Economic Valuation of Larch Plantations

JAMES L. ANDERSON, M.S.

SCHOOL OF FOREST RESOURCES

UNIVERSITY OF MAINE

JAMES.L.ANDERSON@MAINE.EDU

Plum Creek Larch Plantation Data

Site	ID	No. of Trees	DBH Measurement Ages	HGT Measurement Ages	Species
Chase Stream	SR 8801	370	5, 10, 16, 20	3, 5, 10, 16, 20	All (EL, HL, JL, TL)
Carrying Place	SR 8801	359	3, 5, 10, 16	3, 5, 10, 16	All (EL, HL, JL, TL)
Brighton	SR 8801	472	3, 5, 10, 16	3, 5, 10, 16	All (EL, HL, JL, TL)
Lily Bay	SR 8801	355	3, 5, 10, 15	3, 5, 10, 15	All (EL, HL, JL, TL)
West Forks	SR 9004	232	6, 10 ,15	2, 5, 6, 10,15	Hybrid
Brighton/Hartland	TI 9801	900	3, 5, 10	1, 2, 3, 5, 10	Hybrid
Hartland	TI 9802	1800	3, 5	1, 2, 3, 5	Hybrid
North Anson	SR 9004	194	6, 10 ,15	2, 5, 6, 10,15	Hybrid

Completing the Data

Using Regression Imputation, we fill in missing Heights and Diameters

$$DBH = \begin{cases} DBH \; if \; DBH \; is \; recorded \\ \min\left(E[DBH|Height, Age, Species, Unit] + \varepsilon_{Hgt}, 0.0001\right) \; if \; Height \; is \; recorded \\ \min(E[DBH|Age, Species, Unit] + \varepsilon, 0.0001) \; otherwise \end{cases}$$

$$Height = \begin{cases} Height \; if \; Height \; is \; recorded \\ \min(E[Height|DBH, Age, Species, Unit] + \varepsilon_{DBH}, 0.0001) \; if \; DBH \; is \; recorded \\ \min(E[Height|Age, Species, Unit] + \varepsilon, 0.0001) \; otherwise \end{cases}$$

Operational Property Assumptions

Tree stems are narrow paraboloids

DBH measurement height, DBH.Hgt = 4.5 ft

Minimum Diameter at small end for saw logs, sawDSE = 9.0 in

Minimum Diameter at small end for biomass, bioDSE = 3.5 in

Fraction of Unusable Sawlog Volume, cull = 0.100

Density of Larch, ton.p.ft3 = .024 tons/ft^3

We can earn 3% yield on 30yr US bonds, so we want a 4% IRR on our stands

Calculating Stand and Tree Statistics

$$Base\ Diameter,\ DLE = \frac{DBH}{\sqrt{1-\frac{DBH.Hgt}{Hgt}}}$$

$$Max\ Product\ Height,\ \ Saw.Hgt = Hgt * (1 - (\frac{sawDSE}{DLE})^2),\ Bio.Hgt = Hgt * (1 - (\frac{bioDSE}{DLE})^2)$$

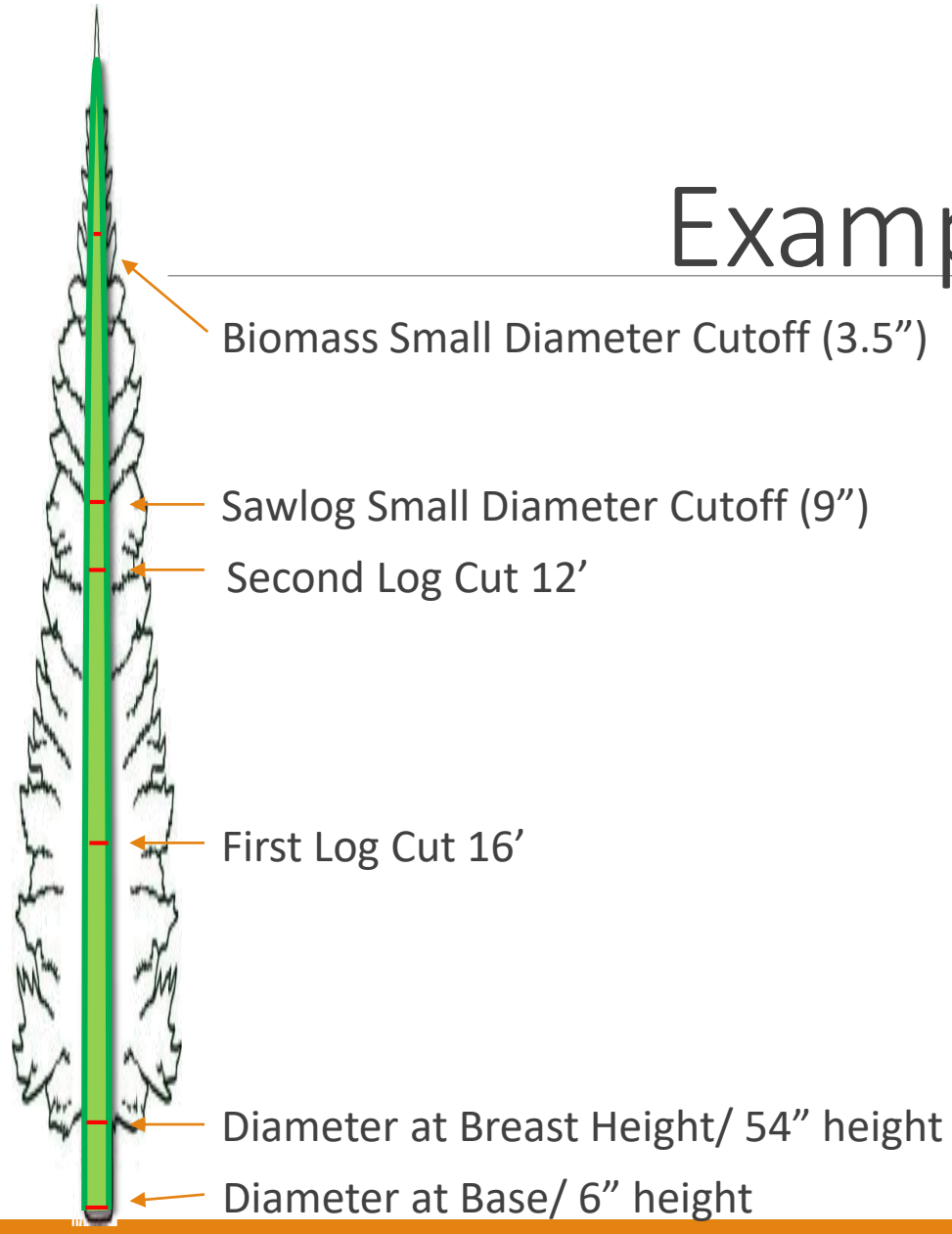
$$Parabolic\ Volume,\ \ Vol = \frac{\pi}{2} * Bio.Hgt * \left(\frac{DLE}{12*2}\right)^2$$

$$Diameter\ at\ hgt,\ \ Dia = DLE * \sqrt{1 - \frac{hgt}{Hgt}}$$

$$Basal\ Area,\ BA = \pi * \left(\frac{DLE}{12*2}\right)^2$$

$$Trees\ per\ Acre,\ TPA = \min_{TPA} |1237.7 * TPA^{-.343} - TPA * BA|$$

Example Breakdown of a Larch



Using the maximum saw height, we calculate the number of 16-, 12- and 8 ft logs (6” trim) we might cut and the height along the stem where they are cut.

Using the Diameter equation, we can calculate the diameter at the small end of each log.

Using each log’s length and small end diameter, we can easily estimate board footage using the International ¼” Rule and removing 10% cull (IntBF).

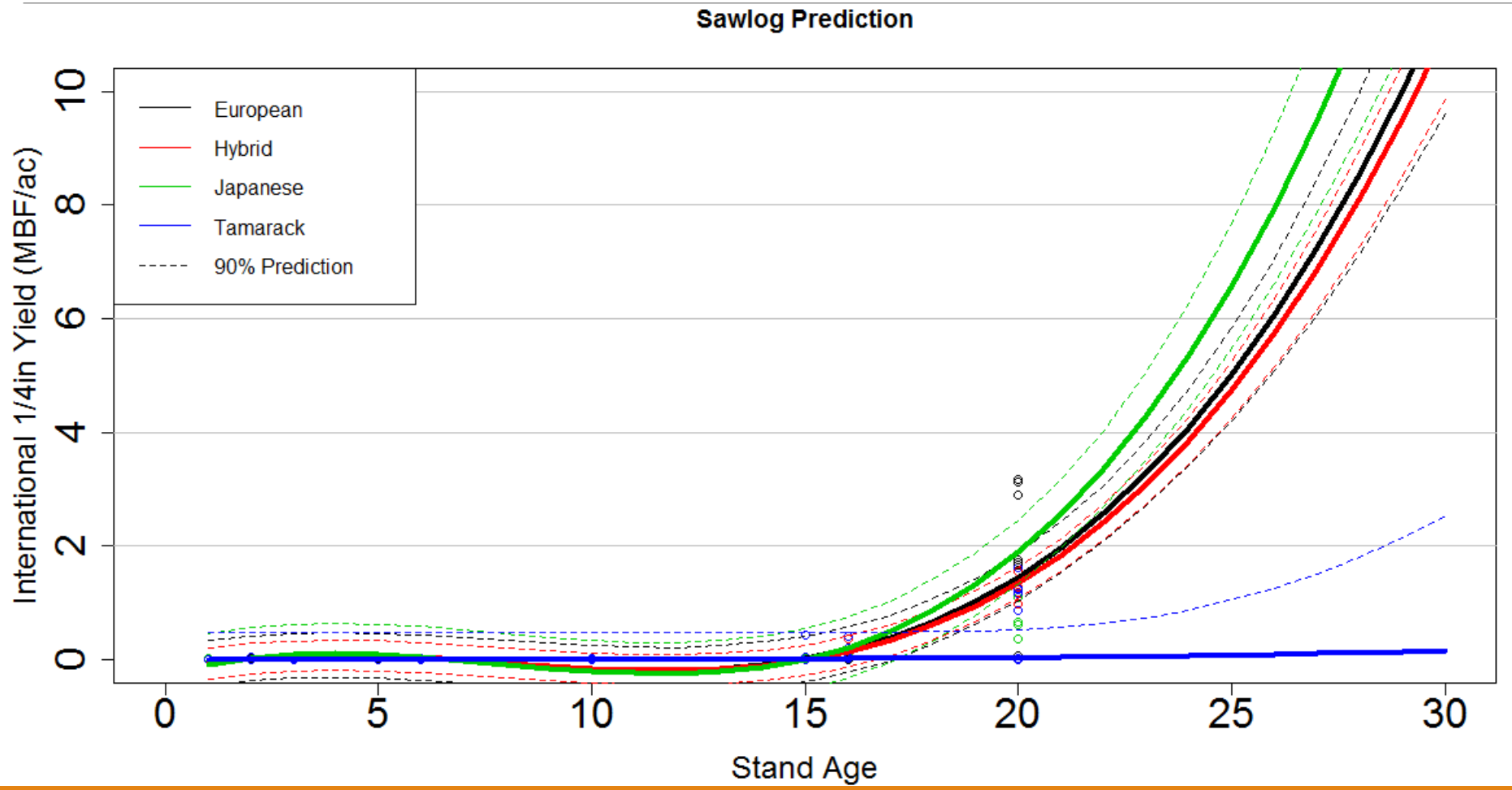
Calculating Stand and Tree Statistics

Convert **board footage to cubic feet** using $\frac{1\ ft^3}{12\ BF}$ conversion

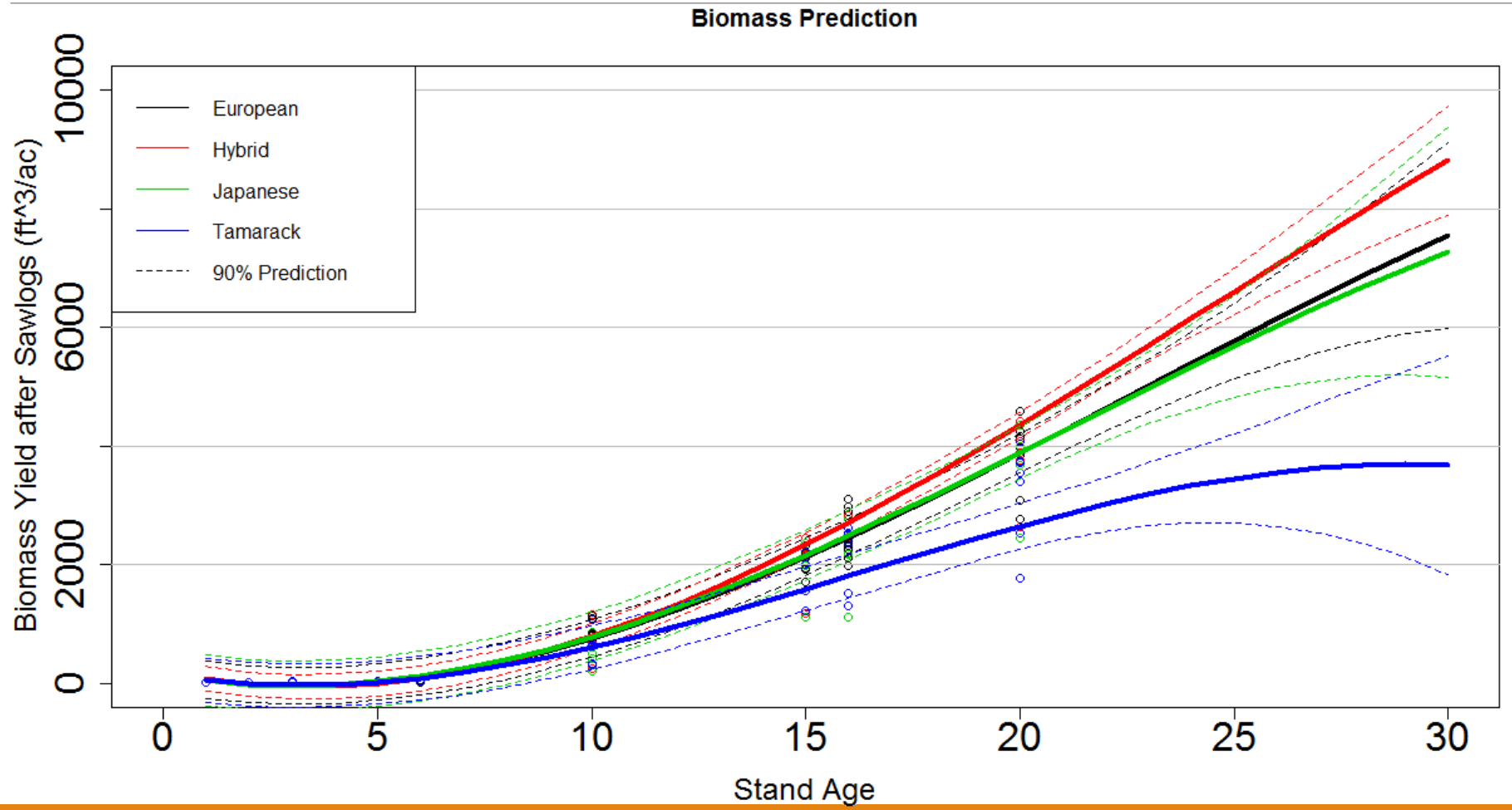
We estimate biomass volume with

$$Biomass(ft^3) = Volume(ft^3) - IntBF * \frac{1\ ft^3}{12\ BF}$$

Predicting Sawlog Volume

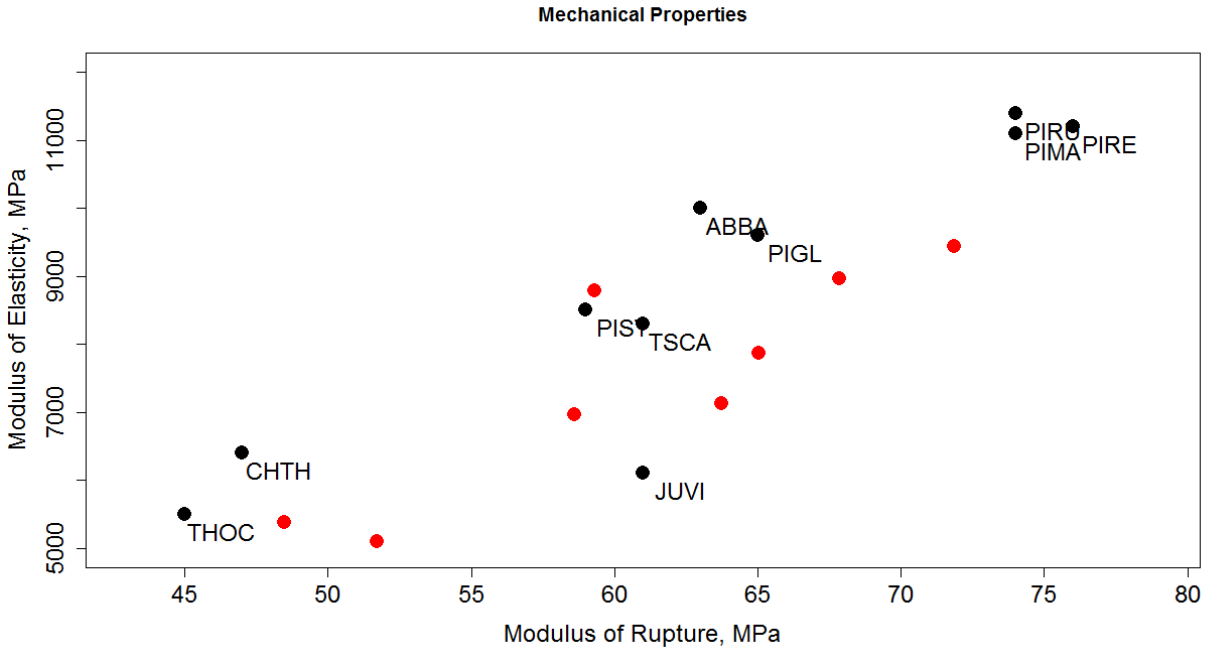


Predicting Remaining Biomass



Matching Larch to Products on the Market

Using k-nearest neighbors (k = 5), we match six Larch lumber properties for each species reported by Koizumi, Kitagawa, and Hirai (2008), Chui and MacKinnon-Peters (1995), and Olson, Poletika, and Hicock (1947) to lumber properties of common commercial species, available in the USDA's Wood Handbook (2010). These 10 Maine species are then mapped to stumpage prices provided by MFS.



European Larch points in Red

Atlantic White Cedar Eastern Red Cedar Northern White Cedar	→	Cedar $2.94/ton, $118/MBF
Eastern White Pine	→	White Pine $2.94/ton, $172/MBF
Eastern Hemlock	→	Hemlock: $2.94/ton, $73/MBF
Balsam Fir, Black Spruce Red Spruce, White Spruce	→	Spruce/Fir: $2.94/ton, $205/MBF
Red Pine	→	Red Pine $2.94/ton, $71/MBF

Matching Larch to Maine Species

European
- Black Spruce, Red Pine, Eastern Hemlock, Red Spruce, White Spruce

Hybrid
- Eastern White Pine, Atlantic White Cedar, Balsam Fir, White Spruce, Northern White Cedar

Japanese
- Eastern Hemlock, Eastern White Pine, Atlantic White Cedar, Balsam Fir, Black Spruce

Tamarack
- White Spruce, Eastern Hemlock, Red Spruce, Black Spruce, Balsam Fir

Matching Larch to Commercial Species

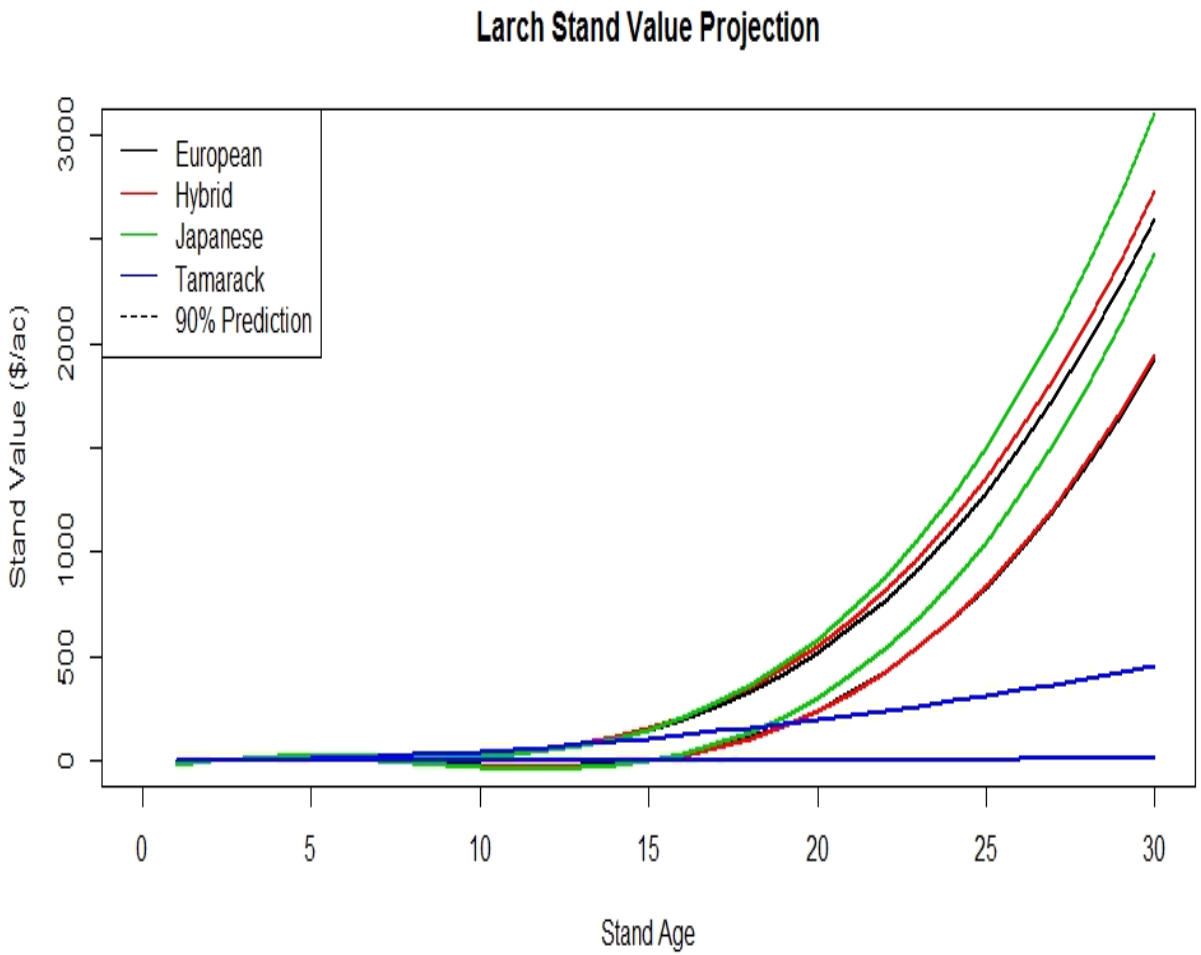
European, $151.80
- Spruce/Fir x 3, Red Pine, Hemlock

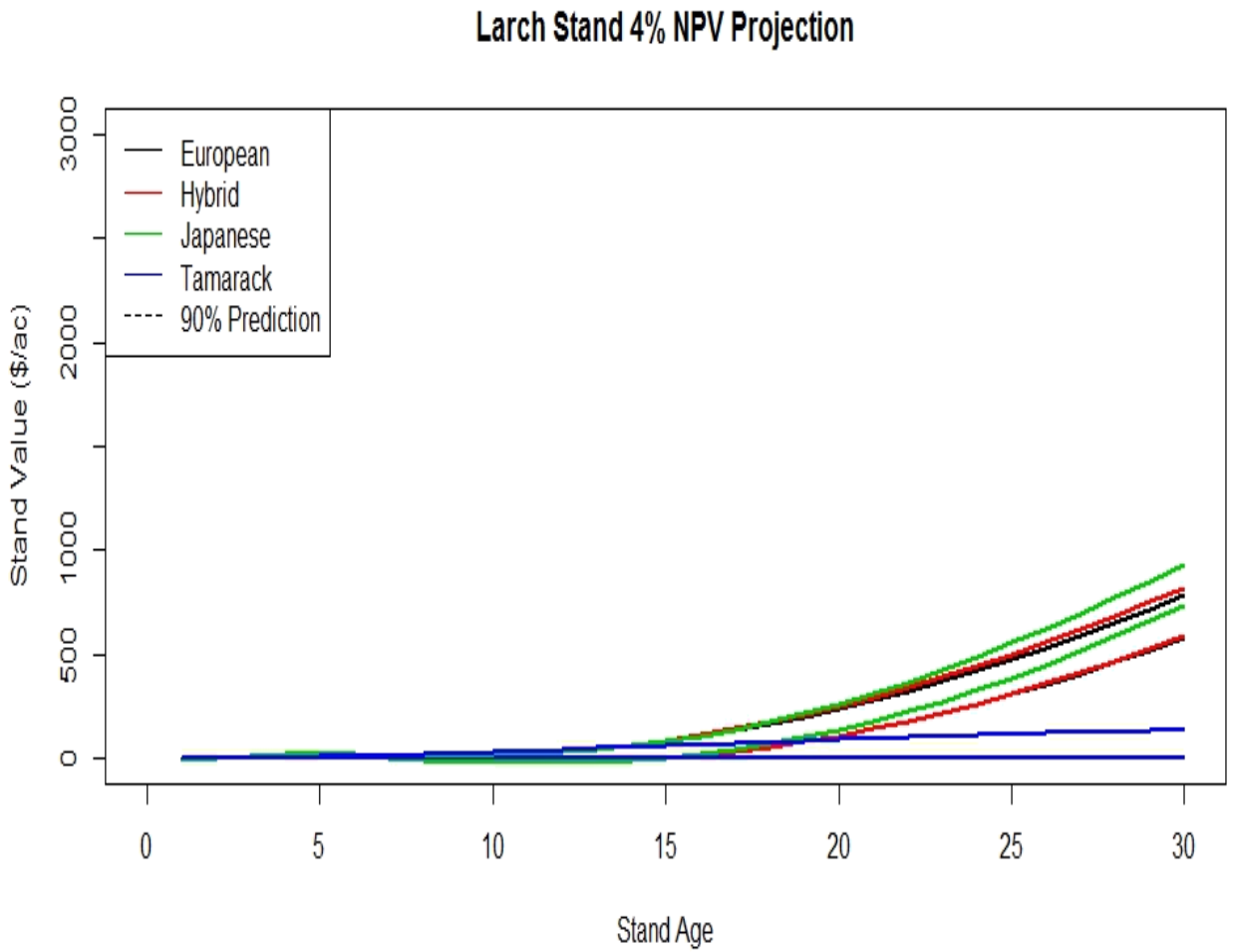
Hybrid, $154.60
- White Pine, Cedar x 2, Spruce/Fir x 2

Japanese, $163.60
- Hemlock, White Pine, Cedar, Spruce/Fir x 2

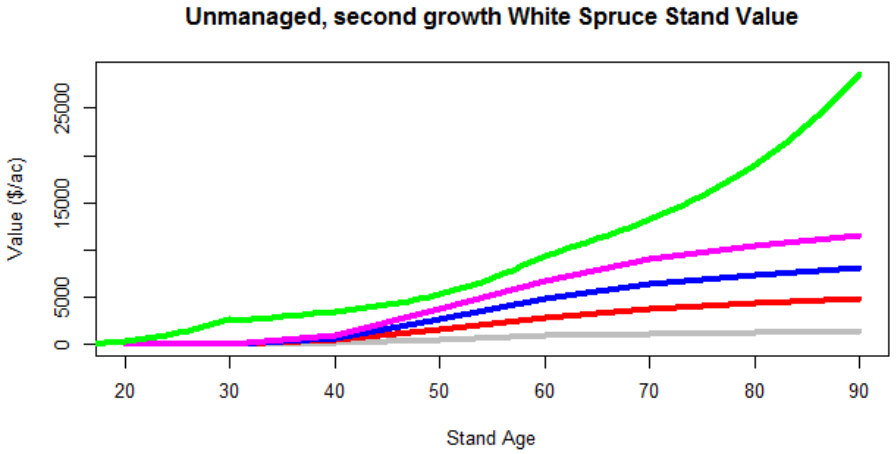
Tamarack, $178.60
- Spruce/Fir x 4, Hemlock

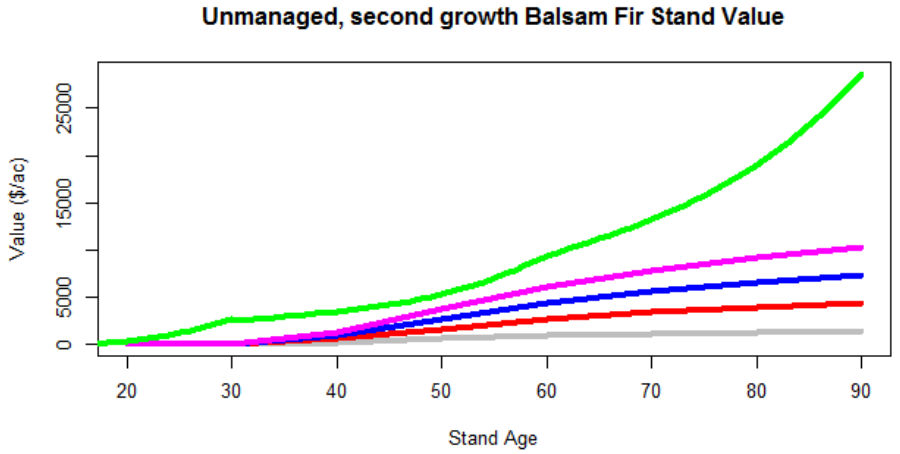
Sawlog and Total Value of a Larch Stand

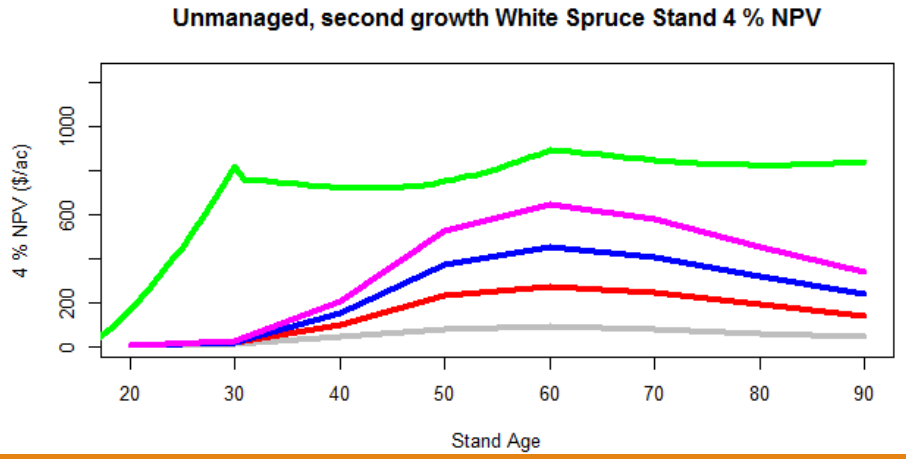


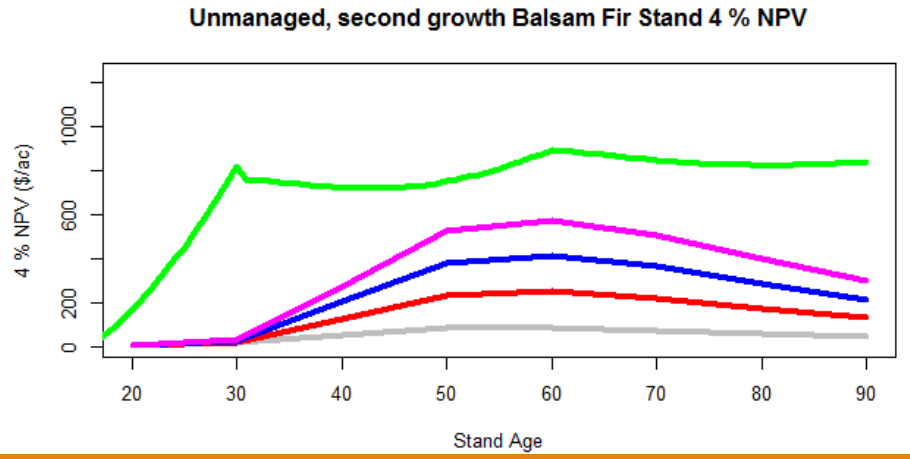


A Comparison with Spruce and Fir Stands









SI = 40

SI = 50

SI = 60

SI = 70

Japanese Larch reinvested @ 3%

Under Infinite Rotations: SEV

Species	‘Optimal’ Rotation Age	SEV
Balsam Fir	52	$650
White Spruce	56	$725
Japanese Larch	30	$1180

Conclusions

Larch grow quite quickly

- Empirically: 2.90 ft/year on average with Hybrid growing an extra 0.41 ft/yr and Tamarack lagging by 0.73 ft/year
- DBH growth is **roughly** 0.16 in/ft of height growth or 0.47 in/year

Quality stands of Hybrid Larch may start producing some saw logs at age 18 with poorer sites lagging by about two years

Not enough data to determine the optimal financial rotation age, but just growing out to 30 years has good returns

Stand value may be even greater with PCT or mortality recovery

Comments and Questions?

*** Special thanks to Mindy Crandall, Ph.D., ***
** Adam Daigneault, Ph.D., Lloyd C. Irland, and David Maass **
*** and larchresearch.com for photos ***