Kim Patten
WSU Long Beach

Irrigation Systems Evaluation

- **Why important**
  - **Direct relationship between yield and irrigation scheduling and design**
  - **Direct relationship between proper frost protection and yield**
  - **Direct relationship good pest management and system uniformity**
  - **Direct relationship between surface water contamination and system design**
  - **2010 BC survey of grower beds some as low as 30% coef. of variability, one brand new field with new Nelson heads on 53’ by 55’ only 70%**

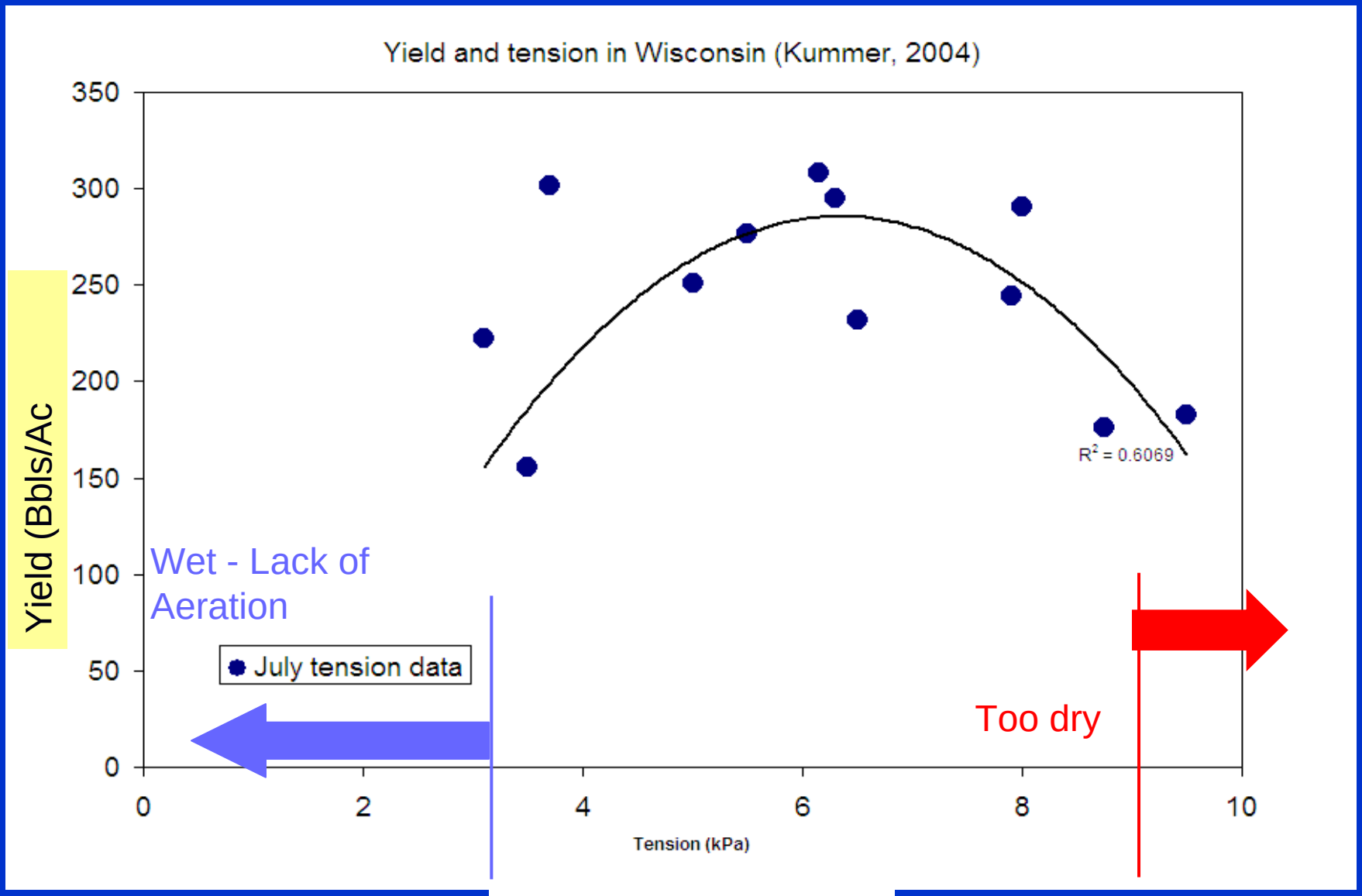
Irrigation Systems Evaluation

- **Why important**
  - **2010 BC survey of grower beds**
    - **31% to 73% coef. of variability**
    - **Pressure at sprinkler heads 30 to 50 psi**
    - **Variability within a system (one as 72% COV near pump 52% COV far from pump)**
    - **Irrigation rates vary within a system (0.14”/hr to 0.11”/hr**
    - **Washoff times 4 to 12 minutes**
    - **Systems vary a lot**
      - **Nelson rotator on wide spacing in wind 31%**
      - **Impacts 40’ by 50’ with good pressure– 73%**
      - **Impacts 30’ by 30’ low pressure 30%**

Irrigation Systems Evaluation

- **Why important**
  - **Don’t know your system unless you test it!**

Centibars Vs Yield



Cranberry botany as it relates to irrigation

- Rooting
  - Structure
  - Depth
  - Growth
  - Factors affecting
    - Herbicide
    - Drainage
    - Temperature
    - Plant development
    - Soil density
    - Hydrogen sulfide
- Protection needs
  - Spring frost (vegetative growth stages vs tolerance)
  - Summer heat scald
  - Fall (Fruit maturity vs tolerance)
  - Winter hardiness
- Cranberry water use needs (general background)
  - ET
  - Crop coefficients
  - Other models/weather stations
  - New plantings vs established plantings

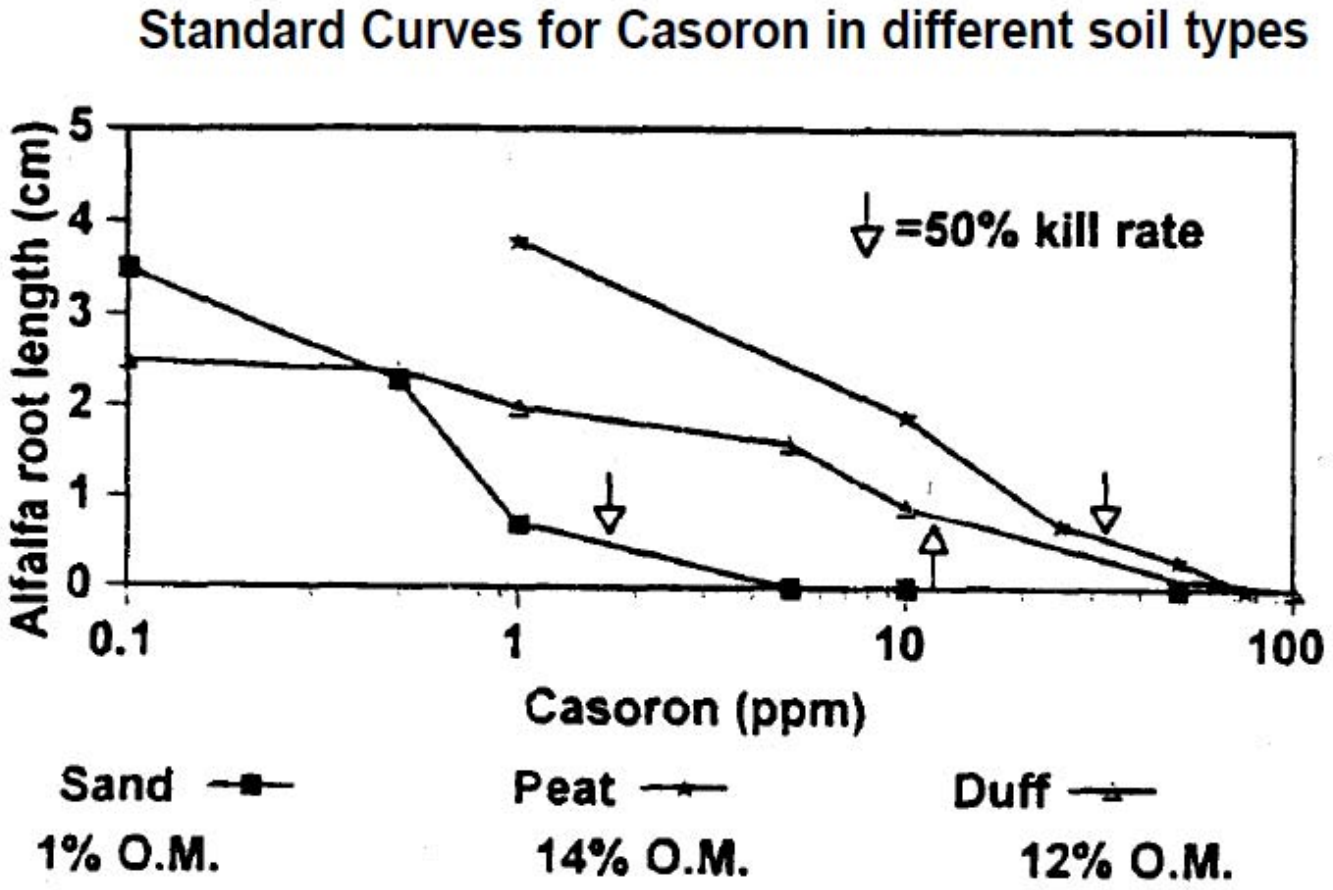
- Rooting
  - Structure
    - fine fibrous root
    - no root hairs
    - mycorrhizal associated with roots but not of economic significance
  - Depth
    - 0-2”
    - Can have air roots along upright in situation of thick vines on peat

2-3” depth of rooting

1 to 2” depth of rooting

3 to 4” depth of rooting

- Factors affecting root growth
  - Herbicide
    - Casoron prunes new growth (rate by soil type effect)
    - Immediate effects subtle, but long-term effects are significant
  - Drainage
    - Root rot
    - Growers in BC and WI report a direct relationship between yield and good drainage and proper irrigation
  - Temperature
    - Cold wet soils – delayed growth until mid-June
    - Sandy dry soils – new root growth in February
  - Plant development
    - Maximum growth corresponds to peak plant activity
    - Data from USDA in OR suggest they are shutting down in August
  - Soil density
    - Fine roots just don’t penetrate dense soil or layer packed sand very well
  - Hydrogen sulfide
    - If you can smell it, you’ve got root damage



Root damage from Casoron is dependent on soil type.
Root damage in sand occurs @ 1/10th Casoron rate than in peat.

- Protection needs
  - Spring frost (vegetative growth stages vs tolerance)
  - Summer heat scald
  - Fall (fruit maturity vs tolerance)
  - Winter hardiness

Frost Protection

Basics of sprinkler protection

- When to stop
  - When ice begins to melt
    - if wind picks up and melting stops -- evaporation can be a problem (heat loss is more than with melting)
  - Sun on the plants
  - Both usually by 7:30 a.m.
  - Above tolerance by 3+ degrees

From UMASS

Frost Protection

Basics of sprinkler protection

- When to start
  - 1-2° above tolerance
  - If manual turn-on alarm usually is set even higher

From UMASS

What is the tolerance

- Temperature that the plant can cool to without ice forming in the cells
- Changes during development
- Tolerance temp increases in the spring and decreases in the fall (always 30 ºF or less)

From UMASS

Tolerance is site specific

- You must scout
- Spring changes are dependent on accumulation of heat units – warmer locations develop faster and lose tolerance sooner
  - Look at buds frequently to recognize changes
  - Look for most advanced stage that is present in more than 3-5% of buds

From UMASS

Determine using visual cues

- Spring
  - Appearance of the bud
  - <18 ºF to 29.5 ºF

- Fall
  - Color of the fruit
  - 28 ºF to as low as 20 ºF

From UMASS

Low to mid 20’s

25- 30

32

From UMASS

4/26/10

Ben Lear Tolerance = 29.5

Ben Lear

4/26/10

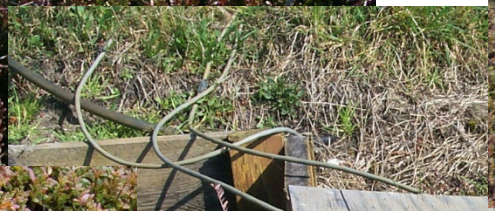
Howes = 25

Howes

From UMASS

Stevens Tolerance = 29.5

Stevens



Which sensor location is best? Protected sensor are warmer and also have a time delay of up to 2 hours before they may reach the critical temperature. Sensors should be exposed to open air at the lowest point in the bed.

WSU Research – mid 90's

l) Uprights from vines grown on peat soil were consistently hardier than those on sand despite having larger bud size and green leaves in the winter.

2) There was a lot of natural flower death over the winter regardless of temperature.

3) For any given date, McFarlin was much hardier than Stevens, but for equal stages of development hardiness is fairly similar. Growers with mixed varieties on the same irrigation system must protect for the most sensitive buds.

4) Flower buds were much hardier in February and early March than most growers suspected. In February, our data indicated good hardiness into the single digits.

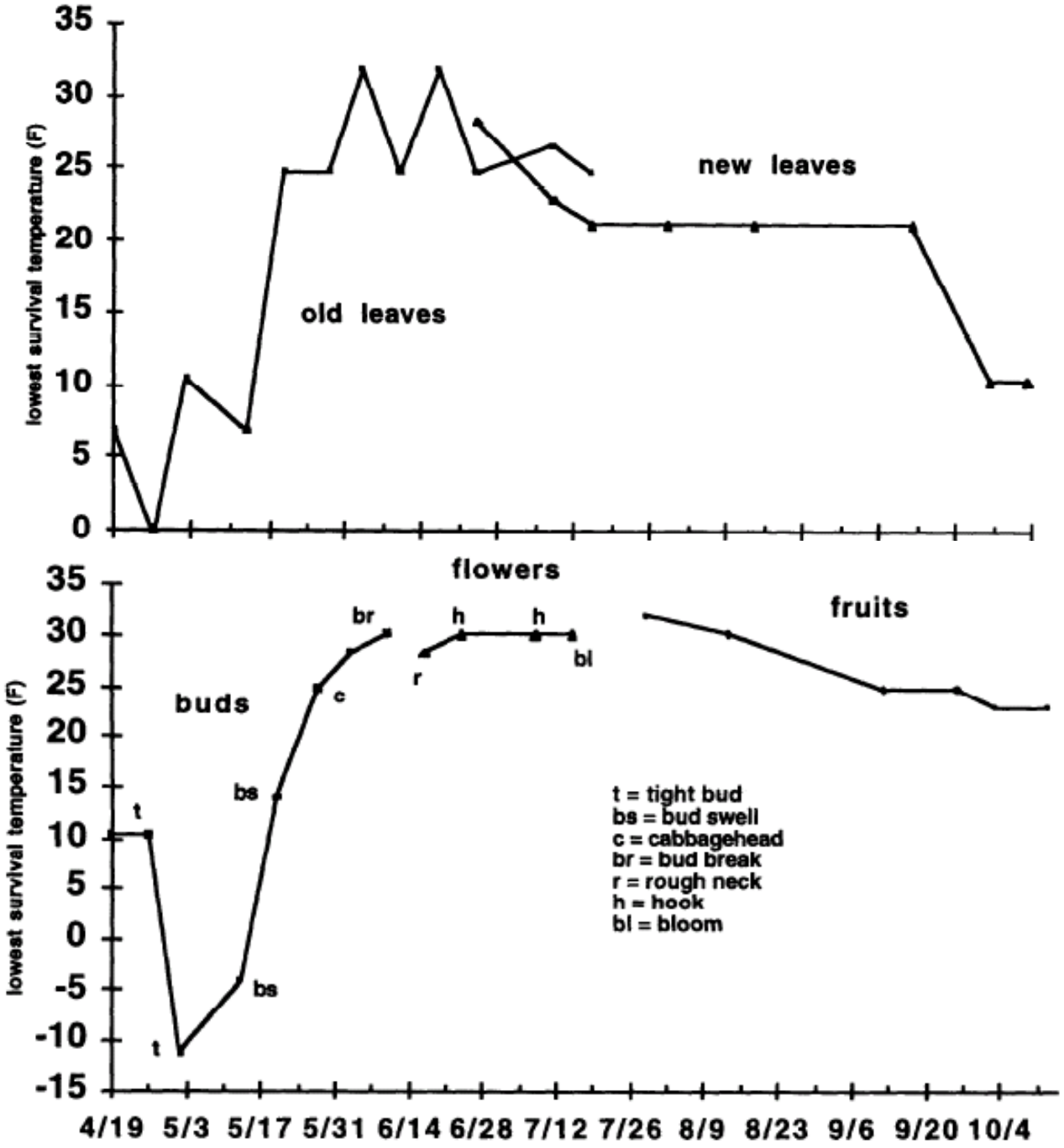
Therefore, frost protection in February was not necessary. It was not until mid- to late March that buds began to experience damage in the 20's.

5) A lot of sensors are set in the wrong locations in the bed. Sensors should be exposed at the level of buds in the lowest location within the beds. Protected sensors are several degrees above real bud temperature and usually have a lag time before they reach a minimal temperature.

Scald/heat damage

- Damage to fruit vs damage to vines
- Fruit
  - No set rule when fruit damage will occur.
  - Weak, brittle vines, open exposed fruit, very sandy soils – better protect at 80.
  - Thick healthy vines, lots of roots, peat soil – should be good up to 85 to 90+
  - Sprinkle for evaporation-cooling
- Vines
  - Hot and windy on sandy soils with weak vines-- damage can occur quickly. Sprinkle for soil- water not evaporation-cooling

From U. Wis.


lowest survival temperature (F)
35
30
25
20
15
10
5
0
old leaves
new leaves
flowers
buds
fruits
t
bs
c
br
r
h
h
bl
t = tight bud
bs = bud swell
c = cabbagehead
br = bud break
r = rough neck
h = hook
bl = bloom
lowest survival temperature (F)
-5
-10
-15
4/19
5/3
5/17
5/31
6/14
6/28
7/12
7/26
8/9
8/23
9/6
9/20
10/4

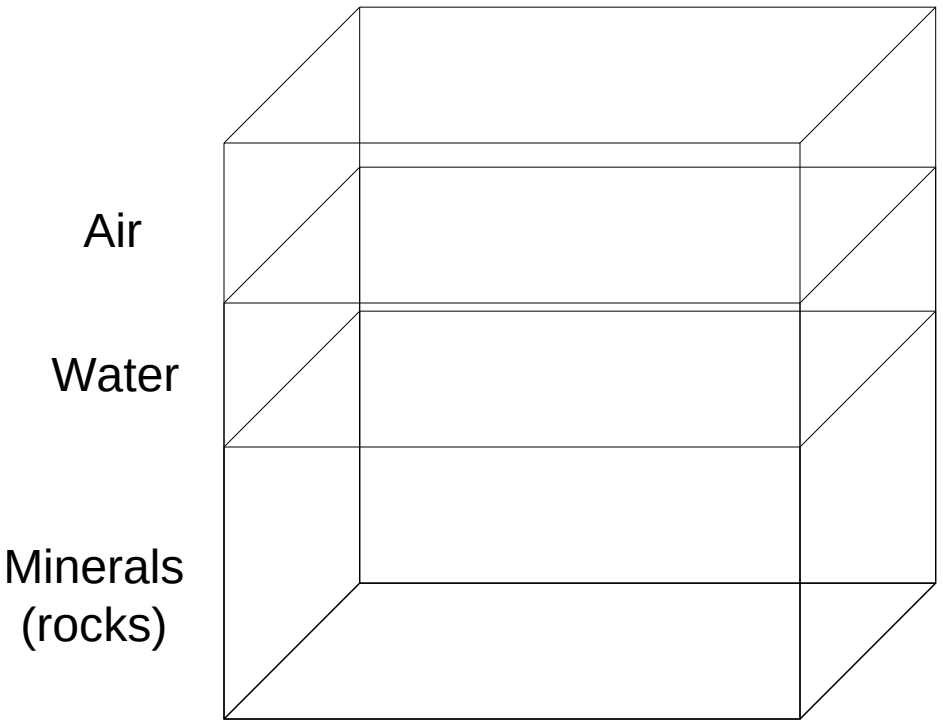
- Cranberry water use needs (general background)
  - ET
  - Crop coefficients
  - Weather stations

Water need and irrigation scheduling

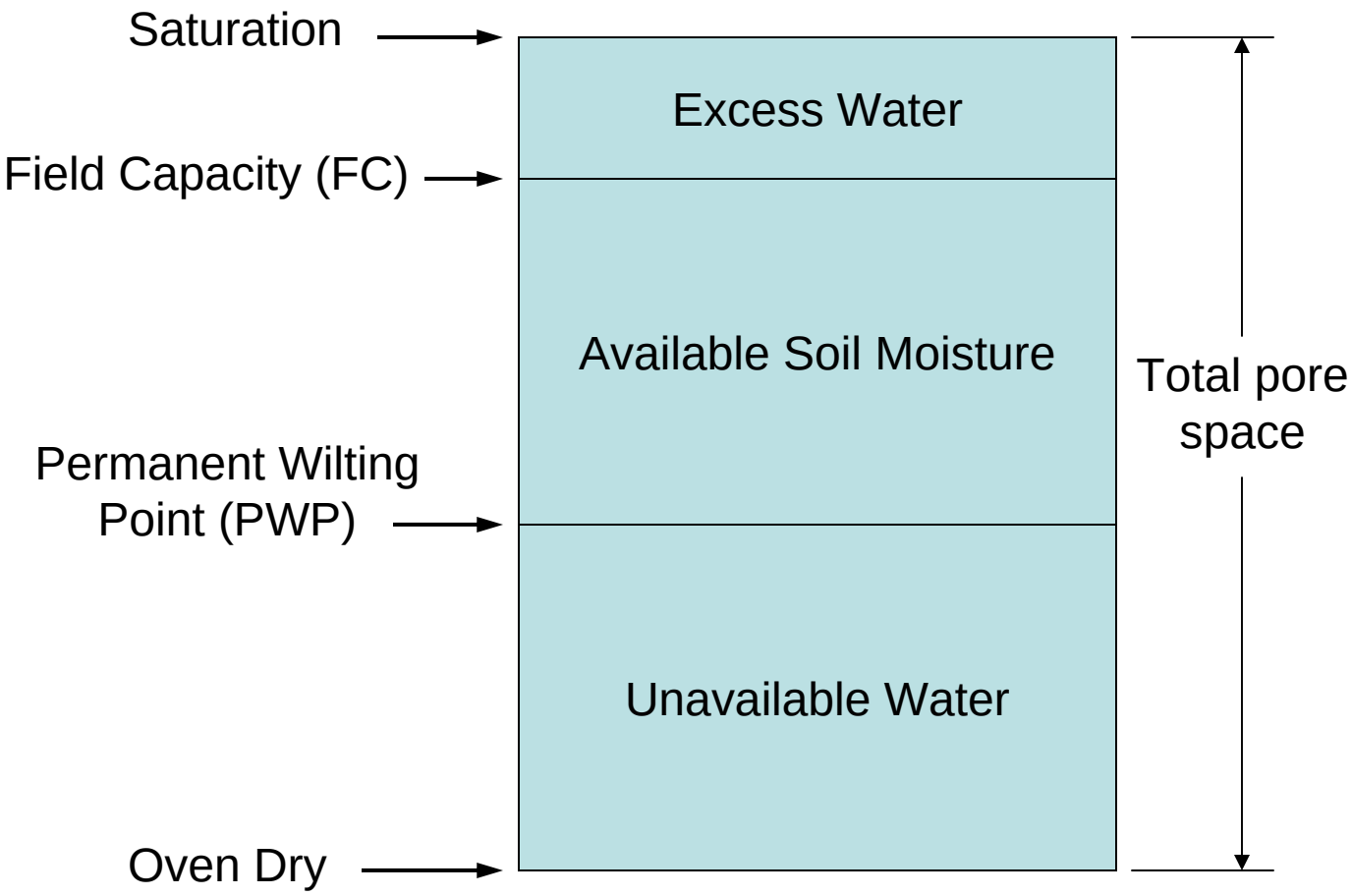
R. Troy Peters & Kim Patten
WSU Extension

Demonstration with sponges

Composition of Soil



Soil Water

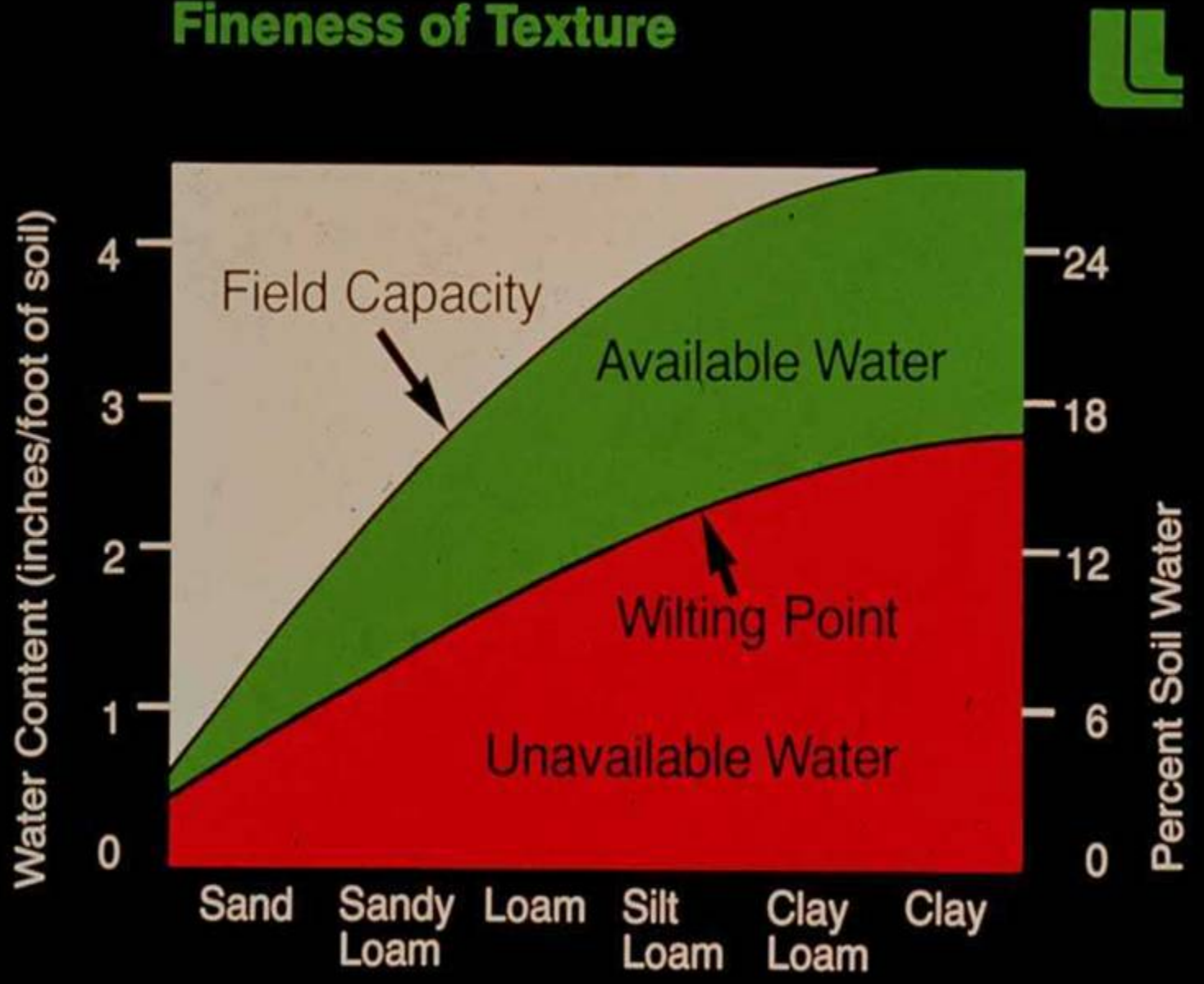

Saturation
Field Capacity (FC)
Permanent Wilting Point (PWP)
Oven Dry
Excess Water
Available Soil Moisture
Unavailable Water
Total pore space

- **Field Capacity (FC)**: Maximum amount of water that a soil can hold indefinitely against gravity (% of volume)

- **Permanent Wilting Point (PWP)**: The amount of water remaining in the soil after plants can no longer pull water from the soil (wilt & die)

- **Available Water (AW)** = FC – PWP

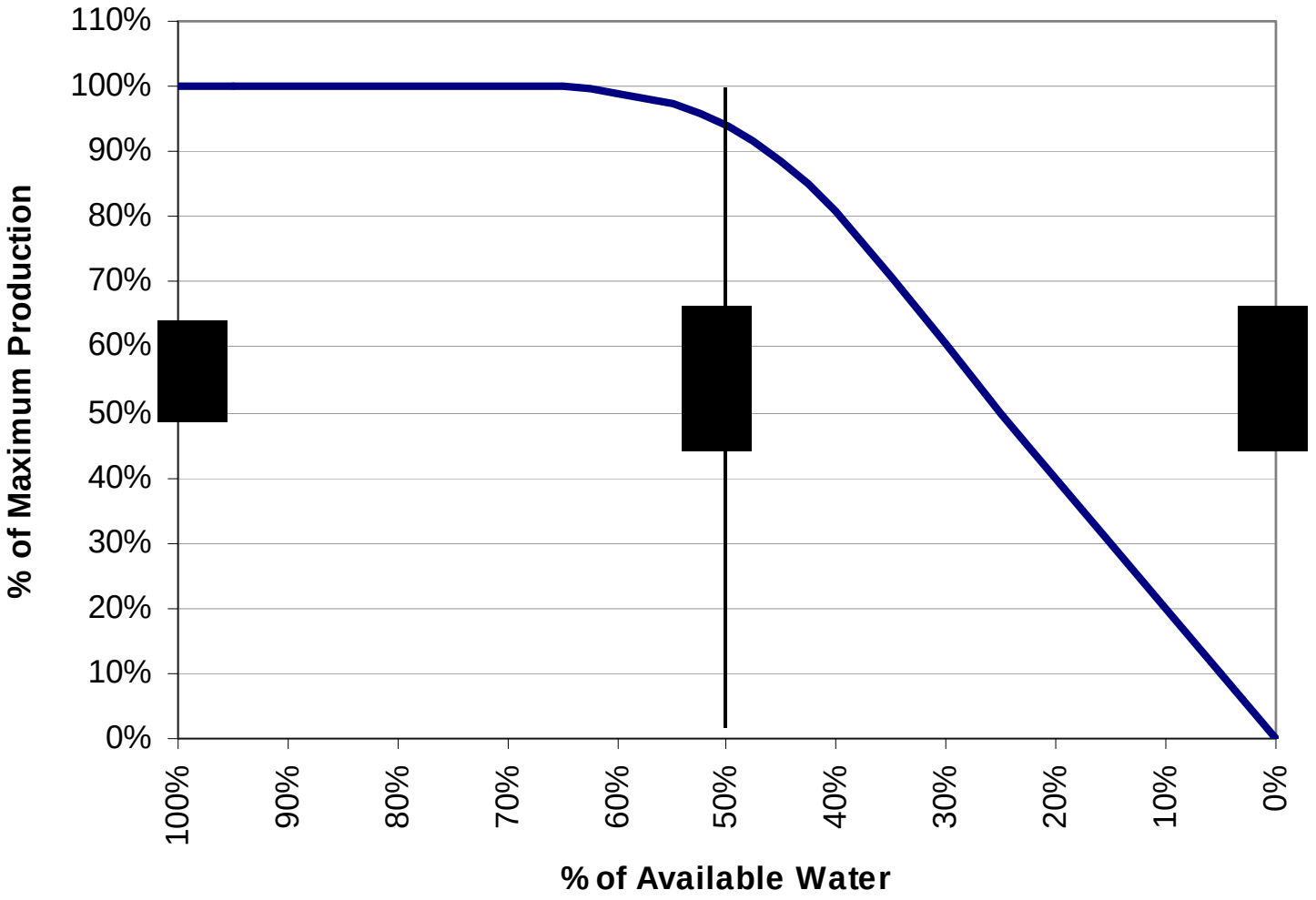
- **Management Allowable Deficit (MAD)**: percent deficit of Available Water (AW) that management will accept (30 to 50% ?)


Fineness of Texture
Water Content (inches/foot of soil)
4
3
2
1
0
Field Capacity
Available Water
Wilting Point
Unavailable Water
24
18
12
6
0
Percent Soil Water
Sand
Sandy Loam
Loam
Silt Loam
Clay Loam
Clay

Soil Texture and Available Water

Soil Texture	Available Water (AW in/in
Coarse Sand	0.16 to 0.07
Fine Sand	0.06 to 0.08
Peat /Muck	0.16 to 0.24

Production Reduction Function



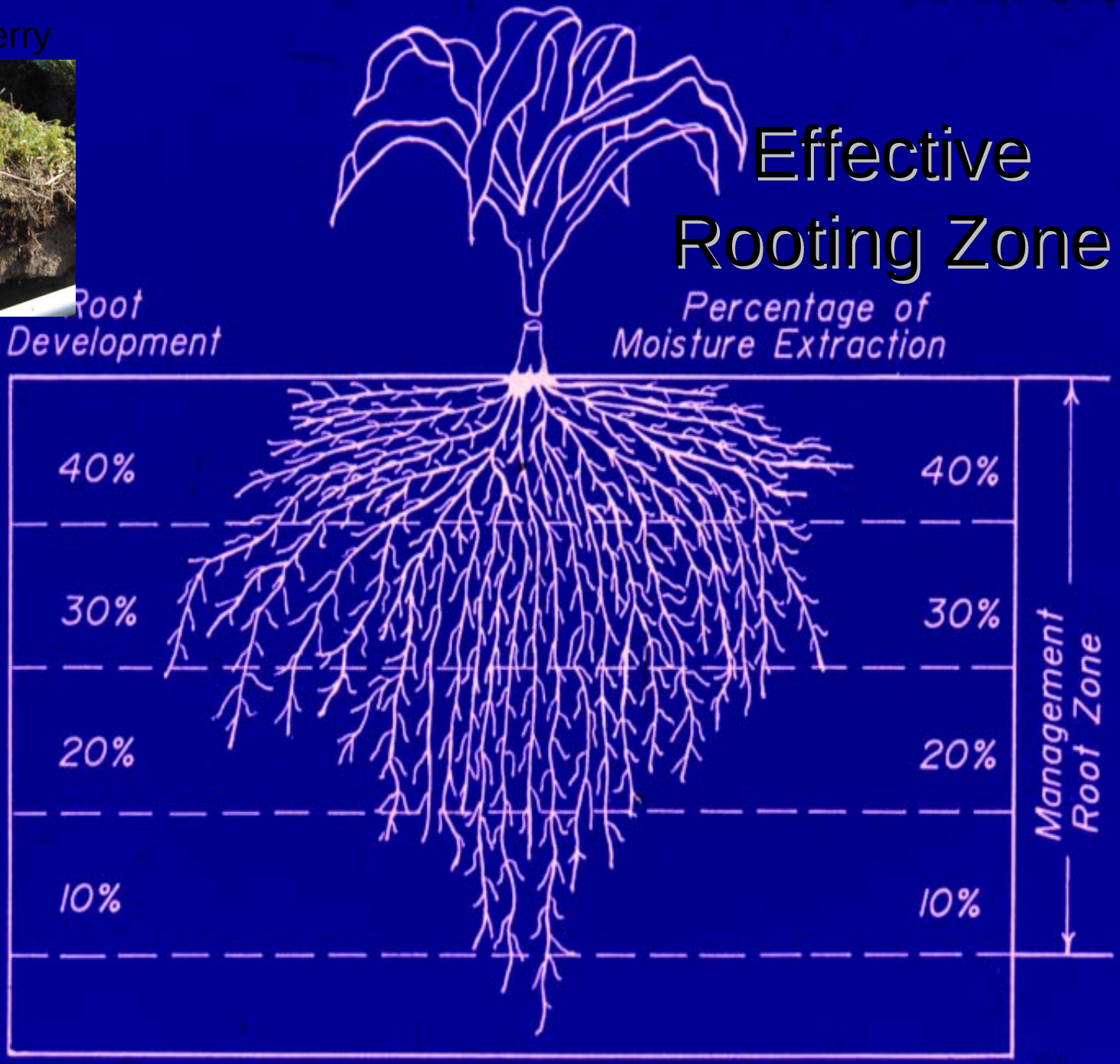
Effective Rooting Zone

For cranberry

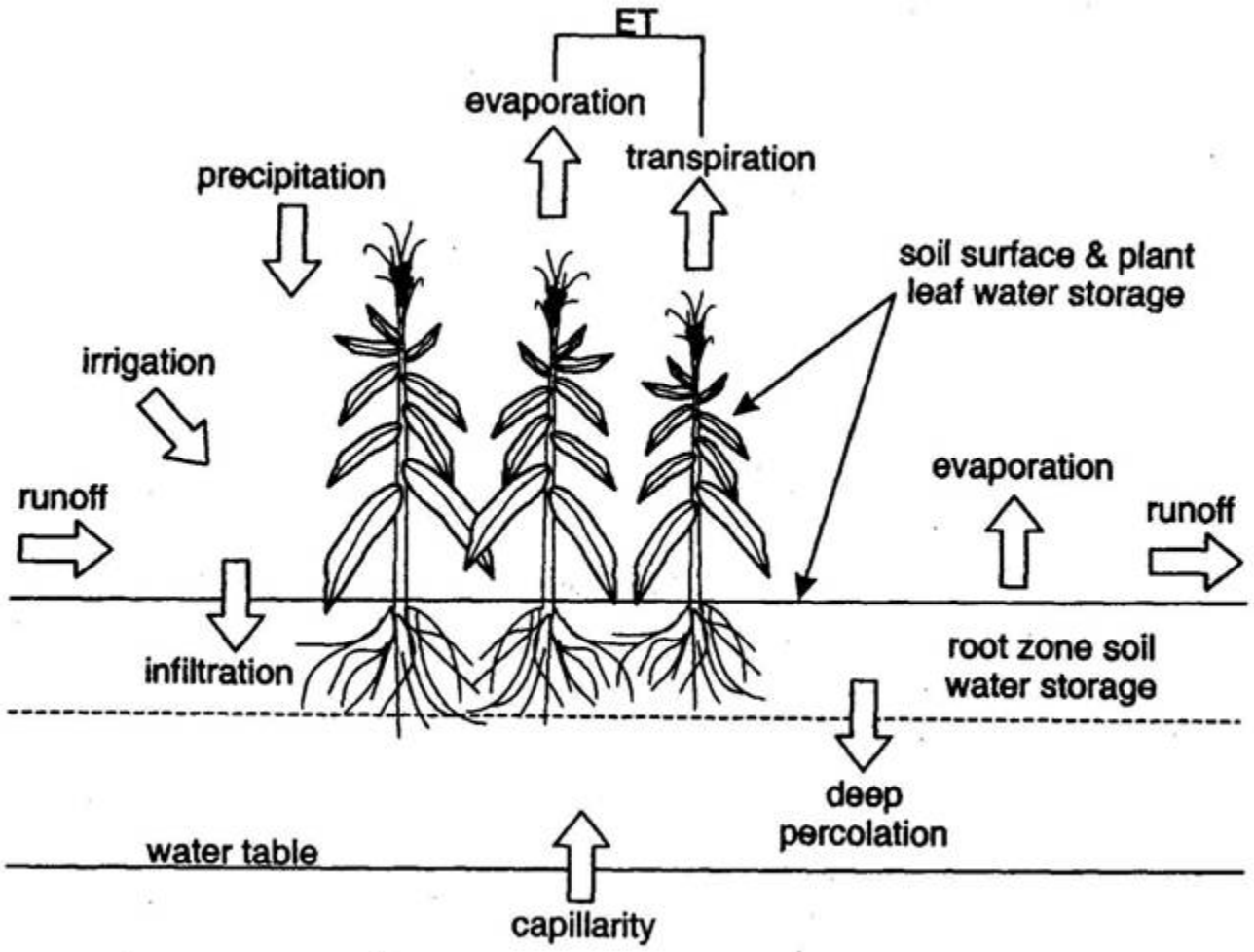
1” - 45%

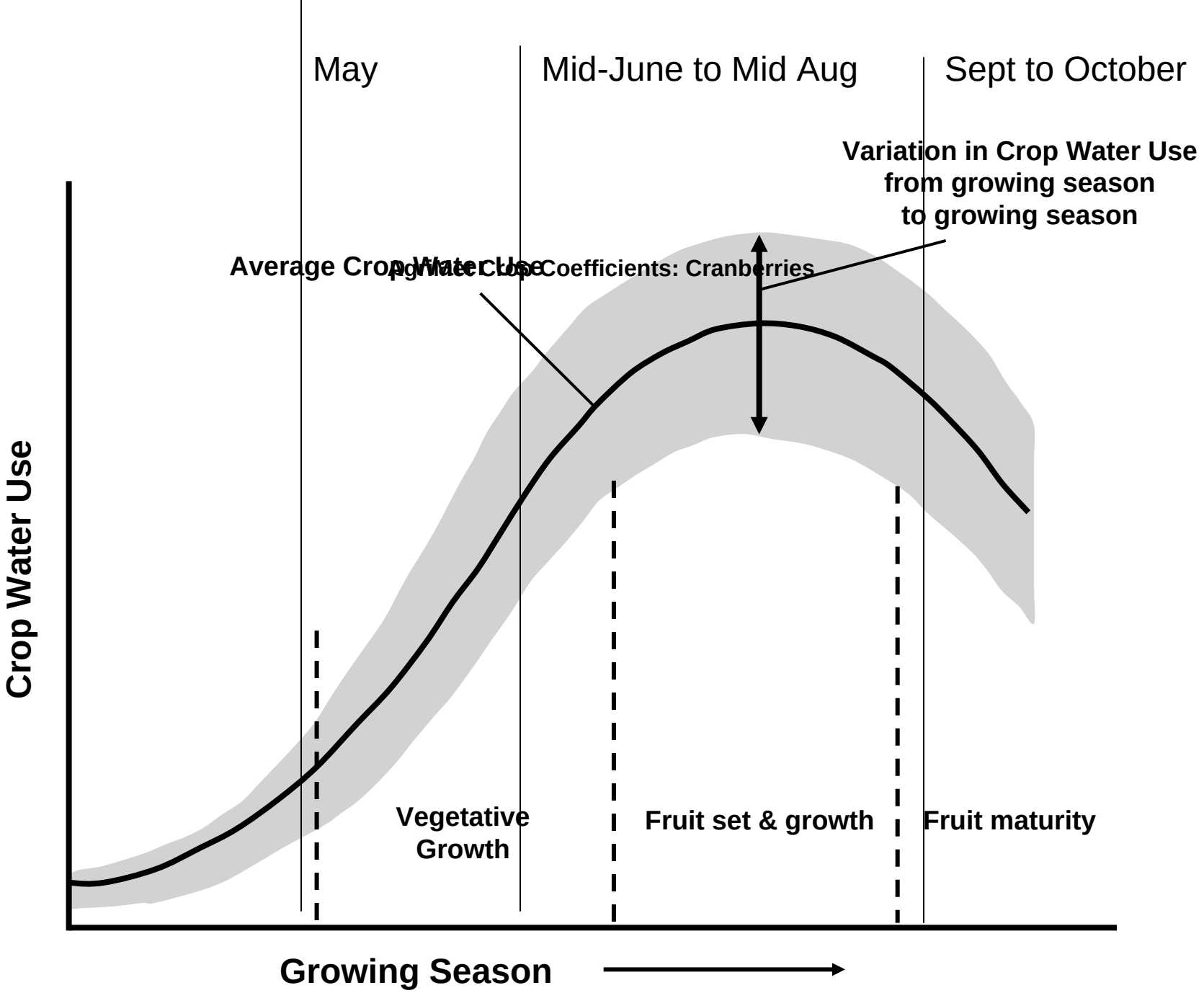
2” – 45%

3” – 10%

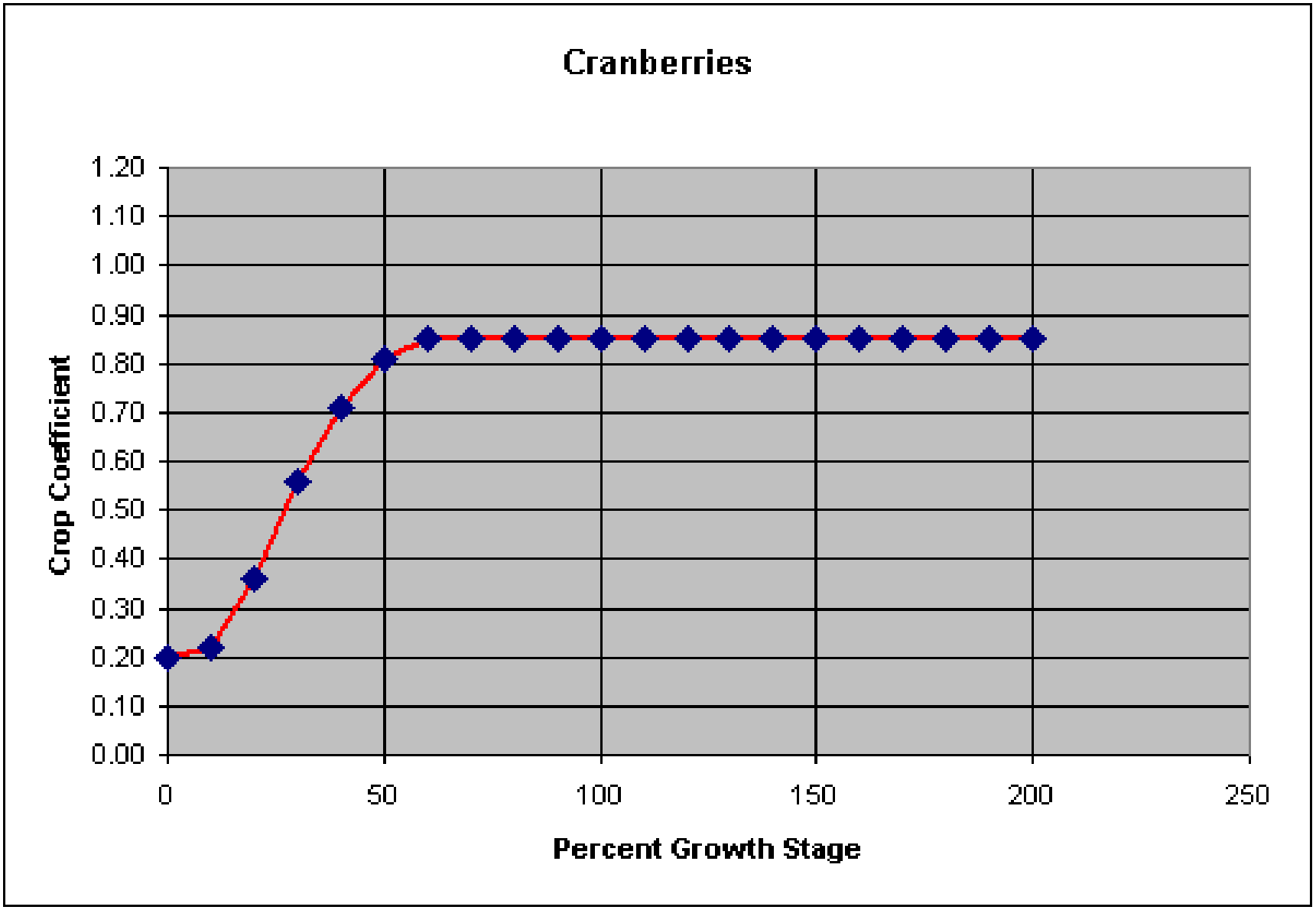


Water Balance

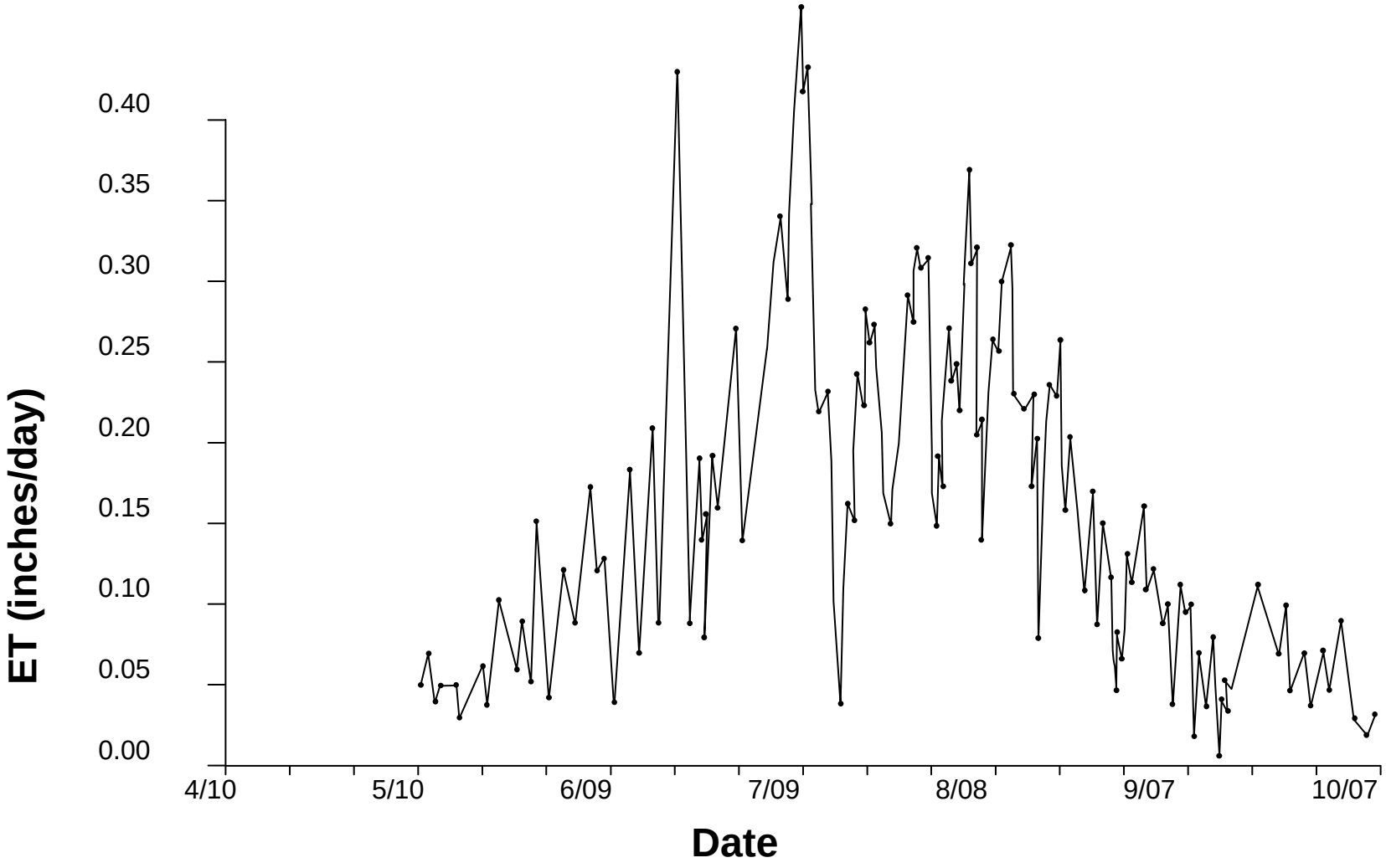



May
Mid-June to Mid Aug
Sept to October
Variation in Crop Water Use
from growing season
to growing season
Average Crop Water Use
Agwater Crop Coefficients: Cranberries
Crop Water Use
Vegetative
Growth
Fruit set & growth
Fruit maturity
Growing Season

AgriMet Crop Coefficients: Cranberries in Oregon



ET and Weather



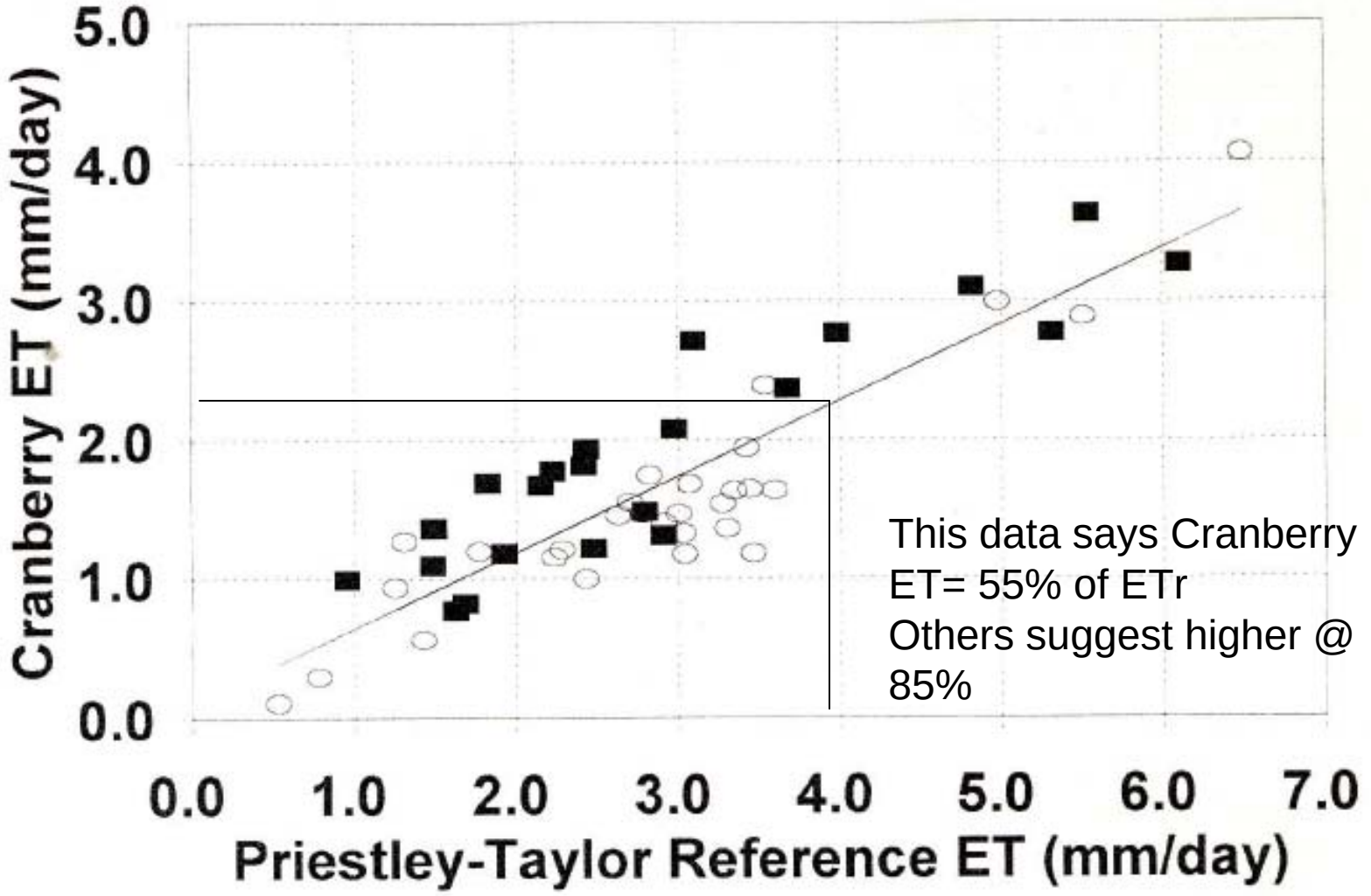


Fig. 1. Regression of cranberry evapotranspiration (ET) on Priestley–Taylor reference ET (ETR) in 1992 at (■) Grayland and (○) Long Beach. ET = 0.10 + 0.55*(ETR), with r^2 = 0.795, n = 51.

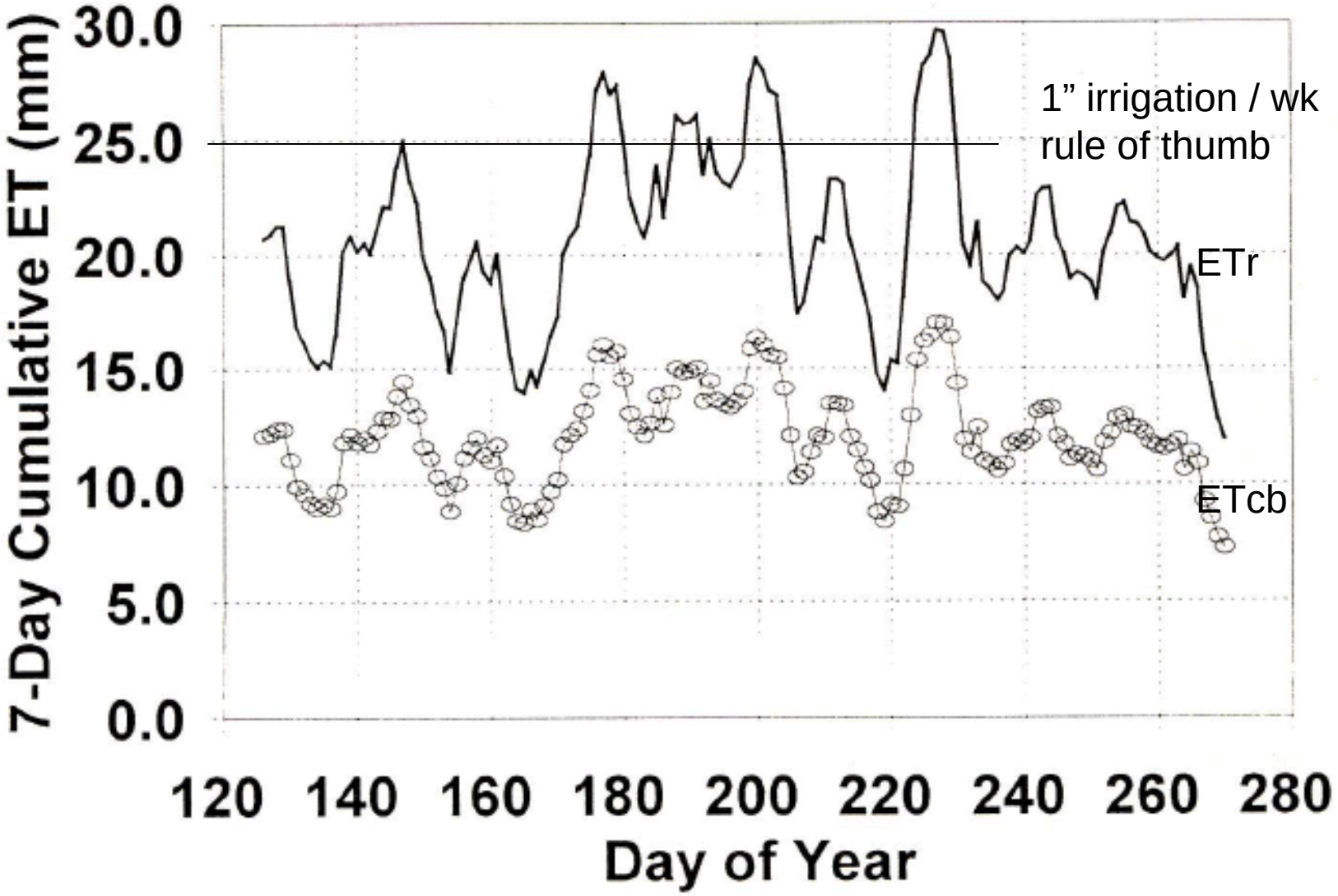
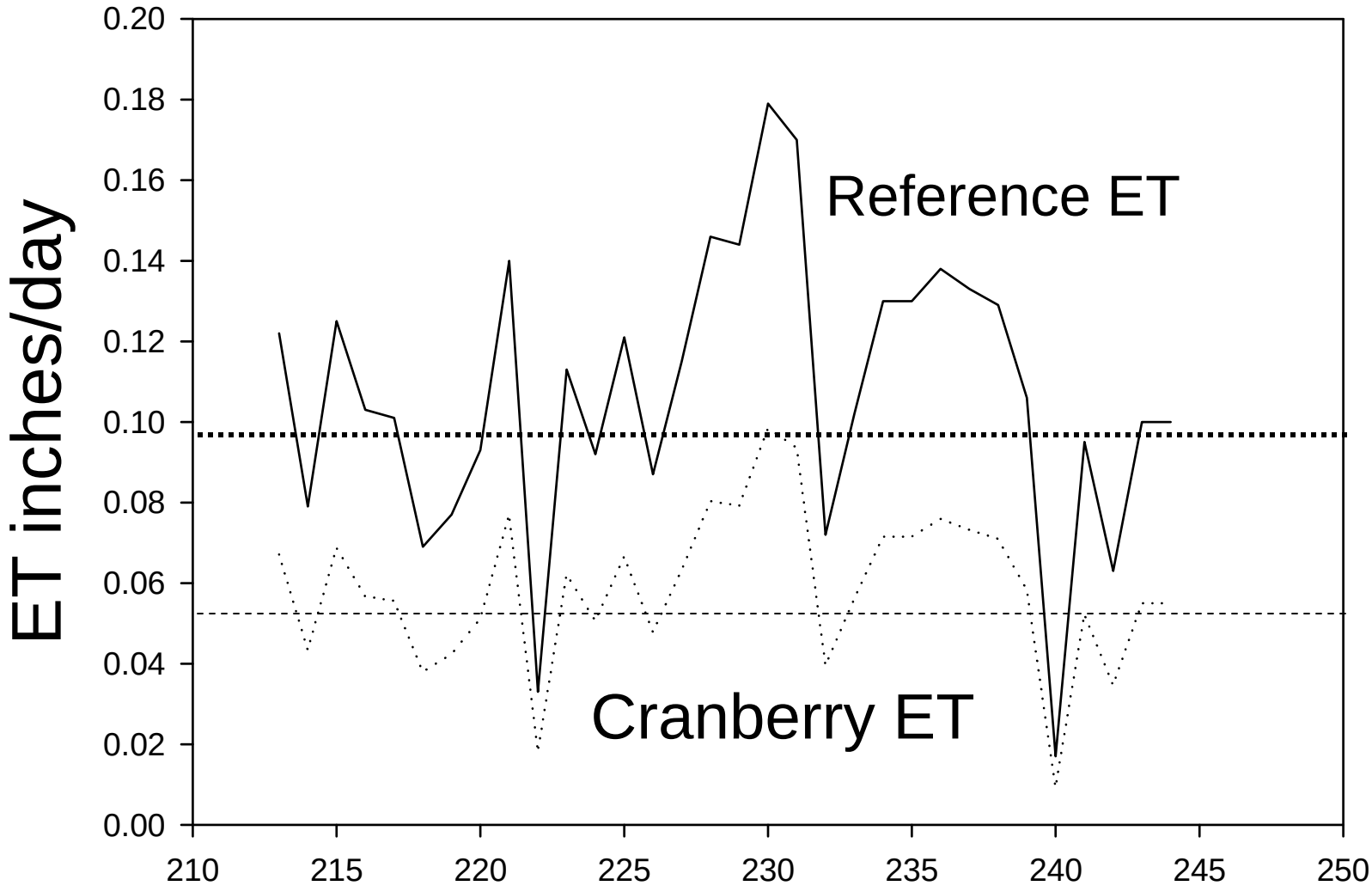


Fig. 2. Seven-day cumulative cranberry evapotranspiration (ET) (—○—) and reference ET (—) at Long Beach, 1992. Sums were calculated by adding daily ET through days 1–7, 2–8, etc.

Evapotranspiration - Long Beach 2009



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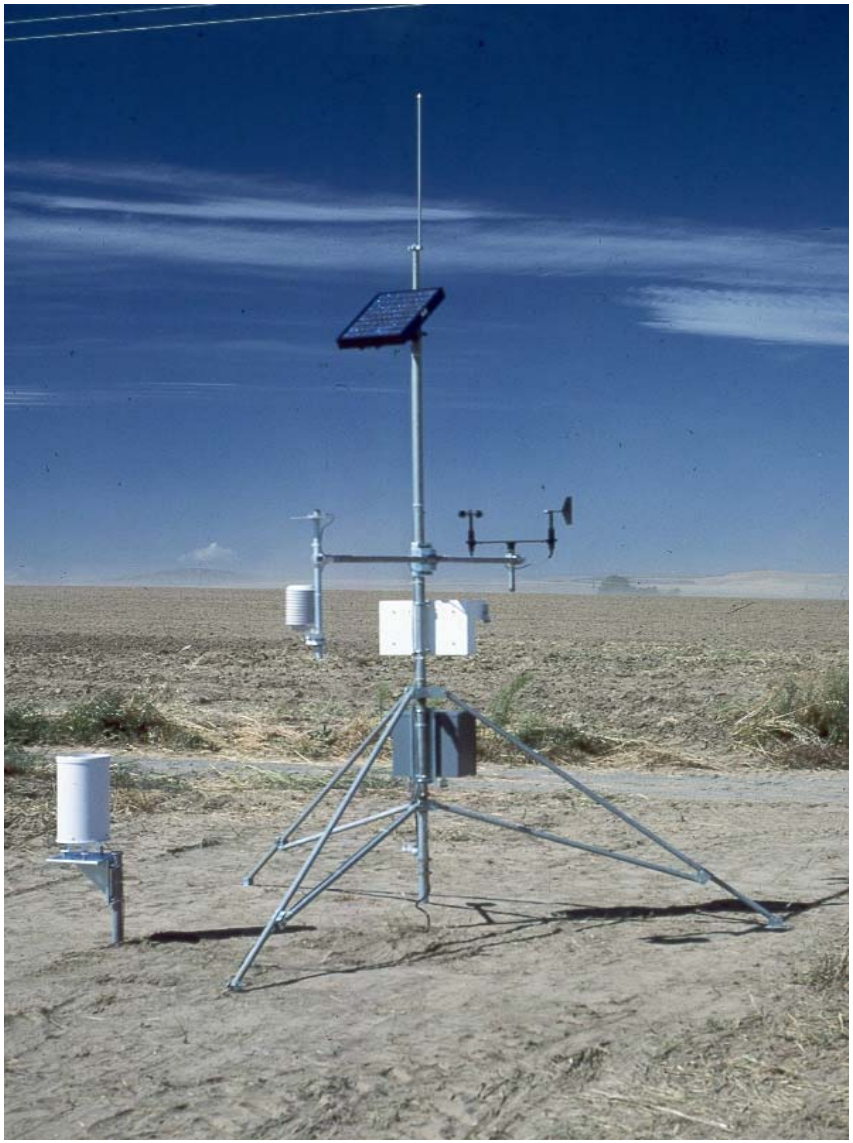

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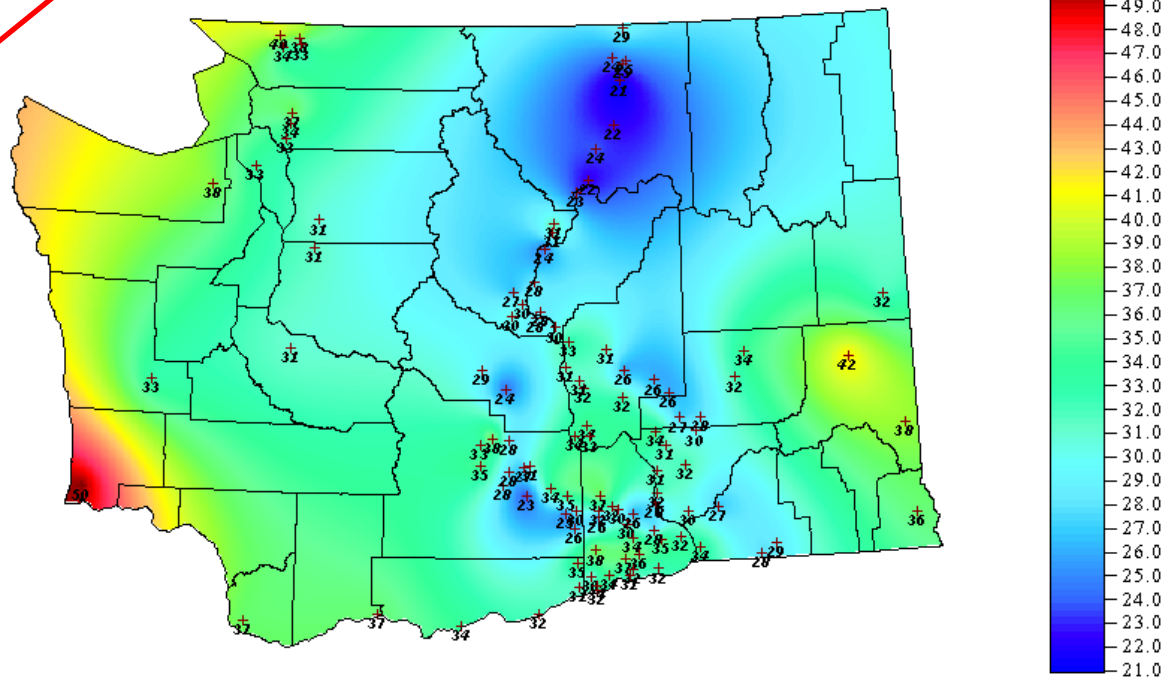
There are 12 members
2 guests viewing the site

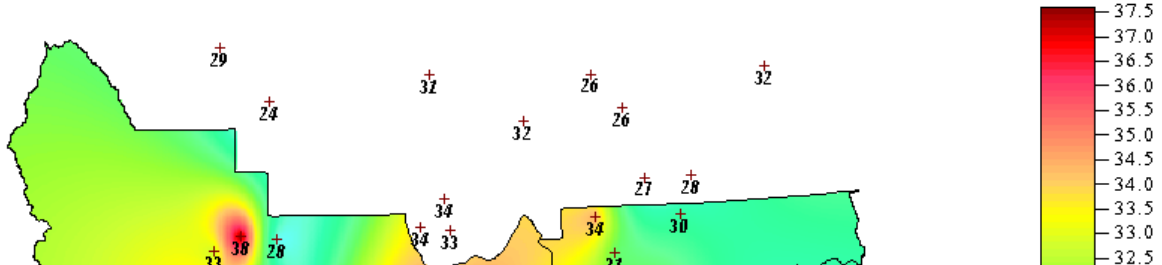
logged in as tpeters

Current

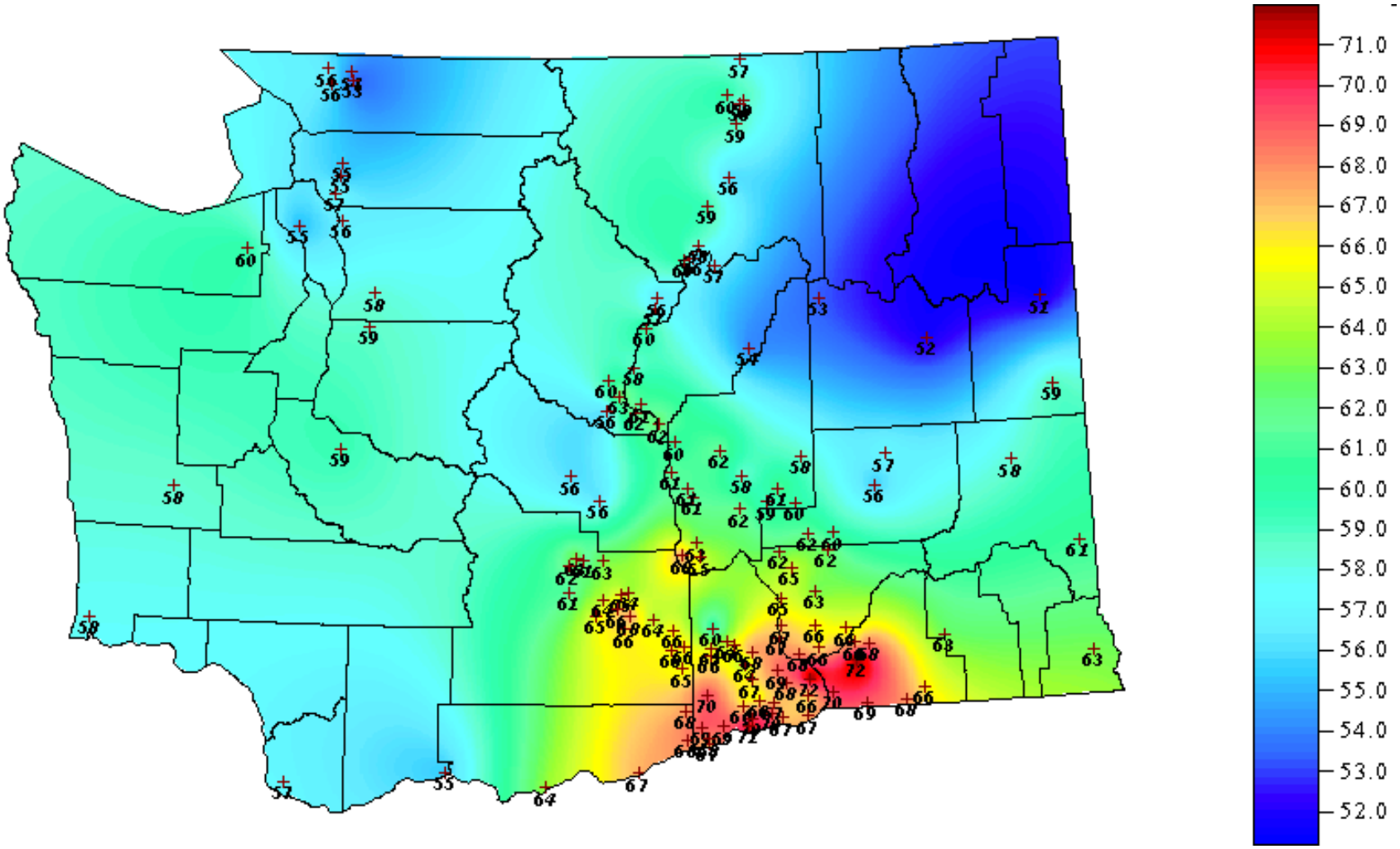
AWN Models



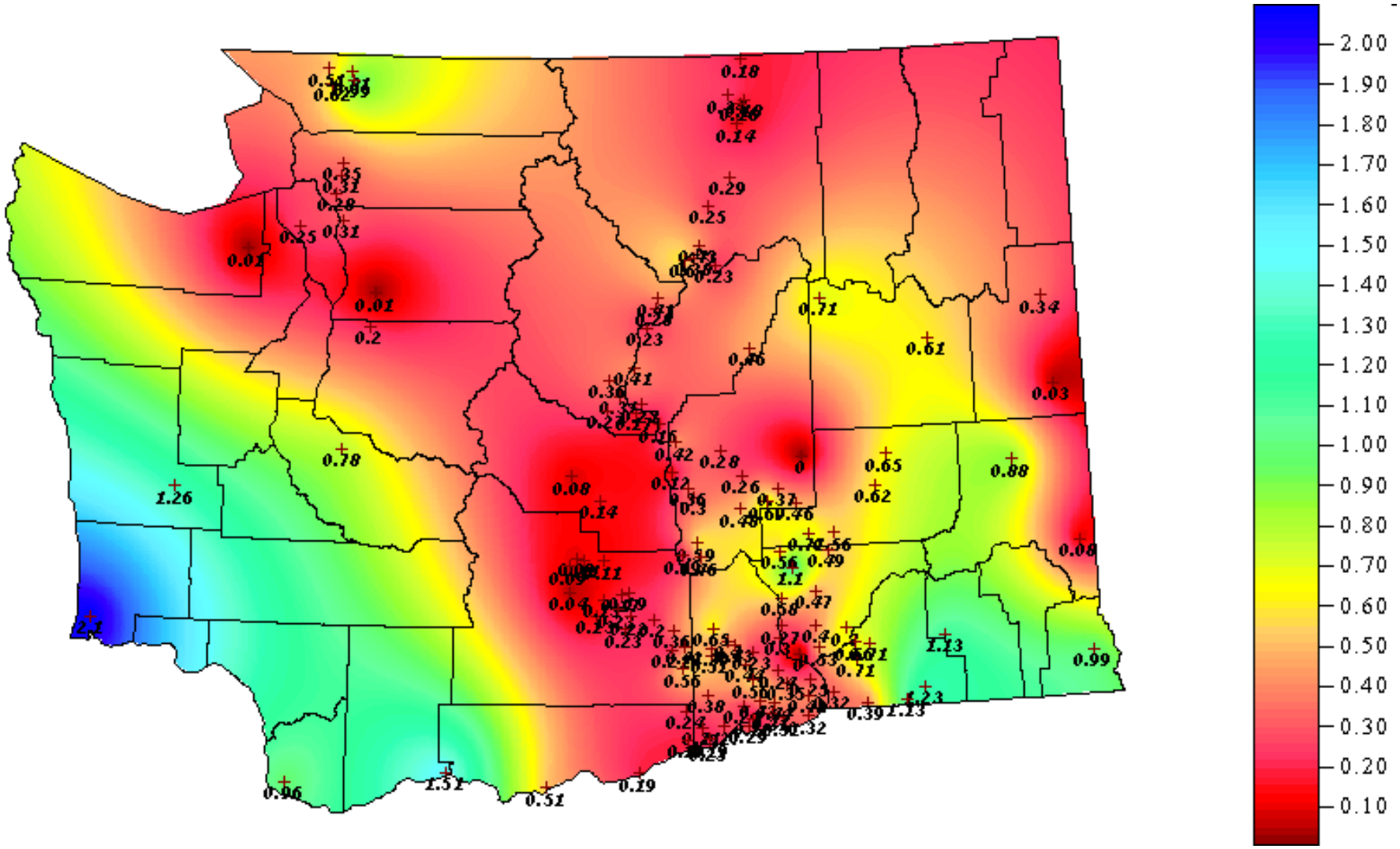
Air Temperature (°F) for Feb-03-2009, 09:00 AM PST



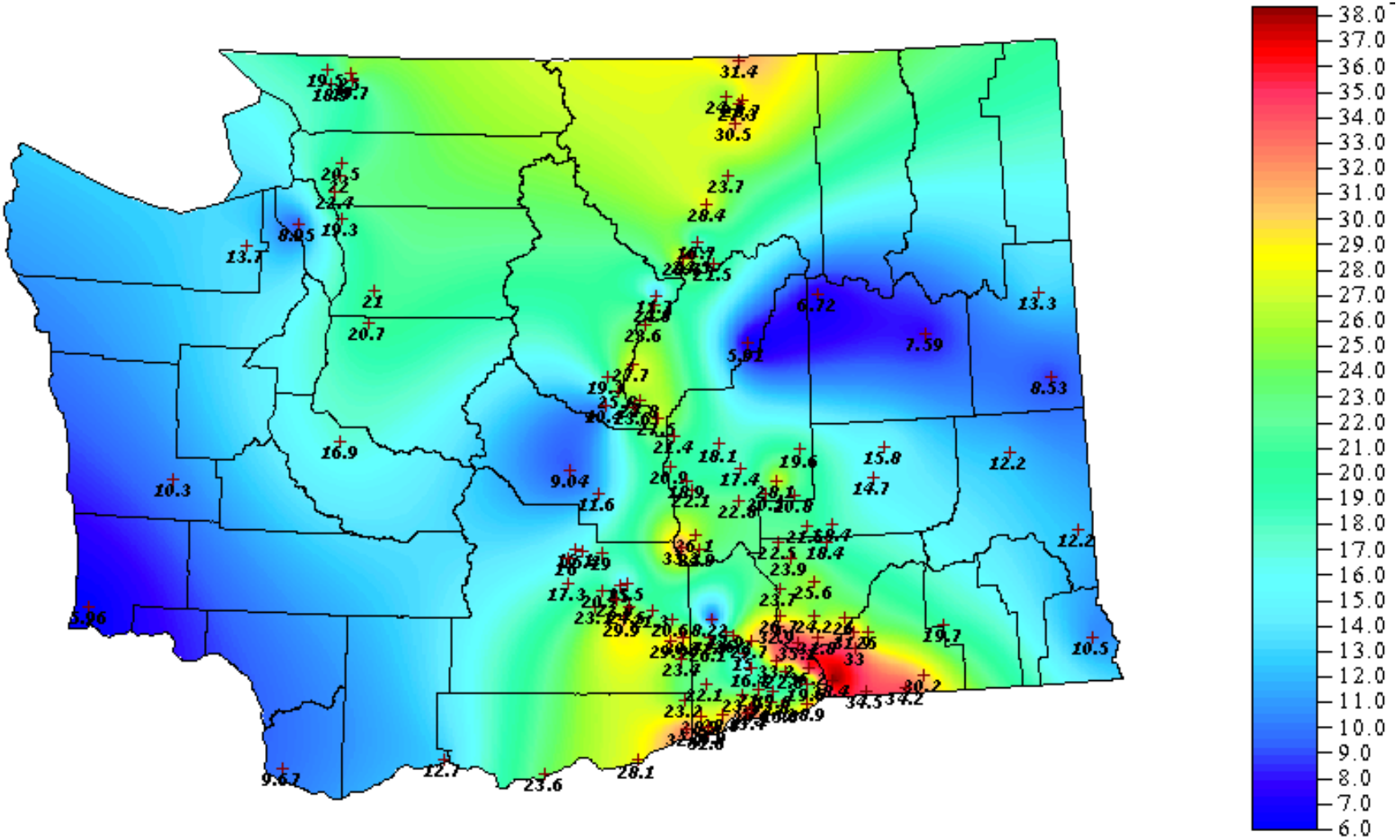
Current temperature



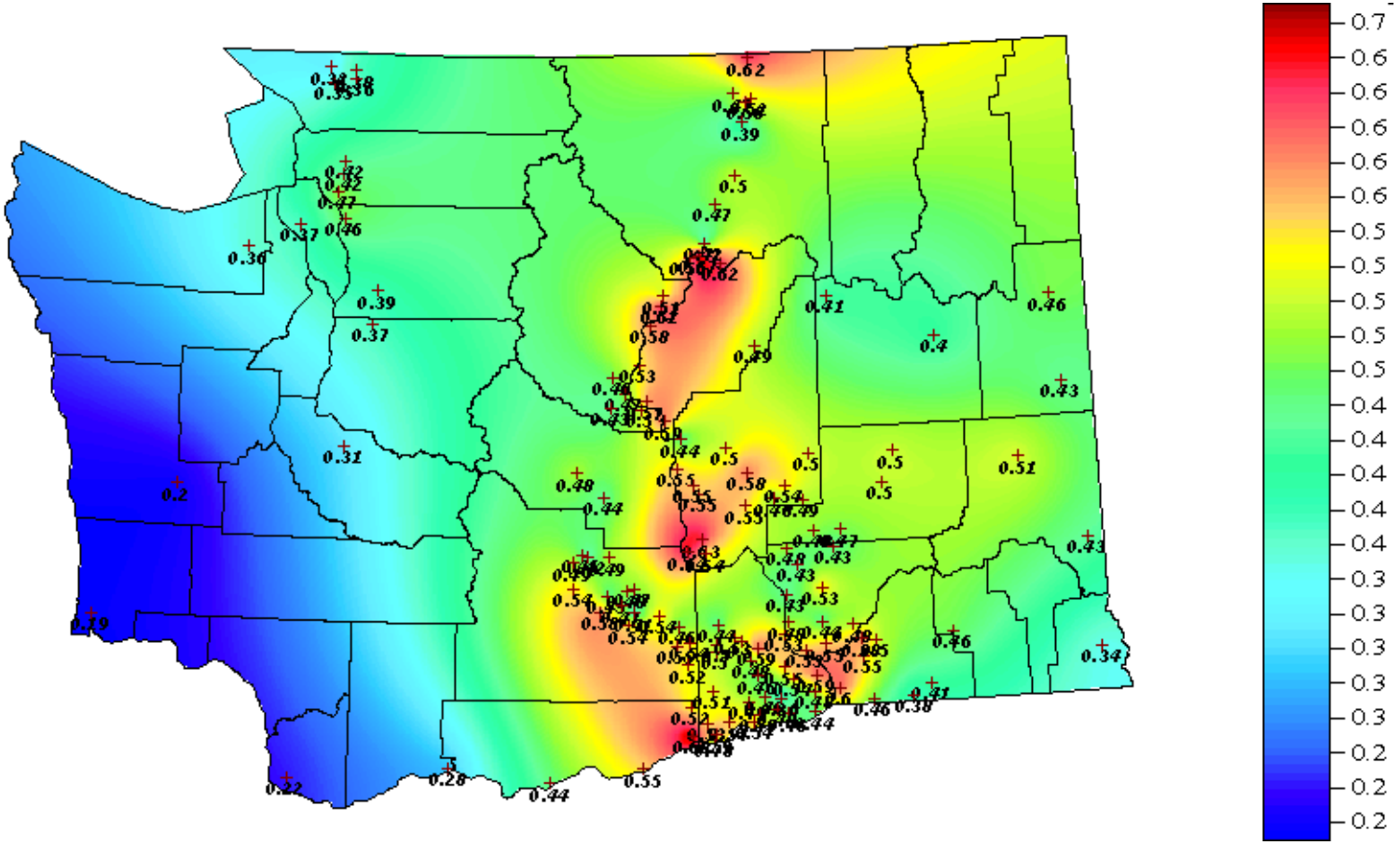
Month to date rain



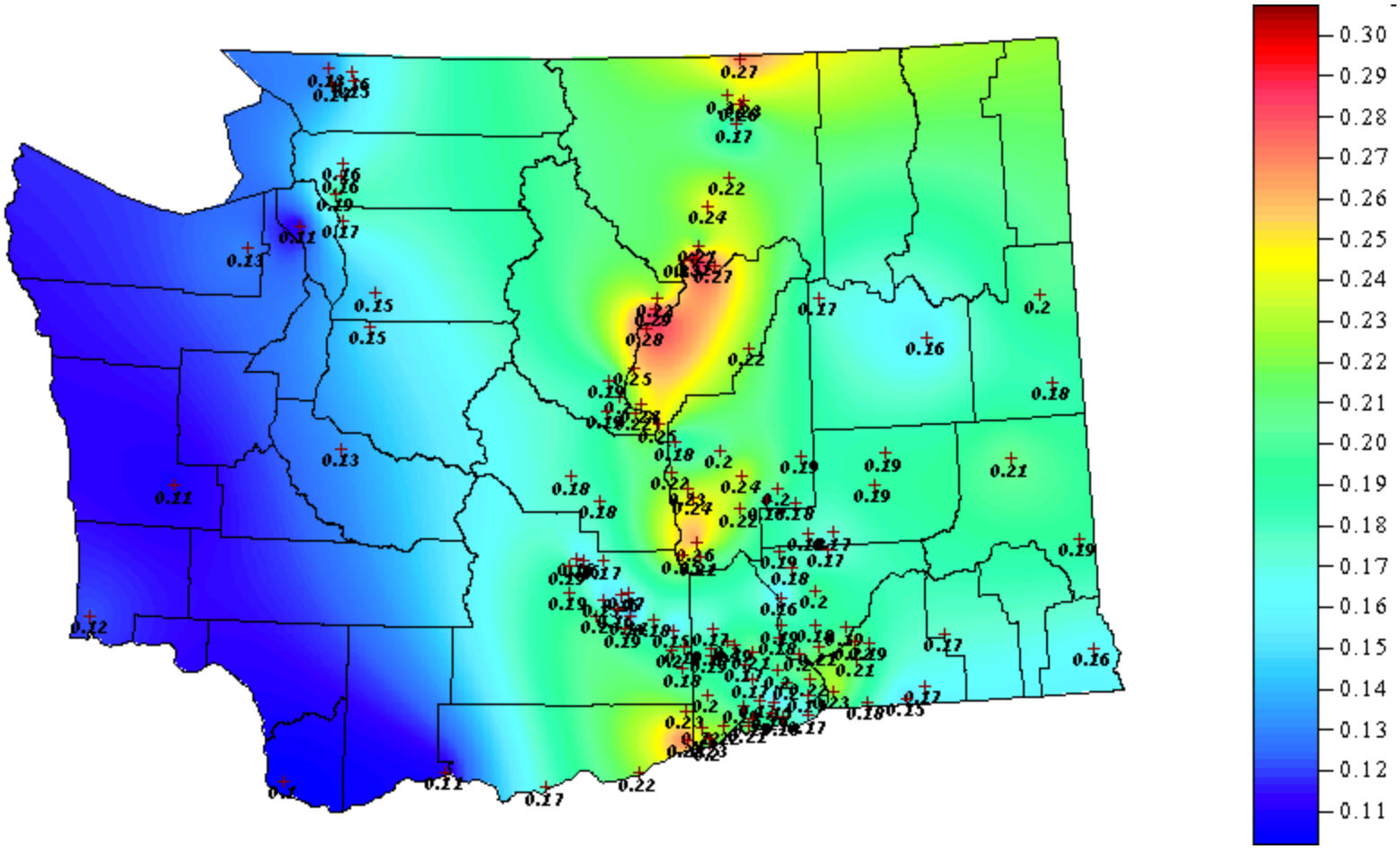
Growing Degree Day (base 50)

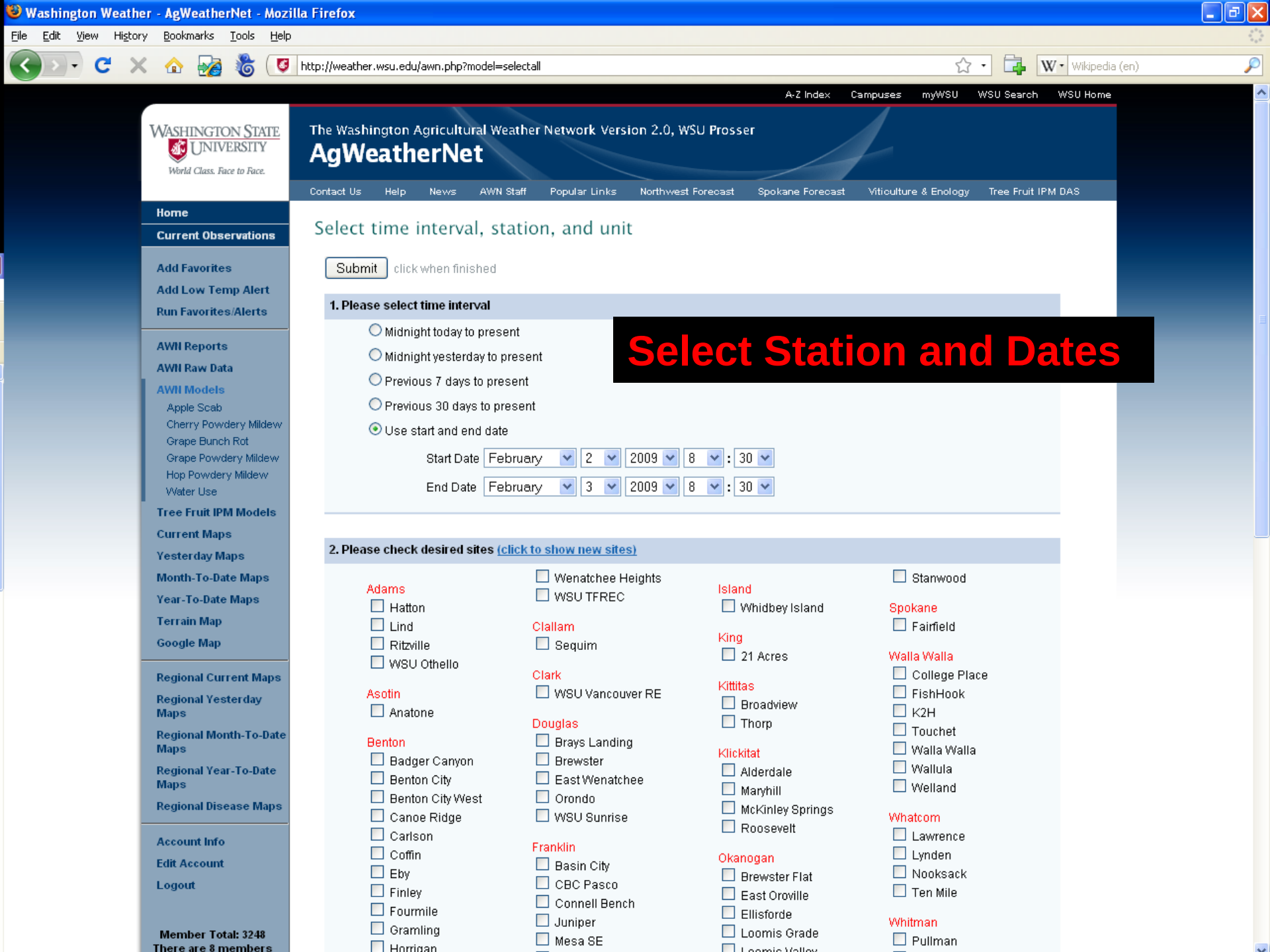


Accumulated Evapotranspiration (in) for Jun-01 to Jun-03-2010



ETr (in) for Jun-03-2010

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Regional Month-To-Date Maps
Regional Year-To-Date Maps
Regional Disease Maps
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Edit Account
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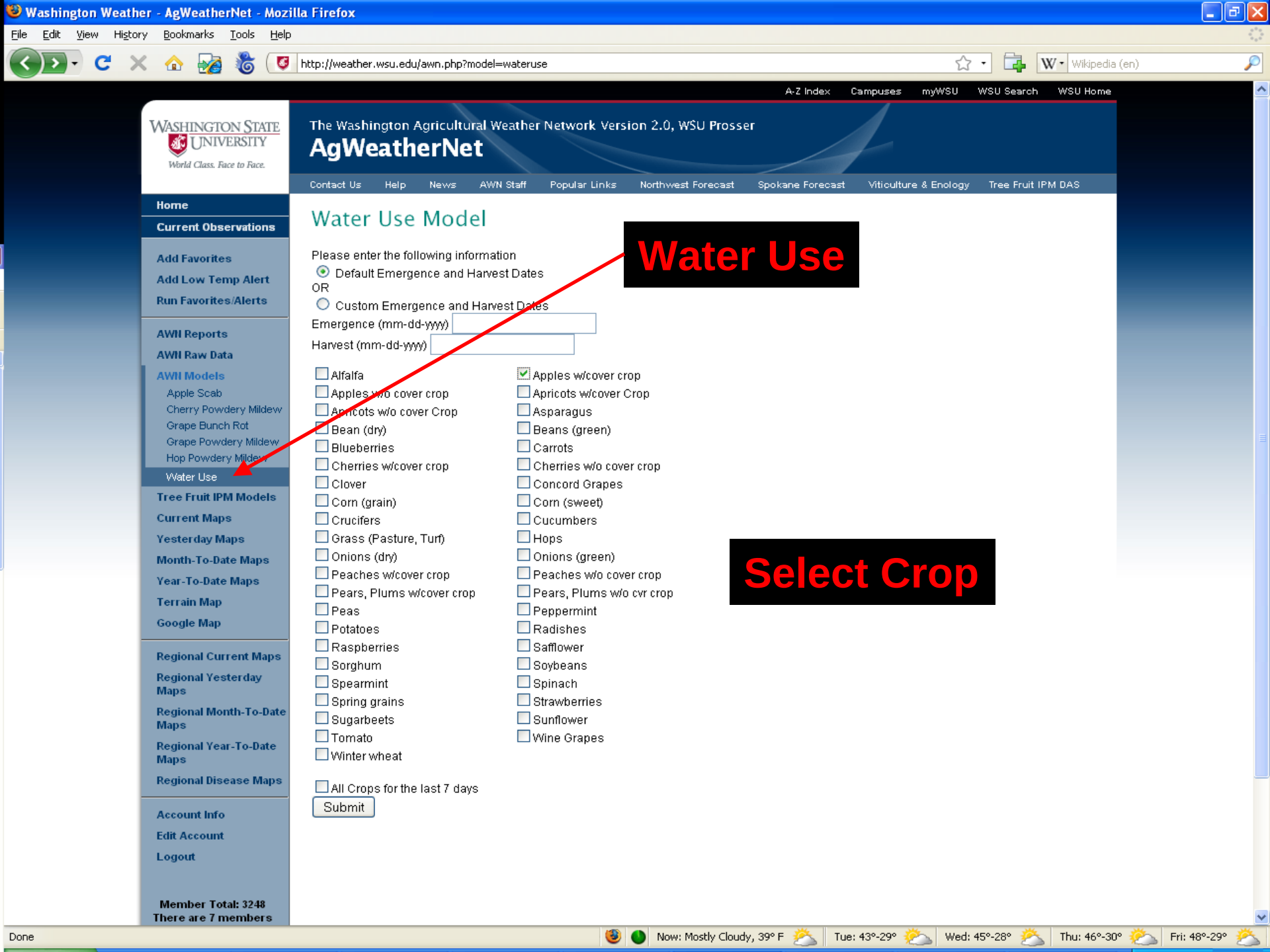
Member Total: 3248
There are 8 members
Select time interval, station, and unit
Submit
click when finished
1. Please select time interval
Midnight today to present
Midnight yesterday to present
Previous 7 days to present
Previous 30 days to present
Use start and end date
Start Date February 2 2009 8 : 30
End Date February 3 2009 8 : 30
Select Station and Dates
2. Please check desired sites (click to show new sites)
Adams
Hatton
Lind
Ritzville
WSU Othello
Asotin
Anatone
Benton
Badger Canyon
Benton City
Benton City West
Canoe Ridge
Carlson
Coffin
Eby
Finley
Fourmile
Gramling
Horrigan
Wenatchee Heights
WSU TFREC
Clallam
Sequim
Clark
WSU Vancouver RE
Douglas
Brays Landing
Brewster
East Wenatchee
Orondo
WSU Sunrise
Franklin
Basin City
CBC Pasco
Connell Bench
Juniper
Mesa SE
Island
Whidbey Island
King
21 Acres
Kittitas
Broadview
Thorp
Klickitat
Alderdale
Maryhill
McKinley Springs
Roosevelt
Okanogan
Brewster Flat
East Oroville
Ellisforde
Loomis Grade
Stanwood
Spokane
Fairfield
Walla Walla
College Place
FishHook
K2H
Touchet
Walla Walla
Wallula
Welland
Whatcom
Lawrence
Lynden
Nooksack
Ten Mile
Whitman
Pullman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Regional Yesterday Maps
Regional Month-To-Date Maps
Regional Year-To-Date Maps
Regional Disease Maps
Account Info
Edit Account
Logout
Member Total: 3248
There are 7 members
Water Use Model
Please enter the following information
Default Emergence and Harvest Dates
OR
Custom Emergence and Harvest Dates
Emergence (mm-dd-yyyy)
Harvest (mm-dd-yyyy)
Alfalfa
Apples w/cover crop
Apples w/o cover crop
Apricots w/cover Crop
Apricots w/o cover Crop
Asparagus
Bean (dry)
Beans (green)
Blueberries
Carrots
Cherries w/cover crop
Cherries w/o cover crop
Clover
Concord Grapes
Corn (grain)
Corn (sweet)
Crucifers
Cucumbers
Grass (Pasture, Turf)
Hops
Onions (dry)
Onions (green)
Peaches w/cover crop
Peaches w/o cover crop
Pears, Plums w/cover crop
Pears, Plums w/o cvr crop
Peas
Peppermint
Potatoes
Radishes
Raspberries
Safflower
Sorghum
Soybeans
Spearmint
Spinach
Spring grains
Strawberries
Sugarbeets
Sunflower
Tomato
Wine Grapes
Winter wheat
All Crops for the last 7 days
Submit
Water Use
Select Crop
Done
Now: Mostly Cloudy, 39° F
Tue: 43°-29°
Wed: 45°-28°
Thu: 46°-30°
Fri: 48°-29°

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Year-To-Date Maps
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Google Map

Regional Current Maps
Regional Yesterday Maps
Regional Month-To-Date Maps
Regional Year-To-Date Maps
Regional Disease Maps

Account Info
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Member Total: 3248
There are 6 members

Water Use Model

ET Report

Data Extracted: 2009-02-03
Station: **WSU HQ**
Lat: 46.3 Lng: 119.7 Elevation: 868
Date Range from 2009-01-04 to 2009-2-3

Accumlated precip for selected period is: 0.02 Inches.

Date yyyy-mm-dd	Penman ETr Alfalfa (in)	Accum Alfalfa ET (in)	Apples w/cover crop ET (in)	Apples w/cover crop Accum ET (in)
2009-01-04	0.01	0.01	0.00	0.00
2009-01-05	0.02	0.03	0.00	0.00
2009-01-06	0.07	0.10	0.00	0.00
2009-01-07	0.17	0.27	0.00	0.00
2009-01-08	0.11	0.38	0.00	0.00
2009-01-09	0.04	0.42	0.00	0.00
2009-01-10	0.02	0.44	0.00	0.00
2009-01-11	0.03	0.47	0.00	0.00
2009-01-12	0.05	0.52	0.00	0.00
2009-01-13	0.01	0.53	0.00	0.00
2009-01-14	0.01	0.54	0.00	0.00
2009-01-15	0.00	0.54	0.00	0.00
2009-01-16	0.00	0.54	0.00	0.00
2009-01-17	0.00	0.54	0.00	0.00
2009-01-18	0.01	0.55	0.00	0.00
2009-01-19	0.01	0.56	0.00	0.00
2009-01-20	0.01	0.57	0.00	0.00
2009-01-21	0.01	0.58	0.00	0.00
2009-01-22	0.01	0.59	0.00	0.00
2009-01-23	0.02	0.61	0.00	0.00
2009-01-24	0.02	0.63	0.00	0.00
2009-01-25	0.04	0.67	0.00	0.00
2009-01-26	0.05	0.72	0.00	0.00
2009-01-27	0.04	0.76	0.00	0.00
2009-01-28	0.07	0.83	0.00	0.00

Example 1 Soil Water Budget

- Fine sand: AW = 0.07 in/in
- Effective rooting depth: 2”
- Total water holding capacity: $0.07^{in}/_{in}$ x 2”=0.14 inches
- MAD: 30%
- Soil water deficit at MAD: 0.14 in * 30% = 0.042 in

Example 1 Soil Water Budget cont..

- Daily ET rate: 0.1 in/day (revised to 0.085” for cranberry or use actual from web site)
- Time to dewater full profile to MAD:

  0.042 in / 0.085 in/day = 1/2 day
- Irrigation Efficiency: 75%
- Irrigation Amount: 0.042 in / 75% = 0.06 in
- If irrigation rate is 0.11”/hr – irrigate ½ hour twice a day.

Example 2 Soil Water Budget

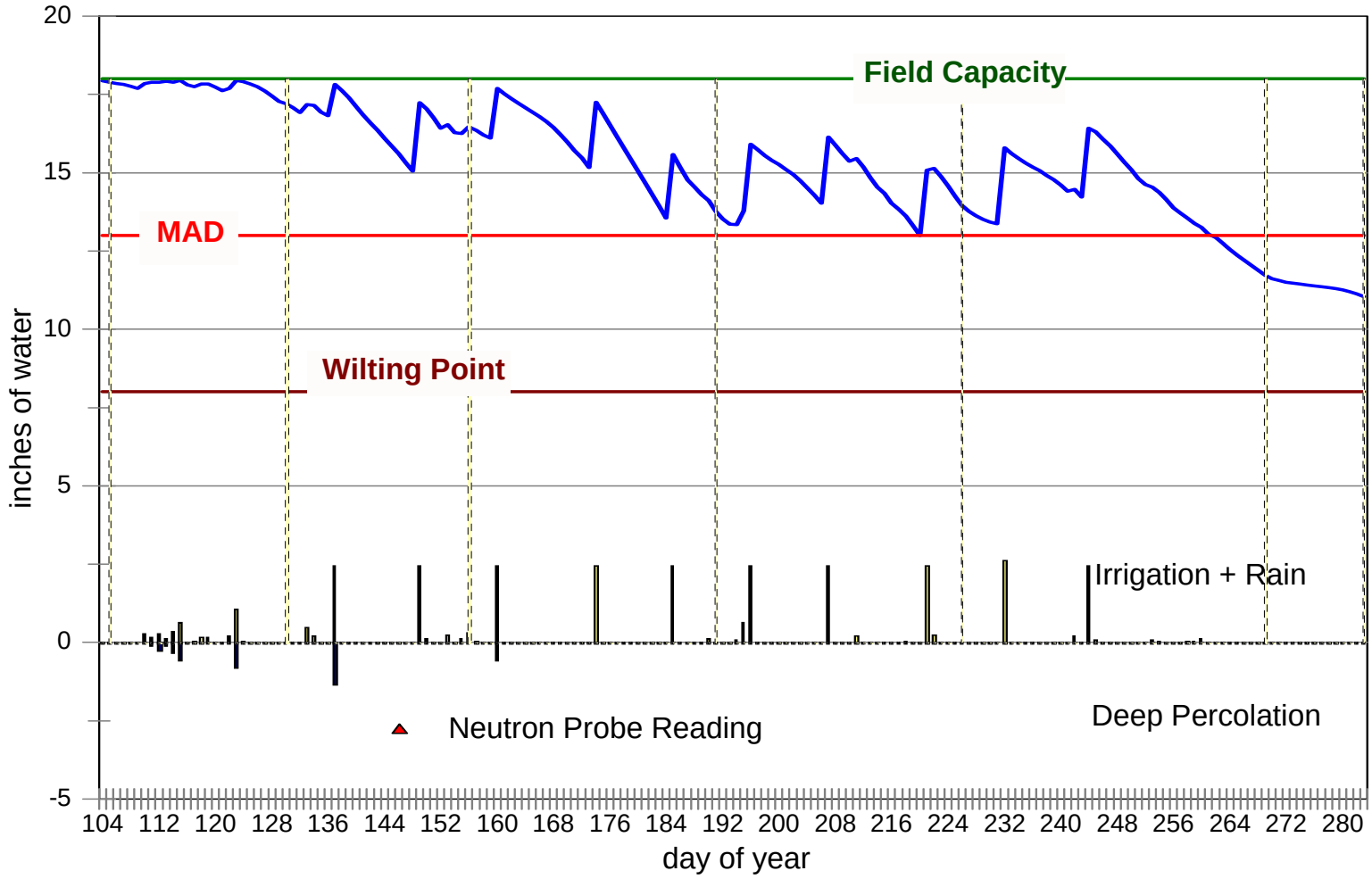
- peat: AW = 0.2 in/in
- Effective rooting depth: 2”
- Total water holding capacity: $0.2^{in}/_{in}$ x 2”=0.4 inches
- MAD: 50%
- Soil water deficit at MAD: 0.4 in * 50% = 0.2 in

Example Soil Water Budget cont..

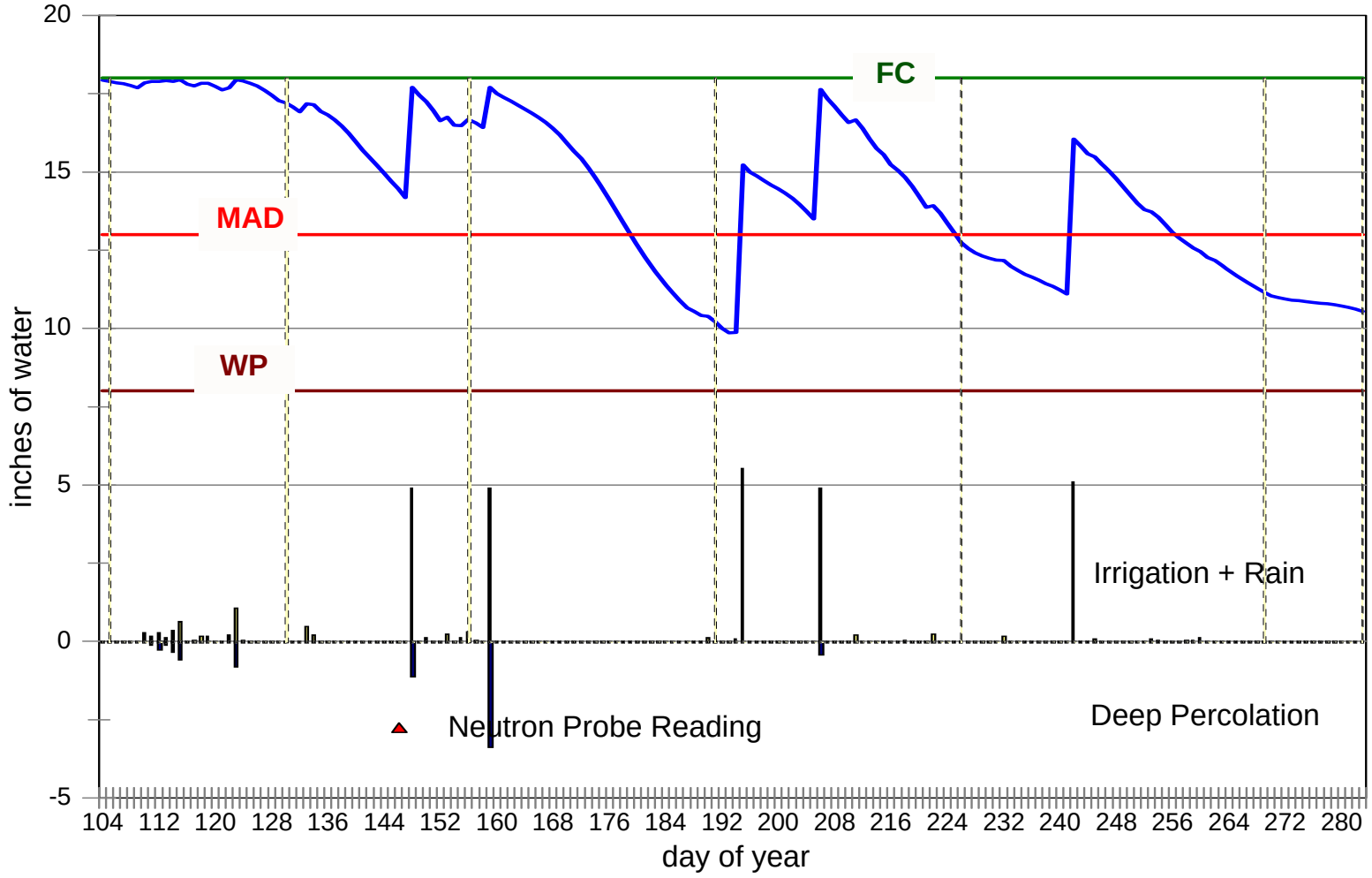
- Daily ET rate: 0.1 in/day (revised to 0.085” for cranberry or use actual from web site)
- Time to dewater full profile to MAD:

  0.2 in / 0.085 in/day = 2.4 days
- Irrigation Efficiency: 75%
- Irrigation Amount: 0.2 in / 75% = 0.26 in
- If irrigation rate is 0.11”/hr – irrigate every two to three days for 2.4 hour.

Good Irrigation Management

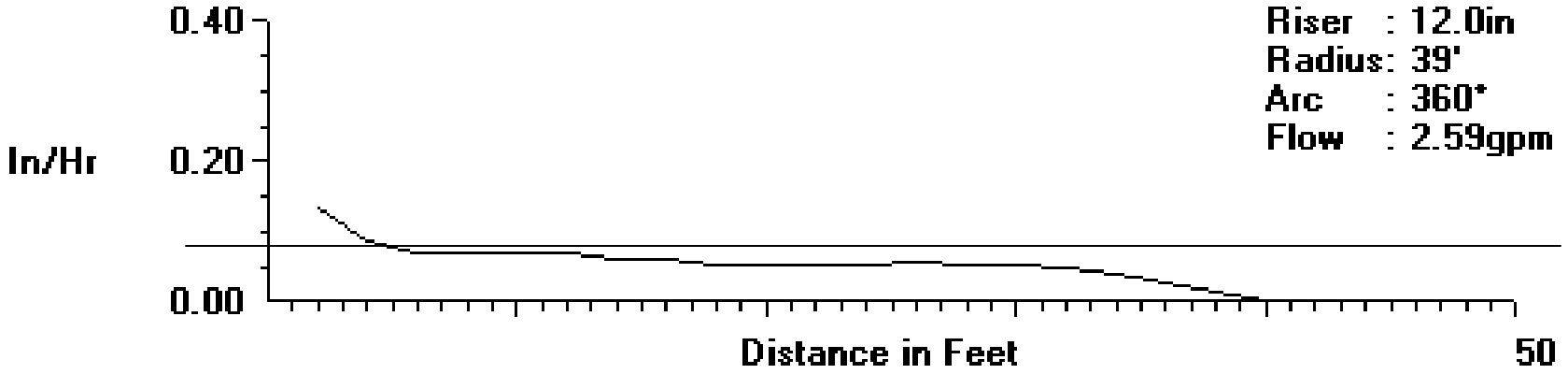


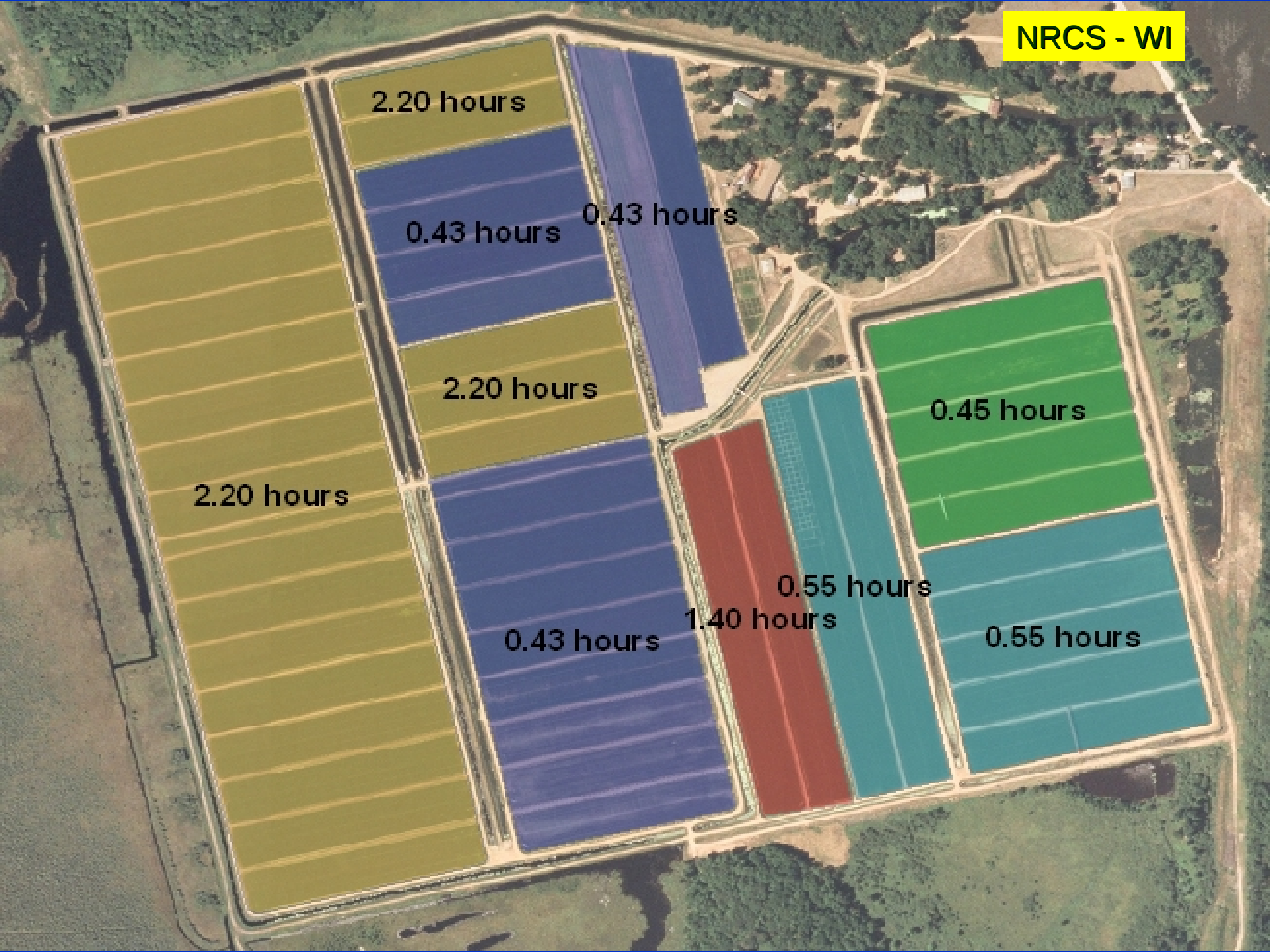
Poor Irrigation Management



Irrigation scheduling - more

- Schedule for sandiest bed on the system.
- Schedule for lowest output sprinklers (near end of line with low pressure)




NRCS - WI
2.20 hours
0.43 hours
0.43 hours
2.20 hours
2.20 hours
0.43 hours
0.45 hours
0.55 hours
1.40 hours
0.55 hours

Soil Moisture Tools To Assist With Irrigation Management

Hortau Tensiometer

ESI Gro Point

Irrometer LT

Acclima TDT Probe

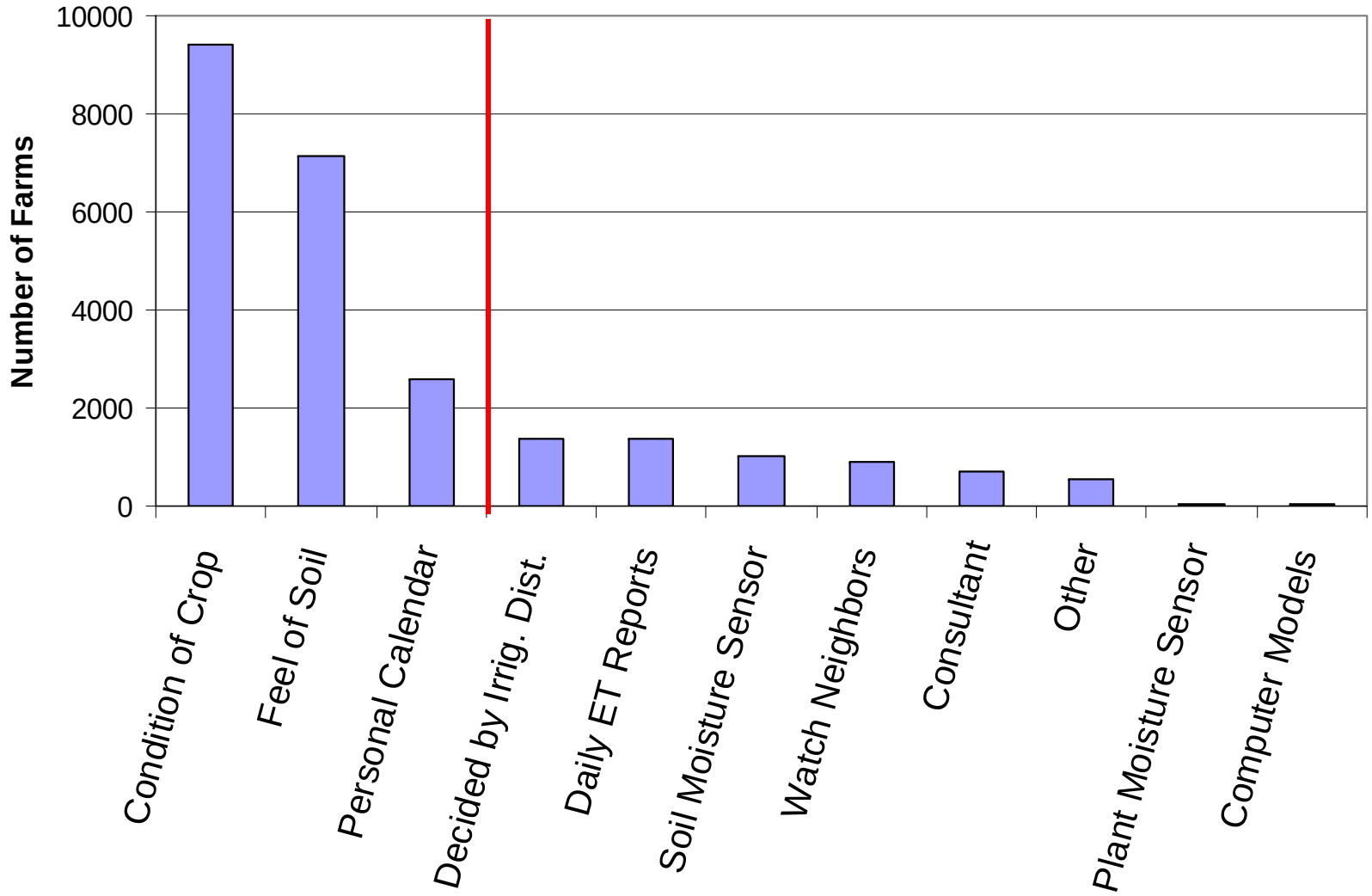
From Leroy Kummer
OS Ag Scientist

Lampinenometers

Hand Method

Gypsum Blocks

Methods Used in Washington to Determine When to Irrigate



Levels of Irrigation Scheduling

Worst

- Same schedule all season / Guessing
- Kicking the dirt / Looking at the plants

Less Profitable

- Look and feel method using shovel or soil probe
- Checkbook method / ET (AgWeatherNet)
- Soil moisture monitoring
- Neutron probe + checkbook

More Profitable Growers

Best

Tensiometers & Soil Texture:

Soil Moisture Irrigation Status	Soil Texture From Leroy Kummer OS Ag Scientist	Soil Tension (cb)
Soil at Field Capacity – No irrigation	Sand, Loamy Sand Sandy Loam, Loam, Silt Loam Clay Loam, Clay	5-10 cb 10-20 cb 20-40 cb
50% of Available Water Depleted –Yes Irrigation	Sand, Loamy Sand Sandy Loam, Loam, Silt Loam Clay Loam, Clay	20-40 cb 40-60 cb 50-100 cb

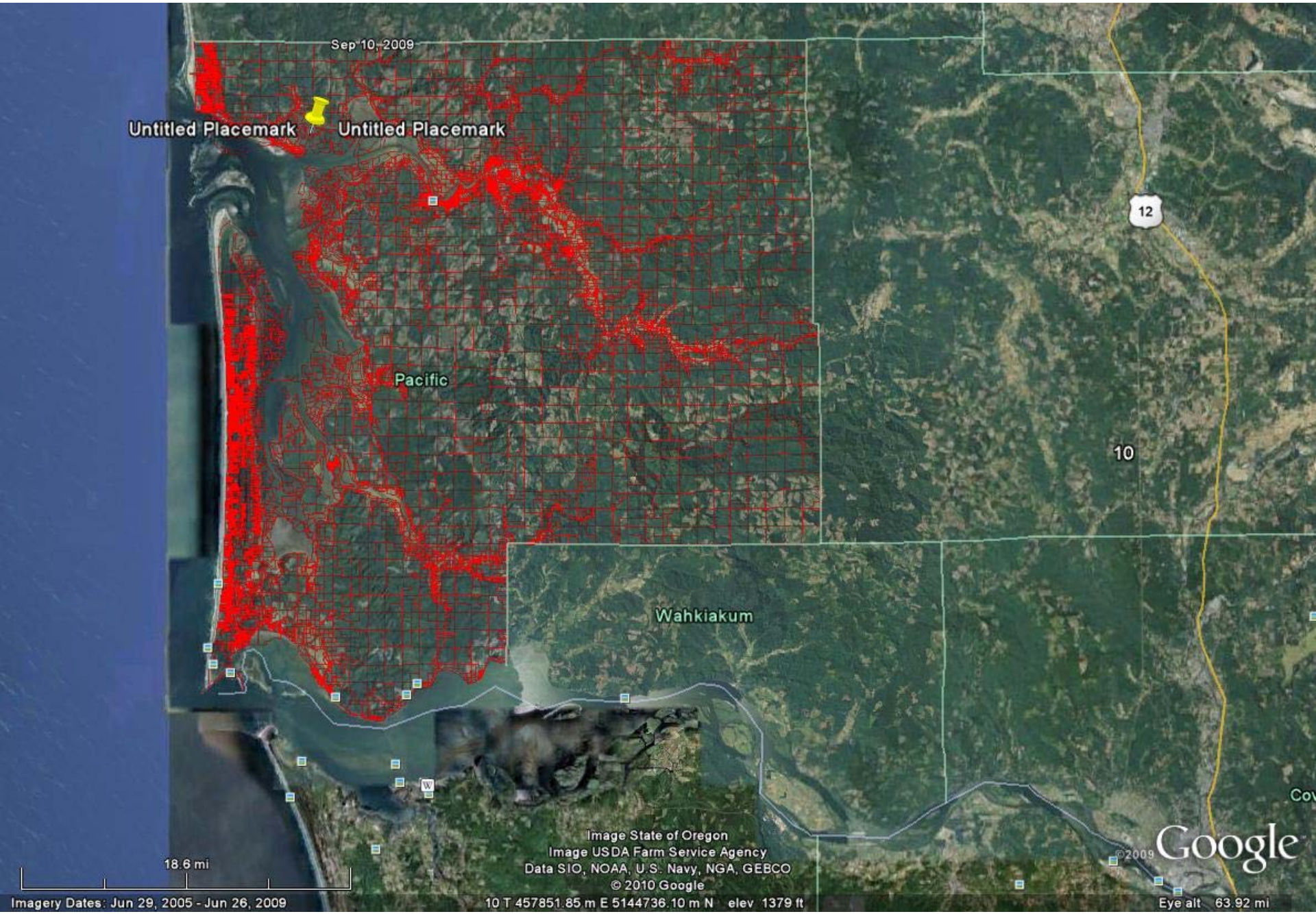
Site assessment : Satellite maps (Goggle earth)

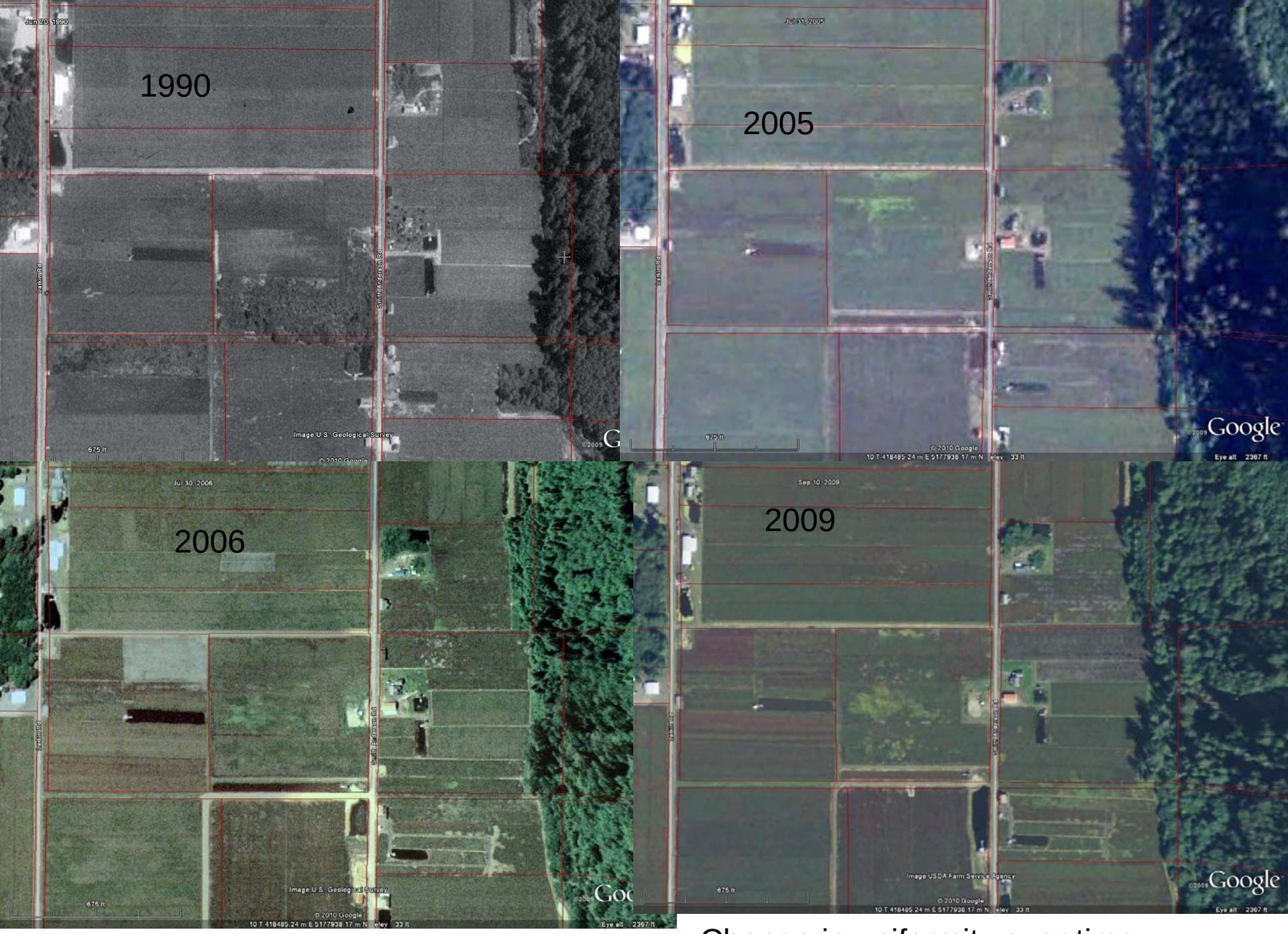
- Field maps
- Site plan
- Historical patterns
- Irrigation patterns
- Water flow patterns

Department of Public Works

ASSESSORS TAXLOT MAPS 2006

Click here to download Pacific County Tax Lots in GOOGLE EARTH format - Updated 3/1/10


Sep 10, 2009
Untitled Placemark
Untitled Placemark
Pacific
12
10
Wahkiakum
Image State of Oregon
Image USDA Farm Service Agency
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2010 Google
18.6 mi
©2009 Google
Imagery Dates: Jun 29, 2005 - Jun 26, 2009
10 T 457851.85 m E 5144736.10 m N elev 1379 ft
Eye alt 63.92 mi


1990
2005
2006
2009
Change in uniformity over time

Poor system design

Poor system design

Poor system design

Poor system design


Poor system design

- Site assessment
  - Bog characterization
    - Bed variability
    - Soil depth
    - Water table depth – seasonal
    - Factors /requirement to avoid leaching of pesticide and nutrients to substrata
    - Drainage



Irrigation scheduling – very site dependent on water holding capacity of soil



Sub-irrigation – very site dependent

Seasonal water table assessment

Too wet

Adequate

Dry spots

Wet spots

Drainage systems:
Flex line with or without sock
Solid – point holes down or up

Growers comments:
•Socks in peat don’t work
•Flex line needs to be flush every 3-4 yr
•In BC on peat every drains running every 15-17’, with growers liking solid with holes up on peat unless chip down in hole and all around then holes down.

Clean out

Chemigation time (maximum time for rinse off and still obtain efficacy for fireworm)

- Treatment
  - Should be < 6 minutes
    - Confirm, Intrepid, Success, low-rate Delegate
  - Should be <8 minutes
    - high rate of Delegate
  - Should be <10-12 minutes
    - Diazinon, Lorsban, Orthene
- 6 hours drying time following application is required for non-OPs, retreat if rain or frost protection interfered.