# Evaluating the Influence of Stem Form and Vigor on Product Potential, Growth, and Survival for Northern Commercial Hardwood Species

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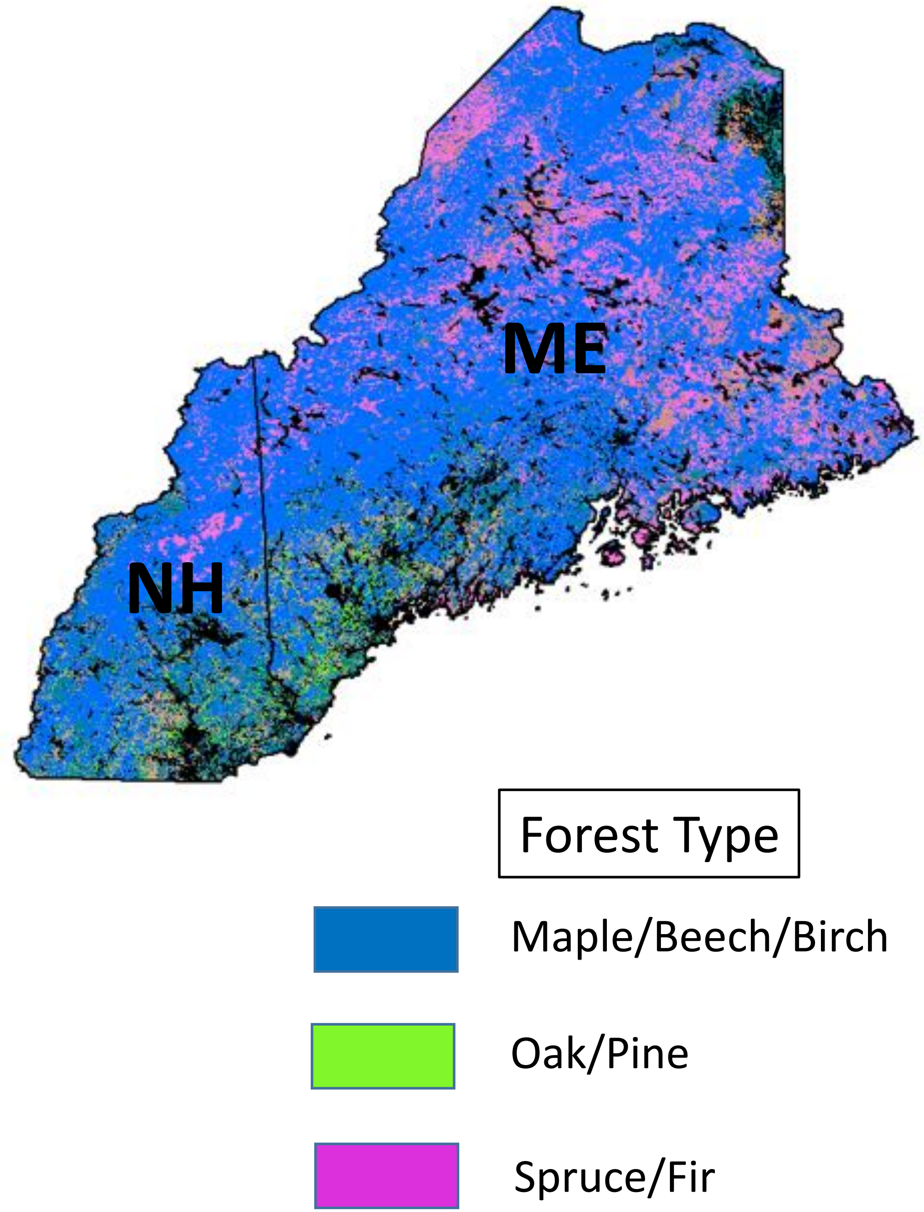
# Introduction

- Northern hardwood and mixed-wood forests occupy a large area from New York to Canada
- Hardwoods species can yield high-value saw log and veneer products
- In 2011 hardwoods accounted for 1/3 of harvested saw log volume across ME, NY, NH, and VT
- Increased prevalence of hardwoods in portions of the northeast



# Hardwood Management

- Stem quality much more variable compared softwood species

## Stem form

- Significant forks
- Multiple stems
- Severe sweep

Fork

Multiple stems

## Stem damage

- Cavities
- Decay
- Fungal pathogens
- Cracks
- Seams and scars

Decay

Fungal pathogens

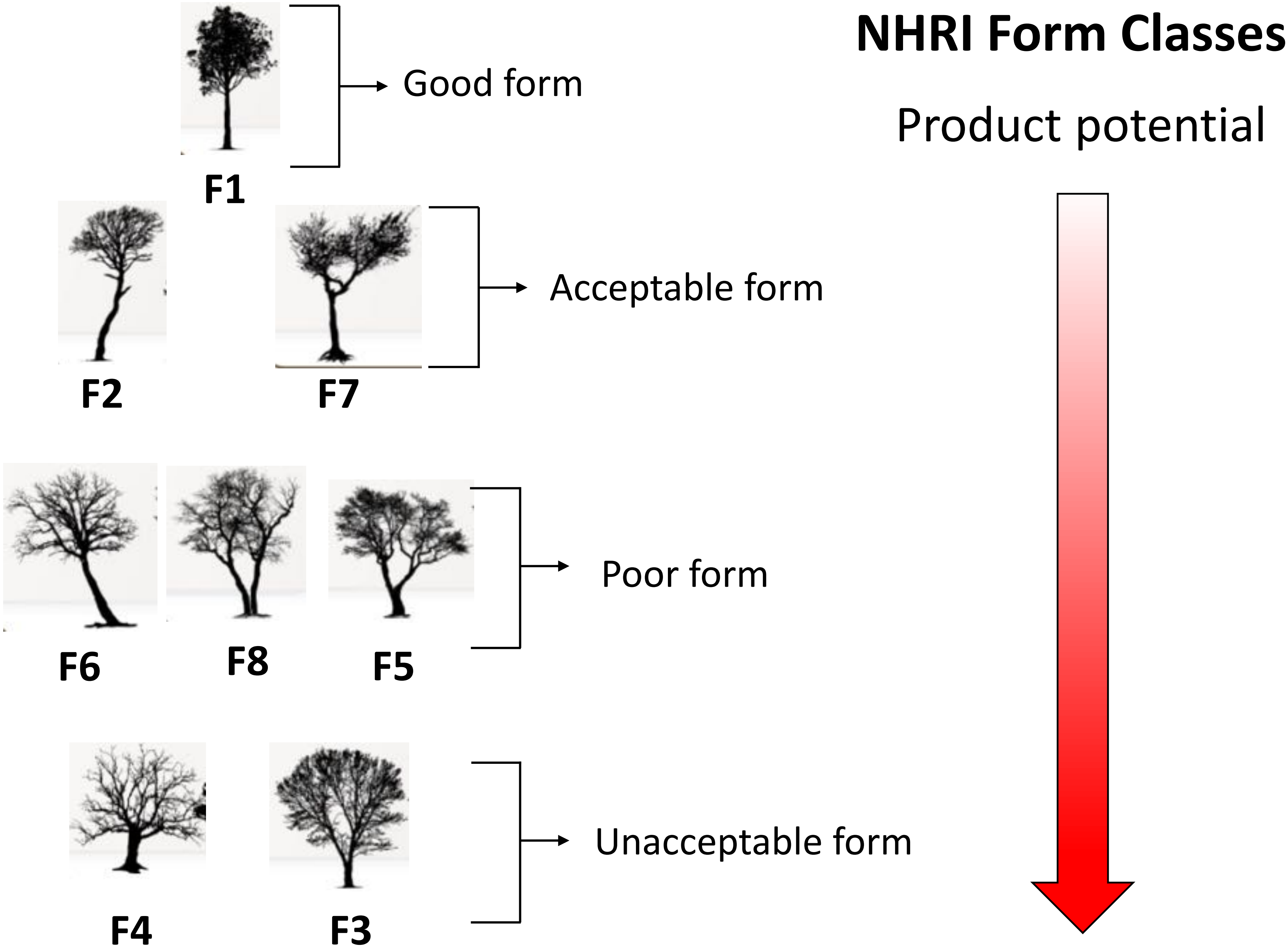
# Gaps in Hardwood G&Y Research

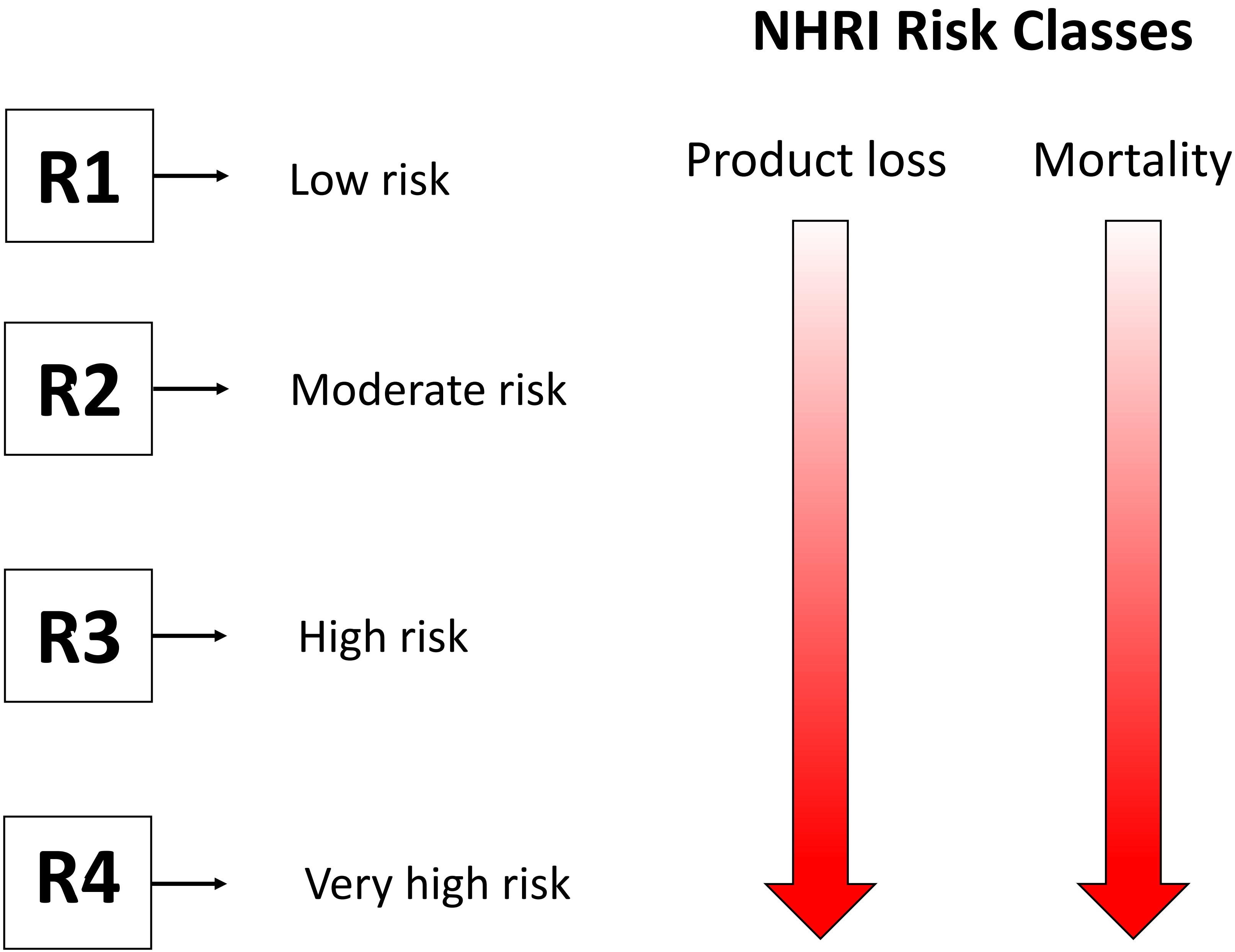
1. Influence of stem form and damage not accounted for in growth and yield applications.

2. Efficacy of tools for hardwood management
   - Tree classification systems

Most influential defects?

Classification complexity?


NHRI Form Classes
Product potential
F1
Good form
F2
F7
Acceptable form
F6
F8
F5
Poor form
F4
F3
Unacceptable form


NHRI Risk Classes
R1
Low risk
R2
Moderate risk
R3
High risk
R4
Very high risk
Product loss
Mortality

# Research Objectives

1. Assess the occurrence of different stem forms and risk across hardwood species

2. Quantify potential saw log product recovery as a function of tree size, stem form, and risk

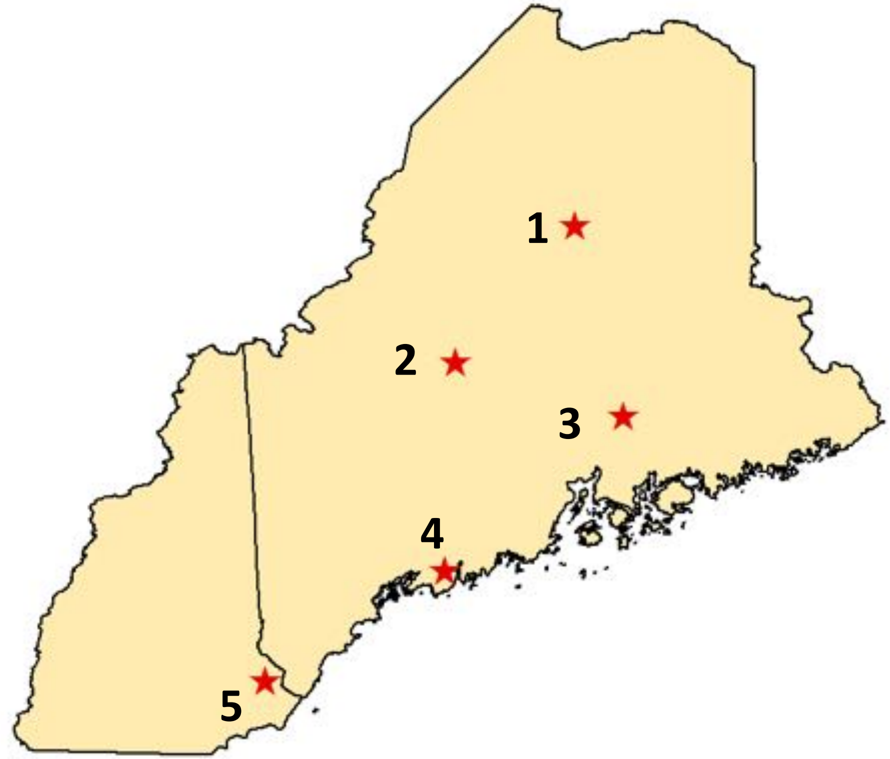
3. Incorporate stem form and damage into growth and mortality predictions

Recommendation of a revised tree classification system

# Data Collection

Sampling Locations

1. Scientific Forest Management Area
2. Austin Pond Research Area
3. Penobscot Experimental Forest
4. Holt Research Forest
5. Kingman Farms Research Area




- 179 previously measured plots were sampled
- Target species: aspen, red maple, sugar maple, northern red oak, paper birch, and yellow birch

*** Additional dataset acquired from NHRI in New Brunswick

## Maine and New Hampshire

1. Standing tree measurements
   - DBH, heights (20% of HW)
2. NHRI form and risk classifications
3. Ocular assessments of product
   - ~2.3 m sections to 10cm top
   - Saw log
   - Pulp
   - Cull

## New Brunswick (NHRI)

1. Destructively sampled measurements
2. NHRI form and risk classifications
3. Measurements of log length and diameters
4. Each log received classification as saw, pulp, or cull

Saw log Criteria: Trees with DBH >= 25.4 cm and minimum 20 cm top

# Quantifying Saw Log Potential

$$S_{vol}/M_{vol} = \frac{\text{Saw log volume } (S_{vol})}{\text{Merchantable volume } (M_{vol})}$$

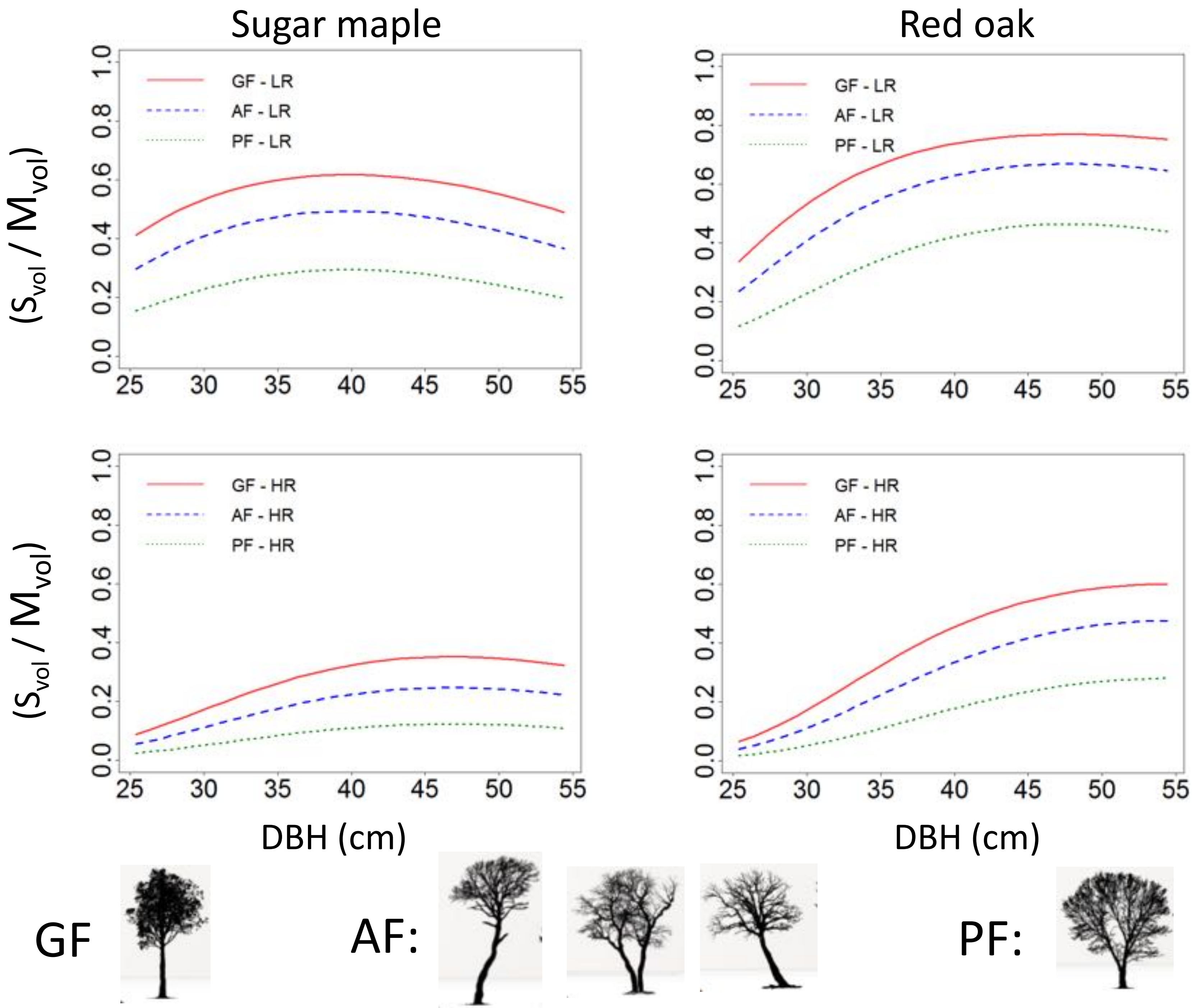
- Linear mixed effects model (Site/Plot)

<u>Explanatory variables tested</u>

- DBH, species, form, risk
- Climate site index, topography, lat-long, soil characteristics

<u>Final Model</u>

$$S_{vol}/M_{vol} = \text{DBH} + \ln(\text{DBH}) + \text{Species} + \text{Form}_3 + \text{Risk}_2 + \ln(\text{DBH}) \text{ x Species} + \ln(\text{DBH}) \text{ x Risk}$$


Sugar maple
Red oak
$(S_{vol} / M_{vol})$
$(S_{vol} / M_{vol})$
GF - LR
AF - LR
PF - LR
GF - HR
AF - HR
PF - HR
0.0
0.2
0.4
0.6
0.8
1.0
25
30
35
40
45
50
55
DBH (cm)
DBH (cm)
GF
AF:
PF:

# Diameter Growth

$$\mathrm{PAI} = \frac{\mathrm{DBH}_2 - \mathrm{DBH}_1}{\mathrm{YIP}}$$

- Continuous forest inventory
- Nonlinear mixed effects model (Site/Plot)

Explanatory variables

- DBH
- Species
- One and two-sided competition

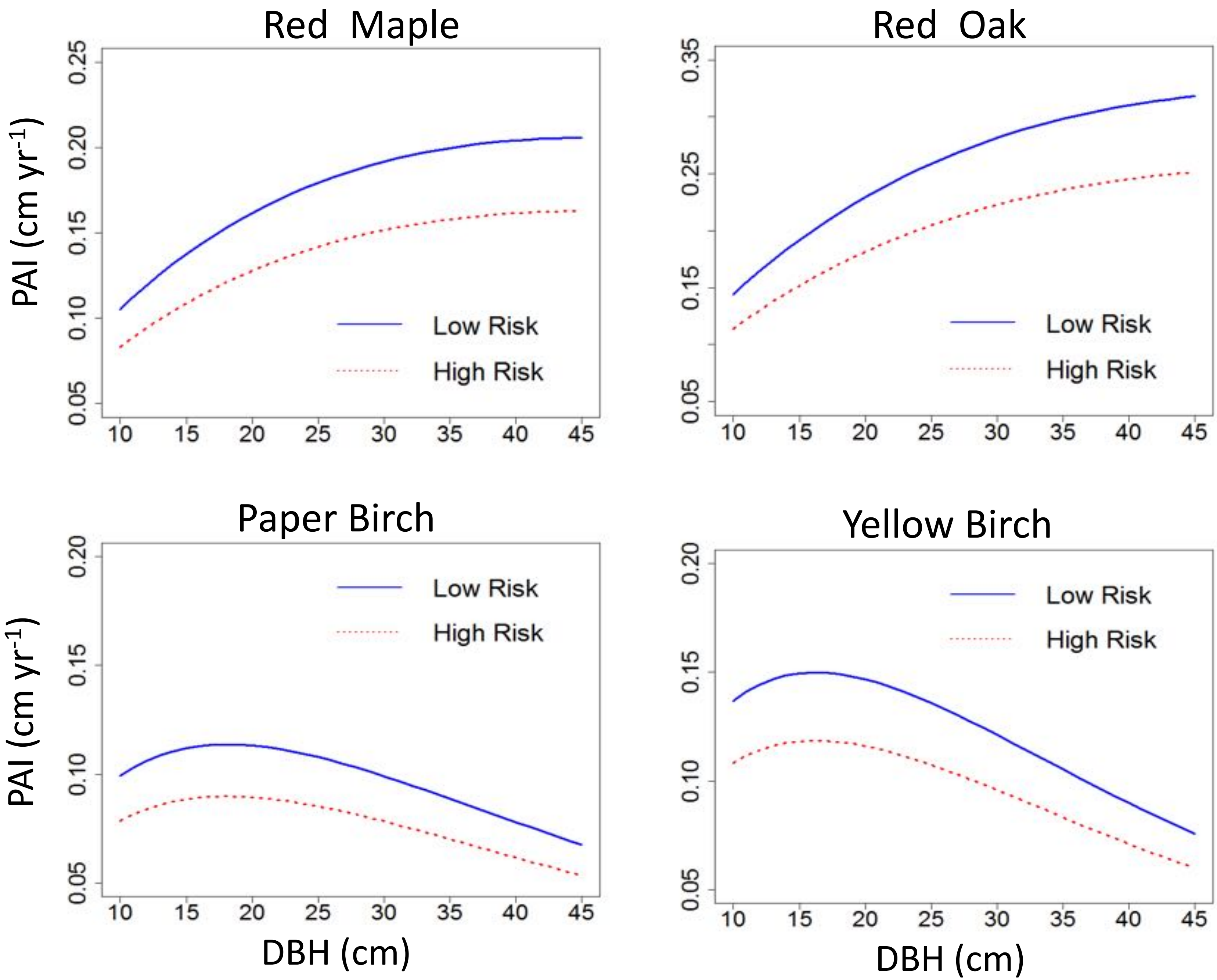
Site quality

Form and risk

Final model

$$\mathrm{PAI} = \mathrm{DBH} + \ln(\mathrm{DBH}) + \ln(\mathrm{BAL} + .1) + \mathrm{BAHA} + \mathrm{DWT} + \mathrm{Species}$$

$$+ \mathrm{Risk}_2 + \mathrm{DBH\ x\ Species}$$



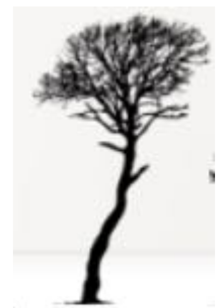
Red Maple
Red Oak
Paper Birch
Yellow Birch
PAI (cm yr$^{-1}$)
DBH (cm)
Low Risk
High Risk
0.05
0.10
0.15
0.20
0.25
0.35
10
15
20
25
30
35
40
45

# Framework For Revised Tree Classification System

## 4 classifications of stem form

Single straight stem

Multiple stems



Sweep - lean

Low fork

## 2 classifications of risk

| LR | HR |
|---|---|

# Acknowledgements

## People

- Aaron Weiskittel
- Robert Wagner
- Mark Ducey
- Jereme Frank
- Karl Buckley
- Alexander Audet
- Alexander Parkhurst
- Dan Perry
- Matthew Todd
- Nathan Andricovich

## Funding

- Northeastern States Research Cooperative
- Cooperative Forestry Research Unit
- US Forest Service

## Data

- Baxter State Park: Scientific Forest Management Area
- Holt Research Forest
- University of New Hampshire
- US Forest Service
- Northern Hardwood Research Institute

# Questions or Comments?

# Model Fits

## Potential Saw log Volume Model

| $R^2$ Fixed | $R^2$ Site | $R^2$ Plot | RMSE | Bias |
|---|---|---|---|---|
| 0.33 | 0.40 | 0.33 | 0.21 | -0.05 |

## Periodic Annual Increment Model

| $R^2$ Fixed | $R^2$ Site | $R^2$ Plot | RMSE (cm $yr^{-1}$) | Bias (cm $yr^{-1}$) |
|---|---|---|---|---|
| 0.20 | 0.20 | 0.34 | 0.072 | 0.02 |