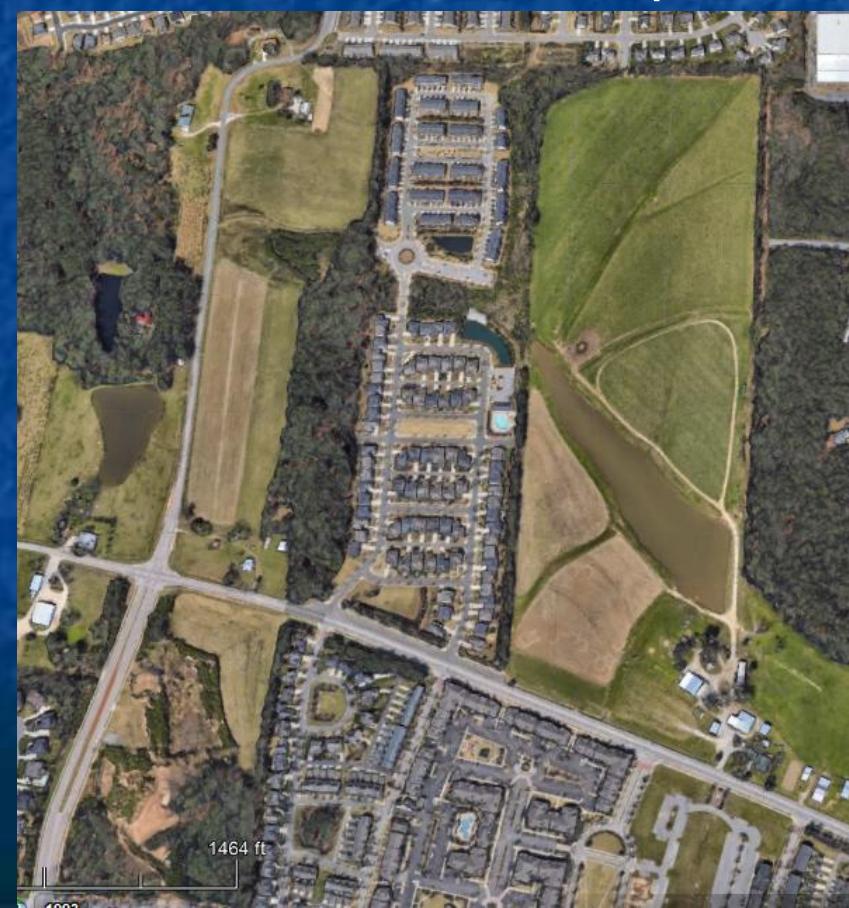
**Available Water Capacity =**

**Field Moisture Capacity – Wilting Point**

# Land Use Affects Soil Productivity



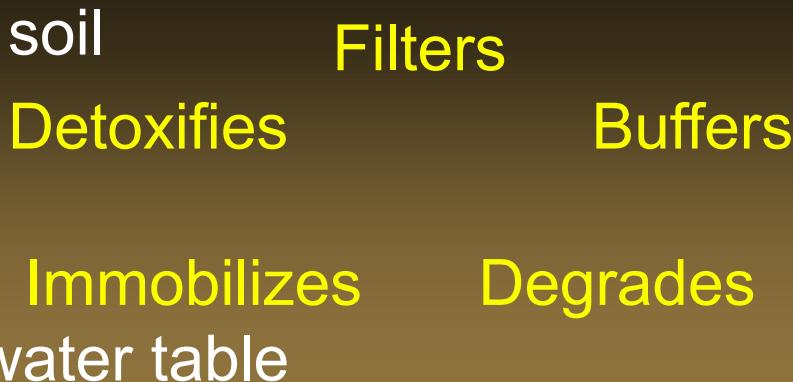
Agricultural practices



Development

# Non-Point Source Pollution: *(soils may act as a treatment system)*

# Organic & Inorganic materials



Courtesy: EPA

# Non-Point Source Pollution

- soils may become contaminated beyond their ability to treat pollutants

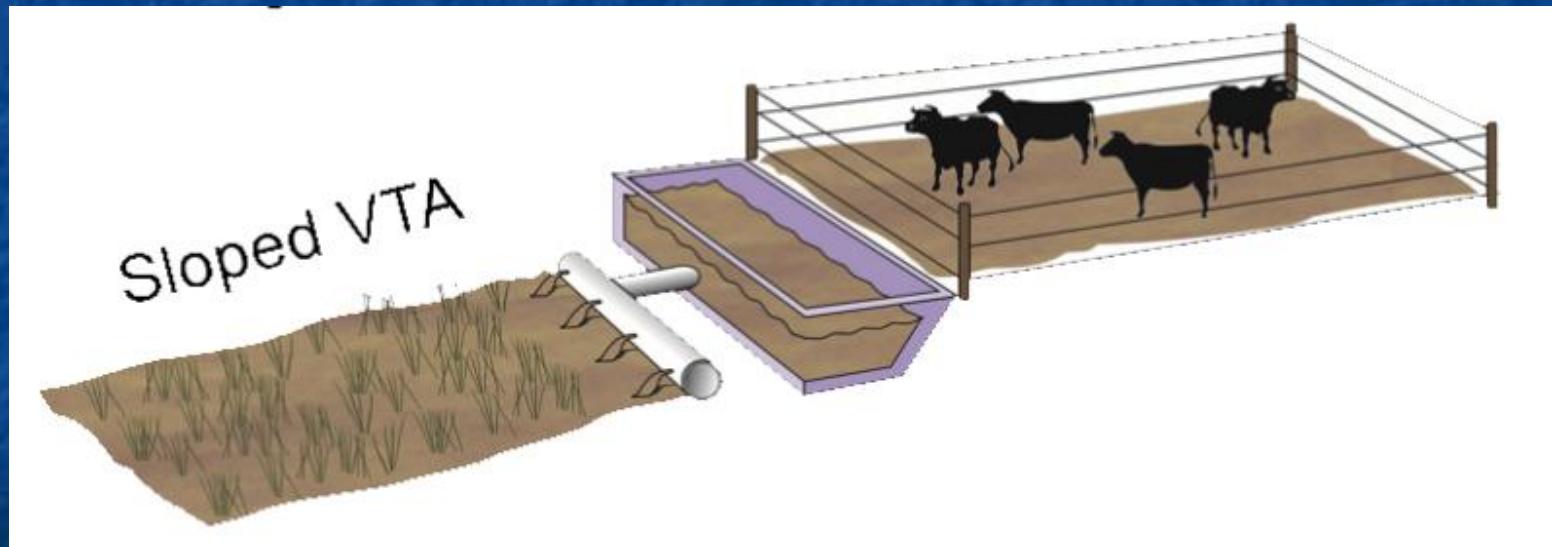


Image courtesy USDA-NRCS

# Non-Point Source Pollution

Soils may become the pollutant if suspended in water-



Term: \_\_\_\_\_ ?

# Soil Erosion

Water



Wind

# Soil Erosion: the Universal Soil Loss Equation

$$A = R \times K \times LS \times C \times P$$

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



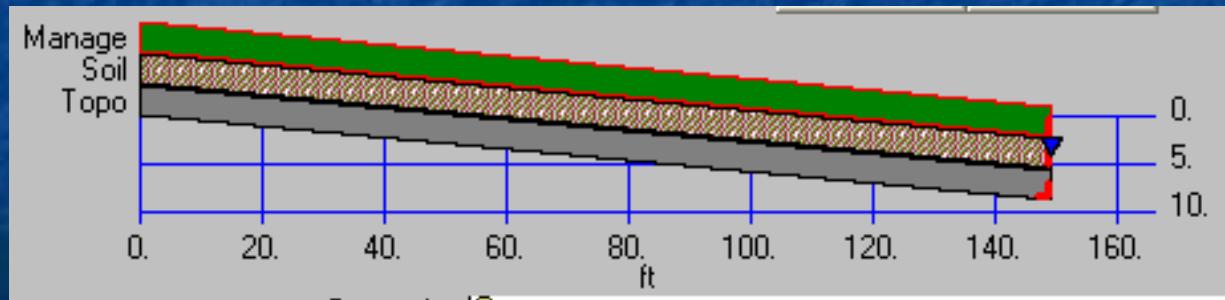
# Universal Soil Loss Equation

- $K$  = 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 & mgmt factor  
*(function of crop canopy and residue)*



# Universal Soil Loss Equation

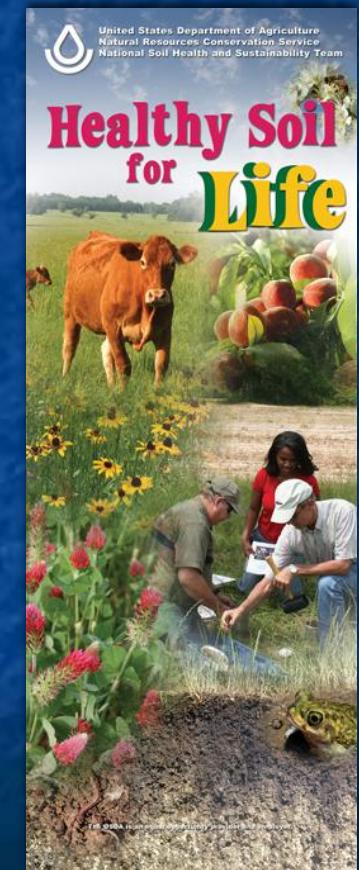
- $P$  = support practice factor
  - up & down hill tillage vs. contour tillage



# 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

*In many cases, our soils are very different than they were under natural conditions. They have been changed by cultivation, erosion, invasive organisms, altered chemistry, and other factors. Often, we can learn how to restore soil health by observing natural processes.*

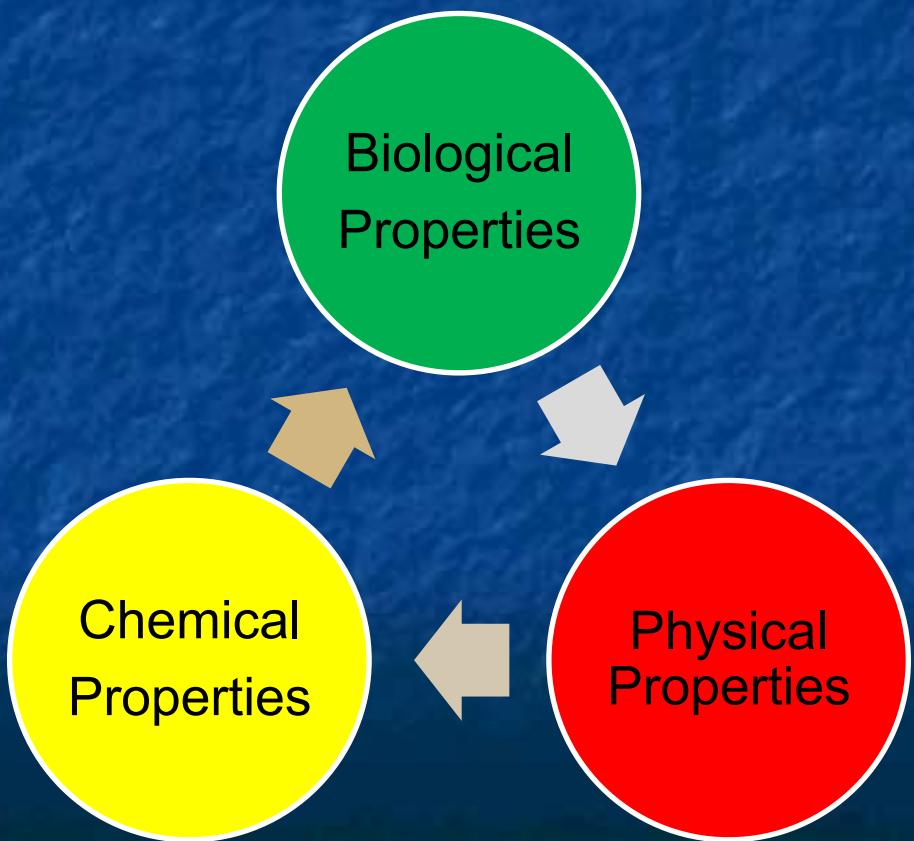


Image courtesy earth.com

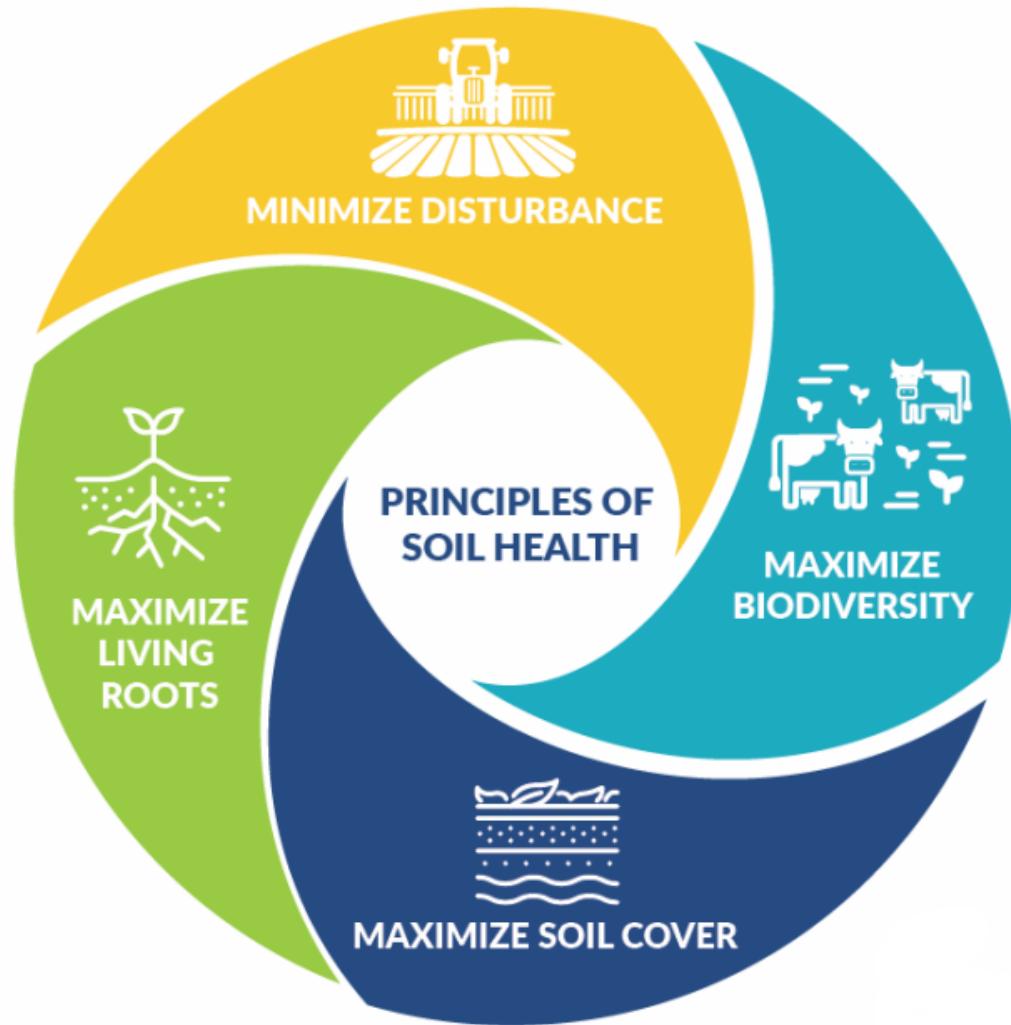


Image courtesy Iowa Natural Heritage Foundation

# Soil Health



# Soil Health



*Practices which lead to healthy soils also enable them to sequester carbon.*

# Soil Health



Minimize soil disturbance



Maximize living roots



Maximize soil cover



Maximize biodiversity

# Soil Taxonomy

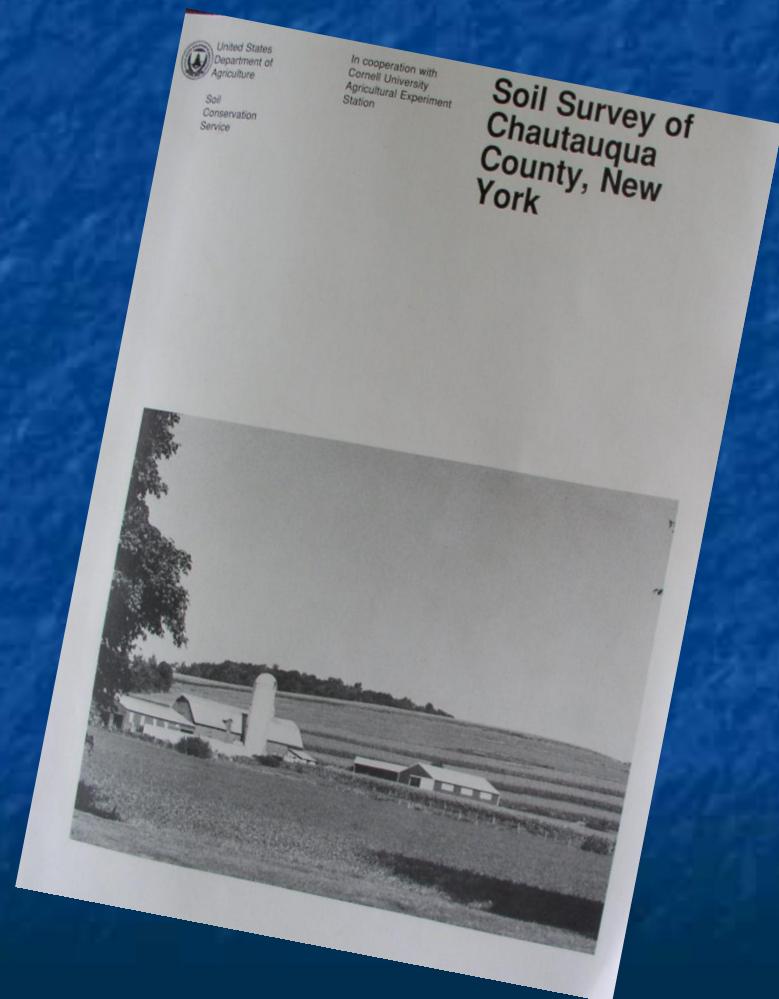
Order	Suborder	Great Group	Subgroup	Family	Series
Inceptisol	Aquept	Haplaquepts	Aeric	Coarse-loamy, mixed, nonacid, mesic	Busti
soils that exhibit minimal horizon development	Aqu=water, ept=Inceptisols	Hapl=minimal horizonation	Aeric=better drained than the typical subgroup	Physical and chemical properties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

Reference County Soil Survey pages 171 and 331.

# Soil Survey

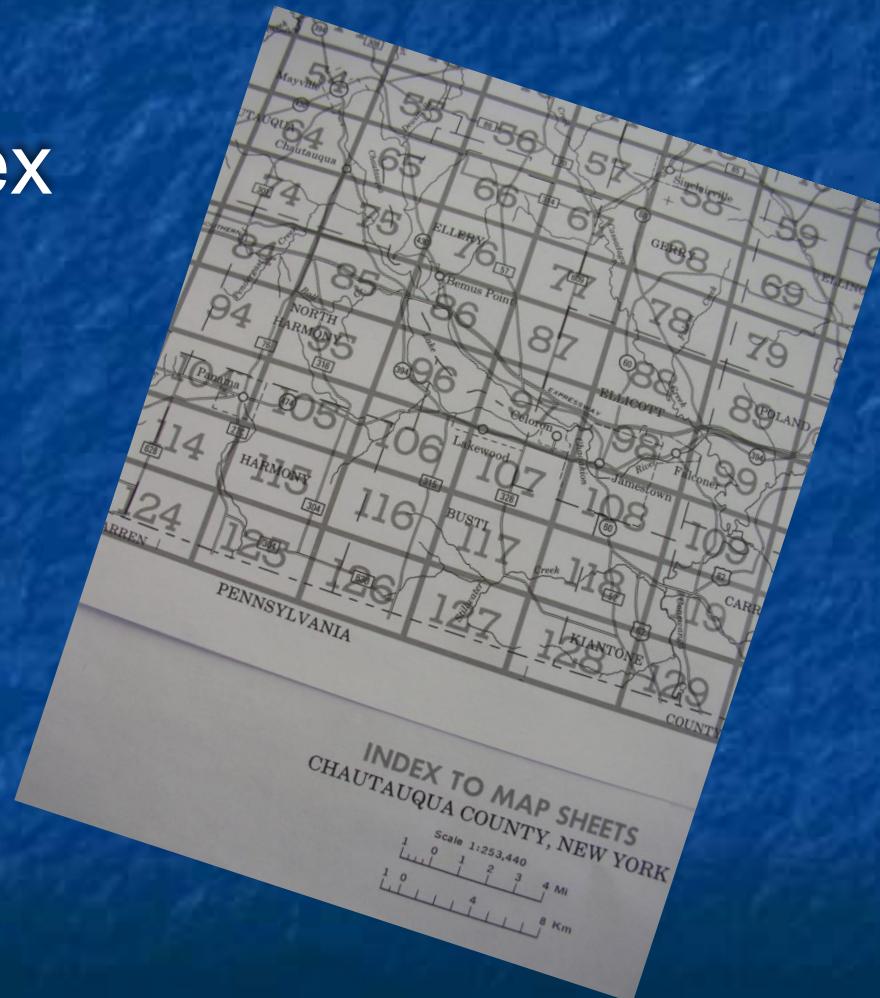
Published survey:

- Mapping & interpretations
- Glossary of terms



# Soil Survey

## ■ Map Index



# Soil Survey

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

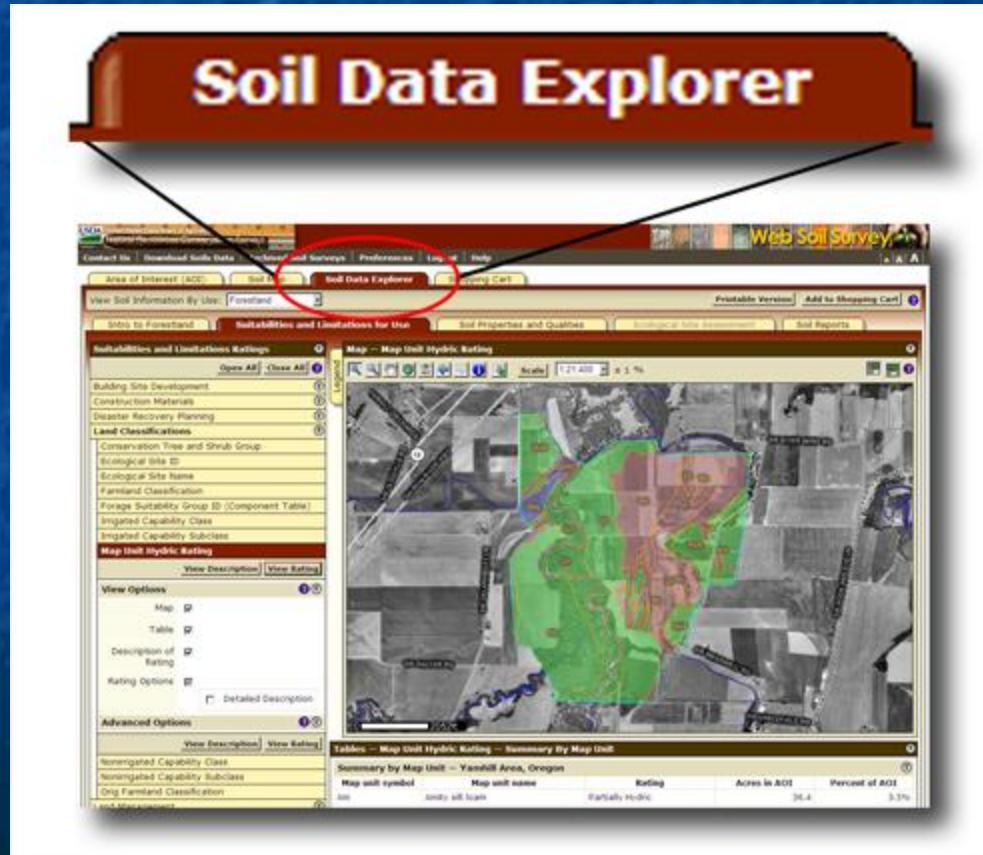
CkC:  
Chautauqua  
silt loam  
8-15% slopes



# Soil Survey

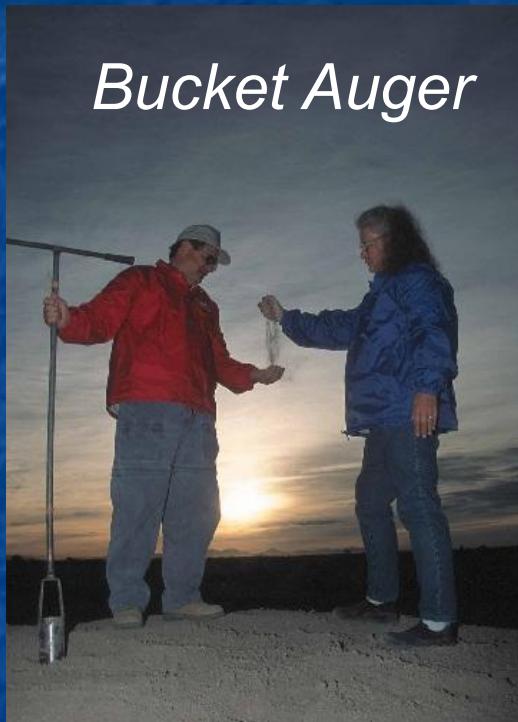
- Also available online at:

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



# Soil Sampling & Survey Tools

*Bucket Auger*



*Punch Probe*



*Screw Auger*



Official State Soil: Honeoye

# Where is it?



These productive soils occur  
on about 500,000 acres  
in New York.

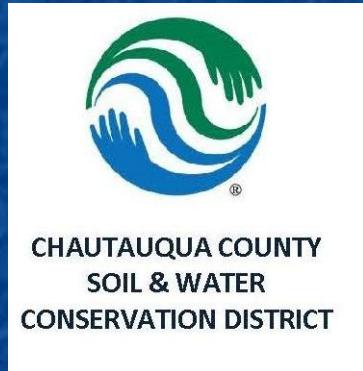
■ New York

■ Honeoye



# Resources:

- <http://www.nrcs.usda.gov/>
- <http://websoilsurvey.nrcs.usda.gov/app/>
- <https://soilwater.org>





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