

Ecological characteristics of a coastal raised bog, one of the rarest wetland types in the western United States



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Joe Rocchio
Program Manager
Washington Dept. of Natural Resources
Natural Heritage Program
Olympia, WA

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- **Coauthors**

F. Joseph Rocchio and Tynan Ramm-Granberg

Washington Depart. of Natural Resources, Natural Heritage
Program, Olympia, WA

- **WA DNR**

**Edward Gage, Andrea K. Borkenhagen*, David
J. Cooper**

Department of Forest and Rangeland Stewardship, Colorado
State University, Fort Collins, CO

*Advisian, Calgary, Alberta, Canada.

- **Colorado State
University**

OVERVIEW

- **What is a bog?**
- **Initial Observations**
- **Research Questions**
- **Results/Discussion**
- **Summary**



What is a bog?

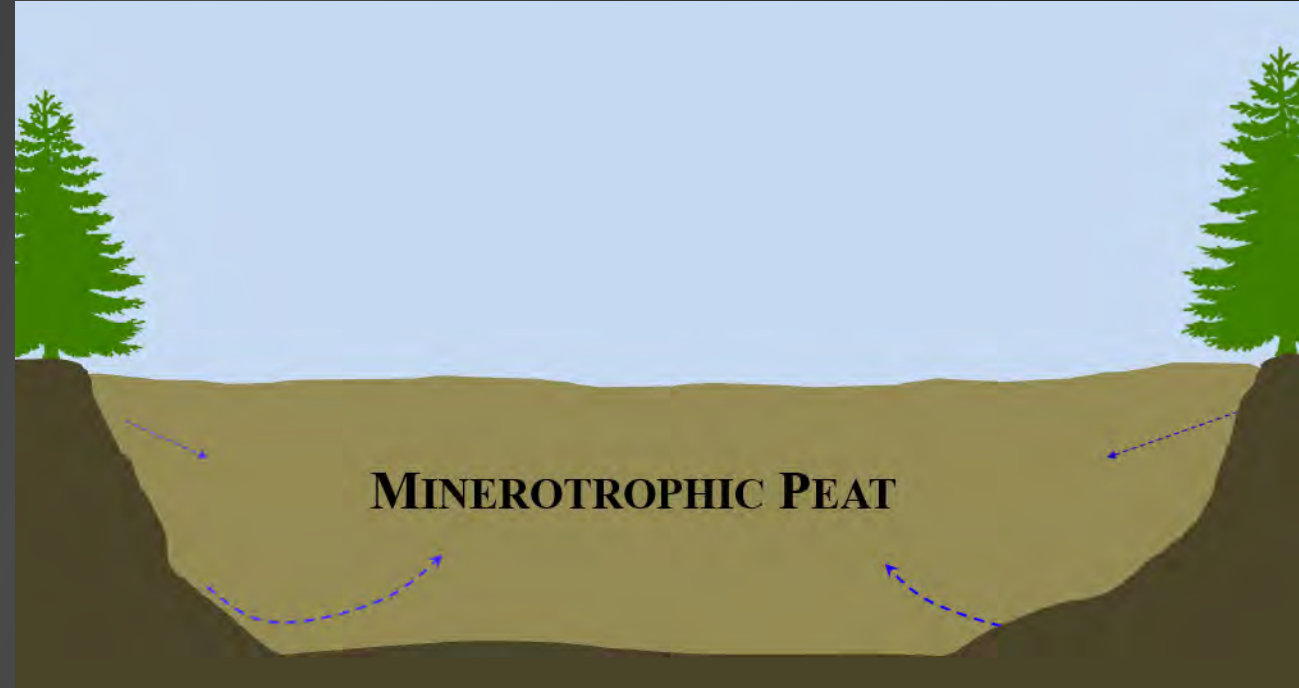
- peat forming ecosystem
- *Peat* = an accumulation of organic matter due to incomplete decomposition
- forms *in situ*



Bog vs Fen

Minerotrophic peatlands (fens)

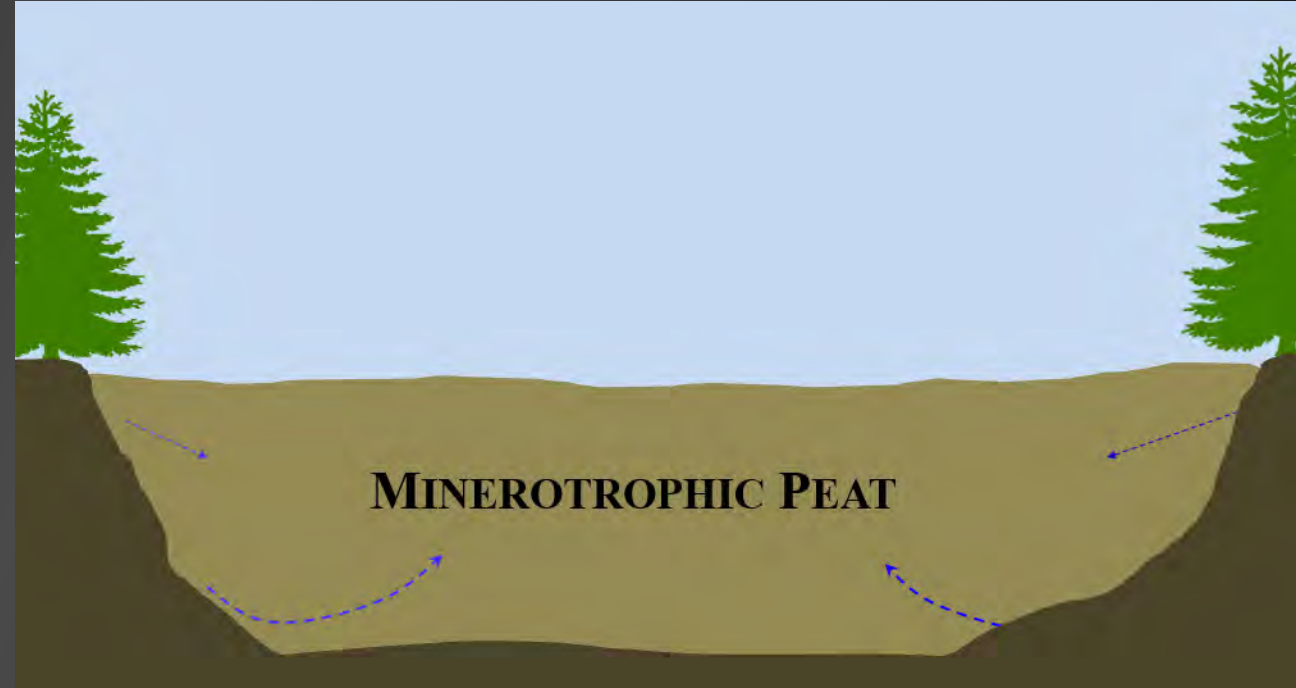
- surface- and/or groundwater supported
- very acidic to alkaline
- variable ion concentrations



Bog vs Fen

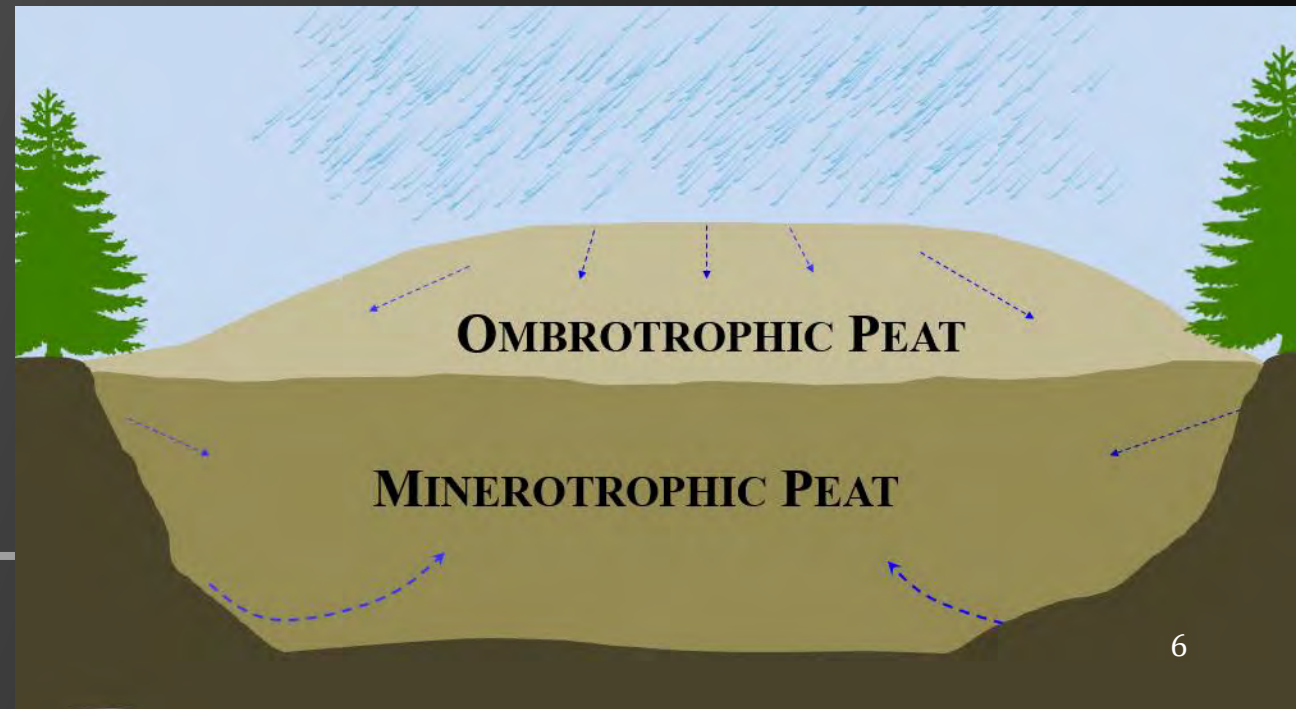
Minerotrophic peatlands (fens)

- surface- and/or groundwater supported
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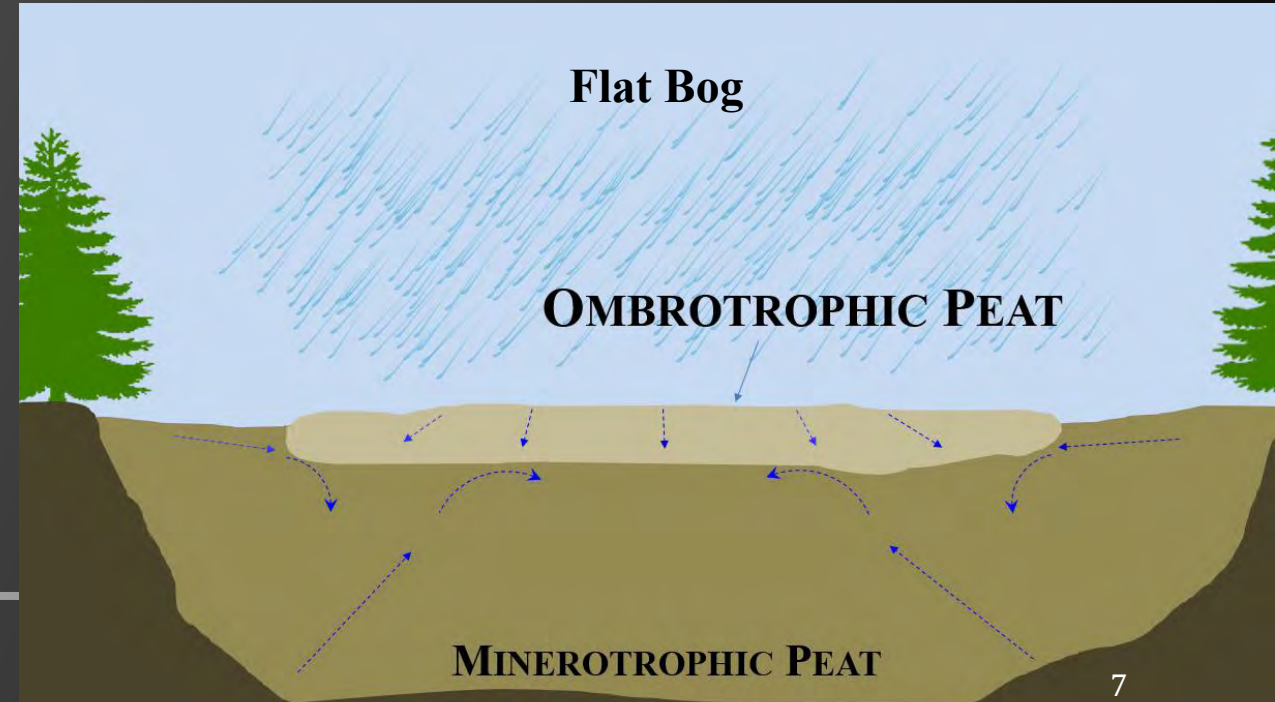
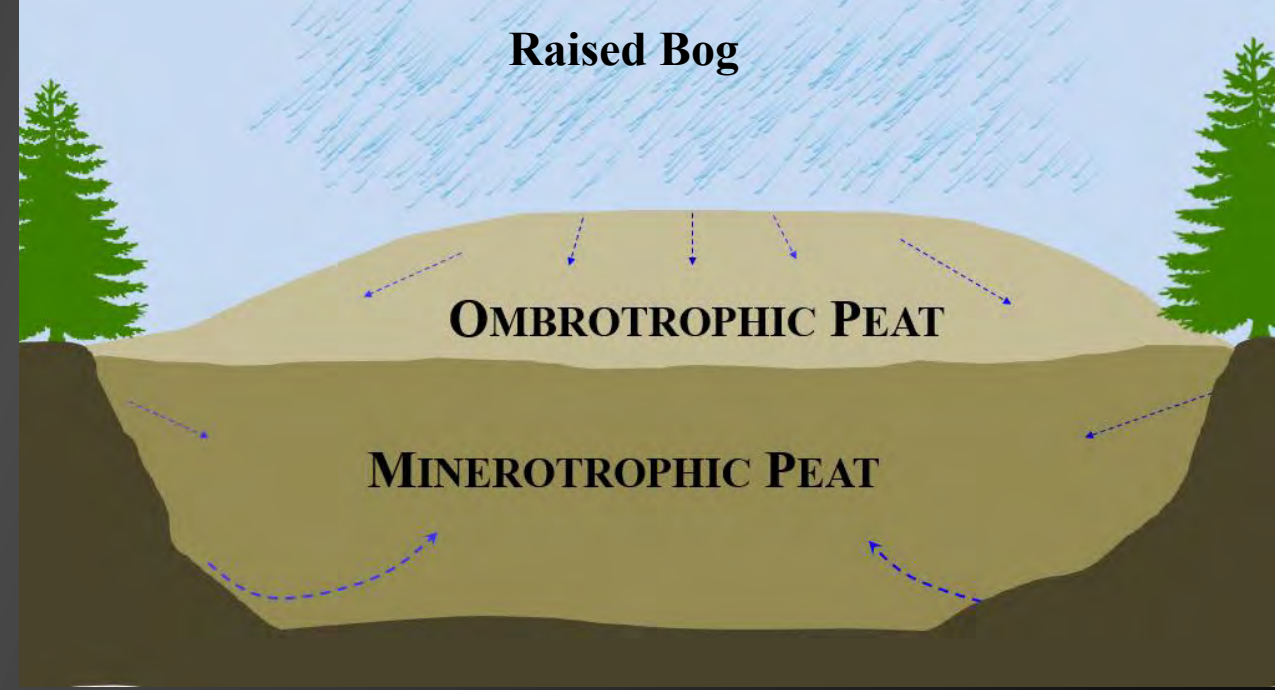
Ombrotrophic peatlands (bogs)

- rain-fed
- very acidic
- low ions



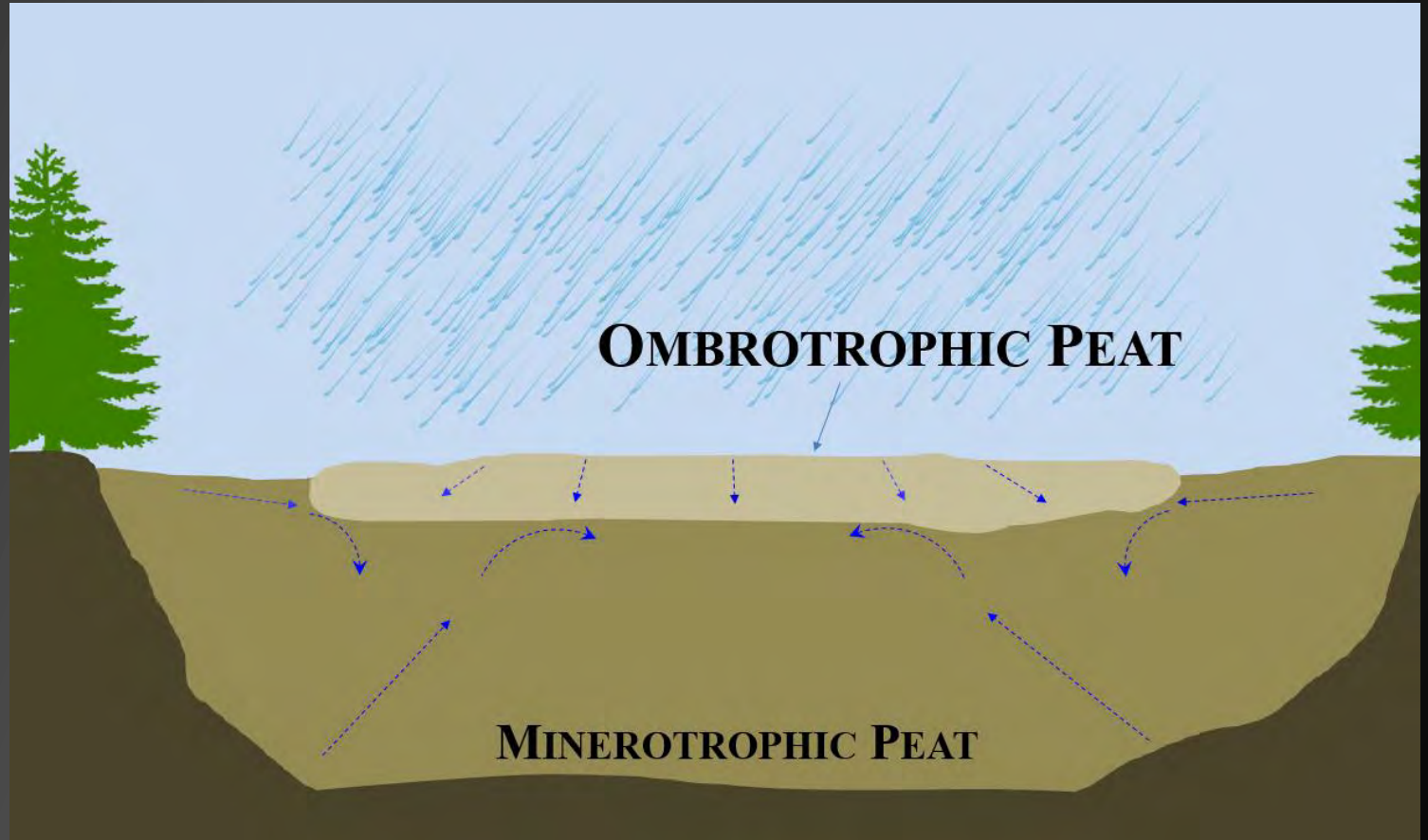
Bogs

- Raised bogs
- Flat bogs



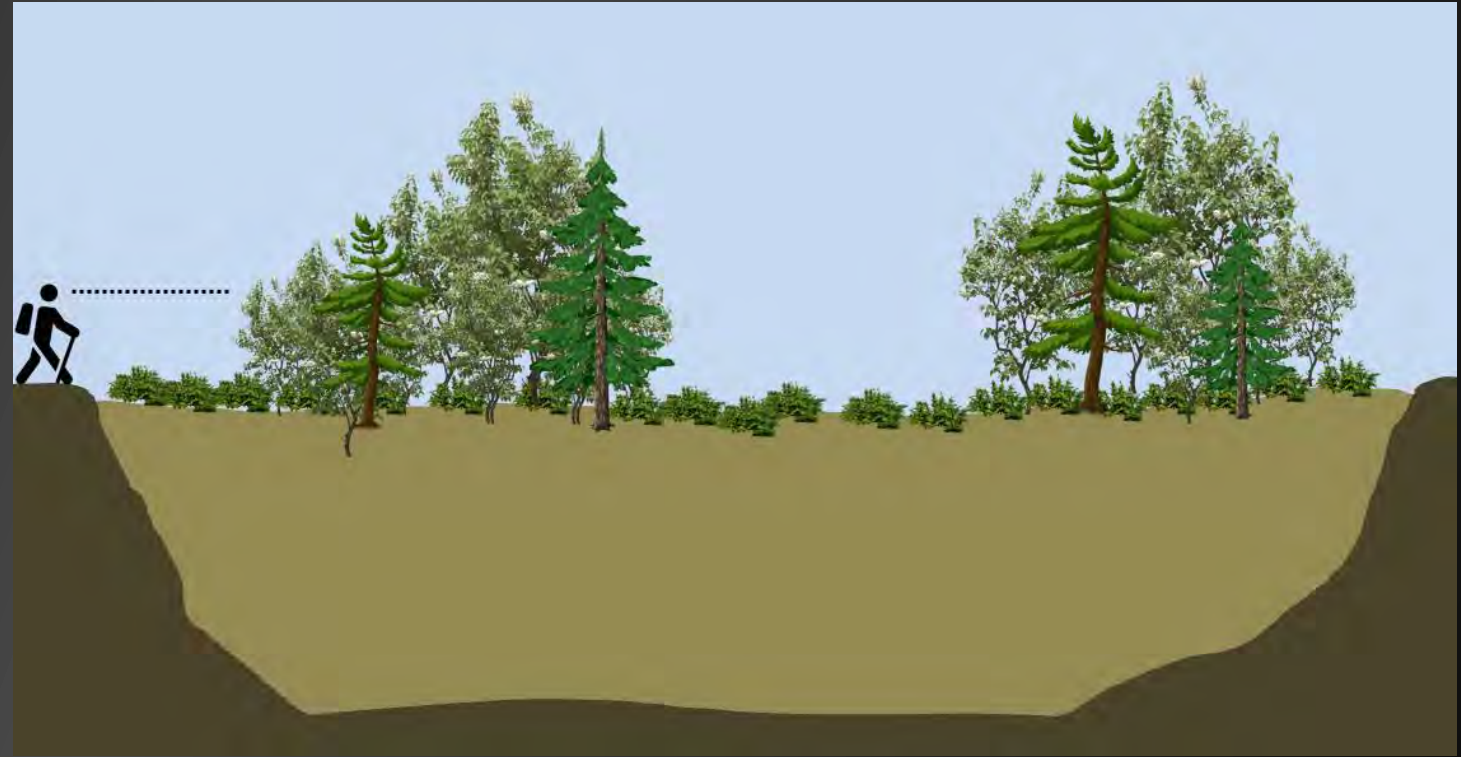
Washington “Bogs”

- Not conspicuously raised
- Bog-like vegetation
- Very acidic
- Ombrotrophic?
 - Maybe flat bogs
 - But, no published data



Initial Observations of Crowberry Bog

It is just another bog...

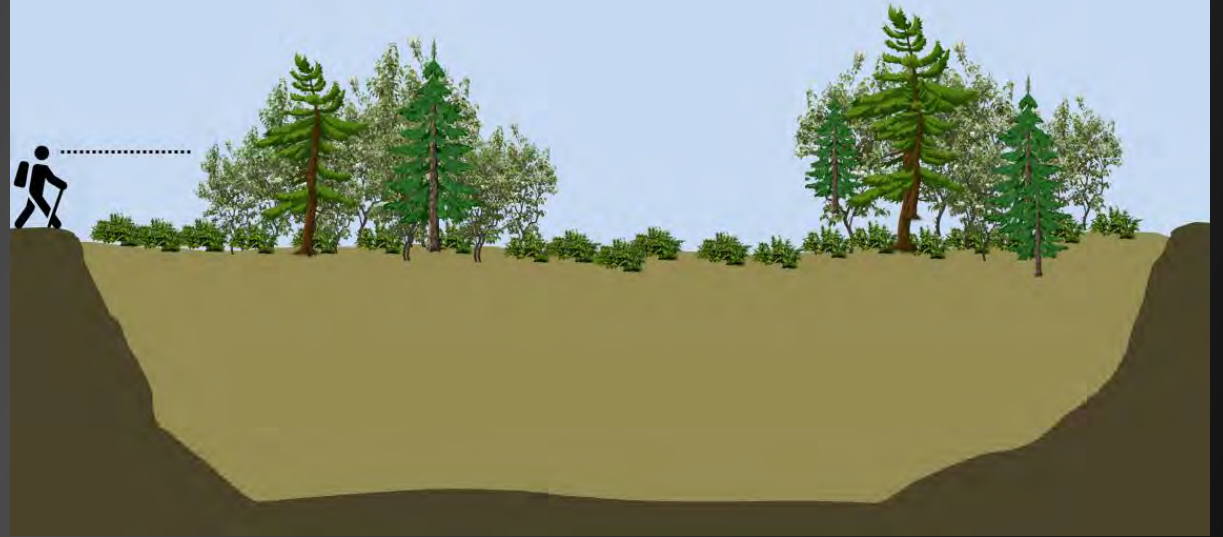


Initial Observations of Crowberry Bog

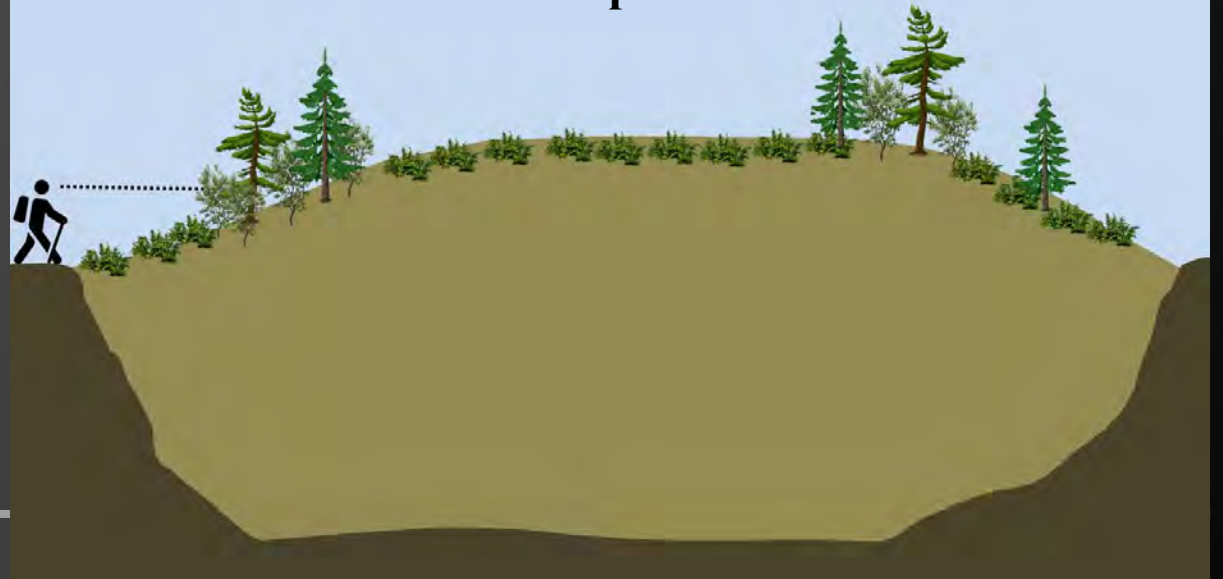
Or, is it something else?



What I thought I saw...

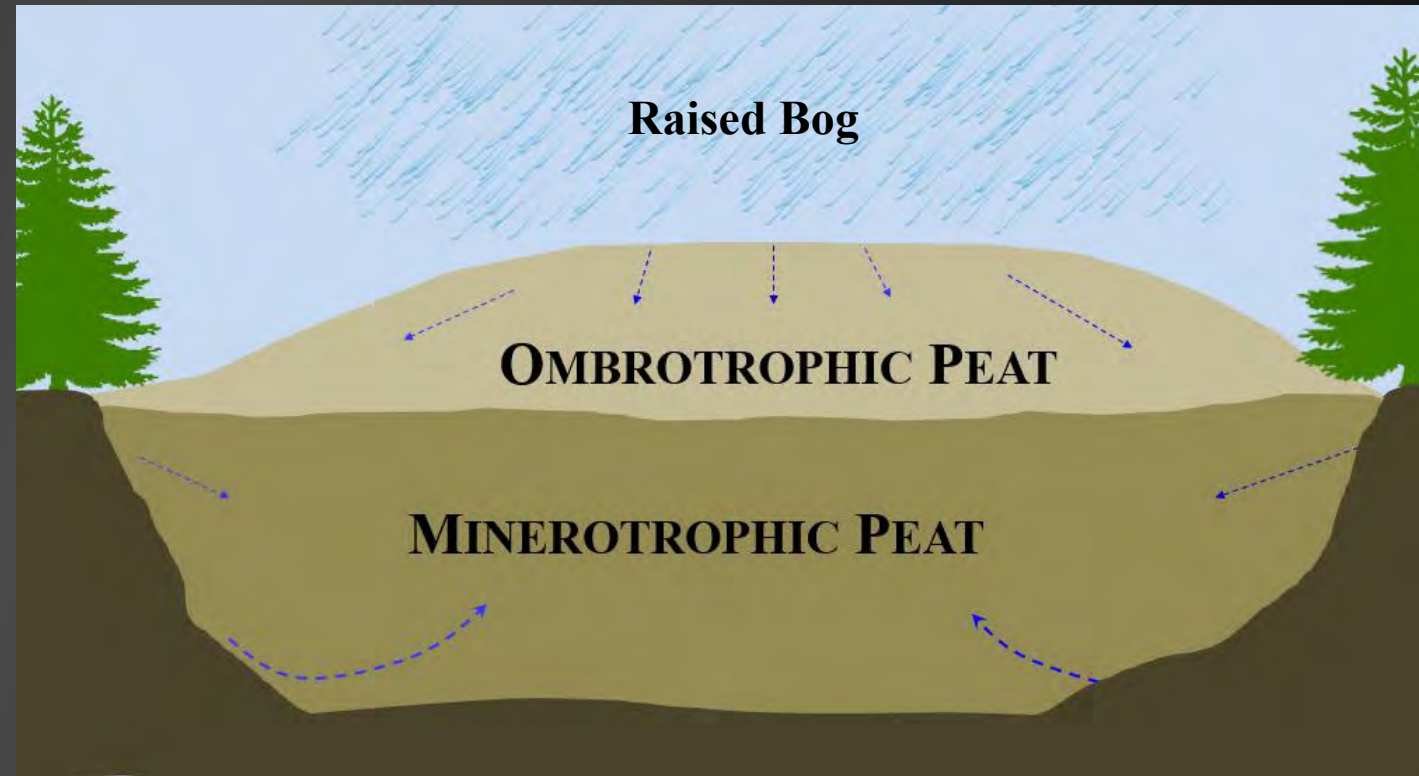


...was not what I experienced.



Initial Observations of Crowberry Bog

Did I just find a raised bog?



RESEARCH QUESTIONS

Is Crowberry Bog
ombrotrophic?

- (1) Is topography consistently raised above the adjacent land area?
- (2) Are there significant periods of the year when groundwater movement is primarily downward?
- (3) Are the concentrations of pore water ions within the range reported for ombrotrophic peatlands?
- (4) Is vegetation composition limited to species tolerant of nutrient poor conditions?

STUDY AREA

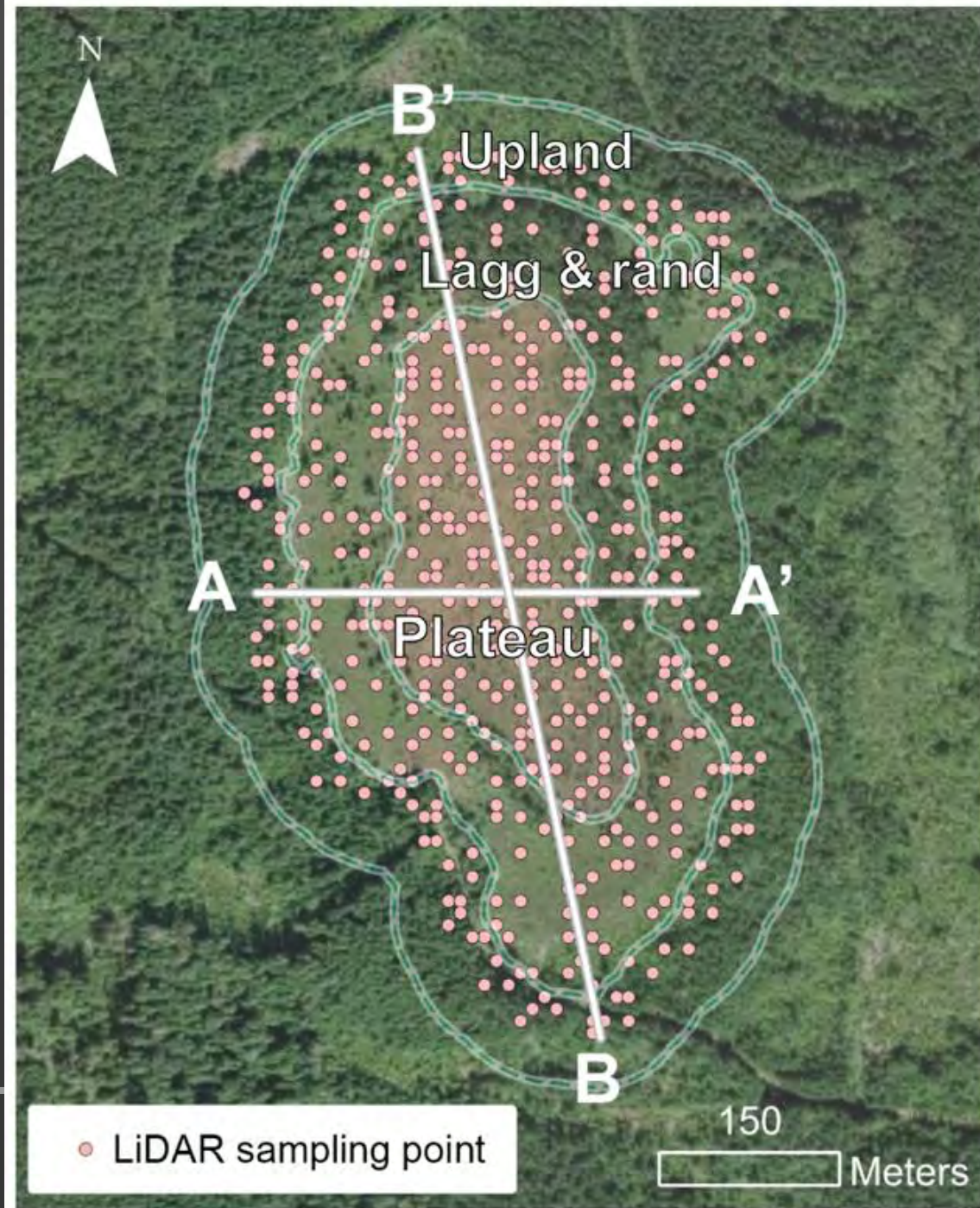
- Occurs on glacial terrace
- 135 m MSL (~410 feet)
- 18 km east of ocean (~11 miles)
- 19 hectares (47 acres)
- Annual precipitation = ~3000 mm (~118 inches)
- Avg. max temp = 14.7° C (58° F)
- Avg. min temp = 4.8° C (40° F)



Methods

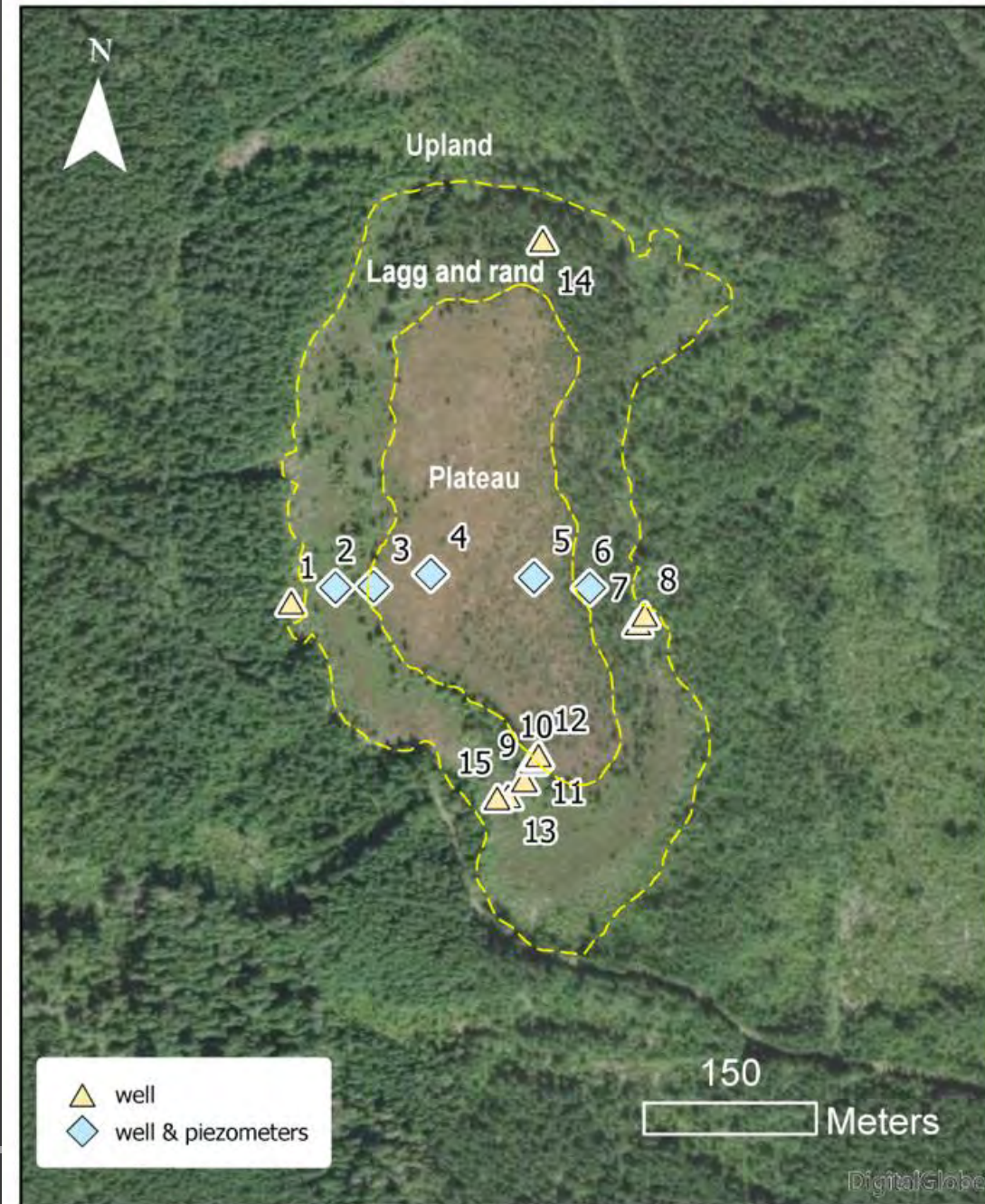
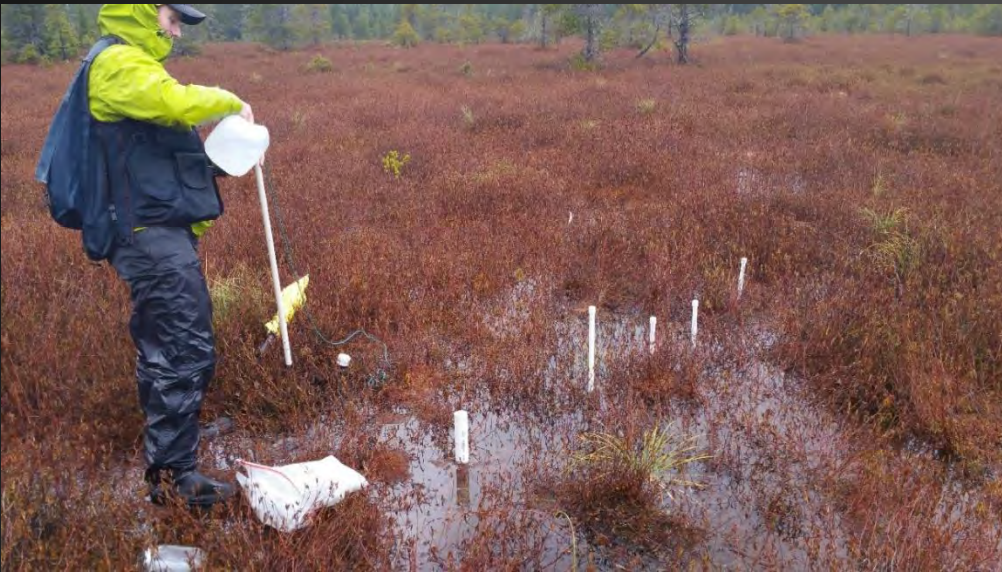
Is topography consistently raised above the adjacent land area?

- LiDAR data from the Puget Sound LiDAR Consortium
- Point cloud data used to produce digital surface models
- The vertical accuracy = 3.1 cm



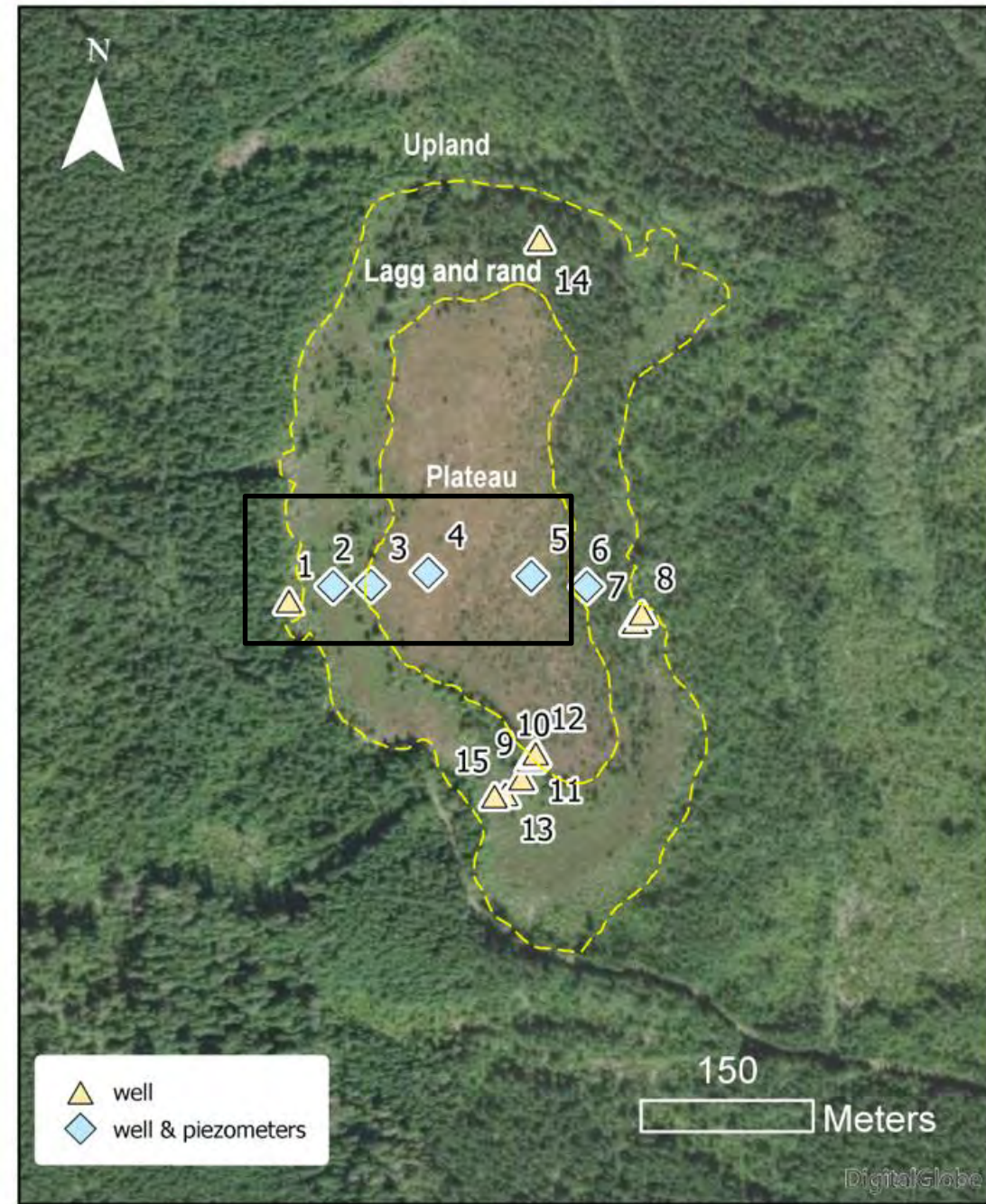
Are there significant periods of the year when groundwater movement is primarily downward?

- 15 shallow groundwater wells
- 5 well “nests”
 - nest = 1 shallow well and 4 piezometers
- Piezometers were installed at 4 depths
 - (50, 100, 150, 200 cm depths)



Are the concentrations of pore water ions within the range reported for ombrotrophic peatlands?

- Water samples collected 4 time/year
- Analyzed at Colorado State University lab



Is vegetation composition limited to species tolerant of nutrient poor conditions?

- 100 m² relevé plots
- Vegetation composition
- Dominant lichen and bryophytes collected

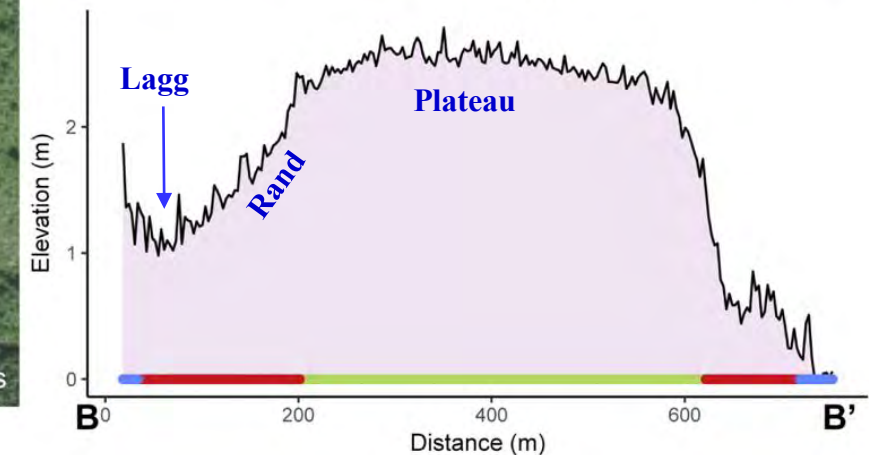
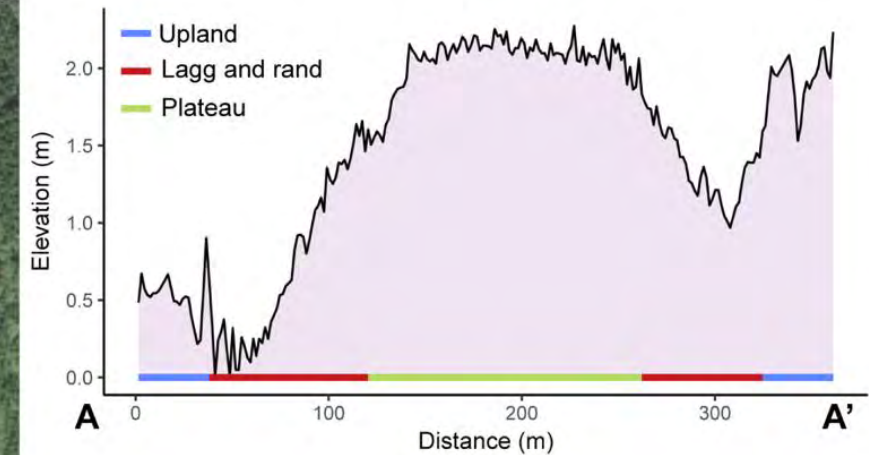
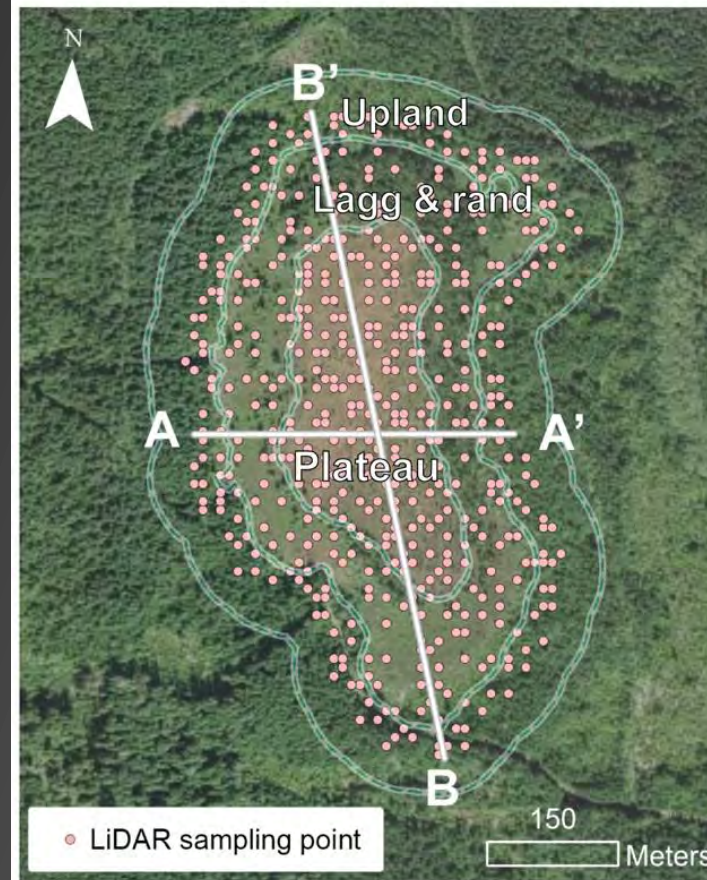


Results

Is topography consistently raised above the adjacent land area?

YES!

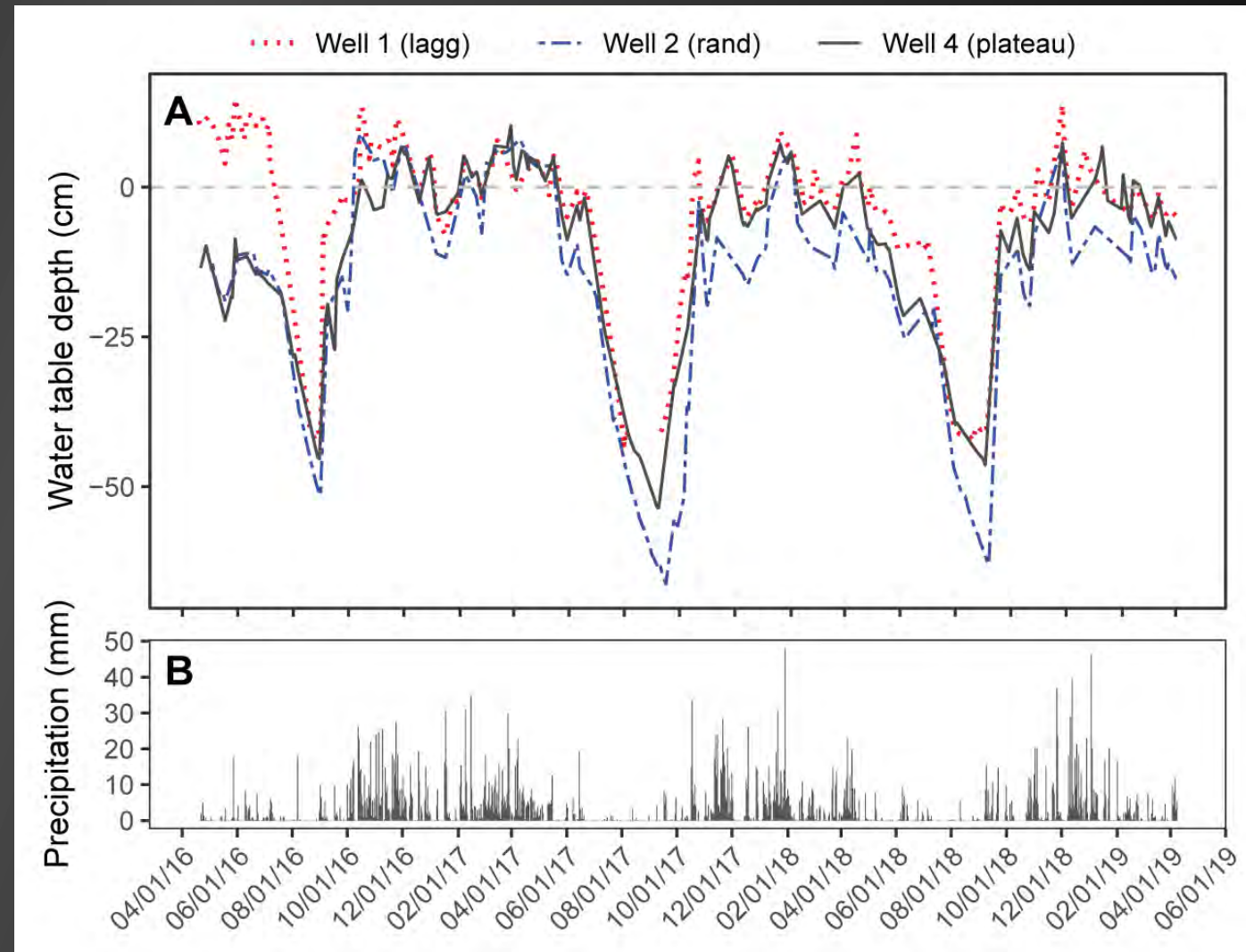
- nearly 3 meters
- *Sphagnum* peat is 3.8 m deep
- Basal age is 15,500 years old



Are there significant periods of the year when groundwater movement is primarily downward?

Shallow groundwater levels

- Water table strongly associated with precipitation events
- Sharp, rapid declines following rain events

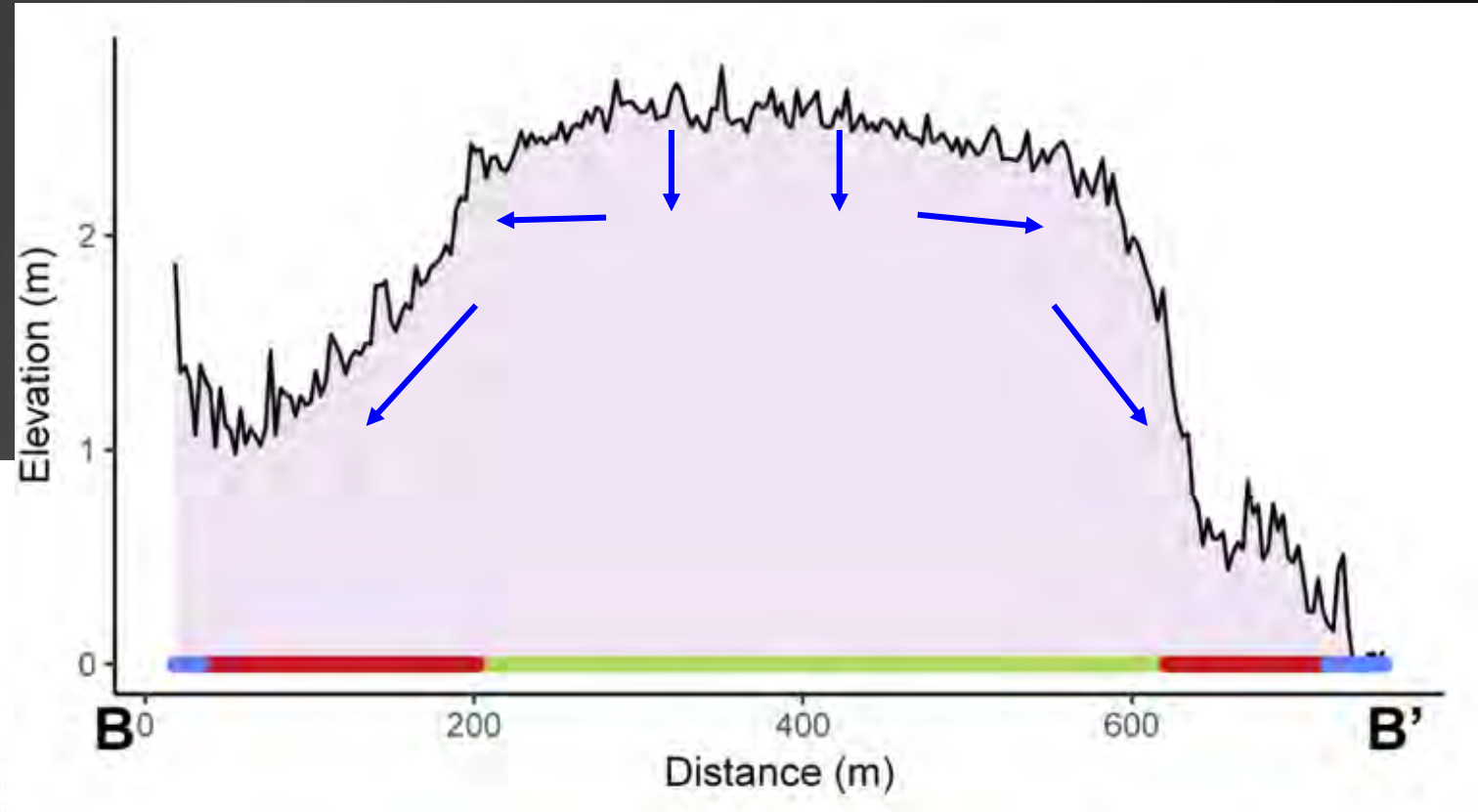
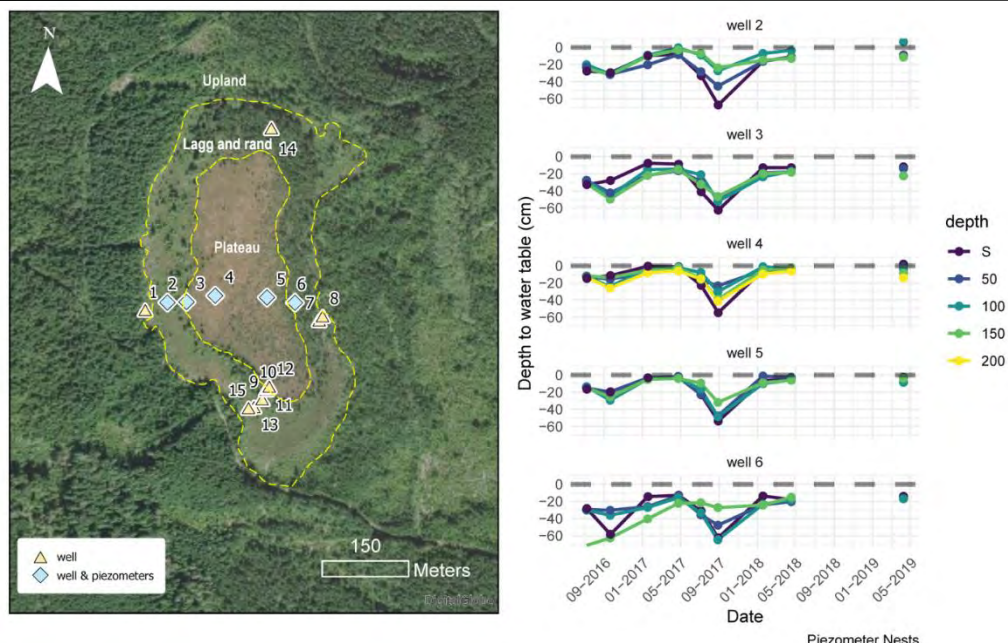


Continuous depth to ground water in wells 1 (lagg), 2 (rand), and 4 (plateau) for April 2016-April 2019

Are there significant periods of the year when groundwater movement is primarily downward?

Piezometers

- Downward during rainy season
- Water moves laterally from plateau, through rand, and discharges to lagg



Are the concentrations of pore water ions within the range reported for ombrotrophic peatlands?

	Western WA Precipitation¹	Crowberry Bog²	Puget lowland bogs^{1,3}	Mineral soils^{1,3}
Calcium (mg/L)	0.02 – 0.07	0.2 to 0.4	< 1.5	2 – 17

- Ca^{2+} concentrations in precipitation are extremely low
- Ca^{2+} concentrations < 2.5 mg/L indicate lack of Ca^{2+} input from mineral soil

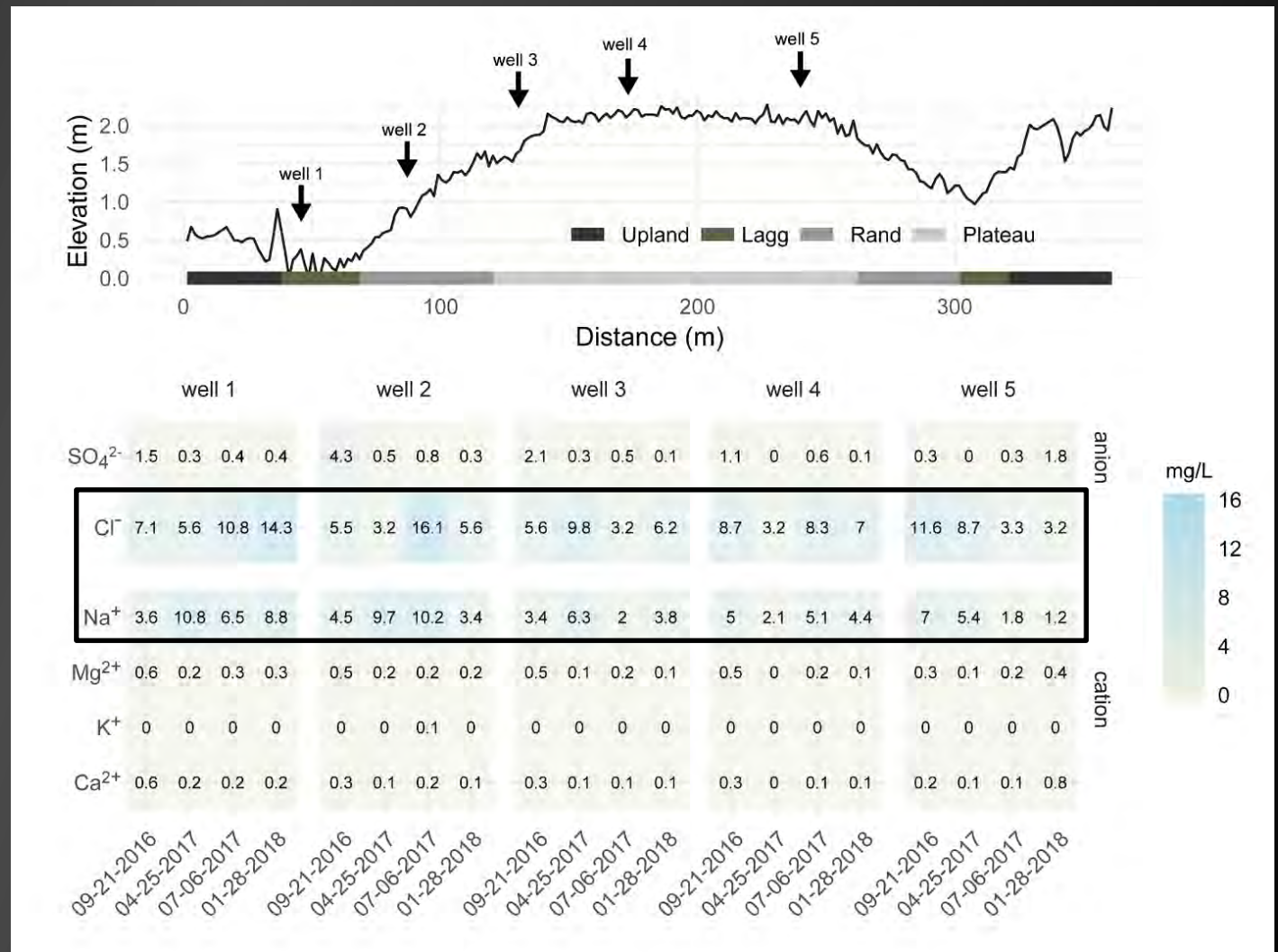
¹ Kulzer et al. 2001. Characteristics of Low-Elevation *Sphagnum*-dominated peatlands of western Washington.

² Rocchio et al. Ecohydrological characteristics of a newly identified coastal raised bog on the western Olympic Peninsula, Washington State, USA, *Ecohydrology*, 2021

³ Rocchio et al. Unpublished data. Land Use Impacts to Bogs of Western Washington.

Are the concentrations of pore water ions within the range reported for ombrotrophic peatlands?

- Na^+ and Cl^- were the most abundant ions in the bog
- Precipitation affected by sea spray has high levels of Na^+ and Cl^-
- Groundwater inputs would dilute Na^+ and Cl^- levels



Anion and cation concentrations across a transect from lagg to plateau.

Is vegetation composition limited to species tolerant of nutrient poor conditions?

Yes!

- Oligotrophic indicator species present
- Composition varied across ecological zones
- Vegetation structure was distinct in each zone

Sphagnum fuscum
(plateau)



Sphagnum capillifolium
(rand)



Sphagnum henryense
(lagg)



Plateau Vegetation

- short statured (<30 cm) Ericaceous shrubs
- continuous carpet of *Sphagnum fuscum* and *S. rubellum*
- *Lysichiton americanus* “wells”
- Stunted *Pinus contorta* var. *contorta* and *Tsuga heterophylla*
- *Eriophorum chamissonis* and *Rhynchospora alba* dominate water tracks



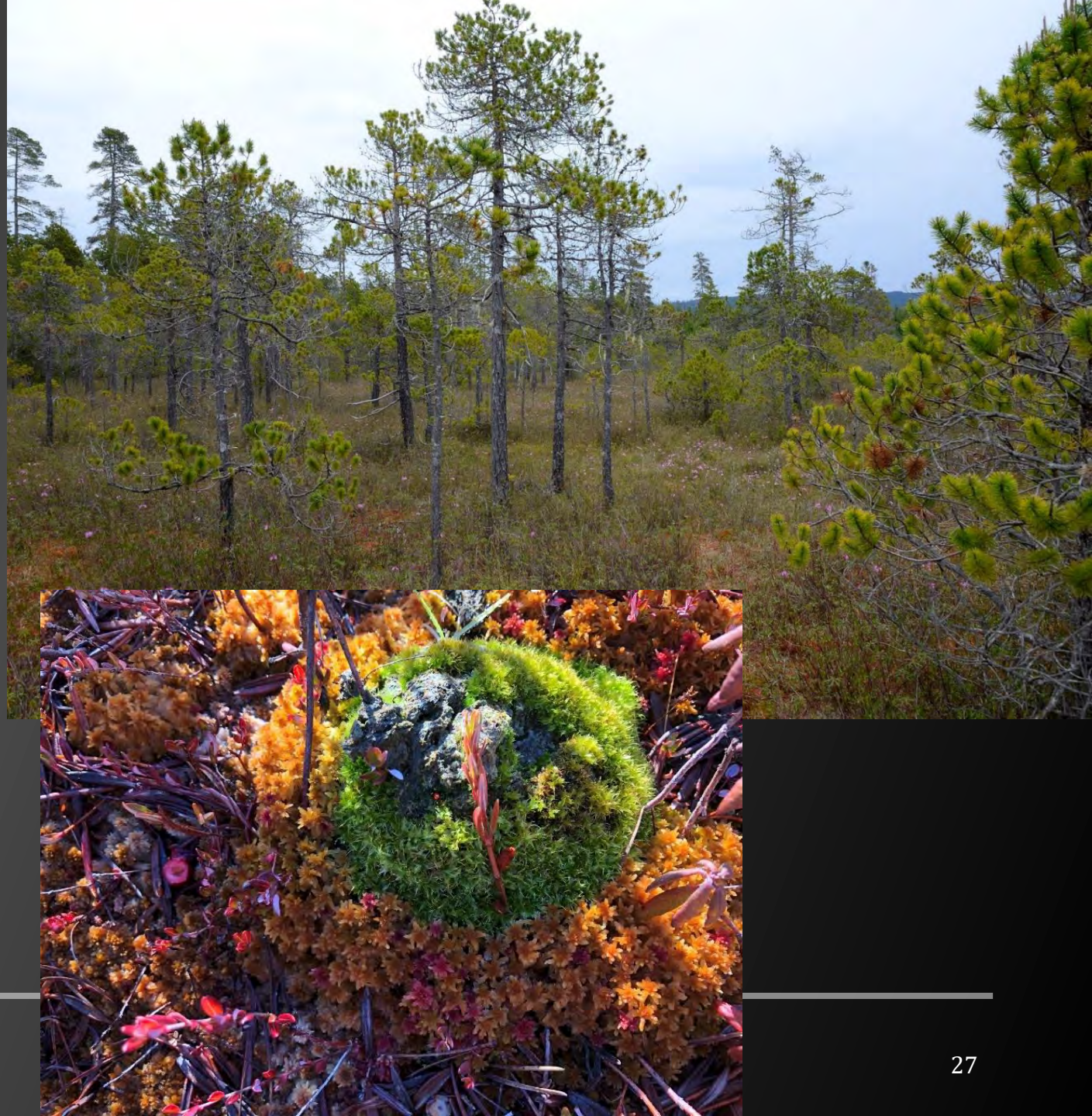
Dung moss (*Splachnum ampullaceum*)

G5 (Globally Secure)

SNR (Not Ranked in Washington)

Only two locations known in Washington

Habitat: limited to herbivore dung found
in acidic peatlands



Rand Vegetation

- Plant height, vigor, and density > plateau
- *Rhododendron groenlandicum*, *Kalmia microphylla*, and *Gaultheria shallon* dominant shrubs
- *Empetrum nigrum*, *Eriophorum chamissonis*, *Triantha occidentalis* spp. *occidentalis* and *Rhynchospora alba* are absent
- Closed canopy, tall forests
- *Sphagnum capillifolium* and *Pleurozium schreberi* are dominant



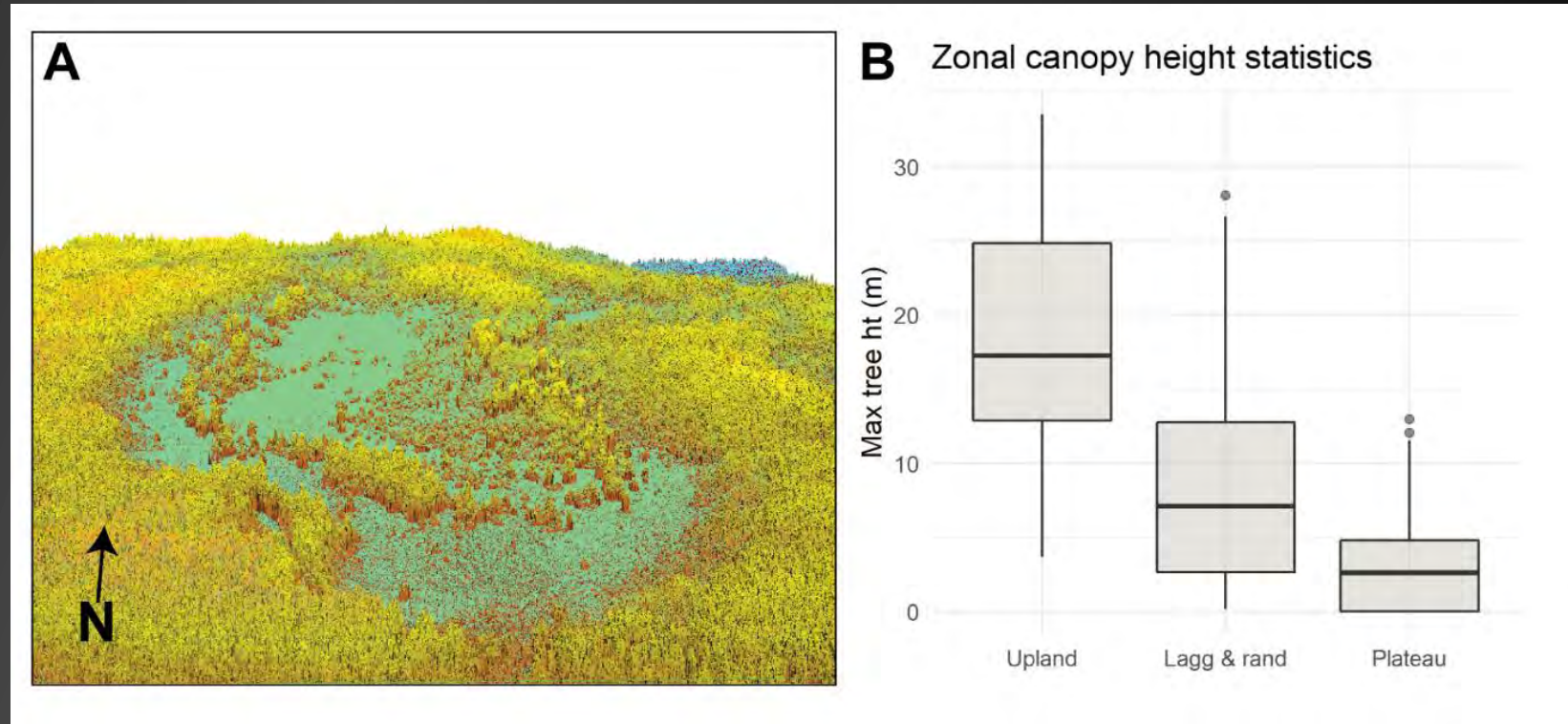
Lagg Vegetation

- Narrow zone between bog and adjacent uplands
- Swamp & marsh species present
- *Sphagnum henryense*, *S. pacificum*, and *S. papillosum* are common



Vegetation Structure

- Woody vegetation is stunted on plateau
- Rand and lagg woody species shorter than uplands
- Distinct zone of tall trees around outer ring of plateau



Summary

- Site topography is raised nearly 3 m
- Water levels closely tied to precipitation events
- Water movement is predominantly downward
- Water chemistry is indicative of coastal raised bogs
- Vegetation is typical of ombrotrophic bogs

Crowberry Bog is first documented raised, ombrotrophic bog in the western United States.



RESEARCH ARTICLE

Ecohydrological characteristics of a newly identified coastal raised bog on the western Olympic Peninsula, Washington State, USA

F. Joseph Rocchio¹  | Edward Gage² | Tynan Ramm-Granberg¹ |
Andrea K. Borkenhagen² | David J. Cooper²

¹Washington Department of Natural Resources, Natural Heritage Program, Olympia, Washington, USA

²Department of Forest and Rangeland Stewardship, Colorado State University, Fort Collins, Colorado, USA

Correspondence

F. Joseph Rocchio, Washington Department of Natural Resources, Natural Heritage Program, Olympia, WA, USA
Email: joe.rocchio@dnr.wa.gov

Present address

Andrea K. Borkenhagen, Advisian, Calgary, Alberta, Canada

Abstract

In western North America, ombrotrophic bogs are known to occur as far south as coastal regions of British Columbia. A recent discovery of a peatland with a raised peat surface on the western Olympic Peninsula in Washington State (Crowberry Bog), USA, suggested that the distribution range of this ecosystem type extends further south along the coast. To confirm if the site was an ombrotrophic peatland, we analysed its topography, hydrologic regime, water chemistry and vegetation. LiDAR data indicated that the peatland is elevated nearly 3 m above the surrounding landscape. Water table variations in the plateau were strongly associated with seasonal and daily precipitation events, indicating ombrotrophy. The hydraulic gradient on the plateau is downward through most of the year, demonstrating that precipitation is percolating vertically into deeper peat layers. In the rand, the hydraulic gradients are horizontal over much of the year, indicating that the plateau is draining through the rand to the lagg. Calcium, magnesium and potassium occur in very low concentrations, and the only ions in higher concentration are sodium and chloride, suggesting inputs of precipitation influenced by Pacific Ocean sea spray. Distinct vegetation composition and structure are associated with the plateau, rand and lagg zones of the site. These multiple lines of evidence indicate that Crowberry Bog is an ombrotrophic peatland, the first of its type identified in the conterminous western USA and the most southerly occurrence of its type in western North America.

KEYWORDS

bog, fen, hydrology, ombrotrophic, peatland, plateau bog, water chemistry

View / download publication:

<https://onlinelibrary.wiley.com/doi/10.1002/eco.2287>

Contact: joe.rocchio@dnr.wa.gov

Crowberry Bog Natural Area Preserve

