# Monitoring the Health of Vermont's Forests: Long-Term Trends and Network Expansion

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By establishing a diverse and robust network of long-term forest health monitoring plots with detailed, yearly measurements, the VMC aims to provide to provide a baseline of forest health conditions across the state of Vermont.  Such field measurements are critical to detect subtle changes in forest health and explore potential drivers of decline.

## Introduction

In 1991, the Vermont Monitoring Cooperative and the Vermont Department of Forests, Parks, and Recreation created a statewide forest health monitoring network, designed to uncover important relationships, changes, and stressors impacting Vermont's forested landscape. Yearly field measurements at these plots were initially concentrated in intensive study sites on Mt. Mansfield and the Lye Brook Wilderness Area where they could be co-located with abiotic environmental measurements.  Recognizing the limitations of limiting analyses to intensive research sites, over the last two years the network was expanded from 14 to 41 plots, intensifying previous forest health surveys and sampling a wider range of biophysical regions. As a result of this recently expanded network, there is more capability to uncover the key trends that are affecting the current state of the broader forested landscape.

## Methods

**Plot Design**:  Plots are established using the National Forest Health Monitoring protocol. Four 7.32 m radius subplots are established following standard Forest Inventory and Analysis protocol. Each subplot contains a 2.01 m radius microplot located 3.66 m east of the subplot center.

**Traditional and Expanded Forest Health Metrics:**  In each subplot, we record the presence of animal **browse**,  abundance and type of **invasive plant species** as well as **hemispherical photo metrics** such as canopy cover, gap fraction and leaf area index. Every tree with a diameter at breast height (DBH) ≥ 12.7 cm in the subplot is marked and measurements made for **DBH and height**, **tree health metrics** (crown class, vigor, dieback, transparency, defoliation, discoloration, and other damages). The canopy of each tree is photographed on up to four sides to be digitally analyzed for **digital transparency**. In the microplot, the **abundance and vigor of seedlings and saplings** is recorded.
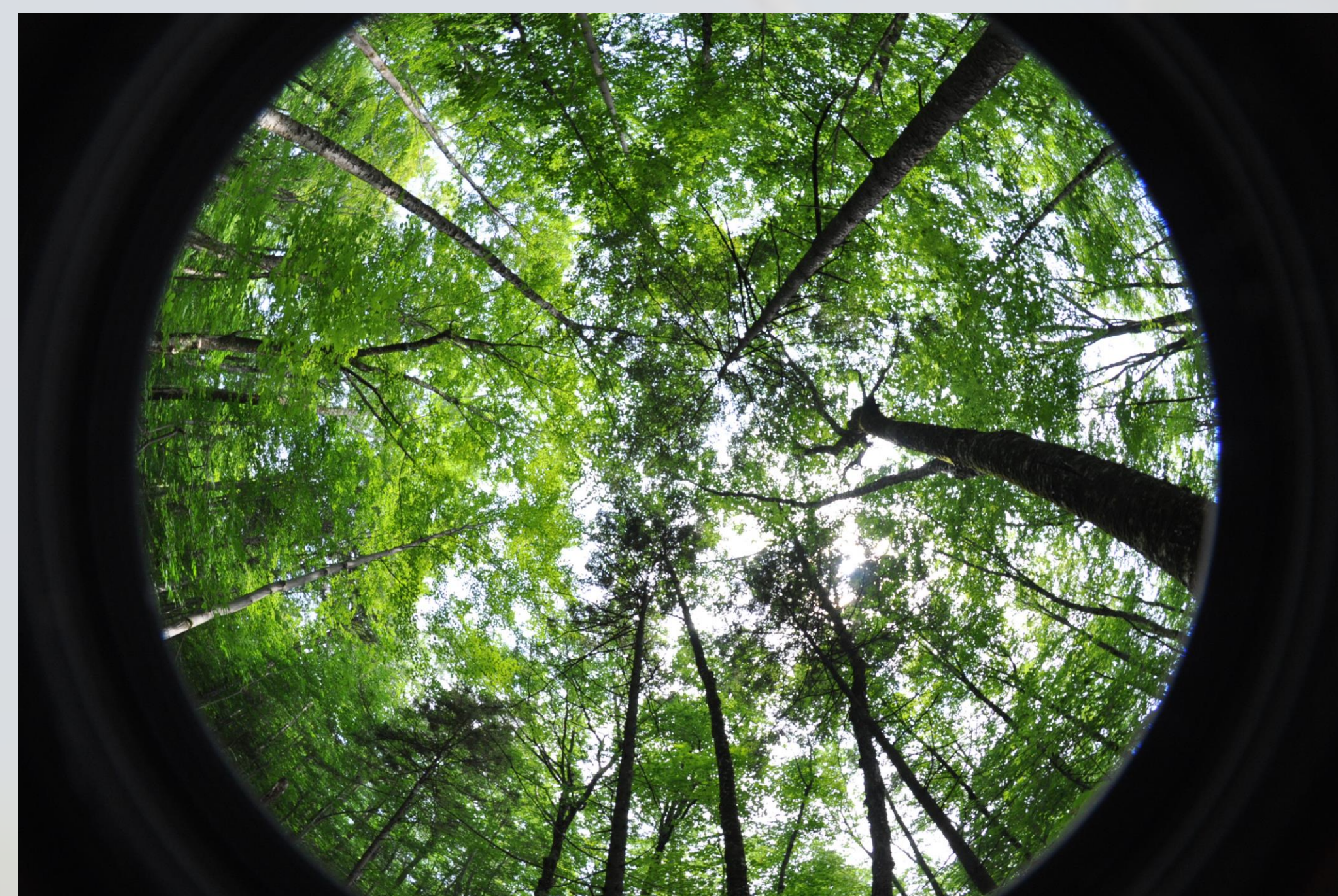


*Hemispherical photo. Transparency and hemispherical photos were added to the methods in 2014.*

## Expansion

From 2014 to 2015, 22 plots were added in new biophysical regions. This expanded the project from 3 to 8 bioregions, and from 4 to 11 forest types.
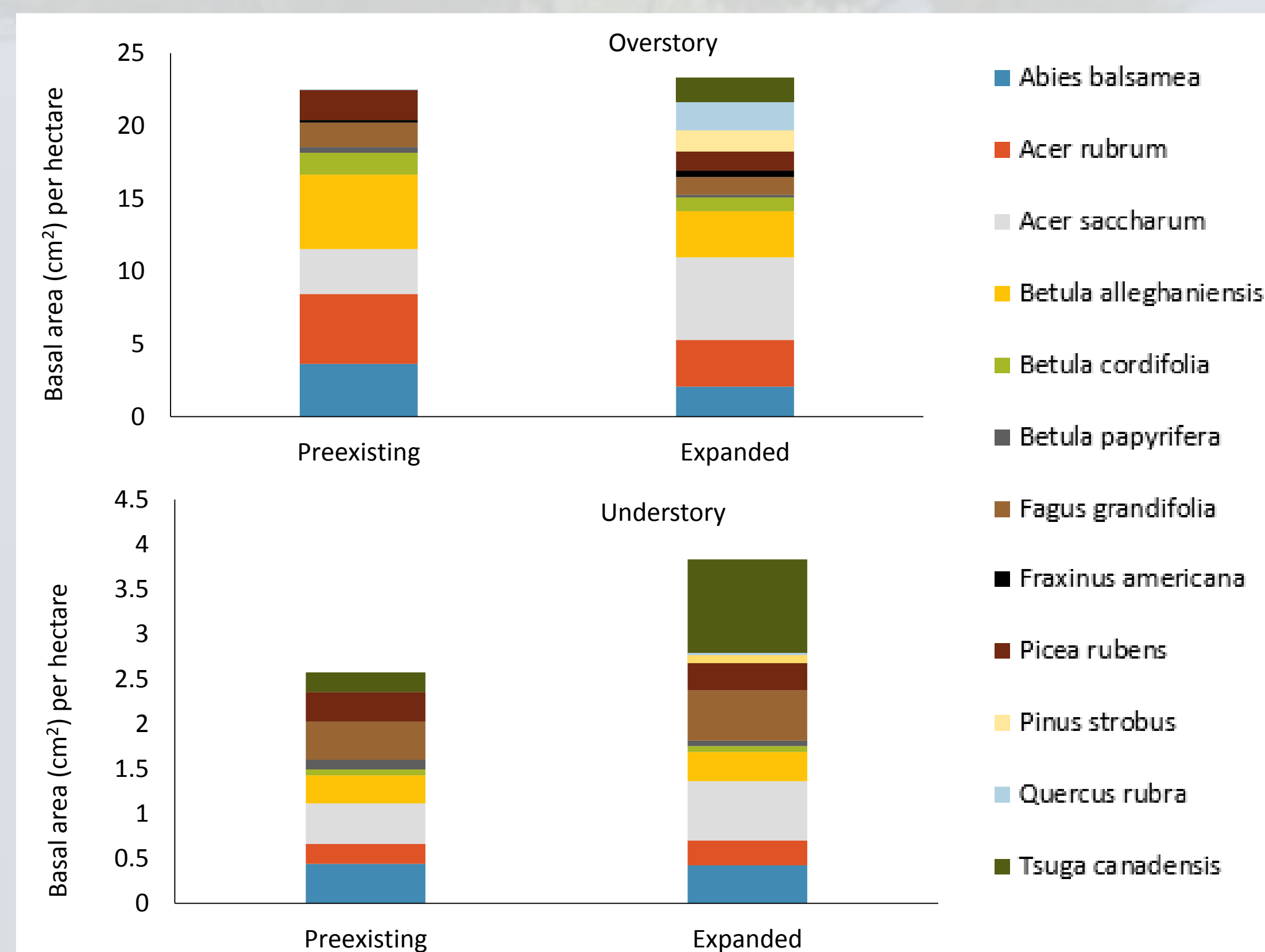


*Basal area per hectare of each species in the overstory and understory, in the preexisting (pre-2014) plot network and in the expanded (2015) plot network.*
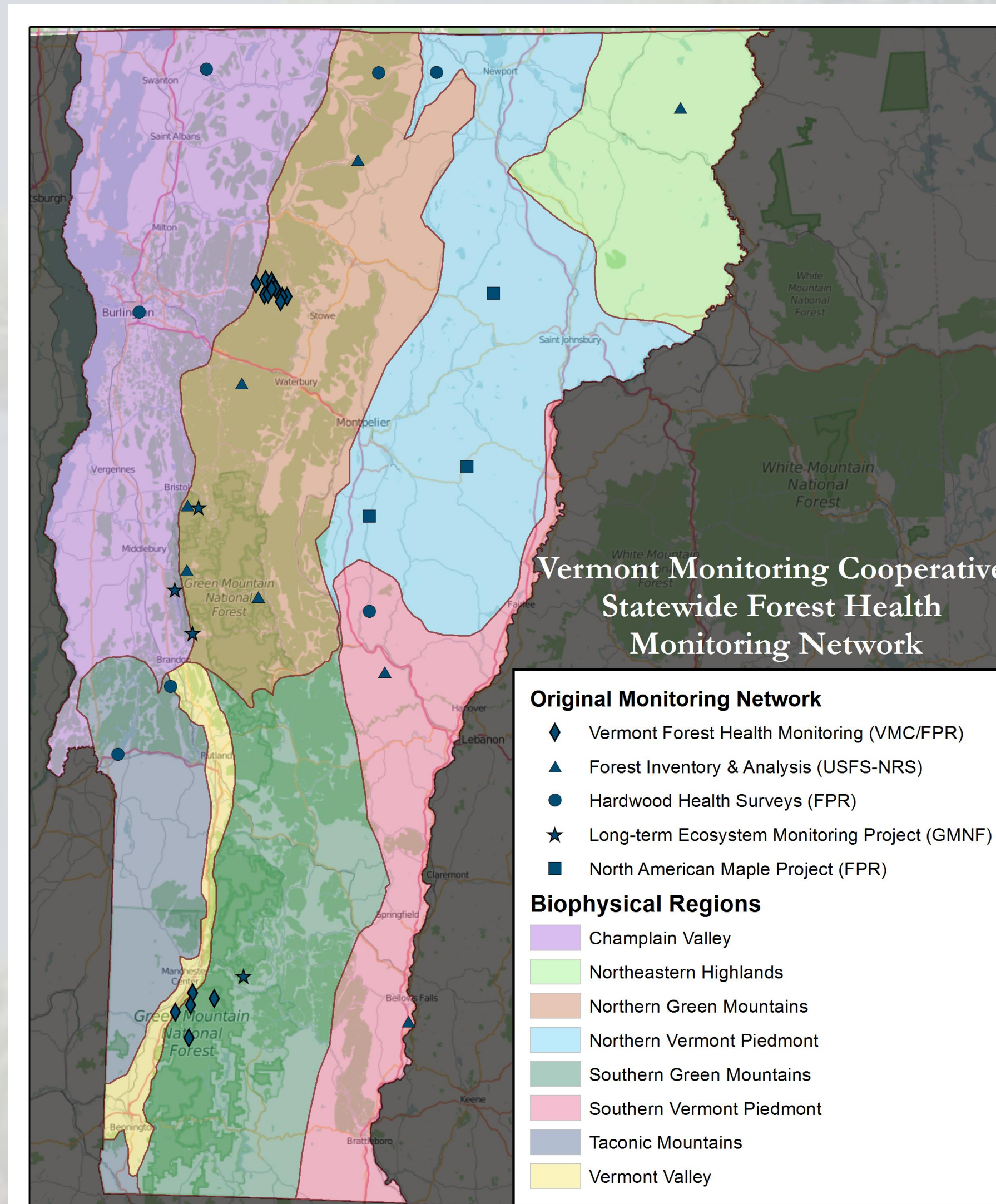


*Map of the Forest Health Monitoring Program plot network.*

## Results and Conclusions

The expanded plot network represents new bioregions, forest types, and tree species. Because of the deliberate expansion of this forest health monitoring network yearly assessments of all dominant species across Vermont can be included in monitoring efforts as a robust baseline for comparison to other broad forest health assessments. This information has already been used to uncover interesting patterns in species demographics and condition.  For example, percent dieback across all major species increased from 2014 to 2015.

In addition, work is ongoing to standardize the forest health data from the historical plots to the expanded network, which will give new insights into the broader forest health trends in the state. Combining the long-term record of the forest health monitoring program with the increased spatial breadth will allow managers and researchers to better understand how forest health patterns fit into the larger ecological picture of Vermont's ecosystems.

***For more information of the forest health monitoring data and results see the VMC 2014 Annual Monitoring Report.***
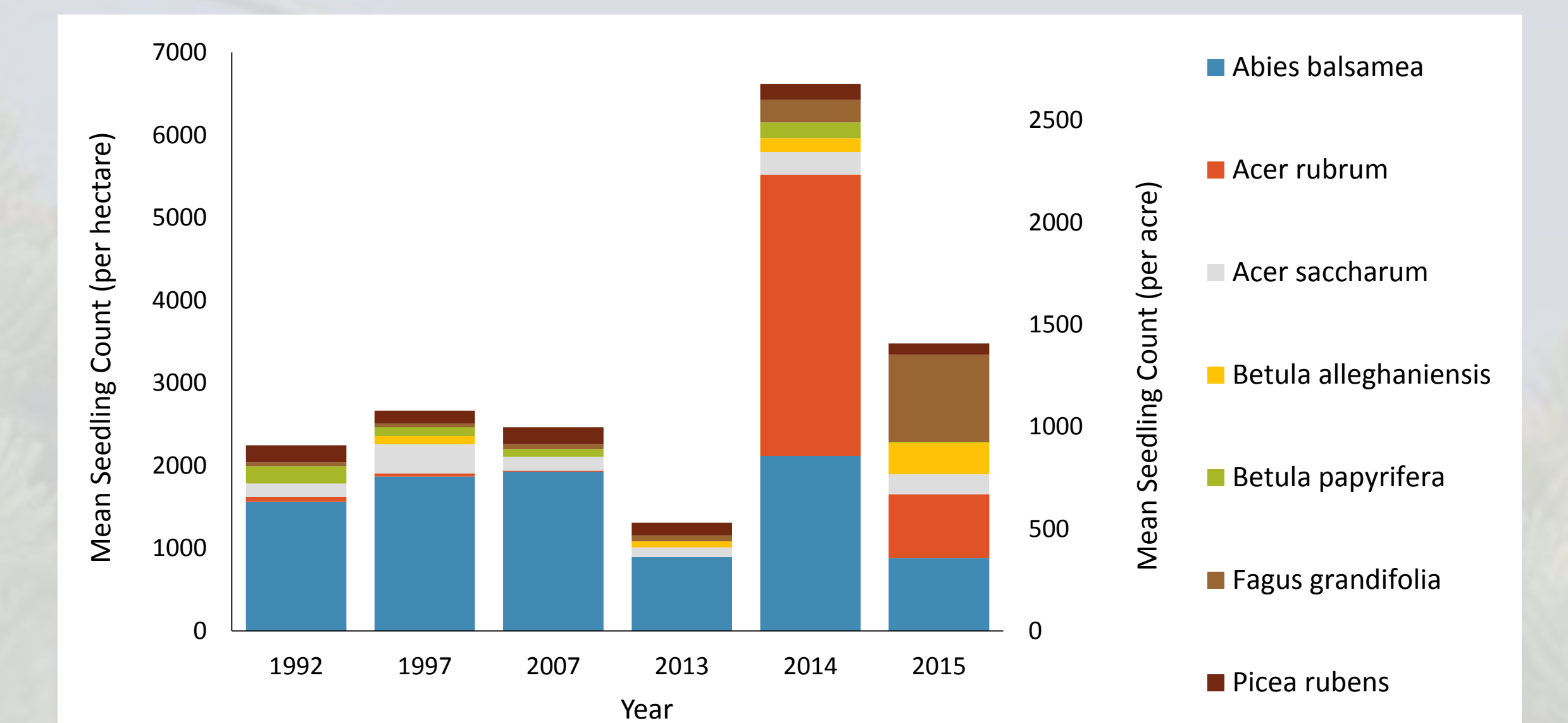


*Mean seedling count per species by year in a subset of plots on Mt. Mansfield with long-term seedling records.*
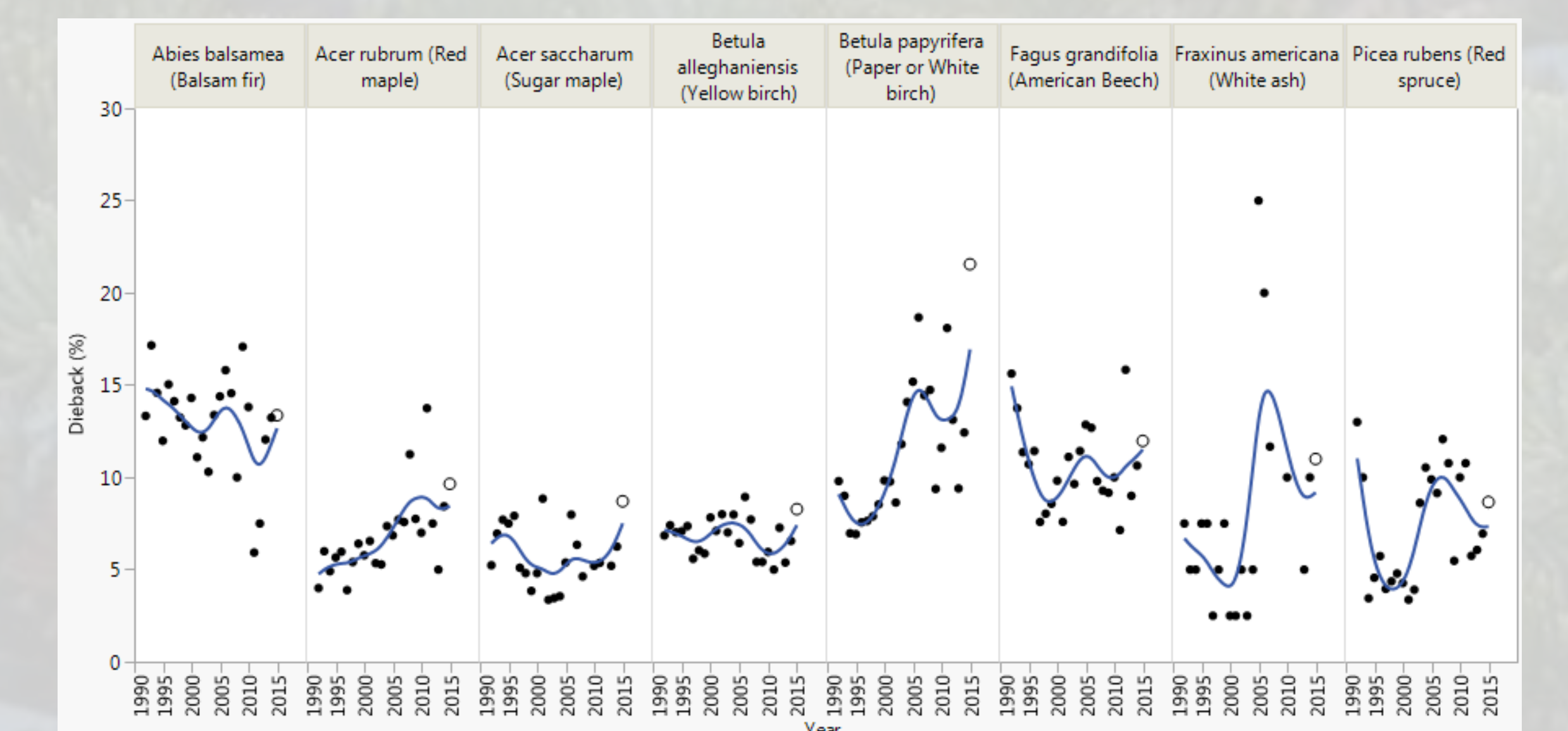


*Mean dieback percentage per species by year.*