Watershed Steward Academy Conference:
February 24, 2018 Northeast High School
Rich Mason. US Fish and Wildlife Service

Healthy Soil Definition

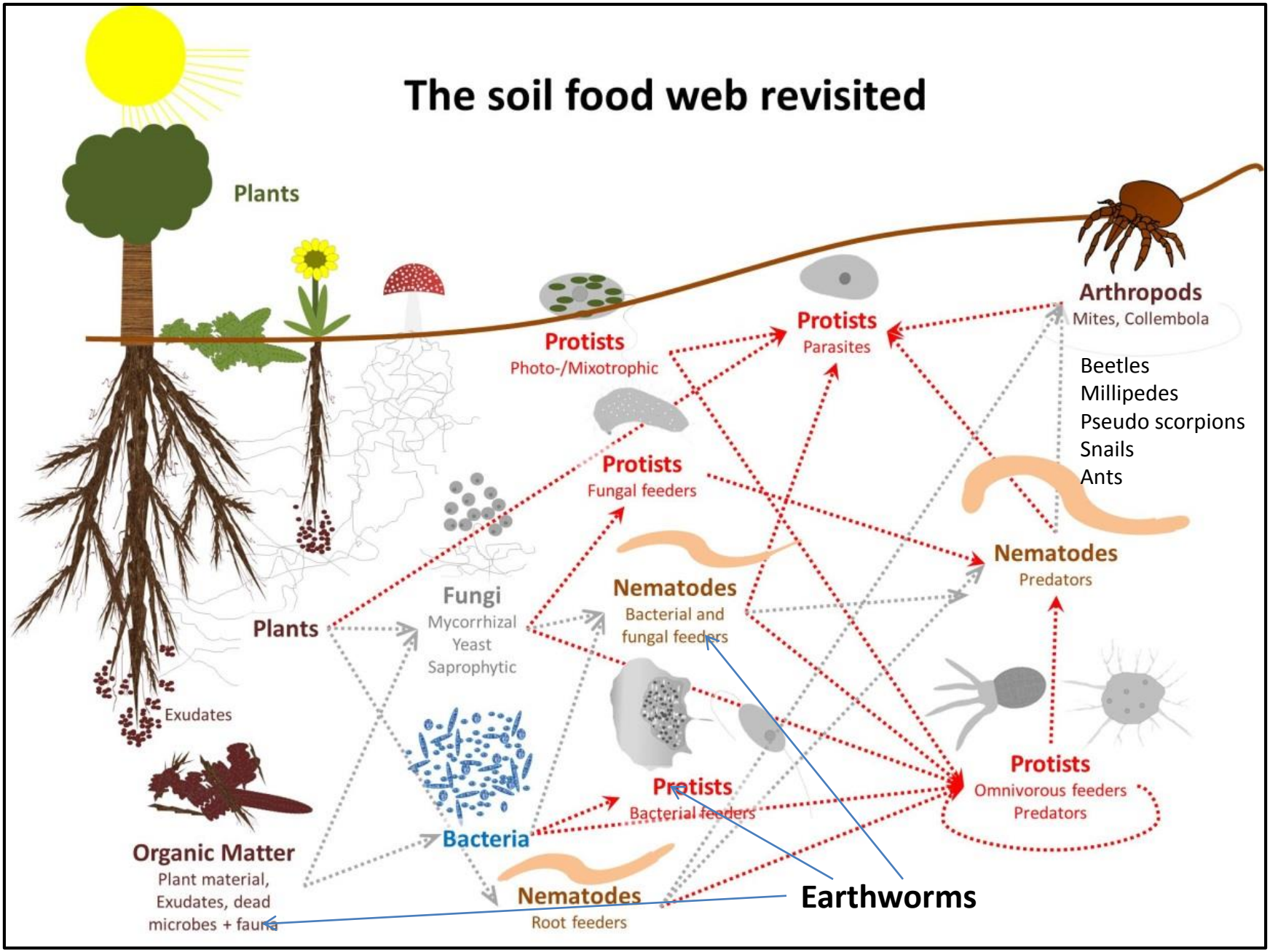
The **continued capacity** of soil to function as a vital living ecosystem that sustains plants, animals, and humans.

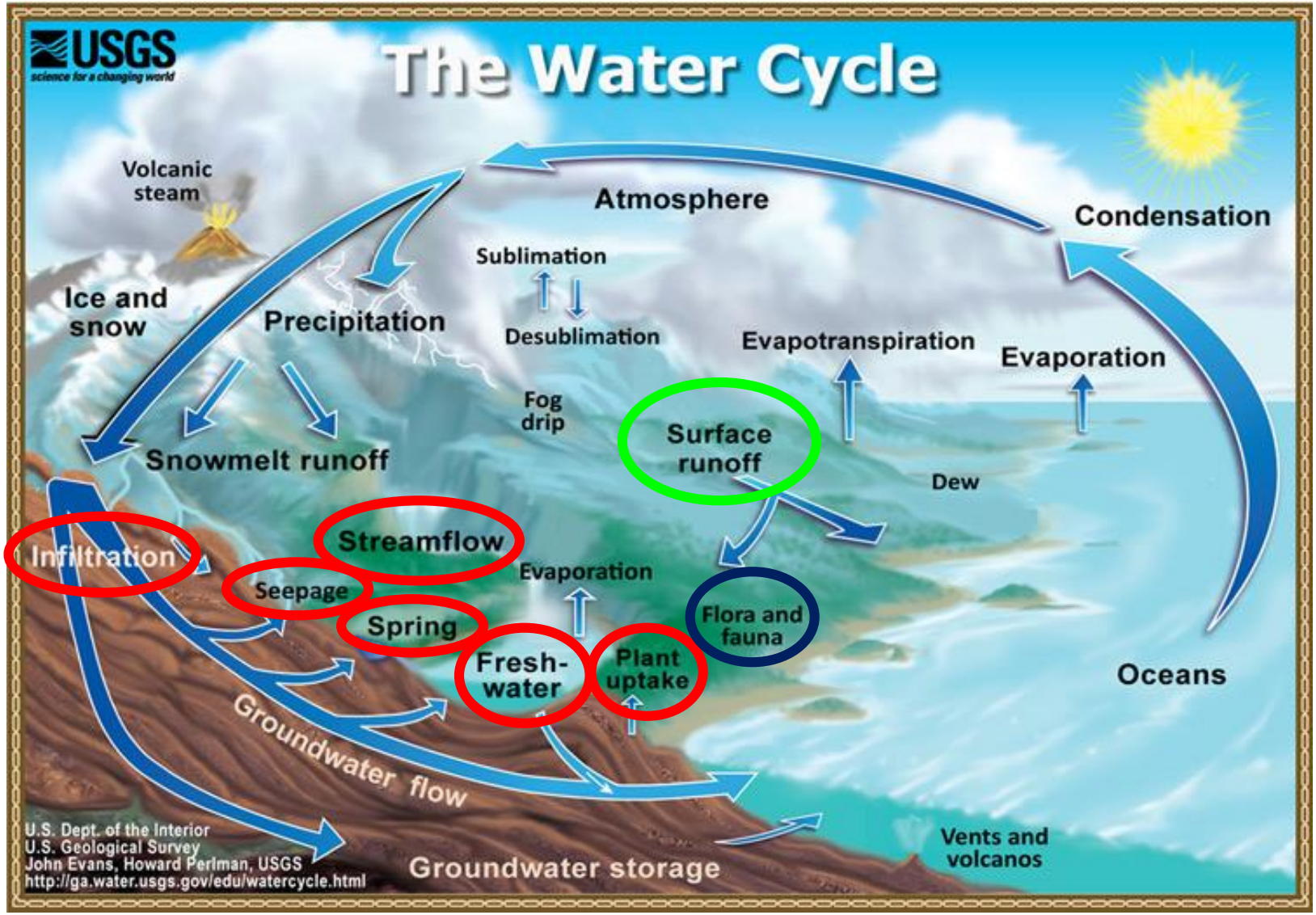
Healthy Soil Functions:

- Retain and Cycles Nutrients, Carbon, and Water
- Support Plant Growth
- Infiltrate and Store Water
- Suppress Pests, Disease, Weeds
- Detoxify Harmful Chemicals
- Clean Water

Health Soils Lead To:

- Nutritious Food
- Clean Water
- Improved Stream Base Flow
- Aquifer Recharge
- Climate Change Mitigation
- Improved Water–Based Recreation
- More Weather Resilient Farms
- Less Chemical Input Costs
- Reduced Fuel Use
- Increased Farm Profits


The soil food web revisited
Plants
Arthropods
Mites, Collembola
Beetles
Millipedes
Pseudo scorpions
Snails
Ants
Protists
Photo-/Mixotrophic
Protists
Parasites
Protists
Fungal feeders
Nematodes
Predators
Nematodes
Bacterial and fungal feeders
Fungi
Mycorrhizal
Yeast
Saprophytic
Plants
Exudates
Protists
Omnivorous feeders
Predators
Protists
Bacterial feeders
Bacteria
Organic Matter
Plant material, Exudates, dead microbes + fauna
Nematodes
Root feeders
Earthworms

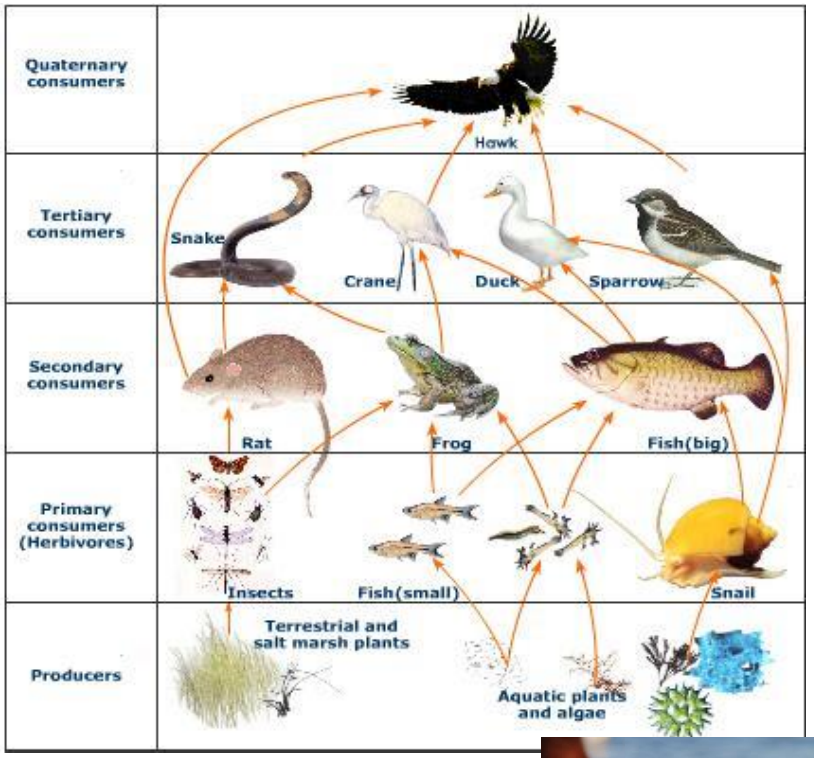


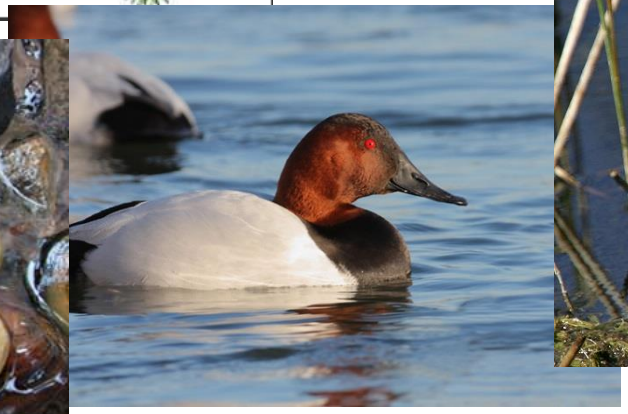
Decreased

Increased

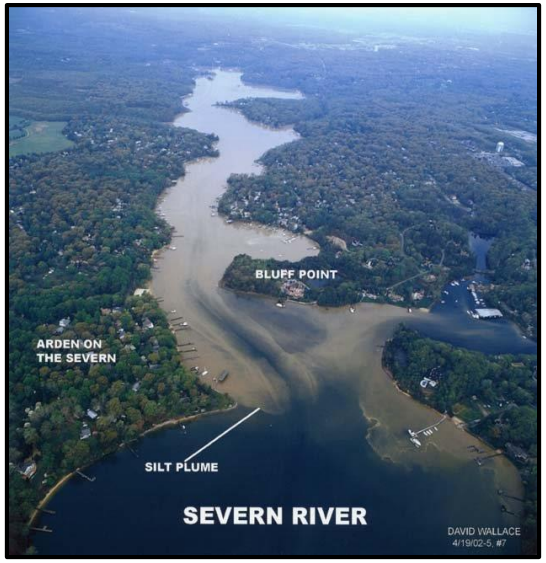
Impaired

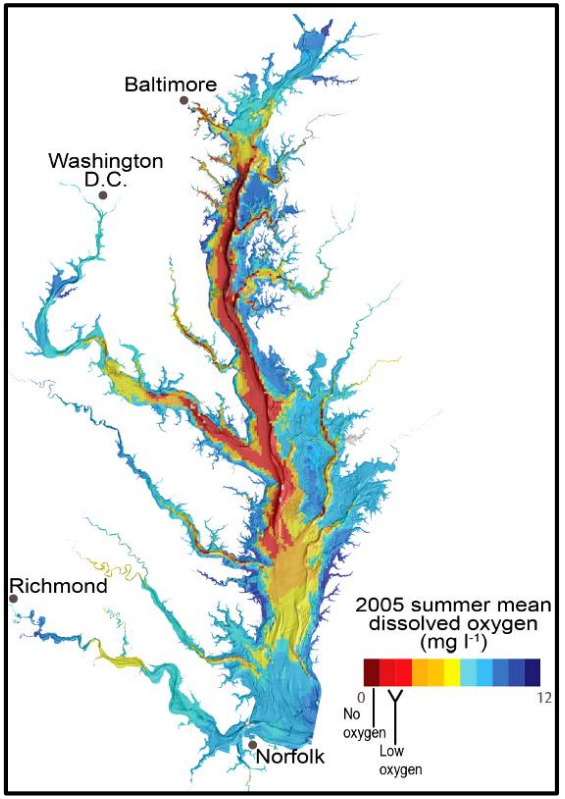
Biodiversity: Healthy Food Web

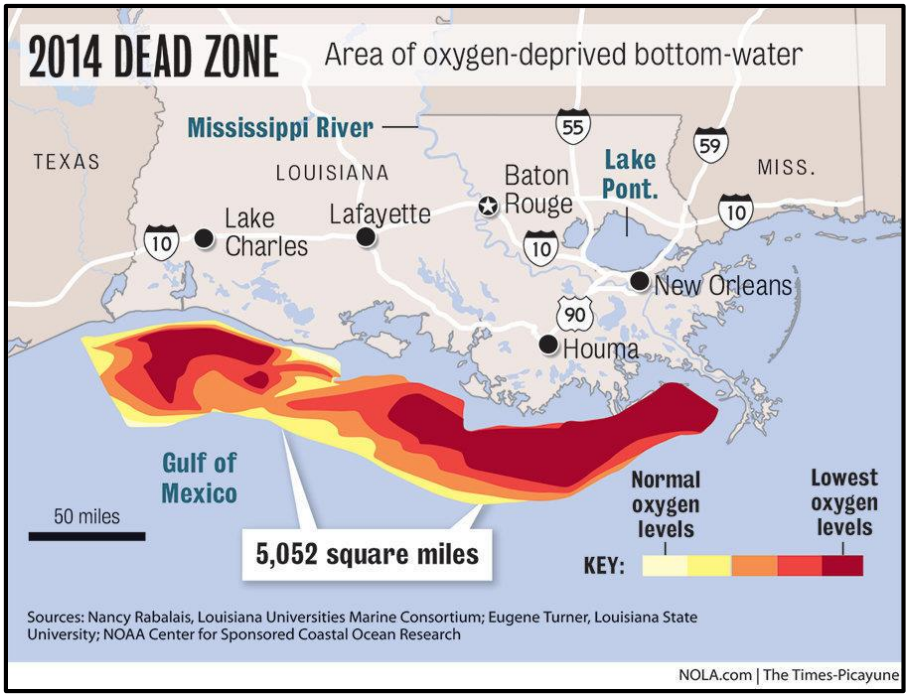




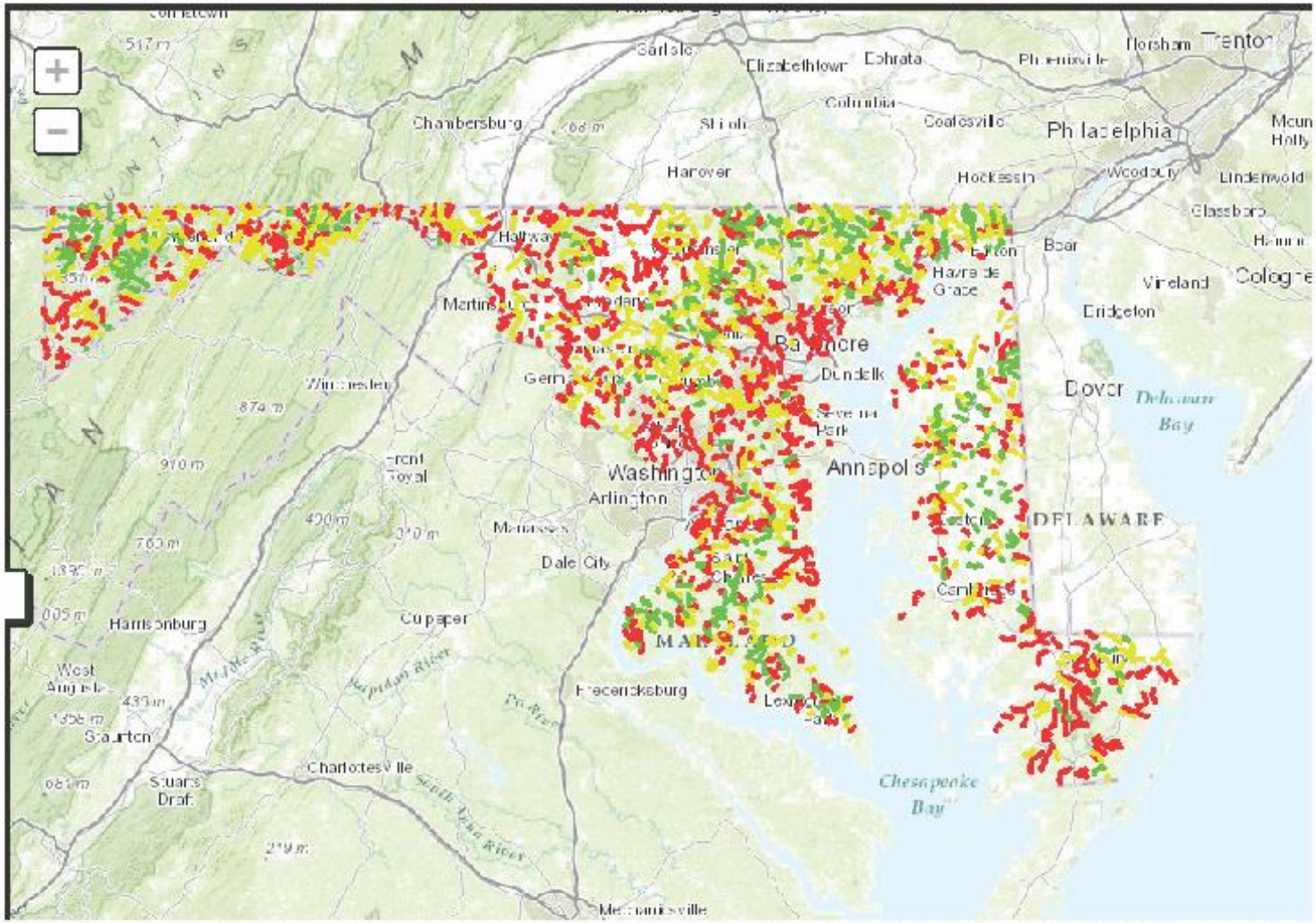
The un-natural flow of water causes major impacts to streams, rivers, in Chesapeake Bay






2014 DEAD ZONE
Area of oxygen-deprived bottom-water
Mississippi River
TEXAS
LOUISIANA
MISS.
Baton Rouge
Lake Pont.
Lake Charles
Lafayette
New Orleans
Houma
55
59
10
10
10
90
Gulf of Mexico
50 miles
5,052 square miles
Normal oxygen levels
Lowest oxygen levels
KEY:
Sources: Nancy Rabalais, Louisiana Universities Marine Consortium; Eugene Turner, Louisiana State University; NOAA Center for Sponsored Coastal Ocean Research
NOLA.com | The Times-Picayune

Stream Health 2014



Status of Freshwater Aquatic Life in the United States[1]

Aquatic Life	Conservation Status
• Fish: 800 species	20% imperiled
• Mussels: 300 species	45% imperiled
• Crayfish: 300 species	48% imperiled
• Salamanders: 150 species	40% imperiled
• Frogs and Toads: 100 species	40% imperiled
• Snails: 500 species	20%-imperiled

1. Helfrich, Louis A., Richard J. Neves, James Parkhurst. *Sustaining America's Aquatic Biodiversity*. Virginia Cooperative Extension. 2009

Food Production

Global[2]

- 40% of Earth's land surface used for agriculture
- 4.4 Billion Acres in Crop Production (area the size of South America)
- 9 Billion Acres in Livestock Production

United States (Lower 48 States) – Total Land Area 1.89 billion acres[3]

- Crop Production: 391 million acres- 21%
- Livestock Production: 654 million acres in- 35%
- Forests: 631 million acres- 28%
- Urban: 69 million acres (includes areas with at least 2500 people)- 3.6%
- Special use areas: Transportation, rural parks, wildlife, defense, industrial, msc farm and special uses: 168 million acres- 9%
- Msc: Marshes, swamps, bare rock, other uses: 68 million acres.-3.6%

55% of Land in US is in Agriculture Production
3.6% of Land in Urban Use

2. Owen, James. *Farming Claims almost half the Earth's Land, New Maps Show*. National Geographic News. Dec 2005.
3. "Major Uses of Land by region, State, and United States, 2012". www.ers.usda.gov/data-products. 2012

Soil Erosion

Cornell University Estimate: 1.7 Billion Tons of Topsoil Lost/Year in US. (4-5 tons/acre/year on average)[4]

Every day, a train load of soil 116 miles long washes off our farm land.

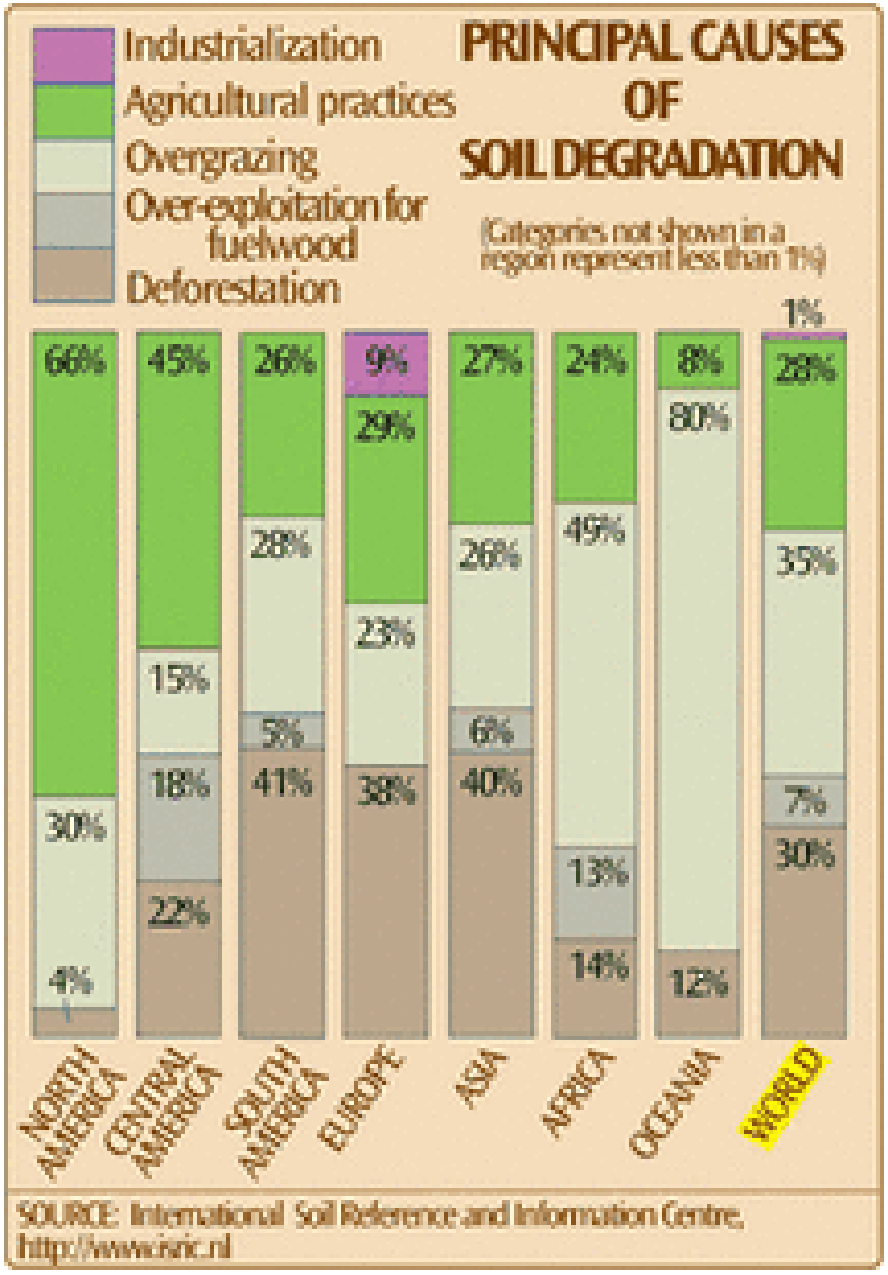
[4]Hansen, Matt. “America is Running Out of Soil.” The Week. http://theweek.com/articles/554677/america-running-soil. 2015

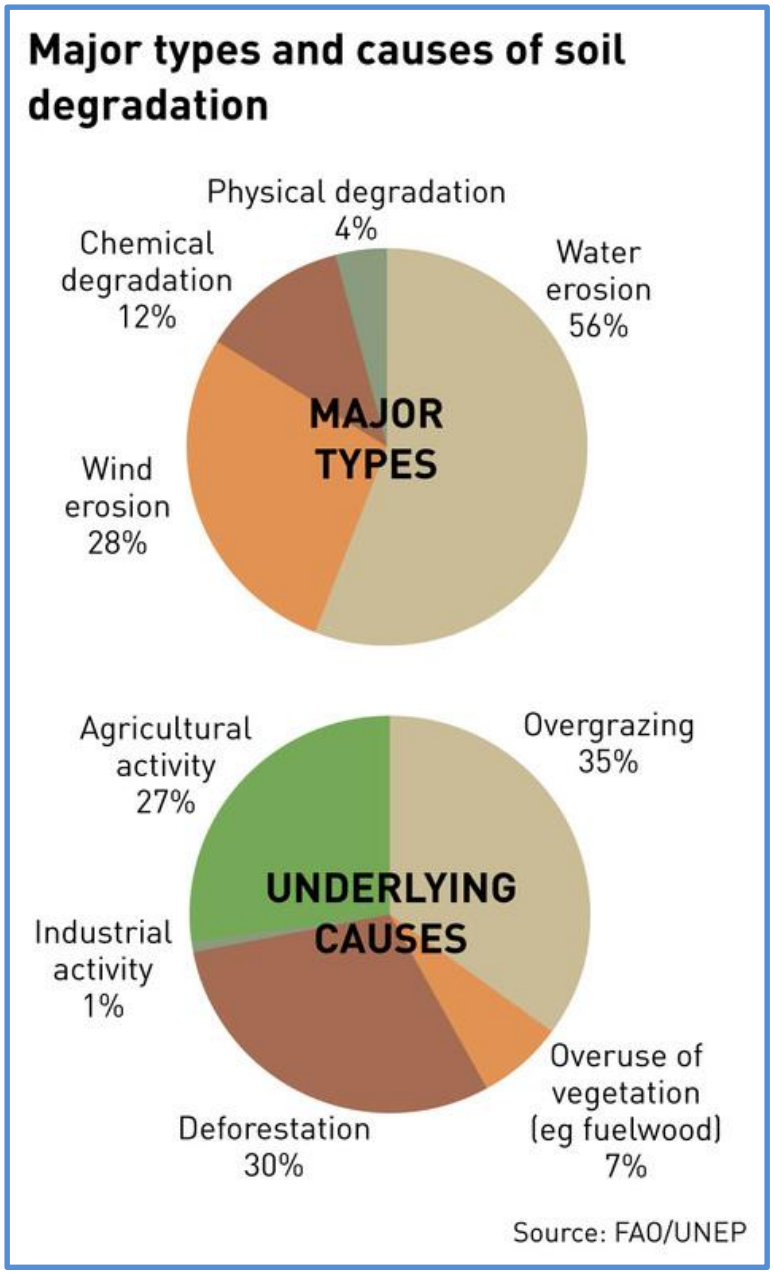

Oklahoma- 1930’s


Oklahoma- 2014


Colorado 2013


Texas 2013

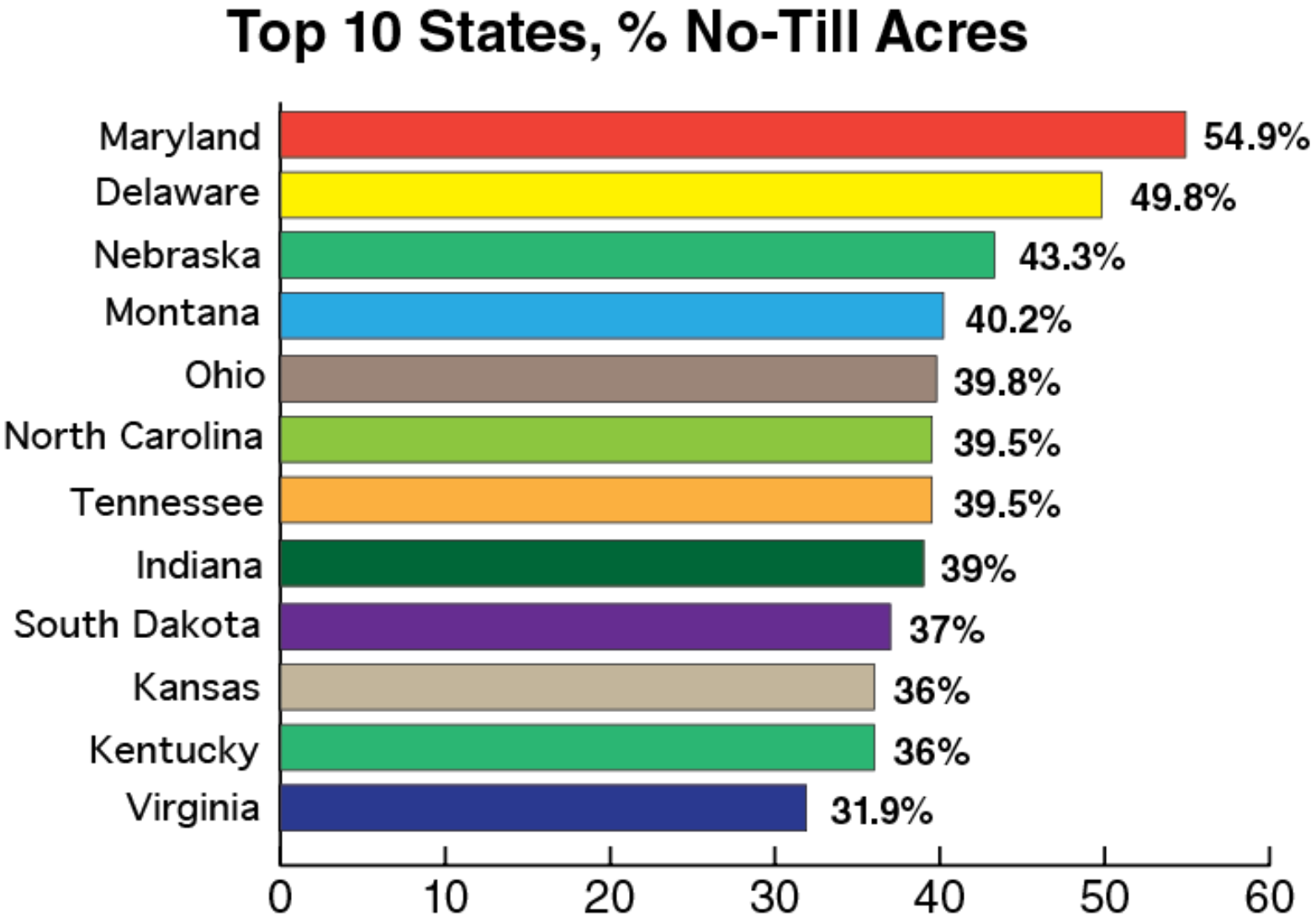

PRINCIPAL CAUSES OF SOIL DEGRADATION
Industrialization
Agricultural practices
Overgrazing
Over-exploitation for fuelwood
Deforestation
(Categories not shown in a region represent less than 1%)
66%
30%
4%
45%
15%
18%
22%
26%
28%
5%
41%
9%
29%
23%
38%
27%
26%
6%
40%
24%
49%
13%
14%
8%
80%
12%
1%
28%
35%
7%
30%
NORTH AMERICA
CENTRAL AMERICA
SOUTH AMERICA
EUROPE
ASIA
AFRICA
OCEANIA
WORLD
SOURCE: International Soil Reference and Information Centre, http://www.isric.nl


Major types and causes of soil degradation
Physical degradation 4%
Chemical degradation 12%
Water erosion 56%
MAJOR TYPES
Wind erosion 28%
Agricultural activity 27%
Overgrazing 35%
UNDERLYING CAUSES
Industrial activity 1%
Overuse of vegetation (eg fuelwood) 7%
Deforestation 30%
Source: FAO/UNEP

Principles of Soil Health

1. Never disturb the soil (plow or disk)
2. Cover the soil 365 days/year
3. Have a living root in the soil as much as possible
4. Incorporate a diversity of plants
5. Incorporate animals
6. Reduce/eliminate chemical inputs

1. Never disturb the soil (plow or disk)



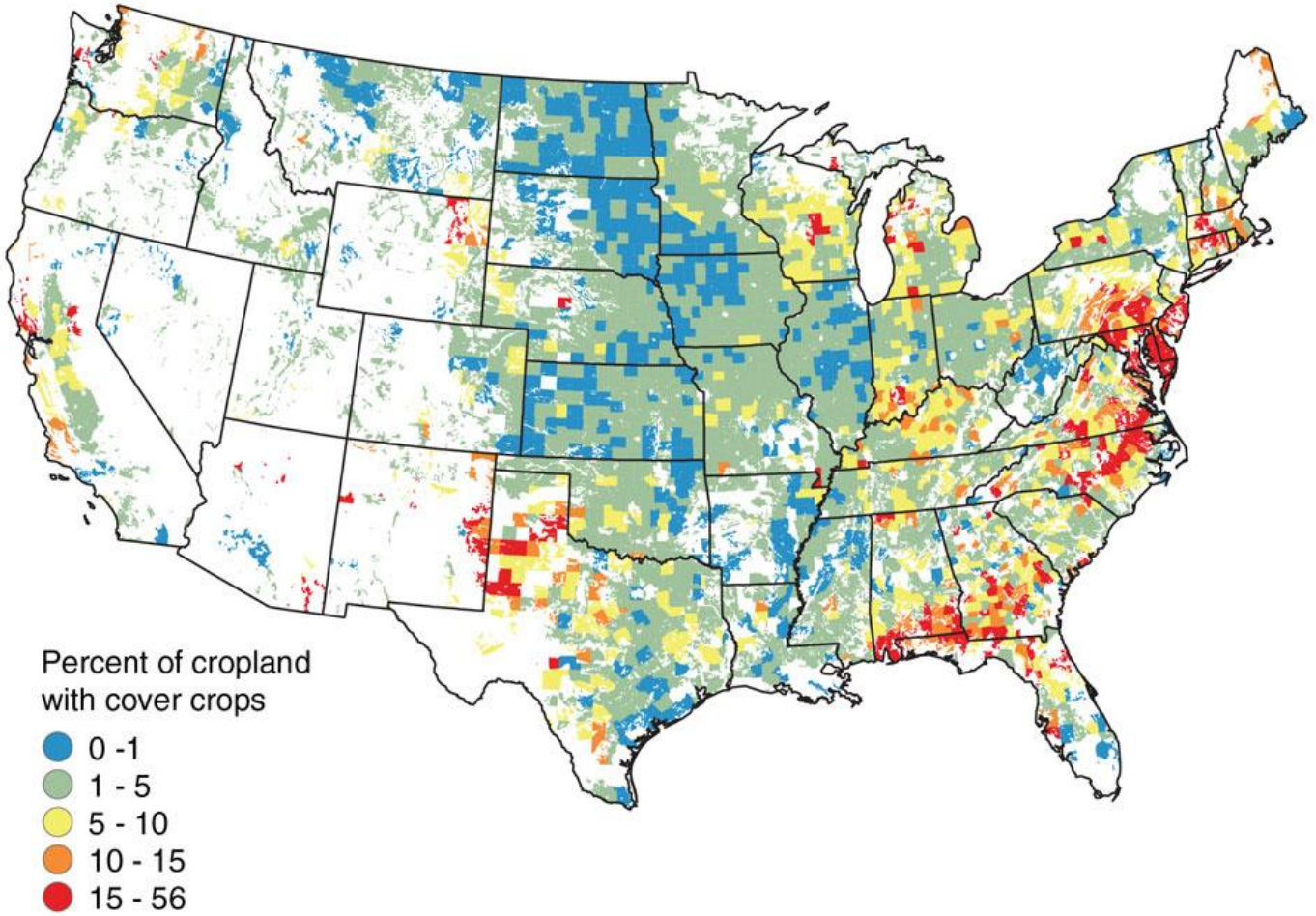
[5]Source: Dobberstein, John. “No-till Movement in US Continues to Grow.” www.no-tillfarmer.com/articles/489. 2014

2. Cover the soil 365 days/year

3. Have a living root in the soil as much as possible

Cover Crop Roots

Cover Crop Use 2012

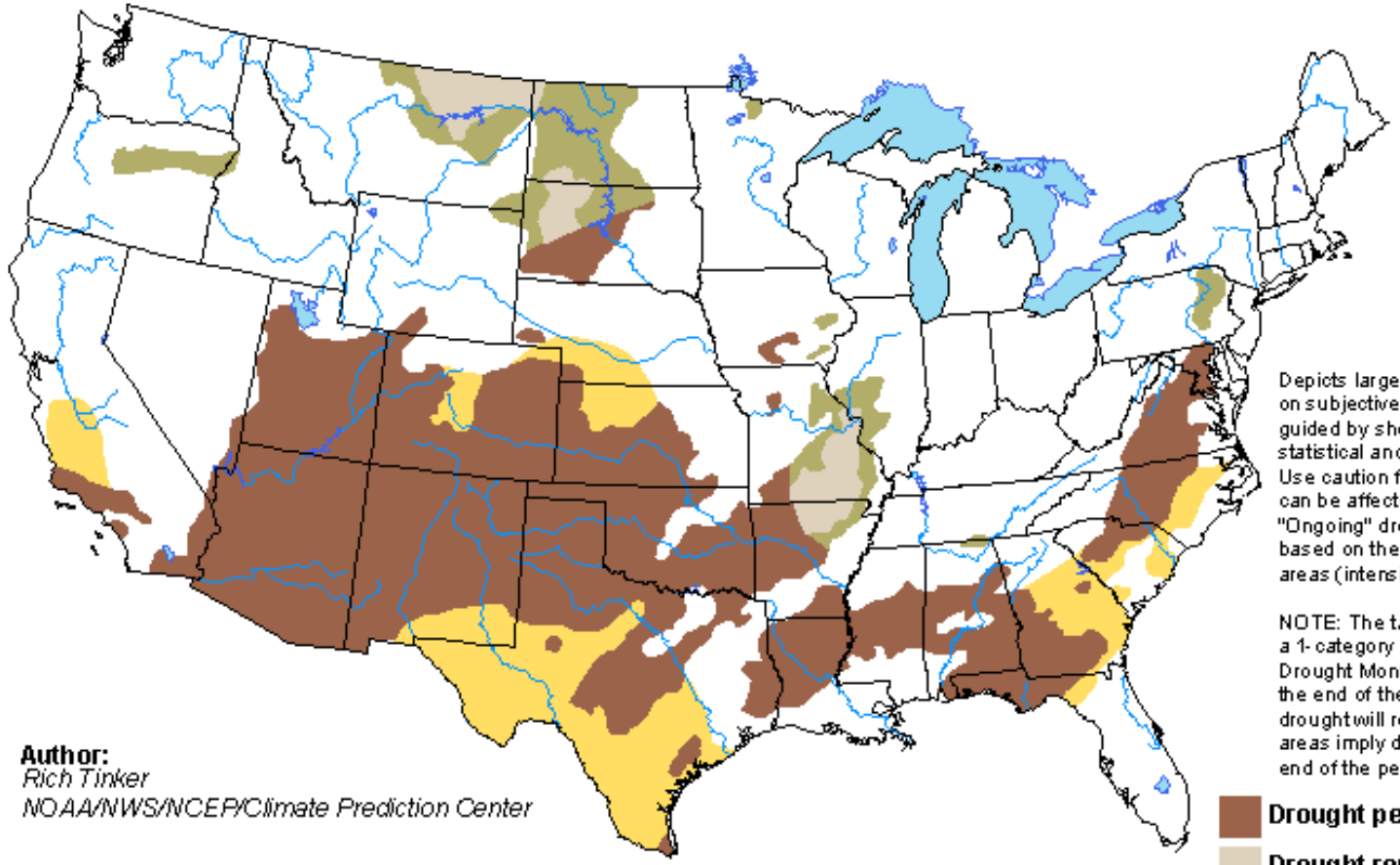


Note: White areas are not cropland or have missing data due to disclosure limitations with Census of Agriculture data.
Source: USDA, Economic Research Service using data from USDA, National Agricultural Statistics Service, 2012 Census of Agriculture.

U.S. Seasonal Drought Outlook

Drought Tendency During the Valid Period

Valid for January 18 - April 30, 2018
Released January 18, 2018

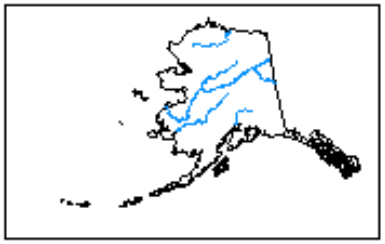


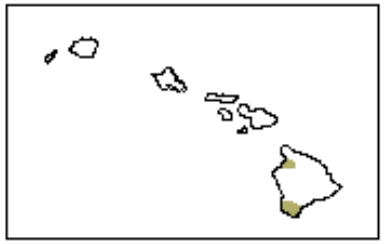
Author:
Rich Tinker
NOAA/NWS/NCEP/Climate Prediction Center

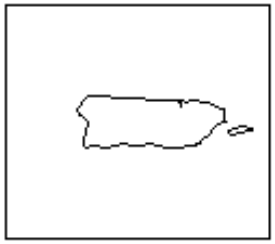
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived events. "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).

NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).

- **Drought persists**
- **Drought remains but improves**
- **Drought removal likely**
- **Drought development likely**

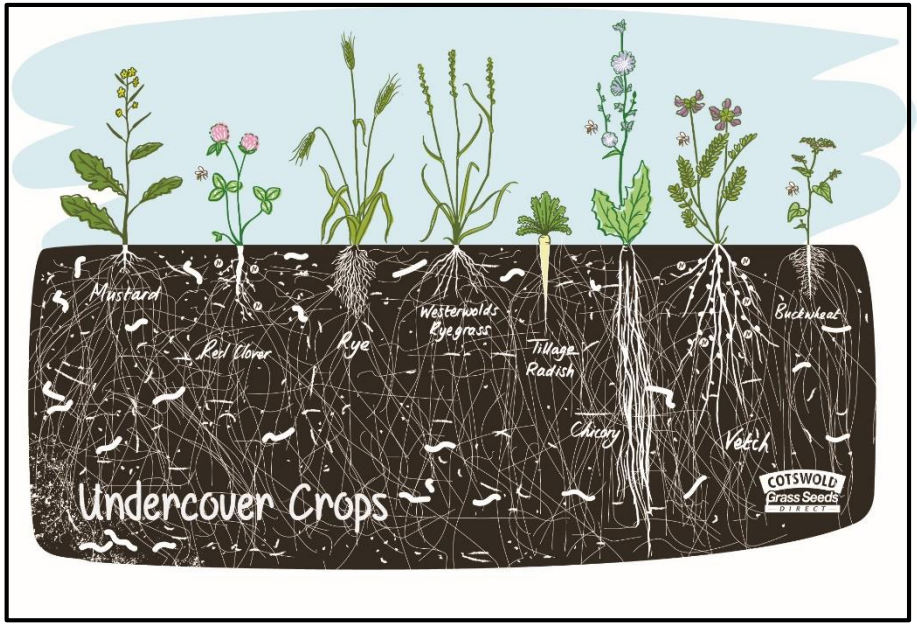






http://go.usa.gov/3eZ73

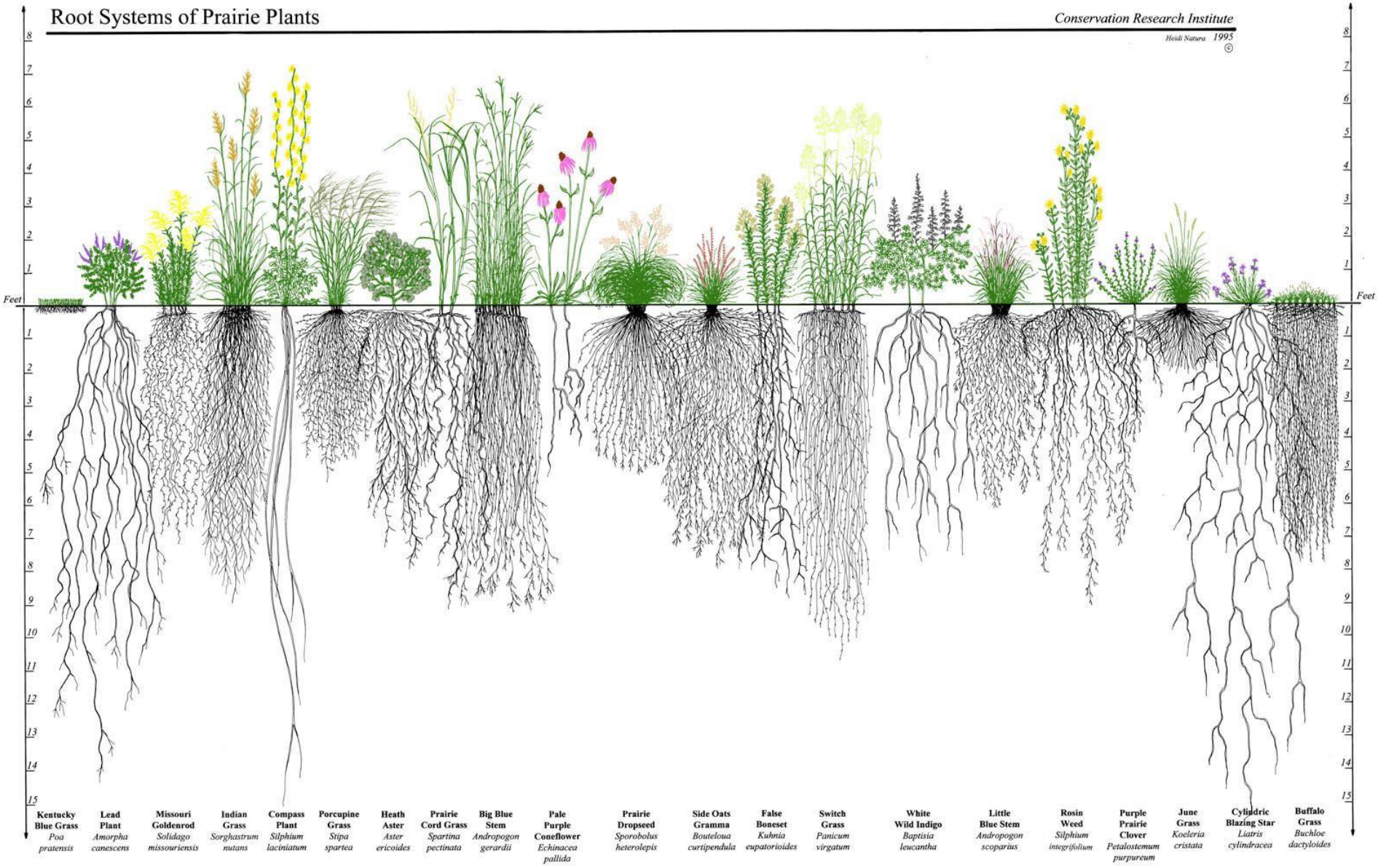
4. Use a diversity of plants



Root Systems of Prairie Plants

Conservation Research Institute

Heidi Natura 1995 ©



Kentucky Blue Grass *Poa pratensis*

Lead Plant *Amorpha canescens*

Missouri Goldenrod *Solidago missouriensis*

Indian Grass *Sorghastrum nutans*

Compass Plant *Silphium laciniatum*

Porcupine Grass *Stipa spartea*

Heath Aster *Aster ericoides*

Prairie Cord Grass *Spartina pectinata*

Big Blue Stem *Andropogon gerardii*

Pale Purple Coneflower *Echinacea pallida*

Prairie Dropseed *Sporobolus heterolepis*

Side Oats Gramma *Bouteloua curtipendula*

False Boneset *Kuhnia eupatorioides*

Switch Grass *Panicum virgatum*

White Wild Indigo *Baptisia leucantha*

Little Blue Stem *Andropogon scoparius*

Rosin Weed *Silphium integrifolium*

Purple Prairie Clover *Petalostemum purpureum*

June Grass *Koeleria cristata*

Cylindric Blazing Star *Liatris cylindracea*

Buffalo Grass *Buchloe dactyloides*

5. Incorporate Animals

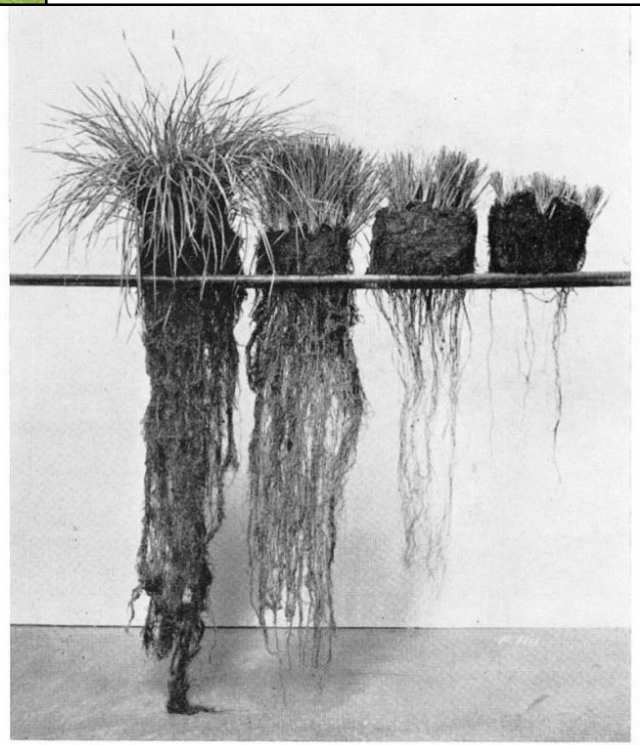
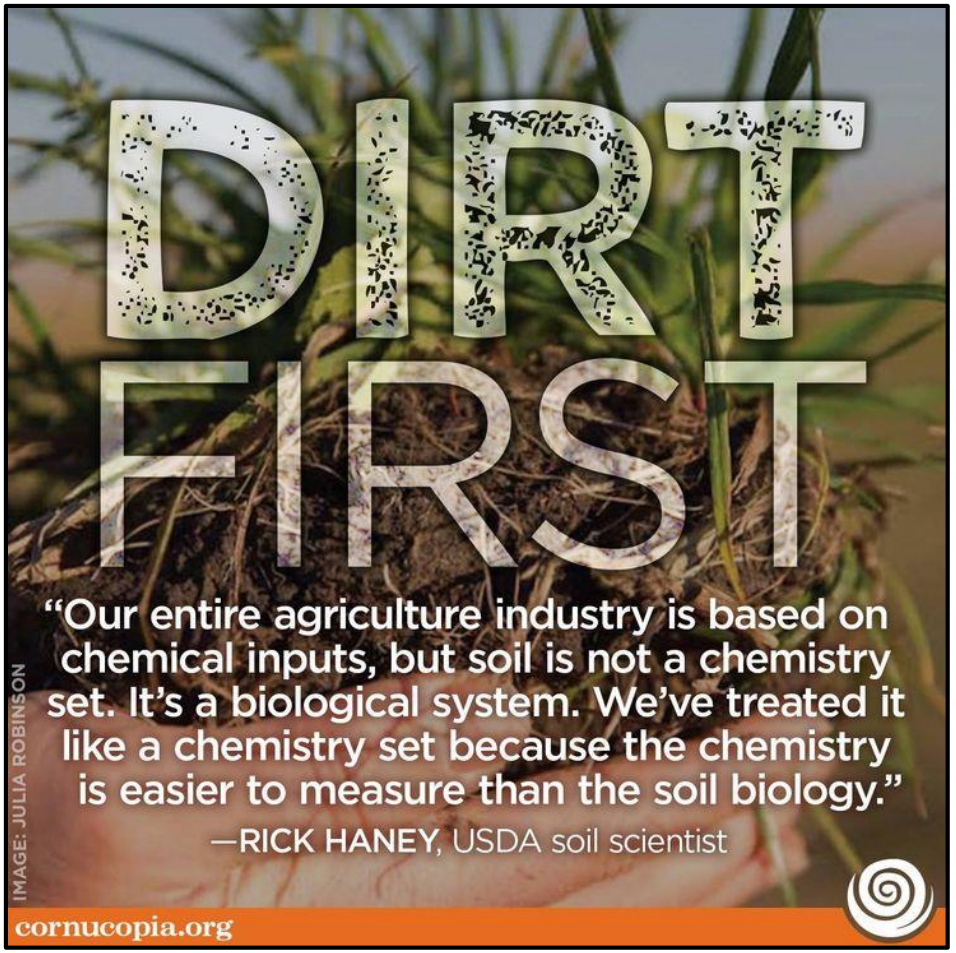
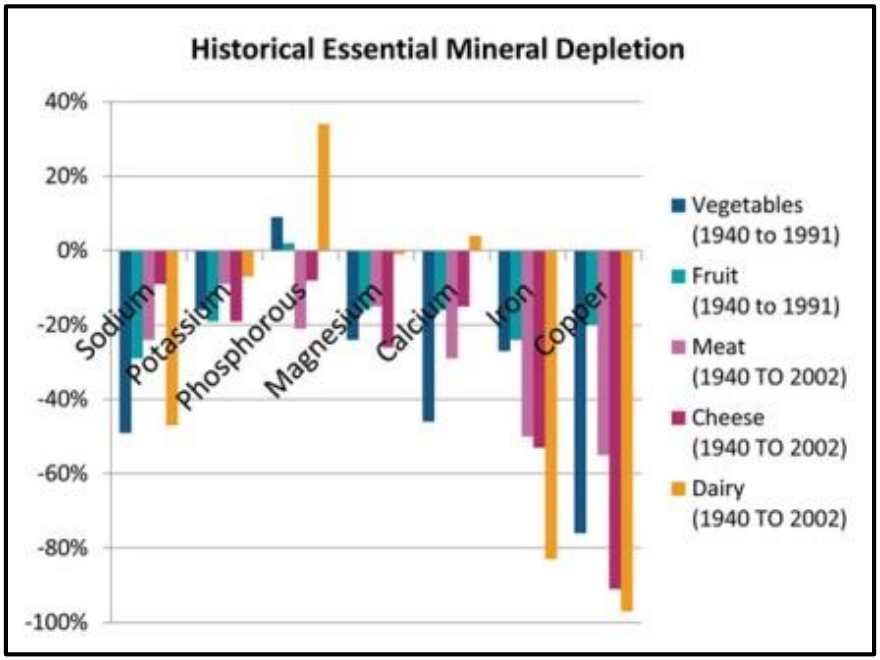


FIGURE 2. Plants of *Festuca scabrella* unclipped and clipped to stubble heights of 5 inches, 3 inches, and 1½ inches at 4-week intervals.

6. Reduce/eliminate chemical inputs



Nutritious Food



Correlation Between Mental Illnesses With Mineral Deficiencies or Imbalances

	Chromium	Copper	Iron	Iodine	Potassium	Magnesium	Molybdenum	Phosphorus	Selenium	Vanadium	Zinc
ADHD		X				X		X			X
Anxiety					X	X		X	X		
Aggression			X		X						X
Bipolar Disorder			X	X	X	X	X			X	
Depression	X	X	X	X	X	X			X	X	X
PMS		X	X			X					X
Schizophrenia		X	X	X		X			X		

[6]"Nutrient Depletion Studies" https://www.secondmessage.com/soil-depletion-studies/

Farm and Farmer Benefits:

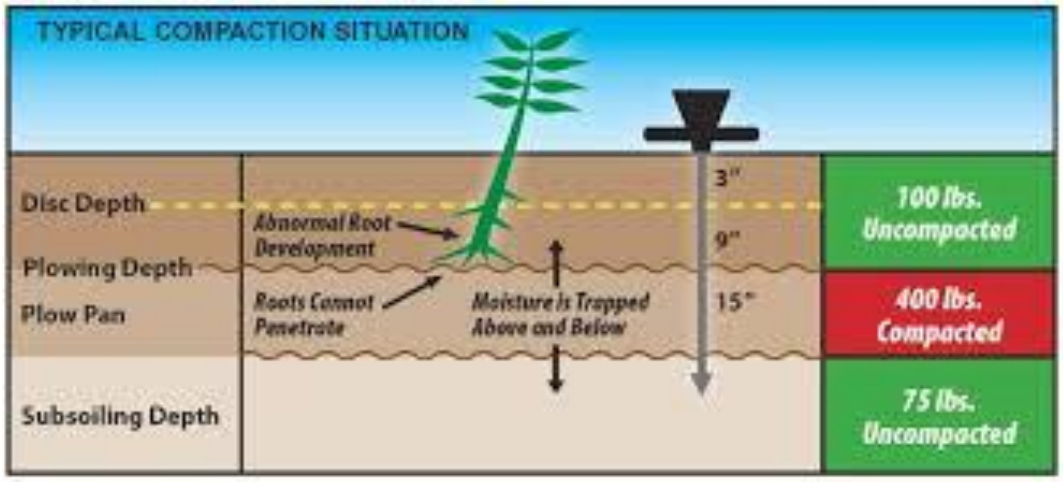
- Better Yields
- More Nutritious Food
- More Weather Resilient Farms
- Better Field Access During Wet Periods
- Less Chemical Input Costs
- Reduced Fuel Use
- Increased Farm Profits
- Clean Water
- Improved Wildlife Habitat

Urban Soil Regeneration

Tools to measure soil Health

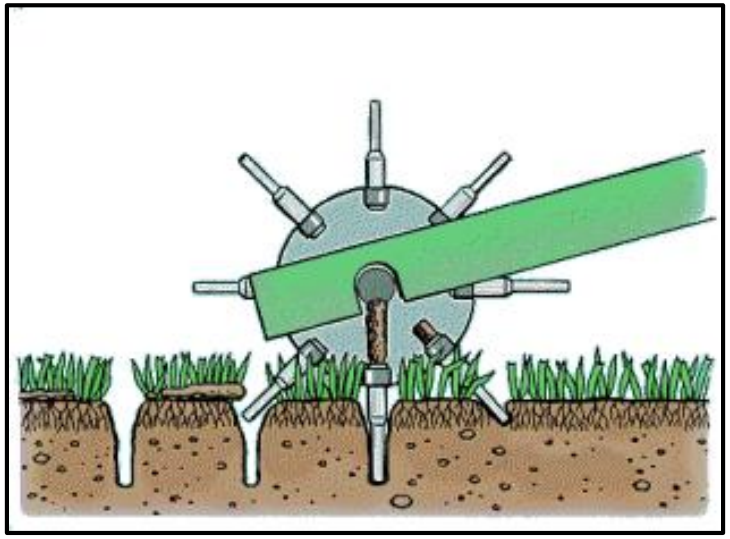
Low Tech
- Shovel
- Pin Flag
- NRCS Soil Health Scorecard

Higher Tech
- Penetrometer
- Single or Double Ring Infiltration Test

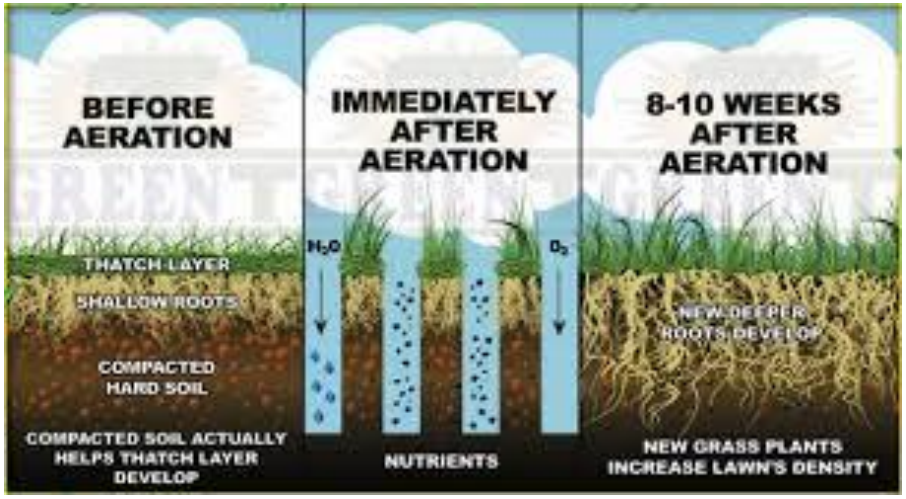


Urban Soil Regeneration Techniques

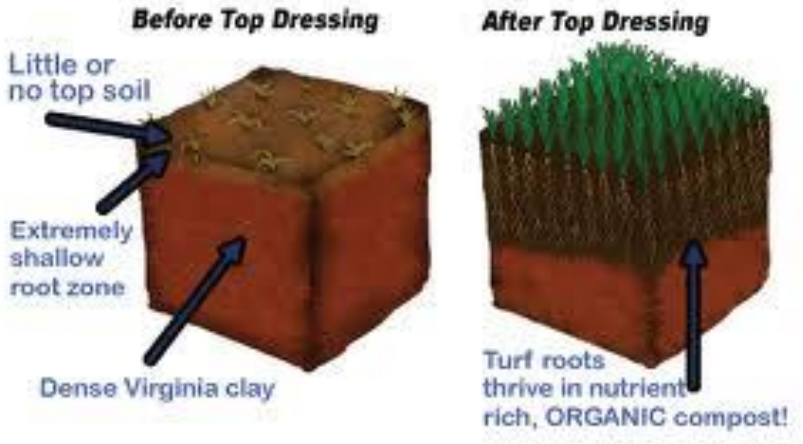
Deep Subsoil Ripping



Aeration



Adding Compost



Using cover crops to loosen compaction

Agronomists Notes on Cover Crops 6-10 weeks after planting in the Midwest[6]

- 21″ deep roots with 4” inch tall Annual Ryegrass
- 15″ deep radish roots that had 2″ tall tops and a “pencil” sized tuber
- 12″ deep crimson clover roots under a 2″ tall top (with many nodules)
- 35″ deep roots on oats that had 20-25″ tall top
- 30″ deep roots on radishes that had 20-25″ tall top growth and 2-3″ diameter tubers
- 12″ deep roots under 18″ tall Austrian Winter Peas (planted in late August after wheat)
- 20″ deep cereal rye roots with 6″ tall top growth

[7]Robison, Dave. “Short Cover Crops put Down Deep Roots”. http://plantcovercrops.com/short-cover-crops-put-down-deep-roots/. 2011

Rain Gardens and Bioretention

Climate Change and Heathy Soils[7]

[8]Source: Kittridge, Jack. *Soil Carbon Restoration-Can Biology do the Job?* Northeast Organic Farming Association/Massachusetts Chapter, Inc. 2015

Multiple Benefits of Healthy Soil

- Cleaner water in lakes, rivers, streams, estuaries
- More economically stable farms-less costly inputs, more drought resistant.
- Much more CO_2 fixed from the atmosphere
- Better resilience to floods and drought
- Improved carbon, nitrogen, and water cycling
- Healthier food with higher nutrient value

Rich Mason, US Fish and Wildlife Service
410-573-4584
Rich_mason@fws.gov