Too many trees and warming winters:

Acadian pitch pines are susceptible to southern pine beetle

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Background

1. Pitch pines grow on Acadia's rocky summits.

Most pitch pine (*Pinus rigida* Mill.) in the park is found on mountains that burned in 1947. Below is Dorr Mountain, which is covered in pitch pine.

2. Southern pine beetle (SPB)

(*Dendroctonus frontalis* Zimmermann) is killing healthy pitch pine in the northeast (NY, MA). [1]

Image courtesy of Marc DiGirolomo, US Forest Service

3. Are Acadia's pines at risk for SPB?

Warmer winters unlock the possibility of SPB establishment. [2,3] Previous work uses stand basal area to determine SPB susceptibility: generally, more pines = more risk. [4,5]

Warmer winters allow SPB to expand its range northward, but forest characteristics contribute to the risk of SPB outbreaks. The nearest SPB outbreak is 200 miles south of Acadia. [6] We found individual beetles in York County, ME in 2021. [7]

Before SPB arrives on MDI, we measure pitch pine basal area and complementary forest metrics. We also assess minimum winter temperature variability in the park through space and time.

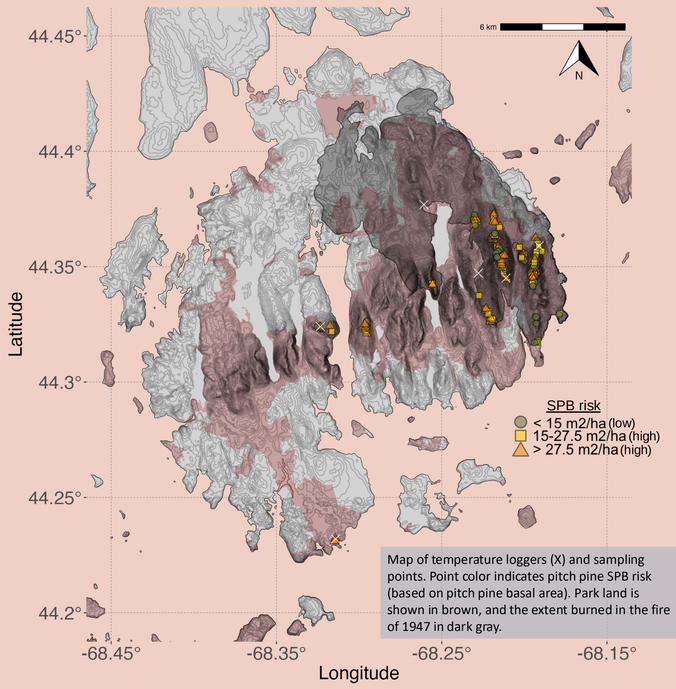
Methods

Temperature sensors:

We set out 5 temperature sensors (Onset HOBO loggers) in each park to record temperature hourly from summer 2023 – summer 2024.

Pitch pine stand sampling:

1. We chose random sampling points based on the pitch pine stands identified by the Vegetation Mapping Inventory Project for Acadia National Park (1997-2003). [8]
2. At each point, we established a variable-radius plot using a prism (BAF 4.592 m2/ha) . The prism determines which trees to measure.
3. We measured dbh (diameter at breast height) and distance from plot center to for each tree using ultrasound DME.
4. We used a fisheye lens and level attachment to capture a photo of the canopy at plot center, and then processed this data in R using the package 'hemispheR'. [9]



Map of temperature loggers (X) and sampling points. Point color indicates pitch pine SPB risk (based on pitch pine basal area). Park land is shown in brown, and the extent burned in the fire of 1947 in dark gray.

Examples of hemispherical photos, taken with a fisheye lens.

The canopy may be open (A; D) or more closed (B; C).

A closed canopy can help the SPB succeed by trapping in the pheromones they use to communicate.

See our webpage for references and more information!

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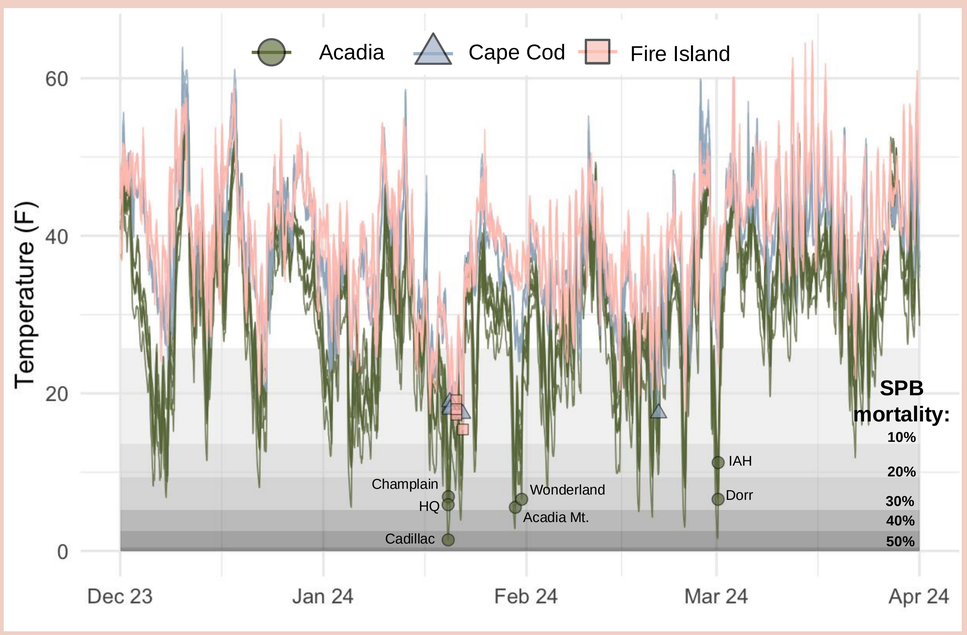
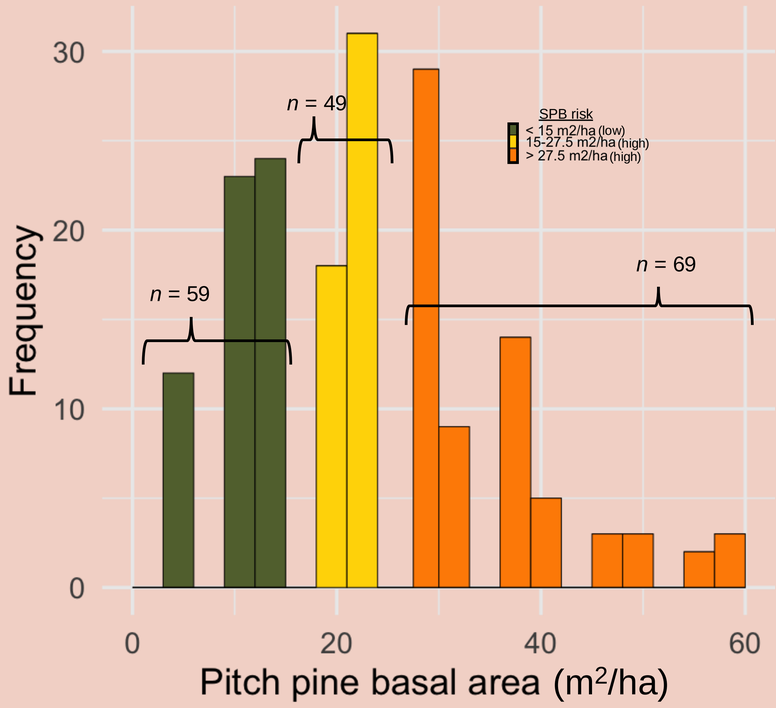
U.S. Department of the Interior
David Evans Shaw Family Foundation
Schoodic Institute at Acadia National Park
National Park Foundation
University of New Hampshire

Results – Temperature



Last winter would have killed < 50% of SPB in Acadia, and < 10% on Fire Island and Cape Cod. [2] Minimum winter temperature differed significantly between sites overall ($P < 0.001$). Just within Acadia, minimum temperature on Cadillac Mt. was colder than all other sites, and Isle au Haut was also warmer than Acadia Mt. and Park Headquarters. **Existing temperature stations (Cadillac, HQ) provide meaningful data about minimum winter temperature in Acadia NP.**

Results – Trees



We measured **high pitch pine basal area in 66% of plots** (seen in yellow and orange)**.** We define this metric (> 15 m^2/ha) based on the hazard rating model created by Jamison et al. 2022 for northeastern pitch pine sites specifically. [4] We also illustrate SPB susceptible stands as defined by older work in southern pine plantations (seen in orange, > 27.5 m^2/ha, Mason et al. 1985). [5] **High basal area was not correlated with environmental variables, like fire history or elevation**.

Take-home points

1. **High pitch pine basal area suggests that 2/3^{rds} of sites sampled in Acadia are susceptible to SPB.**
2. **We did not see spatial patterns of basal area.**
3. **Winter temperatures suggest a growing regional SPB population.**

What can we do?

We can apply the **R.A.D. framework** to respond to SPB risk. [10] Fully **resisting** change will be difficult: SPB is a natural part of the forest landscape, even if it can be destructive. If we **accept** change, we may lose the ecologically important pitch pine at its northern range limit. We can **direct** change by intentionally disturbing this ecosystem. Pitch pine woodlands are an early successional forest type. Periodic fire and removal of some trees can increase the health and vigor of the remaining trees. [4] By directing change, we can preserve Acadia's pitch pine summits for years to come.