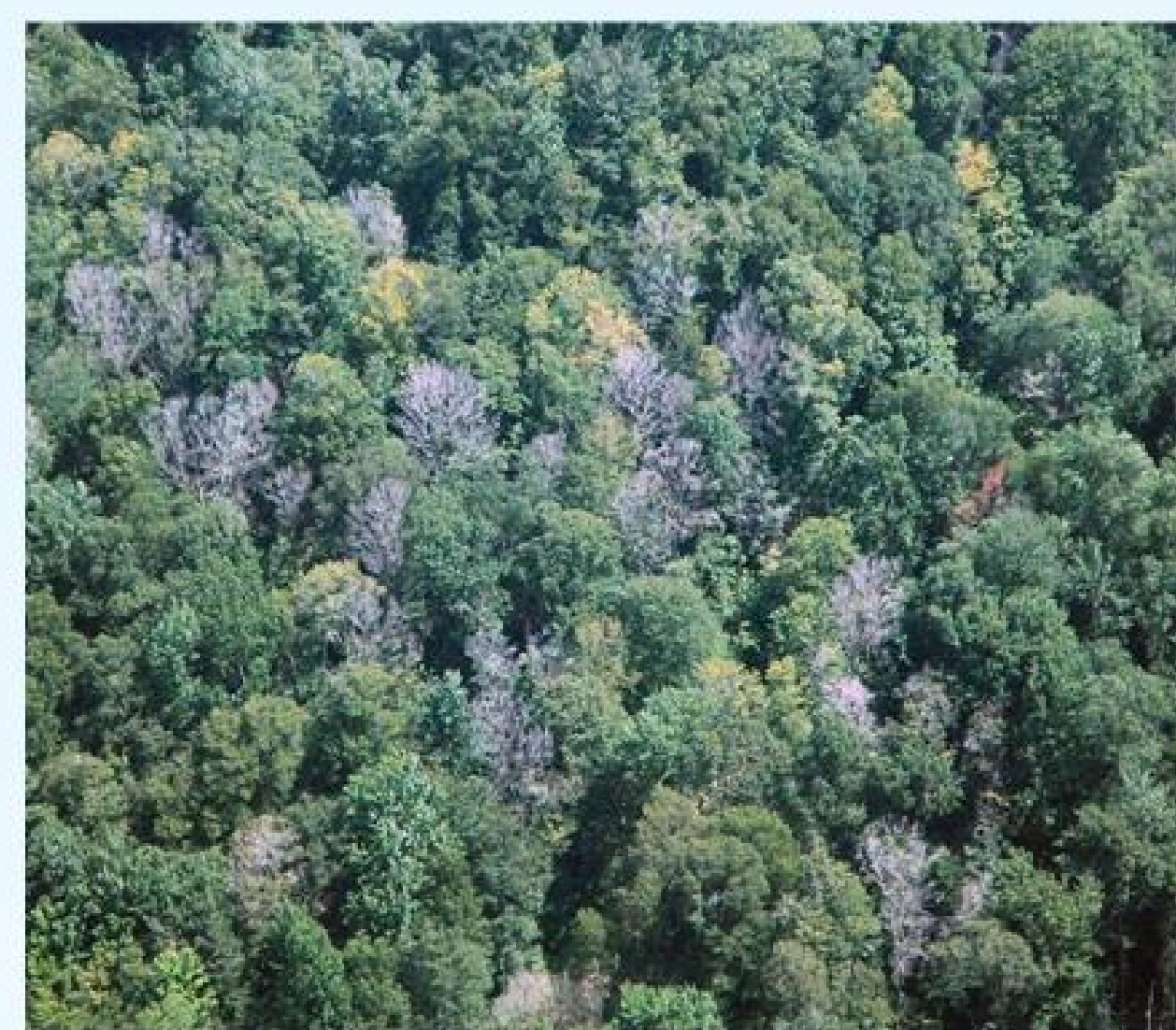


Beech Mortality and Drought in Maine

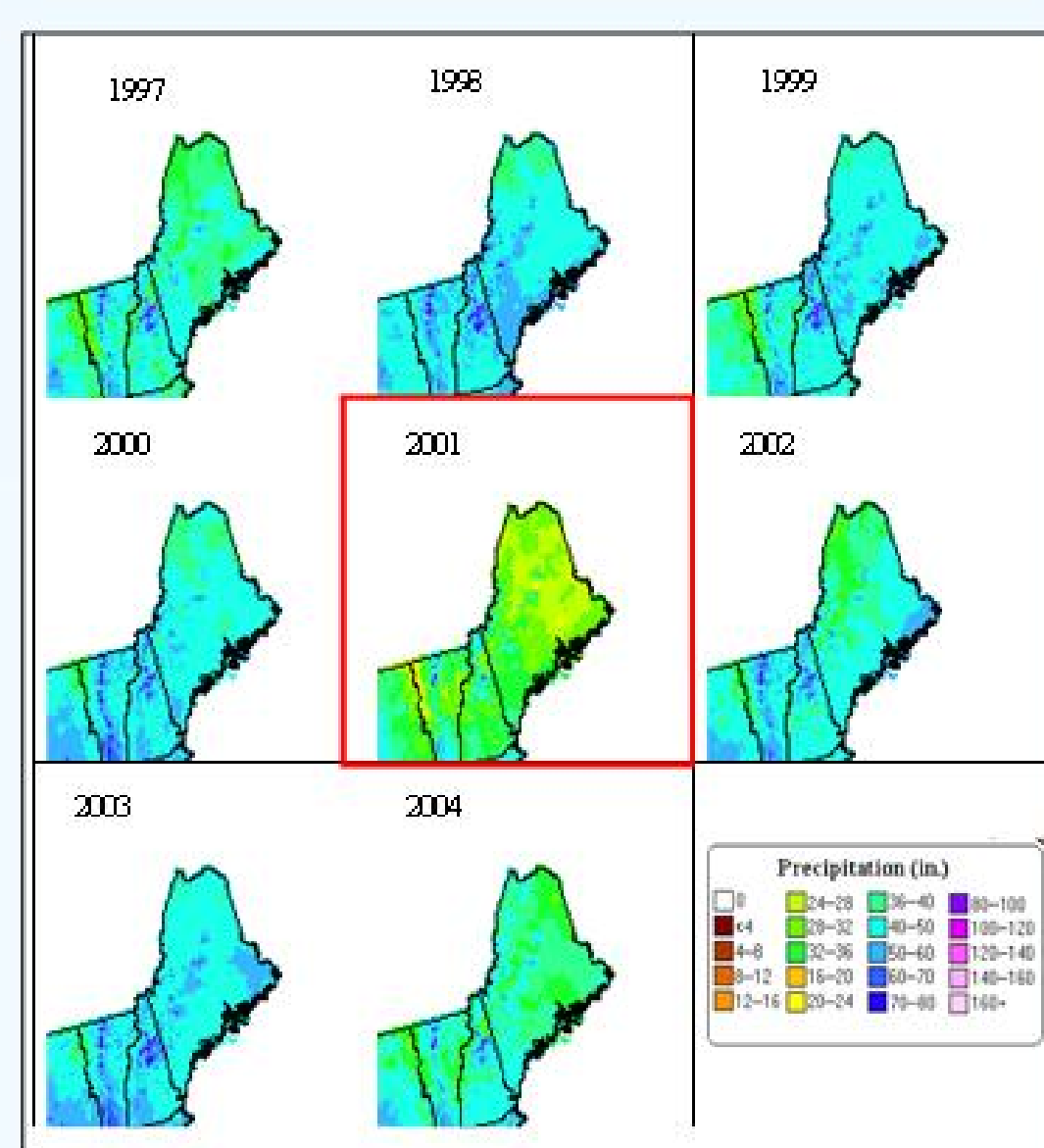
Introduction

Forest Inventory and Analysis (FIA) plots for Aroostook County, Maine's largest northern county, measured from 1999-2002 showed an average cumulative mortality of 13% since 1995 in stands with $\geq 20\text{ft}^2$ of basal area of beech (*Fagus grandifolia*) per acre. Inventory plots measured just one year later showed an average cumulative mortality of 44% since 1995, an increase of 31% mortality in a single year. Beech bark disease has affected most of these stands since the 30's and 40's but can't explain the sudden increase in mortality in 2003. The objective of this study is to investigate the likely causes of the increase in mortality.



Courtesy USFS

Drought is a Likely Factor



- Precipitation was half of normal in 2001.
- Stressed trees would likely appear dead in late 2002 and during the summer of 2003.



Research Question & Hypotheses

What factors have led to the recent increase (since 2003) in beech tree mortality?

- Drought incited mortality event(s)
 - Shallow, well drained soils predisposed trees to stress
 - Neonectria* fungus kills weakened beech, not other tree species
- Beech bark disease predisposed the trees to drought stress
 - Many affected trees were too weak to survive drought
 - Warmer winters favored scale insect population that further weakened trees



Methods

- 23 townships in four northern counties in Maine were sampled
- Paired 1/5 acre plots:
 - High mortality Sites (typically >20% mortality of beech)
 - Low mortality Sites (\leq half the mortality of High Site)
- Measurements:
 - Diameter of all trees > 5 in.
 - Core ≥ 12 beech and 12 from alternate species
 - dominant or co-dominant
 - Slope, Aspect
 - Soils (drainage class, total depth, rooting depth)
- Beech
 - Abundance of scale insect (*Cryptococcus fagisuga*)
 - Area of bark showing symptoms of disease
 - Presence of *Neonectria* perithecia
 - Bark samples in fall containing perithecia for fungal identification

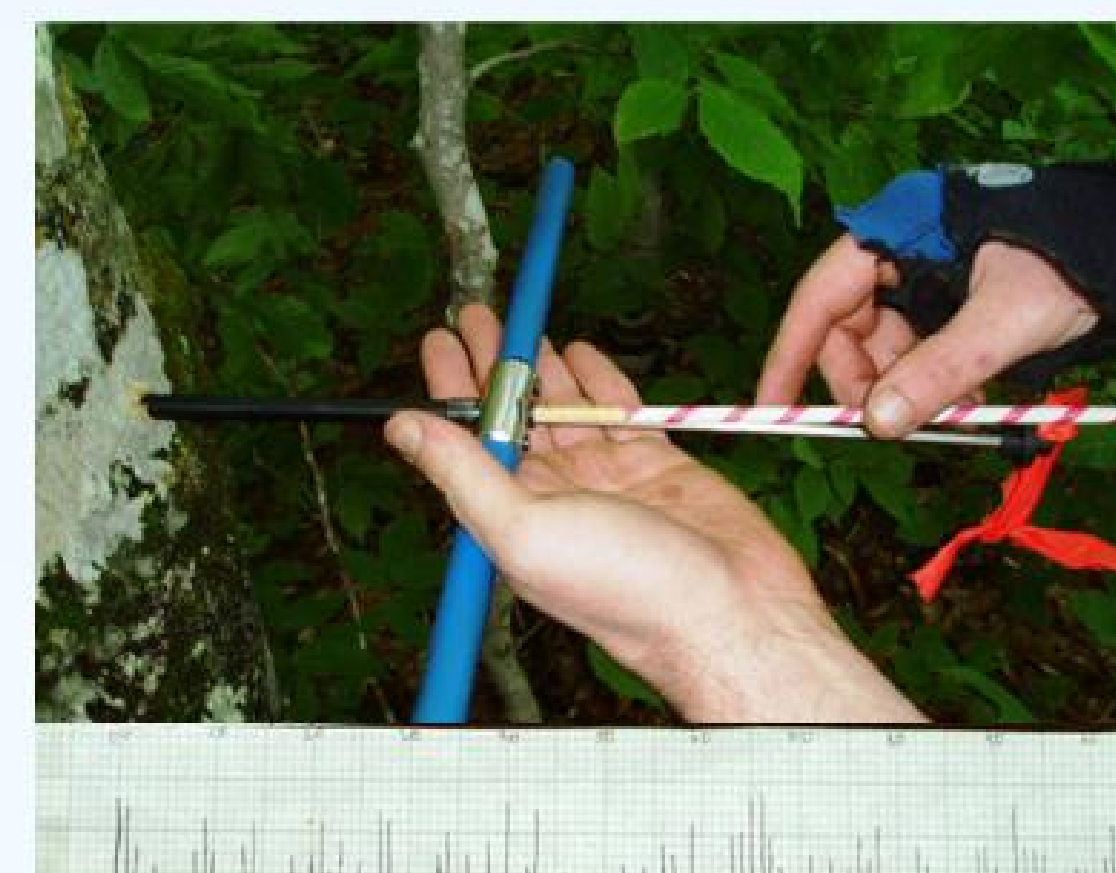
Matthew T. Kasson
& William H. Livingston

School of Forest Resources,
University of Maine
5755 Nutting Hall
Orono, ME 04468

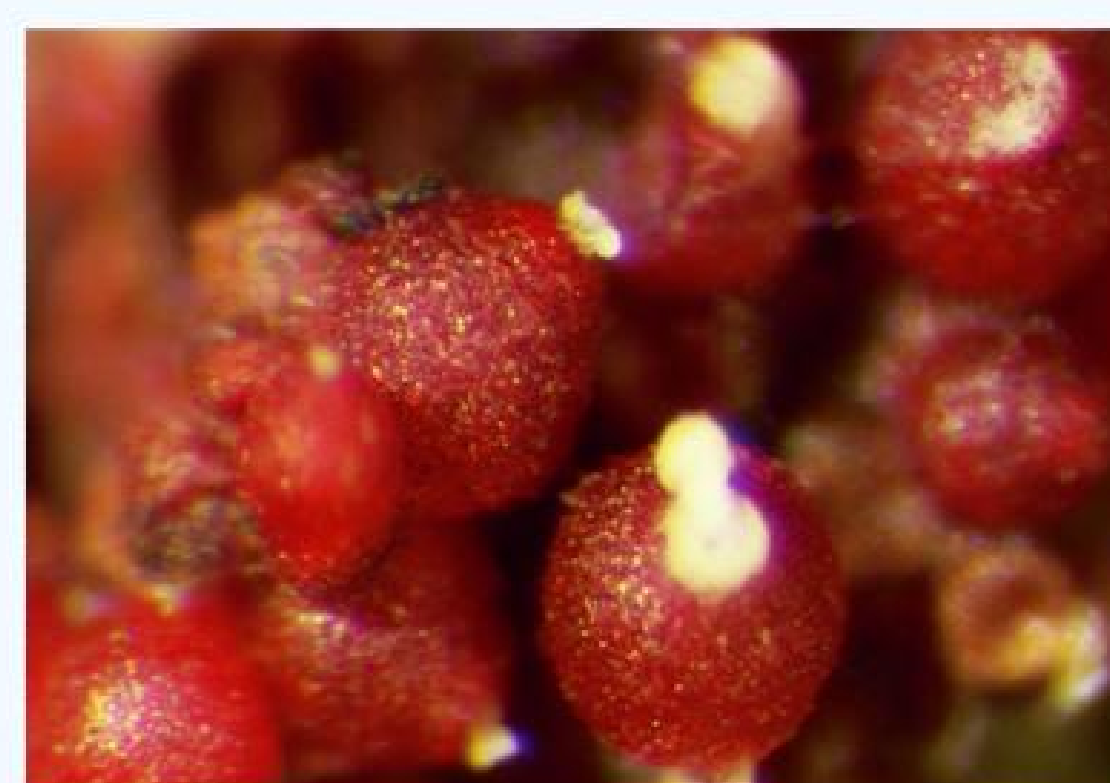


Analysis

- Used of dendrochronology to evaluate the relationship between:
 - drought
 - onset of tree dieback and mortality
 - when and how much beech bark disease affected radial growth
- Relate severity of mortality to:
 - Site factors affecting rooting depths
 - predisposition to drought stress
 - Bark colonization by the *Neonectria* fungus.



Neonectria Fungus Identification



- Two *Neonectria* species associated with BBD
 - Exotic fungus- *Neonectria faginata*
 - Native fungus- *Neonectria ditissima*
- Collected perithecia of *Neonectria* from the bark on the lower stem.
 - Bark discs extracted with arch punch in fall, frozen (-20 C), then rehydrated in the lab to induce sporulation
- Ascospore measurements off exuding perithecia used to differentiate *Neonectria* species
 - Ascospore length >14.3 μm , *Neo. ditissima*
 - Ascospore length <13.3 μm , *Neo. faginata*
- Micro- and macroconidia measurements of *Cylindrocarpon* Anamorph vary by species
- Culture Pigmentation and growth rates somewhat variable



Results – Two Stand Types Found

Stand Type I- “Aftermath” Forest

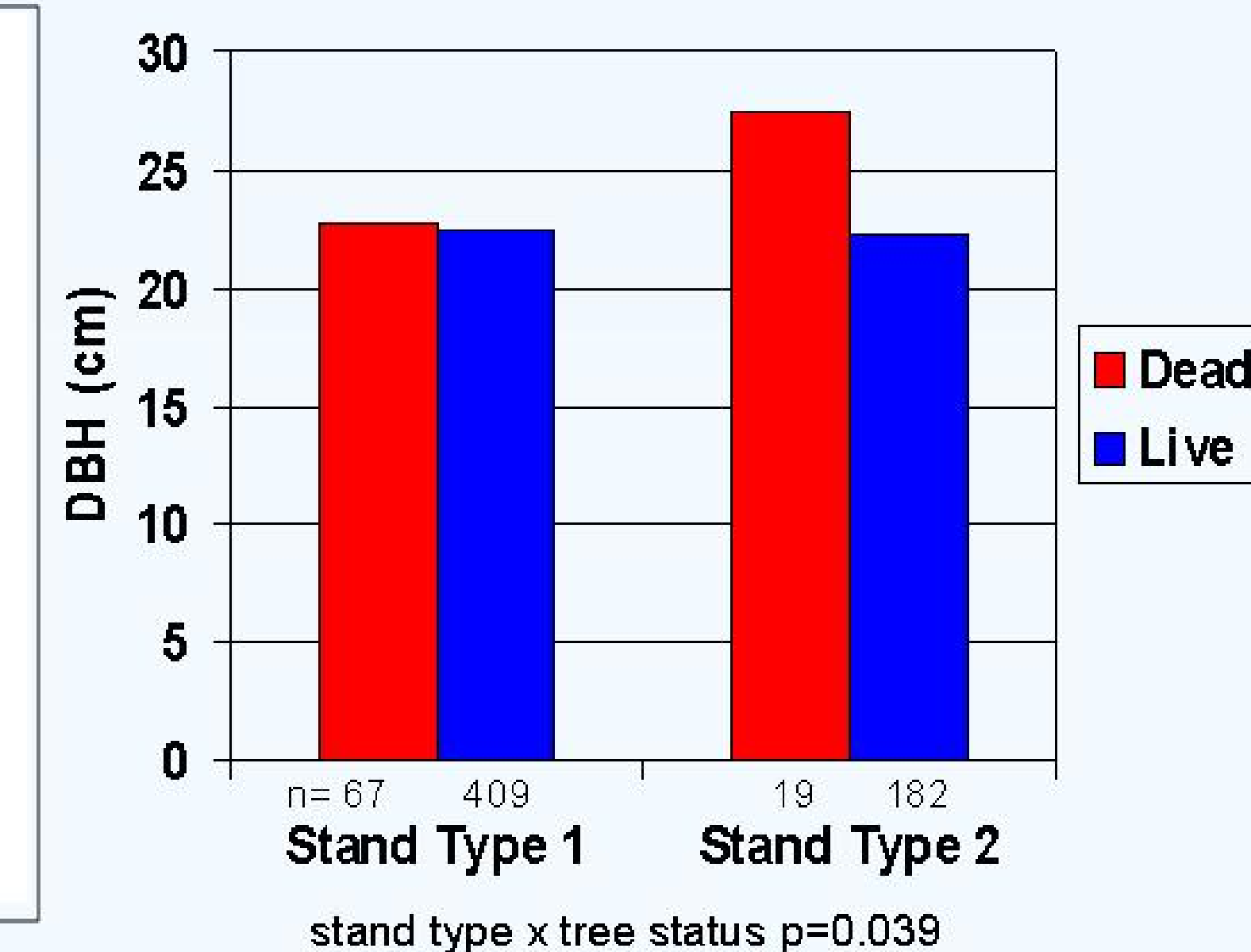
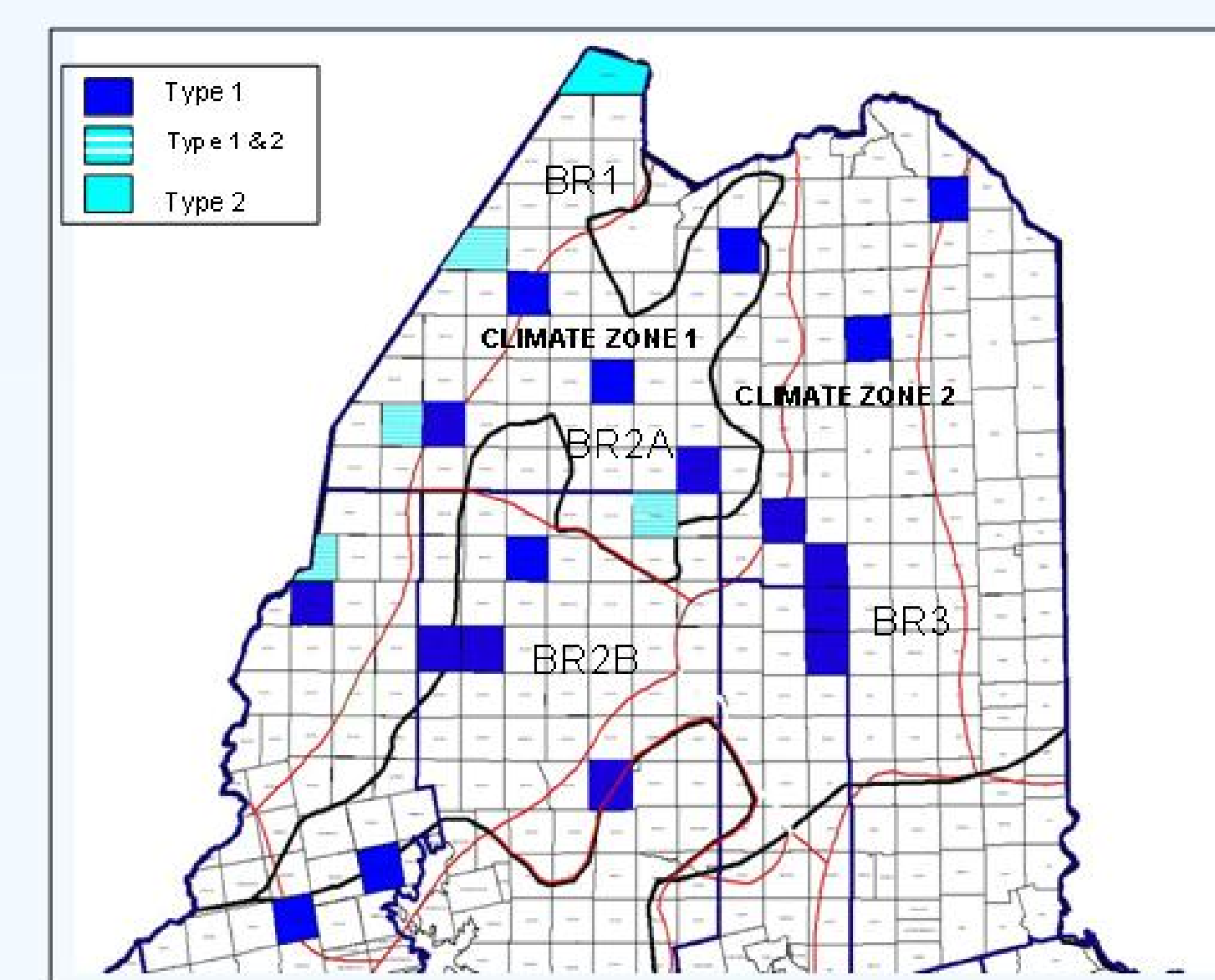


- Characterized by under-productive beech thickets
 - Vegetative sprouts & seed origin regeneration
 - Higher stand densities
 - Typically pole size stems
 - Highly defective tree stems
 - Evidence of Harvesting
- BBD long associated with these stands
 - Well established scale insect pop.
 - Neonectria faginata* dominant
 - Neonectria ditissima* pop. scarce

Stand Type II- Recently Affected Northern Forest



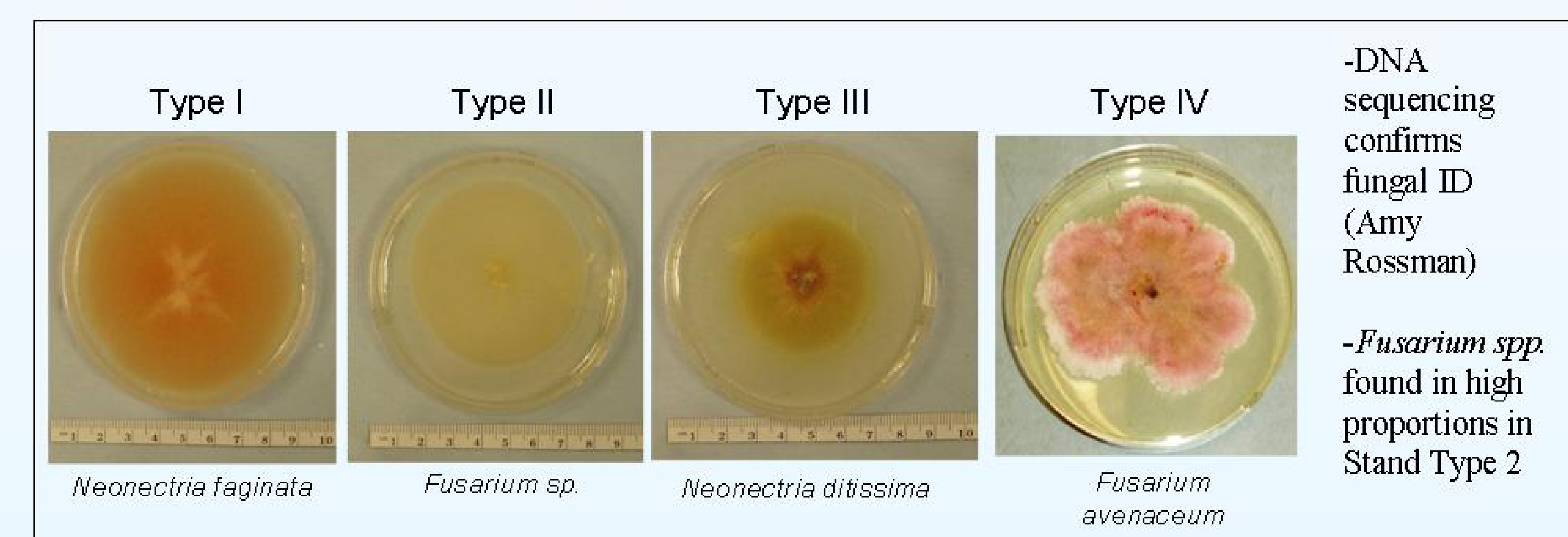
- Characterized by large beech with smooth bark (Some > 200 yrs)
- Presumably unaffected by BBD due to:
 - Extreme winter temps and/or
 - Geographic isolation
- Now suffering substantial mortality and dieback
 - Scale insect present
 - Both *Neonectria* spp. present
 - Tarry spot, a red-brown exudate, bleeds from newly killed areas



(Left) Stand Type 2 appears to be restricted to within the boundaries of Climate Zone 1 (delineated in black) with a majority of stands occurring in Biophysical Region 1-BR1 (delineated in pink).

(Right) Significant interaction between tree status and stand type suggesting dead trees dying within Stand Type 2 were larger and older which helps to support the fact that these stands were historically unaffected by BBD.

Results - Fungal Isolation & Identification



-DNA sequencing confirms fungal ID (Amy Rossman)
-*Fusarium* spp. found in high proportions in Stand Type 2

Updated Hypotheses

Additional data collected during the past field-season will be used to evaluate the following:

- Stand type I- Beech stands on shallow, well-drained soils have been altered and weakened by BBD for years. Drought occurring in 2001 incited mortality in these beech stands. Existing *Nectria* populations flourished on the stressed trees.
- Stand type II- Beech stands on shallow, well drained soils have been historically unaffected by BBD. Warmer winter temperatures in northern Maine allowed over-wintering populations of scale insect to build significantly and weaken the trees. Drought occurring in 2001 incited mortality in these beech stands. Existing *Nectria* populations flourished on the stressed trees.