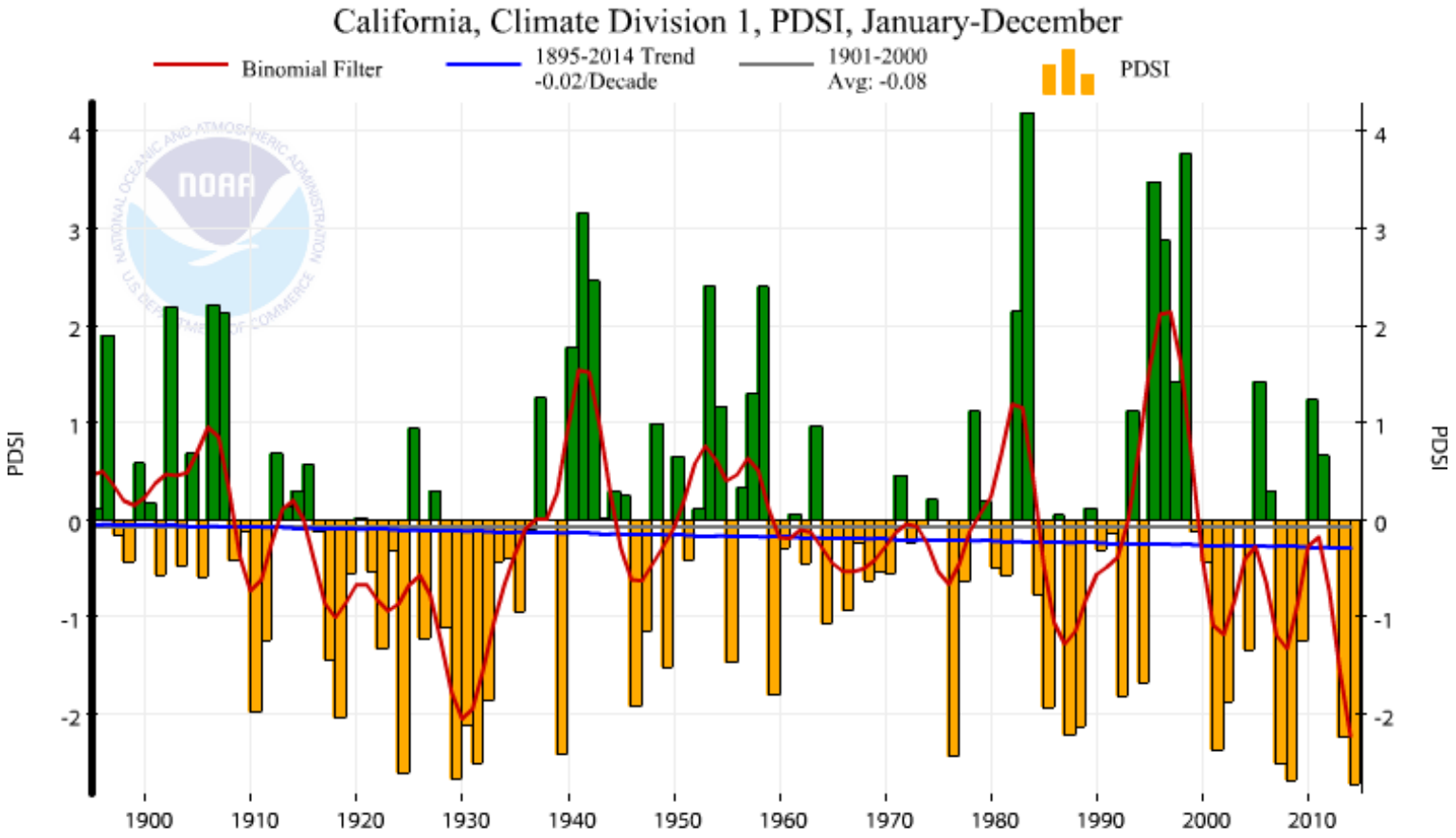
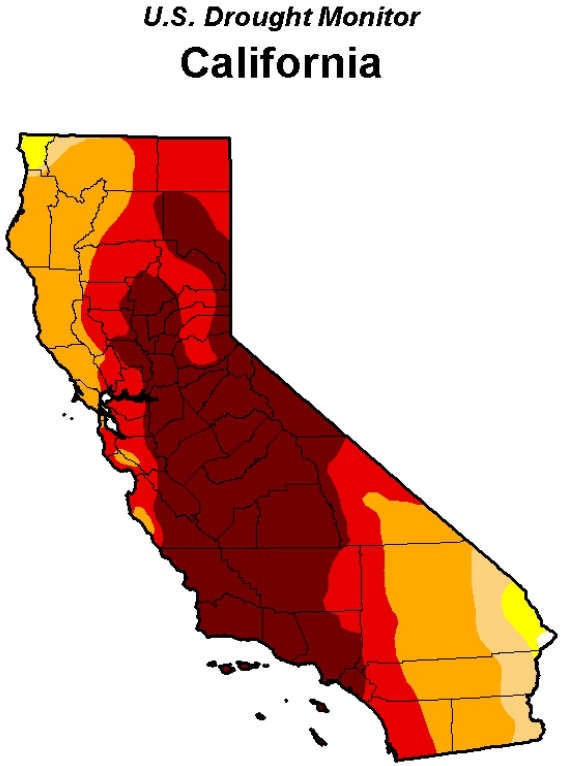
The “Drought”

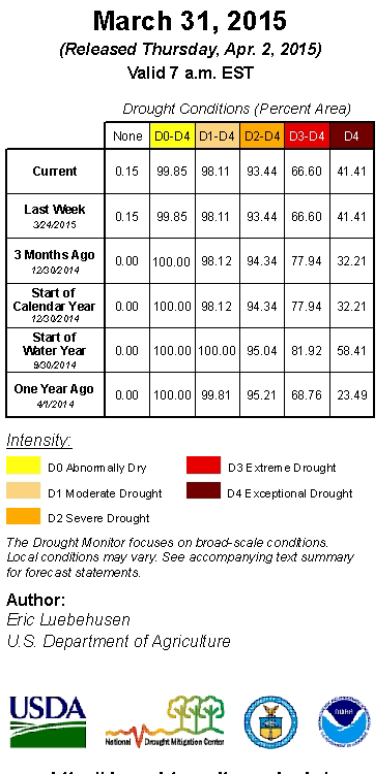
- How should we talk about the drought?
- Departure from “Normal” rainfall
- Palmer drought severity index (PDSI)
- Uses Temperature, Precipitation, Soil Moisture, Water Supply, & Water demand. It is most effective in determining drought status for non-irrigated crop land. Much better than the “Drought Monitor” we see often used in the media.

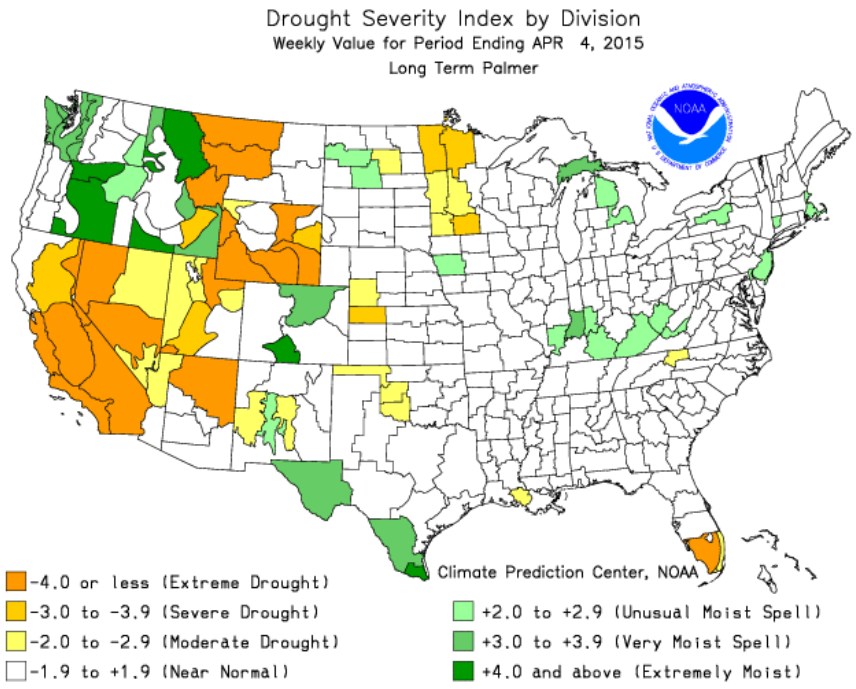


A tale of two indices

- Drought monitor vs. Palmer index?
- Drought Monitor incorporates human “fudge factors”. Incorporates “snow-pack”.
- Palmer model is strictly numbers based, accounting for local evapotranspiration, temperature, soil recharge and other factors. It does not do well with “snow-pack” which is irrelevant to Napa County Agricultural water supplies.

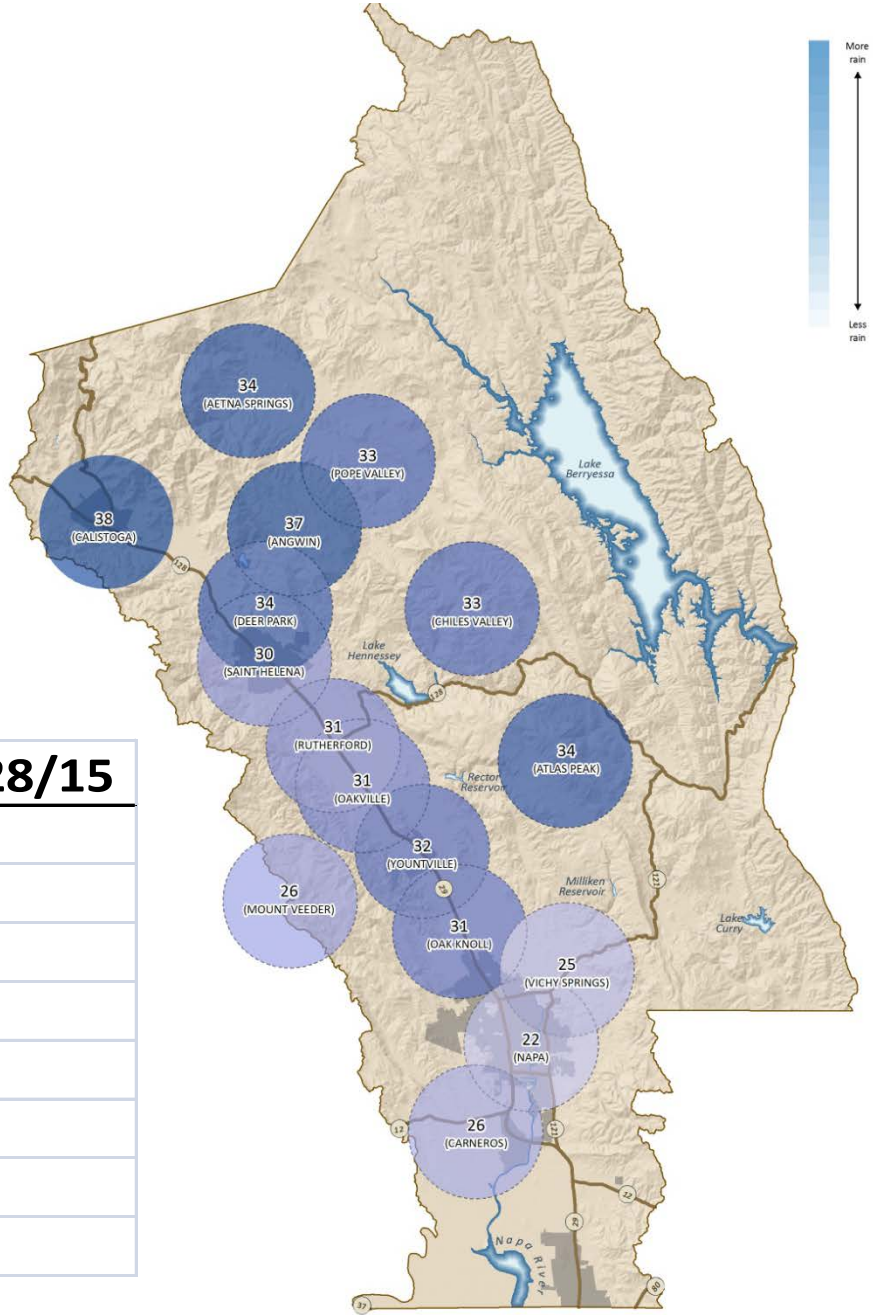






Rainfall Update

- NVG Growing Conditions Report
- Rainfall Totals Strong, above average to date in Carneros and Napa, below average to date up-Valley
- No measurable rainfall in January, 4 days of rain in February, and 1 day of rain in March, Light April and May totals
- Groundwater Levels holding steady, and improving in some areas



Area	Rainfall (inches) 7/1/14 - 5/28/15
Atlas Peak	33
St. Helena	32.5
Angwin	34
Calistoga	33
Rutherford	29.3
Coombsville	28.8
Oak Knoll	29
Carneros	22.6

Rainfall total vs. Rainfall timing

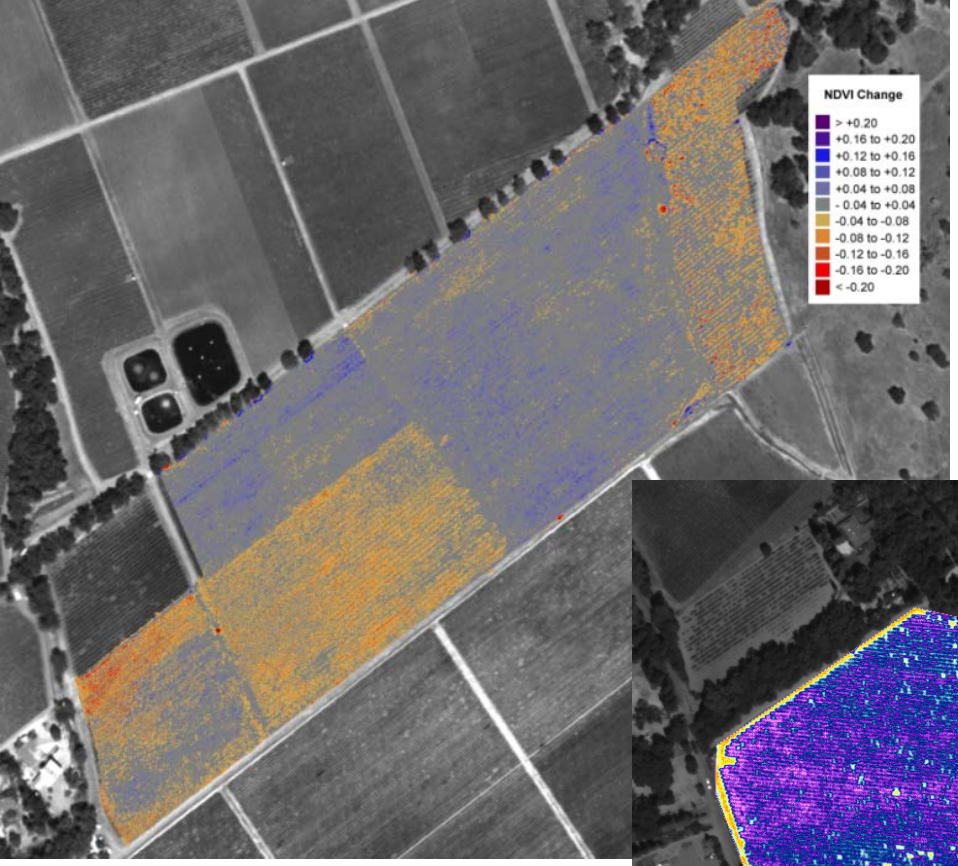
- Timing is Everything
  - •After reaching field capacity, the plant only cares about timing of rainfall
  - •Most soils “hold” 8 inches of water available to grapes
  - •Rainfall in April/May has a larger outcome on the type of season

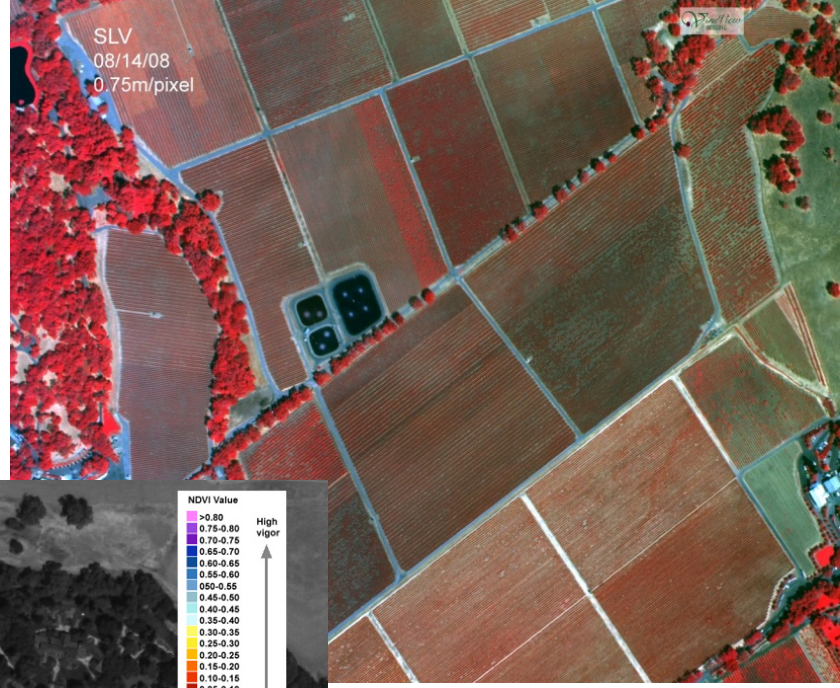
•The Last Day of “Field Capacity” is what concerns us in a low rainfall year

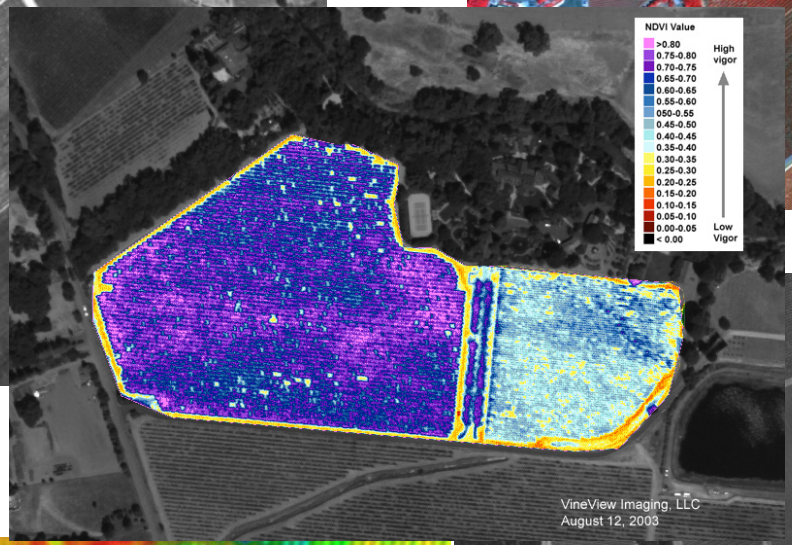
- •Nutrient status is affected in a dry spring
- •Canopy growth is affected in a dry spring
- •Supplemental irrigation is usually initiated earlier in a dry spring

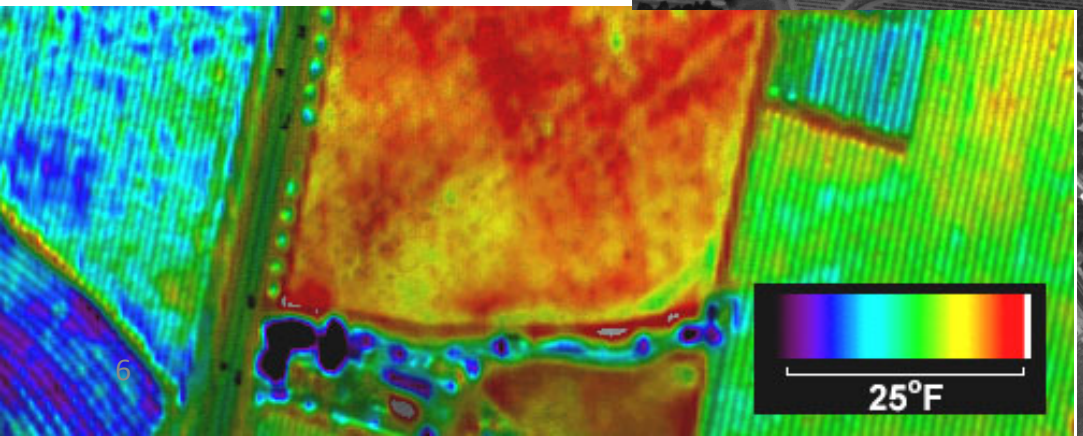
Irrigation Application and Efficiency

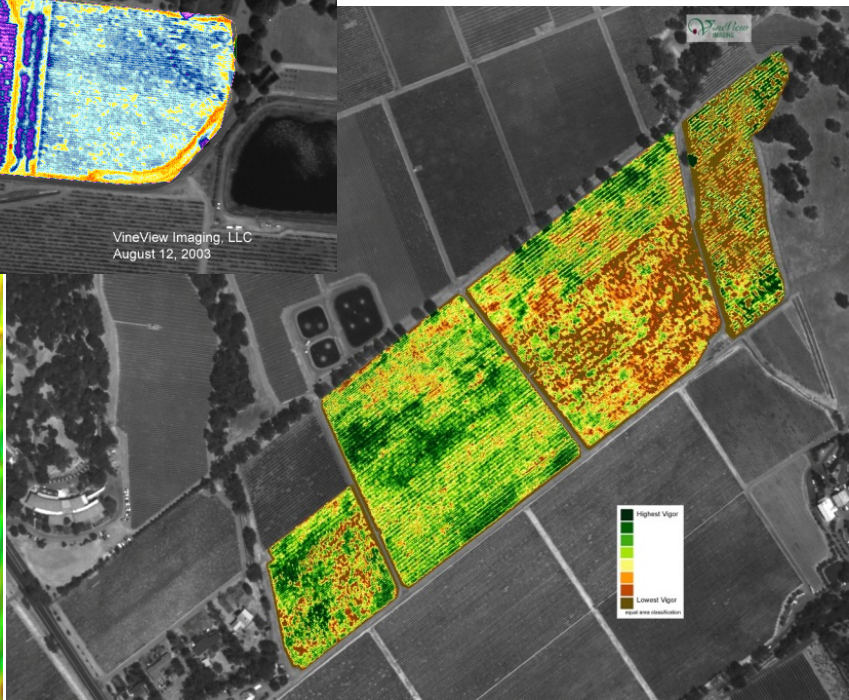
- Conventional tools
  - Neutron Probes
  - ET Deficit Irrigation Model
  - A Shovel
  - Our own Eyes
- Pressure Chamber
  - Pre-Dawn LWP
  - Mid-day Leaf Water Potentials
  - Stem Water Potentials
  - Porometer
- Real Time (constant) vineyard sensors
  - Weather stations
  - Soil Moisture probes
  - Sap Flow Sensors
  - Actual ET sensors (Tule Technologies)
  - Phytogram
  - Dendrometer


NDVI Change
> +0.20
+0.16 to +0.20
+0.12 to +0.16
+0.08 to +0.12
+0.04 to +0.08
- 0.04 to +0.04
-0.04 to -0.08
-0.08 to -0.12
-0.12 to -0.16
-0.16 to -0.20
< -0.20


SLV
08/14/08
0.75m/pixel


NDVI Value
>0.80
0.75-0.80
0.70-0.75
0.65-0.70
0.60-0.65
0.55-0.60
050-0.55
0.45-0.50
0.40-0.45
0.35-0.40
0.30-0.35
0.25-0.30
0.20-0.25
0.15-0.20
0.10-0.15
0.05-0.10
0.00-0.05
< 0.00
High vigor
Low Vigor
VineView Imaging, LLC
August 12, 2003


25°F

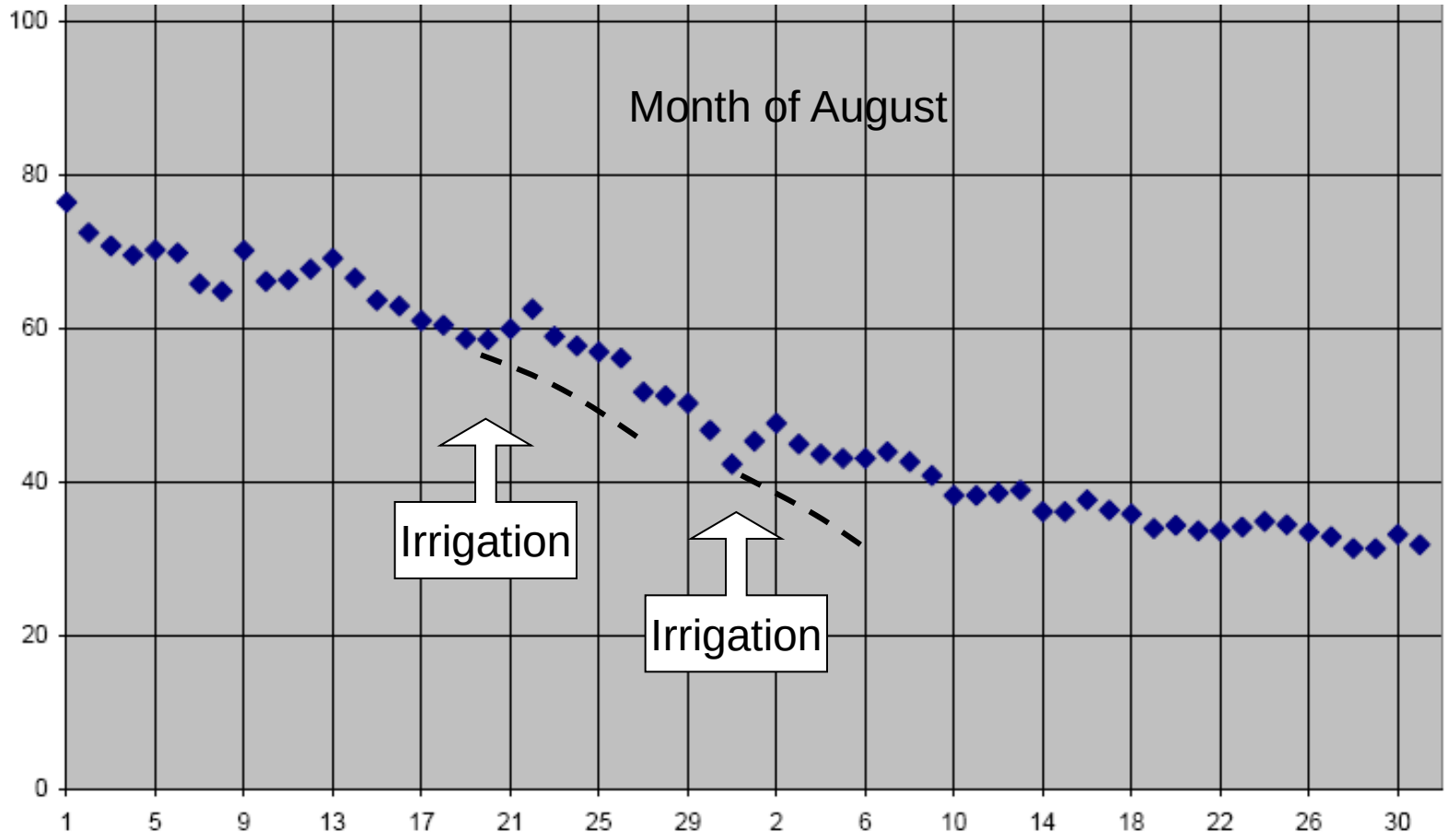

Highest Vigor
Lowest Vigor

Plant Adaptation
Grapevines are extremely drought tolerant

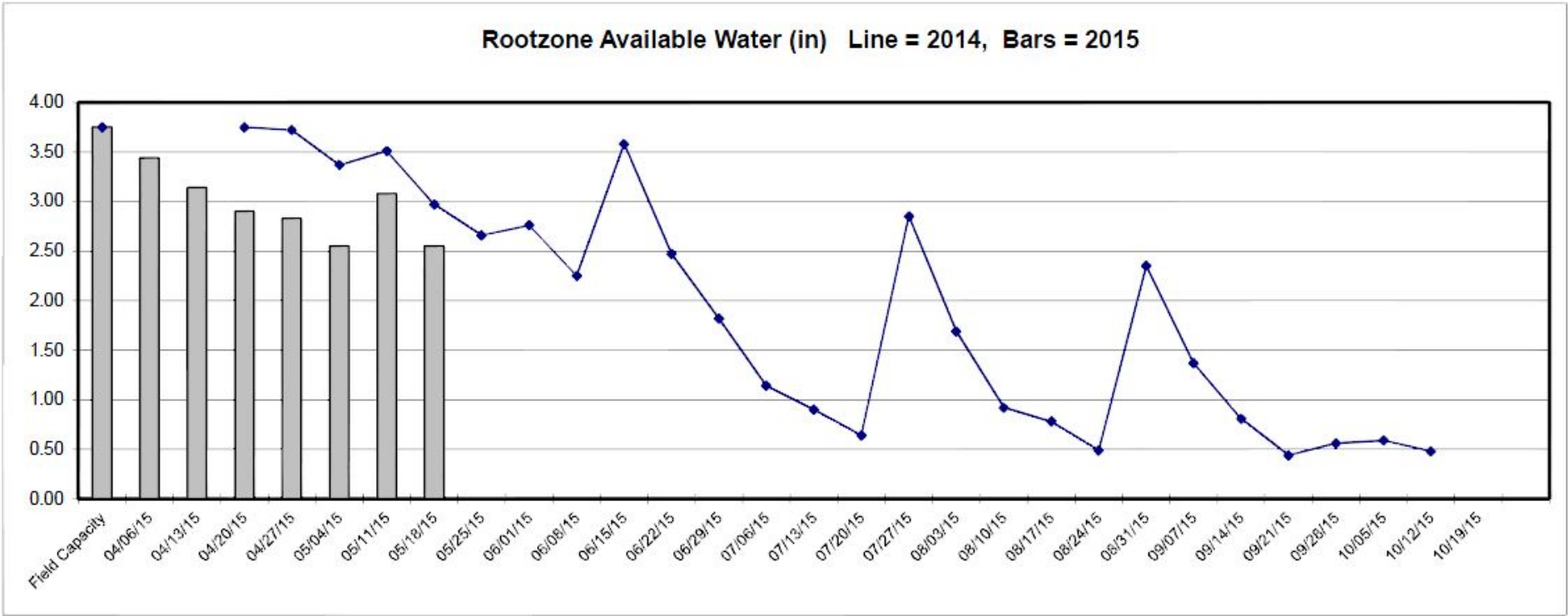
New leaves Using Water-inefficiently

Water-Conserving Canopy

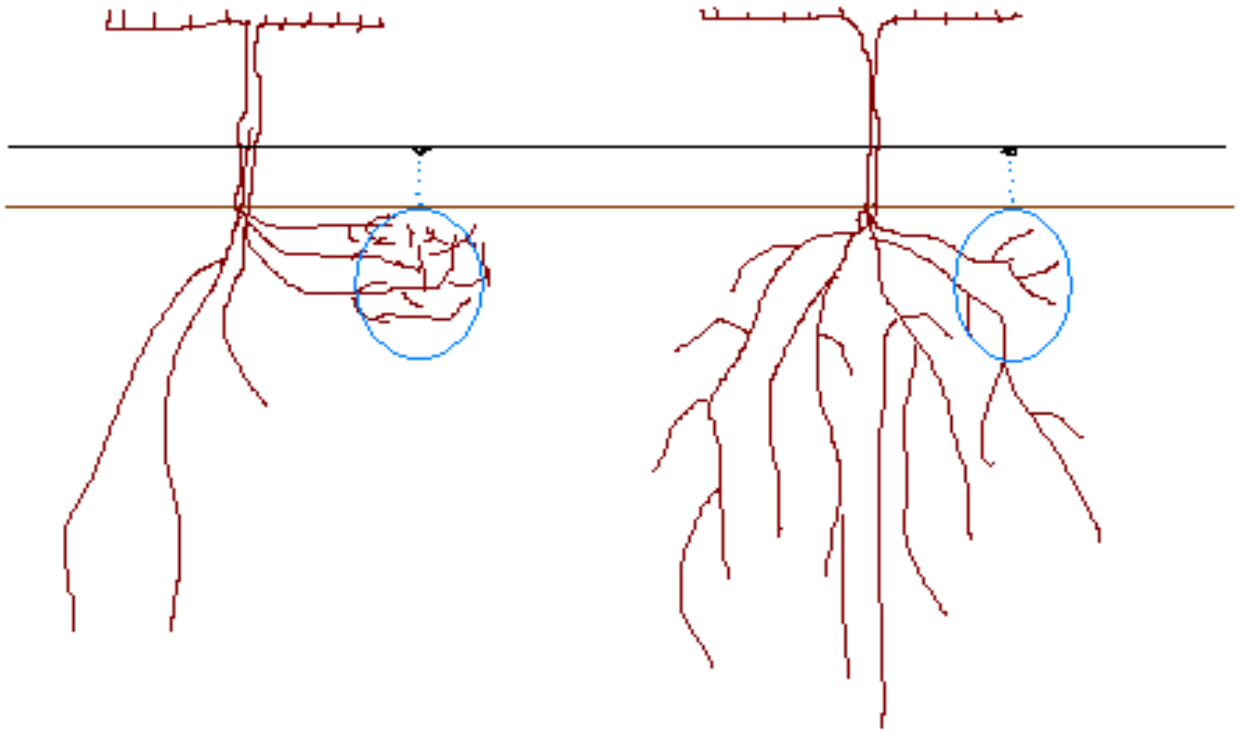
Drip Irrigation Delays Drying Trend



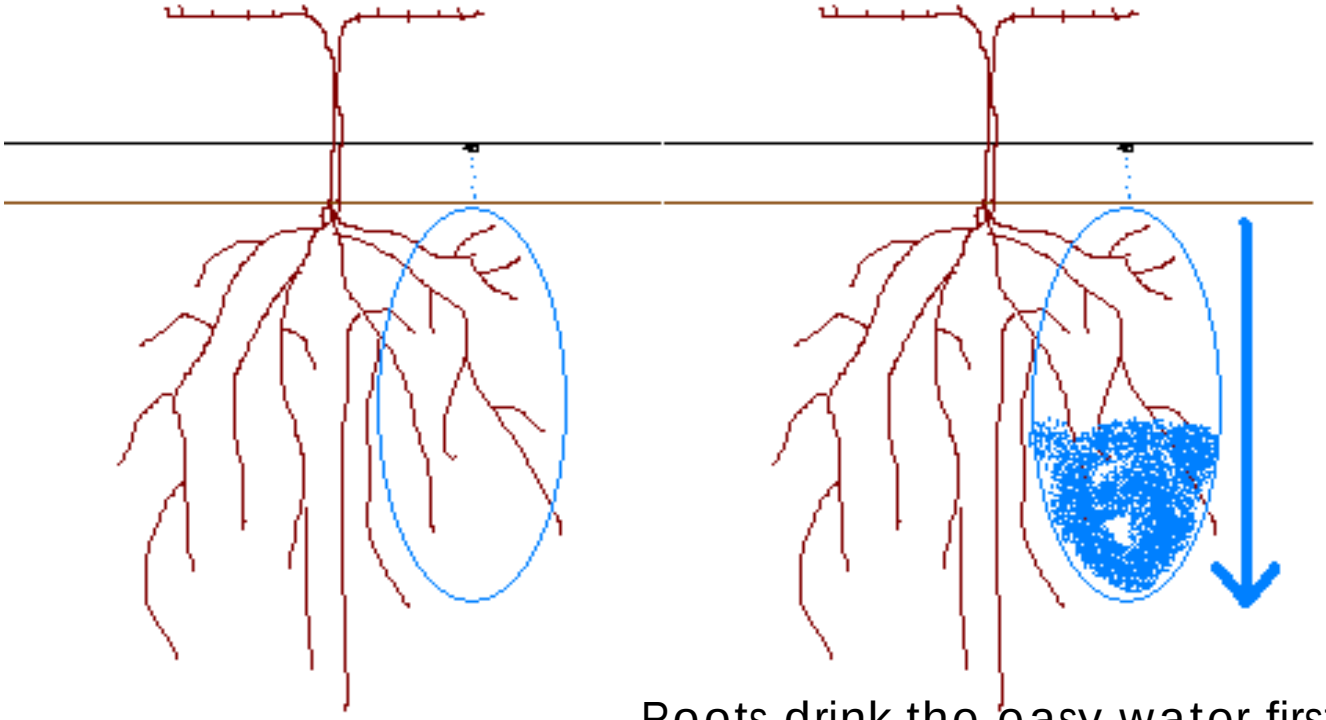
Soil Moisture View



Root Architecture



Big Drink



Long irrigation moves the water to more of the effective roots

Roots drink the easy water first, and work harder and harder to drink from greater depth, creating buffering capacity (and less evaporation)

Additional Steps Growers are Implementing

- Coombsville grower case study
  - Installed 7 new wind machines
    - $245,000
    - Reduced reliance on overhead frost control
  - Installed “Double Poly”
    - $1,500 per acre
    - $129,000 total capital cost
    - Allows to separate management zones, water %10 of the vines more frequently, not water to the least common denominator
  - Installed Weather stations, well level sensors
    - $22,000 total cost
  - Increased farming cultural practices to reduce water usage and improve wine quality
    - $1,350 per acre cost

Timelapse Video

Questions?

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