UCCE
El Dorado County
Master Gardeners
Present

Water-resilient Landscapes
Part 1

Water-resilient Landscapes

Agenda:

- Overview
- California Water Story
- It Starts with the Soil
- Hydrozoning & Plant Selection
- Irrigation
- Capturing & Utilizing Rainwater
- Q & A Class Wrap-Up

Resources

- CNPS – What Grows Here? https://www.calflora.org/entry/wgh.html
- Eco-Friendly Landscape Design Plans for the New California Landscape: www.ecolandscape.org/new-ca/
- River Friendly Inspiration Garden: http://www.ecolandscape.org/riverfriendly/topics/inspiration-garden.html
- The Regional Water Authority's Water-Wise Gardening software: http://www.rwa.watersavingplants.com/
- The UC Davis Arboretum All-Stars: http://arboretum.ucdavis.edu/arboretum_all_stars.aspx
- Native plants for Northern California: https://www.wildflower.org/collections/collection.php?collection=CA_north
- The Bay Area Bringing Back the Natives website includes useful information on using California natives in the landscape.
- California plant database search tool — www.waterwonk.us

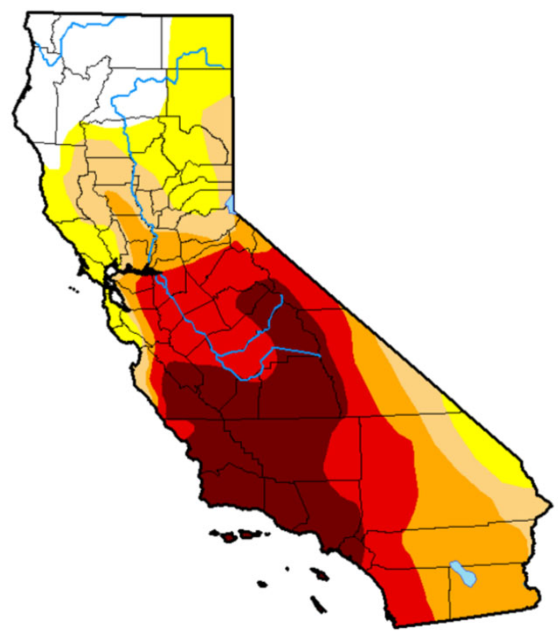
California Water Story

Why Conserve Water?

- **Climate Change- Effect on the Sierra Nevada**
- **Depletion of Our Aquifers & Reservoirs**
- **Contamination of Aquifers**

April 2015 – 25% Mandatory Cutback

88% of state experiencing some level of drought



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	12.03	87.97	73.04	60.27	42.80	21.04
Last Week *11-15-2016*	12.03	87.97	73.04	60.27	42.80	21.04
3 Months Ago *08-23-2016*	0.00	100.00	83.59	59.02	42.80	21.04
Start of Calendar Year *12-29-2015*	0.00	100.00	97.33	87.55	69.07	44.84
Start of Water Year *09-27-2016*	0.00	100.00	83.59	62.27	42.80	21.04
One Year Ago *11-24-2015*	0.14	99.86	97.33	92.26	70.55	44.84

Intensity:

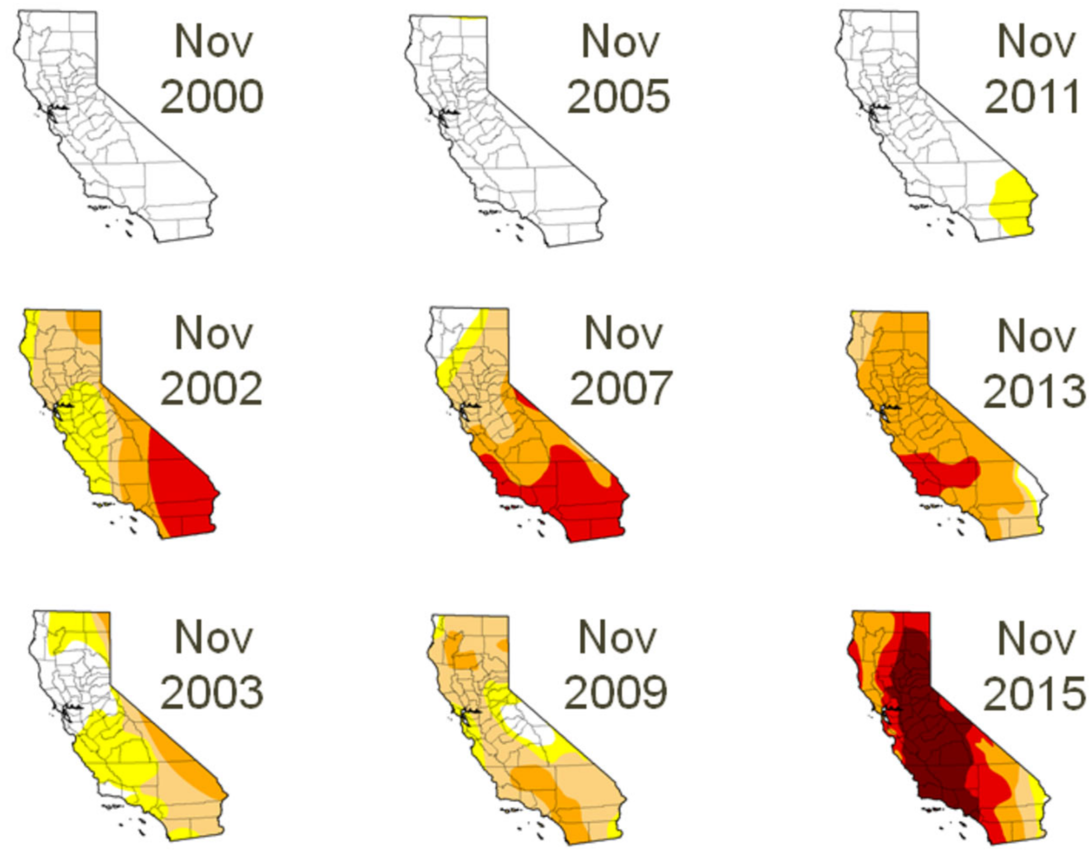
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Richard Heim
NCEI/NOAA

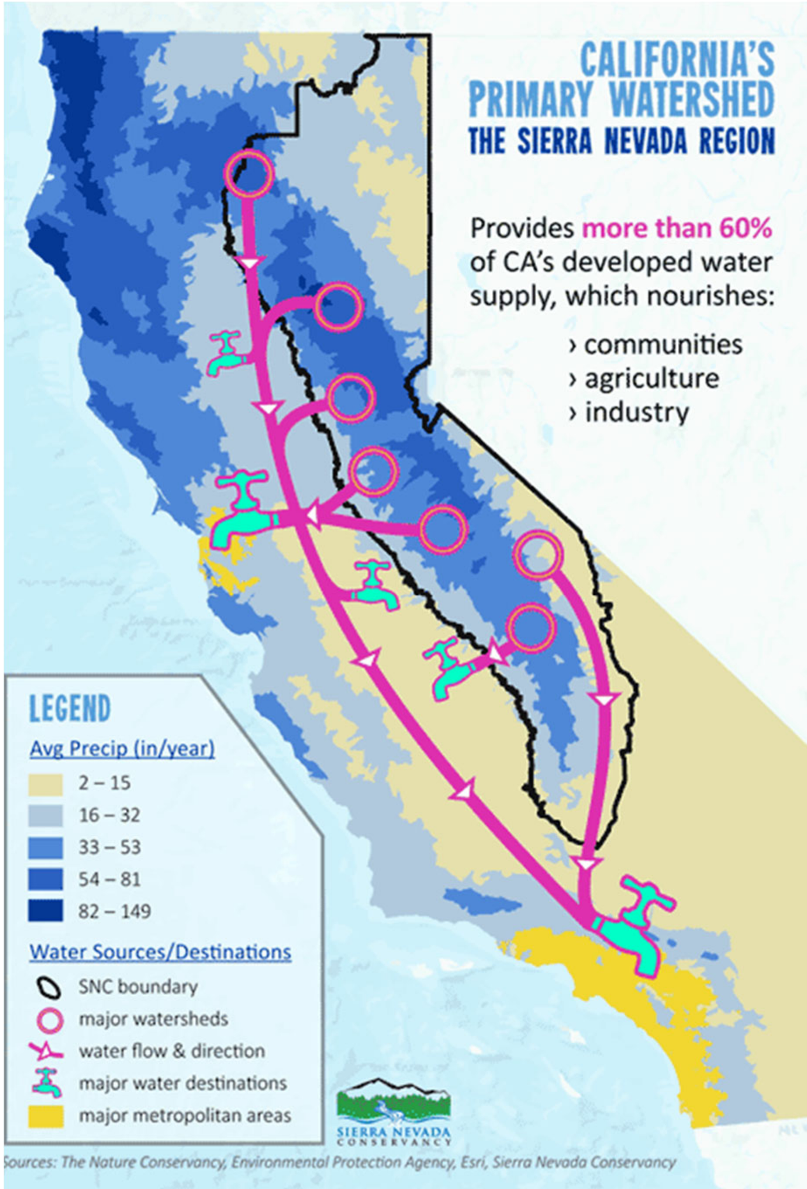
http://droughtmonitor.unl.edu/

15-year Drought Snapshot



Where does Californian's Water Come From?

- 75 percent of the fresh water that flows into the Sacramento-San Joaquin Delta (Delta) comes from the Sierra Nevada
- 60% of treated water comes from the Sierra Nevada
- 30 percent from groundwater in normal years (up to 60 percent in drought years)



Climate Change Effects on Sierra Nevada

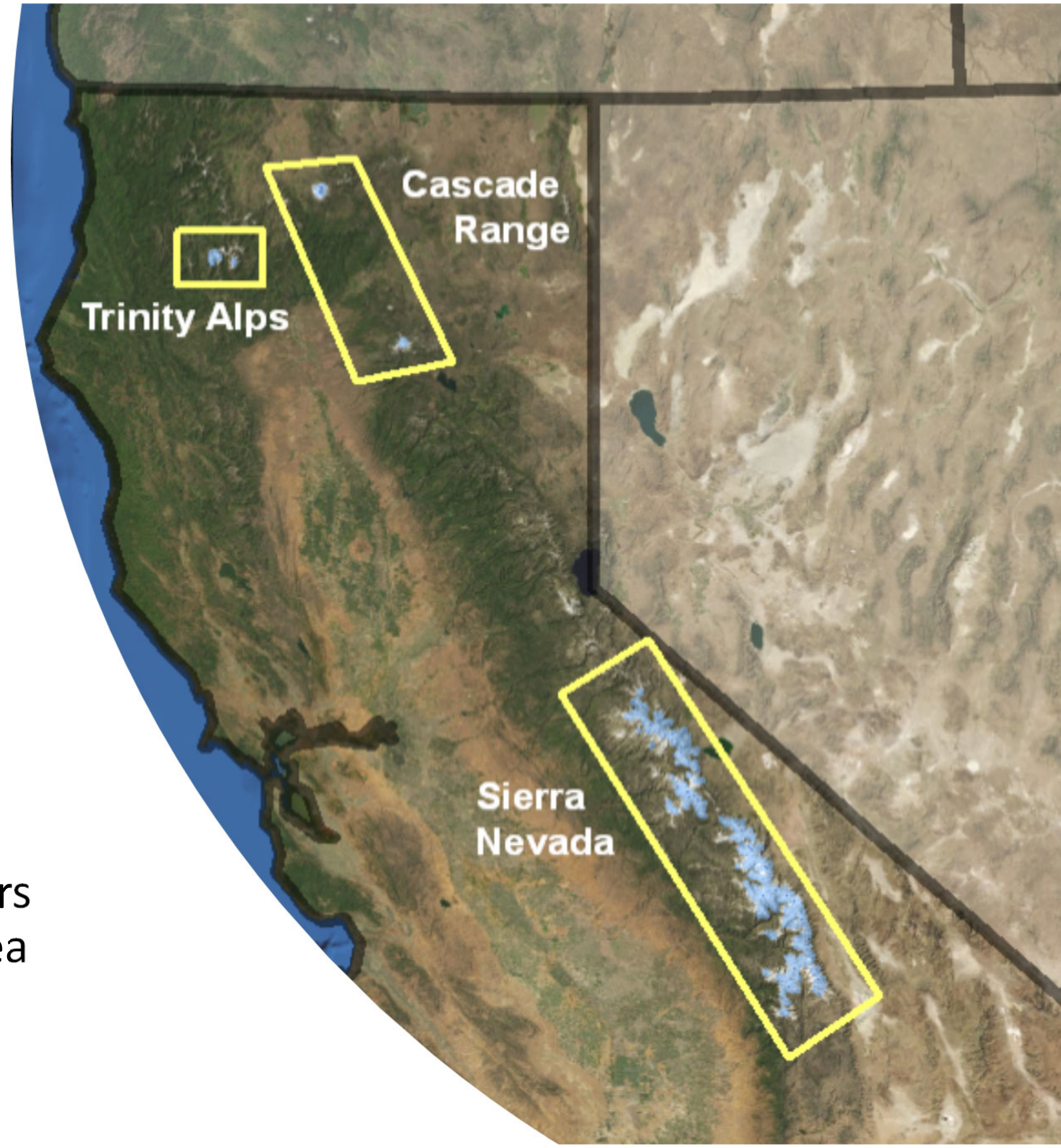
- Glacial retreat
- Snowpack decreasing
- Rise in snow level
- Decline in runoff
- Peak runoff timing
- Off–storage capacity

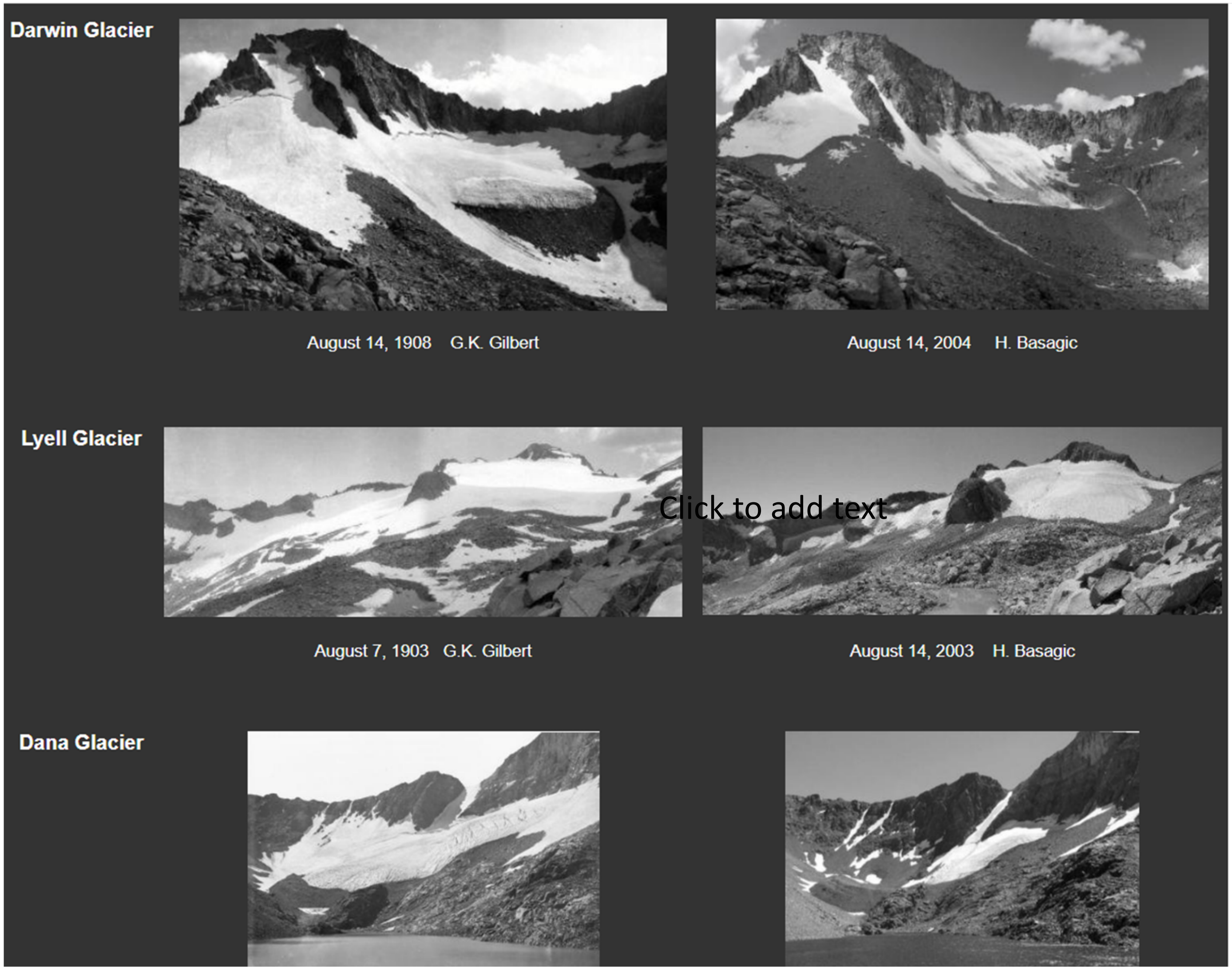
Glaciers in California

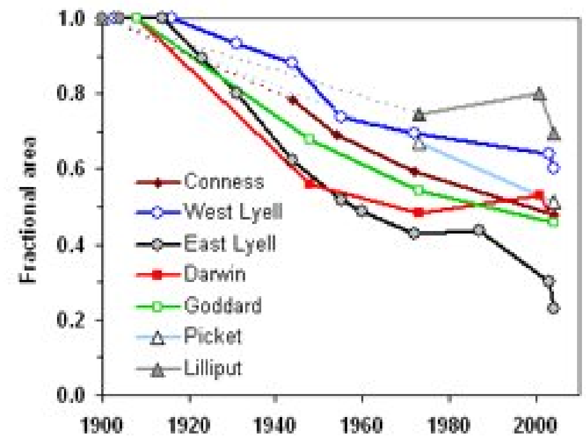
- **Definition:** A body of perennial ice or snow that moves. Movement of ice can be observed as cracks in the ice known as crevasses.

- Estimated number of "true glaciers":118

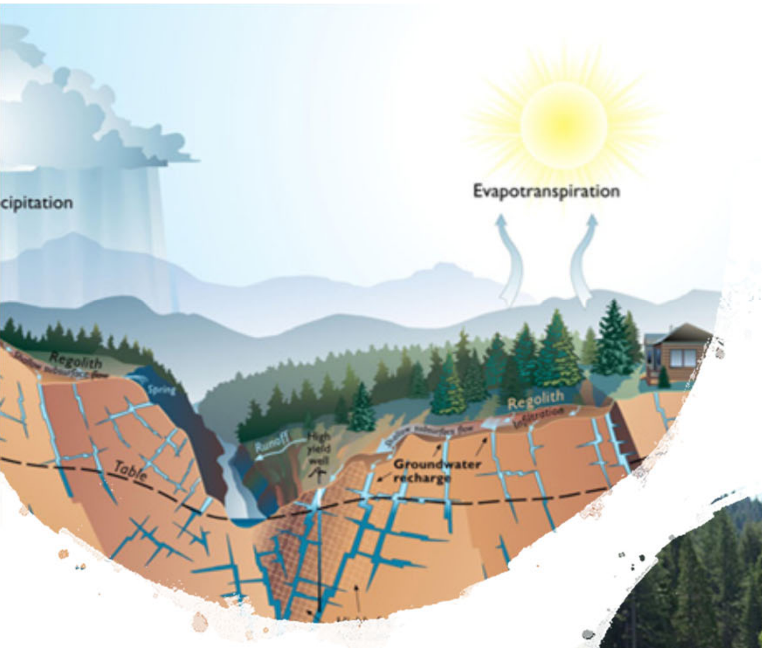
- Based on analysis of photographs, glaciers lost an average of 55 % of their surface area between 1900 and 2004

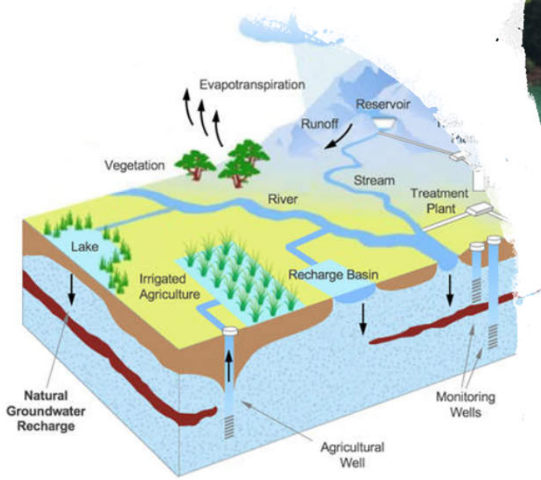






http://www.glaciers.pdx.edu/Thesis/Basagic/snglac.html





How is water stored?

- Surface
  - Lakes
  - Reservoirs
- Sub-surface
  - Fissures and cracks in the rock
  - Aquifers

Changing Water

Snowpack decreasing

- Normally provides 1/3 of the state's total water supply
- Since 1915, average snowpack in western states has declined by between 15 and 30 percent; equivalent to Lake Mead
- Declining trends largest in the spring, in Pacific states, and in locations with mild winter climates

Rise in snow level

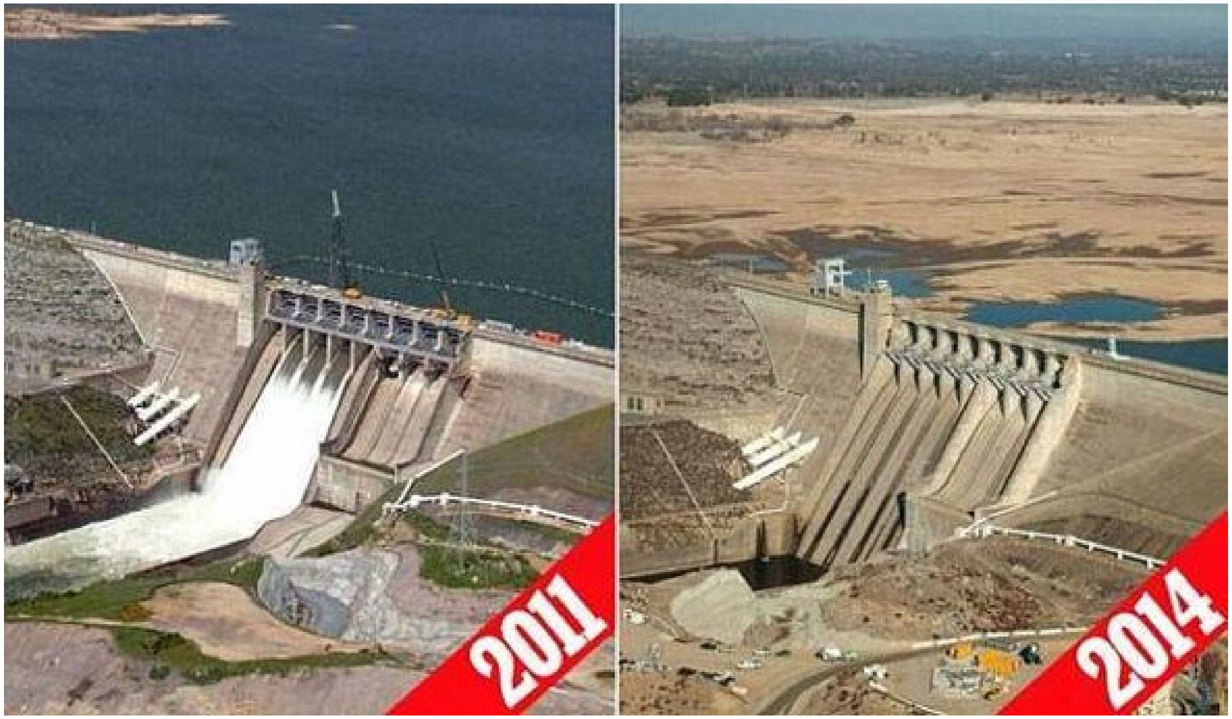
Decline in runoff

Changing Water

- **Peak runoff timing**
  - 50–80% is spring and summer runoff
  - Earlier-occurring snowmelt runoff threatens storage efficiencies
    - Flood control vs. maximum storage

Early runoff → Early release → Less water stored → Longer summer droughts

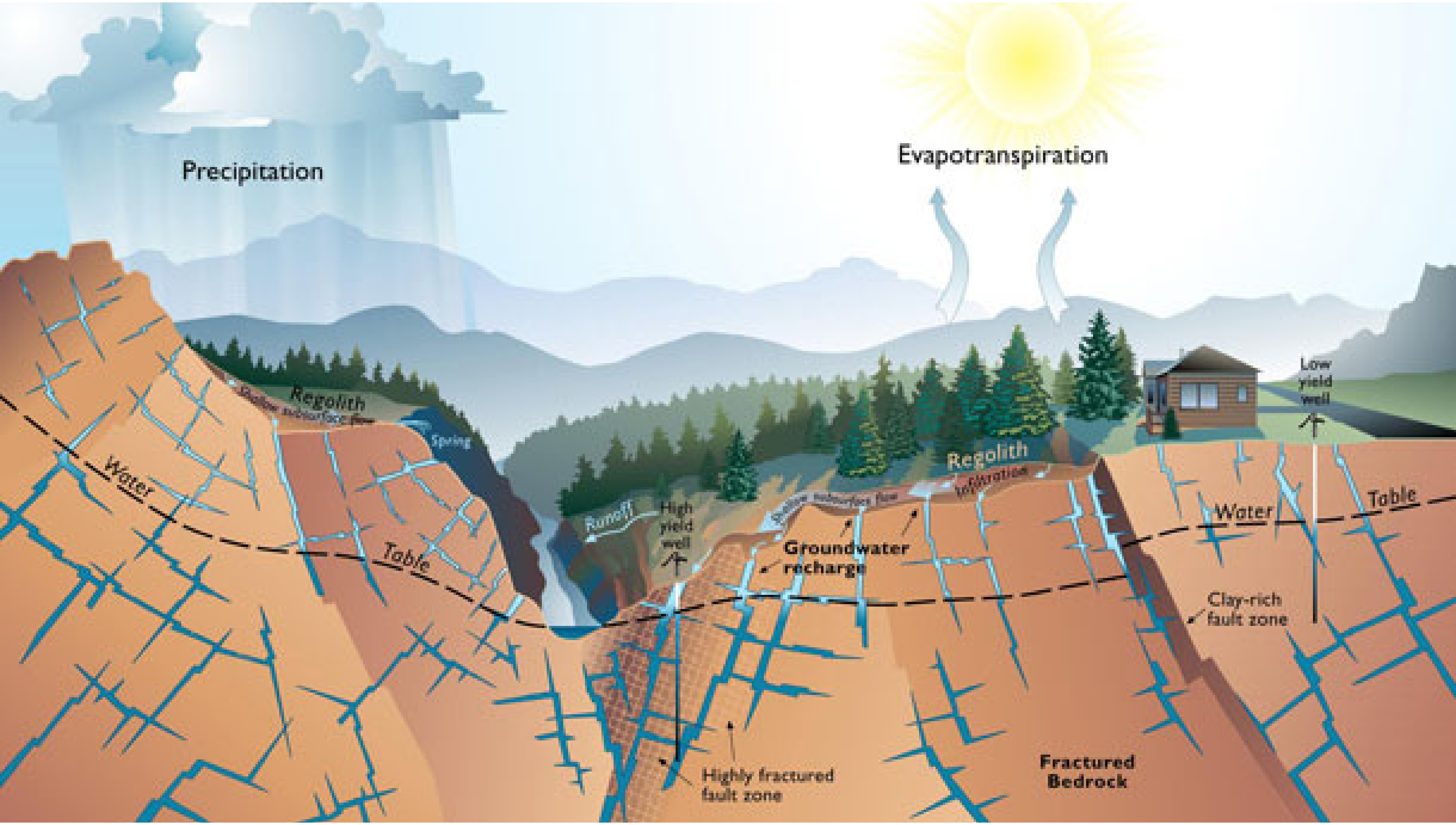
- consequences for water supply, ecosystem, and wildfire management



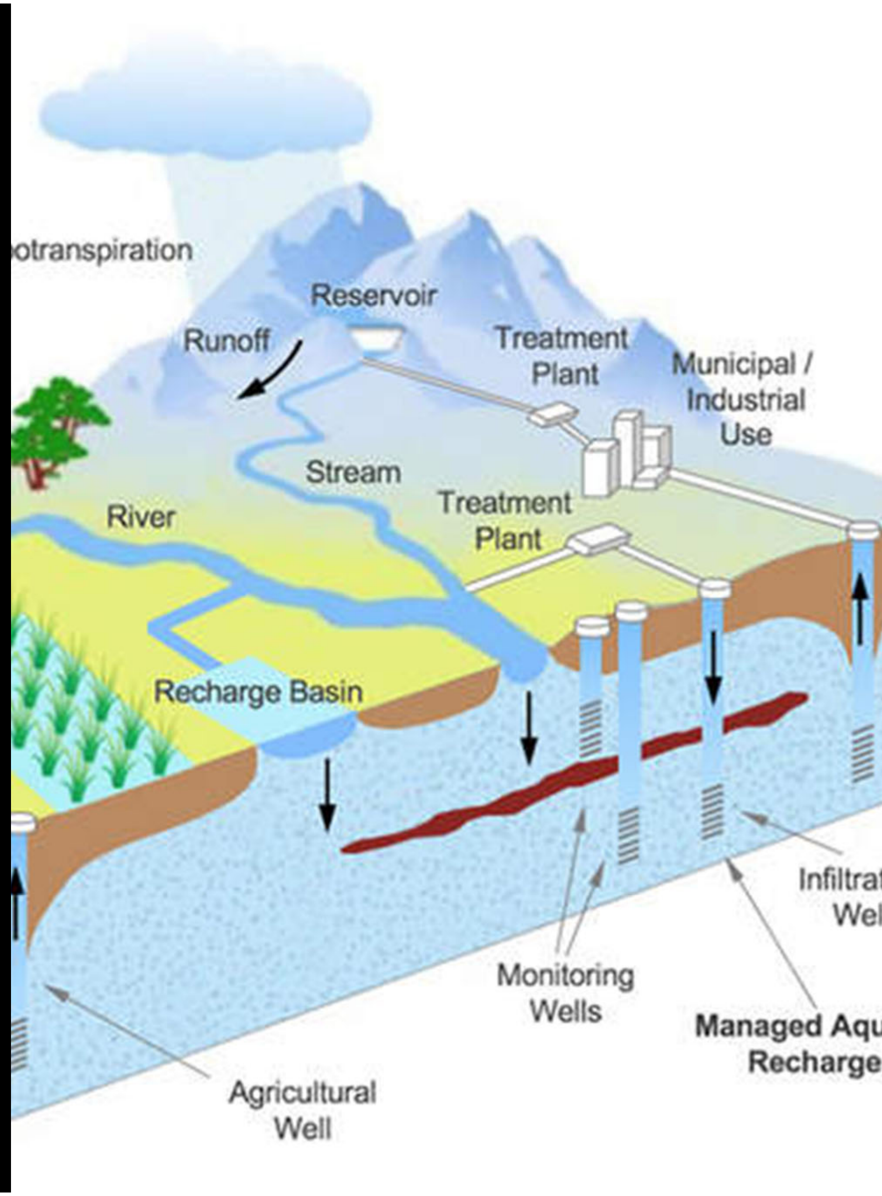
Reservoirs

- New storage capacity has a low and decreasing incremental value for water users and other beneficiaries

"Completing all Proposition 1-funded storage projects ($2.7B) would increase total surface water storage capacity in California by less than 8 percent, and increase water deliveries by perhaps 1-2 percent, because most of the expanded capacity would refill infrequently."


Precipitation
Evapotranspiration
Regolith
Shallow subsurface flow
Spring
Water
Table
Runoff
High yield well
Regolith
Shallow subsurface flow
Infiltration
Groundwater recharge
Low yield well
Water
Table
Clay-rich fault zone
Highly fractured fault zone
Fractured Bedrock

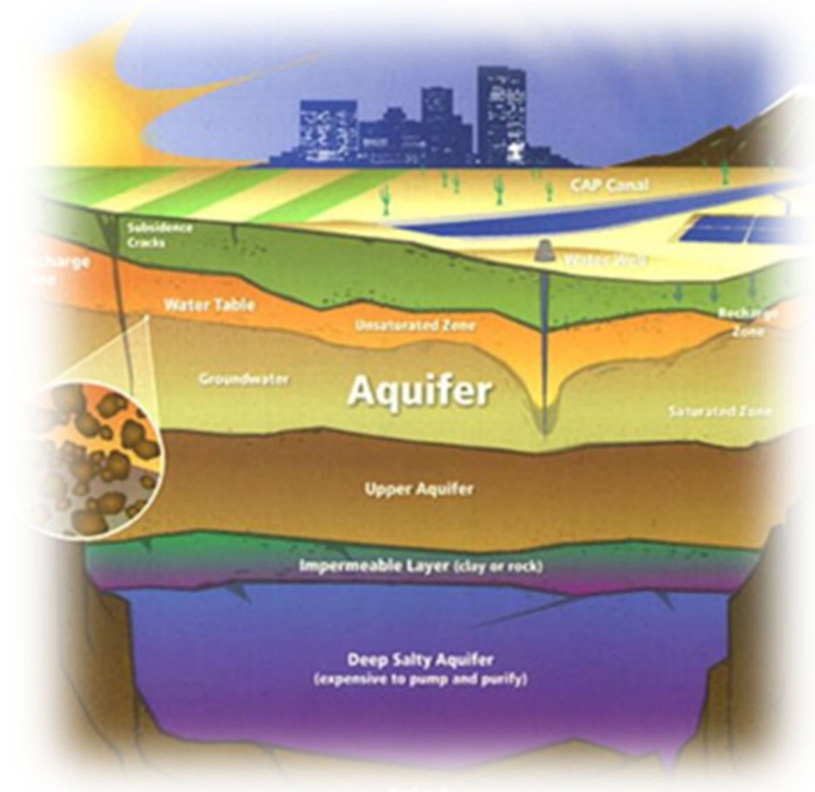
Aquifers



otranspiration
Reservoir
Runoff
Treatment Plant
Municipal / Industrial Use
Stream
River
Treatment Plant
Recharge Basin
Infiltrati
Well
Monitoring Wells
Managed Aqui
Recharge
Agricultural Well

Depletion of Aquifers

- Groundwater
  - does not exist in underground lakes
  - fills pores (spaces) between sand, gravel, silt and clay in water-bearing formations known as aquifers.



Water Conservation

- **A holistic approach of**
  - **Creating drought-resistant soils** with compost and mulch
  - **Use efficient irrigation** systems that include self-adjusting, weather-based controllers
  - **Install systems to capture and reuse water**
    - stormwater, greywater and recycled water in the landscape as much as possible

Water Conservation

- **Selecting plants** naturally adapted to summer-dry climates
- **Group plants by water needs** (hydrozoning)
- **Minimize/eliminate lawn**
  - Lawn requires much more water to keep healthy than other landscape plants.
  - Reducing or eliminating the lawn area conserves water and energy and reduces need for fertilizers and pesticides

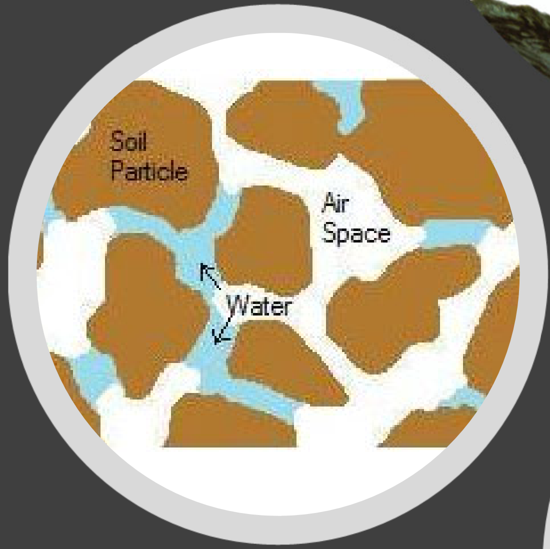
It Starts with the Soil

The Role of Soil

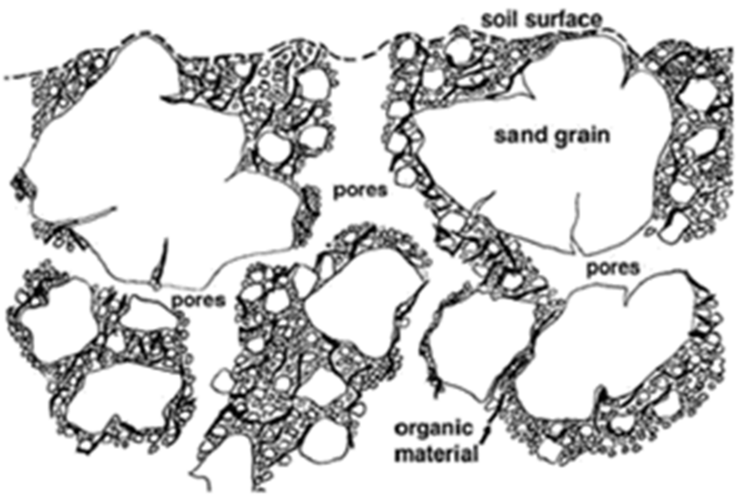
- Topsoil formation occurs when living material descends into Mother Earth followed by the movement of waste material from living things into plants. And the cycle continues…

What is Soil?

- Average garden soil is a complex mixture of
  - 45% minerals (weathered rock)
  - <50% air and water (approximately half and half)
  - 5% organic matter
    - decaying remains of plants, animals and microorganisms



Air and Water

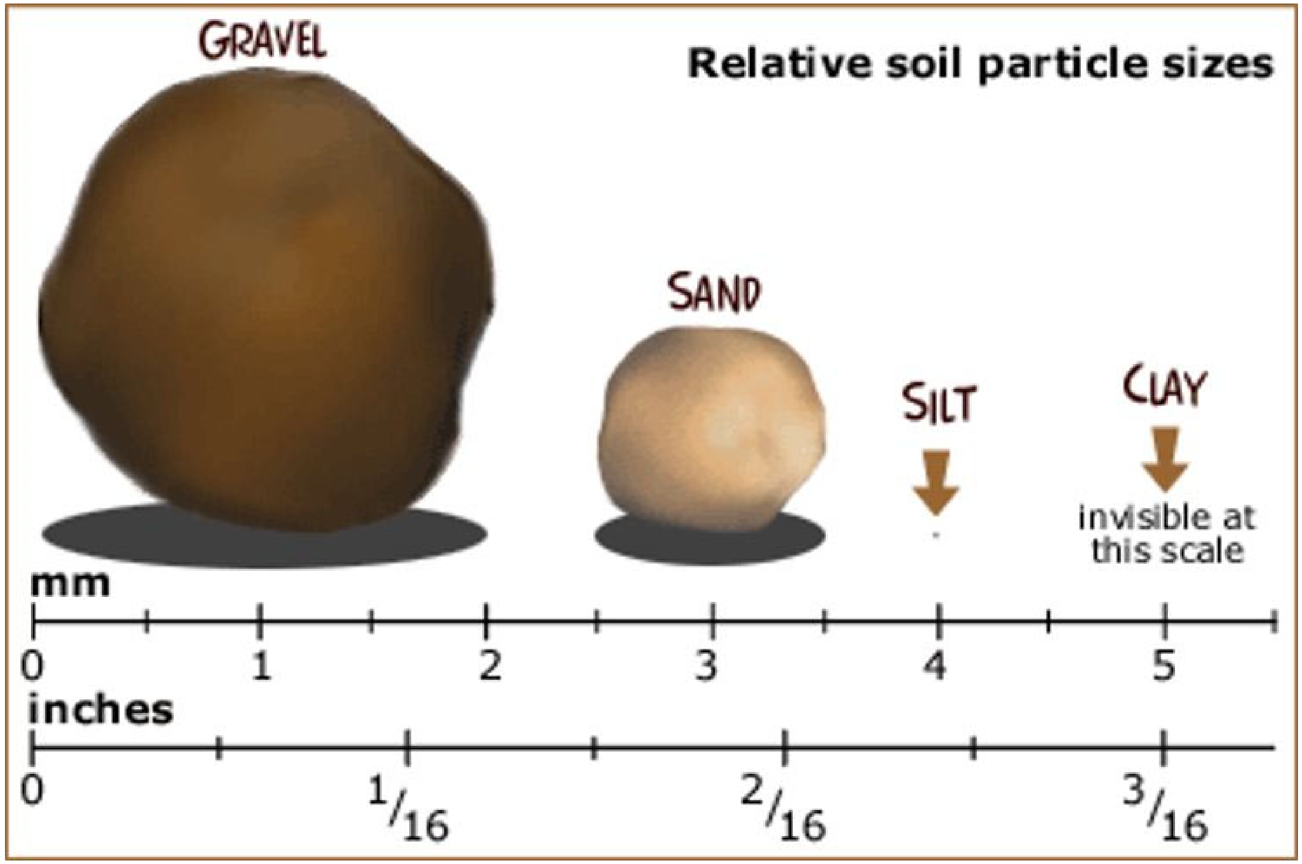


- Fills the voids between the mineral and organic particles
- Water moves through the soil 2 ways
  - Gravitational water moves freely and down
  - Capillary water moves by the molecular attraction of water molecules for each other and can move up and down
- Water movement pushes stale air out and sucks in air from the surface and displaces carbon dioxide

Air and Water (cont.)

- Water movement pushes stale air out and sucks in air from the surface and displacing carbon dioxide
- Soil compaction reduces pore space so that water and air can't move through it and is prone to anaerobic activity
  - In the absence of air, organisms produce alcohols that kill plant roots
- Hydroscopic water
  - A few molecules thick on the surface of particles and hard to break the bond
  - Cannot be used by roots
  - Critical to the ability of microbes to travel and live

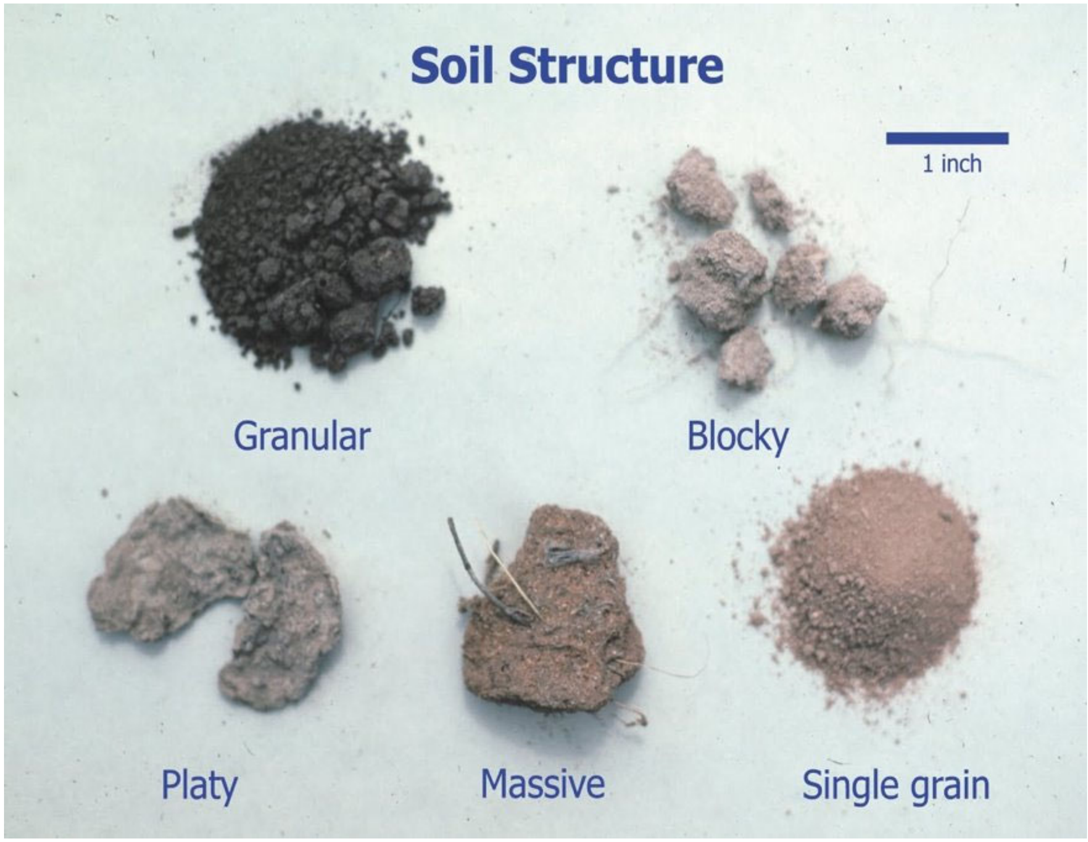
Relative Soil Particle Sizes



- **Texture**
  - **Sand – 0.0625 to 2 mm**
  - **Silt - 0.004 – 0.0625 mm**
  - **Clay - < 0.004 mm**

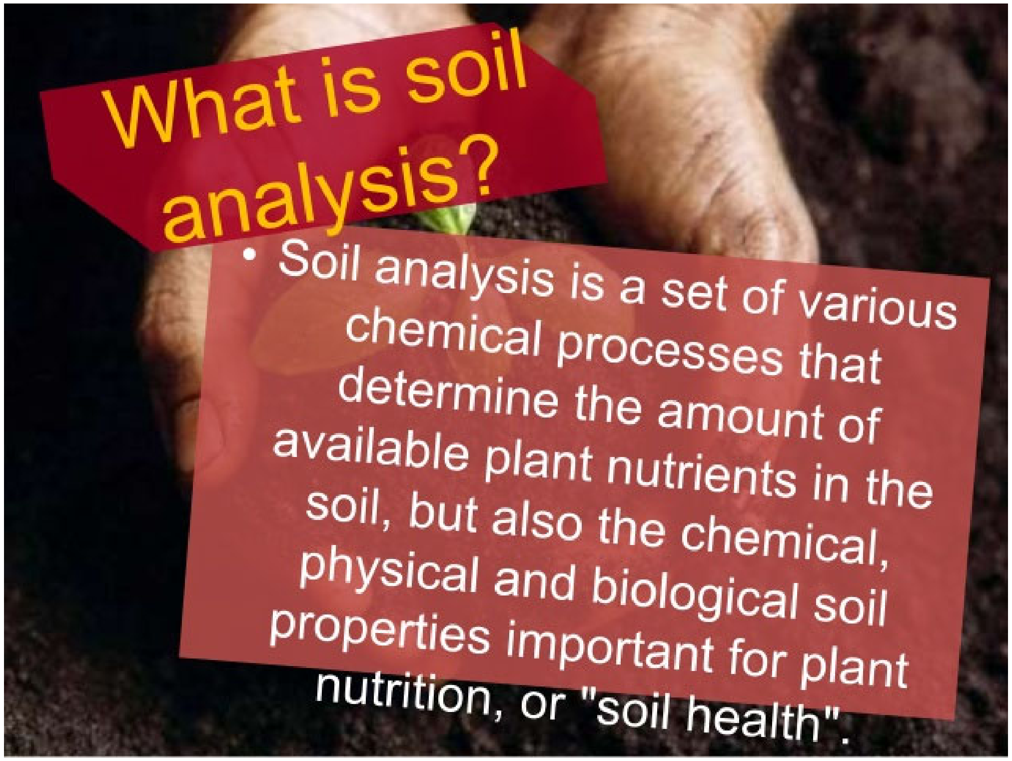
Soil Structure

- The arrangement of the solid parts of the soil and of the pore space located between them
  - Affects drainage and water movement
  - Affects air circulation
  - Space for soil organisms to live



Soils Analysis

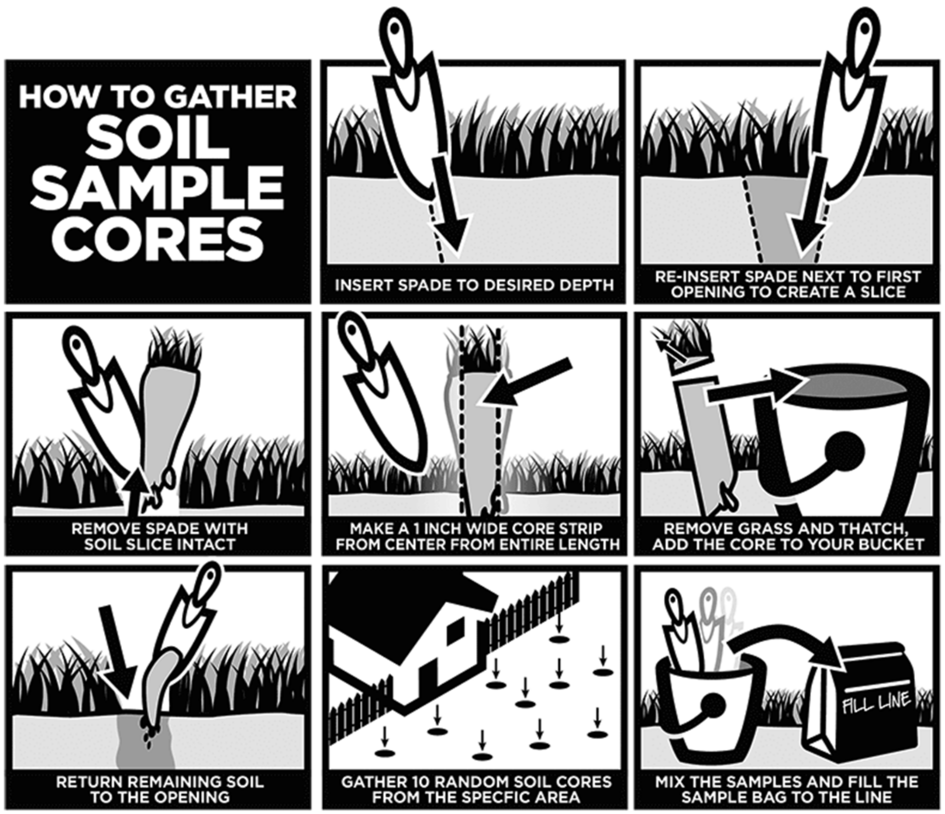
- Nutrient content
  - Macro-nutrients (NPK)
  - Micro-nutrients
- pH
- Organic matter
- Salts
- Soil Structure



Mechanical Analysis of Soils "The Jar Test"

- **Materials**:
  - Various soil samples (remove pebbles, rocks and OM)
  - Mesh sieve or old colander
  - 1 one-quart canning jar (with lid and ring) for each sample
  - Calgon water softener, Dawn detergent or powder dishwasher soap
  - Ruler (metric)
  - ½ cup measuring cup
  - Tablespoon
  - Masking tape and pen (or similar materials for labeling jars)

Getting Soil Samples



- Create a soil slice about ½” thick by 6-10” deep
- Take a 1-inch-wide core strip from the center down the entire length
- Remove grass blades, stems, stones, thatch and other organic matter & place in a bag or bucket
- Return remaining soil to the opening pressing firmly back in place
- Repeat to collect 6 to 10 random soil cores from the area
- Mix the cores thoroughly to make one uniform sample of ½ to 1 cup

Mechanical Analysis of Soils "The Jar Test"

Procedure:

1. Place about ½ cup of loose soil in a quart jar.
2. Add 1 heaping tablespoon of Calgon and 3-½ cups of water. Cap and shake for 5 minutes (alternately inverting the jar will suffice).
3. Allow the jar to sit, undisturbed, for at least 24 hours.
4. At the end of 24 hours, measure the depth of settled soil. This represents the total depth of soil.
5. Shake again thoroughly for 5 minutes.
6. Let the jar sit, undisturbed, for 40 seconds. Measure the depth of the settled soil with a ruler. This is the sand layer.
7. At the end of 30 minutes, measure the depth of the settled soil again. From this depth, subtract the thickness of the sand layer to obtain the depth of the silt layer above it.
8. The remaining unsettled particles in suspension represent the clay fraction and can be obtained by subtracting the depths of the sand and silt layers from the total depth determined in step 2.

Mechanical Analysis of Soils "The Jar Test"

- The more thoroughly your sample is dispersed by mixing, the more accurate your measurements will be.
- Optional method: mix sample initially (step 1) in a blender for 10 minutes rather than shaking by hand.
  - more thoroughly disperses floccules of clay which may otherwise settle with the sand and/or silt fractions due to their size

Mechanical Analysis of Soils “The Jar Test”

- **The measurements may be converted into percentage figures according to the following example:**
  - Total depth of soil: 23 mm
  - Depth of Sand Layer 9 mm
  - Depth of Silt Layer 10 mm

% sand = 9mm/23mm x 100% = 39%

% silt = 10mm/23mm x 100% = 43.5%

% clay = 100% - 39% - 43.5% = 17.5%

Mechanical Analysis of Soils “The Jar Test”

- **Plot your percentages on the soil texture triangle.**
  - Begin by putting a mark on the bottom leg of the triangle at the percent of SAND you calculated in your soil sample.
  - From this point, draw a line upward to the left, parallel to the other slanted lines that start on the sand scale (bottom) of the triangle.
  - On the left side of the triangle, mark the percent of SILT in your sample.
  - From this point, draw a horizontal line across the triangle to the right.
  - On the right side of the triangle, mark the percent of CLAY in your sample.
  - From this point, draw a line down to the left, parallel to the other lines that start on the clay scale.
  - The 3 lines you have drawn should intersect in a point. That point will fall into one of the soil descriptions on the graph.

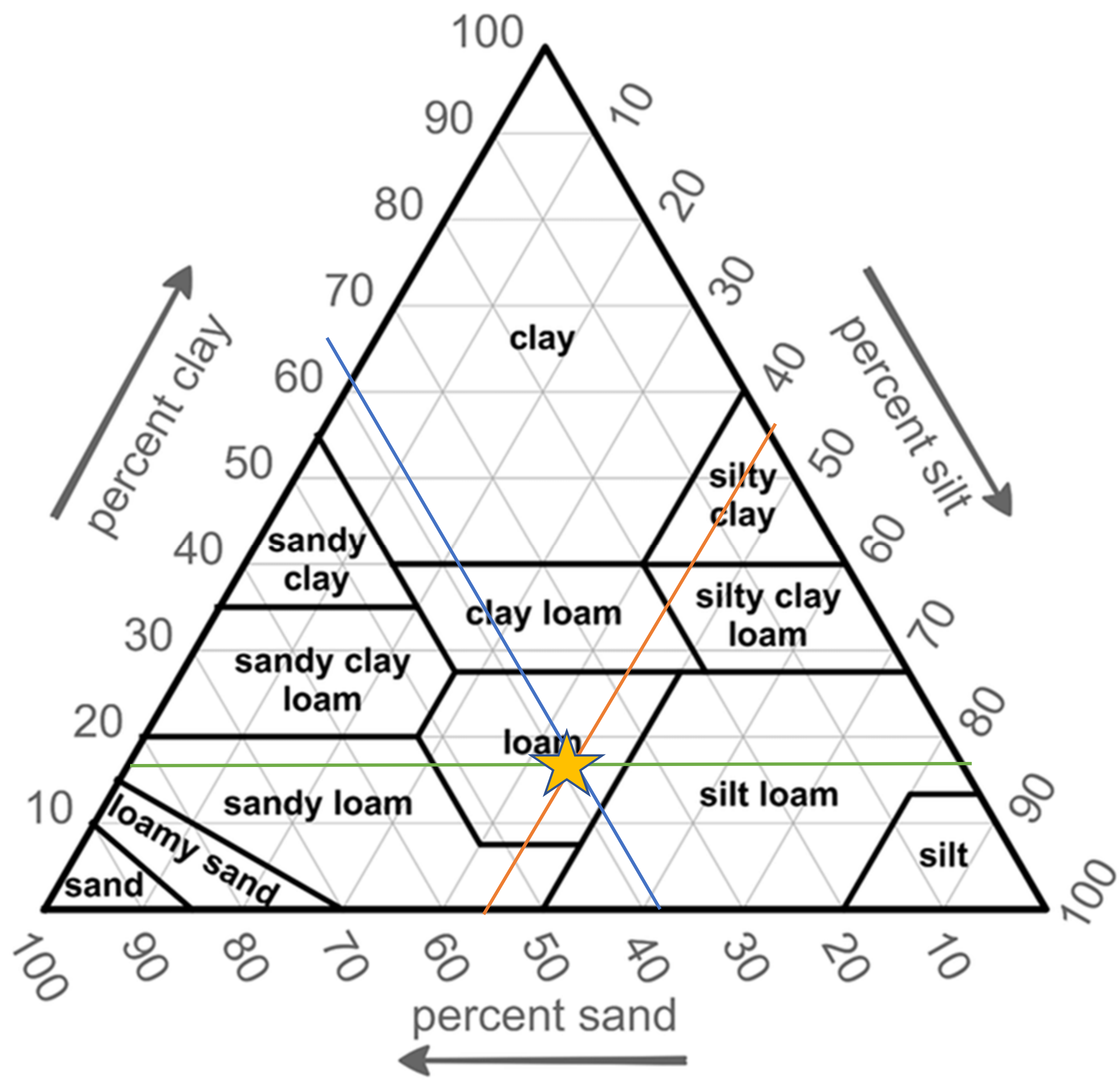
Mechanical Analysis of Soils "The Jar Test"

- Refer to the soil triangle and determine the textural class of your soil.

  % sand = 9mm/23mm x 100% = 39%

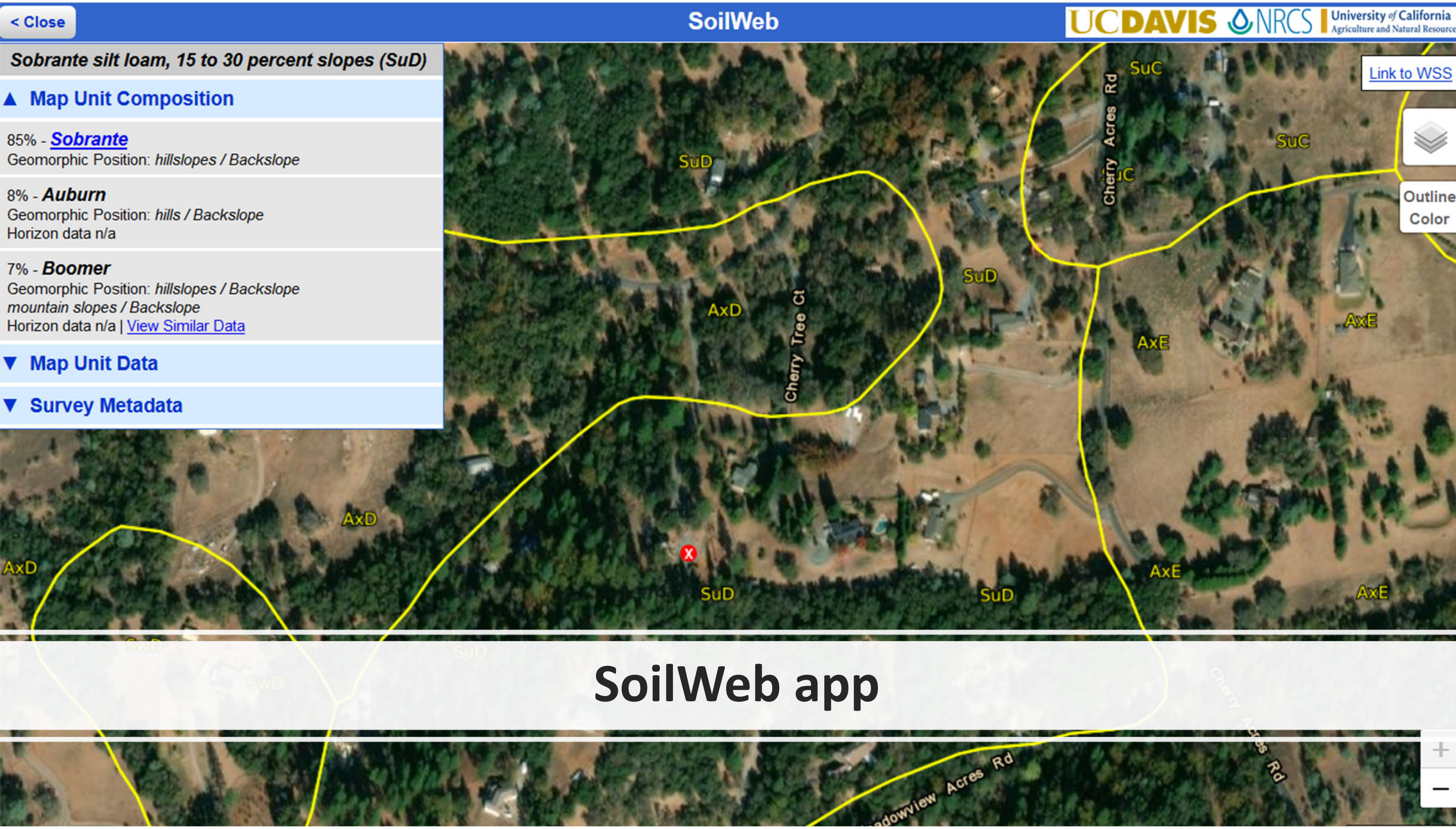
  % silt = 10mm/23mm x 100% = 43.5%

  % clay = 100% - 39% - 43.5% = 17.5%

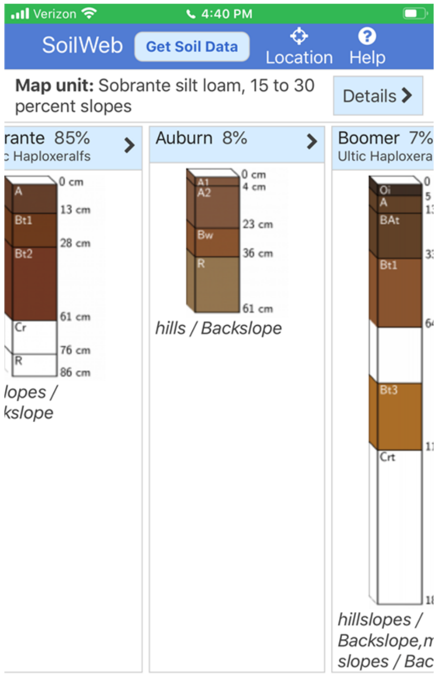


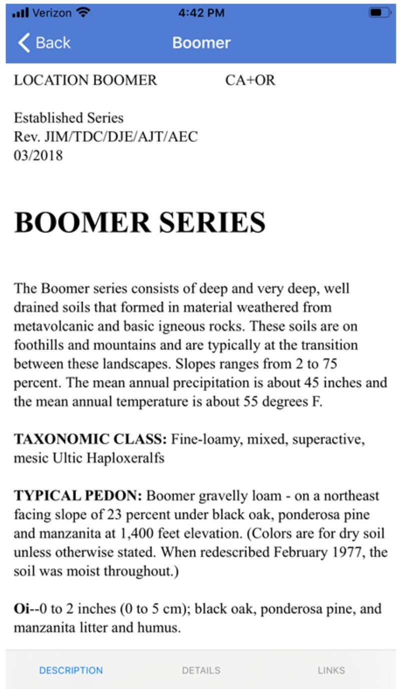
SoilWeb app

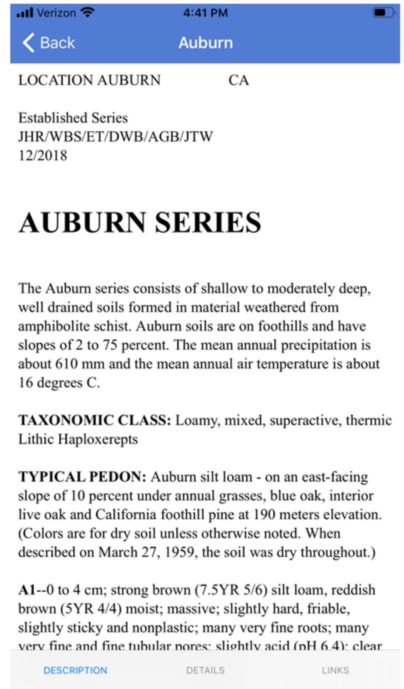
- Accesses USDA-NCSS detailed soil survey data (SSURGO)
- SSURGO database contains information about soil as collected by the National Cooperative Soil Survey over the course of a century

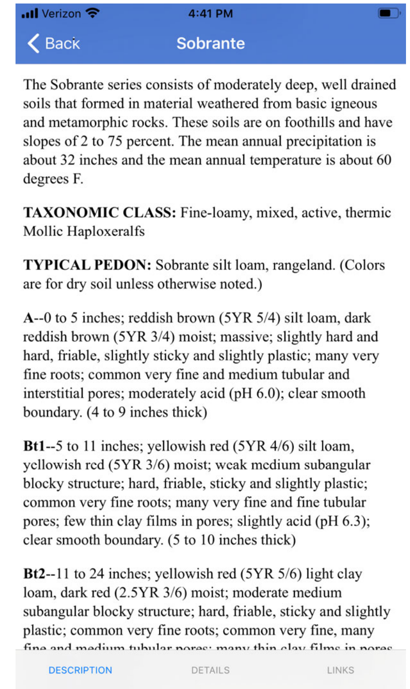

< Close
SoilWeb
UC DAVIS
NRCS
University of California
Agriculture and Natural Resources
Sobrante silt loam, 15 to 30 percent slopes (SuD)
▲ Map Unit Composition
85% - Sobrante
Geomorphic Position: hillslopes / Backslope
8% - Auburn
Geomorphic Position: hills / Backslope
Horizon data n/a
7% - Boomer
Geomorphic Position: hillslopes / Backslope
mountain slopes / Backslope
Horizon data n/a | View Similar Data
▼ Map Unit Data
▼ Survey Metadata
Link to WSS
Outline Color
SuD
SuC
AxD
AxE
Cherry Tree Ct
Cherry Acres Rd
Meadowview Acres Rd

SoilWeb app


Verizon 4:40 PM
SoilWeb
Get Soil Data
Location
Help
Map unit: Sobrante silt loam, 15 to 30 percent slopes
Details
rante 85%
Haploxeralfs
Auburn 8%
Boomer 7%
Ultic Haploxera
hills / Backslope
hillslopes / Backslope,
slopes / Bac


Verizon 4:42 PM
Back
Boomer
LOCATION BOOMER CA+OR
Established Series
Rev. JIM/TDC/DJE/AJT/AEC
03/2018
BOOMER SERIES
The Boomer series consists of deep and very deep, well drained soils that formed in material weathered from metavolcanic and basic igneous rocks. These soils are on foothills and mountains and are typically at the transition between these landscapes. Slopes ranges from 2 to 75 percent. The mean annual precipitation is about 45 inches and the mean annual temperature is about 55 degrees F.
TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Ultic Haploxeralfs
TYPICAL PEDON: Boomer gravelly loam - on a northeast facing slope of 23 percent under black oak, ponderosa pine and manzanita at 1,400 feet elevation. (Colors are for dry soil unless otherwise stated. When redescribed February 1977, the soil was moist throughout.)
Oi--0 to 2 inches (0 to 5 cm); black oak, ponderosa pine, and manzanita litter and humus.
DESCRIPTION
DETAILS
LINKS


Verizon 4:41 PM
Back
Auburn
LOCATION AUBURN CA
Established Series
JHR/WBS/ET/DWB/AGB/JTW
12/2018
AUBURN SERIES
The Auburn series consists of shallow to moderately deep, well drained soils formed in material weathered from amphibolite schist. Auburn soils are on foothills and have slopes of 2 to 75 percent. The mean annual precipitation is about 610 mm and the mean annual air temperature is about 16 degrees C.
TAXONOMIC CLASS: Loamy, mixed, superactive, thermic Lithic Haploxerepts
TYPICAL PEDON: Auburn silt loam - on an east-facing slope of 10 percent under annual grasses, blue oak, interior live oak and California foothill pine at 190 meters elevation. (Colors are for dry soil unless otherwise noted. When described on March 27, 1959, the soil was dry throughout.)
A1--0 to 4 cm; strong brown (7.5YR 5/6) silt loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; many
DESCRIPTION
DETAILS
LINKS


Verizon 4:41 PM
Back
Sobrante
The Sobrante series consists of moderately deep, well drained soils that formed in material weathered from basic igneous and metamorphic rocks. These soils are on foothills and have slopes of 2 to 75 percent. The mean annual precipitation is about 32 inches and the mean annual temperature is about 60 degrees F.
TAXONOMIC CLASS: Fine-loamy, mixed, active, thermic Mollic Haploxeralfs
TYPICAL PEDON: Sobrante silt loam, rangeland. (Colors are for dry soil unless otherwise noted.)
A--0 to 5 inches; reddish brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) moist; massive; slightly hard and hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine and medium tubular and interstitial pores; moderately acid (pH 6.0); clear smooth boundary. (4 to 9 inches thick)
Bt1--5 to 11 inches; yellowish red (5YR 4/6) silt loam, yellowish red (5YR 3/6) moist; weak medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; many very fine and fine tubular pores; few thin clay films in pores; slightly acid (pH 6.3); clear smooth boundary. (5 to 10 inches thick)
Bt2--11 to 24 inches; yellowish red (5YR 5/6) light clay loam, dark red (2.5YR 3/6) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine roots; common very fine, many
DESCRIPTION
DETAILS
LINKS

SoilWeb app

My Soil Jar Test

Fine silty loam

Drainage Test

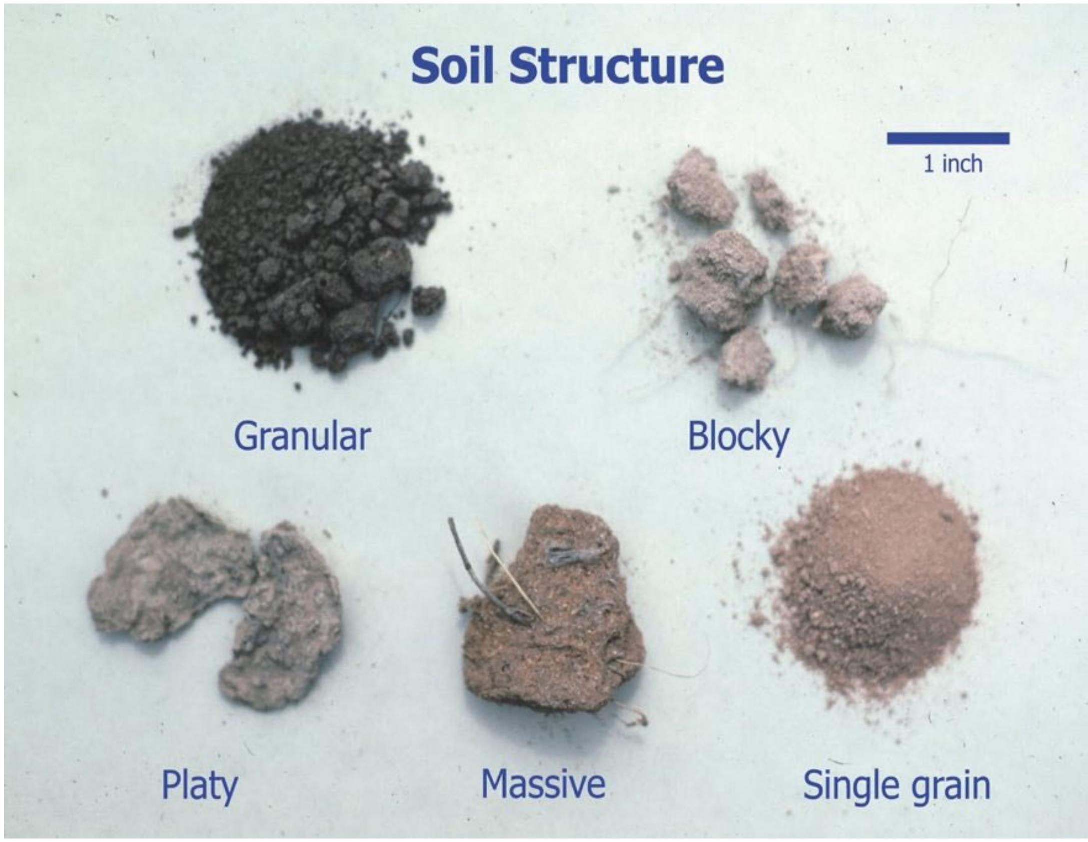
- Dig a hole 12” deep by 6” wide
- Fill with water and allow to drain completely
- Fill again and see how long it takes to drain
- If more than 8 hours, address drainage problems

Soil Nutrient Testing

- **Traditional soil tests (NPK Test) only determine elemental deficiencies, pH, and CEC** (must be done by a lab)
  - Do not measure plant-available nutrients
  - Chemical reagents used in the lab don't interact with the soil like plants do
  - Soil chemistry changes throughout the year
  - Procedures vary greatly from lab to lab

Soil Structure

- The arrangement of the solid parts of the soil and of the pore space
  located between them
  - Affects drainage and water movement
  - Affects air circulation
  - Space for soil organisms to live



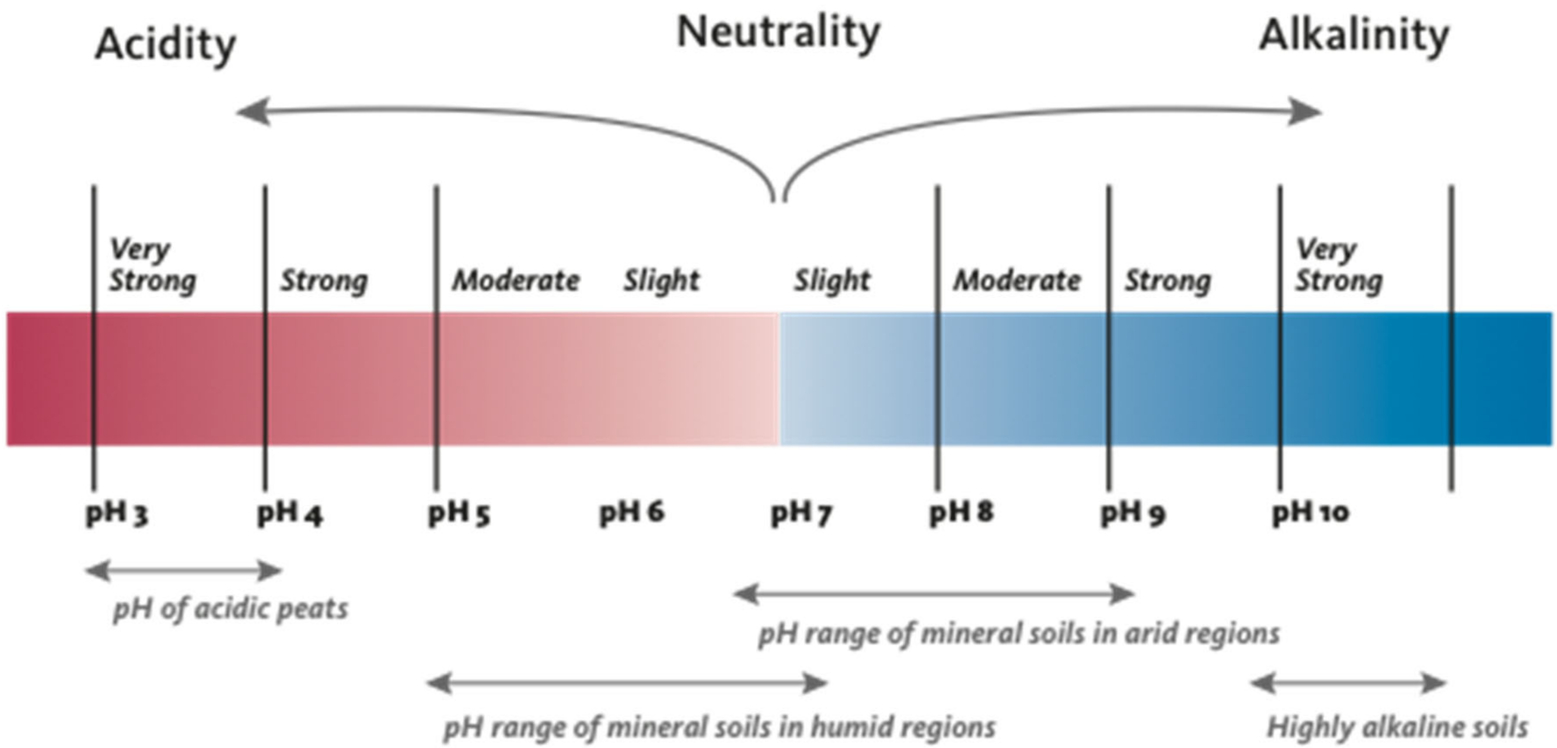
Soil Structure

- **Good soil structure**
  - Granular, crumbly like cookie crumbs
  - Resists erosion
  - Resists drying
  - Nutrient retention is high
- **Poor Soil Structure**
  - Won't hold water
  - Little air for roots or organisms
  - Nutrients are locked up because inaccessible to organisms
  - Often leads to over-watering and fertilizing

Soil on the right has better tilth. Higher organic matter results in better and more stable aggregation that results in a more favorable root environment.

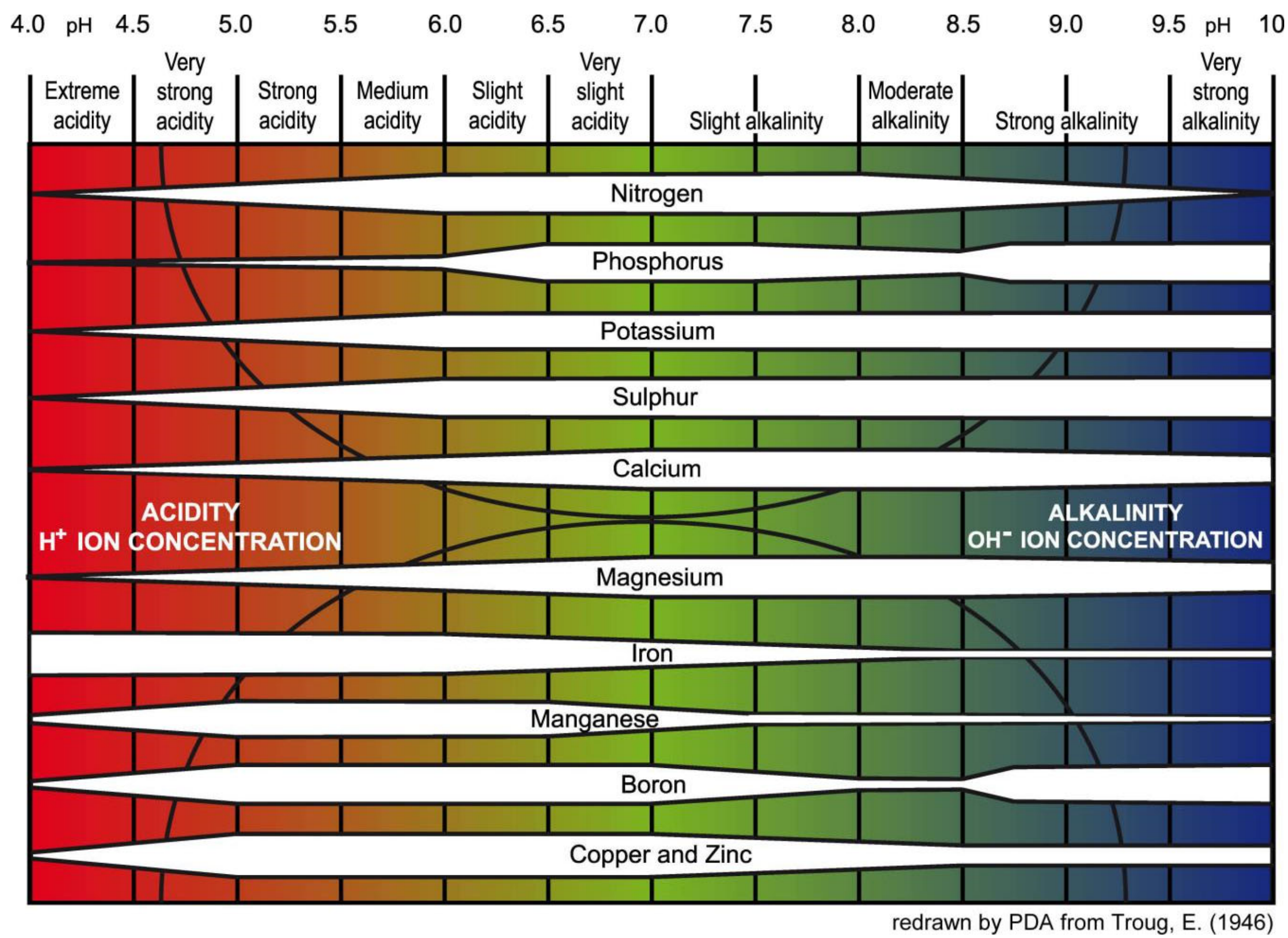
Tilth is GOOD!!

Soil pH

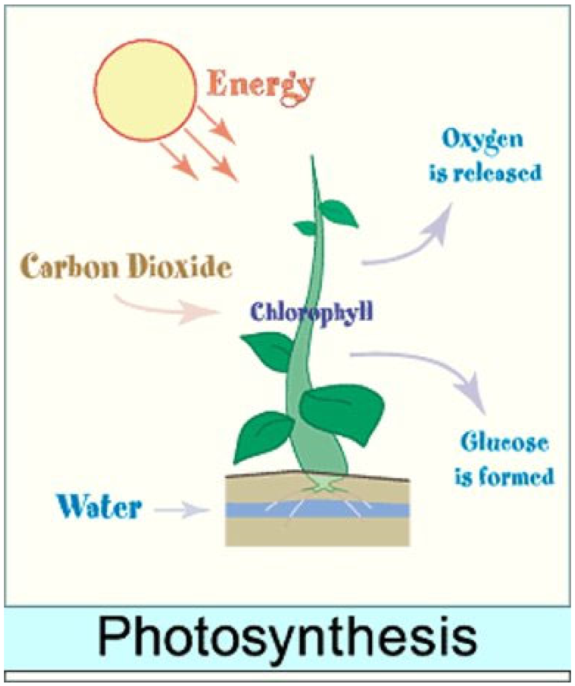


Acidity
Neutrality
Alkalinity
Very Strong
Strong
Moderate
Slight
Slight
Moderate
Strong
Very Strong
pH 3
pH 4
pH 5
pH 6
pH 7
pH 8
pH 9
pH 10
pH of acidic peats
pH range of mineral soils in arid regions
pH range of mineral soils in humid regions
Highly alkaline soils

Soil pH



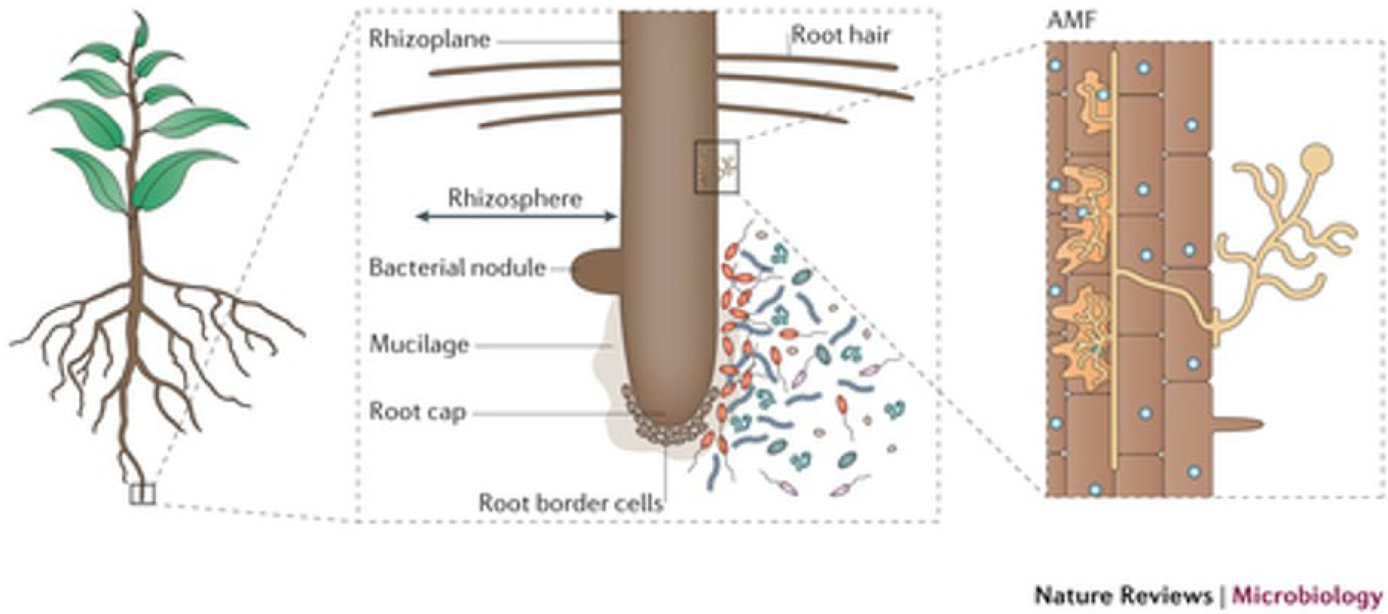
4.0 pH 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 pH 10
Extreme acidity
Very strong acidity
Strong acidity
Medium acidity
Slight acidity
Very slight acidity
Slight alkalinity
Moderate alkalinity
Strong alkalinity
Very strong alkalinity
Nitrogen
Phosphorus
Potassium
Sulphur
Calcium
ACIDITY
H+ ION CONCENTRATION
ALKALINITY
OH− ION CONCENTRATION
Magnesium
Iron
Manganese
Boron
Copper and Zinc
redrawn by PDA from Troug, E. (1946)



The Soil Food Web

- **Plants are in control**
  - Photosynthesis
    - process used by plants to convert light energy into chemical energy, stored in the form carbohydrates (liquid carbon)

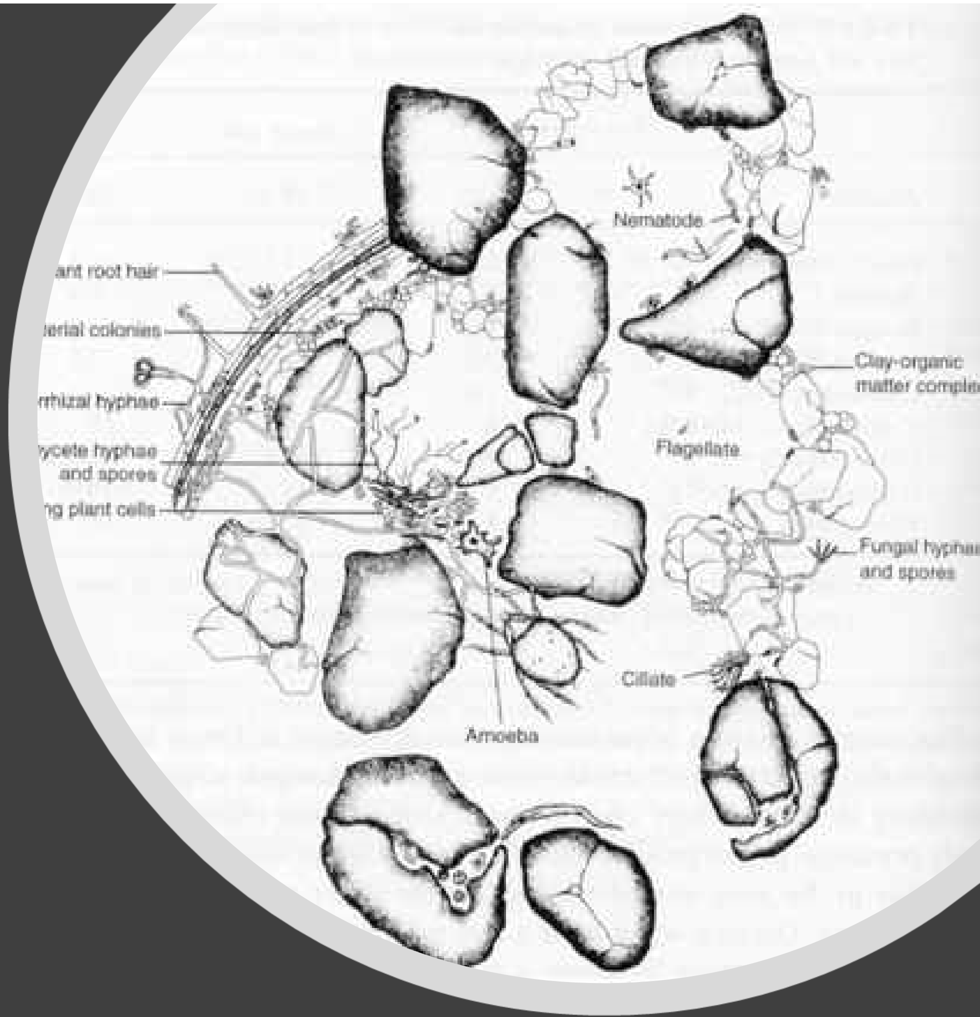
Exudates aka Sugars

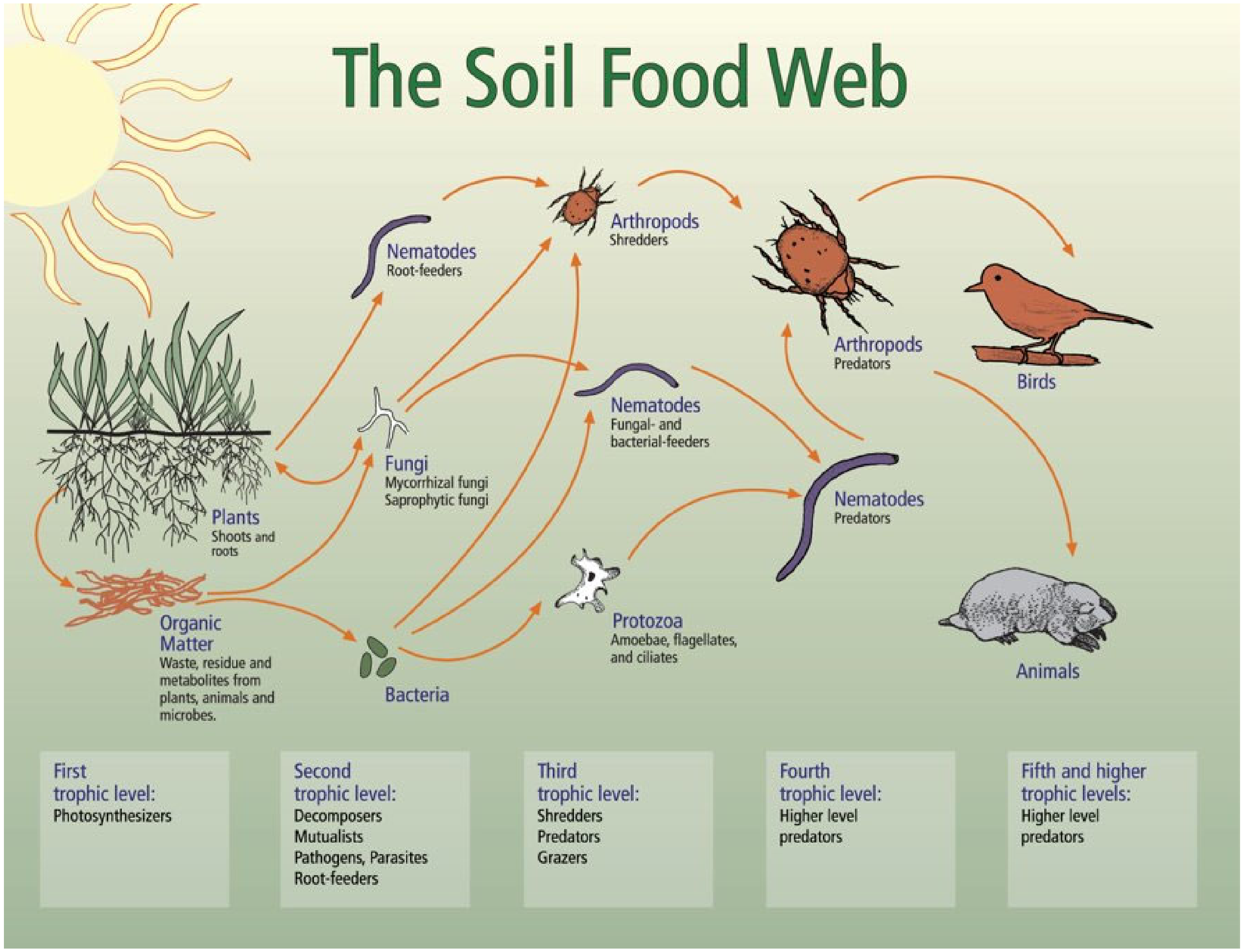


- Exudates: carbohydrate secretions (like humans perspire) in the rhizosphere are traded for nutrients the plant needs for growth
- In healthy soil, plants get 85-90% of nutrients they need through this carbon exchange

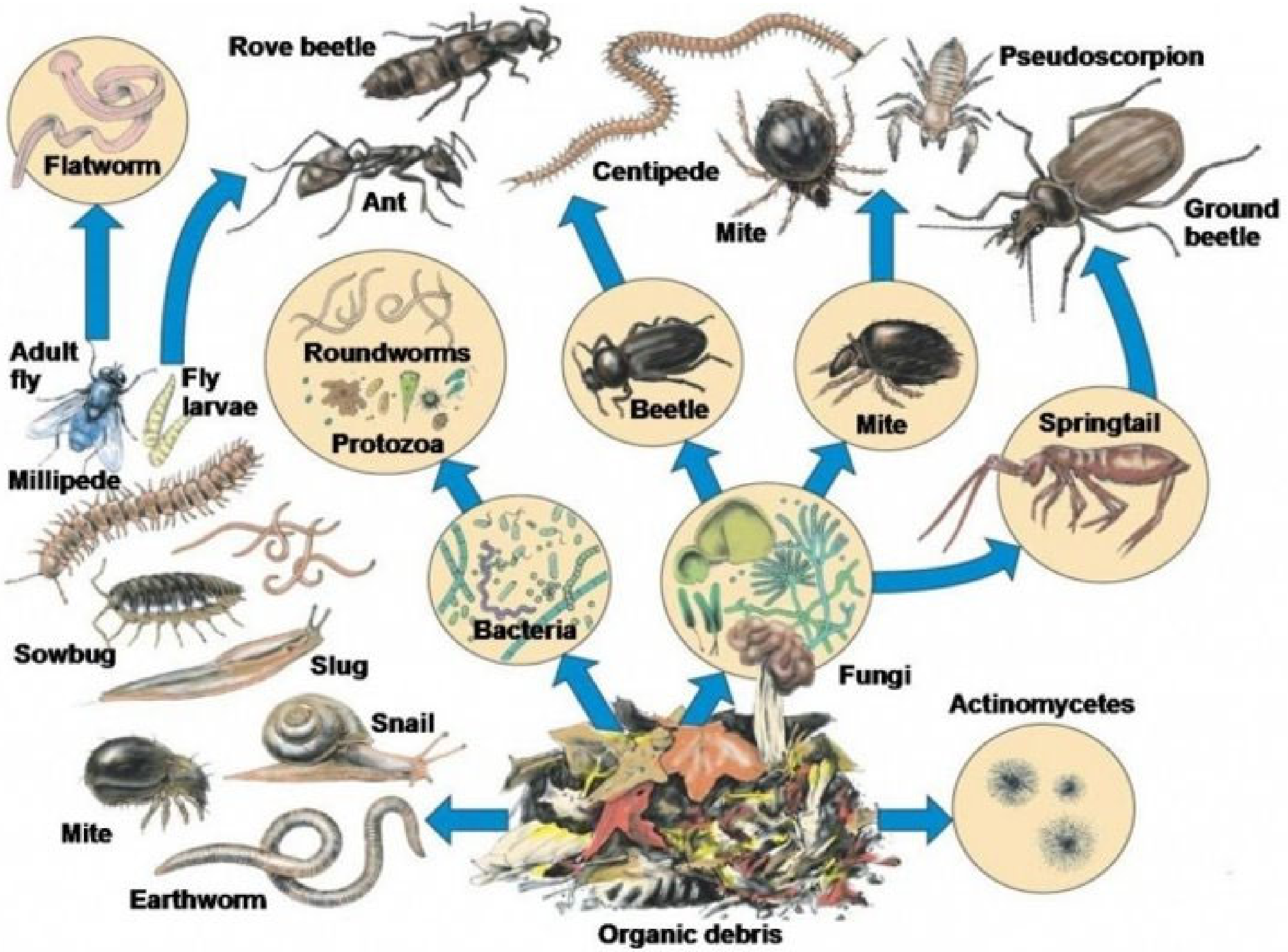
Soil Food Web

- Microorganisms comprise the major part of the Soil Food Web



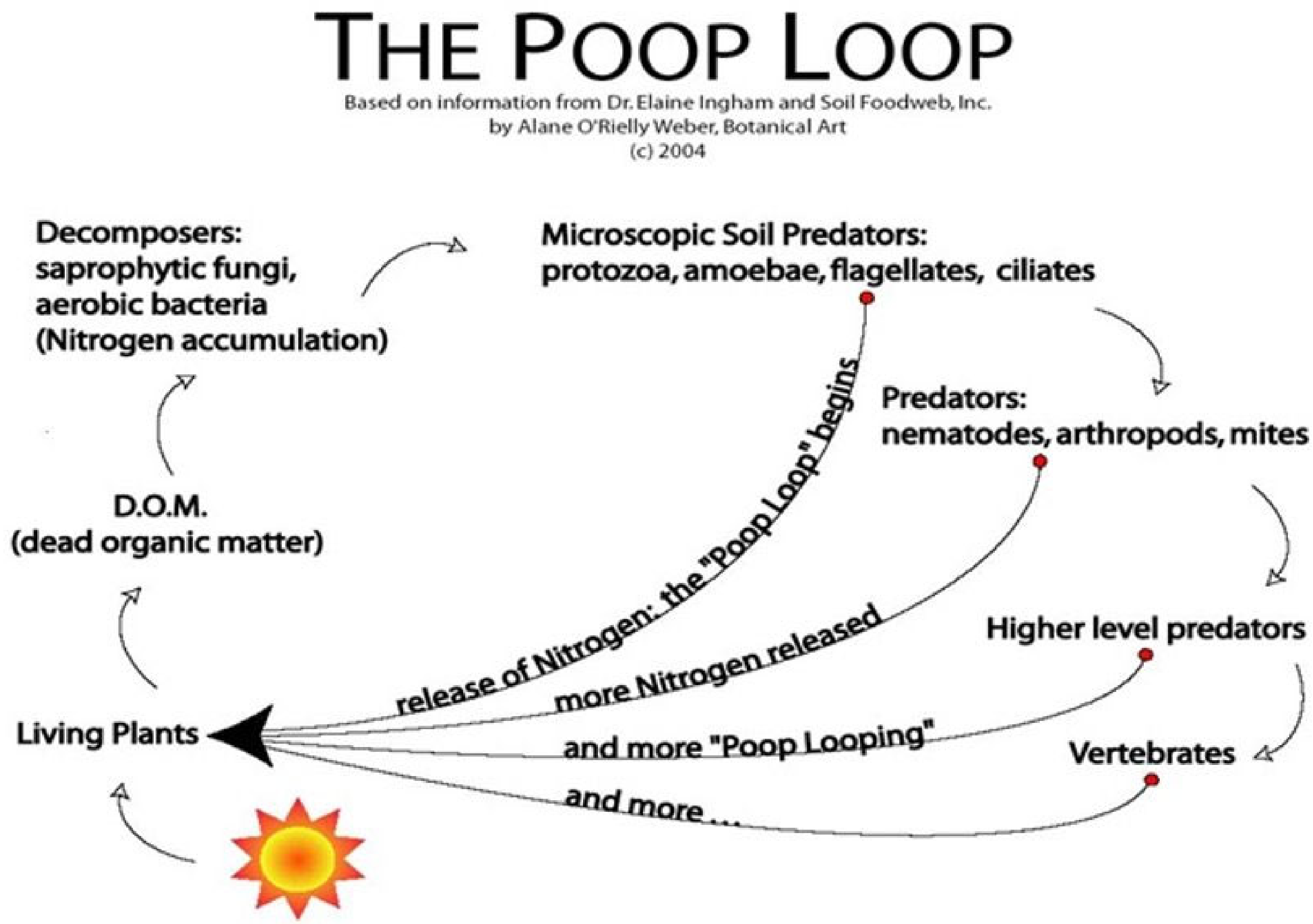


The Soil Food Web
Nematodes
Root-feeders
Arthropods
Shredders
Arthropods
Predators
Birds
Nematodes
Fungal- and
bacterial-feeders
Fungi
Mycorrhizal fungi
Saprophytic fungi
Plants
Shoots and
roots
Nematodes
Predators
Organic
Matter
Waste, residue and
metabolites from
plants, animals and
microbes.
Bacteria
Protozoa
Amoebae, flagellates,
and ciliates
Animals
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


Rove beetle
Flatworm
Ant
Centipede
Mite
Pseudoscorpion
Ground beetle
Adult fly
Fly larvae
Roundworms
Protozoa
Beetle
Mite
Springtail
Millipede
Bacteria
Fungi
Sowbug
Slug
Snail
Actinomycetes
Mite
Earthworm
Organic debris

Soil Food Web

- **Per teaspoon of healthy soil:**
  - 1M to 1B bacteria
  - Miles of fungal hyphae
  - 10,000 to 100,000 protozoa
  - 15 to 500 beneficial nematodes
  - Thousands of microarthropods
  - More organisms than people who have ever lived



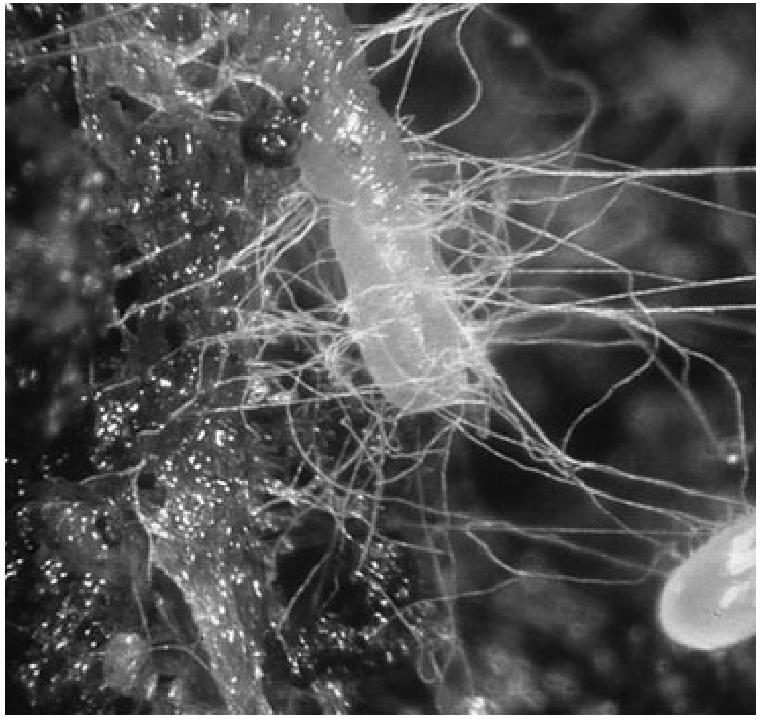
THE POOP LOOP
Based on information from Dr. Elaine Ingham and Soil Foodweb, Inc.
by Alane O'Rielly Weber, Botanical Art
(c) 2004
Decomposers:
saprophytic fungi,
aerobic bacteria
(Nitrogen accumulation)
Microscopic Soil Predators:
protozoa, amoebae, flagellates, ciliates
Predators:
nematodes, arthropods, mites
D.O.M.
(dead organic matter)
Higher level predators
Vertebrates
Living Plants
release of Nitrogen: the "Poop Loop" begins
more Nitrogen released
and more "Poop Looping"
and more . . .

Fungi

- Yeasts – little presence in soil
- Molds – important in humus formation
- Fusarium & Aspergillis
- Penicillium
- Mycorrhizae (hyphae & mushrooms)
- Endophytes - live inside plants

Fungi

- **The primary decay agents in the SFW**
- **Break down a wide range of organic matter**
  - Lignin and cellulose
  - Chitin shells of insects
  - Bones of animals
- **Scout for and find nutrients, bind them up**

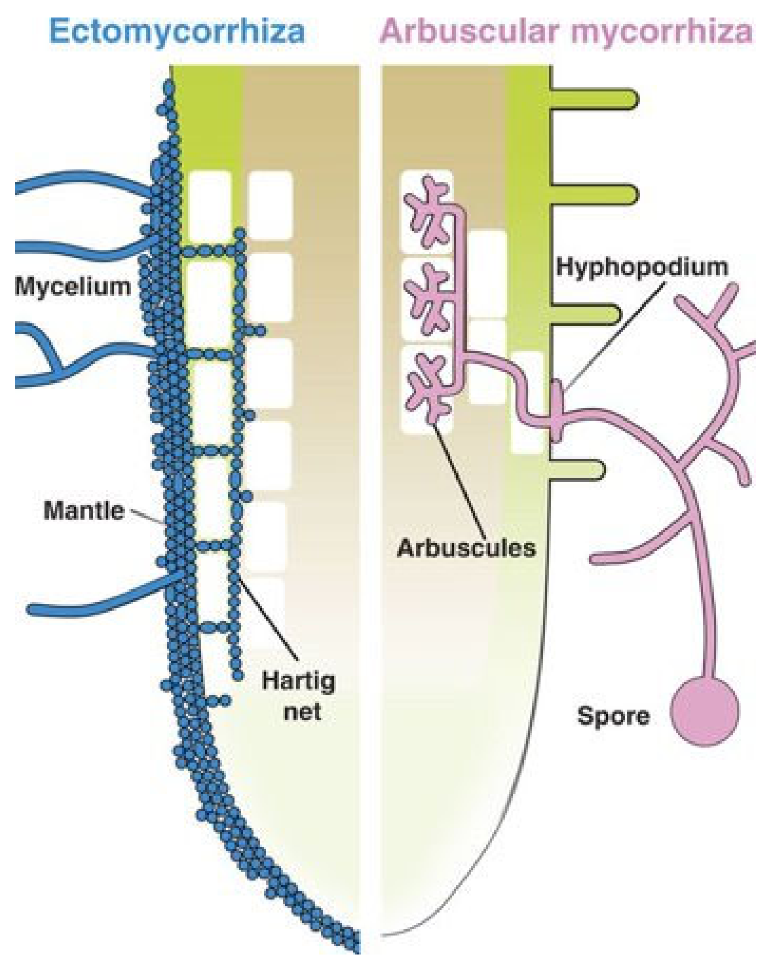


Mycorrhizae

- Fungi that grow in a symbiotic association with plant roots or mildly pathogenic relationship
  - Hyphae grow end-to-end creating strands
  - Masses create mycelia
- Able to grow significant distances to locate food sources
- Transports nutrients through the hyphae, cell to cell
- Hyphae tubes provide paths for air, water and bacteria
- 90-95% of plants have associations with mycorrhizae

Mycorrhizae

- Symbiotic relationship with plant roots
- Convert insoluble nutrients into plant-available forms
- Exchange nutrients for exudates
  - Phosphorus
- Waste provides nitrogen



Mycorrhizae

- Unlock, retrieve and transport minerals
  - Phosphorus
  - Calcium
  - Magnesium
  - Zinc
  - Iron
  - Copper

Earthworms

- Healthy soil contains 10-50 per sf
- Master shredders
- Aerate soil, increase porosity
- Help with soil aggregation
- Increase water-holding capacity
- Move OM and microorganisms
- Increase microbial population
- Aid plant root growth
- Increase fertility

Soil Organisms

Decompose organic compounds

- manure, plant residues

Sequester nitrogen and other nutrients

Fix nitrogen from the atmosphere, making it available to plants

Enhance soil aggregation and porosity

- increase infiltration and reduce runoff

Prey on pests

Food for each other and above-ground animals

Benefits of the Soil Food Web

Soil fertility is the capacity to nurture healthy plants

"Through the activities of soil microbes…the basic raw materials needed by plants are made available at the right time, and in the right form and amount." – The Soul of the Soil

Microorganisms serve as "nutrient facilitators"

Microorganisms are responsible for the formation of humus.

Organic Matter (OM)

OM is vital to soil health

- Improves the physical and chemical properties
- Improves biological health

What is it?

- Bacteria and fungi produce slime so they don't get washed away; this stuff binds mineral particles together
- Fungal hyphae physically bind particles and clods together

Benefits of the Soil Food Web

- **A healthy soil food web controls disease**
  - Not all soil organisms are beneficial
  - A large, diverse community controls problem organisms
  - Competition keeps pathogens in check
- **Eliminate or reduce the need for:**
  - Fertilizers
  - Pesticides
  - Herbicides
  - Fungicides
- **Improved water- and air-holding capacity**
- **Healthier, more productive plants**

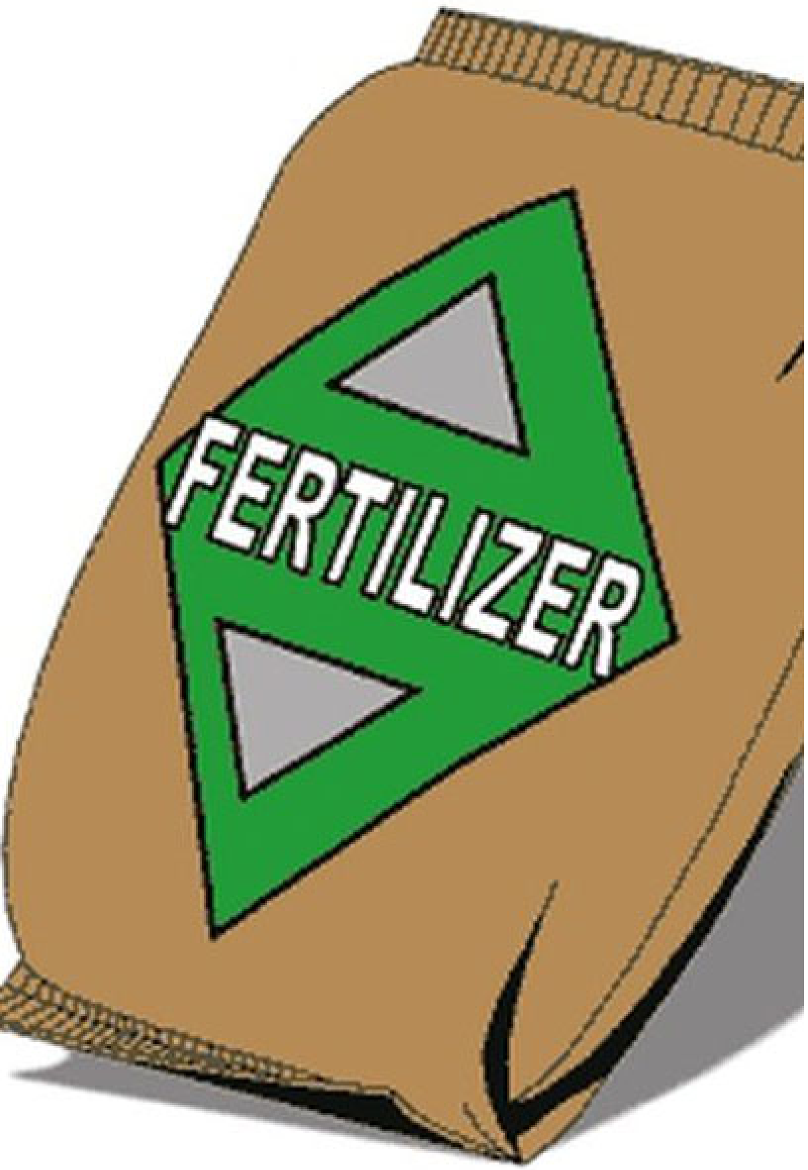
Bacteria + fungi =

Protozoa + nematodes =

Effects of Chemical Fertilizers

Synthetic NPK fertilizer:

- Decline of populations of bacteria and fungi affect all the other organisms down the food line, including worms
- Reduces soil production of plant-available nitrogen
- Slows production of exudates
- Slows down or even halts humus formation (i.e., carbon storage)
- Worms are irritated by chemical fertilizers
- Chemical fertilizers are a one-shot wonder
  - plant uses what is immediately available - the rest leaches out into the soil beyond the plants reach.



Effects of Chemical Fertilizers

- **Chemical fertilizers**
  - Deteriorate soil structure
  - Decrease water-holding capacity
  - Increase salts in the soil
  - Increase the presence of pathogens and pests
  - Are the number one polluter of our waterways

Rototilling

- Breaks up fungal hyphae
- Destroys worms
- Pulverizes arthropods
- Destroys soil structure
- Reduces air- and water-holding capacity

Building the Soil

- **First priority: Restore/build a diverse soil food web**
  - **3 primary strategies:**
    - **Building and Maintaining OM**
    - **Compost**
    - **Mulching**

"The proper care and feeding of soil organisms demands close attention to managing soil organisms." – Soul of the Soil


Building the Soil
No matter what your soil or climate, improving the soil food web will improve your soil
Improve soil structure
Improve nutrient availability and retention
Improve water-holding capacity and drainage
Minimize pests and diseases
Provide the right pH at the root zone

Amendments for Building and Maintaining the Soil Food Web

- **Compost**
- **Manures**
- **Cover Crops**
- **Mulch**
- **Compost Tea**
- **Worm Castings**
- **Mycorrhizal Fungi**
- **Other Amendments**
  - Bio-char
  - Rock dust

Compost

- **Art/science of mixing various OM in a pile and allowing it to decay in to stable humus**
  - **High in microbial life & microarthropods**
  - **Use to inoculate your soil**
  - **NO tainted or toxic materials**
    - No herbicides
    - No pesticides
    - No fungicides
- **Initial soil prep: 12 cubic yards per 1,000 square feet (4”)**
- **Annually: Place ¼” to 1” around your plants**

Animal Manures

- Contributes significantly to SOM
- Stimulates humification of other OM
- Aged at least 6 months
- Best added to compost

Green Manures

- **Any crop that is chopped & dropped before maturity to improve the soil**
  - Compost in place
  - Biomass – perennial grasses & legume sod crops
  - Nitrogen - legumes
- **Especially effective for heavy and compacted soils with little OM**
- **Spring-planting and fall-planting mixes**

Cover Crops

- Planted along side and under plants
- Suppress growth of weeds
- Attract and feed beneficials
- Can add biomass and fix nitrogen
- Shade the soil
- Supress weeds

Mulch

- **Anything placed on the soil to**
  - Reduce evaporation
  - Prevent weed growth
  - Insulate roots
- **Provides a home for beneficial organisms**
- **Place on top of compost 2-3” thick**
- **Taper away from plant stems and trunks**

Organic mulches

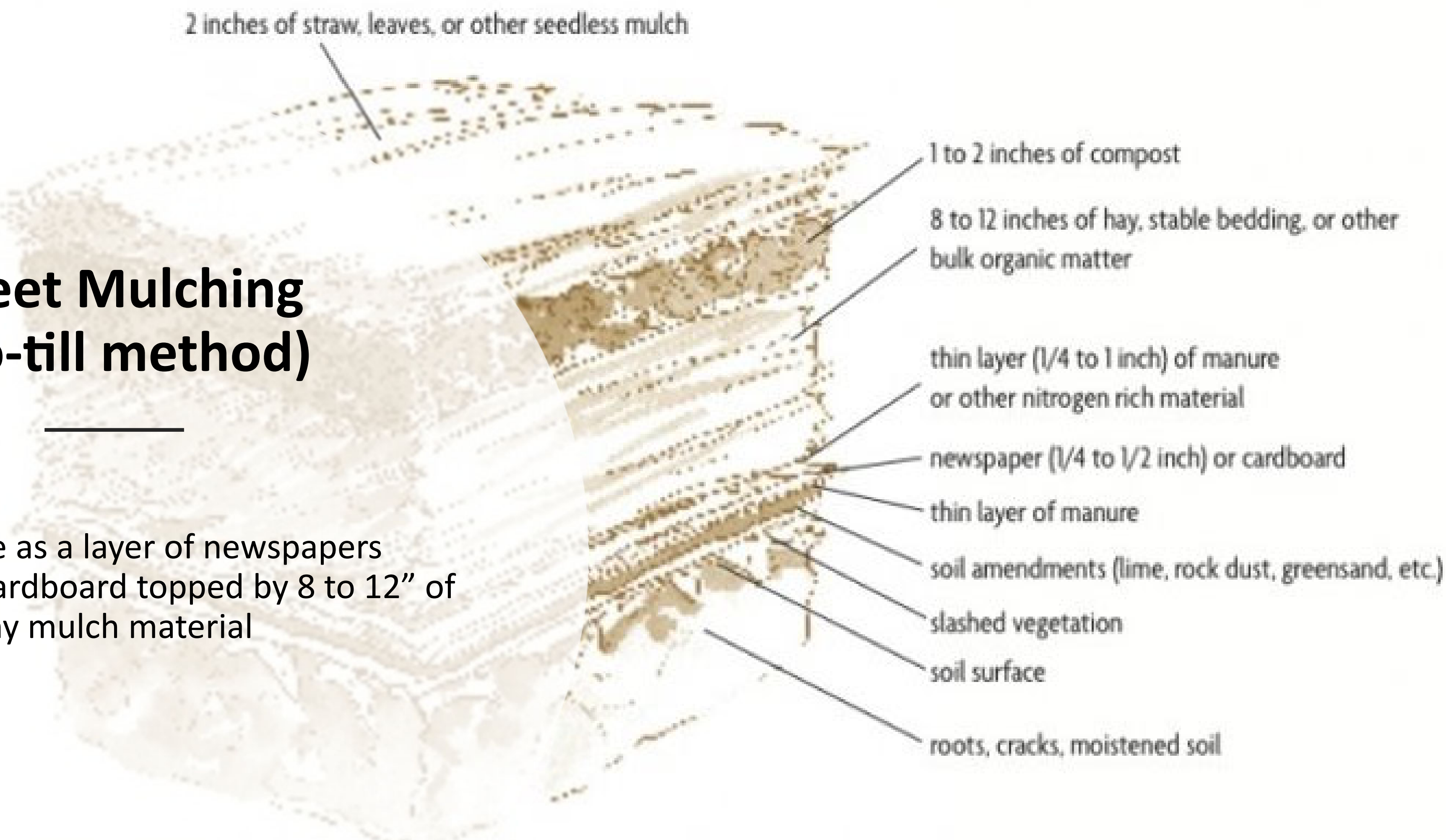
- Wood chips
- Leaves and pine needles
- Grass clippings
- Straw

Building the Soil

- All landscape areas:
  - Add at least 12 cubic yards per 1,000 square feet (4") of compost to the soil and rototill in the greatest depth possible
  - Do this in two 2" lifts, not all at once
  - This is a one-time use of a rototiller
- Use potting soil mix with compost in raised beds

Sheet Mulching (No-till method)

- As simple as a layer of newspapers and/or cardboard topped by 8 to 12" of nearly any mulch material



Toby Hemenway's Bomb-proof Sheet Mulch

Compost Tea

- Actively Aerated Compost Tea (AACT)
- Helps put microbiology in the soil or on plants
- Stretches the use of compost a lot farther
- It is not compost leachate, extract or manure tea (anaerobic mixtures)

Worm Castings

- Water-soluble allowing plants to quickly and easily absorb essential nutrients and trace minerals
- Coating around the grain allows for the nutrients to "time release" into the soil
    - Nutrients are readily available to plant material over a greater length of time and will not burn even the most delicate plants
- Rich in iron, sulfur, calcium, nitrogen, phosphorus and potassium (NPK rating: 5-5-3)
    - much richer in nutrients than bulk compost, requiring lower application rates
- Fruit and vegetable tests have resulted in yield improvements from 57% to over 200% as well as improvement in taste and appearance

https://ucanr.edu/sites/mgfresno/files/262372.pdf

Worm Tea

- Soak 1 part worm castings in 3 parts of water for 24 hours or more, stirring several times over the 24-hour period
- Direct application: Apply one 8-ounce cup of tea per plant every 30 days, or
- Foliar spray: Add 4 ounces of tea to 1 gallon of water
- Apply every 30-60 days

https://ucanr.edu/sites/mgfresno/files/262372.pdf

Water Useage

Plant selection and grouping

Compost

Mulch

Efficient irrigation components

Proper irrigation scheduling

How We Can Influence Water Use

Water Use

1. **Remove & replace lawn**
   - **Lawn substitutes**
2. **Establish Hydrozones**
3. **Utilize drought-tolerant plants**
4. **Install dripline irrigation system**

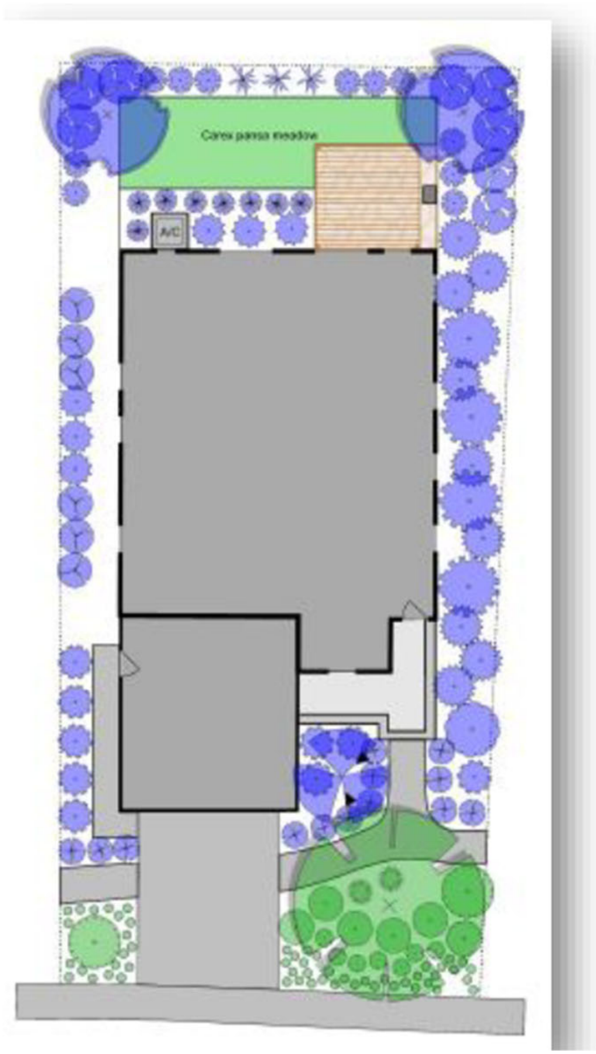
Hydrozoning

The practice of clustering together plants with similar water requirements in an effort to conserve water

- Sun, partial shade, shade
- Water needs (high, medium, low)
- Plants in the ground
- Plants in pots
- Veggie beds

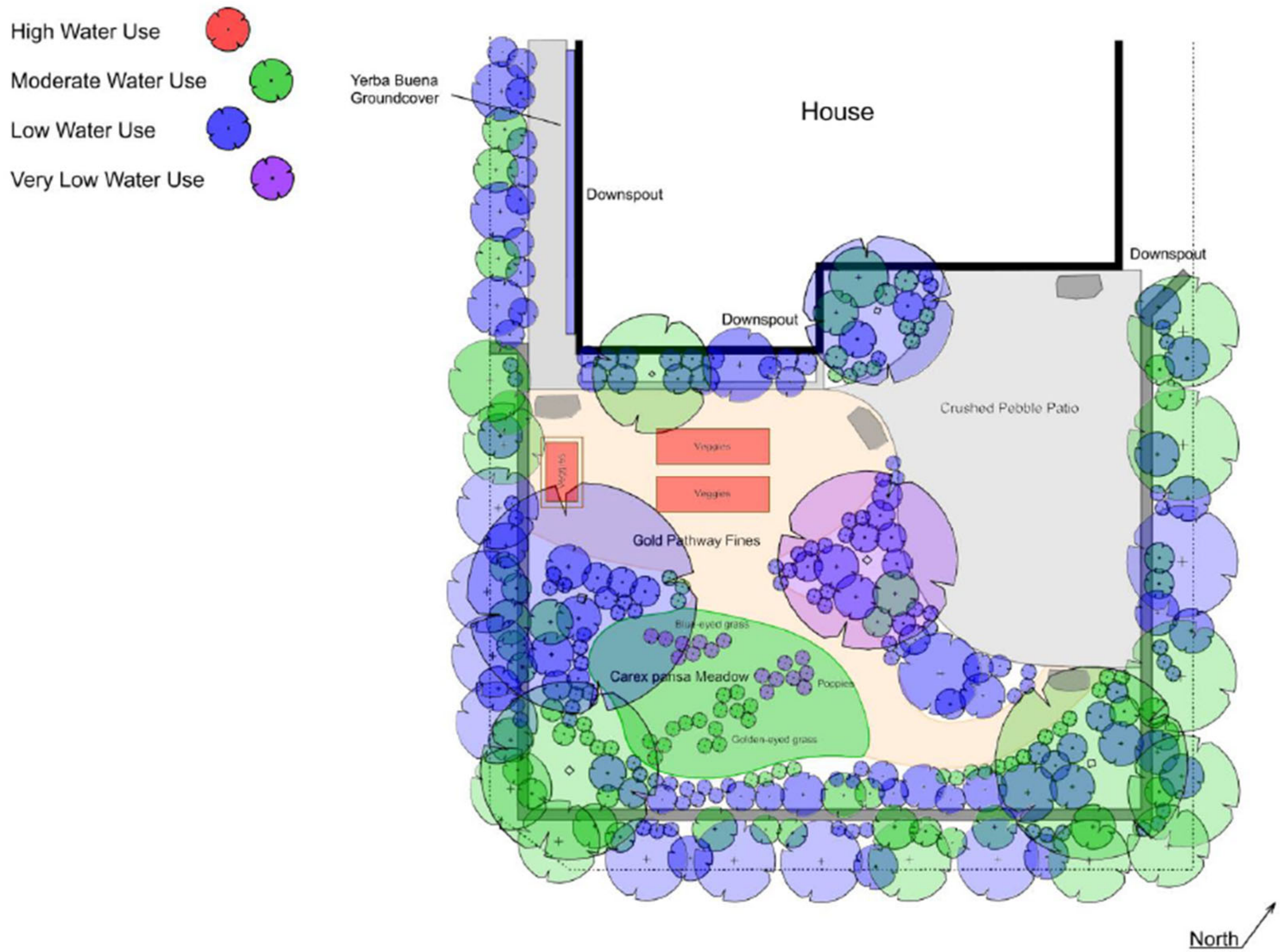
It is a proven effective water management solution

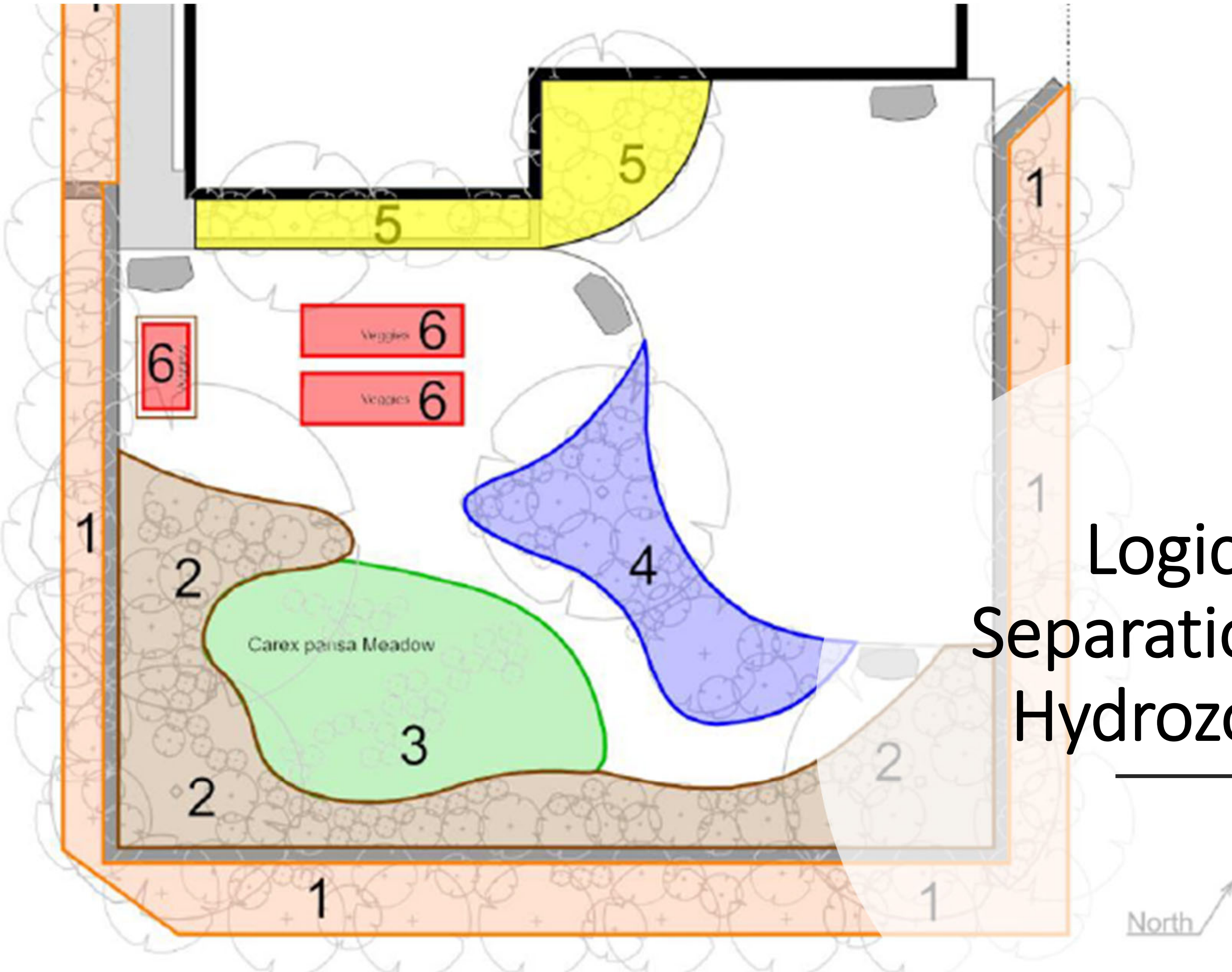
Landscape Design based on Water-use Value of Plants



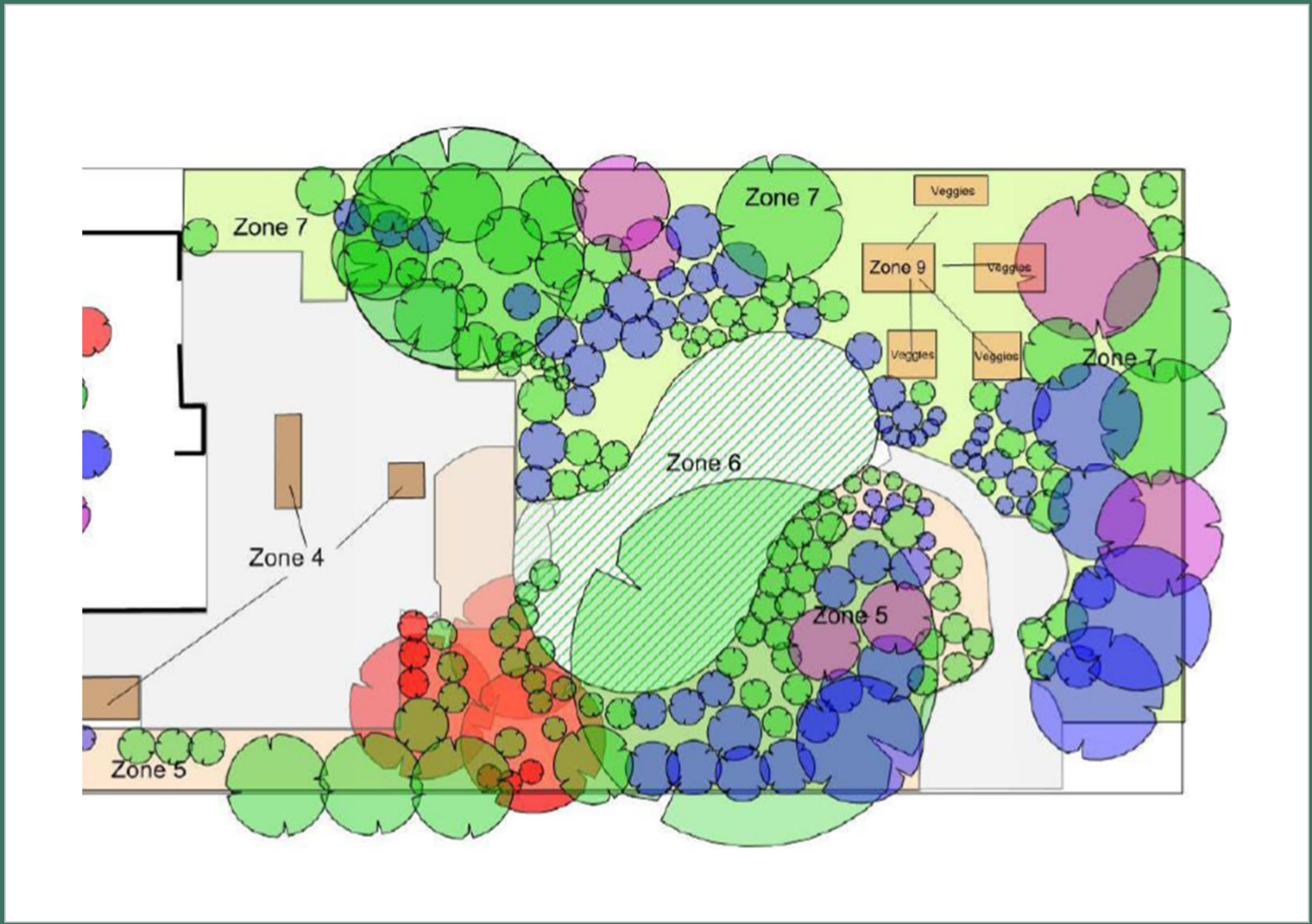
This planting design was based on irrigation. Plants were grouped together according to water use, making it easy to create the hydrozones and valve zones.

Landscape Design based on Water-use





Logical Separations of Hydrozones



Troubleshoot Water-use Differences

Is this water-efficient?

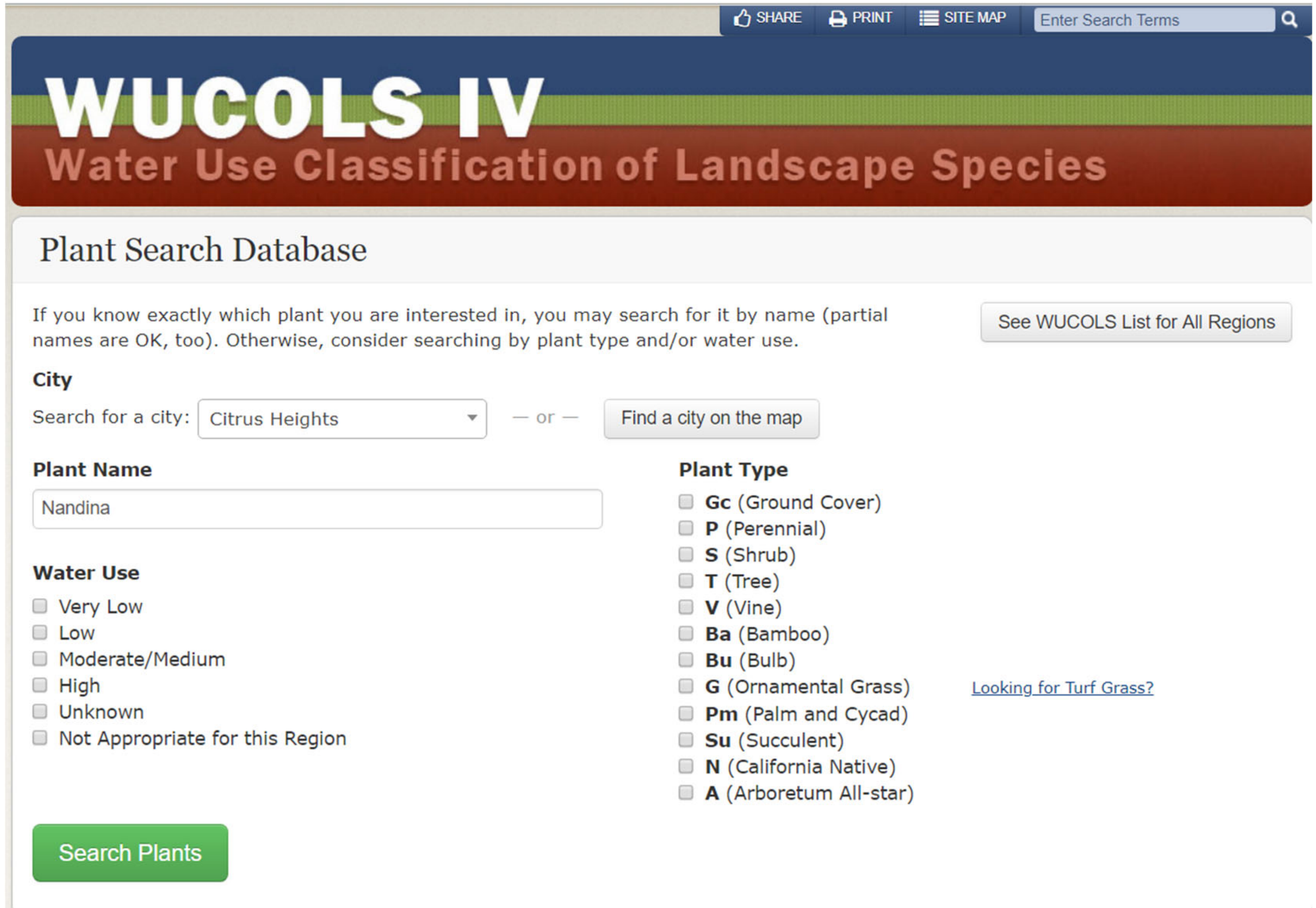

Low
Moderate
Low
Low
Low
Moderate
Moderate
Low
Moderate
Moderate
Low

Not so much

Hydrozoning an Existing Landscape

- Draw a plan of your property indicating your trees, shrubs, annuals, lawn, a vegetable garden and other plants
- Circle and group plants with similar water needs in hydrozones
- Separate hydrozones would include:
    - Lawn
    - Mass plantings of perennials and groundcovers
    - Vegetable garden and or mass plantings of annuals/bedding plants
    - Sun vs. Shade
    - Flat vs. Slopes
- Not sure of your plants' watering needs? Find out the water requirements of specific plants, by clicking on the link: http://ucanr.edu/sites/WUCOLS/

WUCOLS IV


SHARE
PRINT
SITE MAP
Enter Search Terms
WUCOLS IV
Water Use Classification of Landscape Species
Plant Search Database
If you know exactly which plant you are interested in, you may search for it by name (partial names are OK, too). Otherwise, consider searching by plant type and/or water use.
See WUCOLS List for All Regions
City
Search for a city: Citrus Heights
— or —
Find a city on the map
Plant Name
Nandina
Water Use
Very Low
Low
Moderate/Medium
High
Unknown
Not Appropriate for this Region
Plant Type
Gc (Ground Cover)
P (Perennial)
S (Shrub)
T (Tree)
V (Vine)
Ba (Bamboo)
Bu (Bulb)
G (Ornamental Grass)
Looking for Turf Grass?
Pm (Palm and Cycad)
Su (Succulent)
N (California Native)
A (Arboretum All-star)
Search Plants

WUCOLS IV

SHARE PRINT SITE MAP Enter Search Terms

WUCOLS IV
Water Use Classification of Landscape Species

Plant Search Database

City	Citrus Heights
Region	Central Valley

Start Over | Search Again | Export List

▼ **Legend: Plant Types**

▼ **Legend: Categories of Water Needs**

Search Results: 2

Type	Photo	Botanical Name	Common Name	Water Use	Export
S	N/A	Nandina domestica	heavenly bamboo	Low	☐
S	N/A	Nandina domestica 'Purpurea'	heavenly bamboo (Nana)	Moderate/Medium	☐

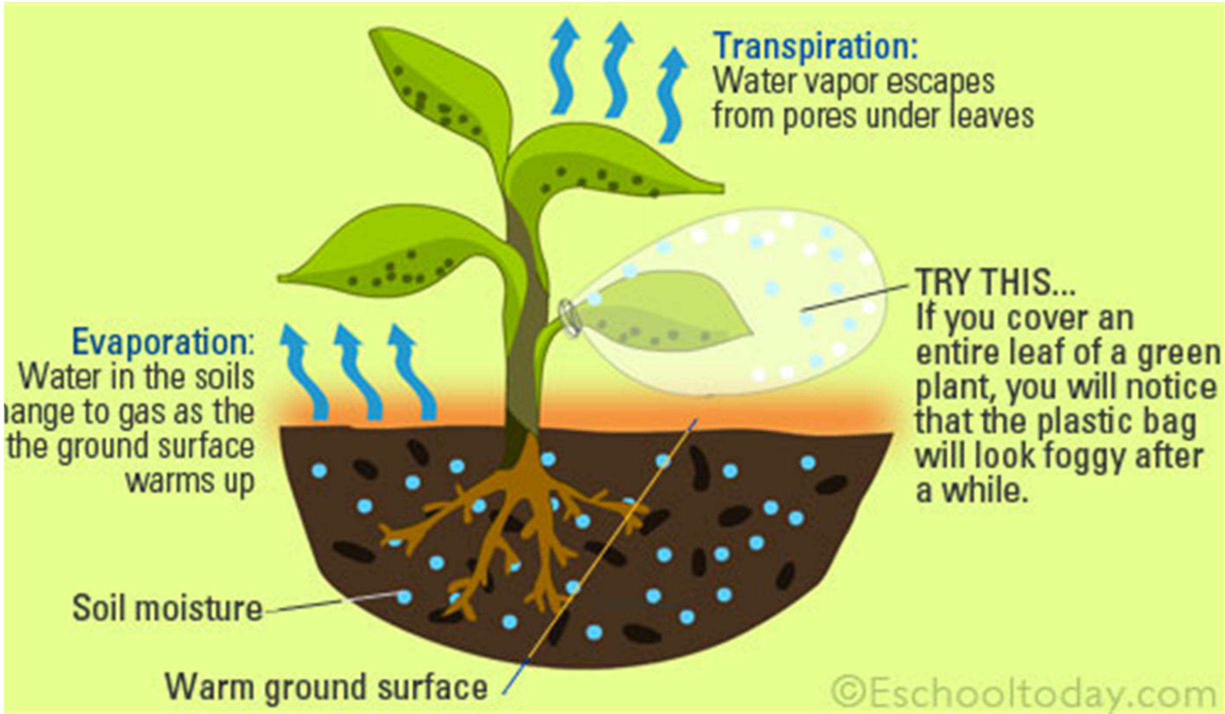
- ***The Water Use Classification of Landscape Species***
  - An online system maintained by the UC Division of Agriculture and Natural Resources
  - Developed by and based on the field experience of landscape horticulturalists & professionals
  - User-friendly enough for home gardeners

WUCOLS IV

WUCOLS IV

- Provides information on water needs of more than 3500 plants
- Different plant species require different amounts of water for optimal health
- Plant Factor (PF) - Expressed as a percentage of ETo

Water Budget = Weather x Plant Factor x Area



Evapotranspiration (ETo)

- The loss of water to the atmosphere by the combined process of:
  - Evaporation from the top 1" of the soil and plant surfaces
  - Transporation through plant tissues

Factors Affecting ETo

- SOLAR RADIATION
- AIR TEMPERATURE
- RELATIVE HUMIDITY
- WIND SPEED
- SOIL EXPOSURE
- PLANTING DENSITY

"Lawns, by acreage, are the nation's largest irrigated crop, surpassing corn."

- Lawns are a vestige that started with English gardens and spread by those living in water-rich environments in the East and mid-West.
- The future profits of the lawn care and horticulture industries rely on the endurance of the myth that we need lawns and persistent sprawl.
- Lawn rebate program in L. A. will save approximately 47 million gallons of water each year
- 9.2 billion gallons of water have been saved through turf removal in Las Vegas
- Time and money consuming

Lawns

Ecological deserts

- Monocrop
- Ecological deserts for pollinators

Fertilizers and pesticides

- Contaminate groundwater
- Pollute waterways
- Toxic to children and pets
  - Fourteen of the 30 most commonly used lawn pesticides are neurotoxins are known or suspected carcinogens, and two-thirds of them may cause reproductive harm in humans

Fossil fuels

- Costly
- Air pollution

Contribute to carbon dioxide load

Resources

- **Soils**
  - Worm Castings: https://ucanr.edu/sites/mgfresno/files/262372.pdf

UCCE
El Dorado County
Master Gardeners

Contact us:
530-621-5512 (Tues-Fri 9:00AM-Noon)
mgeldorado@ucdavis.edu
Visit us at 311 Fairlane, Placerville