Maintaining your trees during drought: challenges and management

With slides from
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Drought: a challenging time for urban trees

Urban trees: Beautiful, beneficial, cost-effective

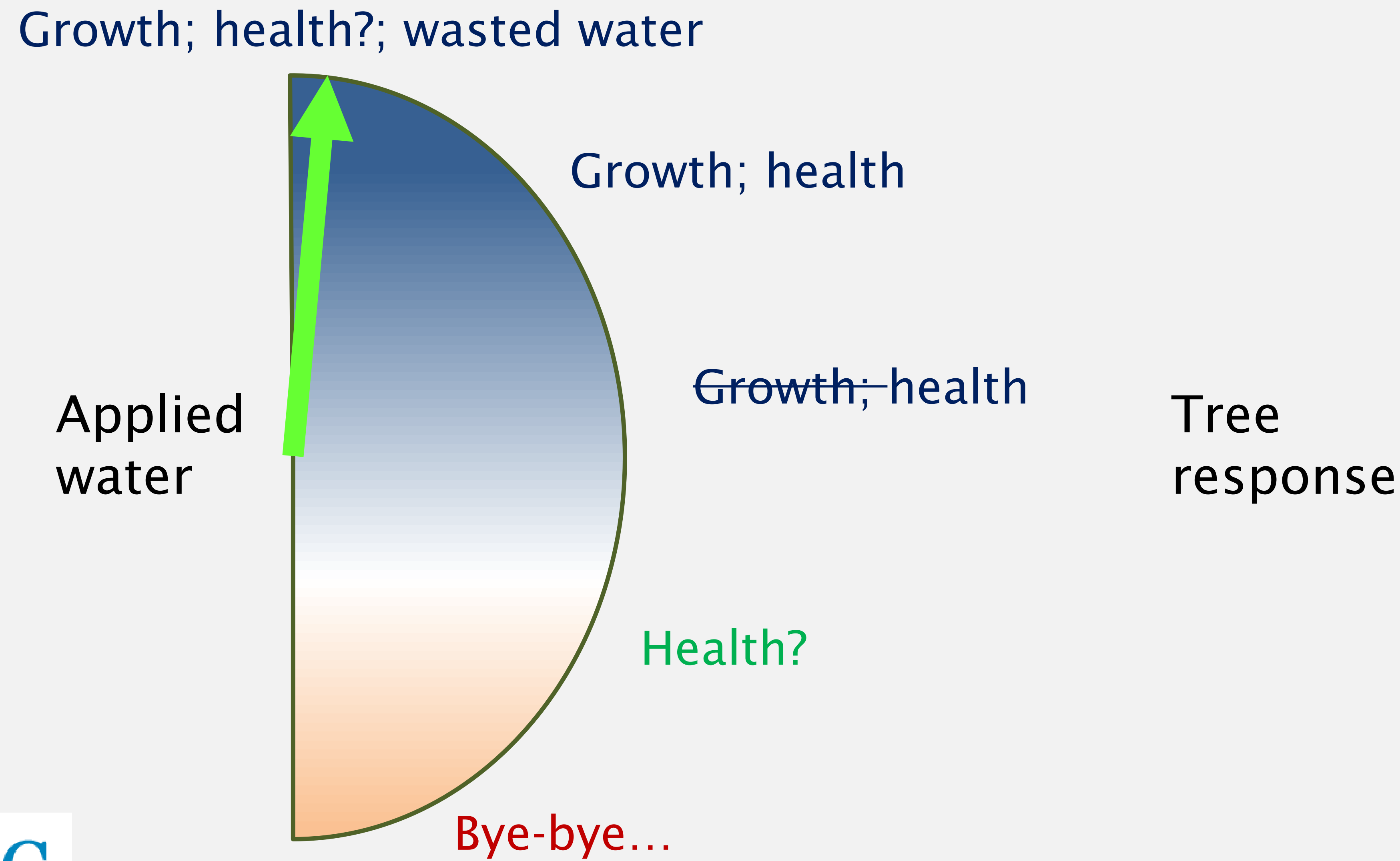
Drought challenges, solutions (as seen by a tree)

Tree <> uses of water, indications of stress
Soil <> water availability, storage, application
In practice <> tools and resources

Resources, Discussion (soft projectiles only, please)

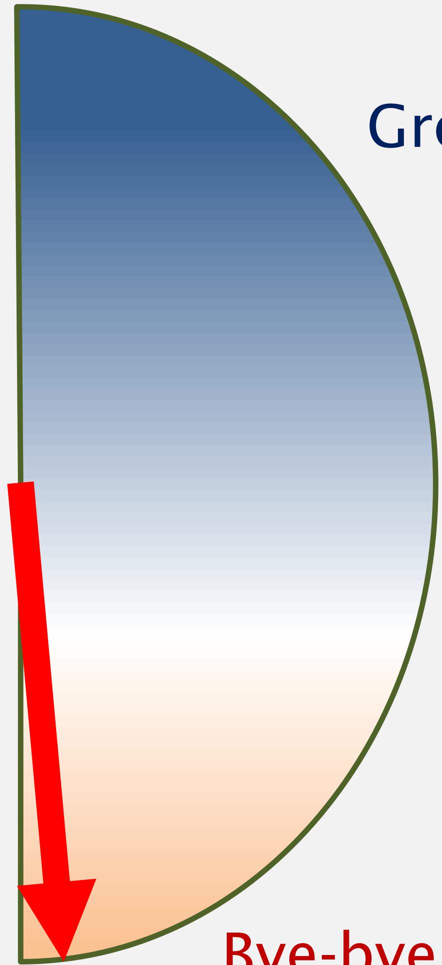
UCCE

Watering “situation” before the drought



Watering “situation” during the drought…

Growth; health?; wasted water



Growth; health

Applied water

~~Growth;~~ health

Tree response

Health?

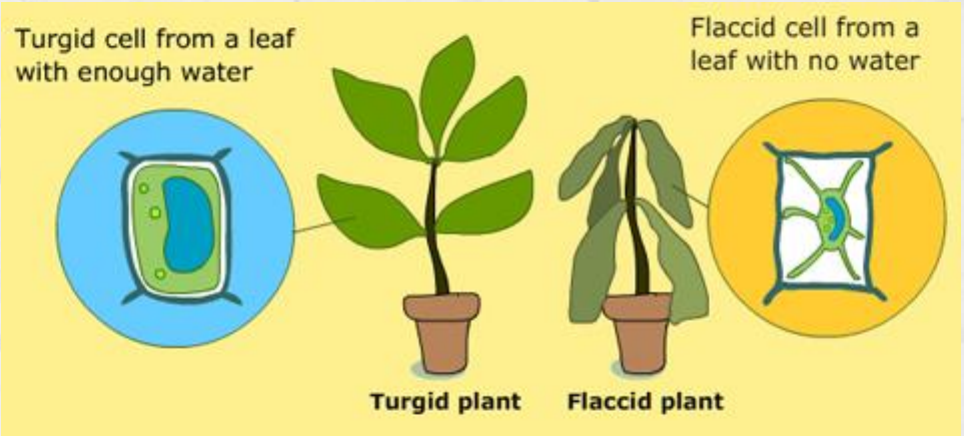
Bye-bye…

Conceptual view of urban trees in drought

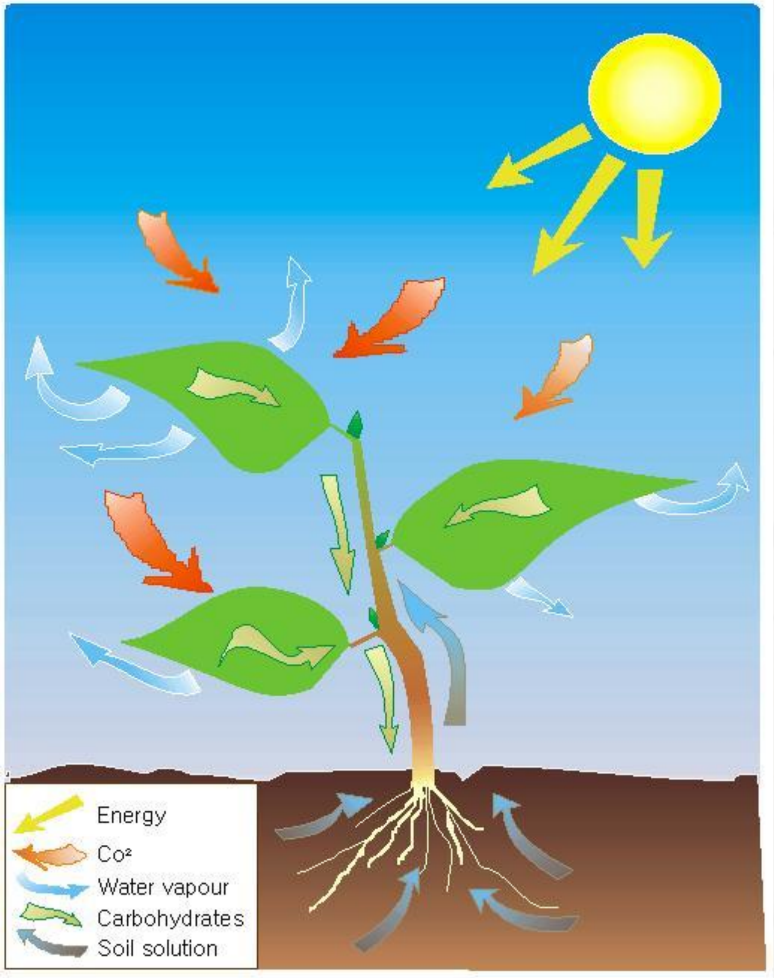
$→ / Situation	Costs now	Costs later	Benefits	Benefit-Cost Ratio
No drought				+ +
Drought				– –
Drought + minimal water				+ +
Drought + optimal water				+

A common sight in 2013, 2014, 2015, 2016, 2017…

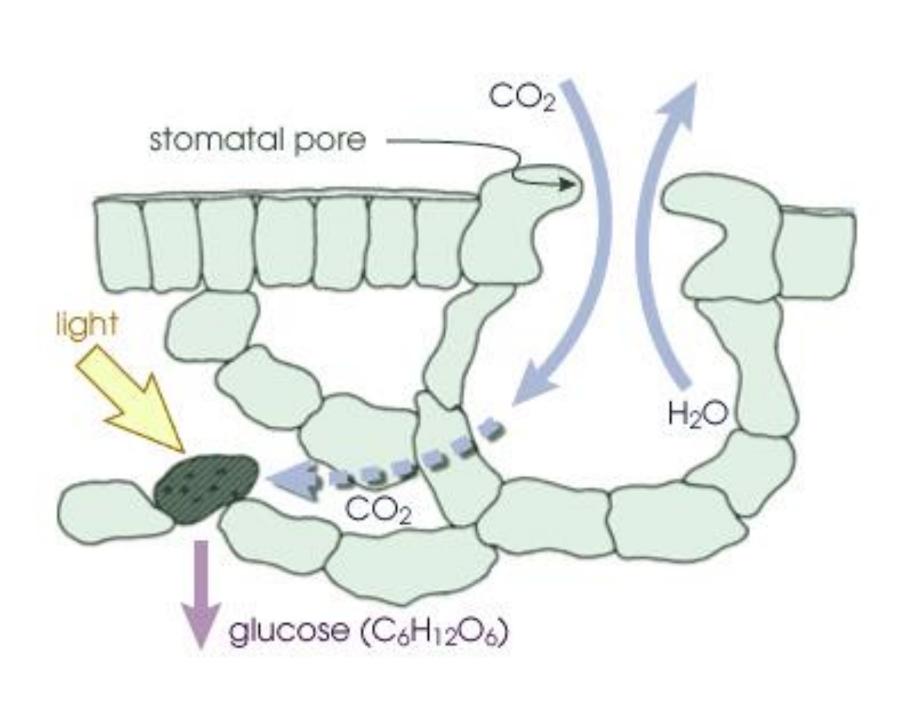
Plants need water…

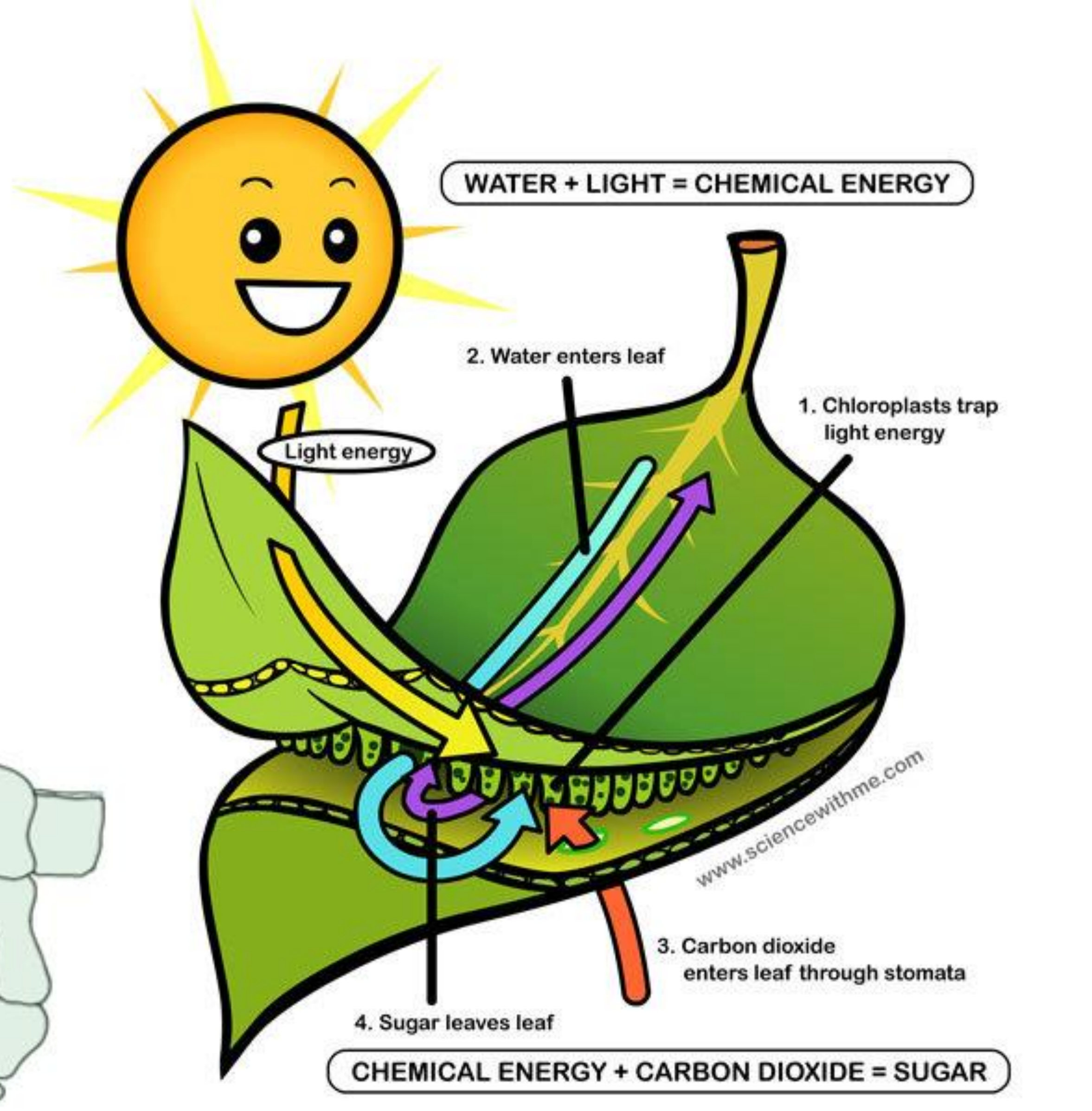


1) Turgor
2) Transport of solutes
3) Photosynthesis



Photosynthesis: CO_2 in, water out





Trees and drought: problematic in several ways…

~ Trees need water to "feed themselves" (photosynthesis)

~ Drought = reduction in growth (which may persist)

~ Drought = less stored energy = lowered defenses

~ Drought = facilitates insects, diseases

Watson and Himelick, 2013

Trees and drought: problematic in several ways…

~ Trees need water to "feed themselves" (photosynthesis)

~ Drought = reduction in growth (which may persist)

Watering can be a critical element of IPM!

Example: Eucalyptus longhorned borer

Water Stress and Insect Injury

Although some species perform well with little or no irrigation water, their susceptibility to insect attack and injury may increase with water stress. For example, many *Eucalyptus* species perform well in nonirrigated locations in many parts of California. When water stressed, however, they become susceptible to attack and injury by the eucalyptus longhorned borer (*Phorocantha semipunctata*). This is also the case for Monterey pine (*Pinus radiata*) and the California fivespined engraver beetle (*Ips paraconfusus*). For these species, evaluations were made with consideration given to water stress and pest interactions. For example, although Tasmanian blue gum (*Eucalyptus globulus*) performs well in Regions 3 and 4 with little summer water, it was assigned the category Moderate to minimize susceptibility to borer injury.

Drought: soil water concepts

Urban trees: Beautiful, beneficial, cost-effective

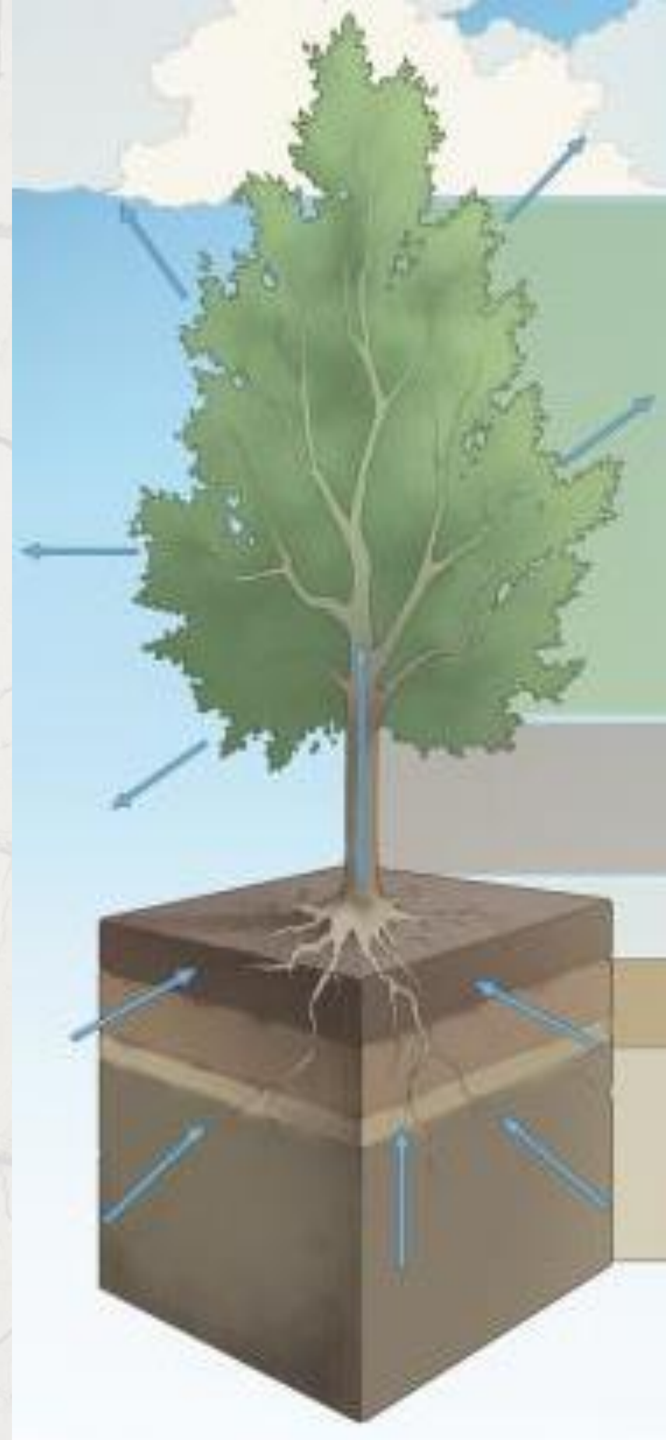
Drought challenges, solutions

Tree <> uses of water, stress

Soil <> water availability, storage, application

In practice <> tools and resources

Resources, Discussion



Young trees: Lack of water = quick death

←Problem: "Deep watering…"

(but how much can it hold?)

"Crispy critters" → (Larry Costello)

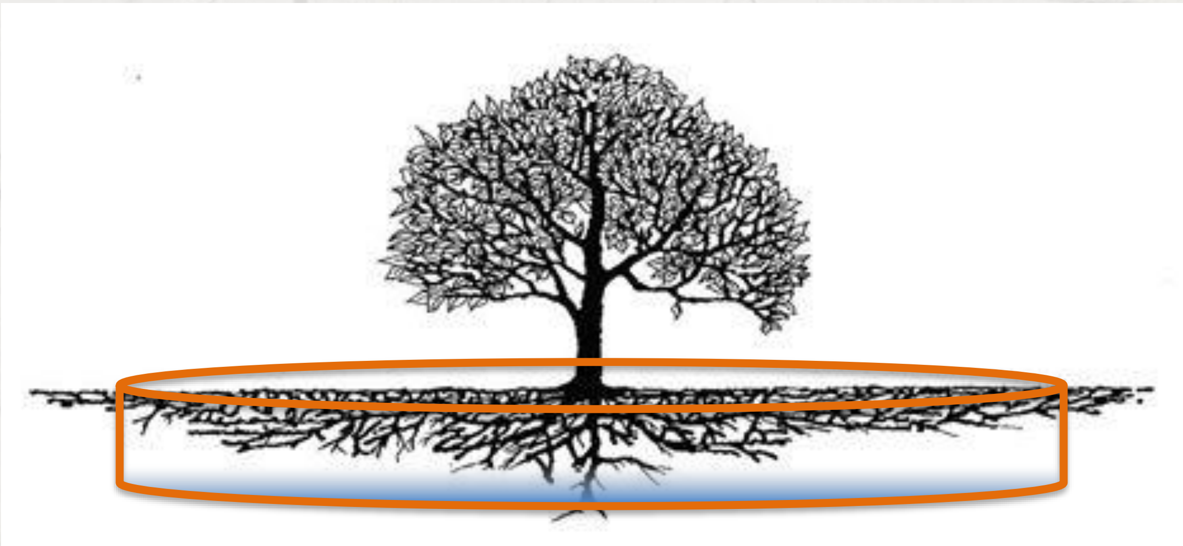
Young tree rapid response

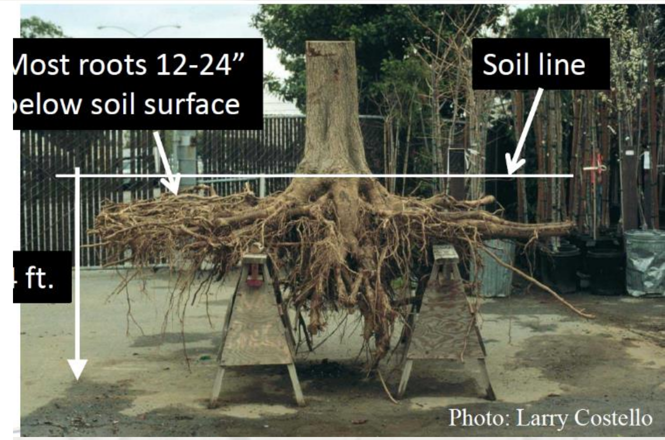
How much?
Amazingly little: 5-10 gal

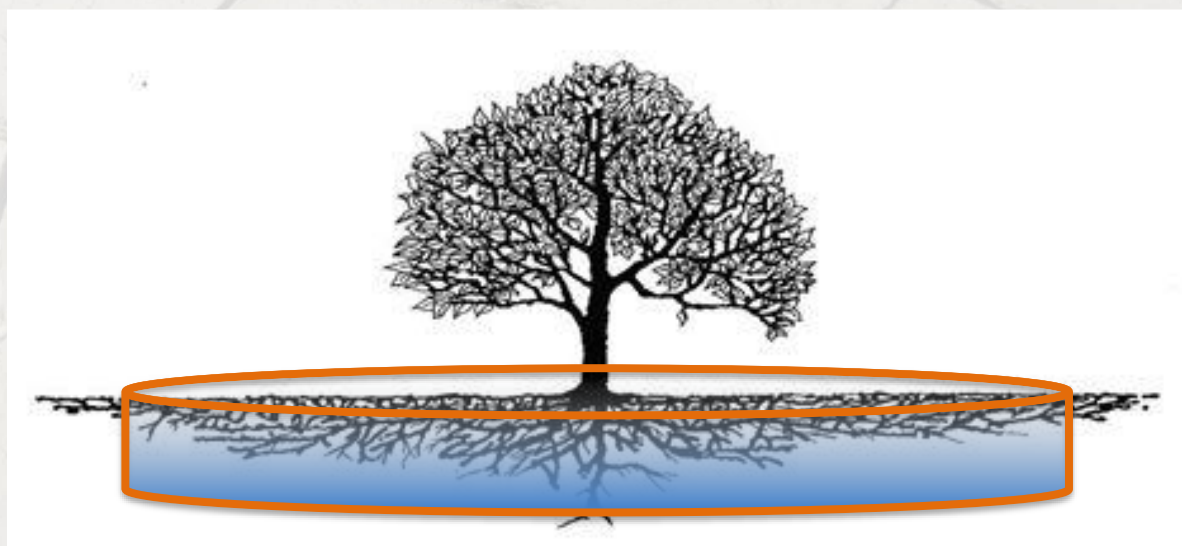
How often?
Frequently! (X times/WEEK)

Who?
Residents
NGOs
Partners (schools, churches, business)

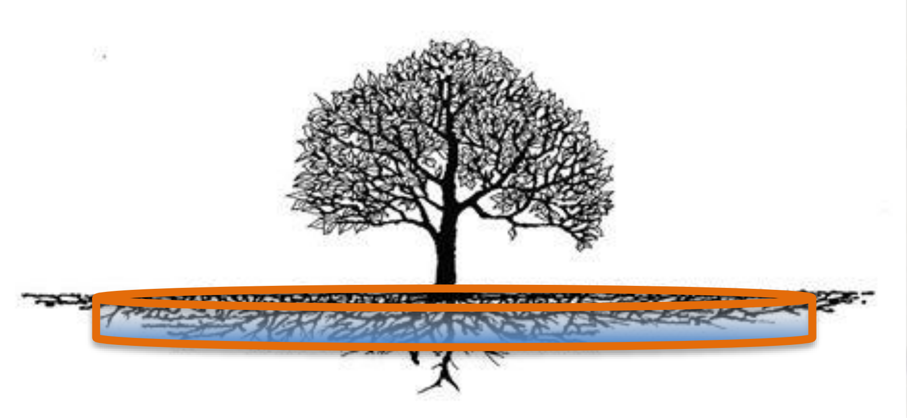
Providing water to mature trees: functional approach (Nelda M. and Larry C.)





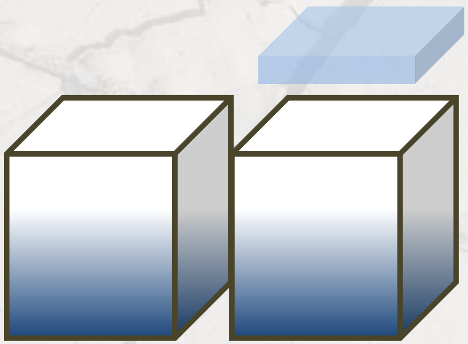


Functional irrigation approach: the truck analogy



Soil water reservoir:	fuel tank
Evapotranspiration:	fuel consumption
Tree condition:	fuel gauge (wilting = empty)

Functional irrigation approach for mature trees: estimating the size of the "water reservoir"



1 in on 1 sq ft
= 0.62 gal.

Soil water reservoir capacity: 2 elements

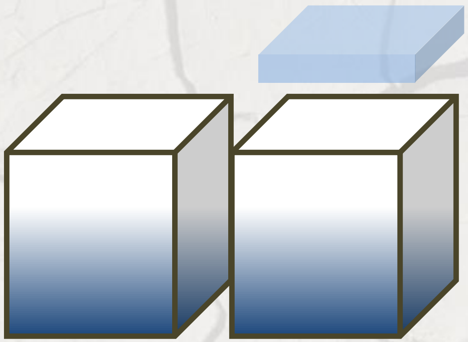
Volume → area*depth, or inches water/foot depth

Texture → water stored→ clay > loam >> sand
water available → sand > loam > clay)

Soil water reservoir: Where are the roots?

Functional irrigation approach: estimating the size of the "water reservoir"

1 in on 1 sq ft
= 0.62 gal.

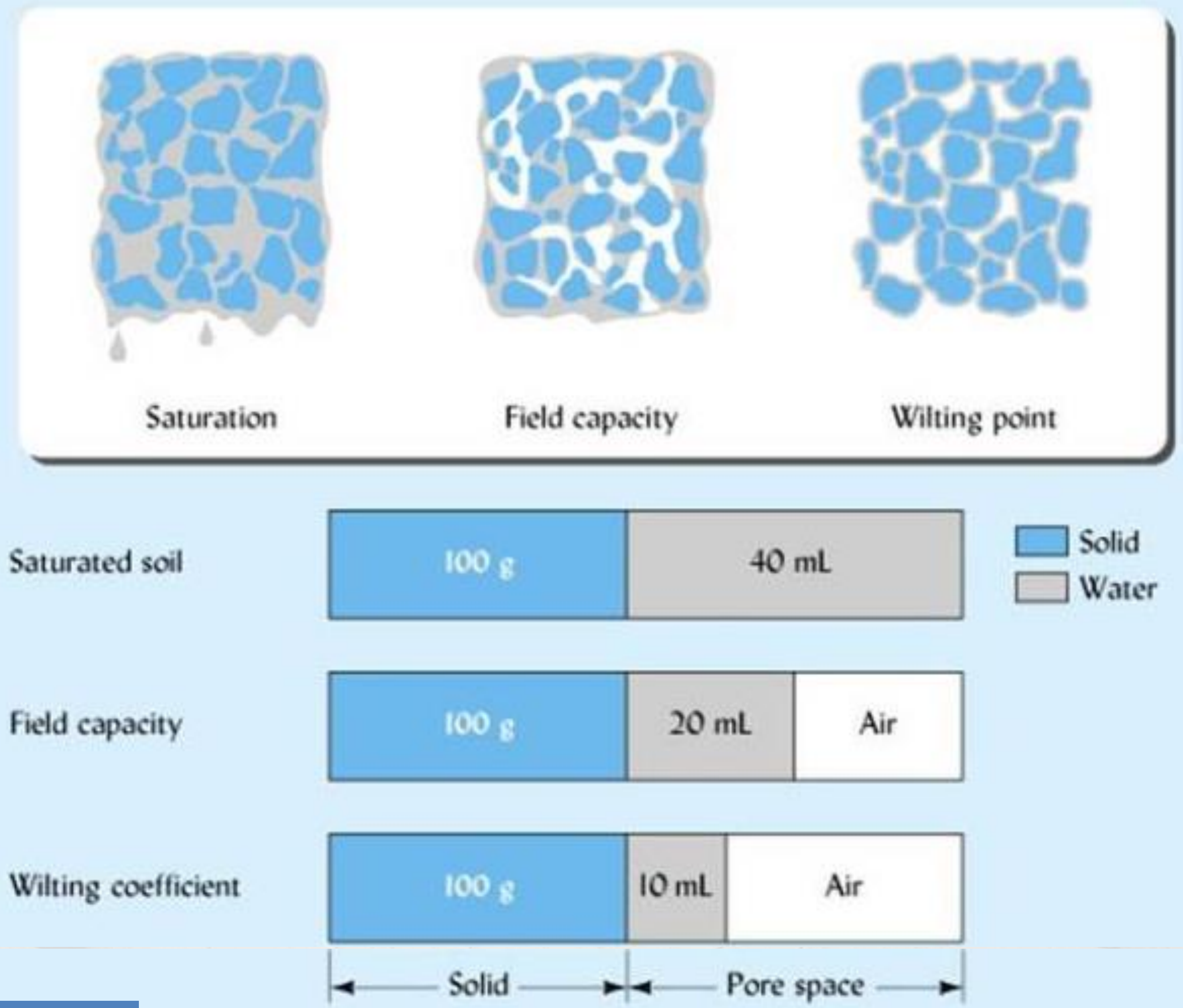


Soil water reservoir capacity: 2 elements

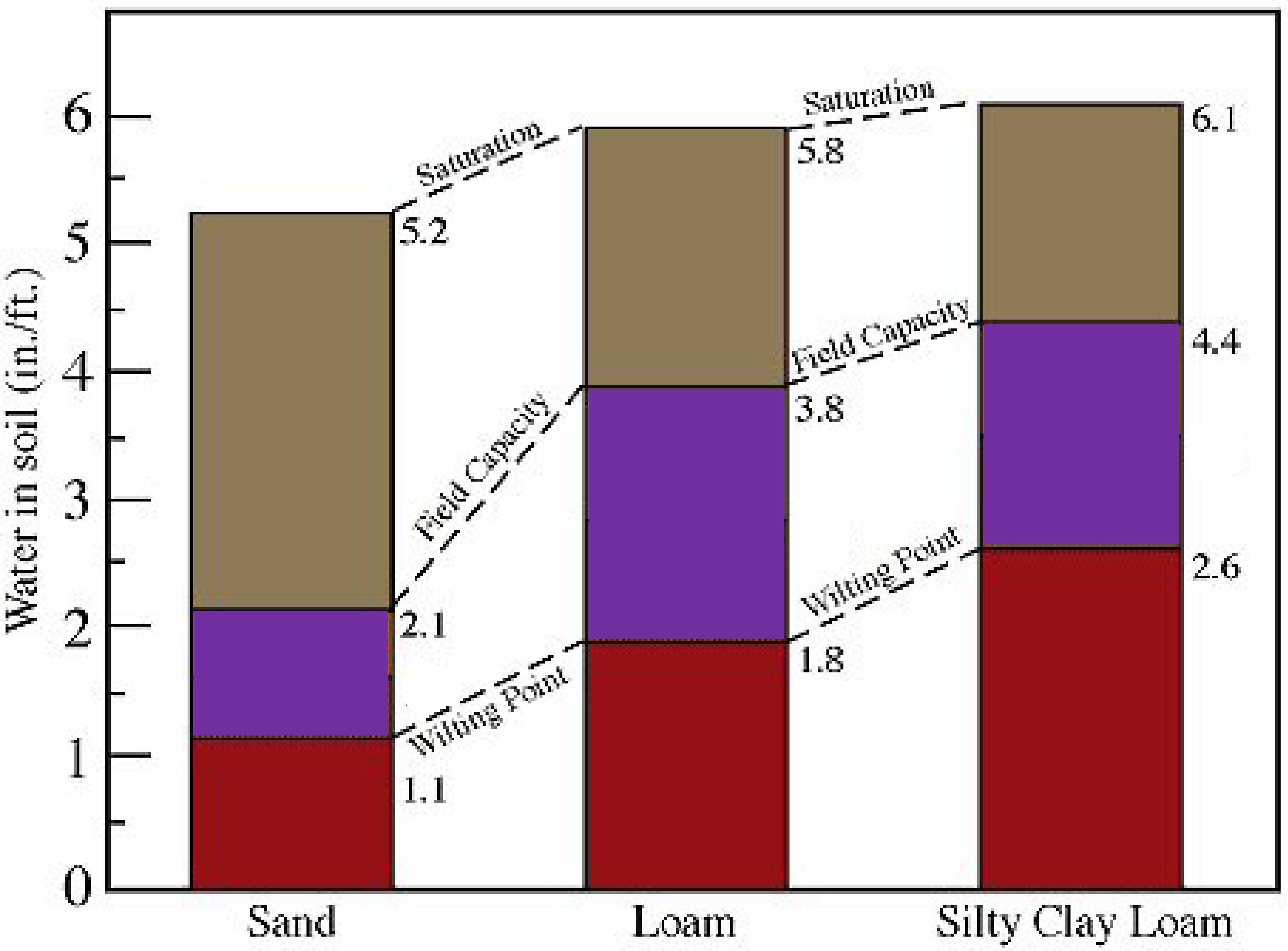
Volume → area*depth, or inches water/foot depth

Texture → water stored→ clay > loam >> sand
water available → sand > loam > clay)

How is water "held" in soils?



Available water in soils (*inches water/foot of soil depth*)

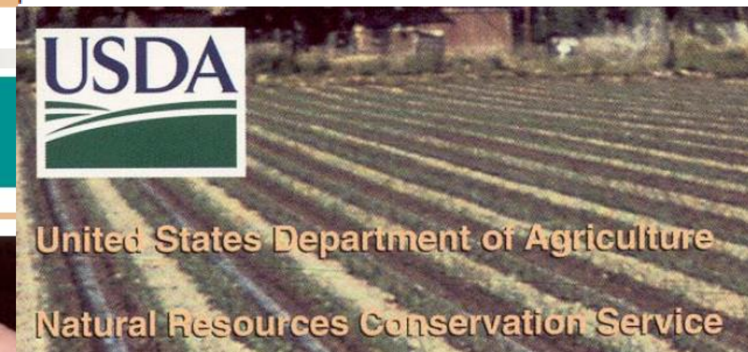


soil texture ~ soil water available ~ how often to water

Sandy

Clayey

Estimating Soil Moisture by Feel and Appearance



Appearance of clay, clay loam, and silt clay loam soils at various soil moisture conditions.

Available WaterCapacity
1.6-2.4 inches/foot

Percent Available: Currently available soil moisture as a percent of available water capacity.

In/ft. Depleted: Inches of water currently needed to refill a foot of soil to field capacity.

0-25 percent available
2.4-1.2 in/ft. depleted

Dry, soil aggregations separate easily, clods are hard to crumble with applied pressure. (Not pictured)

50 - 75 percent available
1.2-0.4 in./ft. depleted

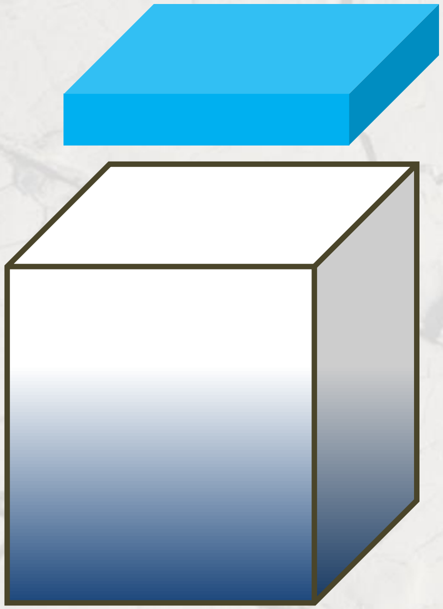
Moist, forms a smooth ball with defined finger marks, light soil/water staining on fingers, ribbons between thumb and forefinger.

Approximate soil moisture/tension values for the "knee-of-the-curve", and Managed Allowable Depletion for 12 Soil Textural Classifications.

Prepared by: Richard White, Technical Applications, Soilmoisture Equipment Corp., August 200' 805-964-3525 x 248

Soil Texture Classification	Approximate range of values for each soil textural classification										
	Bulk Density		Field Capacity	"Knee of Curve"	50% MAD*		Available Water		Field Capacity		Wilting
	g/cm3		cbar=kPa	cbar=kPa	in/ft	cm3/cm3	in/ft	cm3/cm3	in/ft	cm3/cm3	in/ft
Sand	1.66	Min	9	20	1.14	0.04	0.84	0.07	1.56	0.13	0.72
	1.68	Max	10	25	1.32	0.04	0.96	0.08	1.80	0.15	0.84
Loamy Sand	1.61	Min	10	25	1.44	0.04	0.95	0.08	1.91	0.16	0.96
	1.61	Max	11	30	1.50	0.05	1.08	0.09	2.04	0.17	0.96
Sandy Loam	1.53	Min	10	22	1.61	0.05	1.06	0.09	2.14	0.18	1.08
	1.57	Max	11	27	1.85	0.07	1.54	0.13	2.62	0.22	1.08
Silt Loam	1.37	Min	11	27	2.24	0.08	1.84	0.15	3.16	0.26	1.32
	1.44	Max	12	32	2.47	0.10	2.30	0.19	3.62	0.30	1.32
Silt	1.43	Min	11	25	2.39	0.10	2.38	0.20	3.58	0.30	1.20
	1.43	Max	12	30	2.41	0.10	2.42	0.20	3.62	0.30	1.20
Loam	1.41	Min	12	30	2.06	0.06	1.47	0.12	2.79	0.23	1.32
	1.46	Max	13	35	2.33	0.08	1.77	0.15	3.21	0.27	1.44
Sandy Clay	1.30	Min	13	35	3.27	0.04	1.02	0.08	3.78	0.31	2.76
	1.33	Max	14	40	3.51	0.06	1.25	0.11	4.13	0.35	2.88
Sandy Clay Loam	1.37	Min	13	40	2.39	0.04	0.93	0.08	2.85	0.24	1.92
	1.43	Max	14	45	2.63	0.06	1.42	0.12	3.34	0.28	1.92
Clay Loam	1.29	Min	14	45	2.99	0.06	1.41	0.12	3.69	0.31	2.28
	1.33	Max	15	50	3.24	0.08	1.92	0.16	4.20	0.35	2.28
Silty Clay Loam	1.26	Min	13	40	3.27	0.08	1.97	0.16	4.25	0.35	2.28
	1.29	Max	14	50	3.34	0.09	2.12	0.18	4.40	0.37	2.28
Silty Clay	1.21	Min	12	38	4.19	0.08	1.89	0.16	5.13	0.43	3.24
	1.23	Max	14	42	4.34	0.08	1.96	0.16	5.32	0.44	3.36
Clay	1.21	Min	14	55	3.86	0.05	1.23	0.10	4.47	0.37	3.24
	1.28	Max	15	60	4.52	0.08	1.83	0.15	5.43	0.45	3.60

Functional irrigation approach: wrap-up



1 in of water
over 1 sq ft
= **0.62 gal.**

Soil water reservoir:	fuel tank
Evapotranspiration:	fuel consumption
Tree condition:	fuel gauge (wilting = empty)
Soil moisture content:	the other fuel gauge

Example:
An unhappy tree in a green lawn…

Watering BMPs
#1: check the soil, do not presume!

Laboratory method: gravimetric water content

$$\frac{\text{Wet weight - dry weight}}{\text{dry weight}}$$

G) Accurate, versatile

B) Slow

U) Cumbersome

$...?

Water content measurement: **Capacitance** sensors

G) Reasonably accurate, versatile, quick

B) No major badness; but need a “tight fit” with the soil

U) Can get expensive

$100-150/sensor (+$400 for reader)

Water content measurement: **TDR** sensors

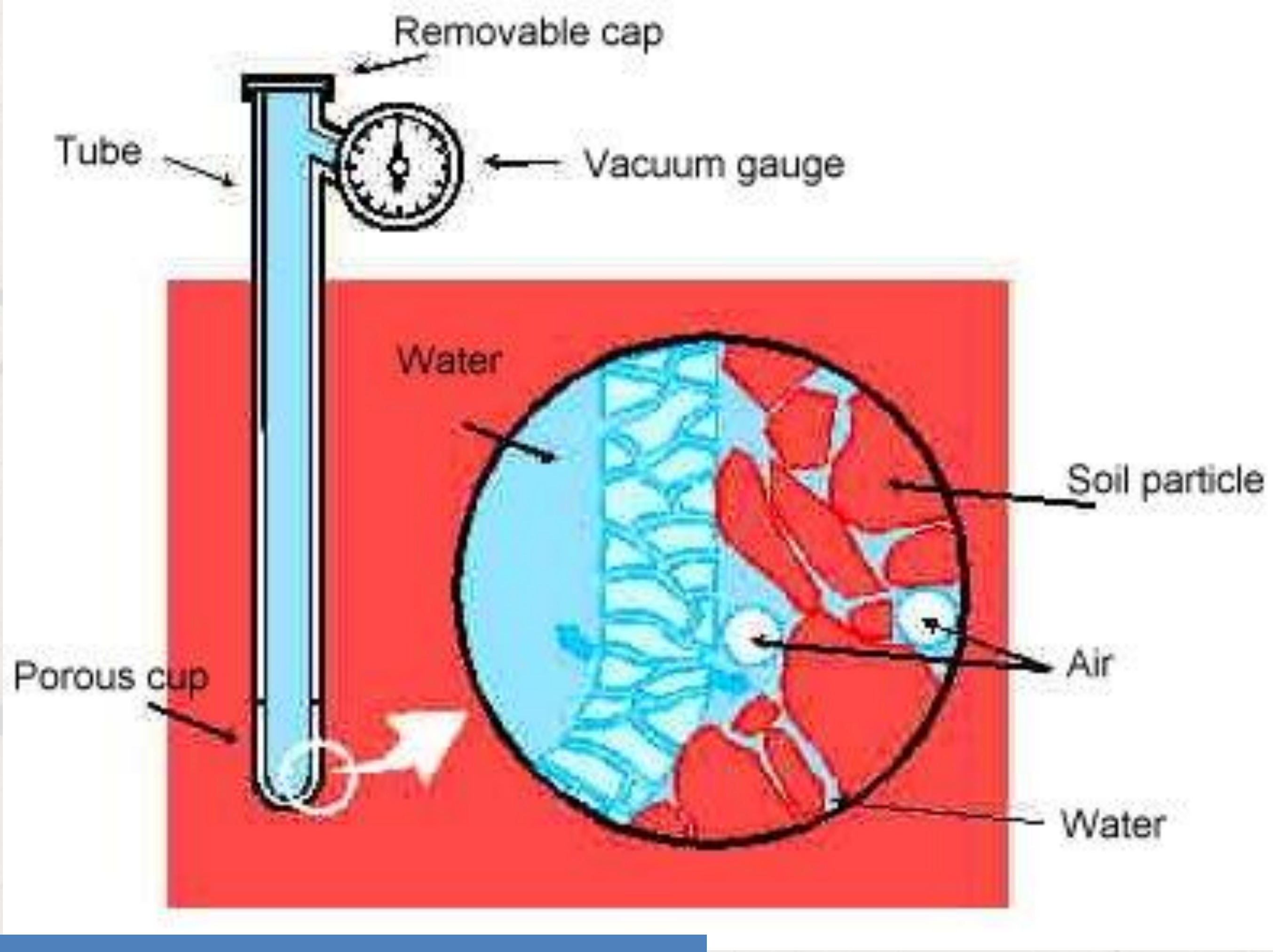
G) Reasonably accurate, versatile, quick

B) No major badness; need a “tight fit” with the soil

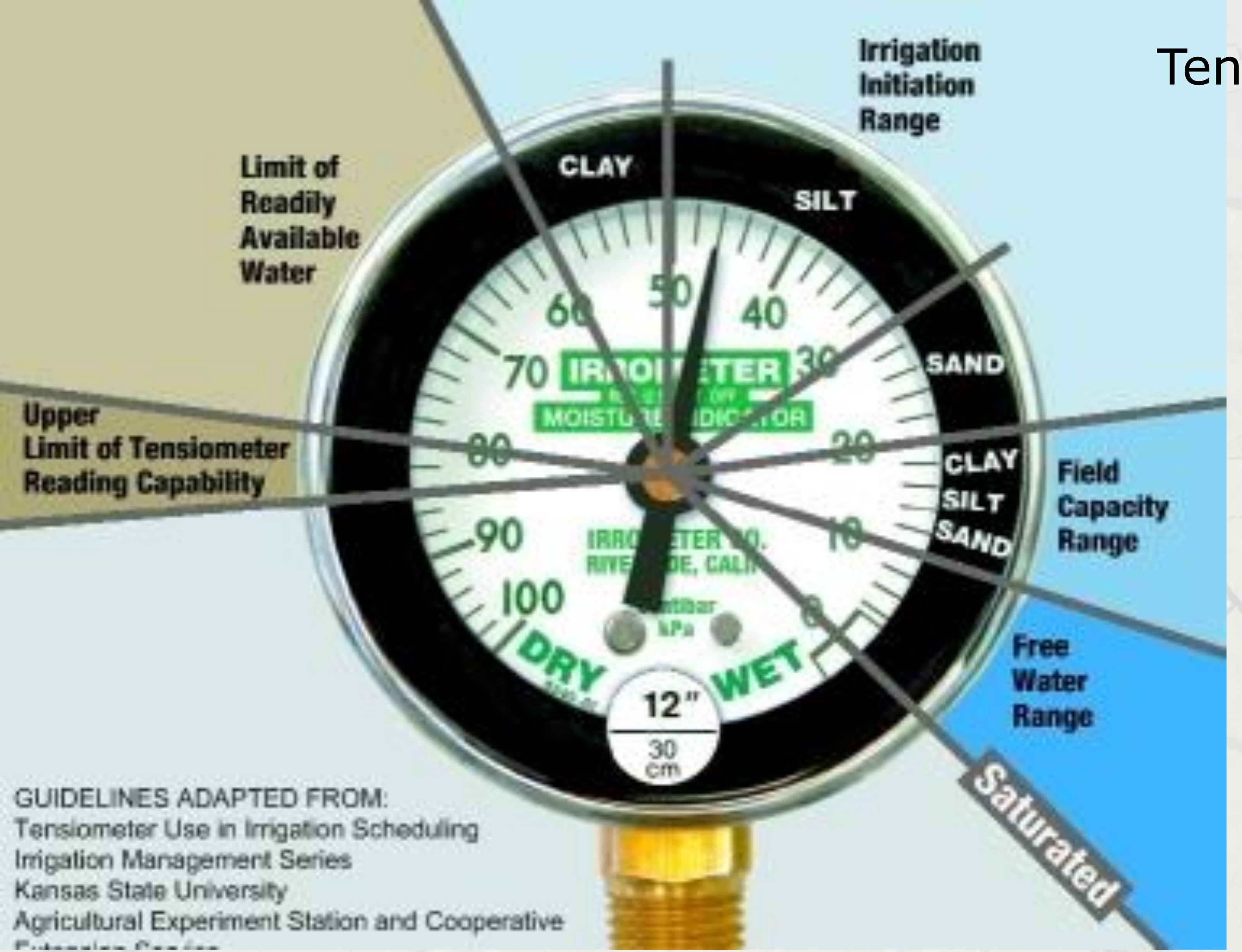
U) Expensive

$850-$3000

Water-potential measurement: Tensiometer



Tensiometer



G) Proven, versatile

B) Slow, vandal-prone

U) Best for wet-ish soils (sandy)

$50-200

Sort-of Water-potential measurement: Gypsum blocks

G) Well-known (but a RELATIVE measurement)

B) Affected by salinity

U) Poor accuracy in wet soils (and limited range in dry…)

$10-$20/sensor+ $300 for reader

"Soil Wetness measurement"
(the inexpensive stuff)

G) Affordable, but a TOTALLY RELATIVE measurement (no units on scale!)

B) Affected by salinity: really – it doubles as a salinity meter!

U) Cannot use across multiple soils without "re-calibrating"

$50-$120

Soil probes and augers for the win!

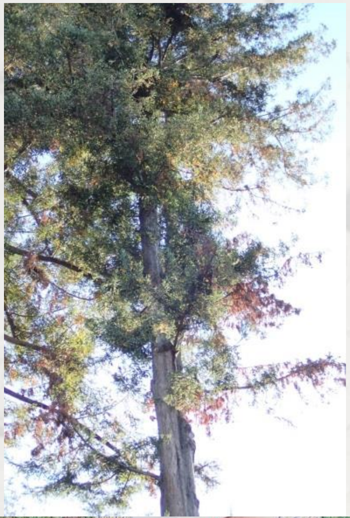
G) Affordable, and super-useful

B) Quite subjective – not a direct replacement for a meter

U) Can be laborious…

$30-$500

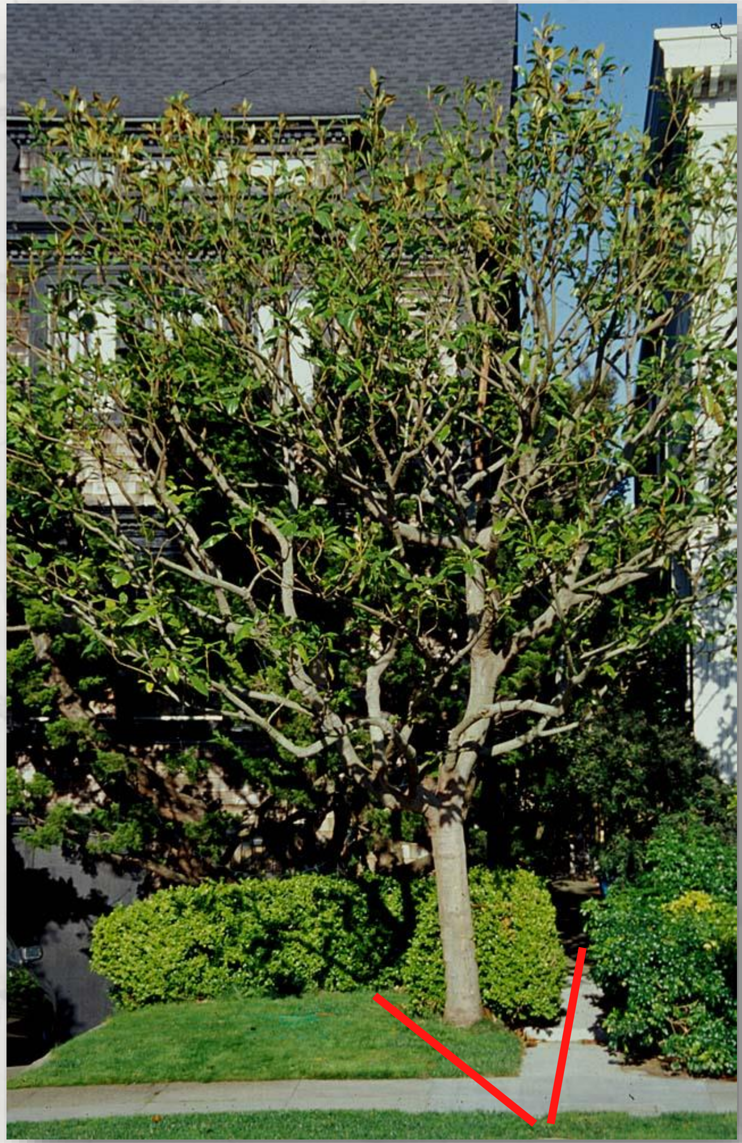
Watering BMPs
#2: check the roots…



Watering BMPs
#3: Avoid damaging the roots!

Trenching and root cutting
leads to water deficits.

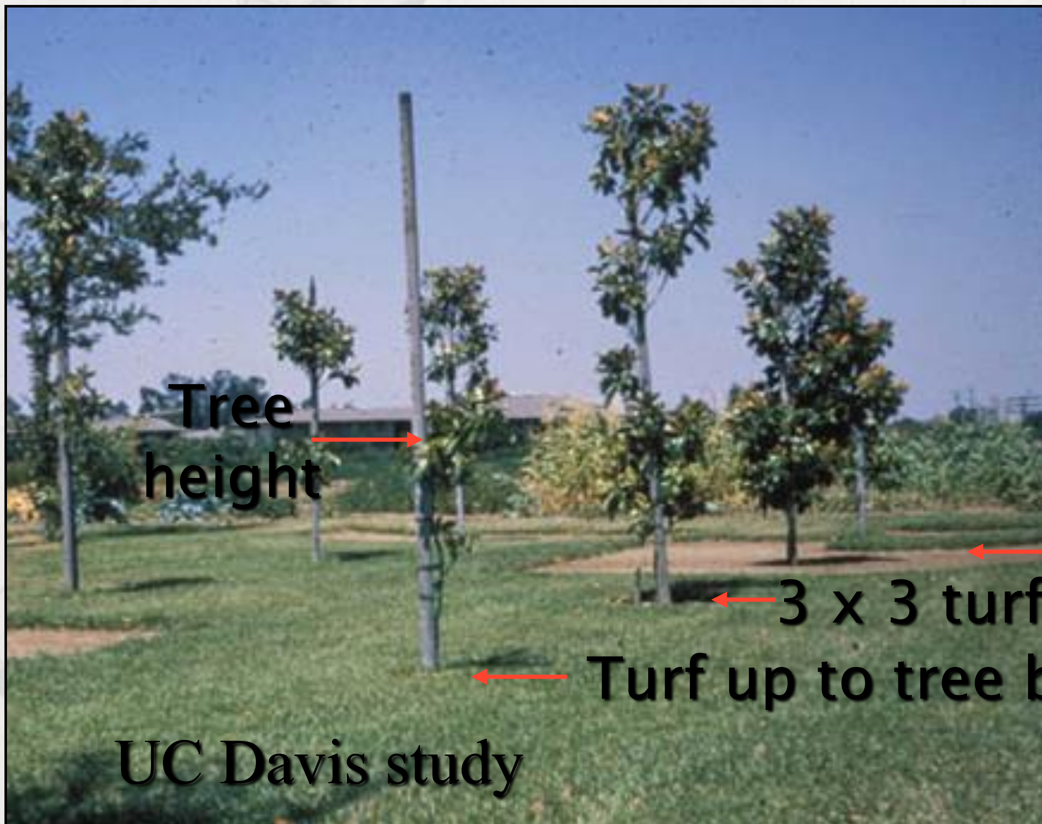
Magnolia grandiflora before trenching….



…and 3 months after trenching.

Watering BMPs

#4: Maintain a turf-free zone around newly planted trees.

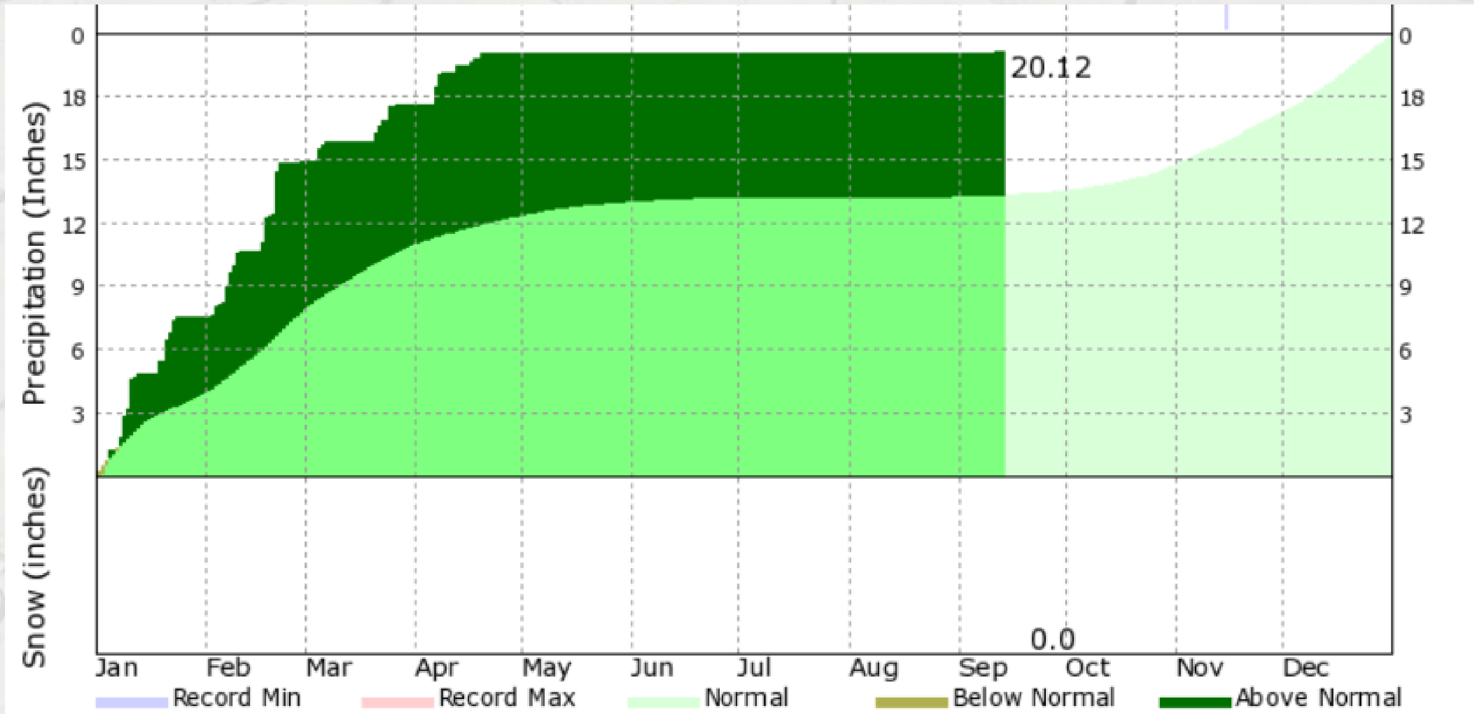


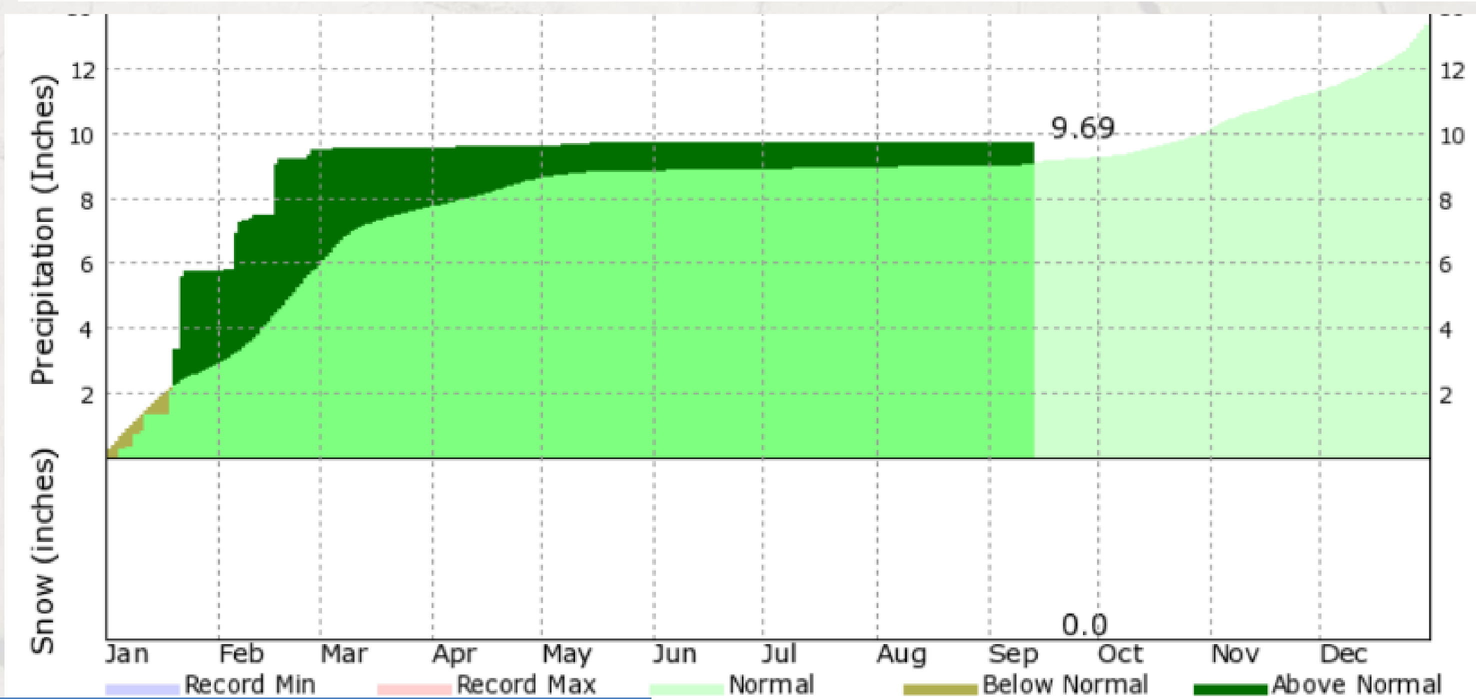
Watering BMPs #5: Mulch!

← Tree roots do better under mulch

Mulch pitfalls: volcanoes

Check your local rainfall…





Drought: some UC resources

ipm.ucdavis.edu

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- develop more water-conserving, pest-resistant and disease-resistant home gardens
- create environmentally sound public landscapes and parks
- produce better plant materials for sustainable urban landscapes

We seek to address the state's growing water demands, increasing chemical inputs into the environment, and loss of wild lands in order to improve the quality of urban life.

News

San Jose Drought Workshop Presentations & Handouts Now Available!

Jun 18, 2015

Lake Tahoe Drought Workshop Presentations & Handouts Now Available!

Jun 08, 2015

More news...

Featured

NEW! Landscaping Resources During Drought!!

NEW! Landscape Irrigation Scheduling!

Results from Kurapia Irrigation Trial Available Now!

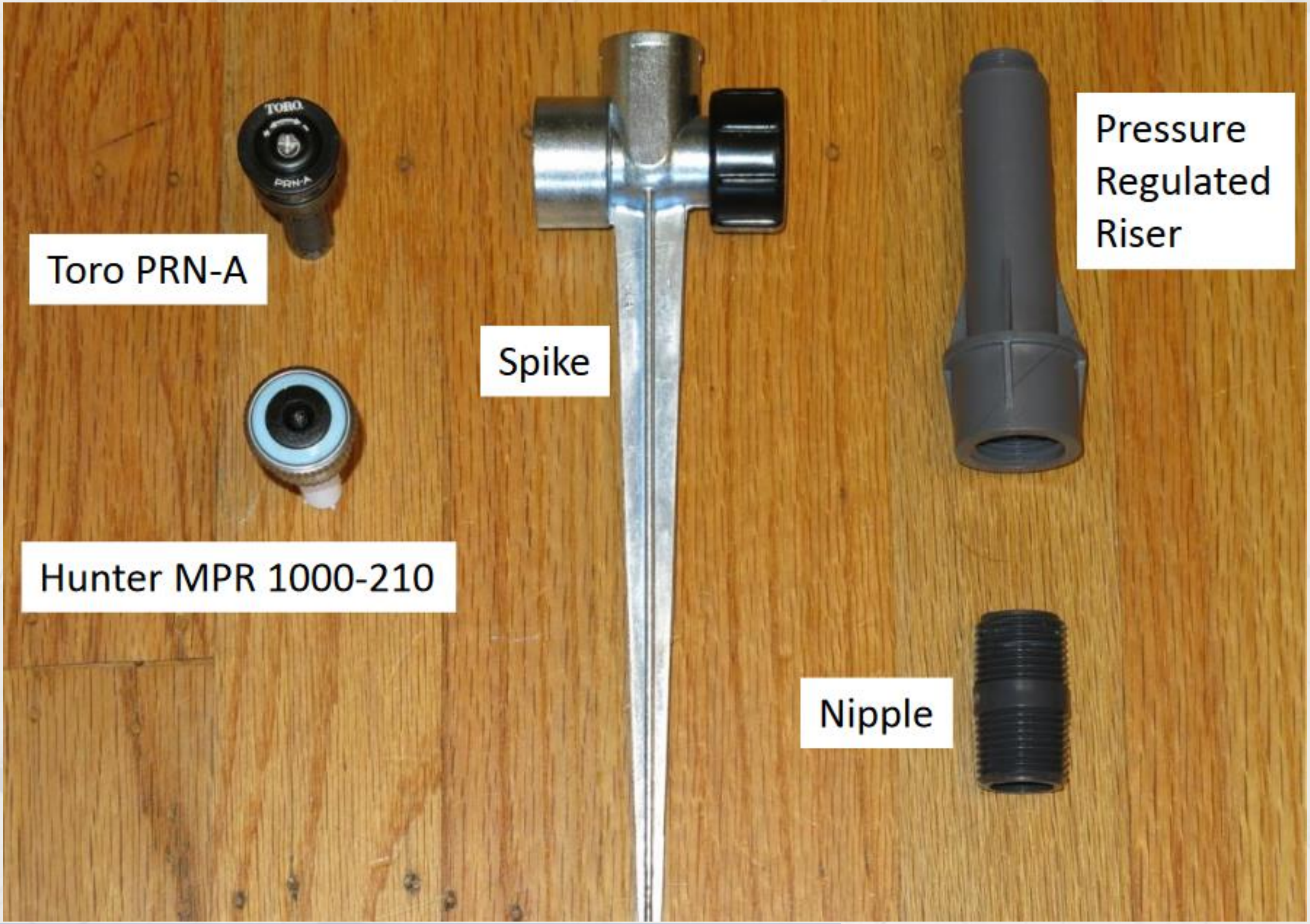
New article about the TRIC on the UCANR Master Gardener Website!

Low Water Use Landscaping Presentations from Nov 8th Available Here

Tree Ring Irrigation Contraption (TRIC): A New Way to Water Trees with Confidence

Rotary sprinkler irrigation contraption - RSIC

by Dr. Loren Oki and Dr. Dave Fujino, UCD CCUH



Fujino/Oki *Rotary sprinkler irrigation contraption*

Parts List (Est. cost = $15 - $20)

- **Sprinkler spike** **$4**
  *Aqualine SS-50Z ½ in.
- **Pressure regulated shrub riser** **$4**
  *Hunter PROS-00-PRS30
  *Rain Bird PA-8S-PRS
  *Toro 570S-PRX
- **Pipe nipple** **$1**
  ½ in. x 2 in. PVC
- **Multi-stream rotary sprinkler** **$6**
  *Hunter MP1000210-270
  *Rain Bird R-VAN1318
  *Toro PRN-A

*You need only one in each category

Fujino/Oki *RSIC:* How long to run it?

Time required to wet the soil down to 18" →

Depends on soil type

Multi-stream rotors have LOW flow rates; **good**: less chance for runoff

Soil type	Run time (hr:min)*		
	Hunter	Rain Bird	Toro
sand / fine sand	2:15	1:30	1:30
loamy sand	3:00	2:00	2:00
sandy loam	4:45	3:00	3:15
loam	6:45	4:30	4:45
silt / silty loam	8:30	5:30	5:45
sandy clay loam	6:30	4:15	4:15
clay loam	6:45	4:30	4:45
silty clay loam	7:45	5:00	5:15
sandy clay	5:15	3:15	3:30
silty clay	6:00	4:00	4:00
clay	6:30	4:15	4:15

*Rounded to 15 minutes

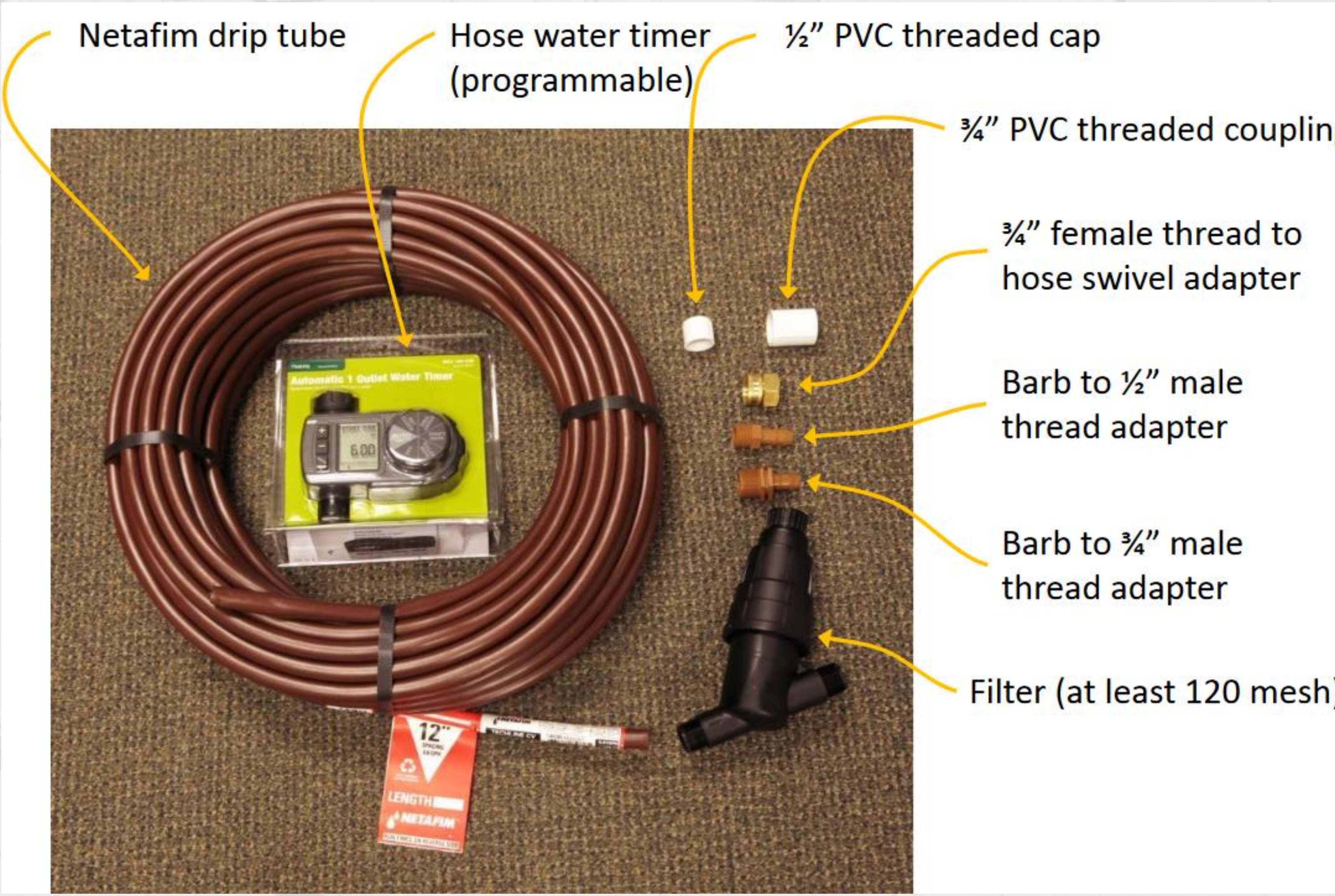
Times in red denote runoff may occur

"Tree Ring Irrigation Contraption"

Loren Oki and Dave Fujino

- Calculates irrig. run time to wet a tree to 36" deep
- Input info for 1' spacing:
  - Canopy radius, soil type, no. of 100' drip lengths (Netafim)
- http://ccuh.ucdavis.edu/

Fujino/Oki Tree ring irrigation contraption: Parts



Tree canopy

Radius= 6 ft — 1. Enter the radius of the tree canopy

Circumference= 37.7 ft — This calculator should not be used for trees with canopies with radii less than 4 ft.

Drip tubing

Use 100 ft. lengths of Netafim CV drip line with 0.6 gph emitters with 12" spacing

1 — 2. Enter how many 100' lengths of drip line are used

Flow rate= 60.8 gph

1 — Recommended number of lengths

For the radius of 6 feet, you will need 113 feet of drip tube.

There should be 1 foot between the circles of drip tube around the tree. The 1 length will be long enough to make nearly four circles of drip tube around the tree and will be sufficient.

Start laying the drip tube about 1 foot outside of the drip line of the tree canopy.

Irrigation

Precip rate= 0.98 in/hr

Soil texture

silty clay — 3. Click on the green cell to the left to see different soil textures

Then, select your soil texture from the drop down list

Duration*

*To wet to 36 inches deep — 4. This is the run time required to wet the soil to 36 inches.

2:35 hours:minutes

Fujino/Oki TRIC Calculator

Example: **silty clay**

Compare my trees' water use to other species:

ucanr.edu/sites/Wucols

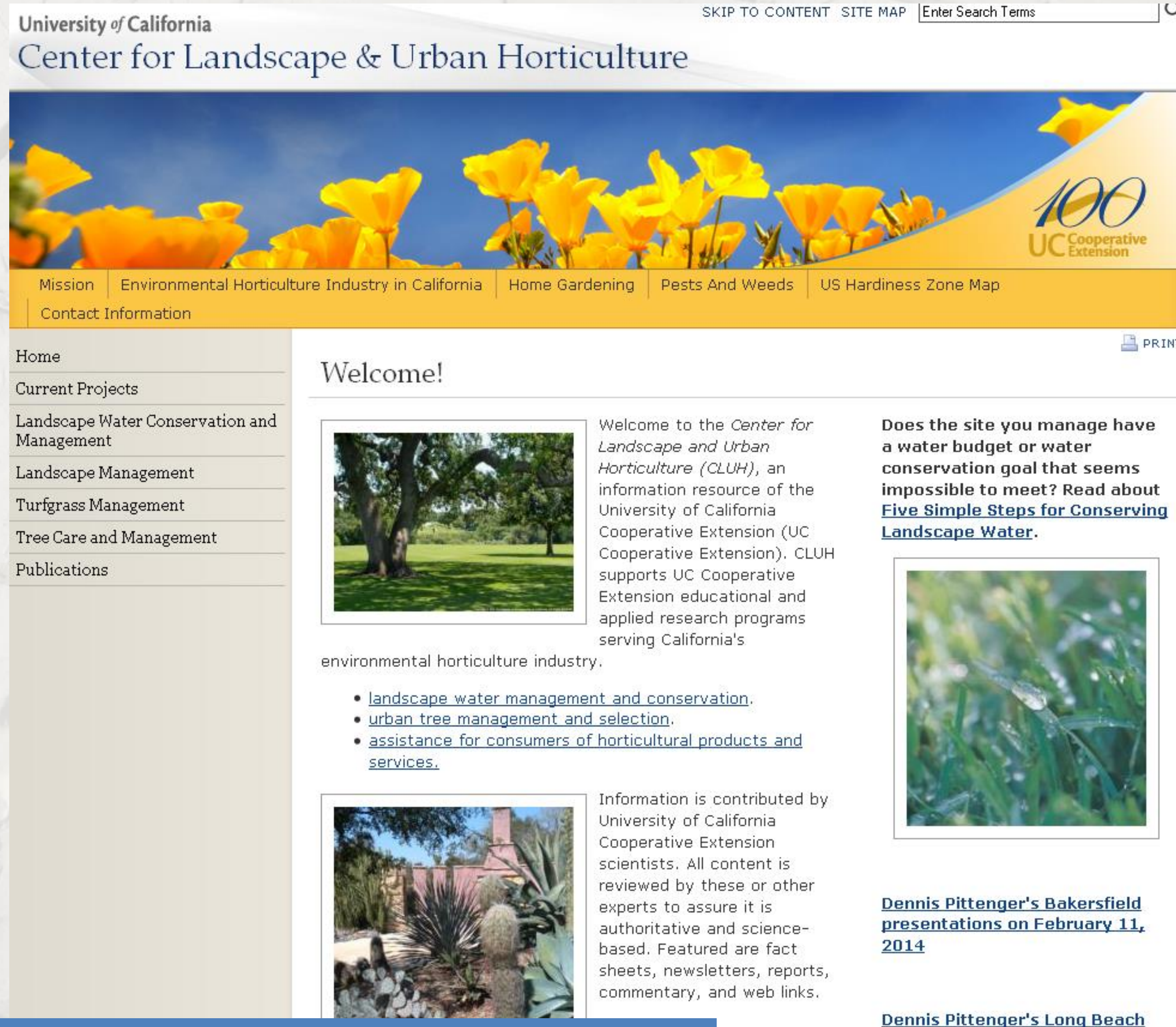
WUCOLS categories

CATEGORIES OF WATER NEEDS

Category	Abbreviation	Percentage of ET_0
High	H	70–90
Moderate	M	40–60
Low	L	10–30
Very Low	VL	< 10

Fig. 2. Five-finger fern was assigned to the "high" water needs category in four regions.

ucanr.edu/sites/UrbanHort



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Welcome to the *Center for Landscape and Urban Horticulture (CLUH)*, an information resource of the University of California Cooperative Extension (UC Cooperative Extension). CLUH supports UC Cooperative Extension educational and applied research programs serving California's environmental horticulture industry.

- landscape water management and conservation.
- urban tree management and selection.
- assistance for consumers of horticultural products and services.

Information is contributed by University of California Cooperative Extension scientists. All content is reviewed by these or other experts to assure it is authoritative and science-based. Featured are fact sheets, newsletters, reports, commentary, and web links.

Does the site you manage have a water budget or water conservation goal that seems impossible to meet? Read about Five Simple Steps for Conserving Landscape Water.

Dennis Pittenger's Bakersfield presentations on February 11, 2014

Dennis Pittenger's Long Beach

Elements of the problem, and responses

Aspect	Problem	Response
Lack of knowledge	"The trees will be fine"	Maybe – but they need a little help right now
Values, perspective	"We need to save water" *or* "there's no water for trees"	Trees are water-thrifty, their benefits are huge and irreplaceable
Technical	Don't know how to apply water, or how often, or how much	Young tree:10s gal/wk; Mature tree: 100s gal/month (in summer)
Attitude	"The city is not watering their trees…"	I will do the little bit that's needed to save **our city trees**

New sources of water

Local:

Greywater

How much?

Some…

Pros/Cons

+ Reliable, cheap

- Wrong place

Use for other plants; saves potable water for trees

New sources of water

Local/regional:

Recycled

How much?

Lots… maybe!

Pros/Cons

+ Volume!

- Distribution, salts

Keep track, test soils; but USE IT if you have it!

Long term response: reconsider trees + water

Element	Characteristics or Function
Water	***Grey*** → ubiquitous; for landscape trees or plants ***Recycl.*** → available to residents and city crews; distribution lines not crucial ***Potab.*** → "backup" or last resort for mature trees ***Storm*** → provides all of trees' winter needs; remains stored in soils/accessible
Plant palette & setup	**Landscapes** → water-conserving, tree-compatible **Trees** → drought- and recycled water-tolerant **Irrigation** → separated: trees vs. other plants
Steward-ship	**Shared** between residents, NGOs, local groups, and municipal staff

Thank you!

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Cooperative Extension

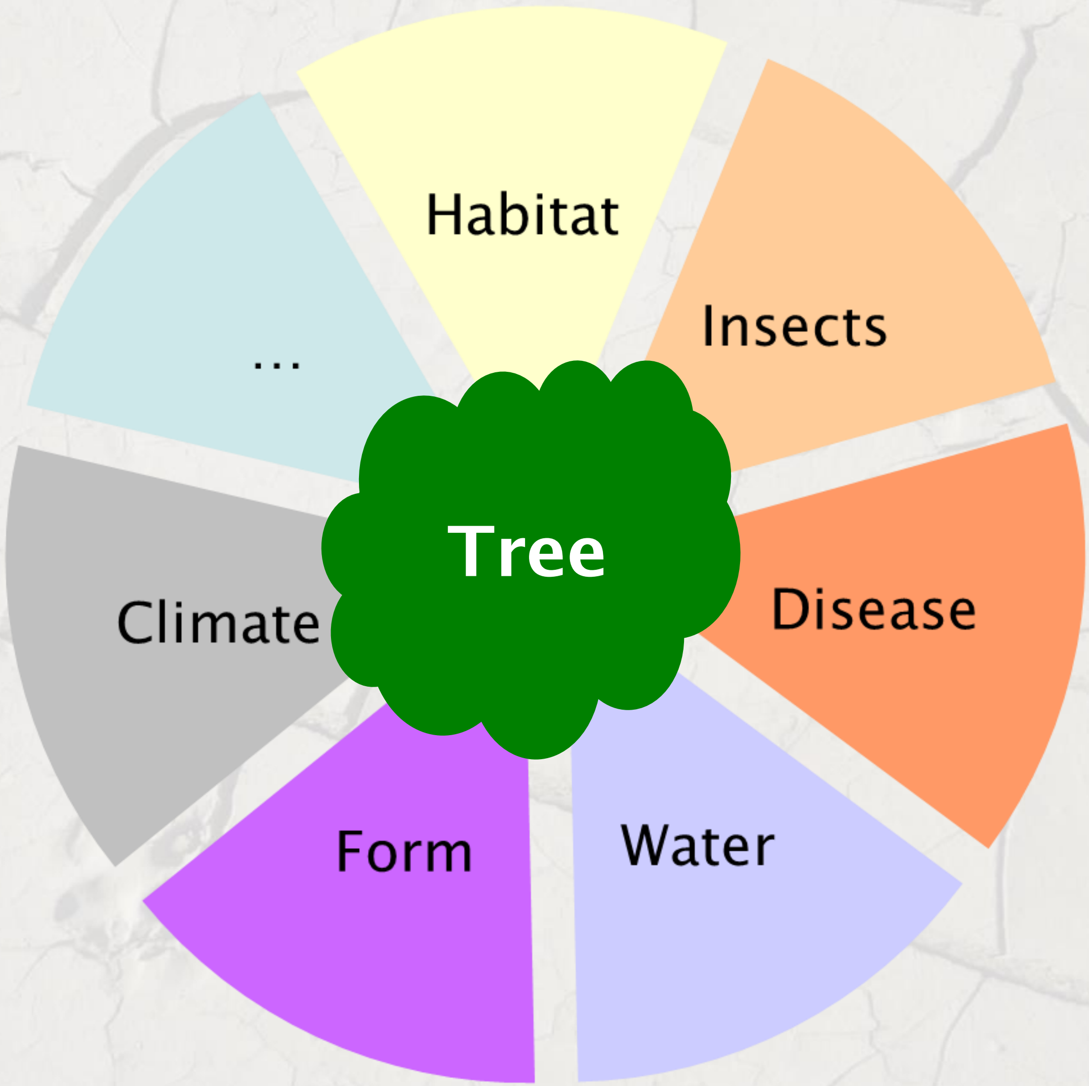
“Making the 50+ Year Decision”

Ralph Mize, City Arborist emeritus, San José, CA

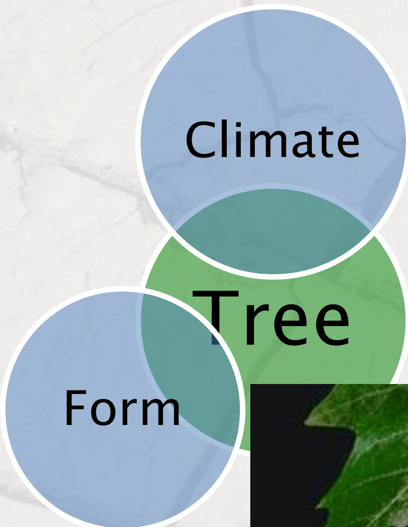
Goal: a “**successful urban tree**”

Provides benefits	*whose value exceeds the costs of maintenance*
Is well-behaved	*does not cause problems (roots; pollen; litter)*
Is alive	*lives and grows in the desired location*

Tree species selection 1: Individual considerations



Another example of single-tree considerations



Anthracnose and powdery mildew on plane trees

Cultivars resistant (and not)

Shothole Borers

John Kabashima, UCCE

Photo: Richard Stouthamer

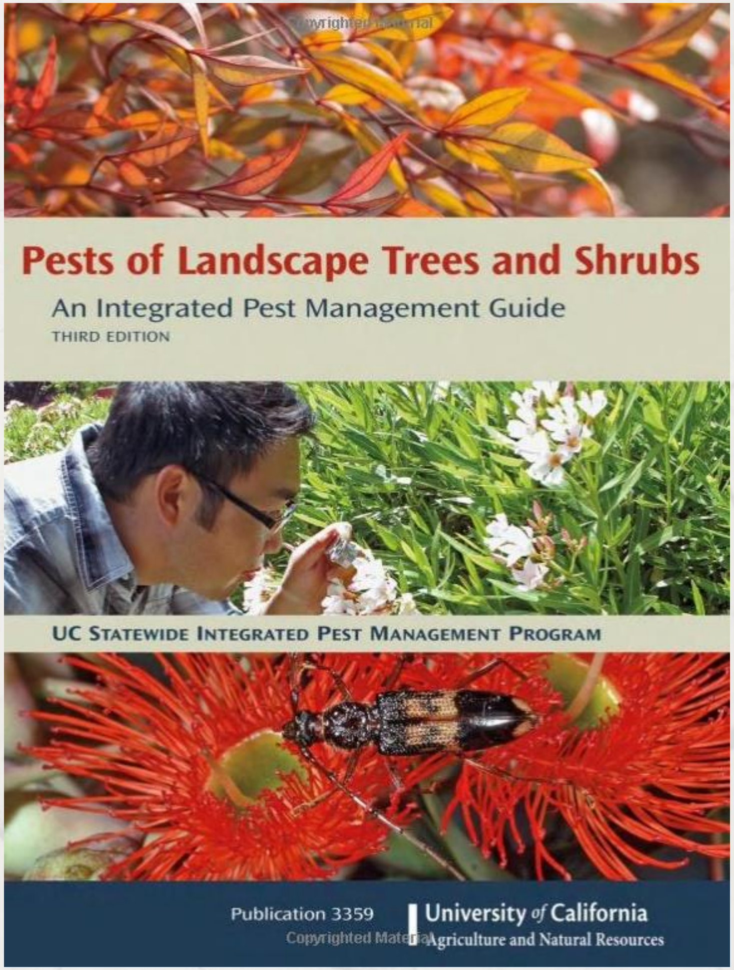
Pest Vulnerability Matrix

Construction

1 Obtain pest-host information

2 Arrange in table, indicate severity

3 Verify local importance

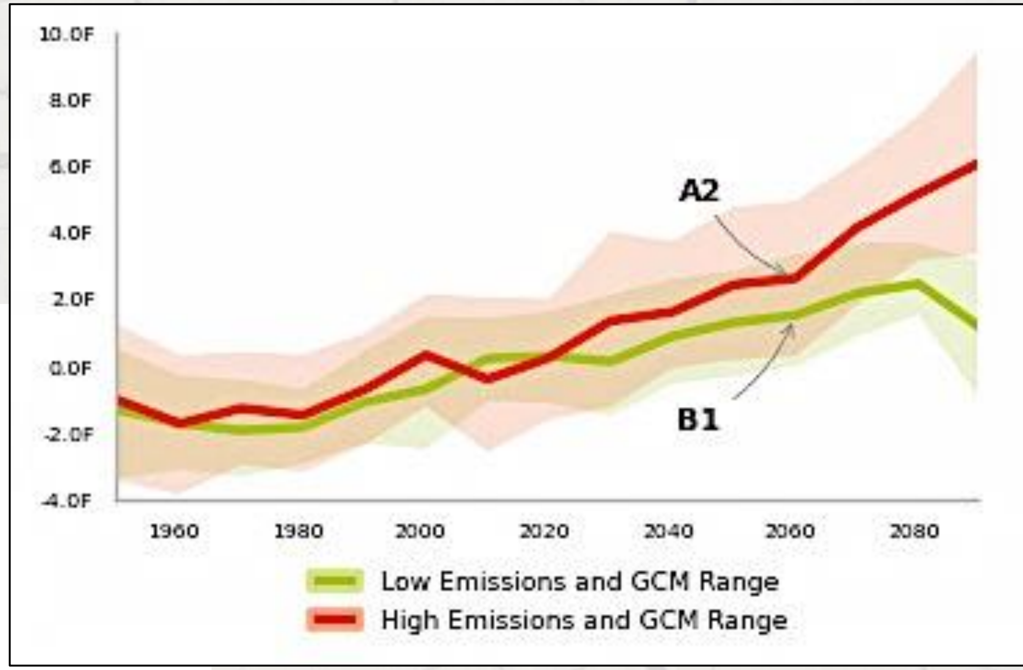


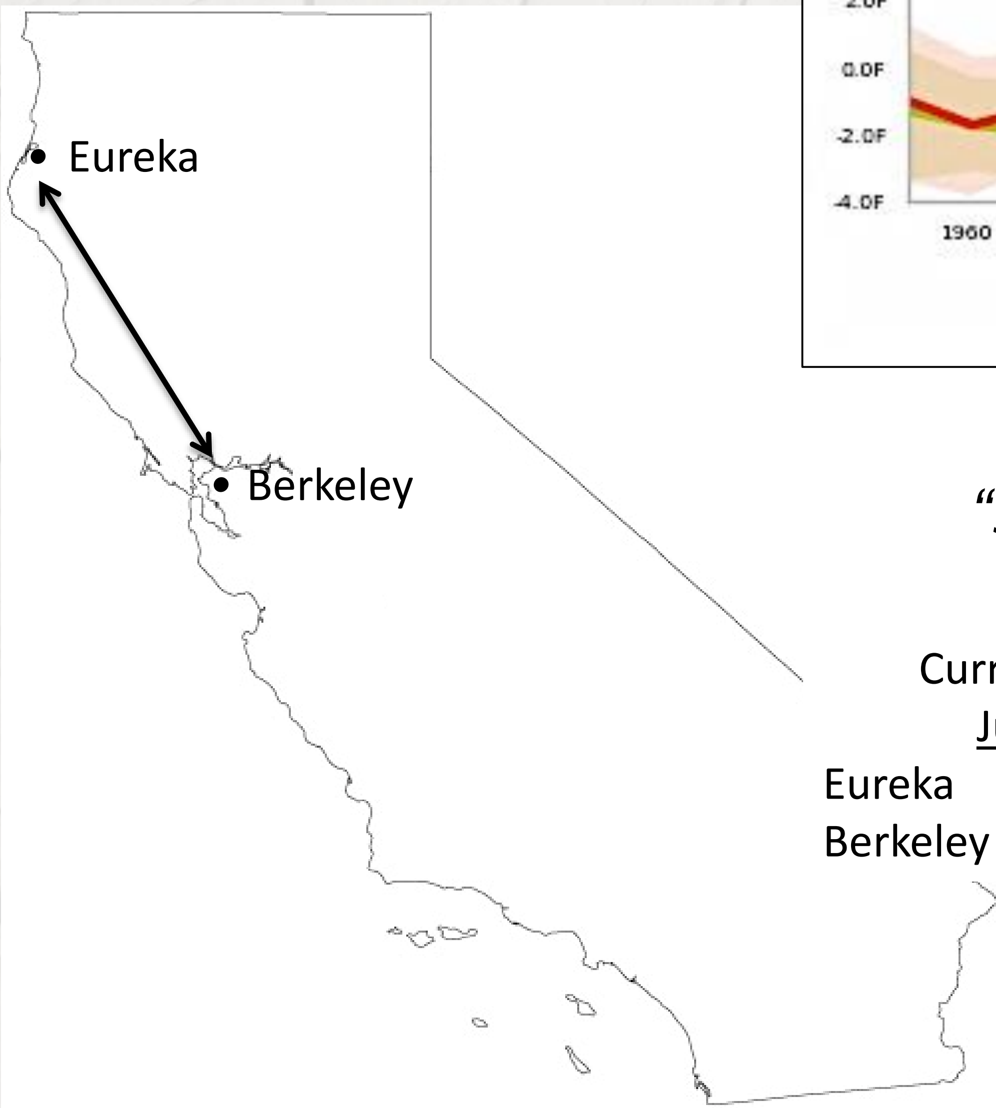
Pest	London plane tree	Maple	Honey Locust	Callery pear	Linden	Zelkova	% Tree species affected	Proportion of tree population affected
Pest count >>>	5	6	3	1	2	2		
Proportion of all trees >>>	0.4	0.2	0.1	0.1	0.1	0.1		
Anthracnose (fungal disease)							*50%*	*70%*
Defoliating caterpillars							*50%*	*70%*
Soft scales (insect)							*50%*	*70%*
Aphids (other)							*50%*	*70%*
Asian longhorned beetle							*33%*	*60%*
Spider mites (combined)							*33%*	*30%*
Armillaria root rot or Oak root fungus.							*17%*	*10%*
Fireblight (bacterial disease)							*17%*	*10%*
Other native borers (combined)							*17%*	*10%*

Tree species selection 2: considering all trees

Photo: Purdue Extension

(3) Street trees & climate change



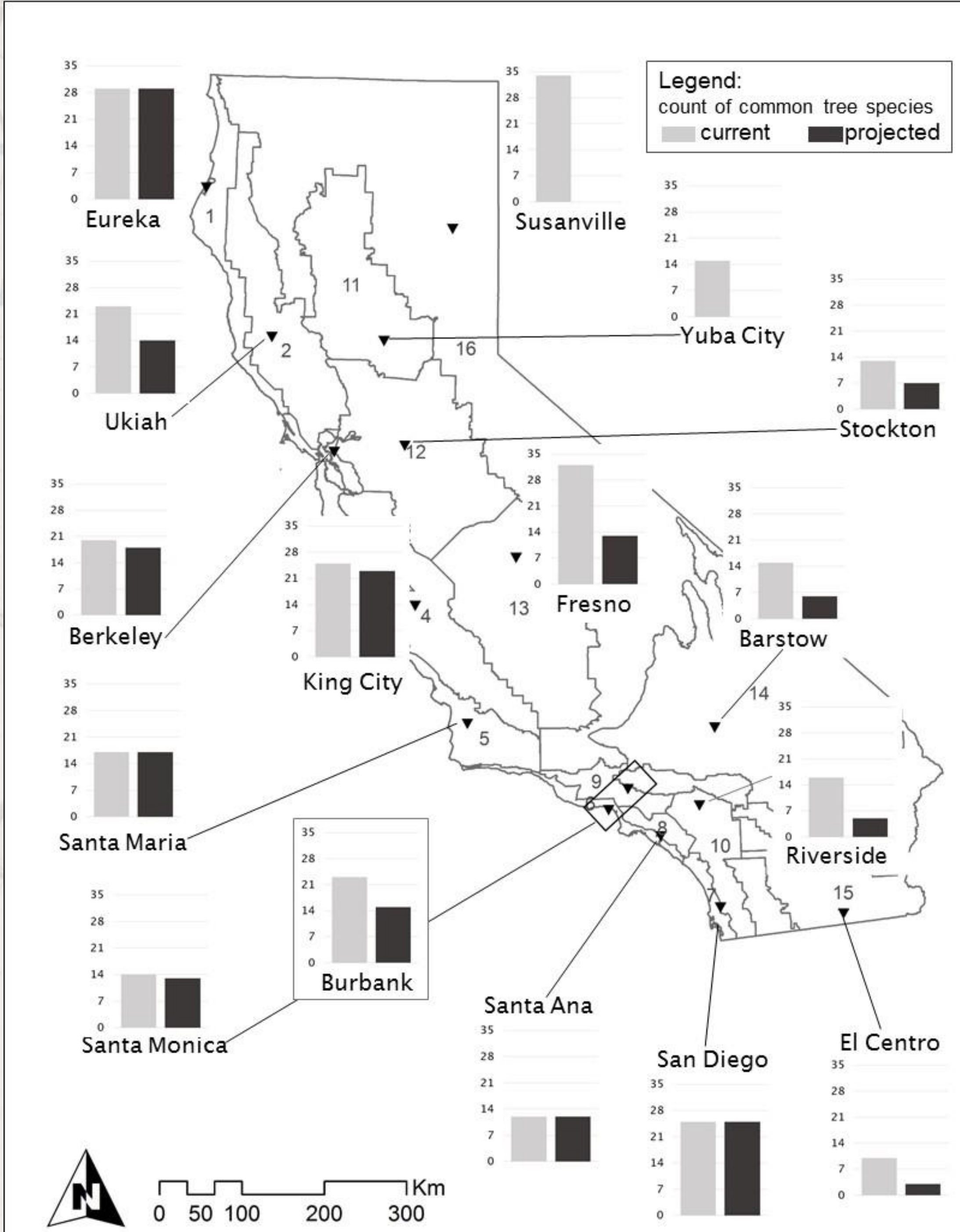


"substituting space for time"

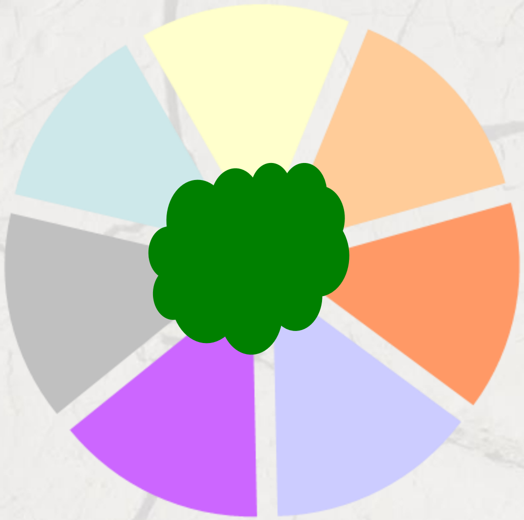
Temperature °F

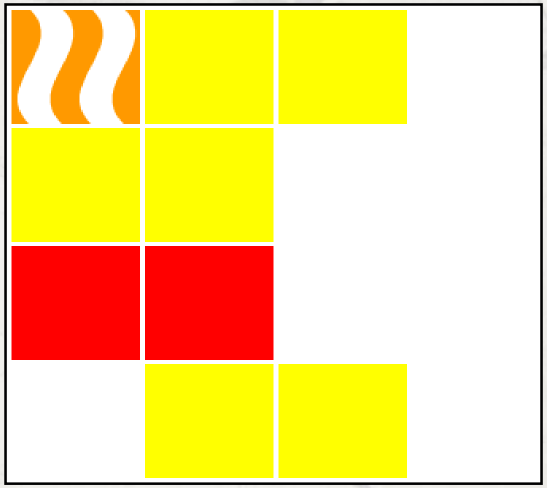
	Current Ave. July Max. Temp.	Predicted Ave. July Max.
Eureka	62	70
Berkeley	70	

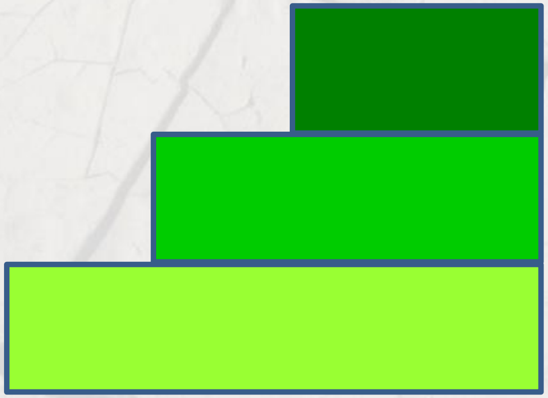
Many common street tree species are unsuitable for a warmer climate

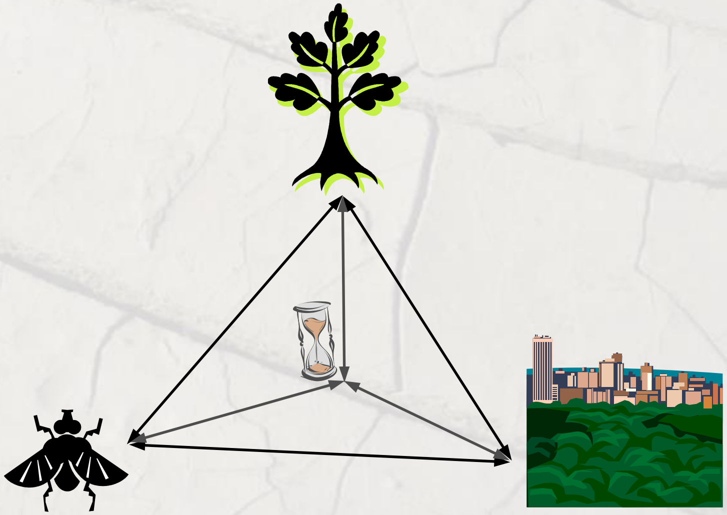


summary









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