

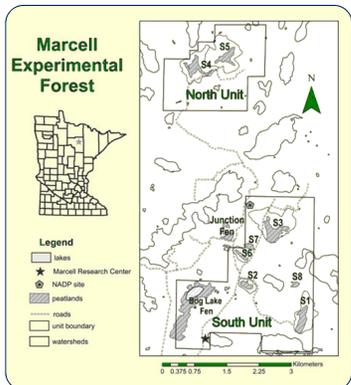
THE MARCELL EXPERIMENTAL FOREST RESEARCH CATCHMENTS

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INTRODUCTION:

- 1960s: Established to address a research gap on low-topographic relief catchments with uplands that drain to peatlands.
- Now, nearly 6 decades of data, findings, & site knowledge.



The Marcell Experimental Forest (MEF) in northern Minnesota, USA, where six catchments & other sites are part of a long-term research program.



Photo of the South Unit showing some experimental & reference catchments.

MARCELL EXPERIMENTAL FOREST (MEF)

<https://www.nrs.fs.fed.us/ef/marcell/>

<https://www.fs.usda.gov/rds/efrdata/efr/1>

STUDY AREAS

- Six research catchments (9 - 72 ha) for long-term monitoring & experimentation.
- Plot to landscape level studies of ecosystems at multiple additional sites.

FUNDING:

- USDA Forest Service funds long-term research.
- US Federal, State, & non-governmental funds for short-term studies.

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SITE CHARACTERISTICS

- Northern Minnesota, USA.
- 47.51°N, 93.47°W.
- Mississippi River & Hudson Bay headwaters.
- Continental, warm summer climatic region (Koppen).
- MAP = 780 mm, ~1/3 as snow. MAT = 3.4°C (-40 to 40 °C).
- Boreal peatland vegetation (*Picea*, *Larix*, & *Sphagnum*).
- Mixed northern forests on uplands: *Populus*, *Betula*, *Picea*, & *Pinus*.
- Glacial till & outwash sands (>50 m deep) & Precambrian bedrock.
- Surface elevation 412 - 438 m (12 m max. relief within catchments).
- Raised-dome bogs (precip. fed) or fens (groundwater fed).

RESEARCH THEMES

- 1960s - now: Forest & peatland hydrology. Properties of organic soils.
- 1970s - now: Land management effects on soil, water, air, & forests. Water, energy, & solute budgets.
- 1980s - now: Atmospheric deposition. Biogeochemistry. Peatland methane production.
- 1990s - now: Net ecosystem C exchange. Mercury cycling.
- 2000s - now: Climatic & environmental change. Carbon cycling. Source area dynamics.

ECOSYSTEM MONITORING

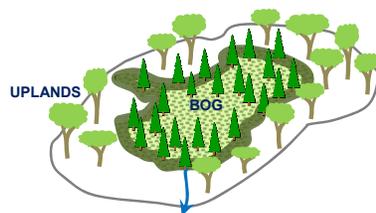
- 1960s - now: Streamflow. Water table elevation. Air temp. Precipitation. Soil moisture. Snow depth & water equivalents. Frost depth. Forest biomass. Upland runoff.
- 1978 - now: Stream water chem. Atmospheric deposition.
- 1980s - now: Static chambers for CO₂ + CH₄. Soil temps.
- 2000s - now: H₂O, CO₂, & CH₄ exchange with eddy covariance. Net radiation & PAR. Water isotopes are coming for all samples.
- Data from short-duration studies & recent monitoring.

EXPERIMENTATION

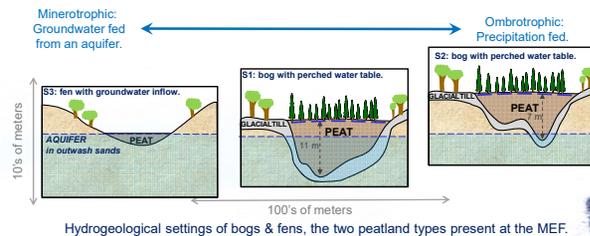
- 1967: S7 bog, drainage.
- 1968 - 1972: S8 bog, water manipulations.
- 1969 / 1974: S1 bog, stripcuts of black spruce.
- 1970 - 1972: S4 uplands, clearcut (aspen/birch harvest).
- 1972 - 1973: S3 fen, clearcut (*Picea* & *Larix*).
- 1980 - 1987: S6 uplands, clearcut (*Populus* / *Betula*) & forest conversion (to *Pinus* & *Picea*).
- 2001- 2009: S6 bog, sulfate deposition elevated.
- 2010: FACE log decomposition.
- 2012: S7 uplands, biomass harvest, with mercury isotope tracing.
- 2015 - now: S1 bog, SPRUCE warming & eCO₂.
- 2010s: snow removal & frost formation. Frost exclusion in peat.



Streamflow & water level monitoring in the S2 catchment.



Five of six research catchments have bogs, where uplands & central bogs drain to a perimeter lags that coalesce into zero-order streams.



Hydrogeological settings of bogs & fens, the two peatland types present at the MEF.

OTHER RESOURCES:

- Site & data managers.
- A research center with a prep lab, conference room, & lodging / kitchen.
- A chemistry laboratory for major ions, nutrients, metals, & water isotopes.

DATA AVAILABILITY:

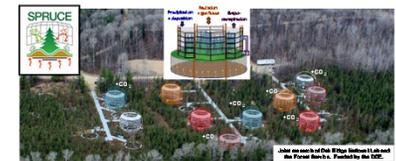
- We collaborate & share data.
- Some data are published @ the Forest Service Research Data Archive.

CURRENT CHALLENGES:

- Long-term funding & shrinking Federal allocations for research.
- A backlog of data to be published.
- Completing a transition from paper stripcharts to electronic sensors / logging.

THE FUTURE:

- More ecosystem manipulations.
- Collaboration & data synthesis.
- **Have ideas? Join us!**



SPRUCE, a peatland warming & eCO₂ experiment.



LEFT: The S2 bog (foreground), S6 bog (center left), & S3 fen (upper right) among the lakes & uplands of the northern Minnesota landscape. RIGHT: The S6 catchment after the 1980 upland harvest. BOTTOM: The S4 bog.

