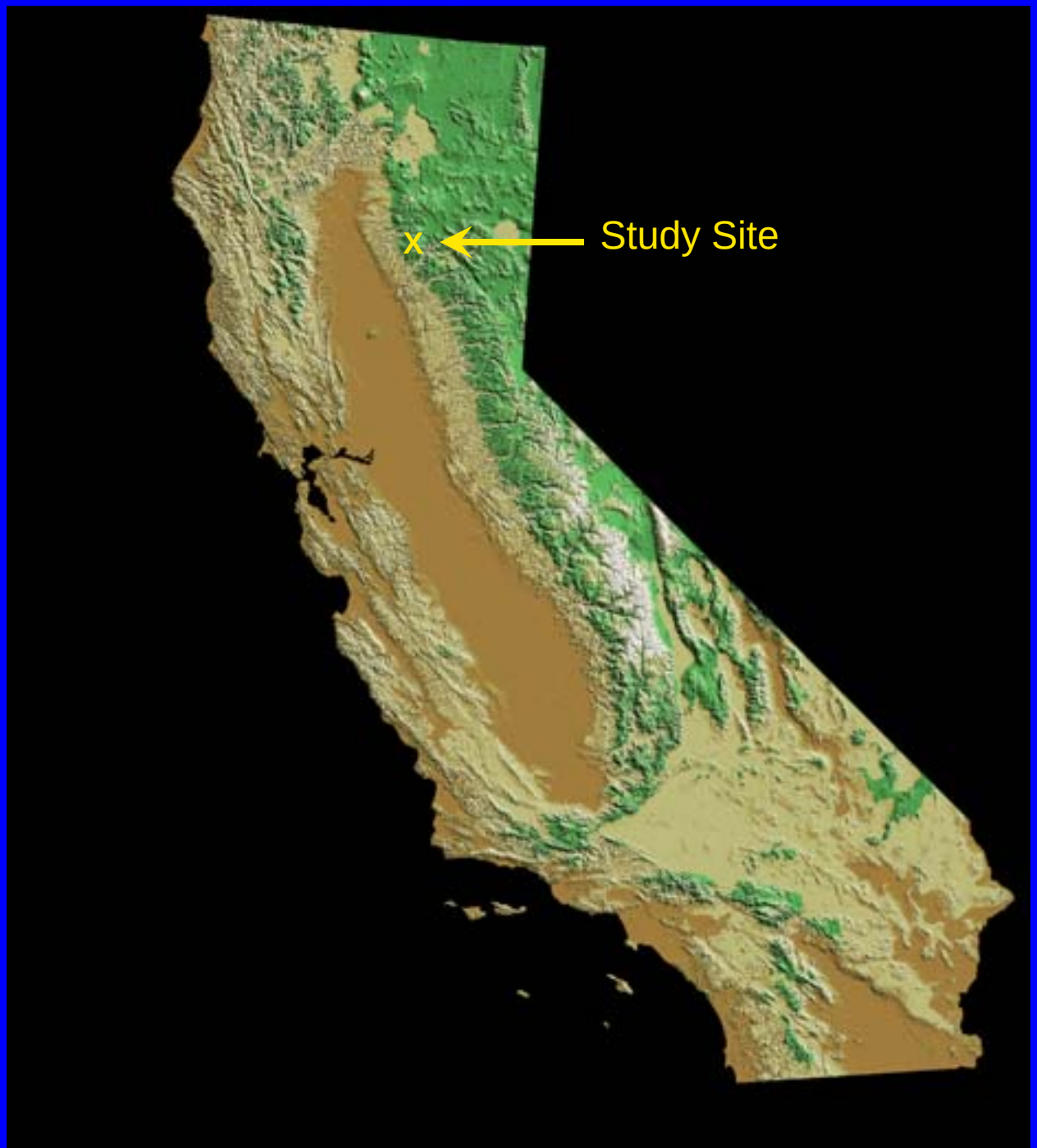
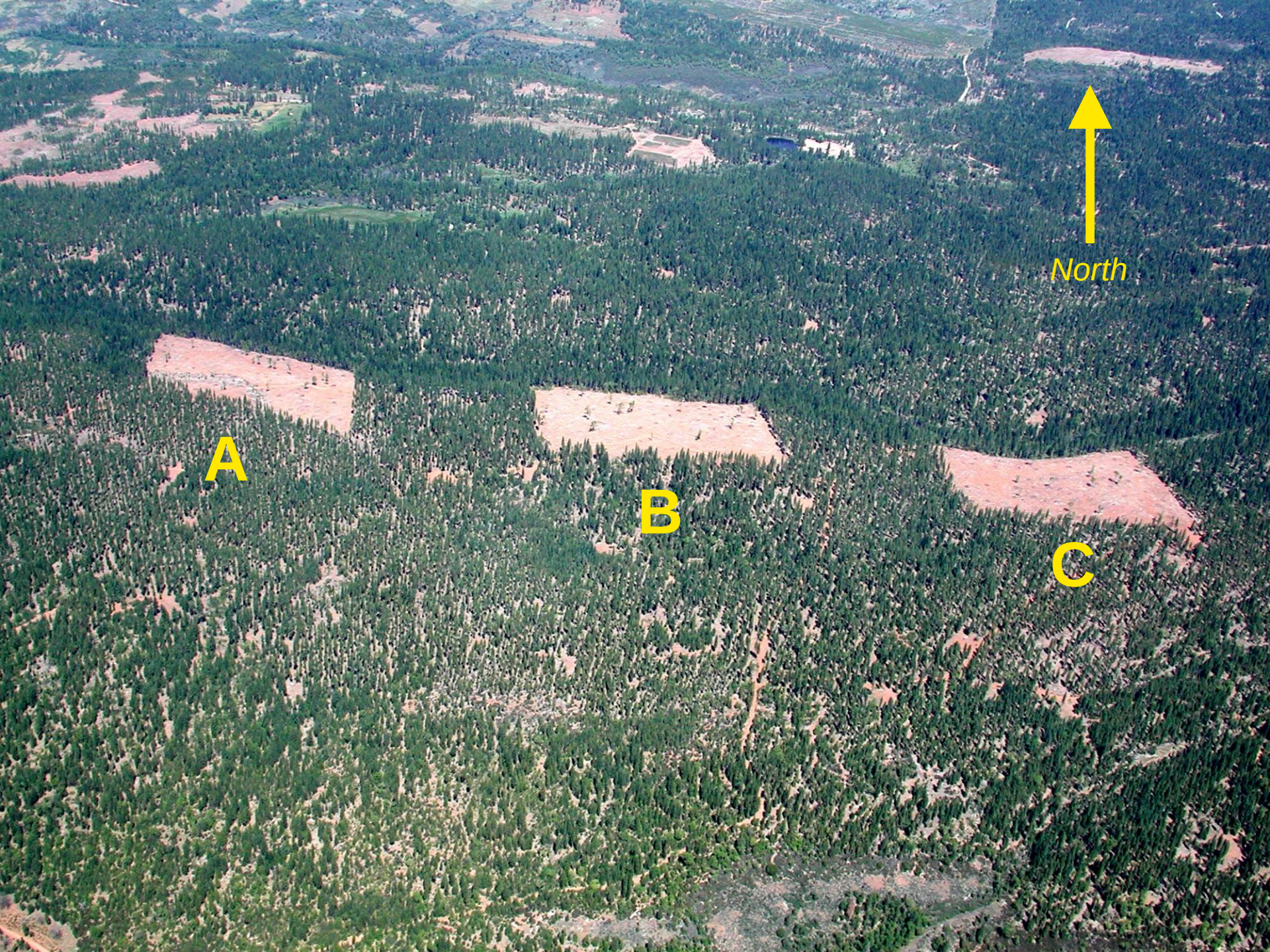
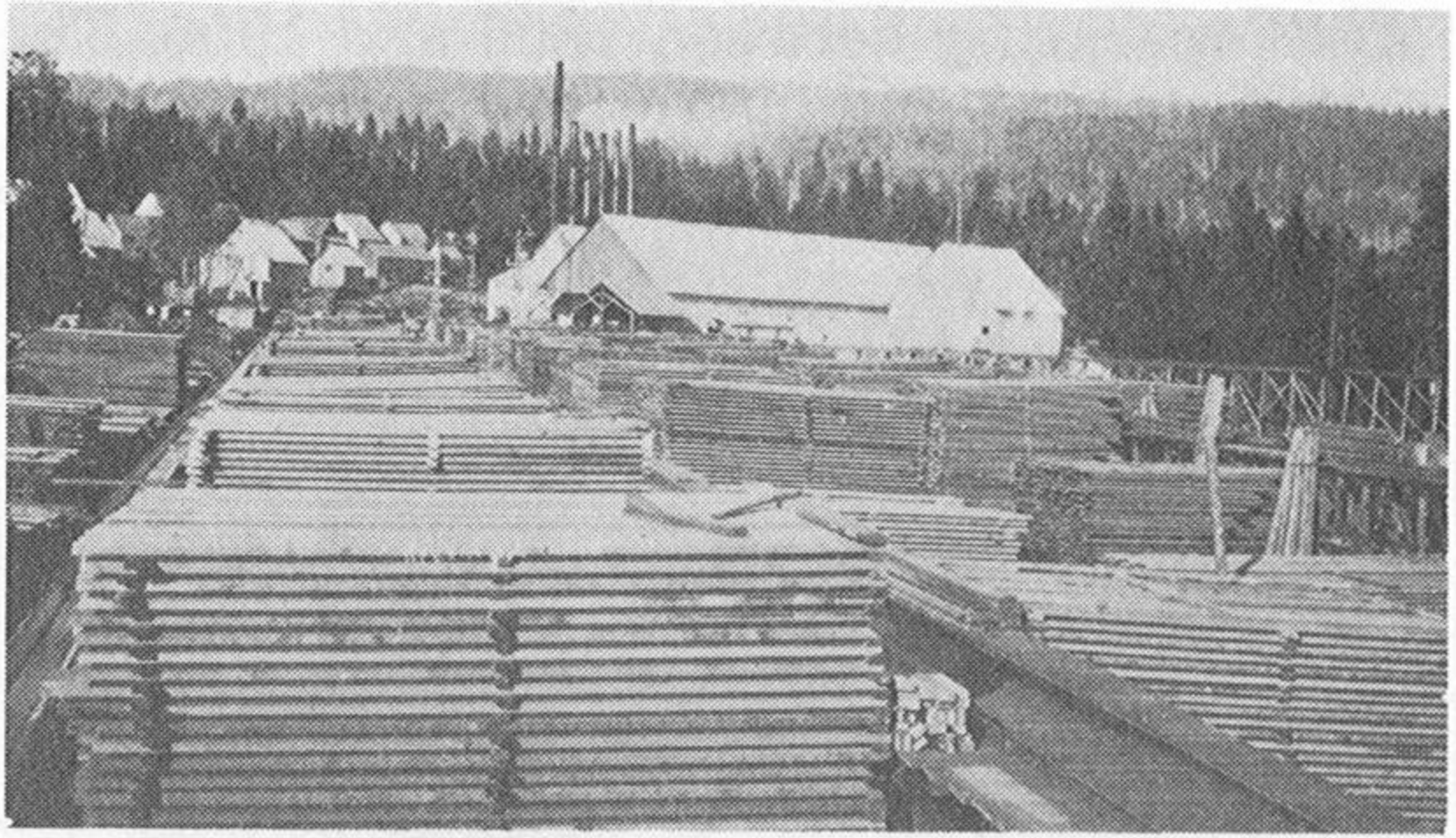
# Benthic Macroinvertebrate Response to Multiple Clear-cut Forest Harvest: Local Habitat Effects Override Cumulative Watershed Effects

Morgan Hannaford – Shasta College, Redding, CA
Cajun James – Sierra Pacific Industries, Redding, CA


x
Study Site


North
A
B
C

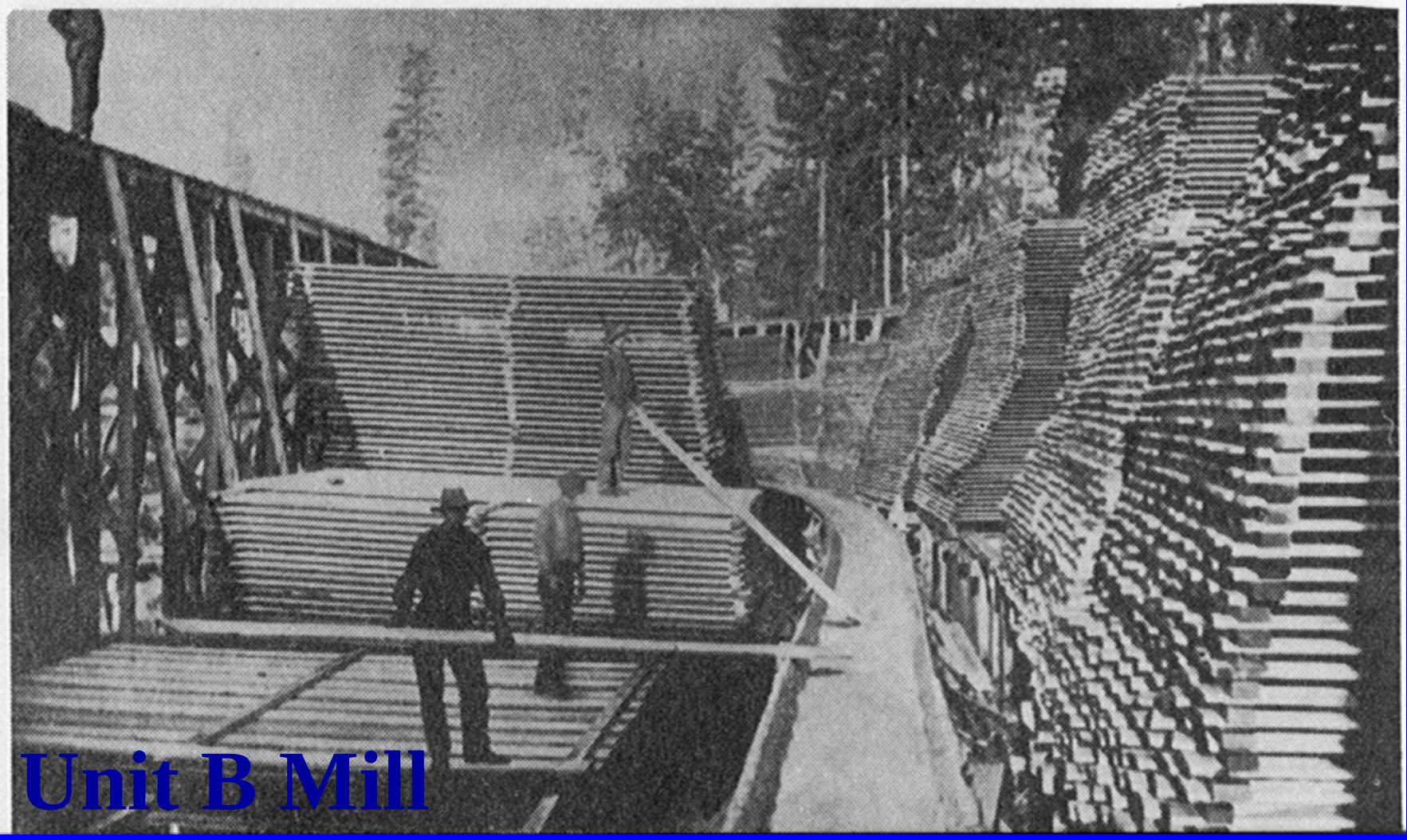


The last Champion Mill at Lyonsville—built by Diamond National in 1908. A fine stand of young timber almost hides the site today. (James Weldin)

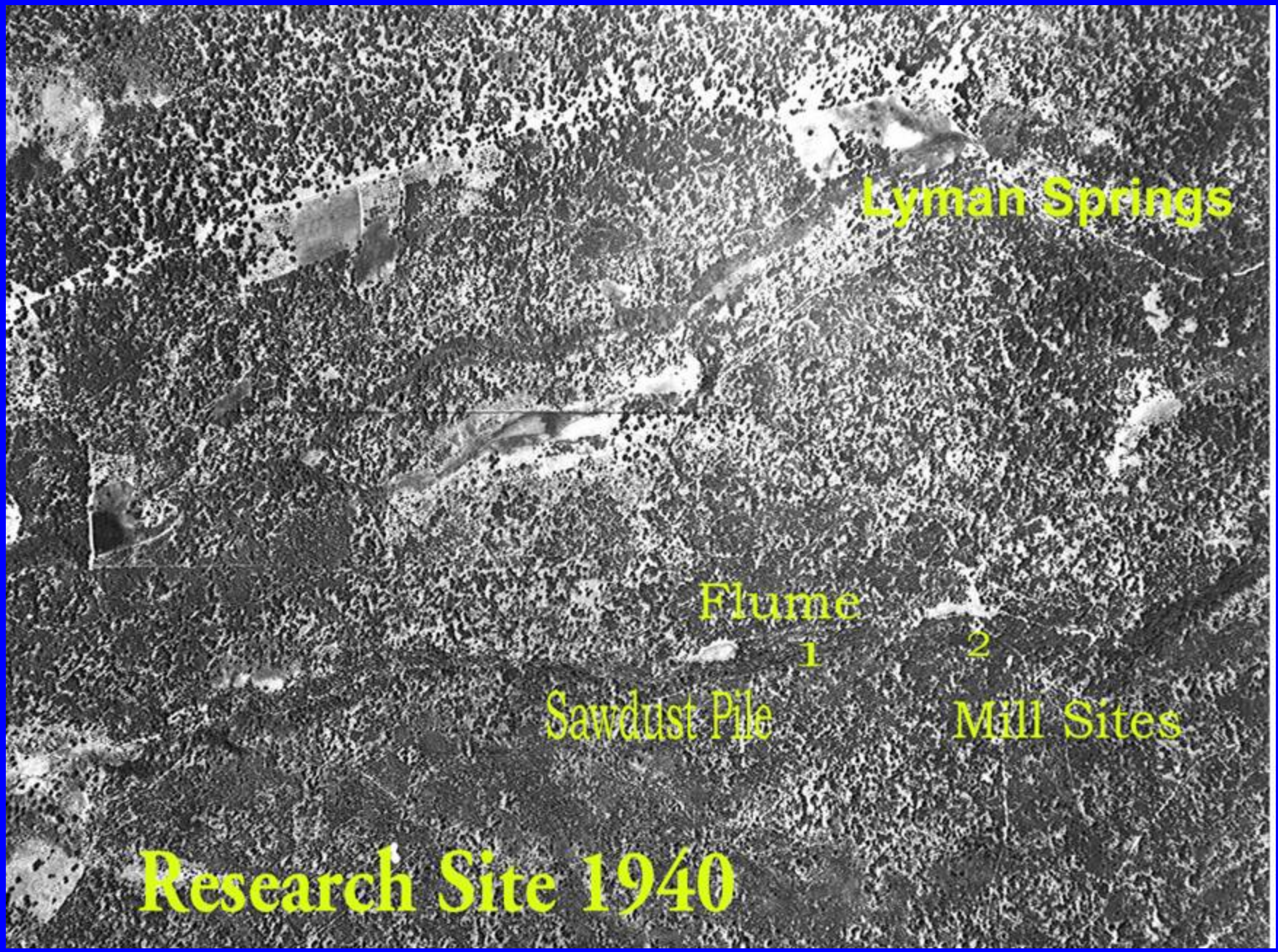
Picture from Leonard Silva Collection

***Logging with Horses***

Taken at A. E. Engebretsen's sawmill well after the turn of the century, this photograph shows method of fluming lumber used by C. F. Ellsworth in 1871. (Miss Edith Engebretsen)



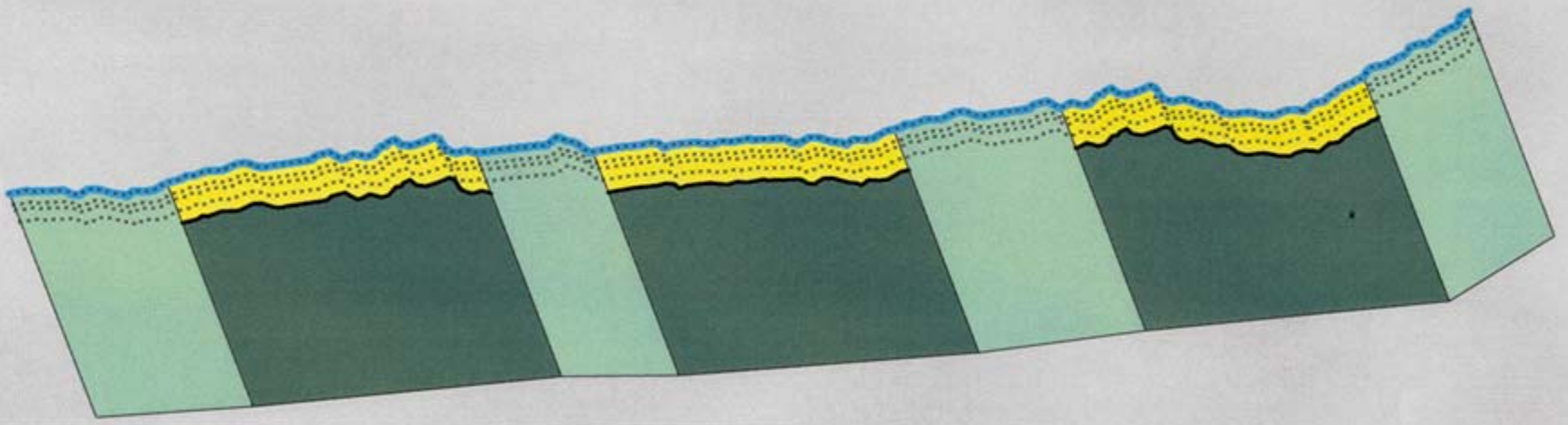
Unit B Mill


Lyman Springs
Flume
1
2
Sawdust Pile
Mill Sites
Research Site 1940

# *Southern Exposure Research Project*

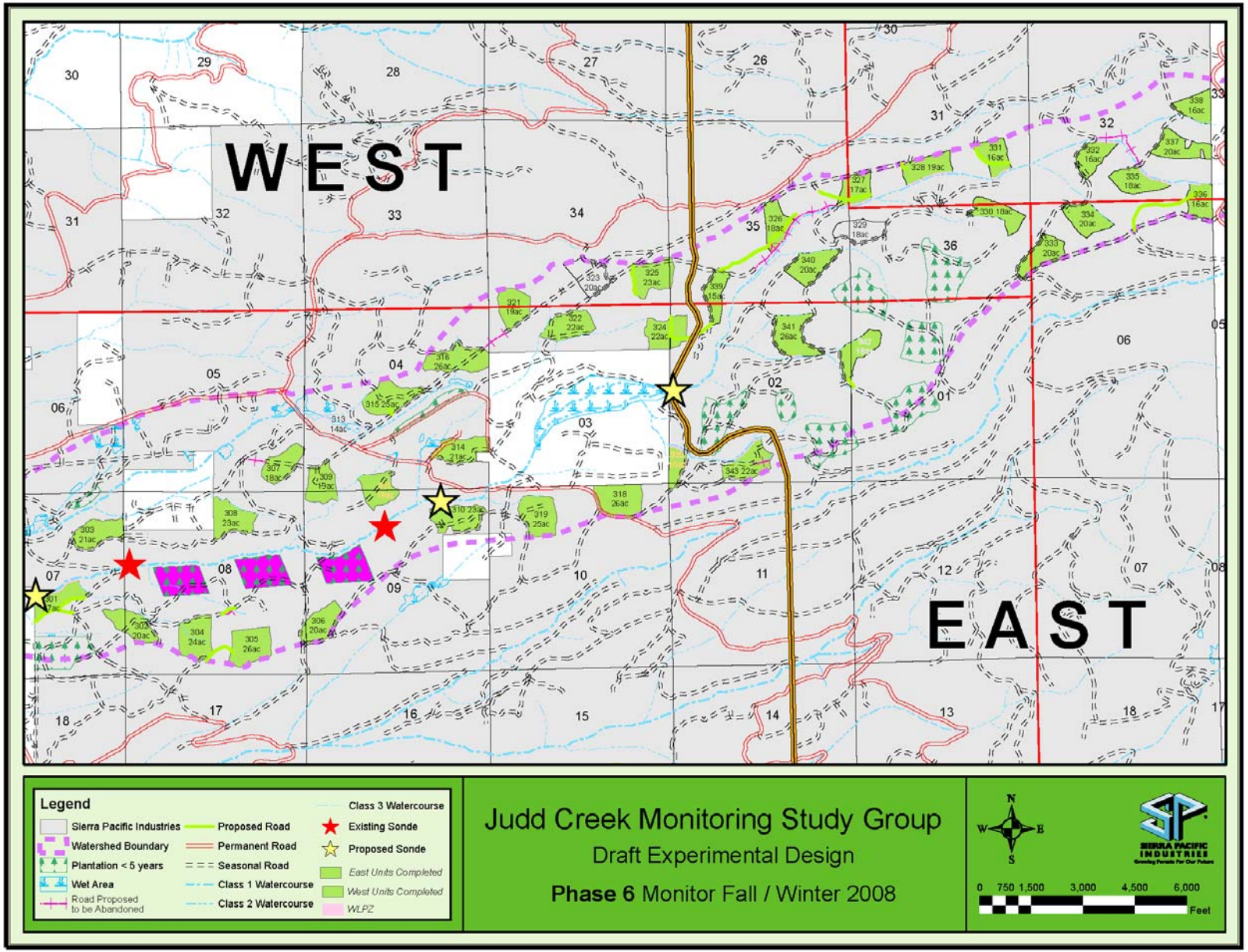
## Canopy Plot Location

130 Canopy Plots Per Line: Mid Stream, 50', 75', & 125'



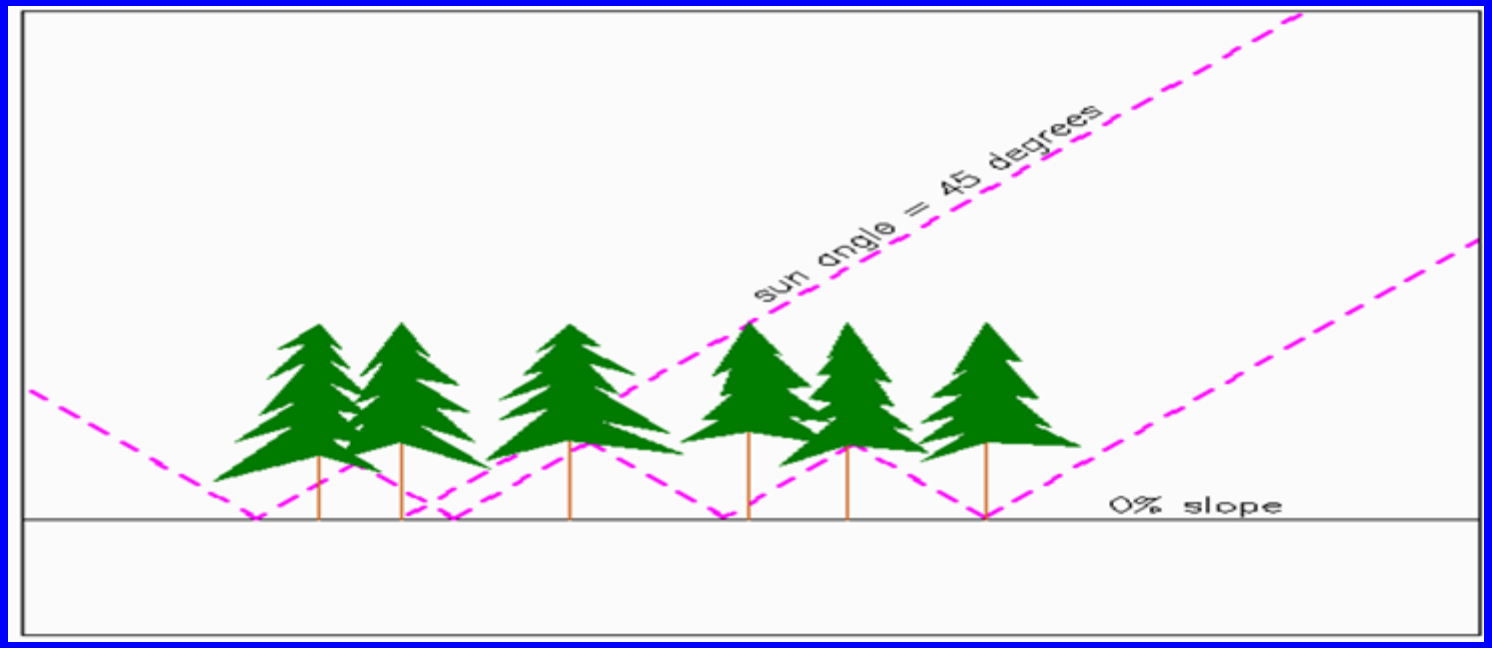
- Southern Exposure Study Area Pre-Harvest
- Watercourse & Lake Protection Zone (WLPZ) to 175'
- Non-harvested Control Unit
- Class 1 Stream
- 175' Line
- Canopy Plot (130 points per line)

| Year of Impact | Logging effect description |
|---|---|
| 2000 | Untreated |
| 2001 | Clear cut to 175 ft from the bank. Thin the WLPZ zone to 50% overhead canopy cover (late August of 2000) |
| 2002 | Benthic Macroinvertebrates Sampled using California Bioassessement Protocol (Fall) |
| 2003 | No Treatment |
| 2004 | Clear – cut to 50 feet from the bank. (late Oct of 2003) |
| 2005 | Economic clear- cut of all remaining buffer trees. (Late Oct of 2004) |
| 2006/2007 | No Treatment |


WEST
EAST
Legend
Sierra Pacific Industries
Watershed Boundary
Plantation < 5 years
Wet Area
Road Proposed to be Abandoned
Proposed Road
Permanent Road
Seasonal Road
Class 1 Watercourse
Class 2 Watercourse
Class 3 Watercourse
Existing Sonde
Proposed Sonde
East Units Completed
West Units Completed
WLPZ
Judd Creek Monitoring Study Group
Draft Experimental Design
Phase 6 Monitor Fall / Winter 2008
N
W
E
S
0 750 1,500 3,000 4,500 6,000
Feet

# Vertical Canopy Measure

**Figure 3-29.** The sight tube is preferred by CDF for evaluating vertical project canopy.


sun angle = 45 degrees
0% slope

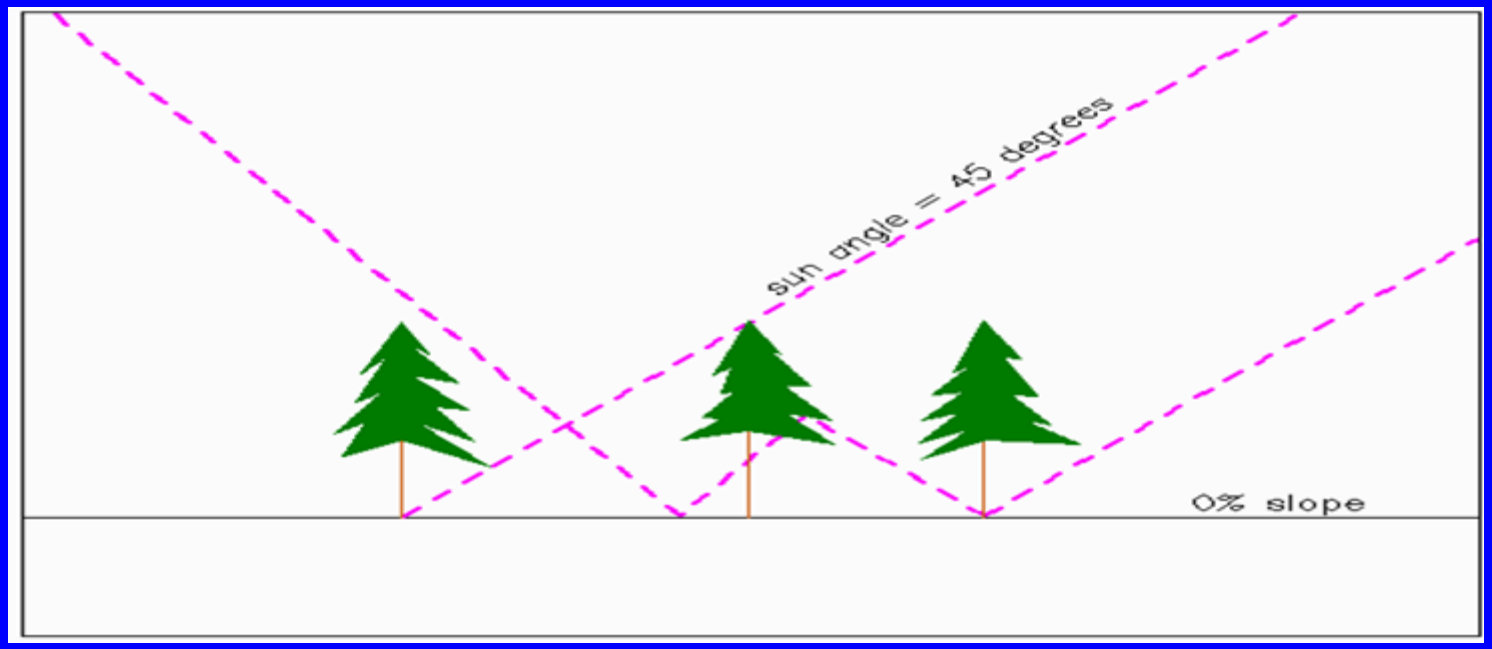

sun angle = 45 degrees
0% slope

**Figure 3-26.** Spherical Densiometer quantifies the amount of total canopy overhead at the plot center.

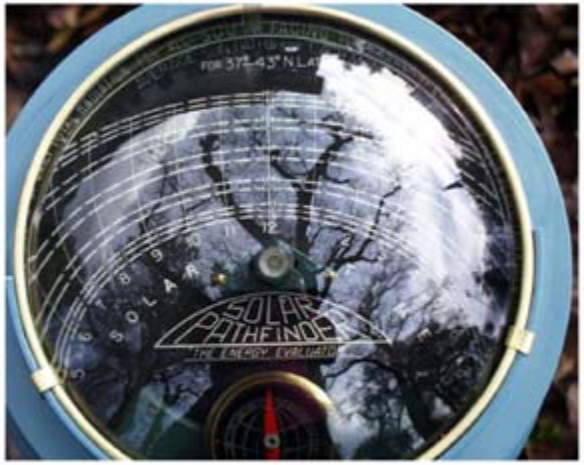



**Figure 3-27.** The Solar Pathfinder is used to determine the amount of total shade, total canopy, and total incoming solar radiation.

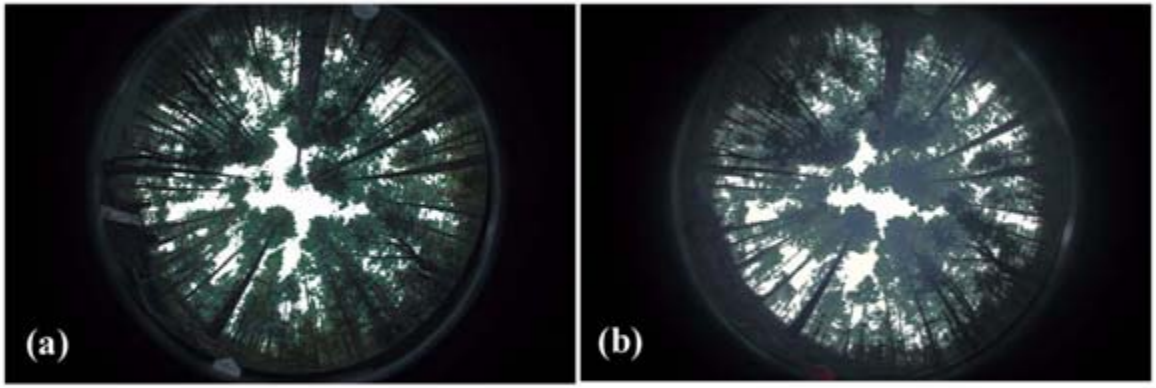



**Figure 3-28.** Hemispherical images (a) pre-harvest, and (b) post-harvest, are used to determine the amount of total shade, total canopy, and total incoming solar radiation.

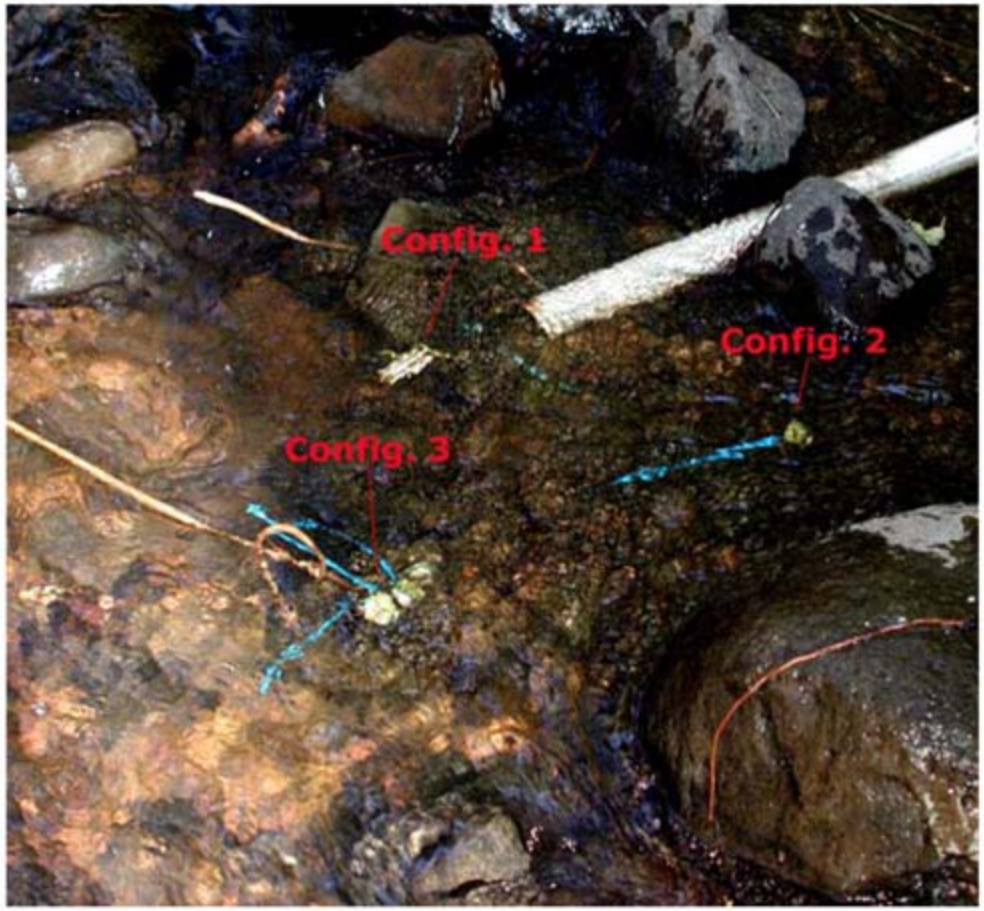
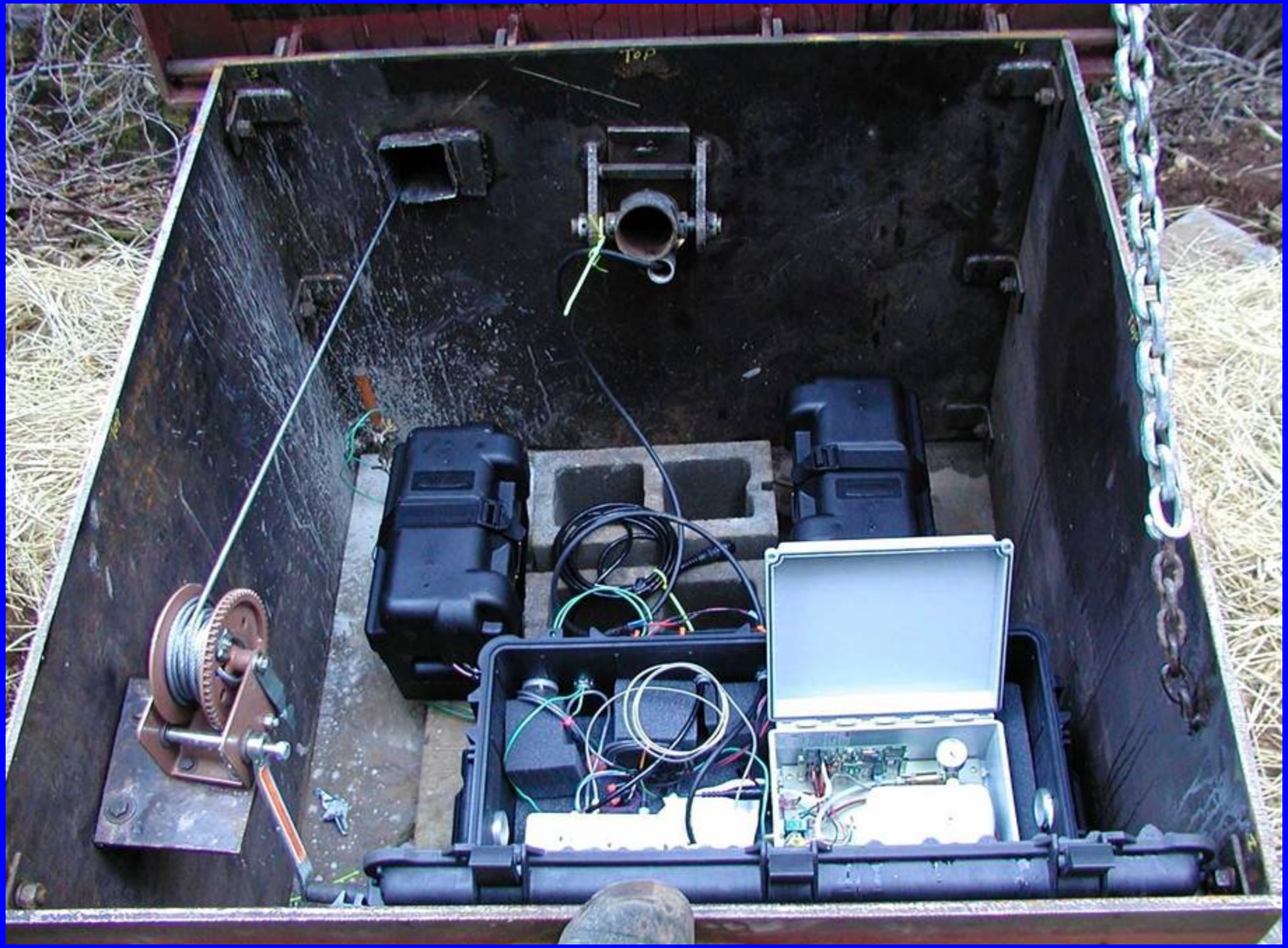
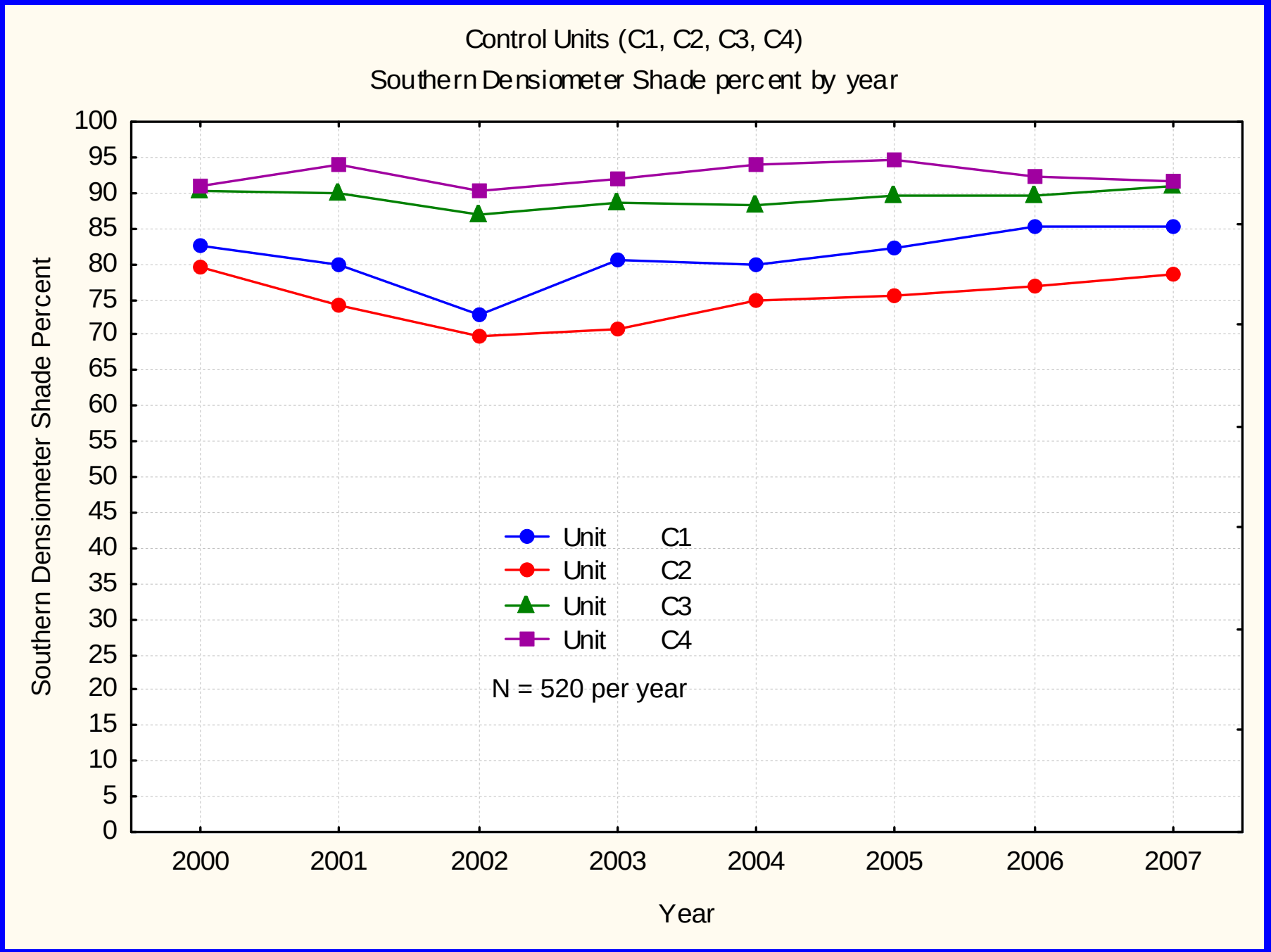


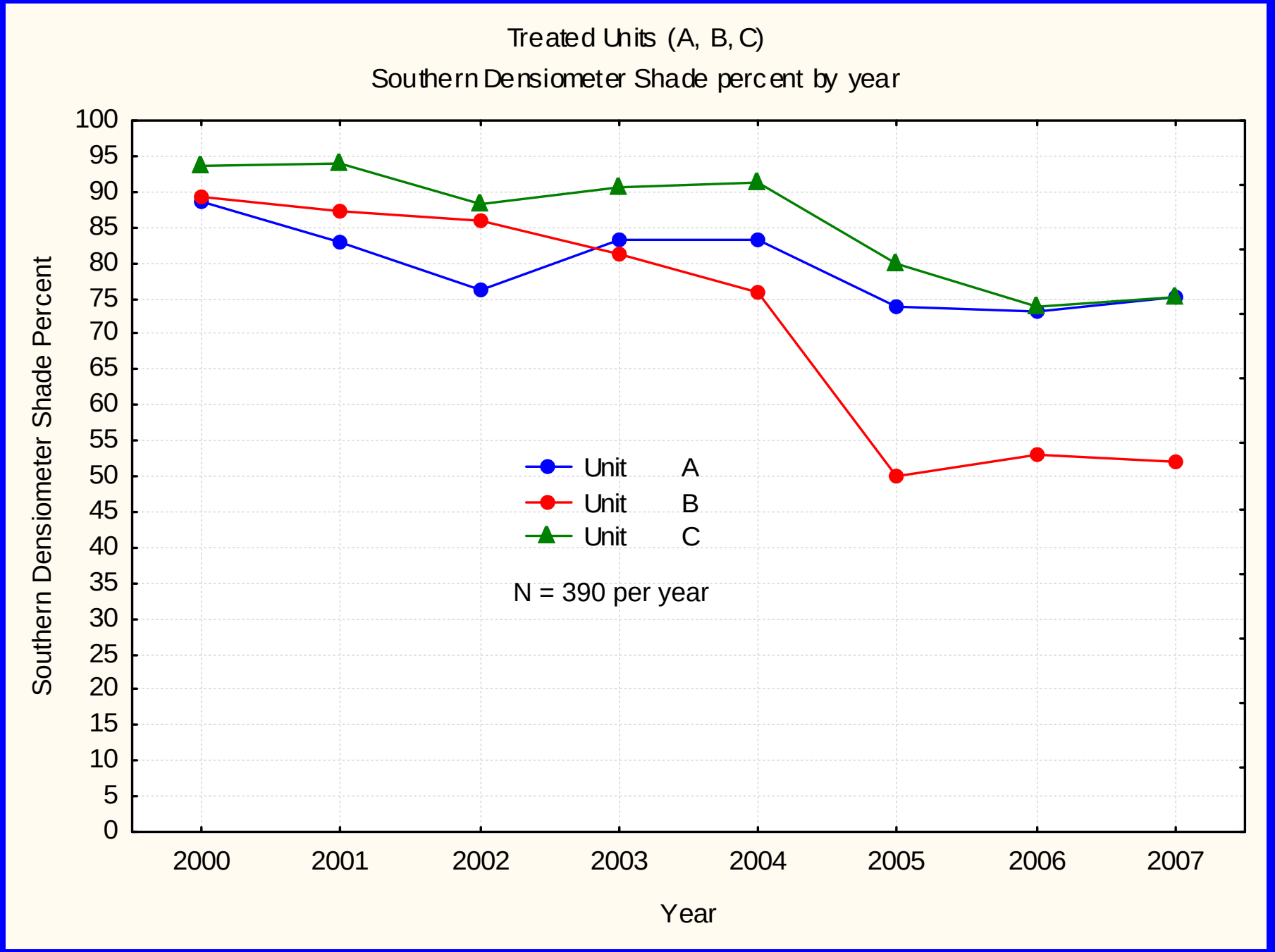

**Figure 3-19.** Three configurations of water temperature sensors used on the Southern Exposure Research Project.

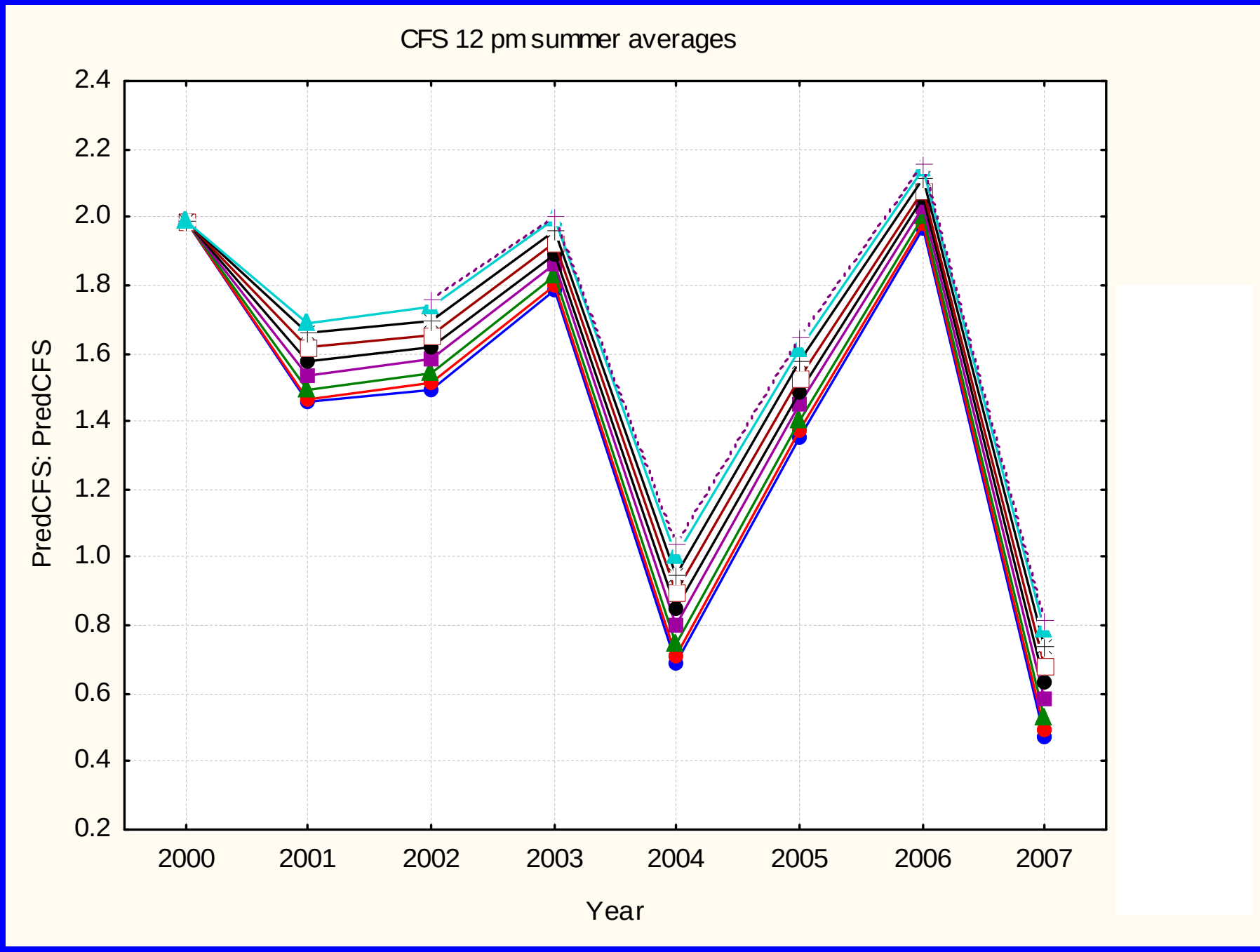
# YSI Water Quality Sonde

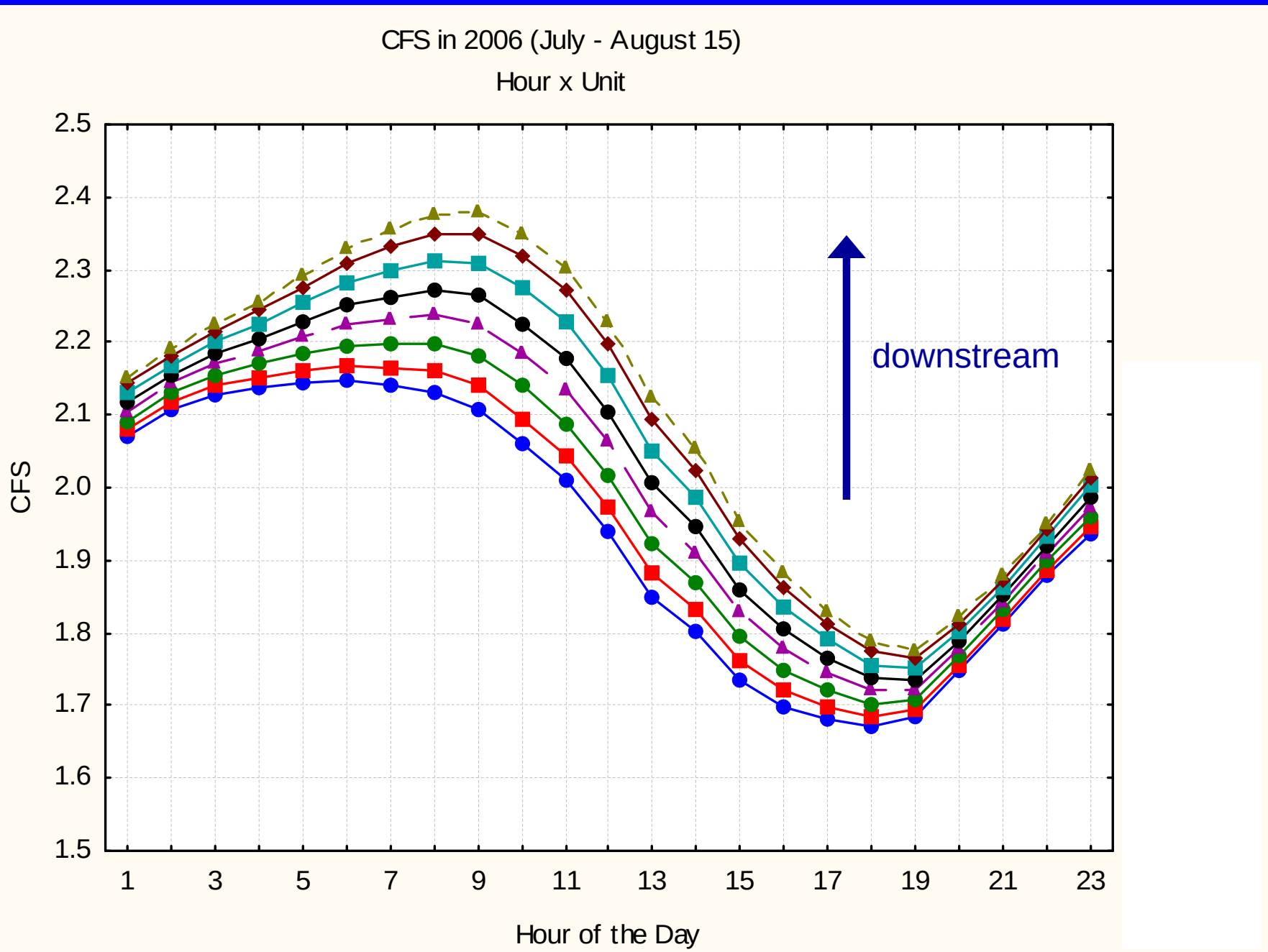

Top

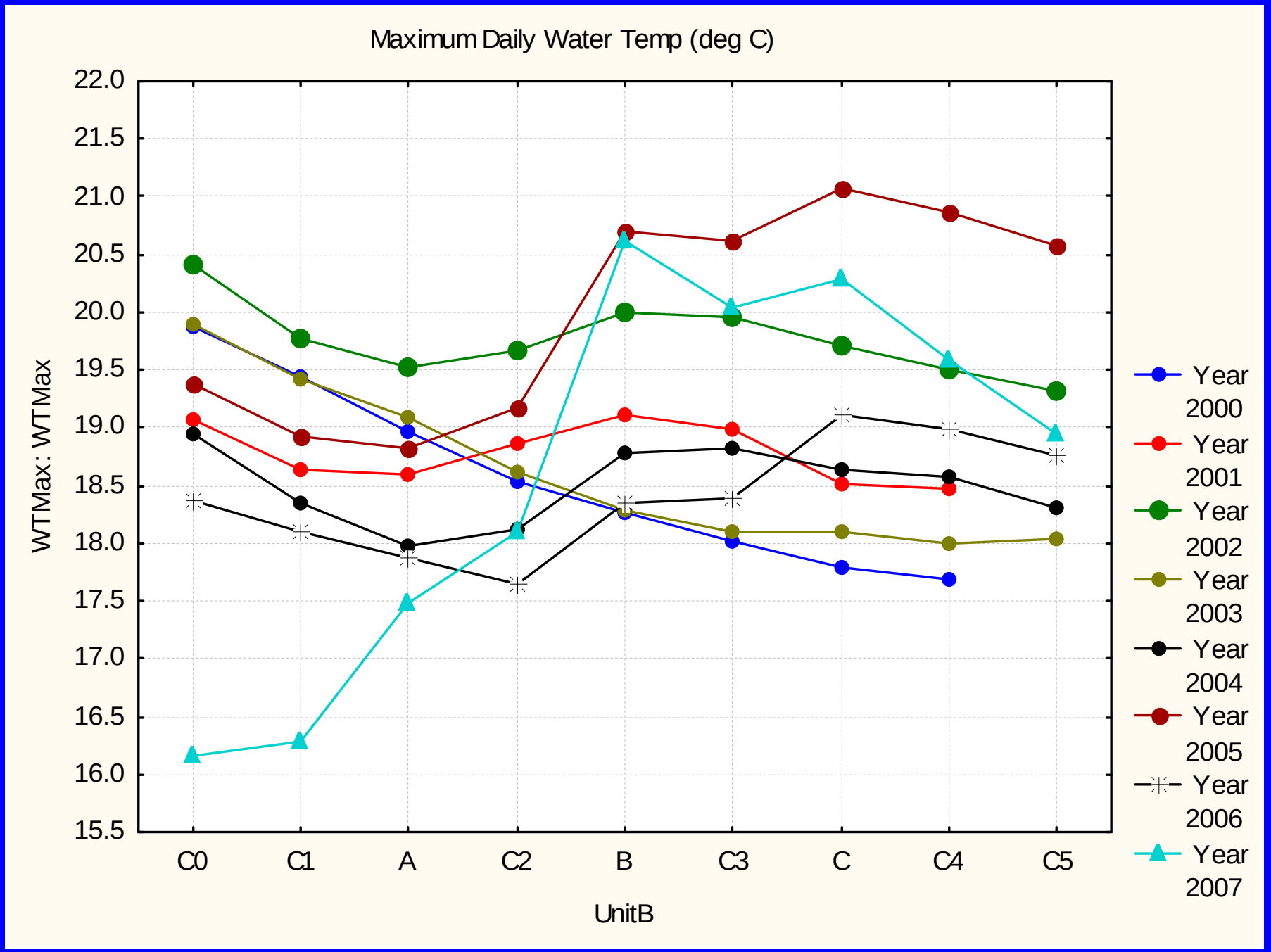

3,0
2,0

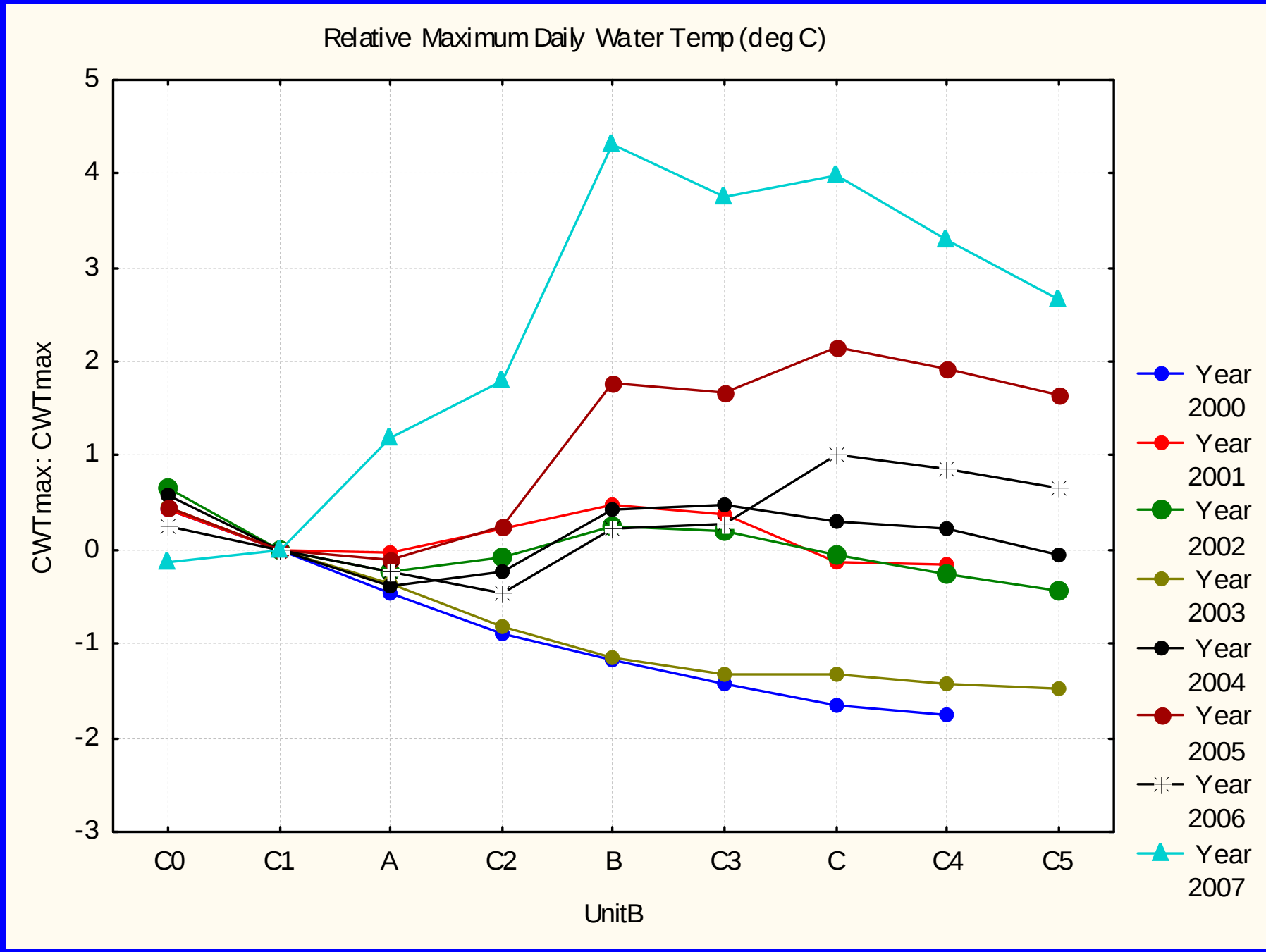

Control Units (C1, C2, C3, C4)
Southern Densiometer Shade percent by year
Southern Densiometer Shade Percent
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2000
2001
2002
2003
2004
2005
2006
2007
Year
Unit C1
Unit C2
Unit C3
Unit C4
N = 520 per year

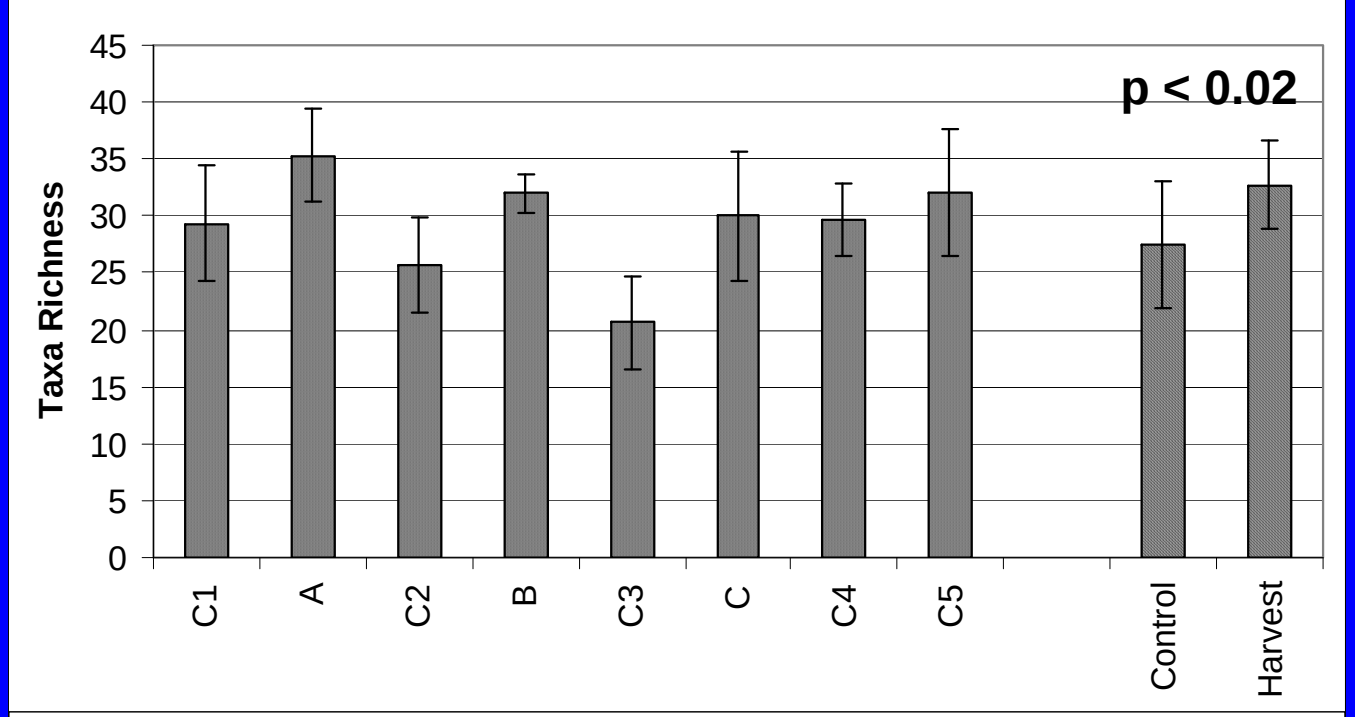

Treated Units (A, B, C)
Southern Densiometer Shade percent by year
Southern Densiometer Shade Percent
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2000
2001
2002
2003
2004
2005
2006
2007
Year
Unit A
Unit B
Unit C
N = 390 per year

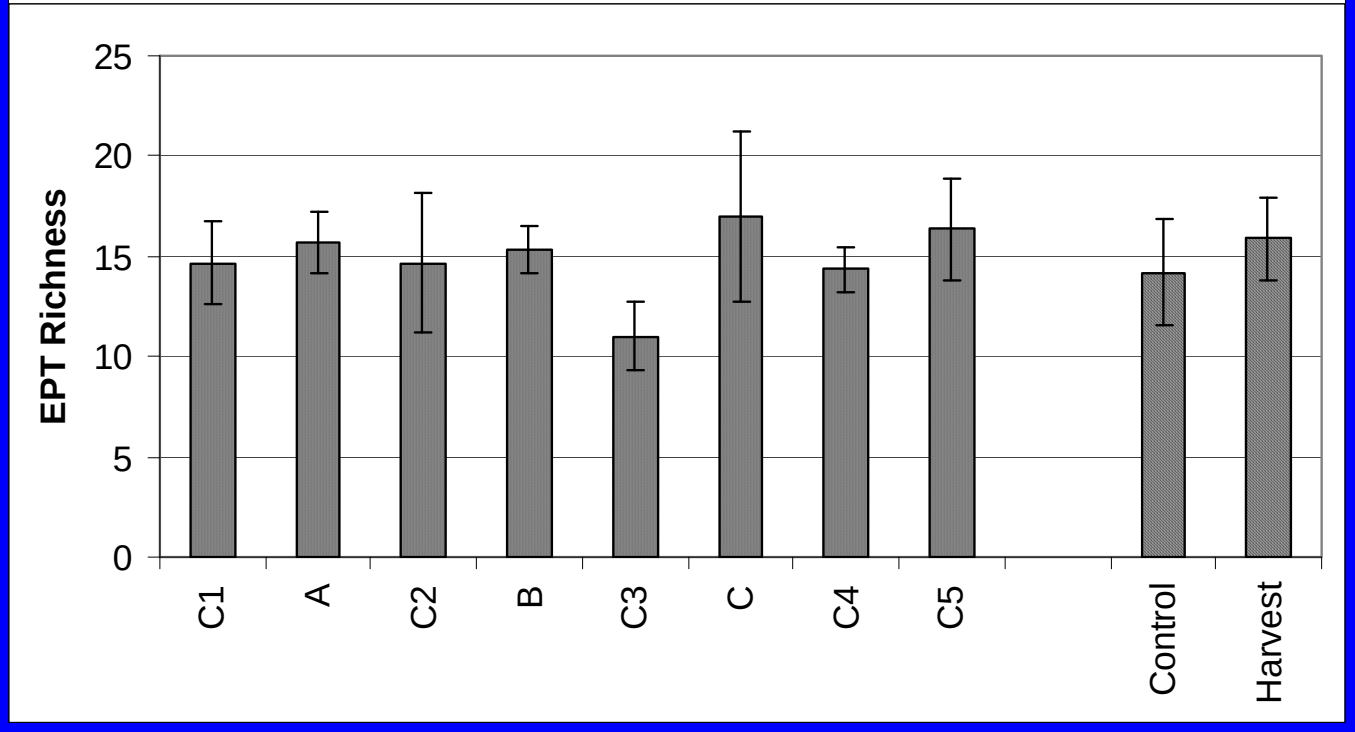

CFS 12 pm summer averages
PredCFS: PredCFS
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
2000
2001
2002
2003
2004
2005
2006
2007
Year

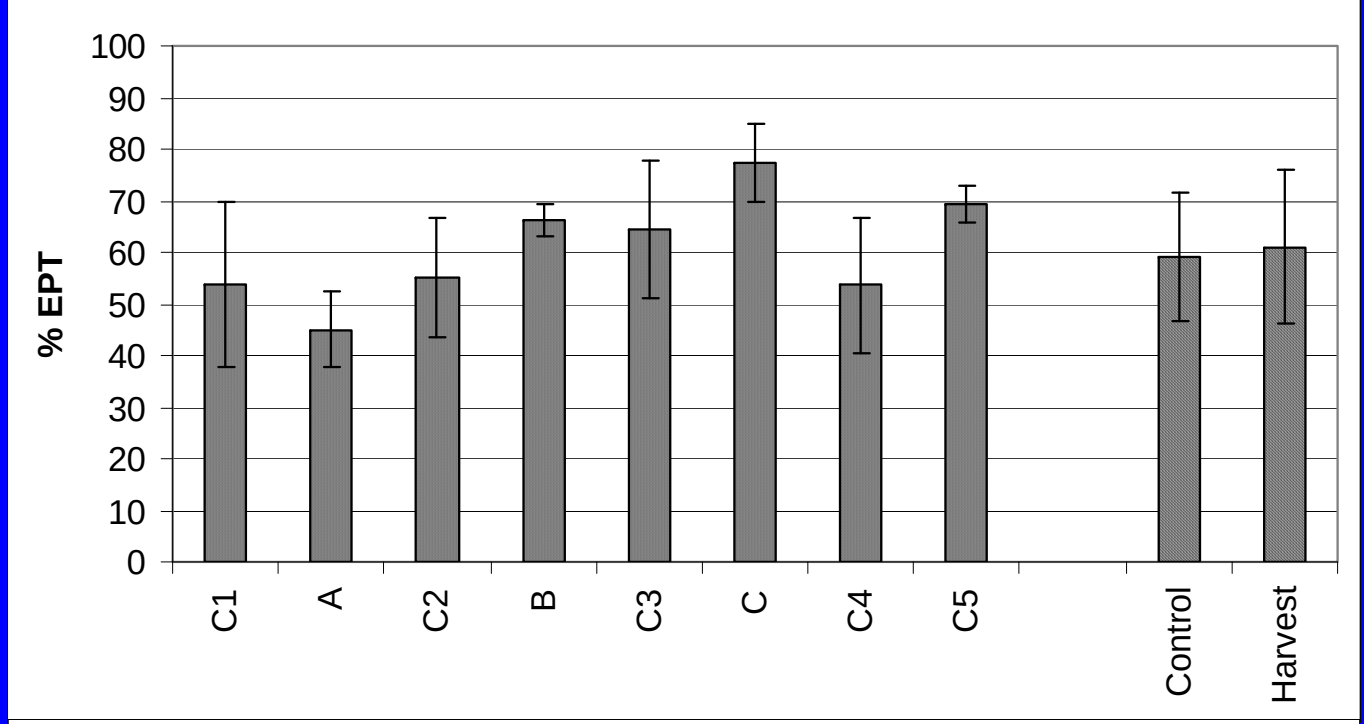

CFS in 2006 (July - August 15)
Hour x Unit
CFS
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1
3
5
7
9
11
13
15
17
19
21
23
Hour of the Day
downstream

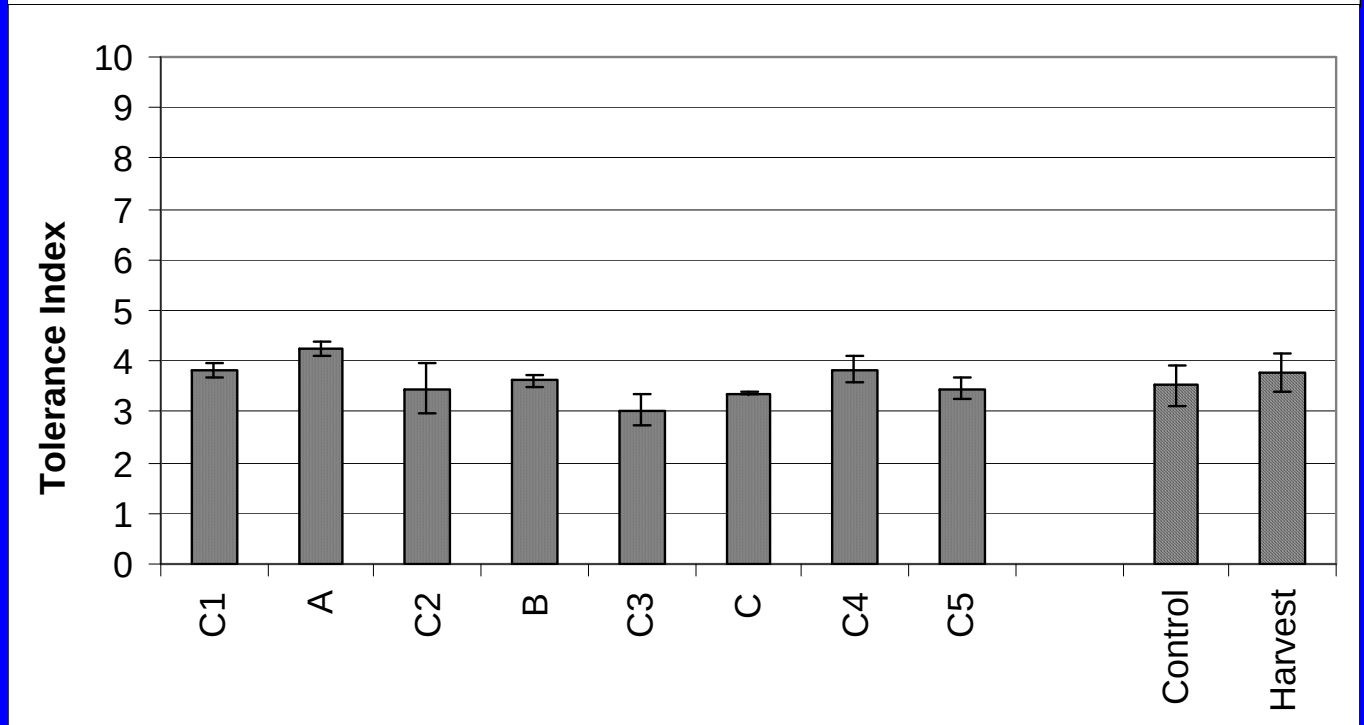

Maximum Daily Water Temp (deg C)
WTMax: WTMax
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
C0
C1
A
C2
B
C3
C
C4
C5
UnitB
Year 2000
Year 2001
Year 2002
Year 2003
Year 2004
Year 2005
Year 2006
Year 2007

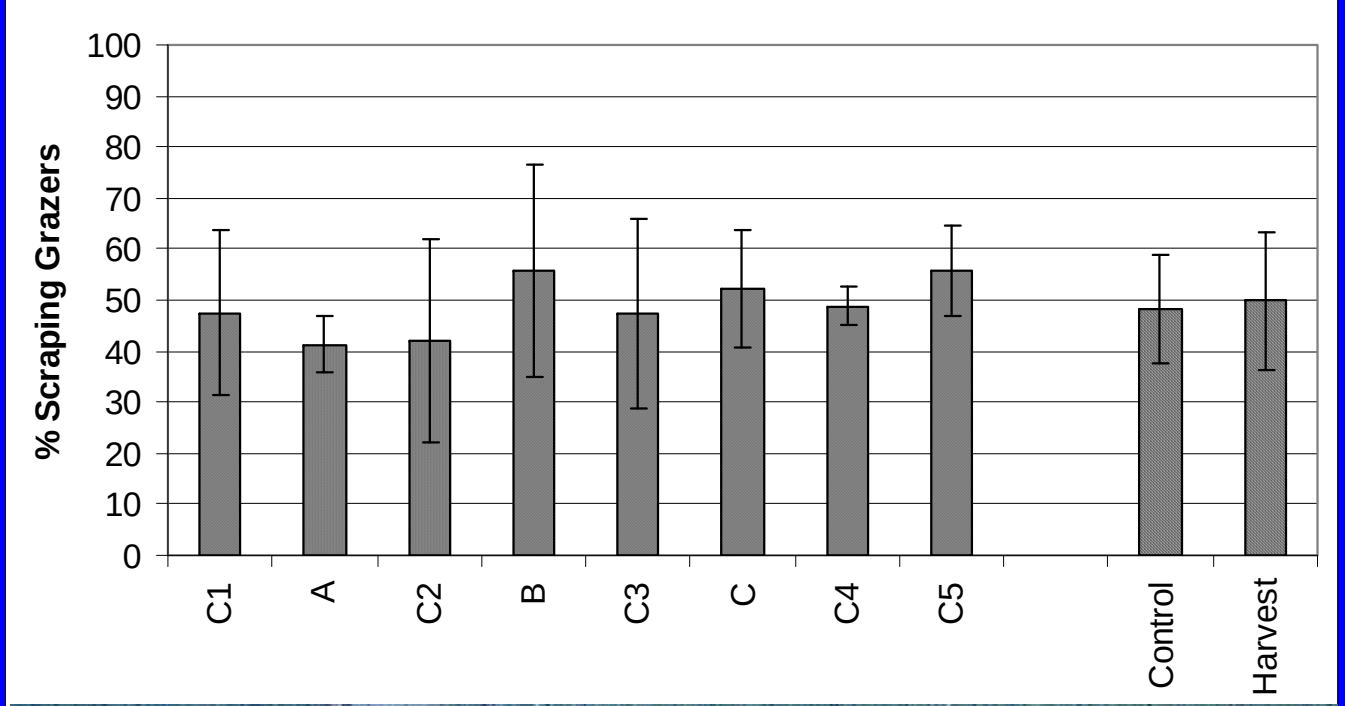

Relative Maximum Daily Water Temp (deg C)
CWTmax: CWTmax
5
4
3
2
1
0
-1
-2
-3
C0
C1
A
C2
B
C3
C
C4
C5
UnitB
Year 2000
Year 2001
Year 2002
Year 2003
Year 2004
Year 2005
Year 2006
Year 2007

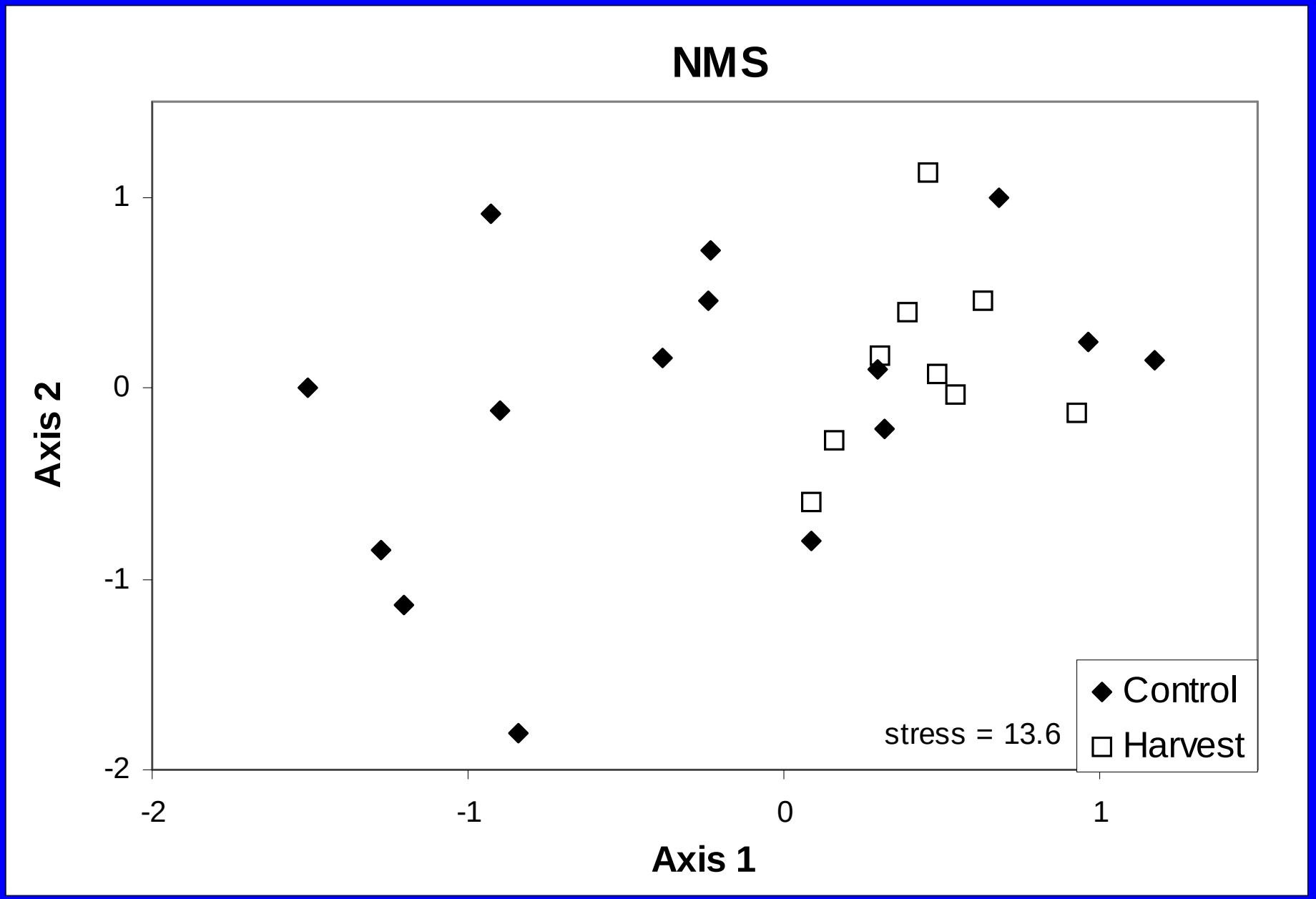

Taxa Richness
45
40
35
30
25
20
15
10
5
0
p < 0.02
C1
A
C2
B
C3
C
C4
C5
Control
Harvest

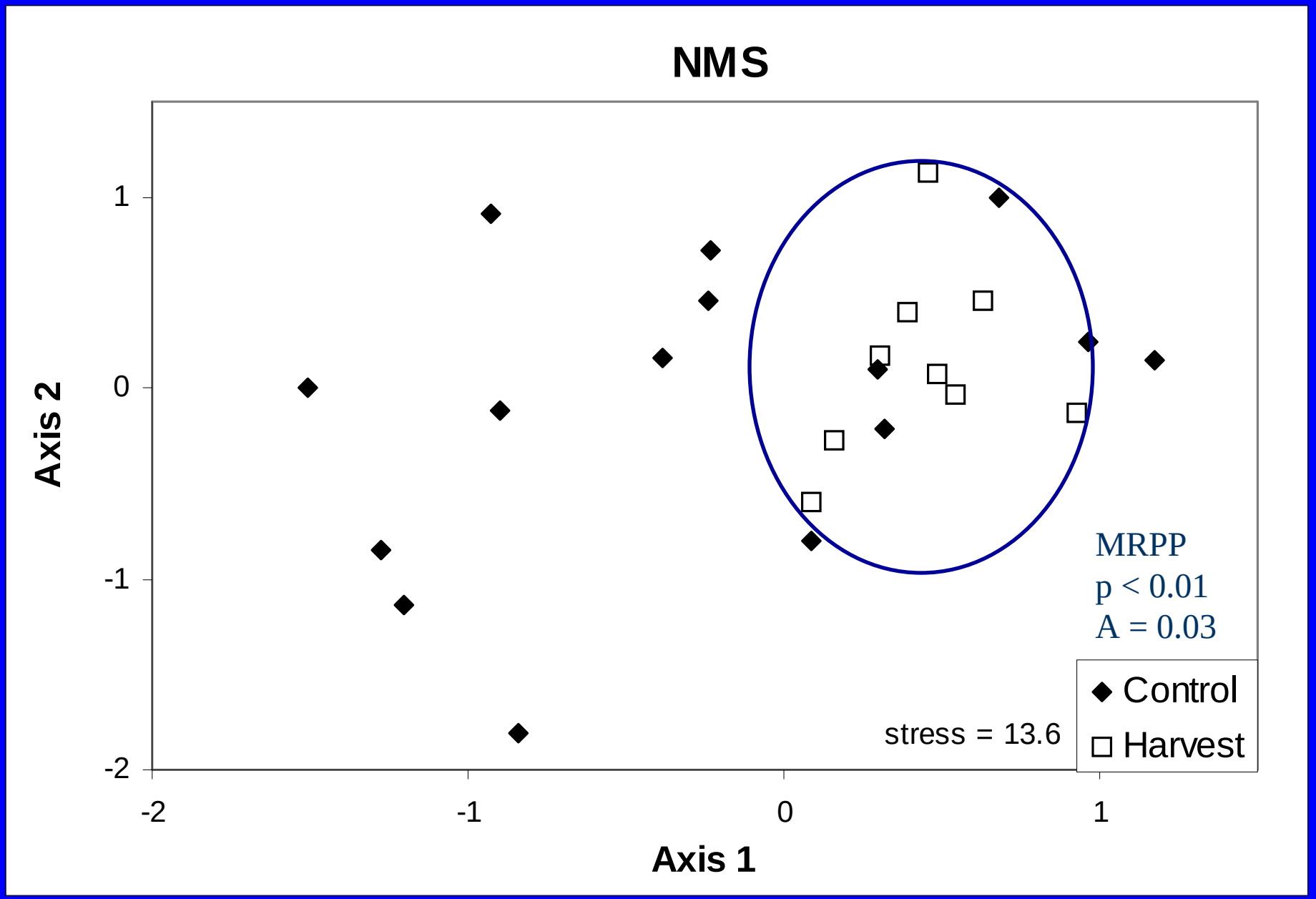

EPT Richness
25
20
15
10
5
0
C1
A
C2
B
C3
C
C4
C5
Control
Harvest


% EPT
100
90
80
70
60
50
40
30
20
10
0
C1
A
C2
B
C3
C
C4
C5
Control
Harvest


Tolerance Index
10
9
8
7
6
5
4
3
2
1
0
C1
A
C2
B
C3
C
C4
C5
Control
Harvest


% Scraping Grazers
100
90
80
70
60
50
40
30
20
10
0
C1
A
C2
B
C3
C
C4
C5
Control
Harvest

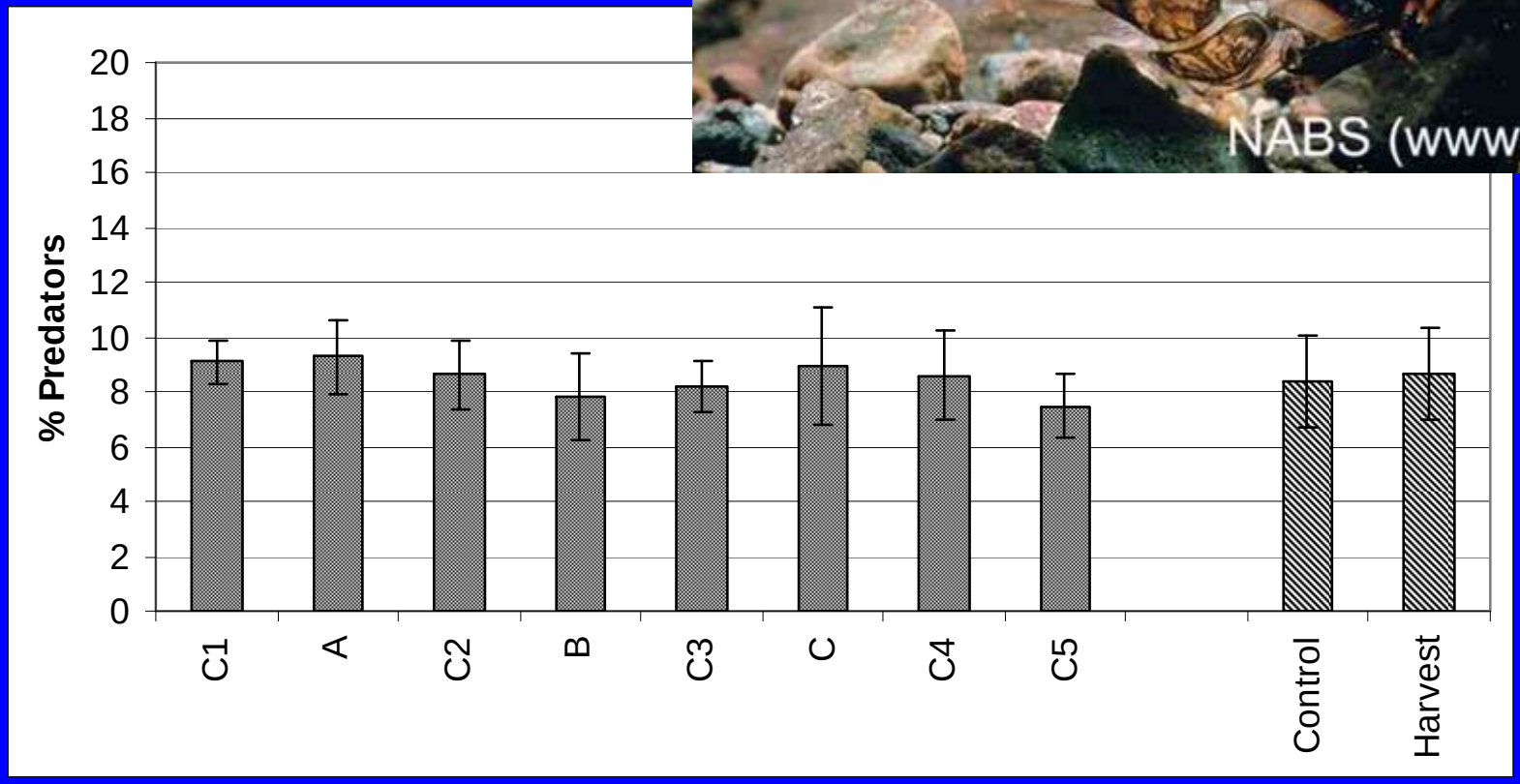

NMS
Axis 2
Axis 1
1
0
-1
-2
-2
-1
0
1
stress = 13.6
Control
Harvest


NMS
Axis 2
Axis 1
1
0
-1
-2
-2
-1
0
1
MRPP
p < 0.01
A = 0.03
stress = 13.6
Control
Harvest

# Indicator Species Analysis
PC-ORD

| Family | p < | I.V. |
|---|---|---|
| – *Corydalidae* *(Neohermes)* | 0.005 | 73.7 |
| – *Gomphidae* *(Gomphus)* | 0.013 | 68.5 |
| – *Simuliidae* *(Simulium)* | 0.015 | 71.6 |
| – *Elmidae* *(Ampumixis)* | 0.023 | 59.3 |
| – *Aeschnidae* *(Aeschna)* | 0.040 | 33.3 |
| – *Calamoceratidae* *(Heteroplectron)* | 0.047 | 49.0 |
| – *Perlidae* *(Hesperoperla)* | 0.060 | 47.1 |


Photo by Larry Serpa



# Conclusions

- Temperature showed a cumulative downstream effect post-harvest
- BMI techniques and metrics did not identify a clear-cut response at the current level of treatment
- Multivariate analyses identified species-assemblage differences between treatments – no longitudinal pattern
- Predators and sensitive species associated with harvested reaches may result from response to thriving riparian hardwoods after thinning

# Acknowledgements


- Sierra Pacific Industries Forest Research Lab

- California Board of Forestry Monitoring Study Group

- Lytle Lab at Oregon State University