HYDROLOGIC CRITERION FOR HYDRIC SOILS

M. J. Vepraskas, NC State University

Is this a hydric soil?

Yes, because it meets the definition of a hydric soil.

Definition

"A hydric soil is a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop ***anaerobic conditions*** in the upper part"

(59 Fed. Reg. 35680, 7/13/94)

The USDA Field Indicators of Hydric Soils

- ***Are layers*** of soil that formed in anaerobic or reduced soils.
- Field Indicators have been identified for nearly all hydric soils in the U.S.
- Indicators contain ***features*** composed of C, Fe, Mn, or S (gas); or form by a loss of Fe oxides.
- They are used for ***on-site*** verification

Two Types of Hydric Soil Field Indicators

Layer of C accumulation (Umbric surface)

Layer where Fe reduction occurred (Depleted matrix)

Issue: Hydrology of Hydric Soils

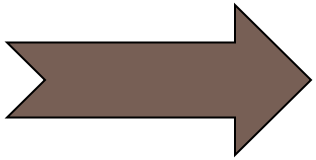
Objectives/Questions to be addressed

1: What is the relationship between **hydric soil colors** and **hydrology**?

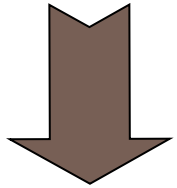
2: If an undrained soil has a ***hydric soil field indicator***, then how often does it meet ***wetland hydrology*** requirements?

METHODS Overview: a 4-Step Approach

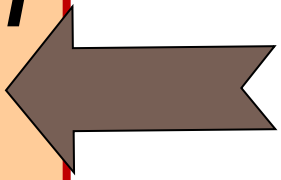
Calibrate *model to predict water table levels from rainfall*



Compute 40 yr *of daily water table levels using historic rainfall data*

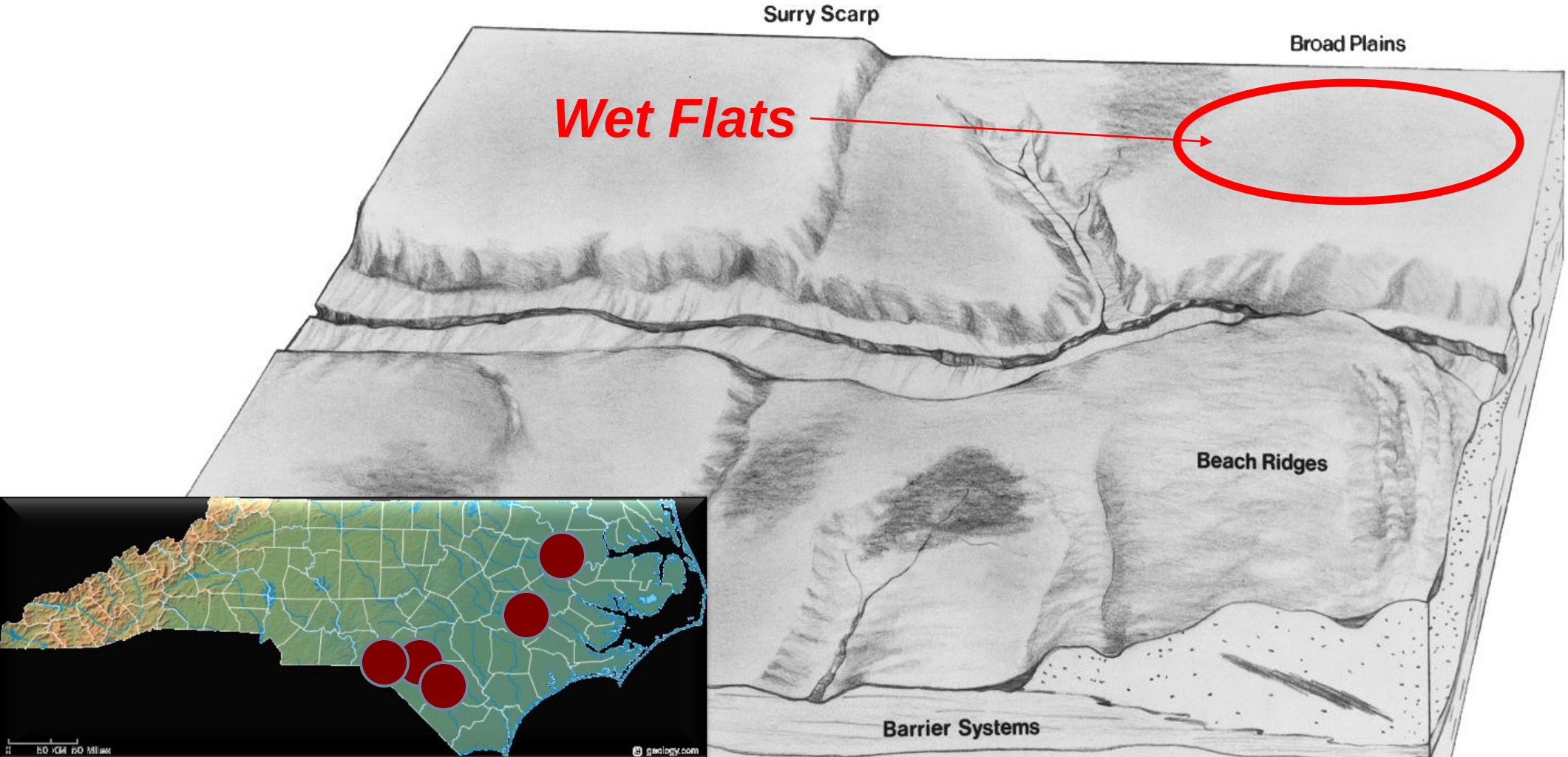


Estimate *saturation parameters of interest*

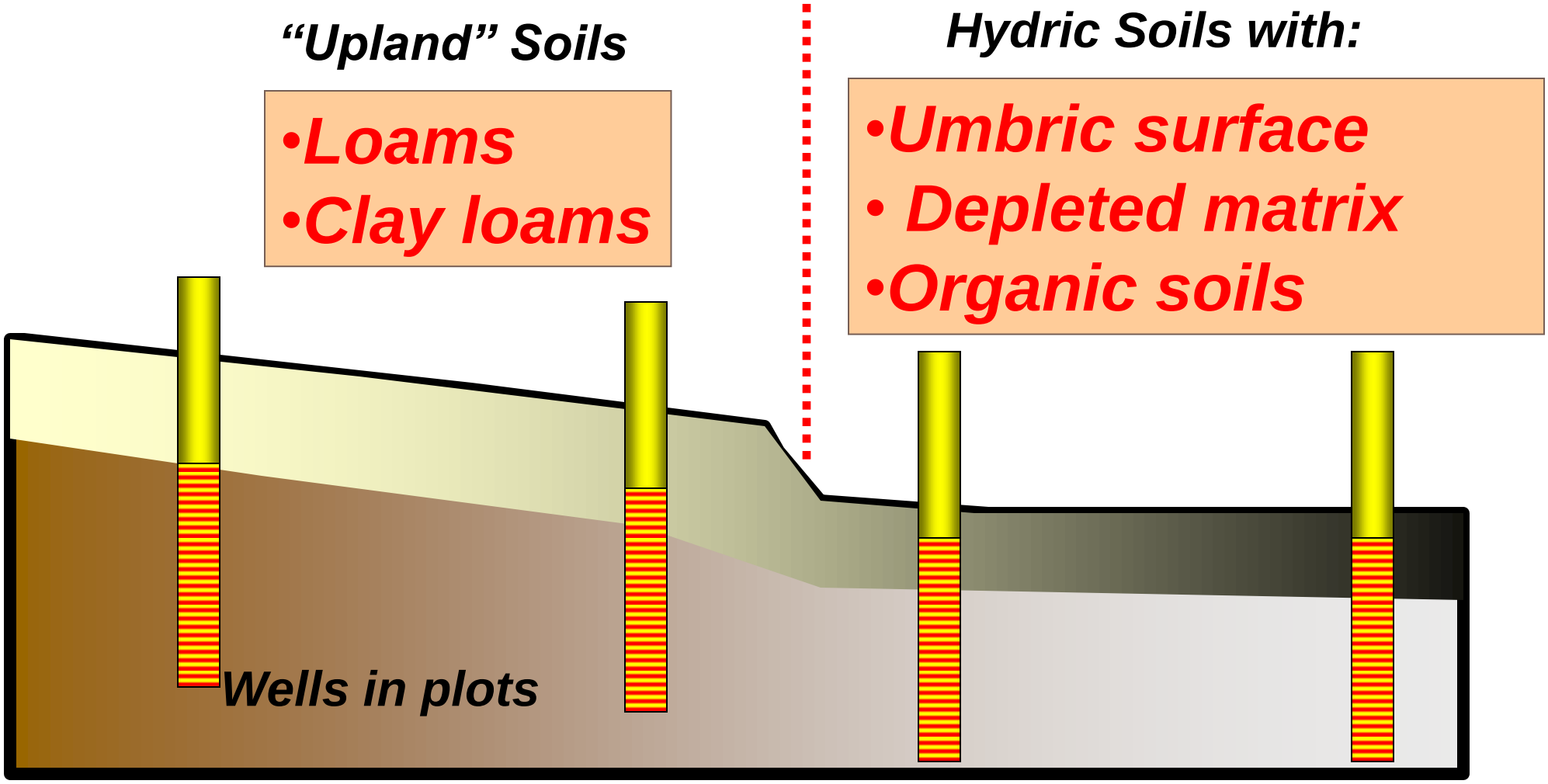


Relate *the saturation parameters to field indicators or colors*

Wet Flat Landscapes in the Coastal Plain



Soils monitored include both Hydric and Upland soils



Soil Plot Measurements

- 30 soil plots monitored and soil colors described at 5 sites
- Water table levels measured daily for 2 to 3 years.
- Soil properties (Ksat, pore size distribution) determined for major horizons
- Soil colors described in detail to 1 m for this study.

Hydrologic Modeling

- DRAINMOD was calibrated for each well installed
- Calibrated models were used to compute daily water table levels for 40 yrs (1959-1998) to cover wet and dry years
- Data averaged over 40 yr period

Study 1: Related soil color to saturation

Saturation Parameters

- ***Minimum Duration of Saturation***: lag between start of saturation and Fe reduction
- ***Saturation Frequency***: how often the *Minimum Duration of Saturation* occurs over time

Study 1:
How long must this horizon be saturated before "Gray Colors" begin to form?

Gray color forms by reduction of iron in saturated soils

Minimum Durations of Saturation needed for Fe Reduction to occur

Depth	***Site 1***	***Site 2***
cm	----------days----------	
15	***6***	***18***
30	***21***	***13***
60	***35***	***13***
Means	***21***	***15***

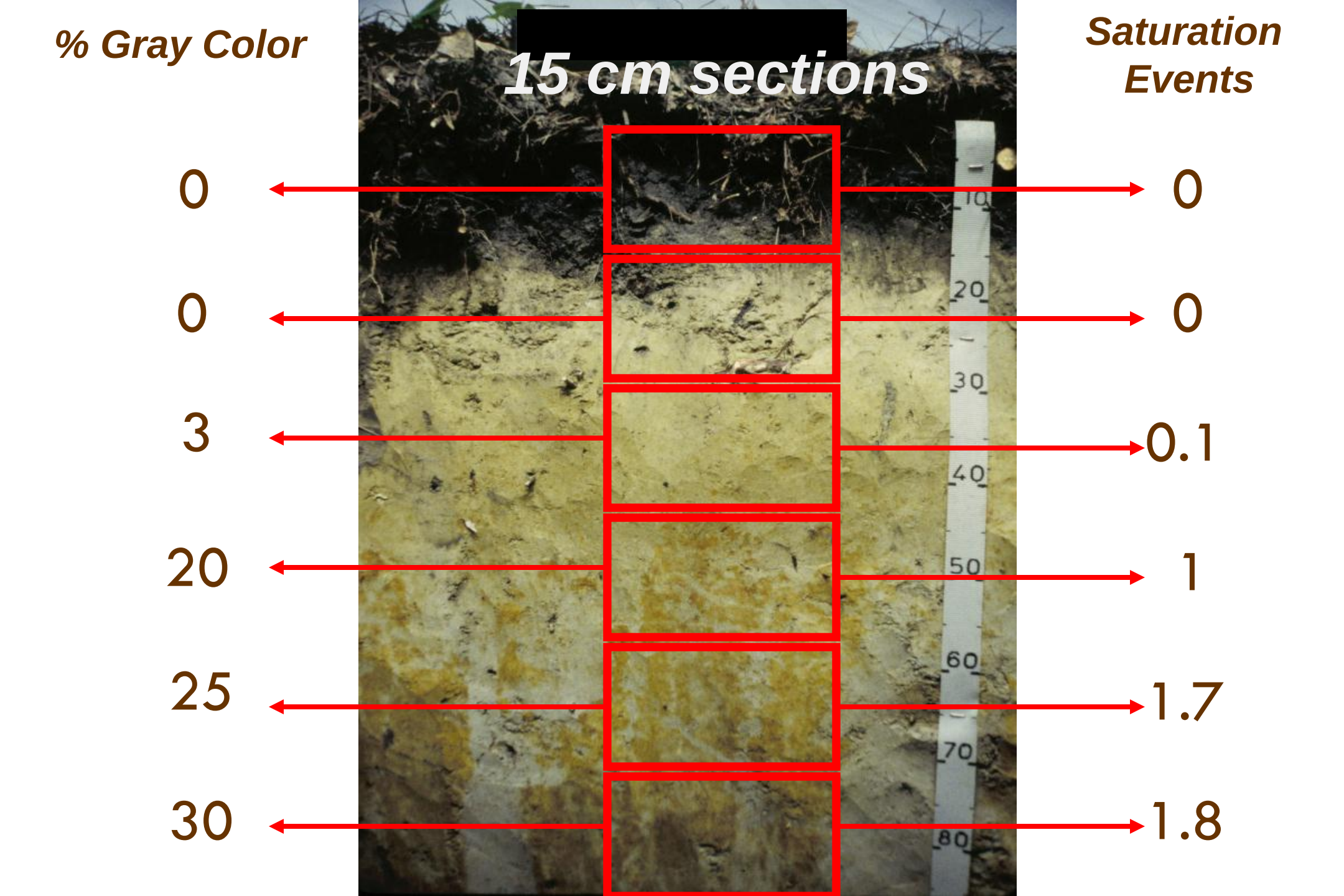
Saturation Event Index

A variable that combines saturation frequency and duration that occurred each year.

$$\text{Saturation Event Index (SEI)} = \left\{ \left[\frac{\text{Longest Saturation}}{21 \text{ days}} \right] - \{ \text{No. Events} - 1 \} \right\}$$

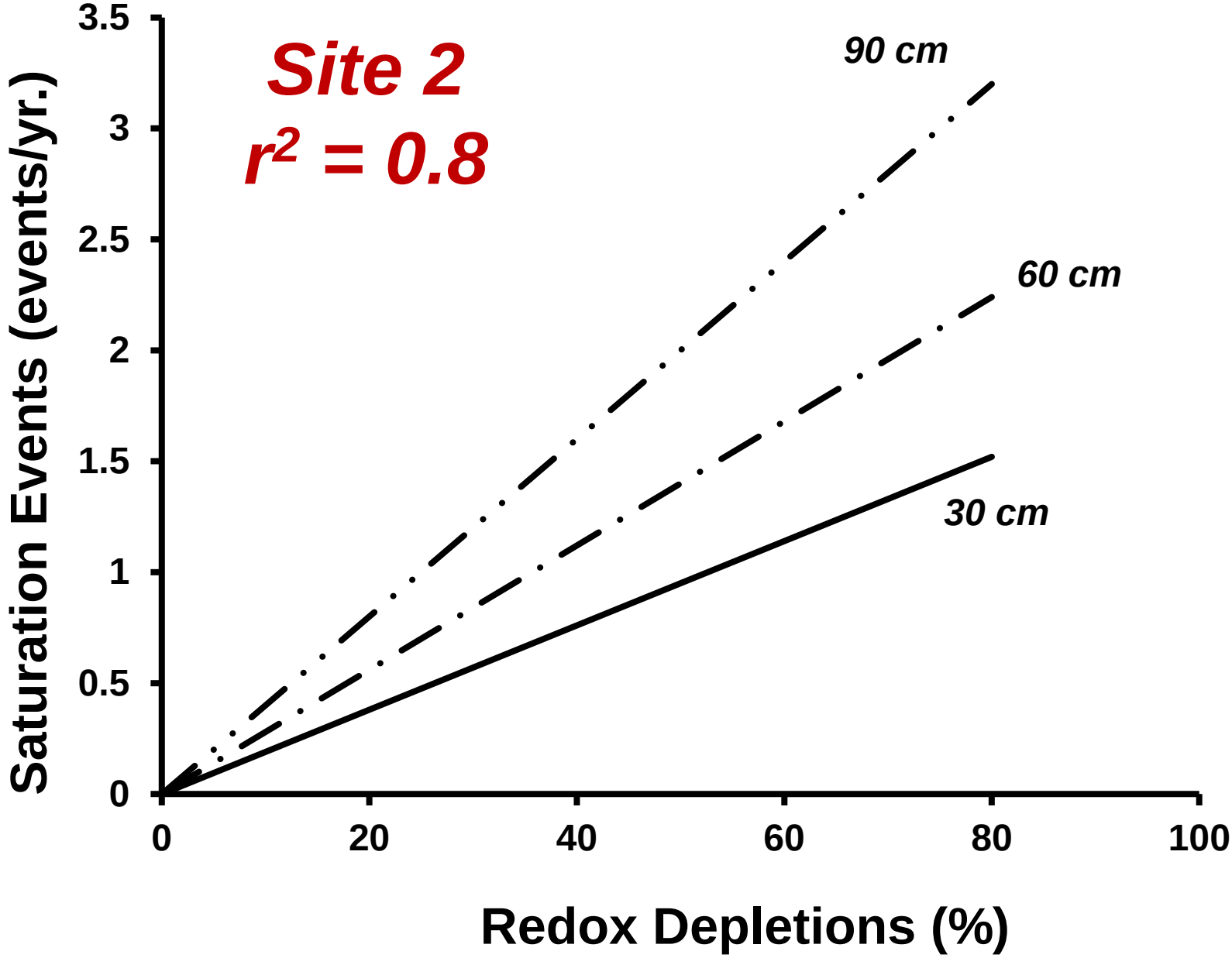
Computed the Average SEI by depth for each soil/well plot over a 40-yr period

- The ***Average SEI*** is the average number of times a soil layer saturates for "21 days or longer" per year
- Average SEI was then correlated to percentage of gray colors (***redox depletions***)


% Gray Color
15 cm sections
Saturation Events
0
0
3
20
25
30
0
0
0.1
1
1.7
1.8
10
20
30
40
50
60
70
80

Results: Modeling

Predicted and measured water table levels differed by <15 cm for most plots at both sites over a 3-yr. period


Site 2
r² = 0.8
90 cm
60 cm
30 cm
Saturation Events (events/yr.)
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
Redox Depletions (%)

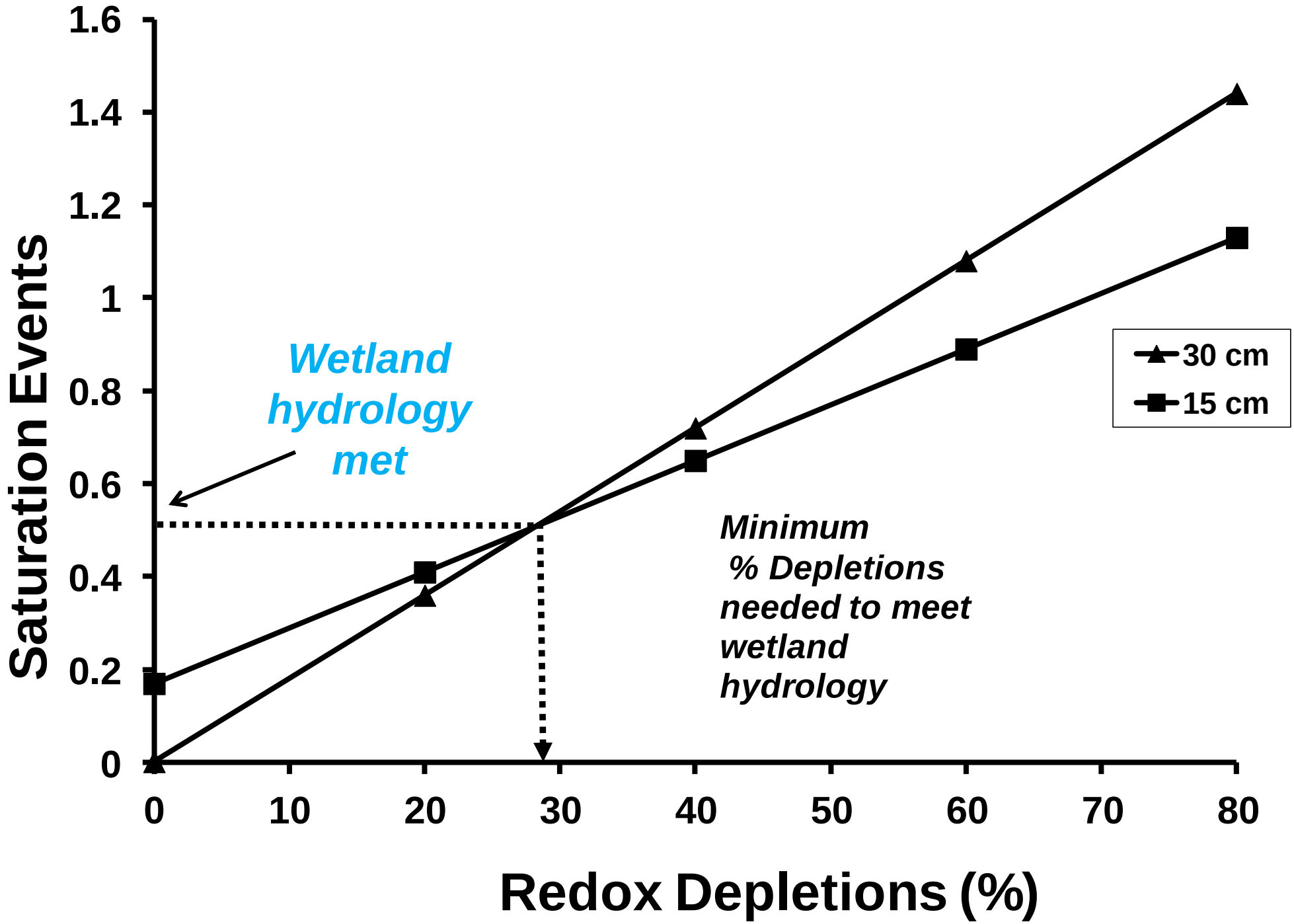
<u>Soil at 60 cm</u>
Contains 50%
redox depletions,

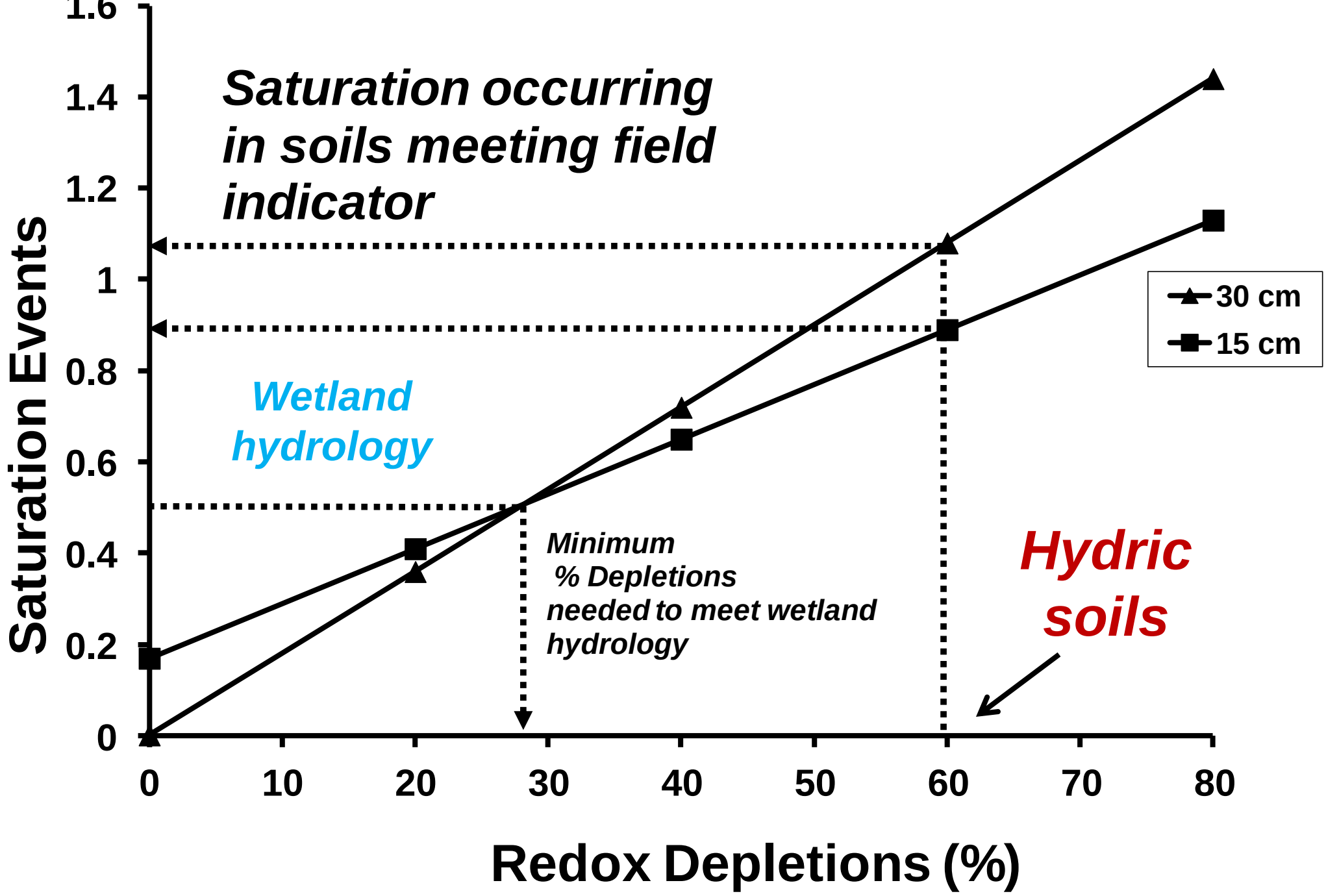
Has a
Saturation
Event Index of 1,
and
is saturated for:
21 to 41 d each year

Wetland Hydrology Requirements

- Soil must be saturated within 30 cm of surface, for 14 d or more, during the growing season, in at least 5 out of 10 years.

- Growing season was assumed to be the "frost-free" period.


Saturation Events
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
Redox Depletions (%)
Wetland hydrology met
Minimum % Depletions needed to meet wetland hydrology
30 cm
15 cm


Saturation occurring in soils meeting field indicator
Wetland hydrology
Minimum % Depletions needed to meet wetland hydrology
Hydric soils
30 cm
15 cm
Saturation Events
Redox Depletions (%)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0
10
20
30
40
50
60
70
80

Meets Wetland Hydrology only

Saturates for 21 to 40 days, 5 years in 10

Meets Hydric Soil and Wetland Hydrology

Saturates for 21 to 40 days, 9 yrs out of 10

Comments

- Relationships between average SEI and color varied by site and depth
- New hydrology field indicators could be defined, but many more sites would need to be studied.

Wetland Hydrology and Hydric Soil Indicators (Study 2)

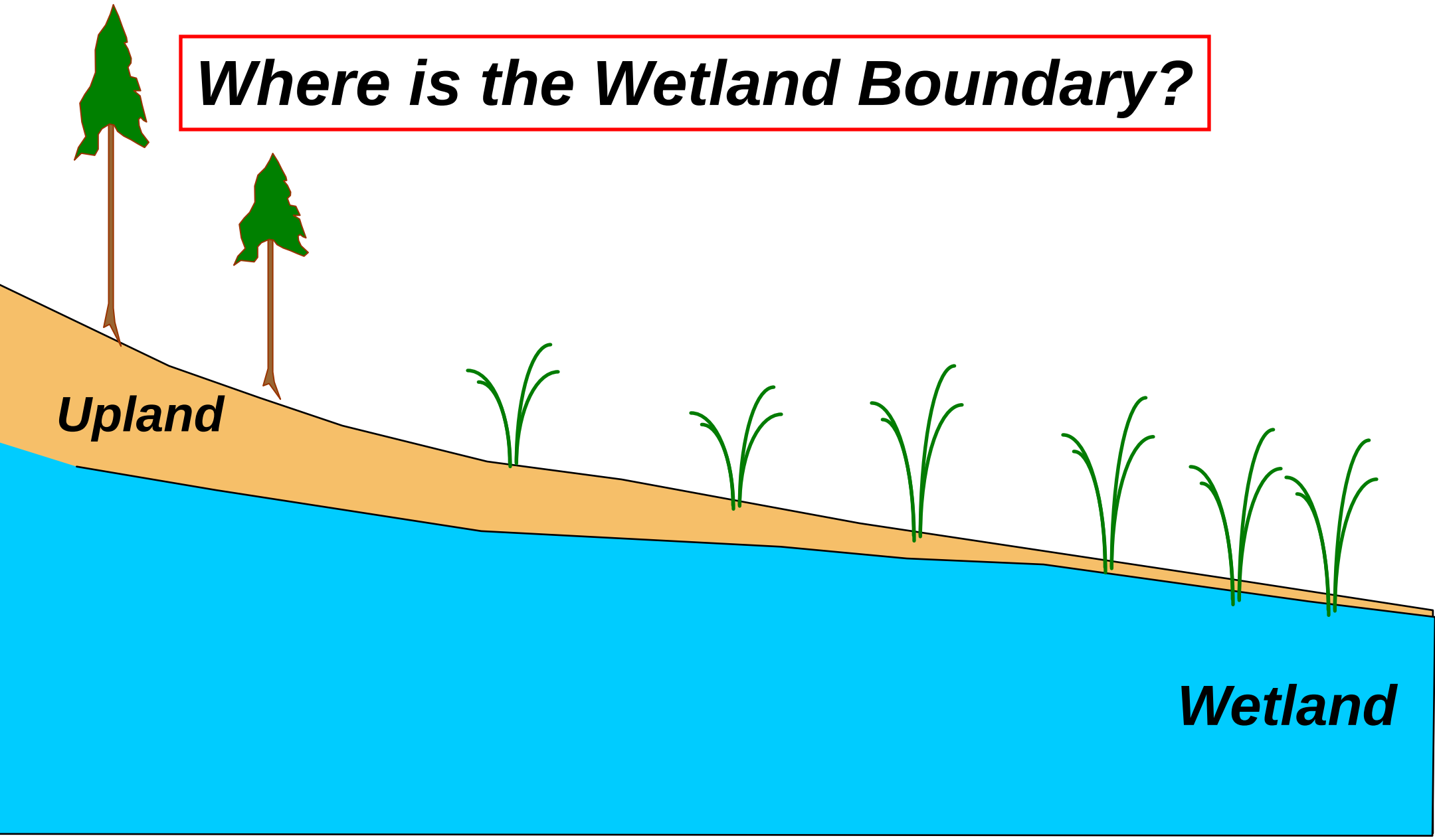
How often do hydric soils meet wetland hydrology requirements?

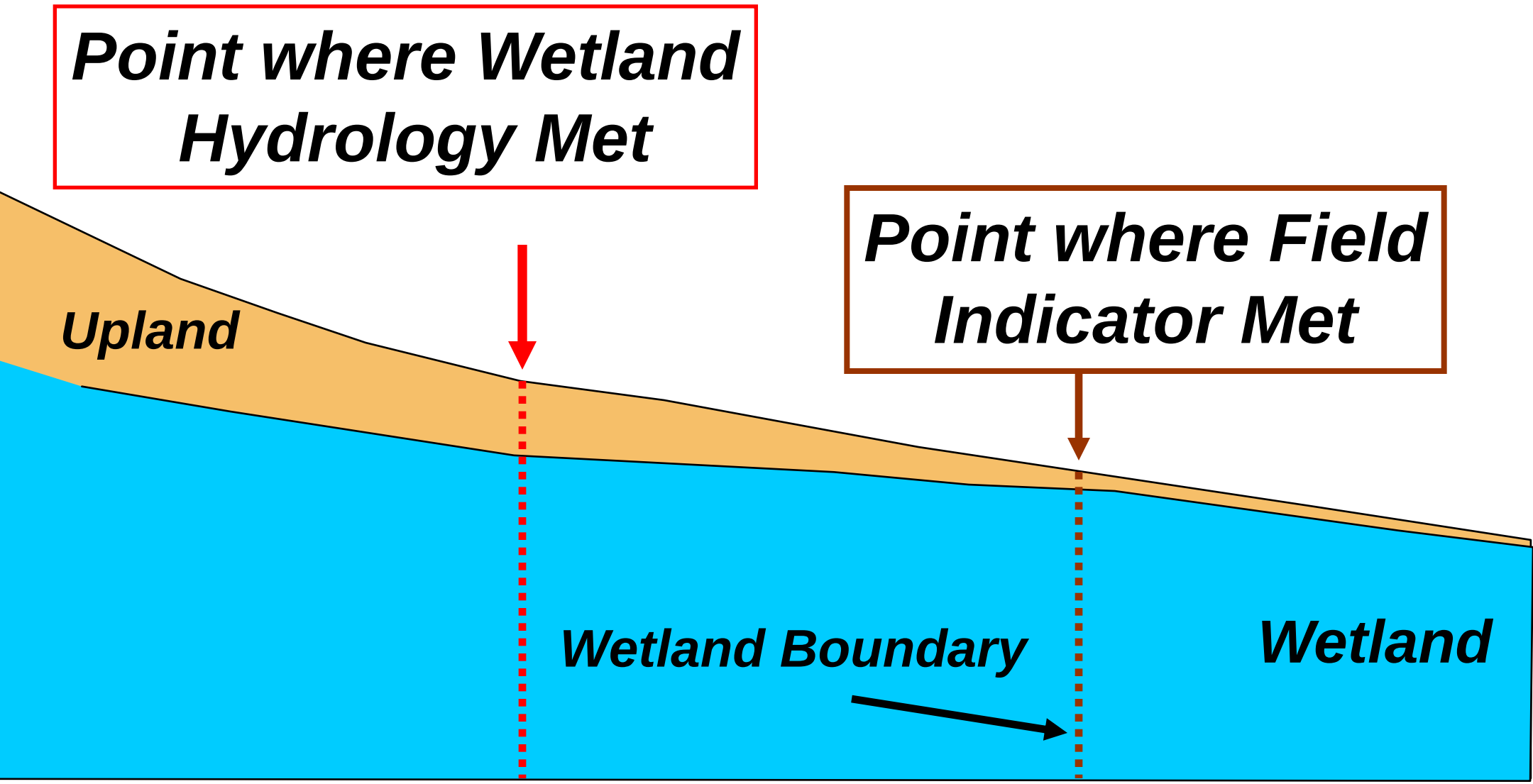
Relation of 40-year wetland hydrology requirements to field indicators

Hydric soil field indicator	Years wetland hydrology met (% of years)	Average duration of saturation (days yr^{-1})	Average duration of ponding (days yr^{-1})
Organic soil	*100*	*228*	*139*
Organic Surface	*“*	*178*	*67*
Dark Surface	*“*	*115*	*3*
Depleted Matrix	*95*	*40*	*ND*
Redox Depression	*87*	*29*	*ND*
No Indicator met	*6*	*5*	*ND*

Implications and Conclusions

- Existing hydric soil field indicators show a site meets wetland hydrology conditions (for undrained sites).
- Field indicators tend to move the wetland boundary "downhill" because they need longer periods of saturation to form than 14 d every other year.


Where is the Wetland Boundary?
Upland
Wetland


Point where Wetland Hydrology Met
Point where Field Indicator Met
Upland
Wetland Boundary
Wetland

Conclusions

- Percentages of redoximorphic features can be calibrated to soil hydrology.
- Relationships vary among soils (sites) and depend on how long soils take to become anaerobic.


The End