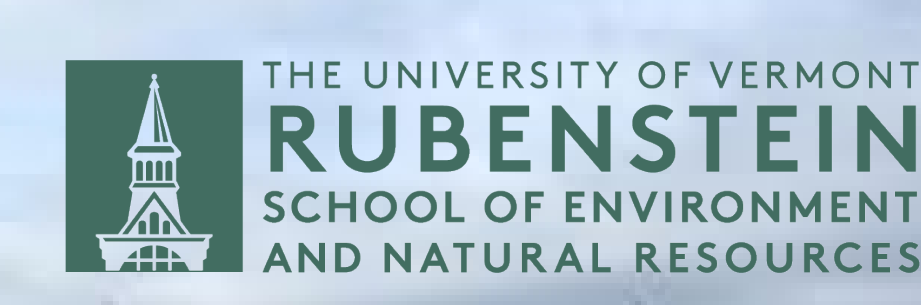# Sixty years of coastal red spruce: Stand dynamics at historic inventory sites

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Project Overview

The coastal forests of Maine are dominated by red spruce (*Picea rubens*), a cold-adapted species projected to lose 45% suitable habitat in the US by 2100. The maritime climate has allowed a narrow band of spruce to persist along Maine's northern coastline. However, not enough is known about the forest dynamics and climate sensitivity of coastal red spruce to predict its response to climate change.
We leveraged historic inventory sites established in 1959 by Dr. Ron Davis to address this knowledge gap.

Project Questions

In coastal red spruce:

1) How has forest composition and structure changed in 60 years?
2) What are the primary drivers of radial growth?

Study Area
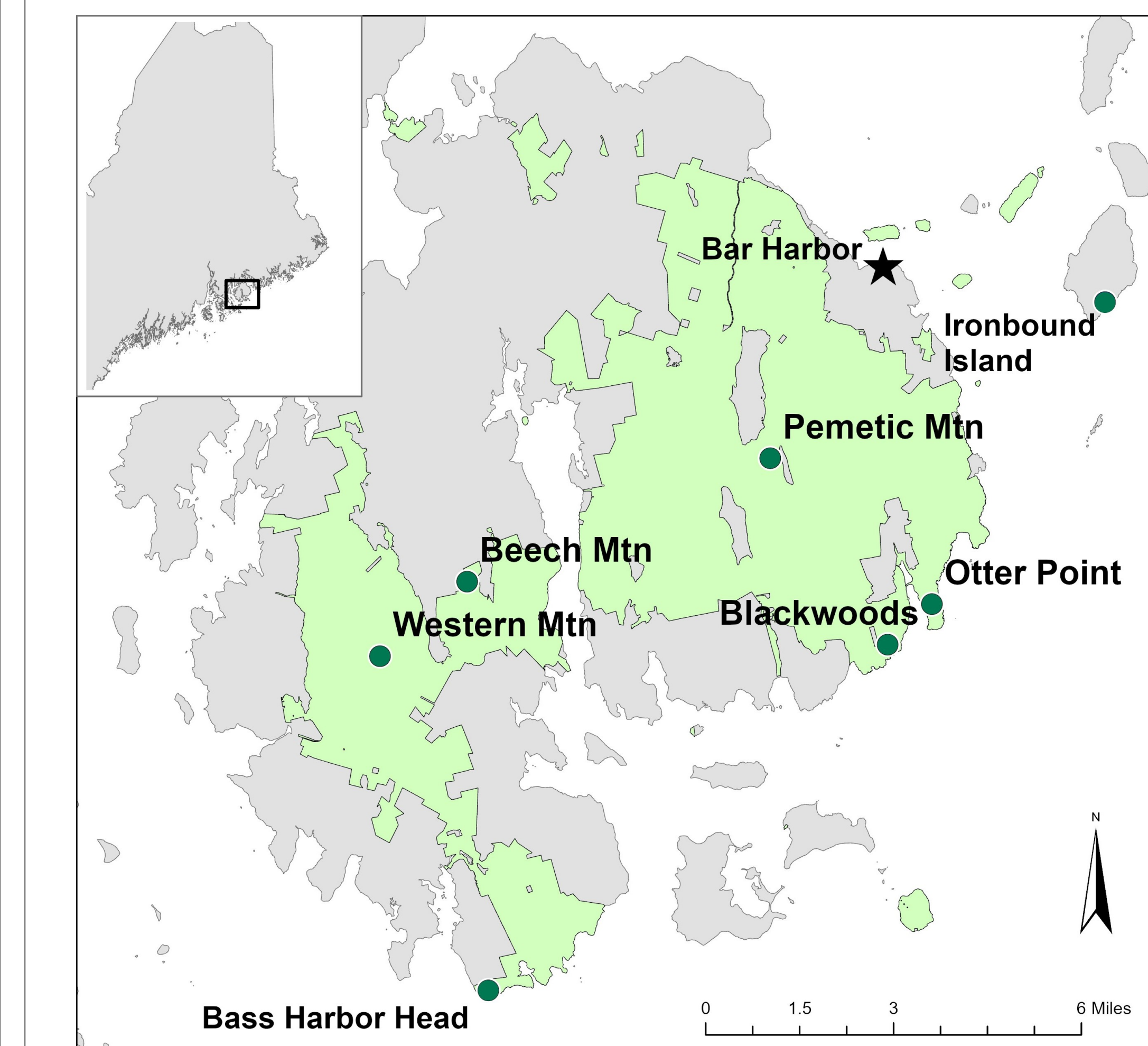
Figure 1. Site locations (dark green dots) in Acadia National Park (light green shading), ME (inset). Each site was sampled in 1959 and resampled in 2020/ 2021.

Methods

- Site relocation based on published maps and descriptions, as well as personal communication with Dr. Davis
- Established 10 x 200 m plots
  - Sampled in the full 2,000 m² plot:
    - Trees: DBH, crown class, status, species, coordinates
    - Saplings: DBH, species
  - Sampled in 30 1 m² quadrats:
    - Vascular plant % cover by species
    - Seedling count by species and size class
    - Lichen, bryophyte, rock, wood, and stem % cover
- 20 soil depth measurements
- 30 increment cores from stratified random trees
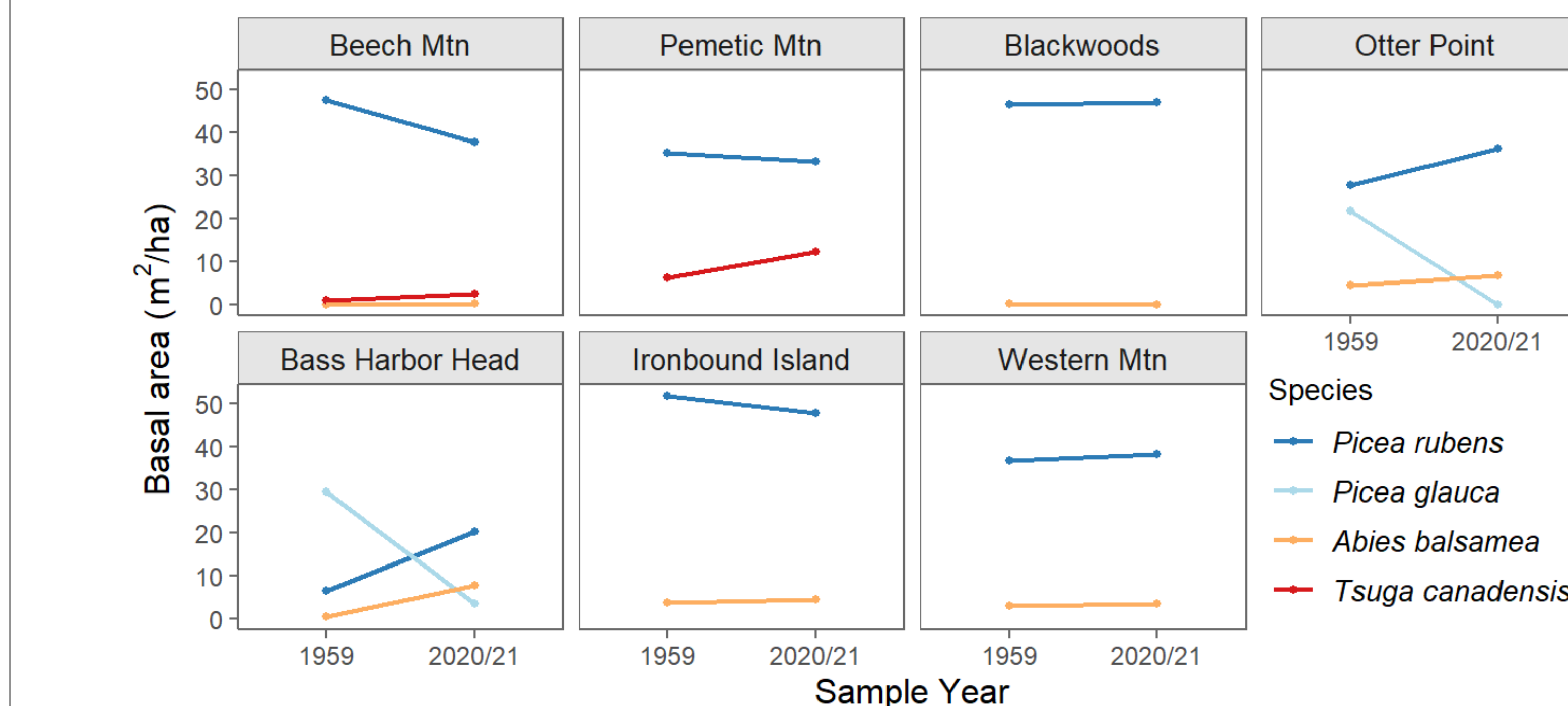- Hourly temperature readings using iButtons

Preliminary Observations
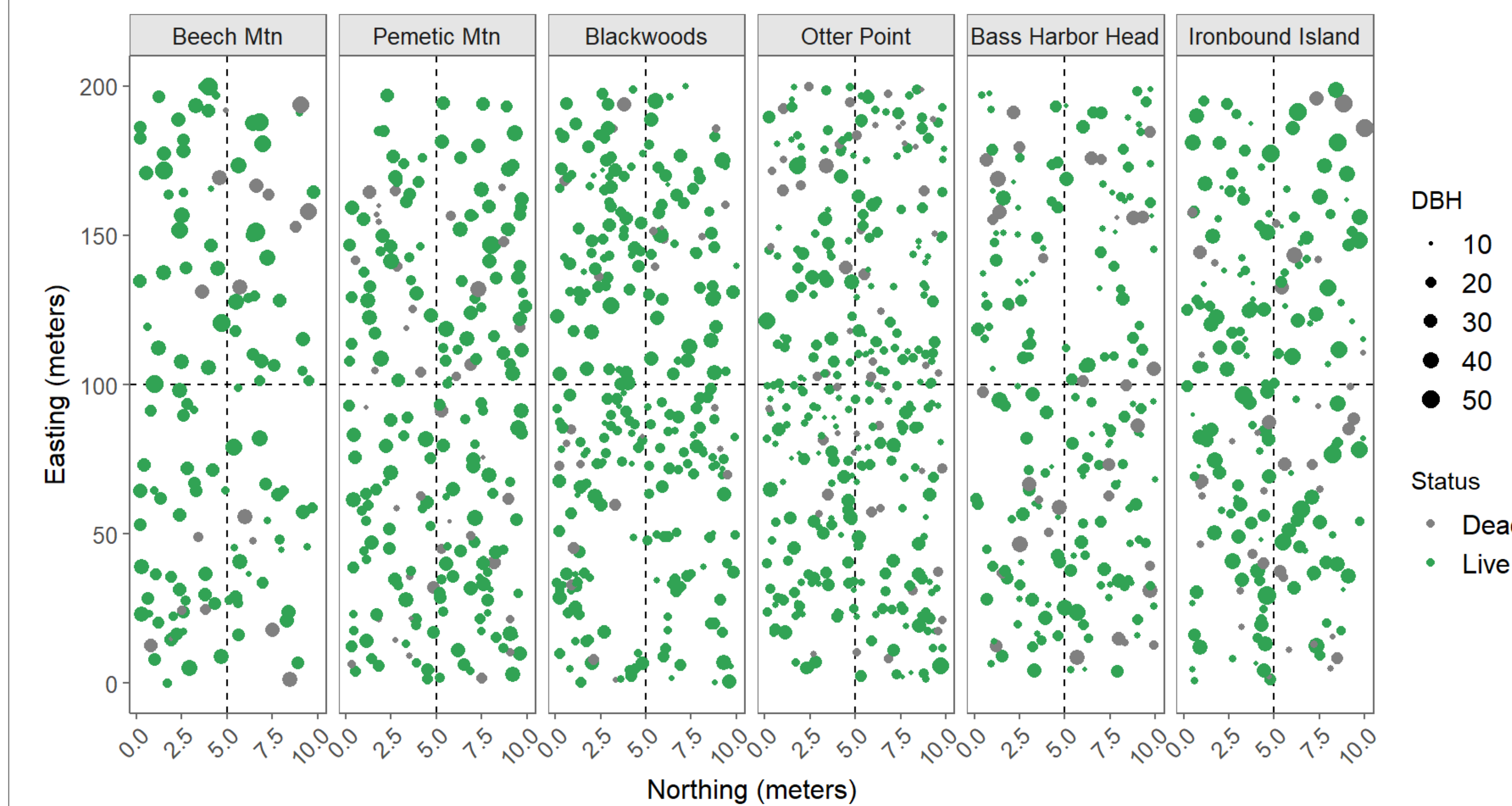
Figure 2. Mapped locations of all trees ≥ 10 cm DBH (diameter at breast height) at six spruce dominated stands resampled in 2020 and 2021.
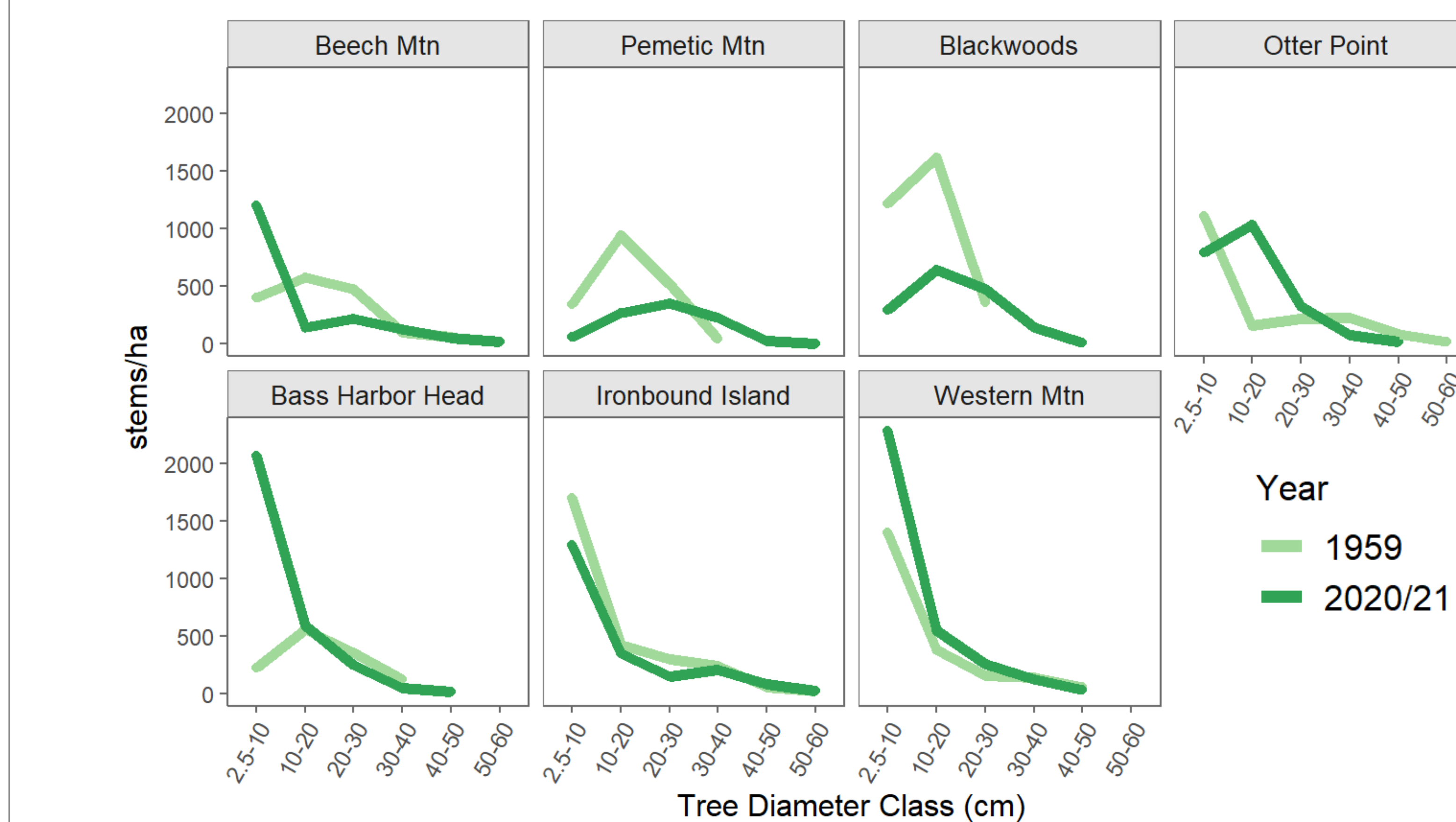
Figure 3. Tree diameter distributions for each site by DBH in 10 cm increments.

Figure 4. Change in basal area (m²/ha) between the two sampling periods for the four most abundant tree species. All live trees ≥ 2.5 cm DBH were included. The total plot size was 500 m² in 1959 and 2,000 m² in 2020/21.

Table 1. Tree density, basal area, above-ground biomass, and coarse woody debris (CWD) volume calculated for each site and sampling event. CWD was not inventoried in 1959. Live trees ≥ 10 cm were included in the density, basal area, and biomass calculations.

Site	Density (stems/ha) 1959	Density (stems/ha) 2020/21	Basal area (m²/ha) 1959	Basal area (m²/ha) 2020/21	Biomass (Mg/ha) 1959	Biomass (Mg/ha) 2020/21	CWD Vol. (m³/ha) 2020/21
Beech Mtn	1220	560	51	39	294	230	77
Pemetic Mtn	1500	885	44	49	234	277	81
Blackwoods	1980	1265	44	48	217	258	21
Otter Point	700	1450	50	40	295	206	68
Bass Harbor Head	1040	895	38	27	201	138	160
Ironbound Island	1040	815	57	50	336	296	118
Western Mtn	740	960	36	37	205	205	62

Initial Impressions

- The sites were structurally and compositionally diverse in 1959 and followed different trajectories over the last 60 years
- Disturbance varied across sites
  - Severe wind events at Otter Point and Bass Harbor Head
    -> Decline of white spruce
    -> Change in diameter distribution
- The diameter distributions of the two oldest stands (Western Mtn + Ironbound Island), were largely unchanged over the sampling period

Future directions

- Quantify structural differences through time and among sites
- Relate the historic inventory sites to spruce forests throughout the rest of Acadia National Park using National Park Service long-term monitoring data.
- Increment core data:
  - Reconstruct past disturbance at each site
  - Construct age distributions for each site
  - Assess impact of spruce budworm outbreaks
  - Explore climate-growth relationships and identify primary drivers of radial growth
- Generate management recommendations for coastal red spruce

Acknowledgements