How the lateral redistribution of soil moisture within a humid, temperate watershed affects carbon cycling

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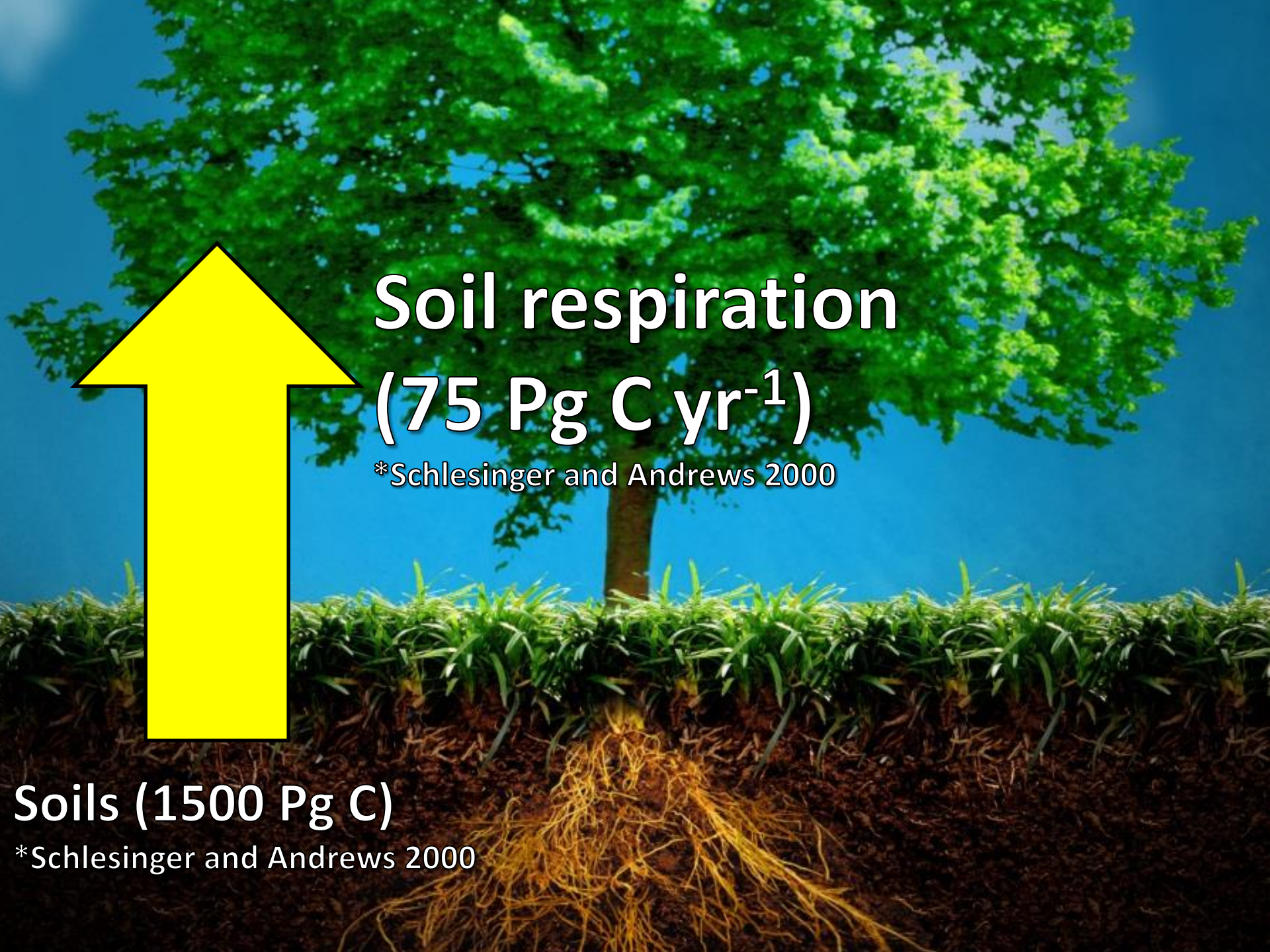
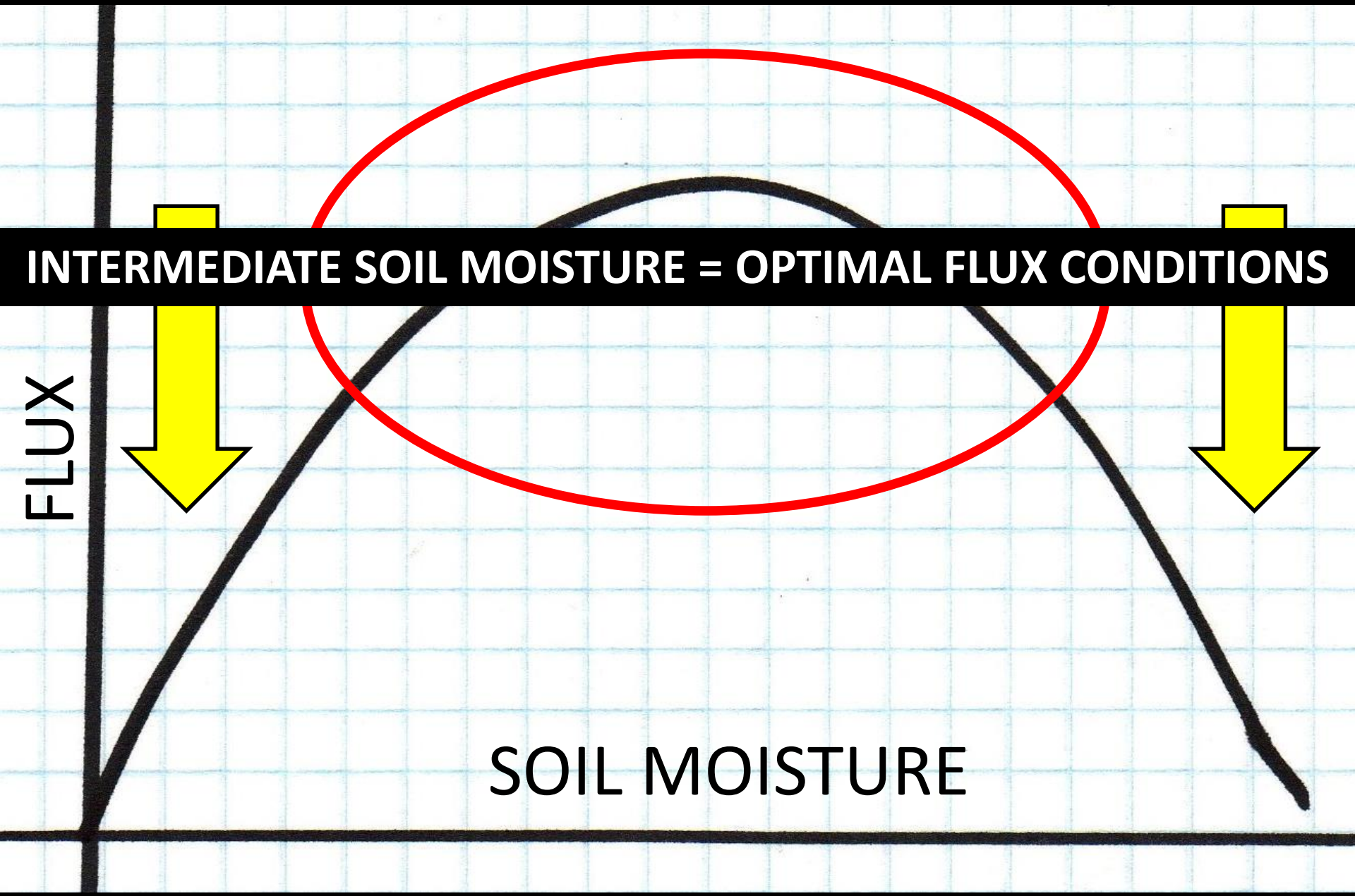

Soil respiration
(75 Pg C yr-1)
*Schlesinger and Andrews 2000
Soils (1500 Pg C)
*Schlesinger and Andrews 2000

Soil CO_2 Efflux

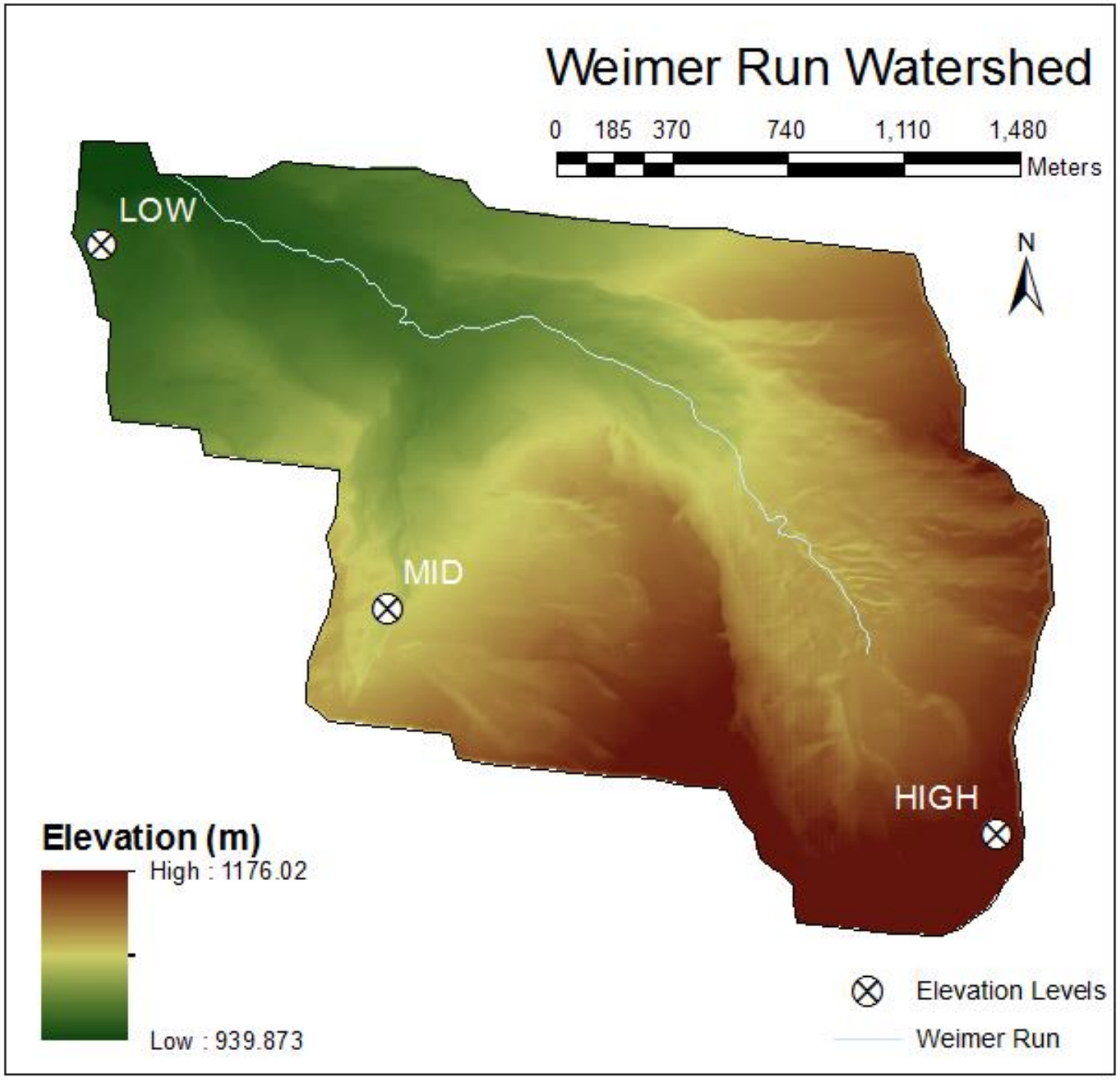
- The instantaneous measurement of CO_2 leaving the soil surface
- Approximately equivalent to soil respiration at long-time scales
- Is a function of both transport and production


INTERMEDIATE SOIL MOISTURE = OPTIMAL FLUX CONDITIONS
FLUX
SOIL MOISTURE

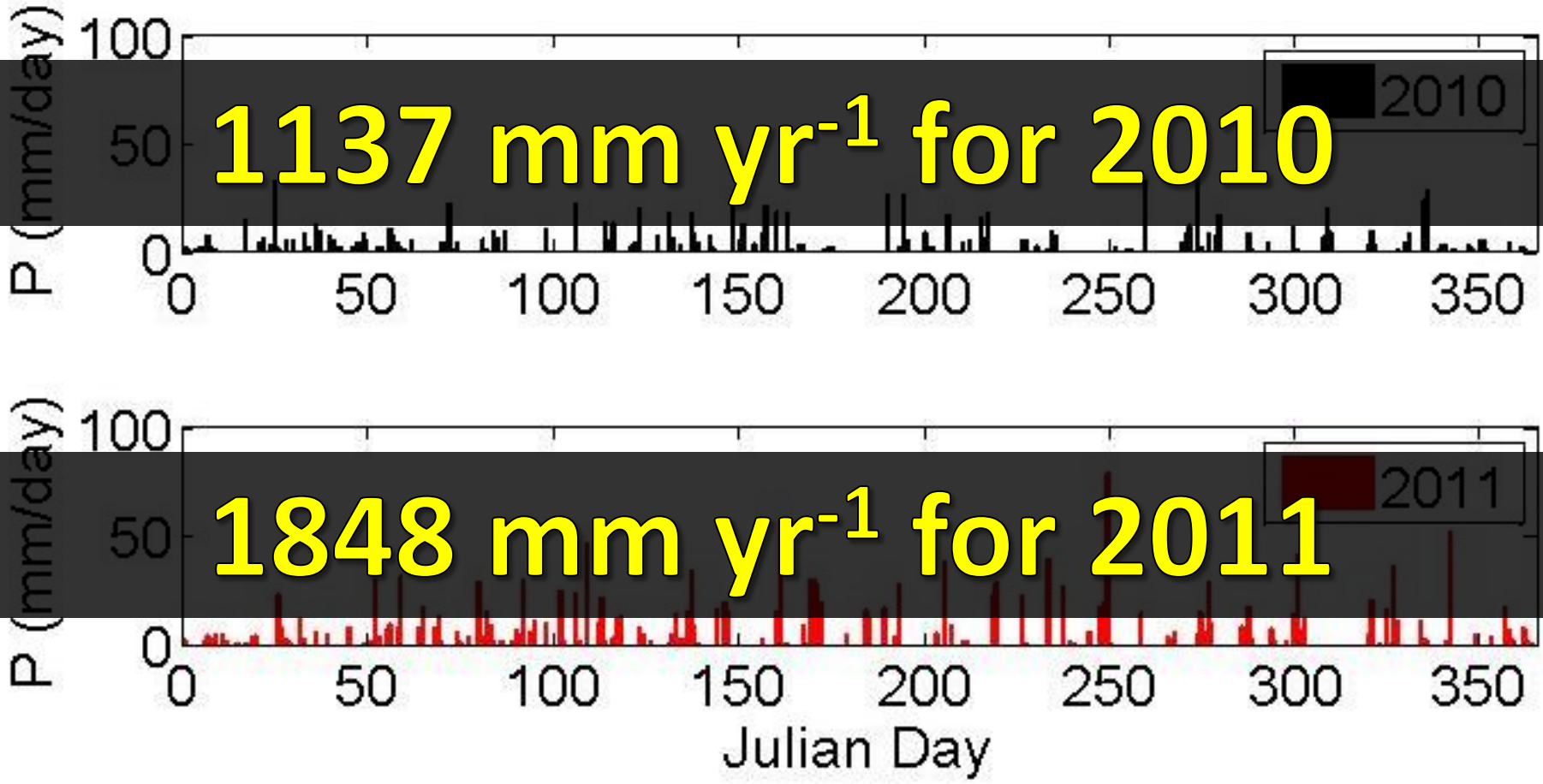

Pittsburgh
OHIO
Mt Vernon
Steubenville
Coshocton
Bethel Park
McKeesport
Johnstown
Huntingdon
Newark
Wheeling
Washington
Connellsville
Gahanna
Cambridge
Zanesville
Waynesburg
Somerset
Chambersburg
Mt Davis
Lancaster
Moundsville
Uniontown
New Martinsville
Morgantown
Frostburg
Cumberland
Fairmont
Marietta
Grafton
Martinsburg
Keyser
Chillicothe
Athens
Parkersburg
Clarksburg
Backbone Mtn
Charles Town
Leesburg
Winchester
Jackson
Weston
Buckhannon
Point Pleasant
Elkins
Front Royal
Gallipolis
Spencer
Spruce Knob
WEST
VIRGINIA
Warrenton
Ironton
Harrisonburg
Ashland
St Albans
Huntington
Charleston
Monterey
Culpeper
Staunton
Charlottesville
Waynesboro
Logan
Lewisburg
Clifton Forge
Beckley
Lexington
Covington
Buena Vista
Williamson
Hinton
Dillwyn
Pikeville
Welch
Princeton
Lynchburg
Farmville

Weimer Run Watershed

Elevation 940 - 1176 m
MAT = 8° C
MAP = 1410 mm yr^{-1}
Growing season = 90 – 100 days
Watershed area = 373 ha
Mixed hardwood-evergreen overstory

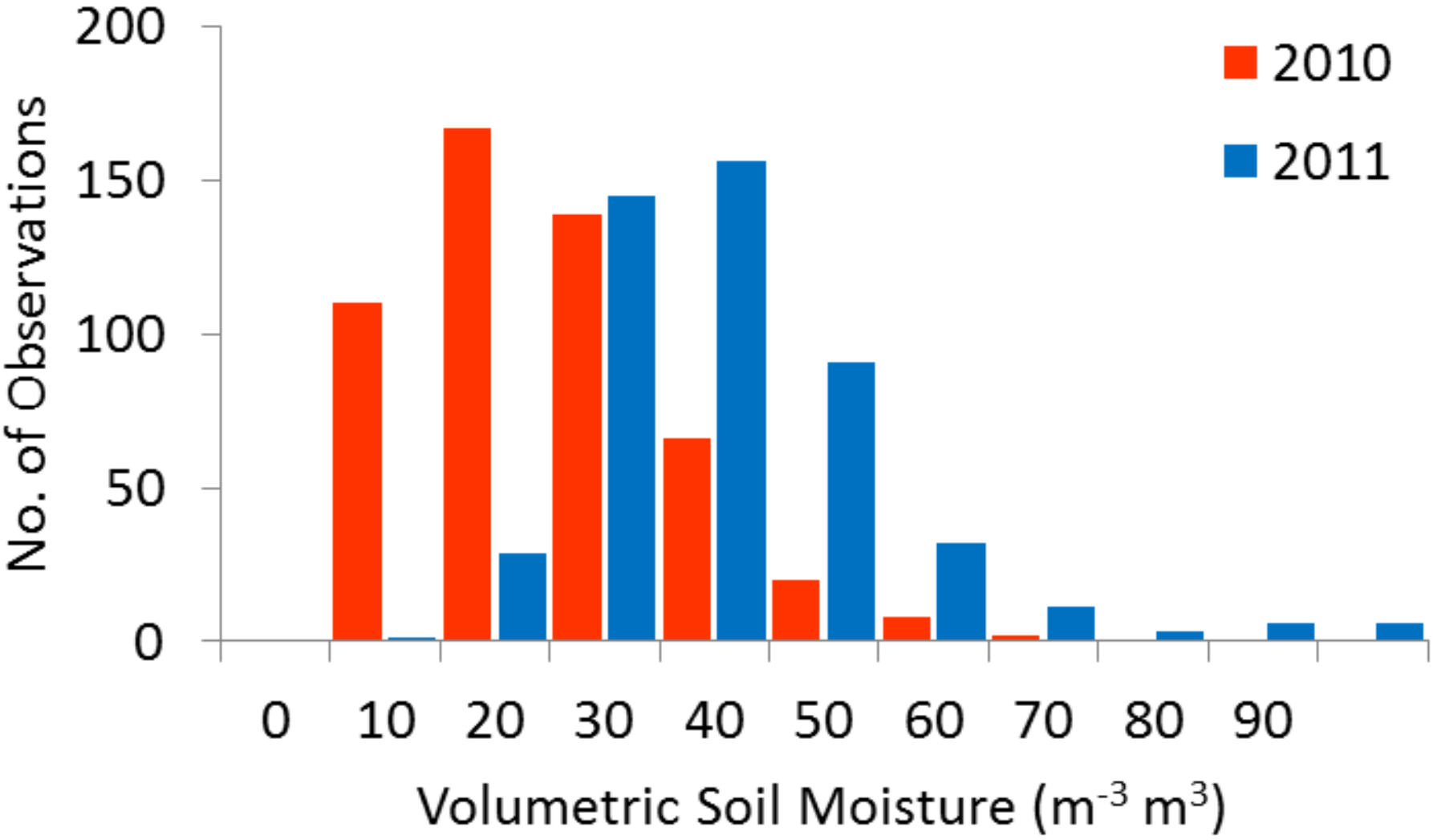

Weimer Run Watershed
0 185 370 740 1,110 1,480
Meters
N
LOW
MID
HIGH
Elevation (m)
High : 1176.02
Low : 939.873
Elevation Levels
Weimer Run

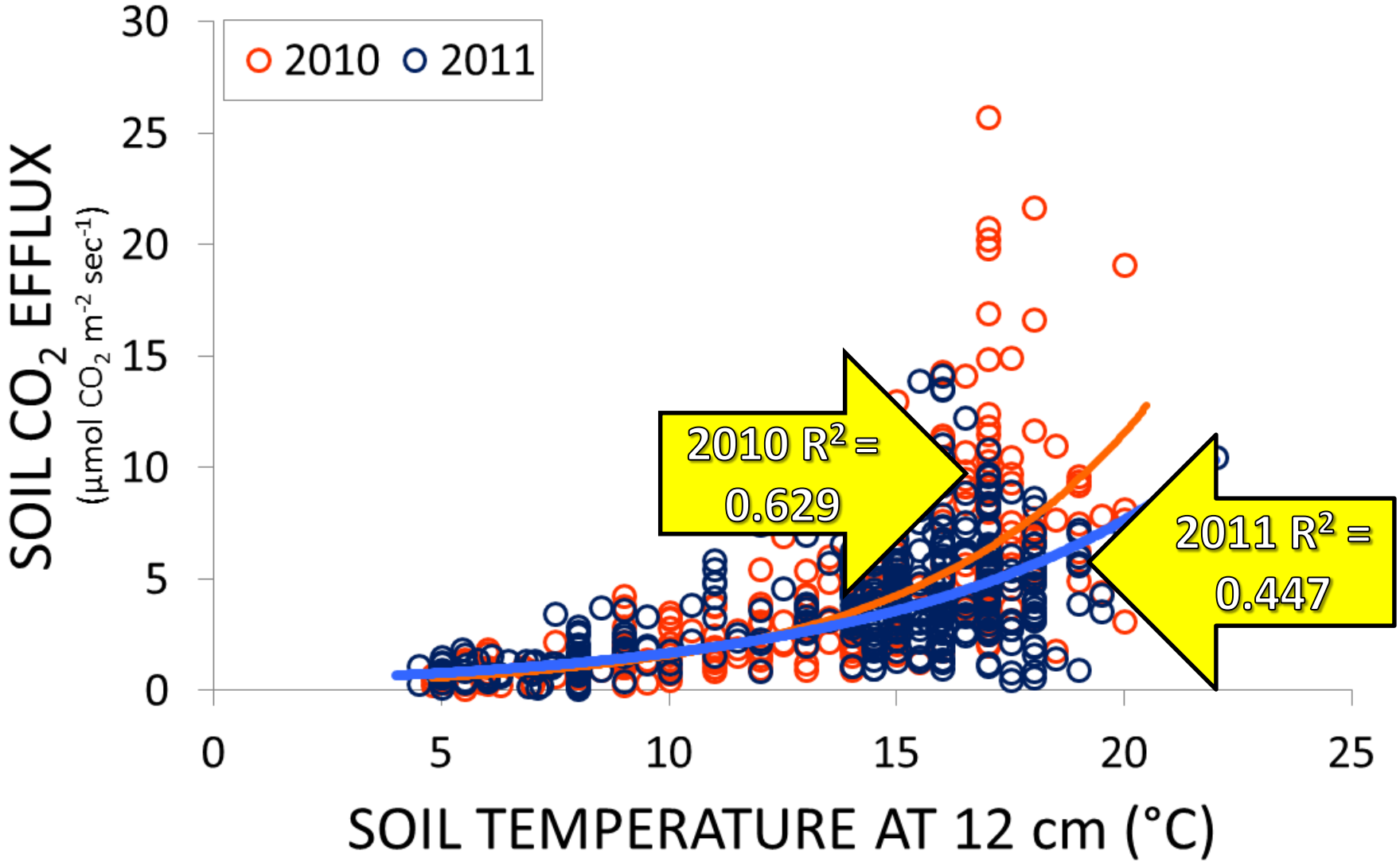

OPEN
SHRUB
CLOSED

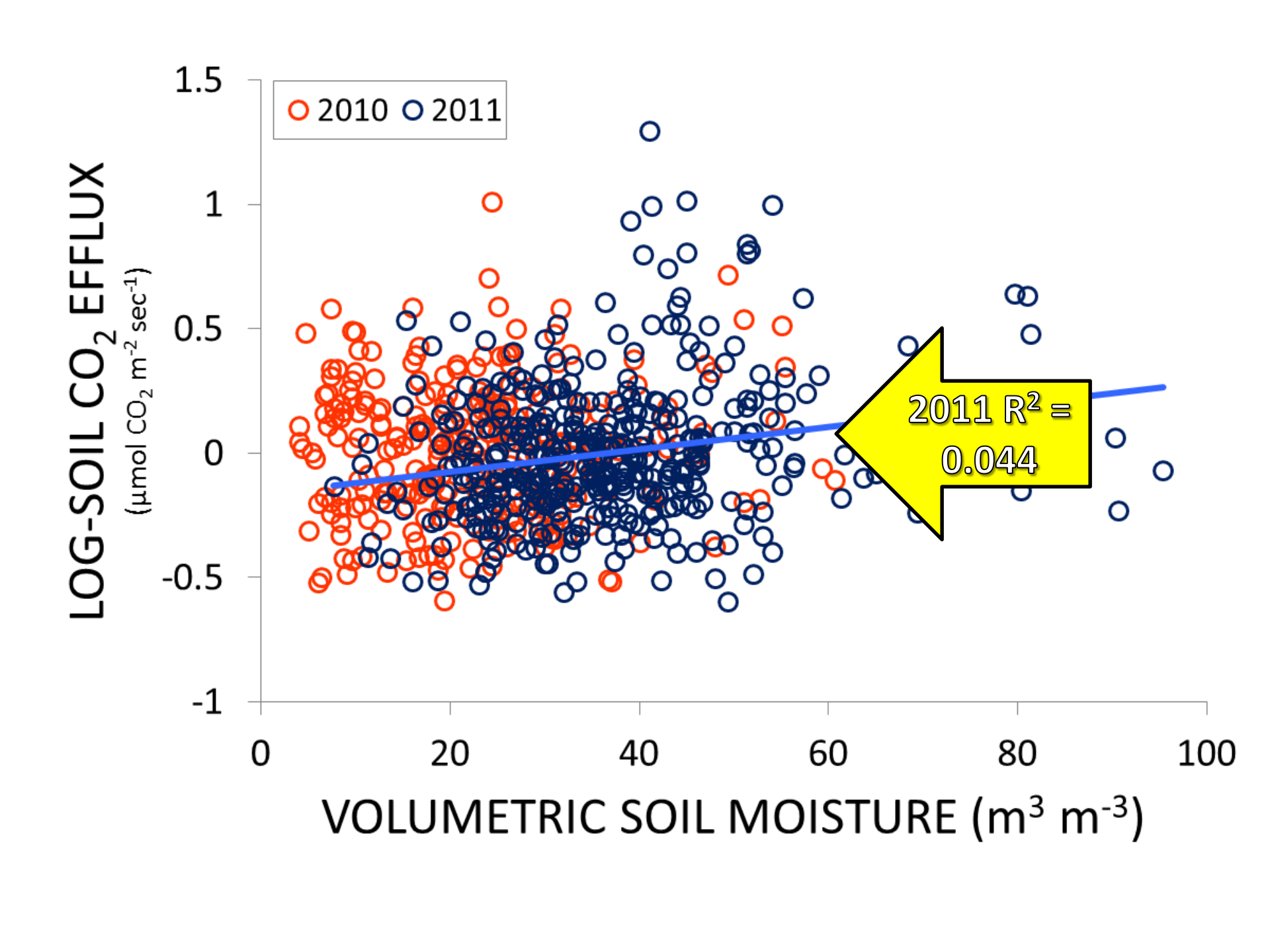


1137 mm yr^{-1} for 2010

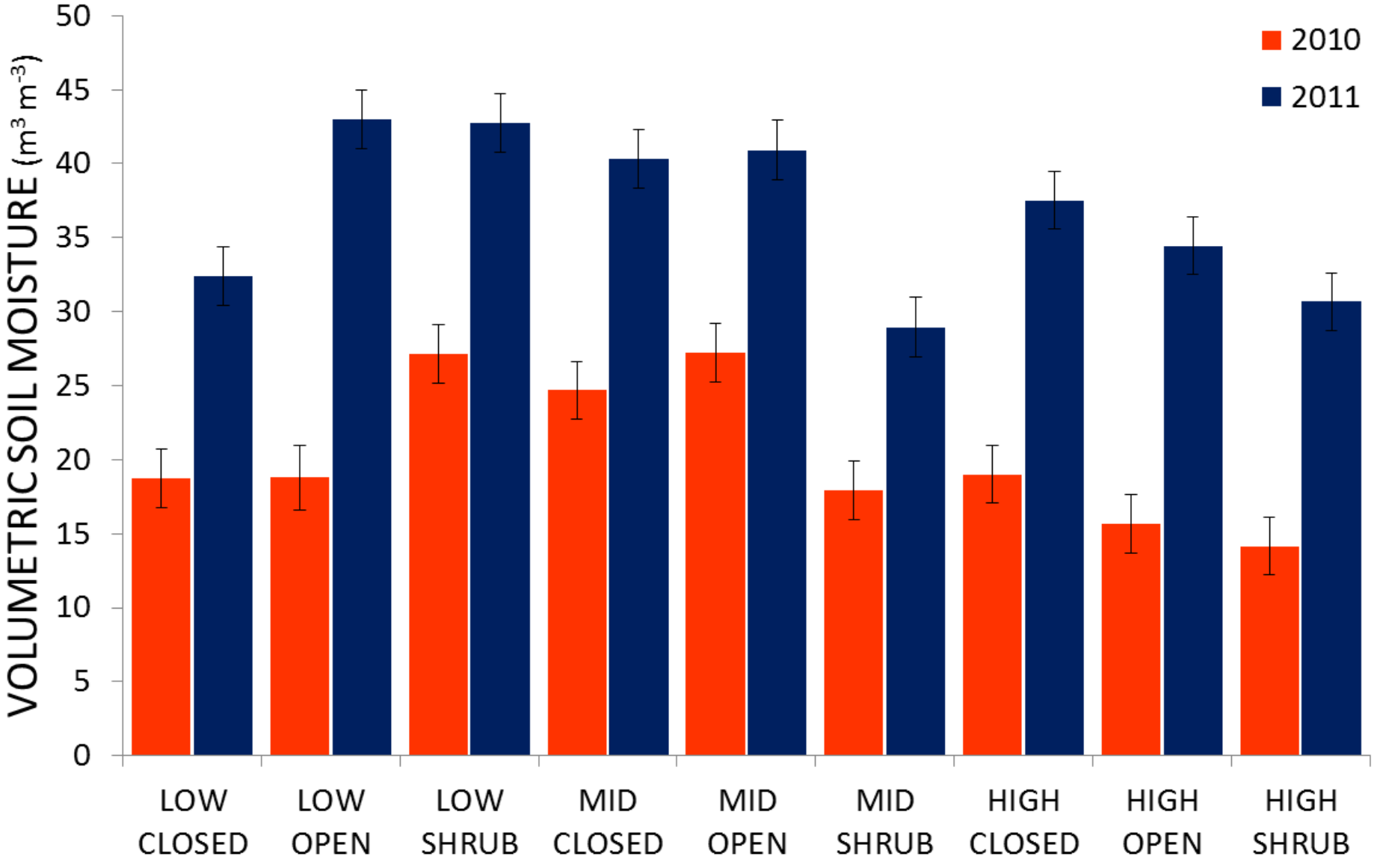
1848 mm yr^{-1} for 2011

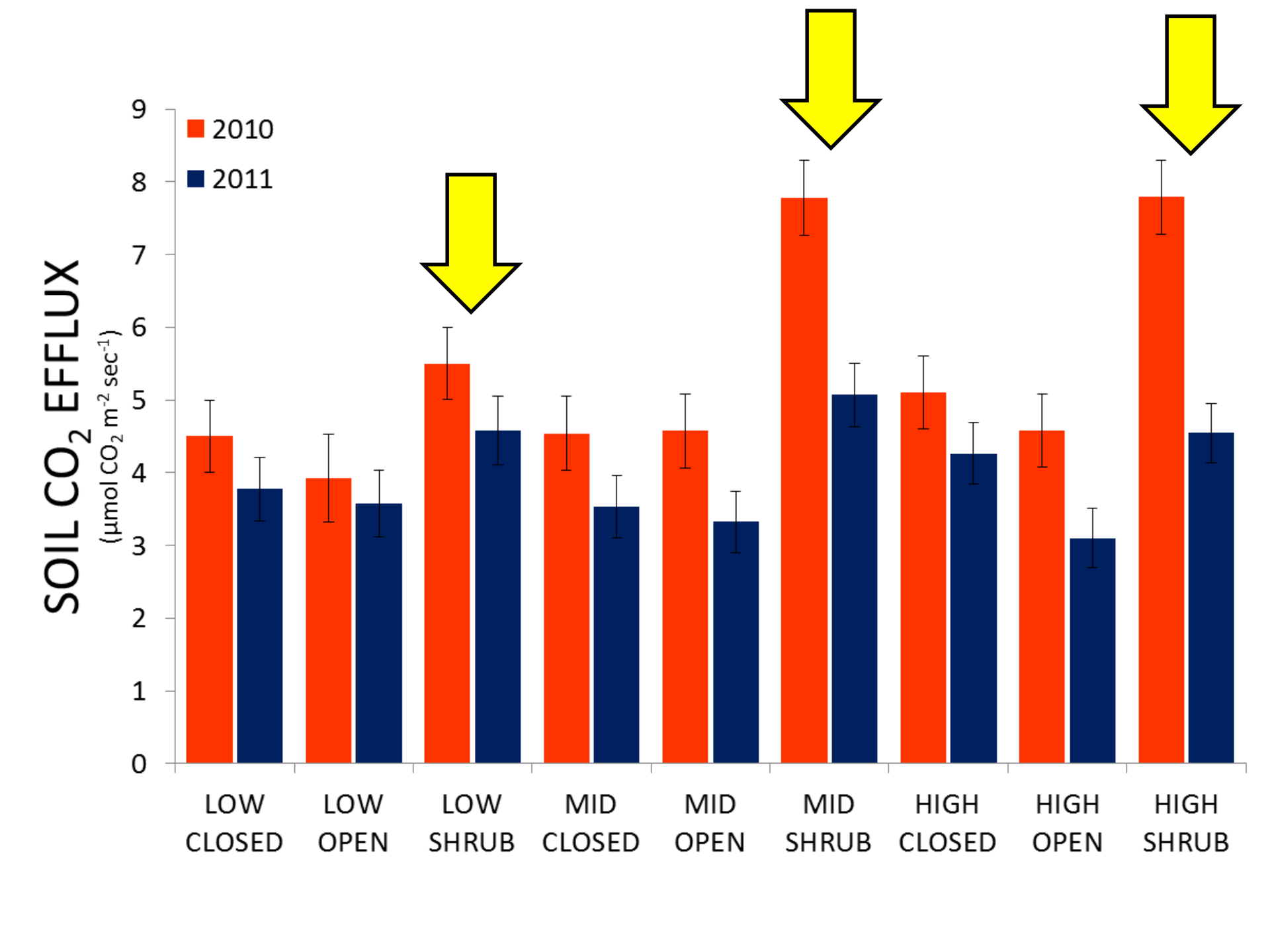

200
150
100
50
0
No. of Observations
2010
2011
0
10
20
30
40
50
60
70
80
90
Volumetric Soil Moisture (m-3 m3)


2010
2011
SOIL CO_2 EFFLUX
(µmol CO_2 m^{-2} sec^{-1})
30
25
20
15
10
5
0
0
5
10
15
20
25
SOIL TEMPERATURE AT 12 cm (°C)
2010 R^2 = 0.629
2011 R^2 = 0.447


2010
2011
1.5
1
0.5
0
-0.5
-1
0
20
40
60
80
100
LOG-SOIL CO_2 EFFLUX
(µmol CO_2 m^{-2} sec^{-1})
VOLUMETRIC SOIL MOISTURE (m^3 m^{-3})
2011 R^2 = 0.044

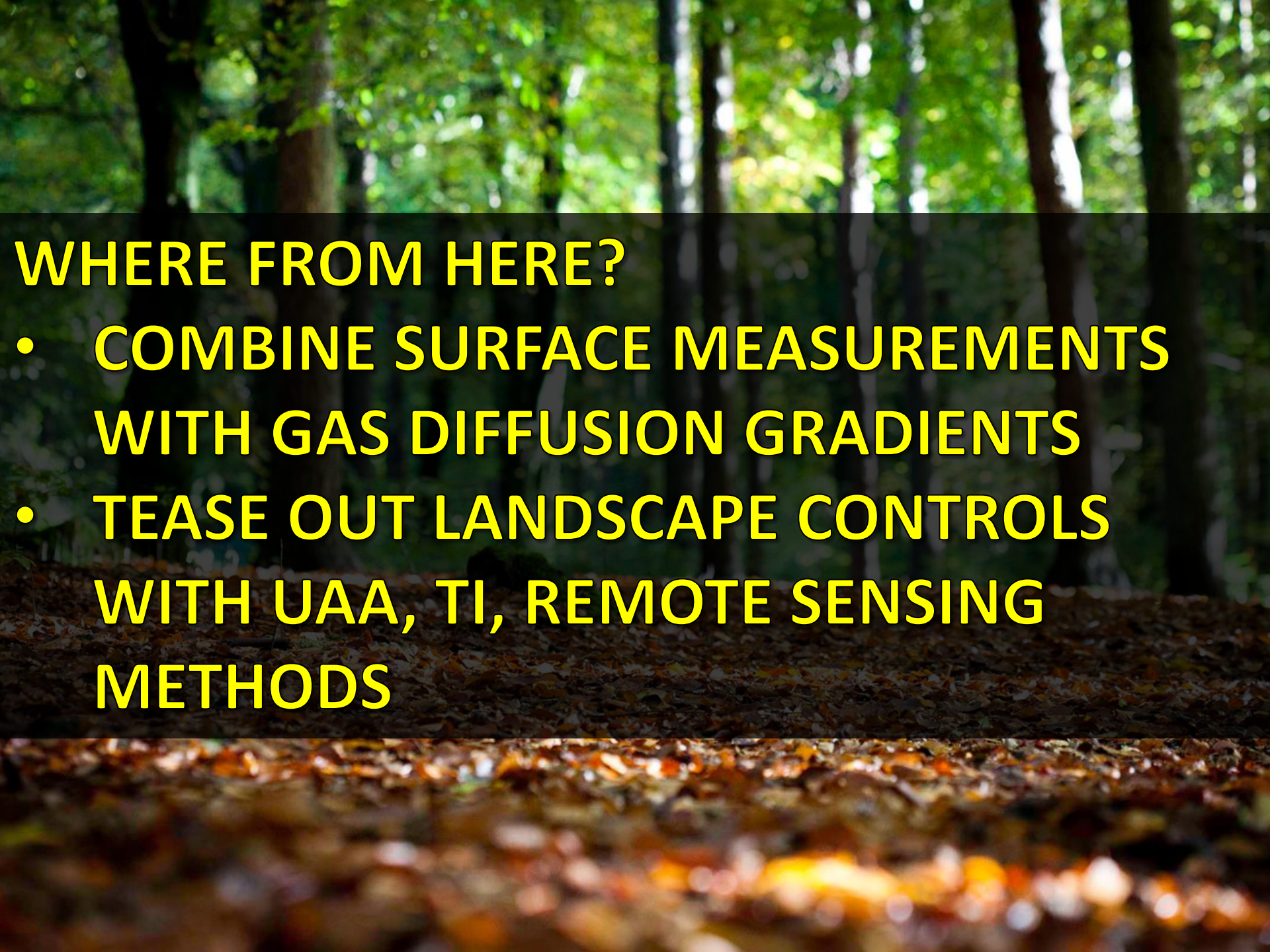
- Soil temperature primary driver both years
- For 2011 (wet year) – soil temperature explains less variance
- For 2011 (wet year) - soil moisture explains more variance


VOLUMETRIC SOIL MOISTURE (m^3 m^{-3})
50
45
40
35
30
25
20
15
10
5
0
2010
2011
LOW CLOSED
LOW OPEN
LOW SHRUB
MID CLOSED
MID OPEN
MID SHRUB
HIGH CLOSED
HIGH OPEN
HIGH SHRUB


SOIL CO_2 EFFLUX
(μmol CO_2 m^{-2} sec^{-1})
2010
2011
0
1
2
3
4
5
6
7
8
9
LOW CLOSED
LOW OPEN
LOW SHRUB
MID CLOSED
MID OPEN
MID SHRUB
HIGH CLOSED
HIGH OPEN
HIGH SHRUB

FROM 2010 TO 2011

- SOIL CO_2 EFFLUX DECREASED SIGNIFICANTLY AND DIFFERENTIALLY ACROSS THE WATERSHED
- LOW -16%, MID -40%, HIGH -46%
- OPEN -32%, CLOSED -22%, SHRUB -48%



WHERE FROM HERE?

- COMBINE SURFACE MEASUREMENTS WITH GAS DIFFUSION GRADIENTS
- TEASE OUT LANDSCAPE CONTROLS WITH UAA, TI, REMOTE SENSING METHODS

Shenandoah Watershed Study
&
Virginia Trout Stream Sensitivity Study

Appalachian Stewardship foundation

Environmental values leading our energy future

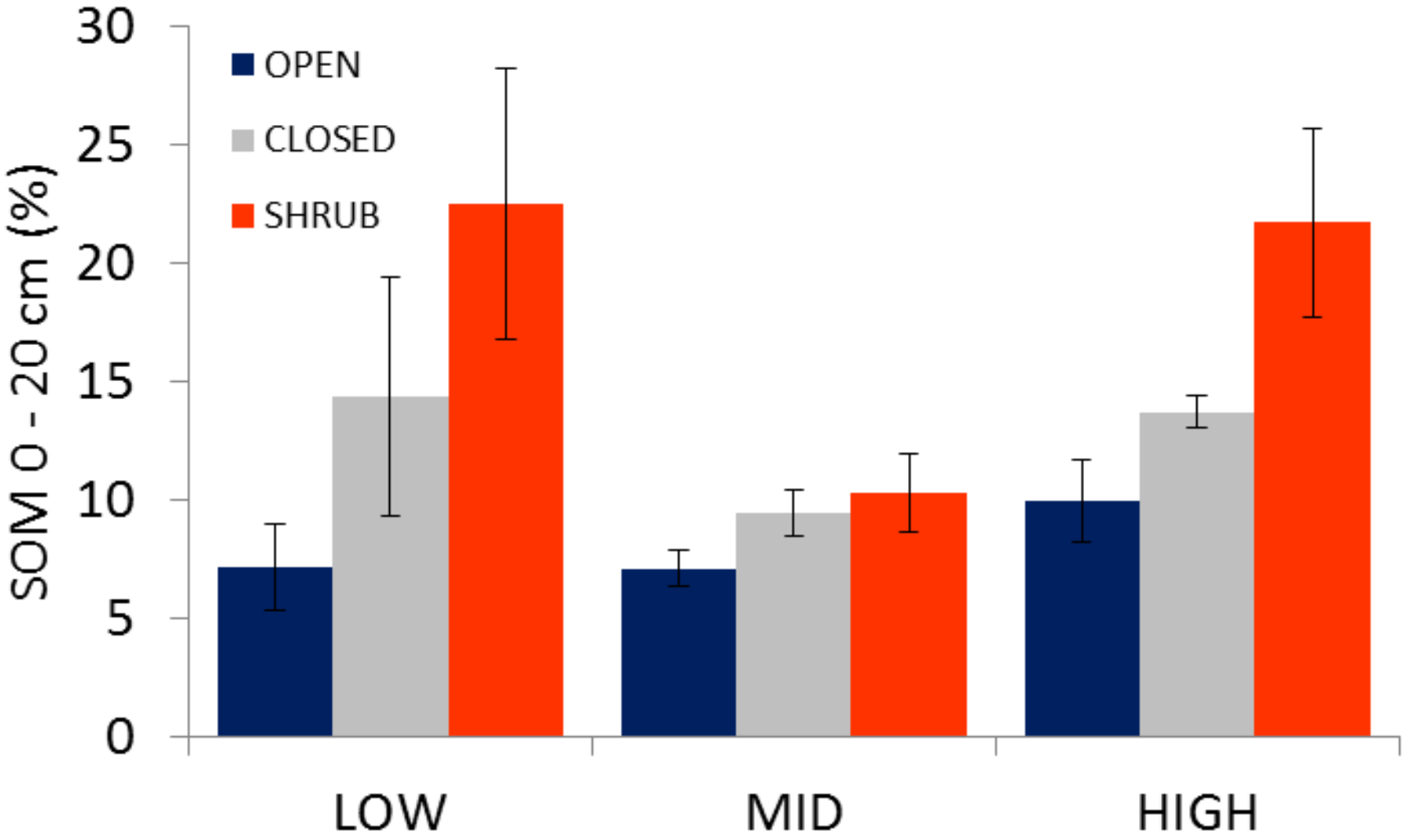
Canaan Valley Institute

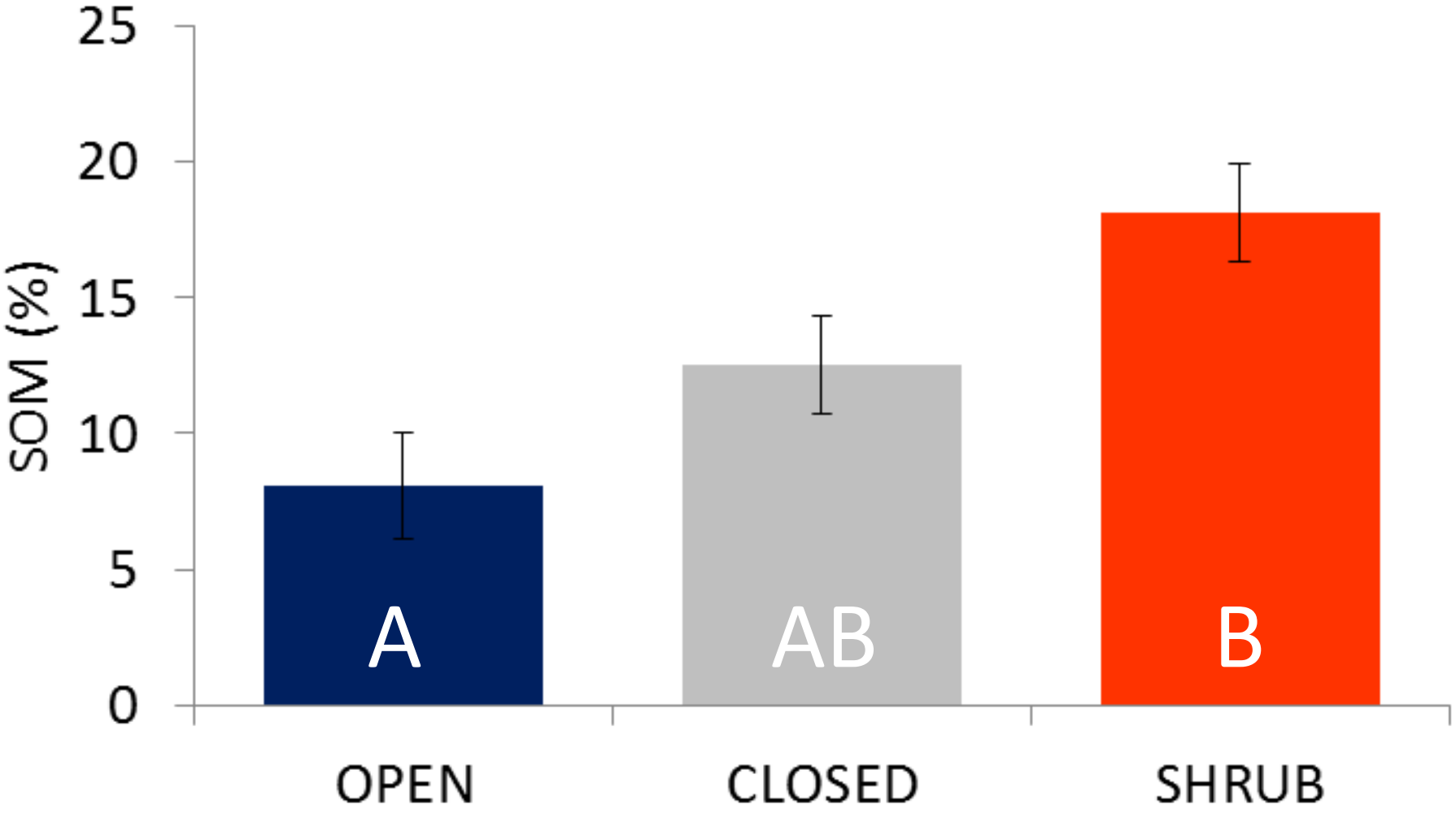
WORKING FOR THE SUSTAINABILITY OF THE MID-ATLANTIC HIGHLANDS SINCE 1995

DEPARTMENT of ENVIRONMENTAL SCIENCES

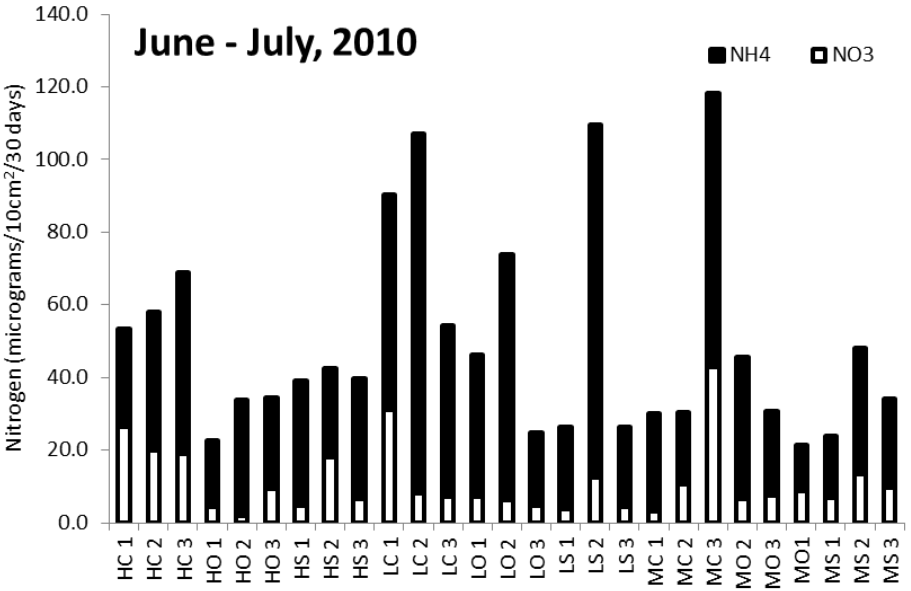
AT THE UNIVERSITY OF VIRGINIA

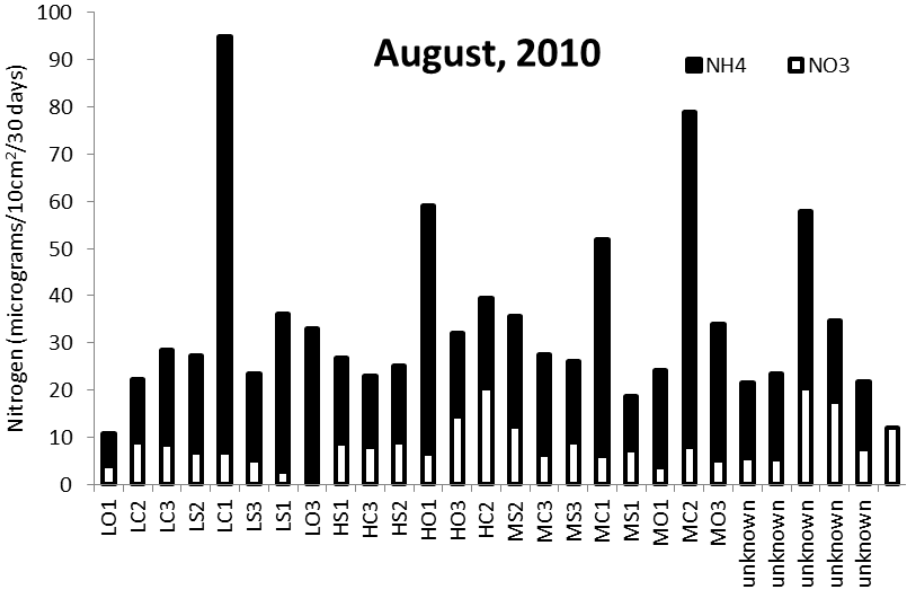
Thanks to the Canaan Valley Institute, EVSC, SWAS-VTSSS, and the Appalachian Stewardship Foundation for funding and support. Many thanks to all of those who have helped with fieldwork, data management, lab work, and/or support: Stesha Dunker, Sara Taube, Grace Wilkinson, Jon Walter, Jerrica Frazier, Josh Richards, Wes Andrews, Tom Williams, Briana Collins, Suzanne and John Maben, Meg Miller, Trevor Klein, the Canaan Valley Institute staff. And thanks to my committee and lab group.

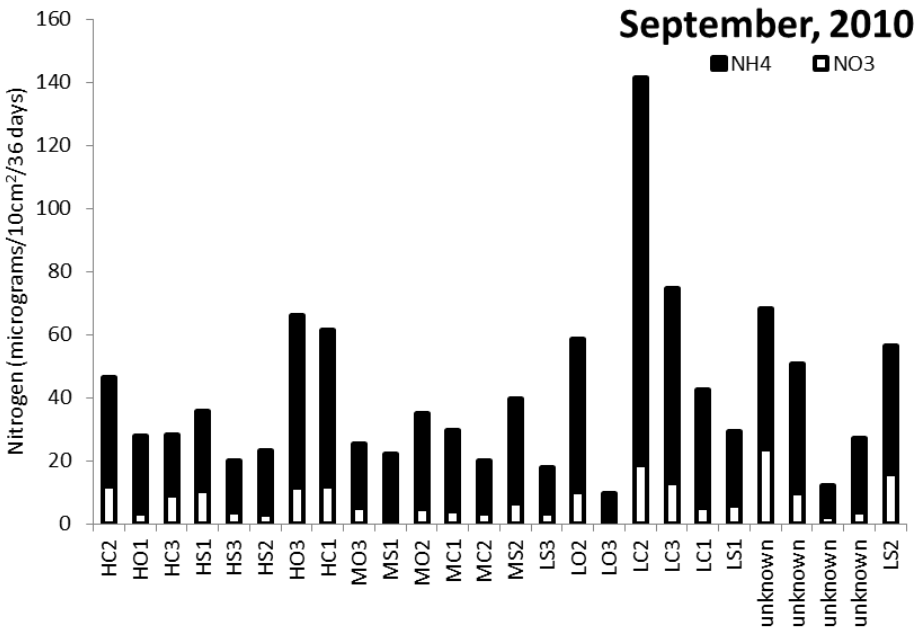

30
25
20
15
10
5
0
SOM 0 - 20 cm (%)
OPEN
CLOSED
SHRUB
LOW
MID
HIGH

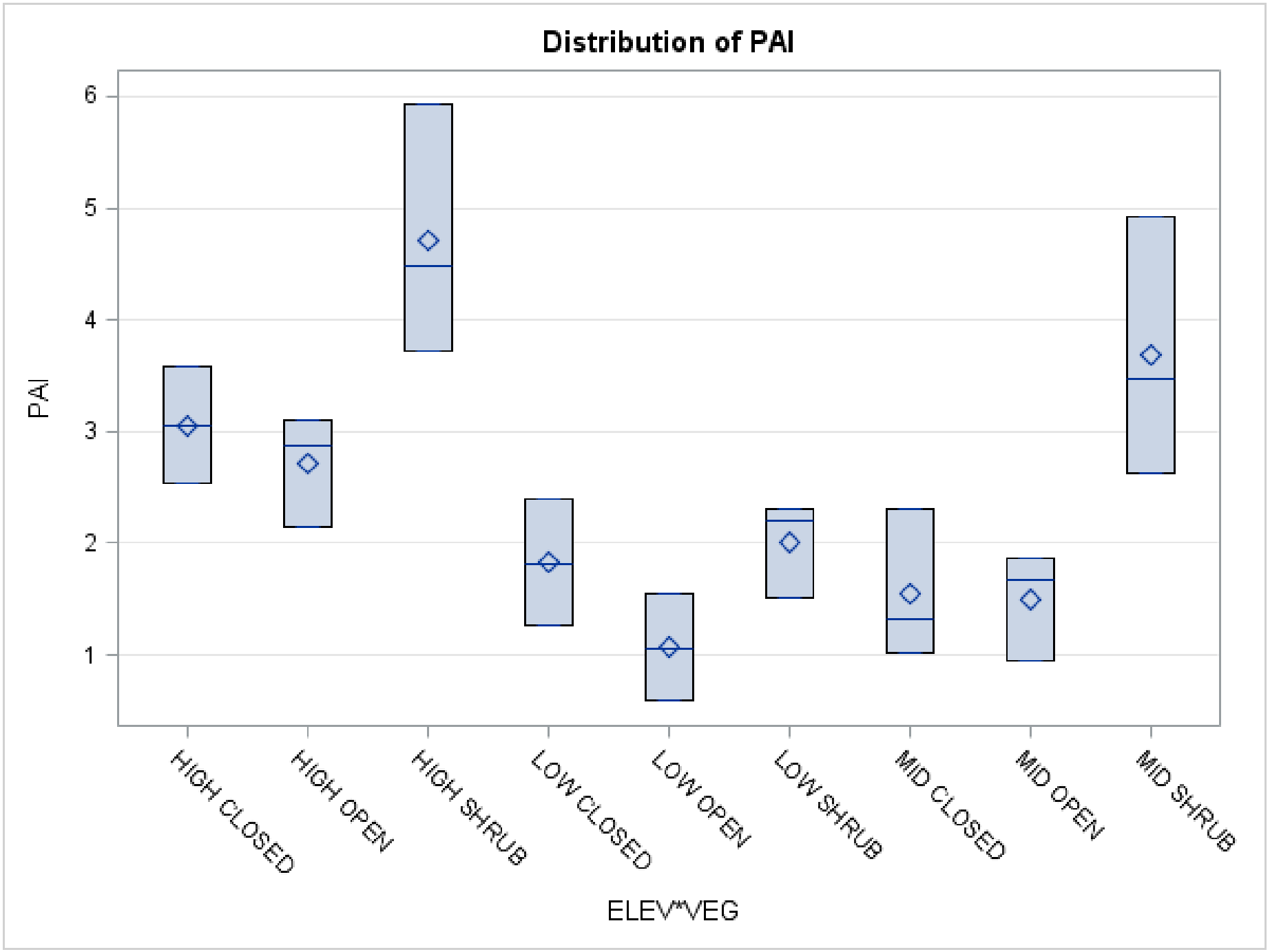


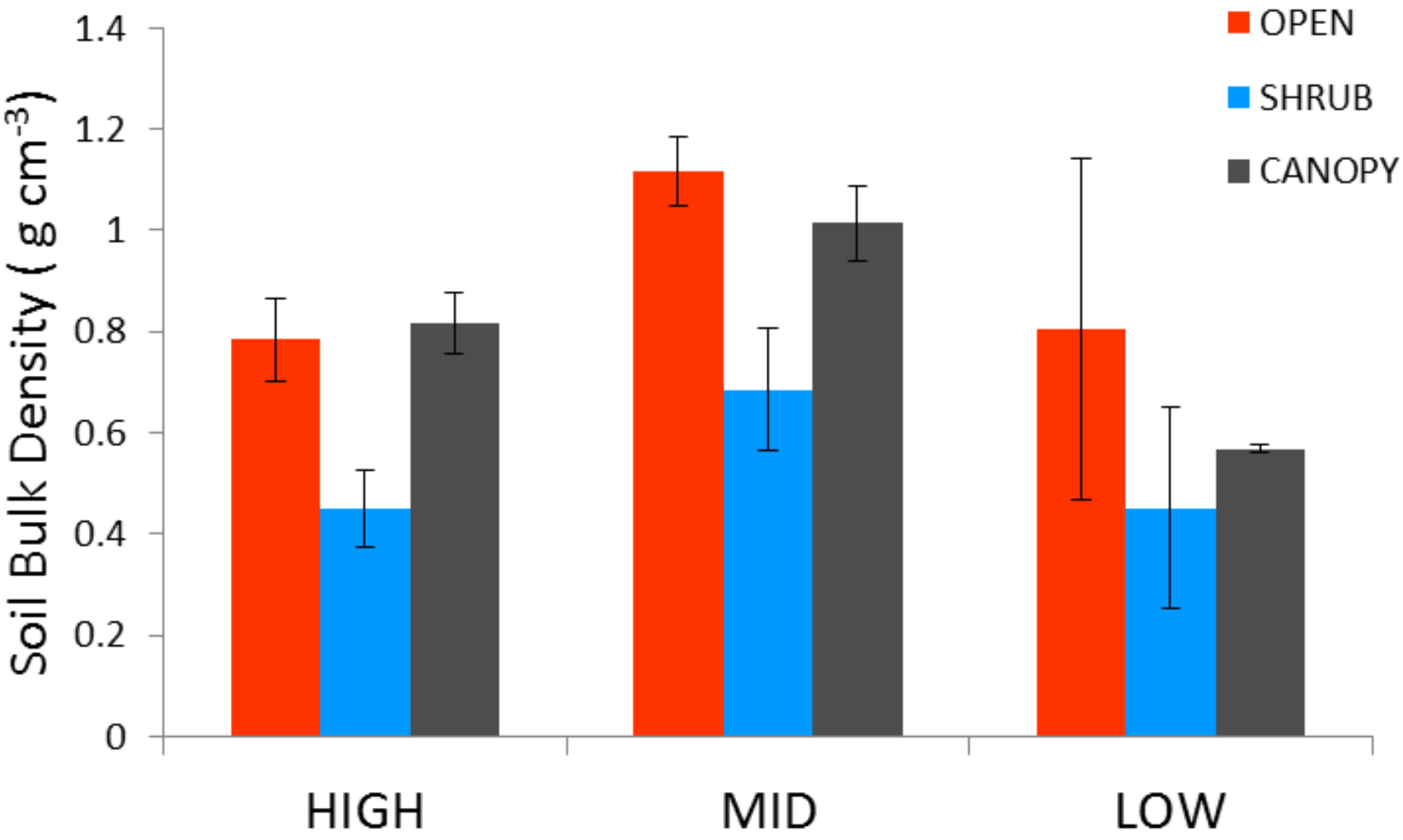
*Using LSMEANS; Proc Mixed SAS; PDMIX800 Saxton, 1998

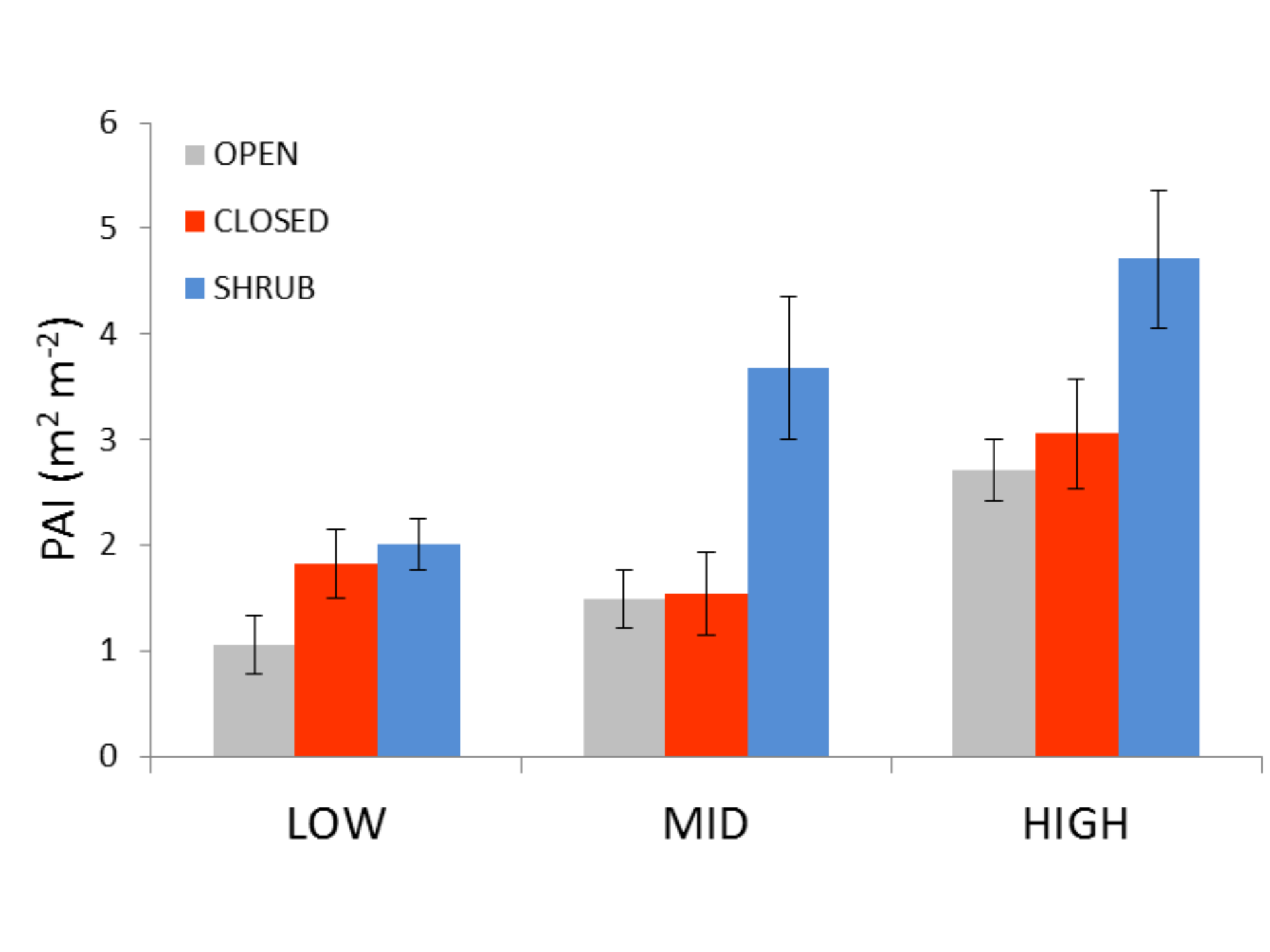

June - July, 2010
NH4
NO3
Nitrogen (micrograms/10cm2/30 days)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
HC 1
HC 2
HC 3
HO 1
HO 2
HO 3
HS 1
HS 2
HS 3
LC 1
LC 2
LC 3
LO 1
LO 2
LO 3
LS 1
LS 2
LS 3
MC 1
MC 2
MC 3
MO 2
MO 3
MO1
MS 1
MS 2
MS 3


August, 2010
NH4
NO3
Nitrogen (micrograms/10cm2/30 days)
100
90
80
70
60
50
40
30
20
10
0
LO1
LC2
LC3
LS2
LC1
LS3
LS1
LO3
HS1
HC3
HS2
HO1
HO3
HC2
MS2
MC3
MS3
MC1
MS1
MO1
MC2
MO3
unknown
unknown
unknown
unknown
unknown


September, 2010
NH4
NO3
Nitrogen (micrograms/10cm2/36 days)
160
140
120
100
80
60
40
20
0
HC2
HO1
HC3
HS1
HS3
HS2
HO3
HC1
MO3
MS1
MO2
MC1
MC2
MS2
LS3
LO2
LO3
LC2
LC3
LC1
LS1
unknown
unknown
unknown
unknown
LS2


Distribution of PAI
PAI
6
5
4
3
2
1
HIGH CLOSED
HIGH OPEN
HIGH SHRUB
LOW CLOSED
LOW OPEN
LOW SHRUB
MID CLOSED
MID OPEN
MID SHRUB
ELEV*VEG


Soil Bulk Density (g cm-3)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
OPEN
SHRUB
CANOPY
HIGH
MID
LOW


6
5
4
3
2
1
0
OPEN
CLOSED
SHRUB
PAI (m2 m-2)
LOW
MID
HIGH