Aboveground Live Tree Carbon Calculation Comparison Using Jenkins and Local Equations

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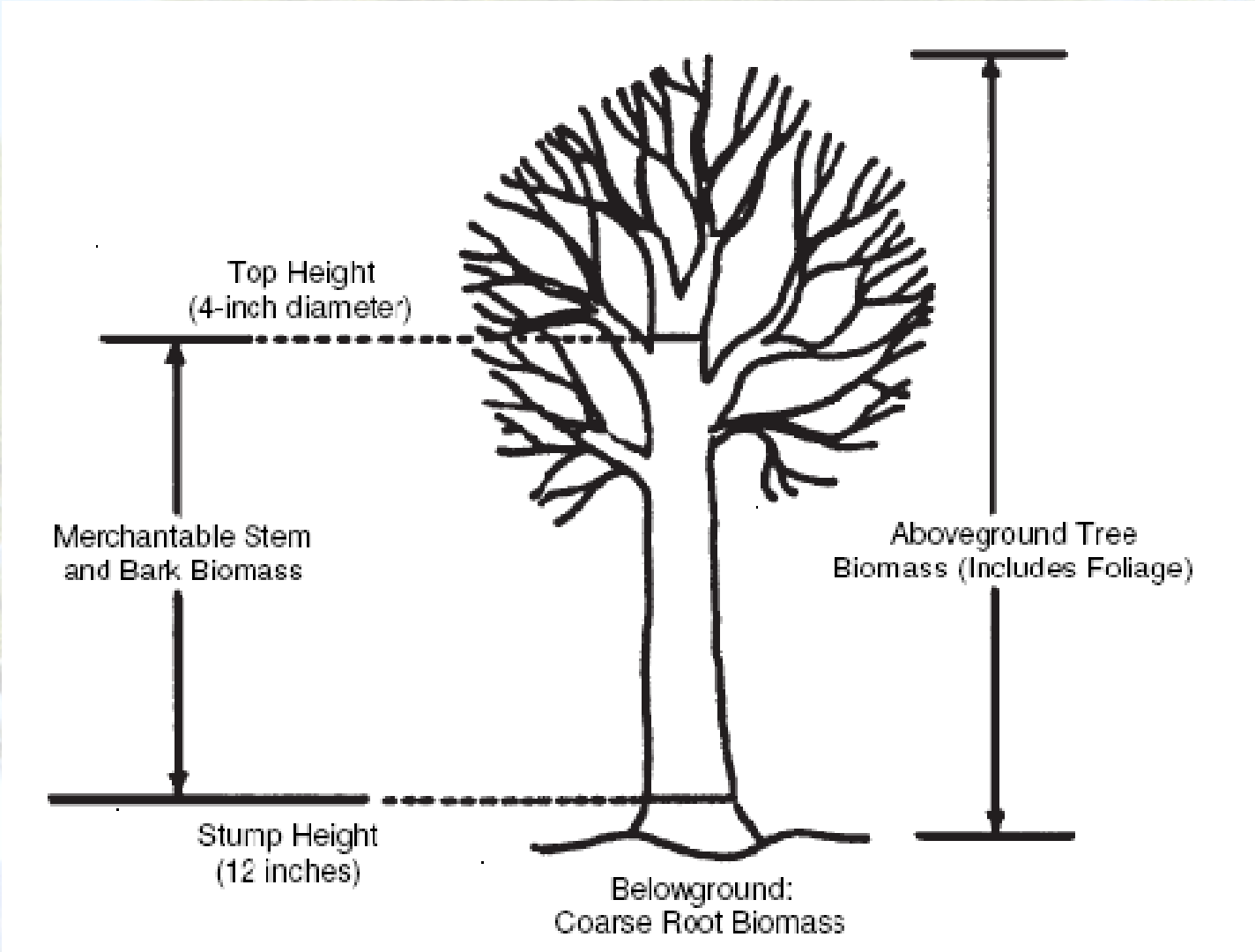
Forest Carbon Pools (components)

- Aboveground live tree
- Belowground live tree
- Understory vegetation --- include woody shrubs and trees less than one-inch dbh
- Dead wood --- include standing dead trees (above and below ground) and down dead wood (dead wood with 7.6 cm)
- Forest floor (litter carbon) --- organic carbon (e.g. duff, humus, fine woody debris) above the mineral soil and includes woody fragments with diameter<7.5 cm
- Soil organic carbon

Tree Component Biomass Definition
(Jenkins,2003)



Jenkins Aboveground Live Tree Biomass Equations

- Biomass ⟶ Carbon (0.5 of B) ⟶ CO2 (3.67of C)

(1 unit of B = 0.5 unit of C stored 1 unit of C stored = 3.67 unit of CO2 emission equivalent)

- Total 10 above ground biomass equations associated to 10 tree species groups
- The 10 species groups include: 4 softwood groups, 5 hardwood groups and 1 woodland group
- Form of biomass (bm) equations in Jenkins is:

$$bm = \mathrm{Exp}(\beta_0 + \beta_1 \ln(dbh))$$

bm total aboveground biomass for trees larger than 2.5 cm in dbh (dbh in cm

Parameters for Estimating Total Aboveground Biomass

	Species group[b]	Parameter β_0	Parameter β_1
Hardwood	Aspen/alder/ cottonwood/ willow	-2.2094	2.3867
	Soft maple/birch	-1.9123	2.3651
	Mixed hardwood	-2.4800	2.4835
	Hard maple/oak/ hickory/ beech	-2.0127	2.4342
Softwood	Cedar/larch	-2.0336	2.2592
	Douglas-fir	-2.2304	2.4435
	True fir/hemlock	-2.5384	2.4814
	Pine	-2.5356	2.4349
	Spruce	-2.0773	2.3323
Woodland[f]	Juniper/oak/ mesquite	-0.7152	1.7029

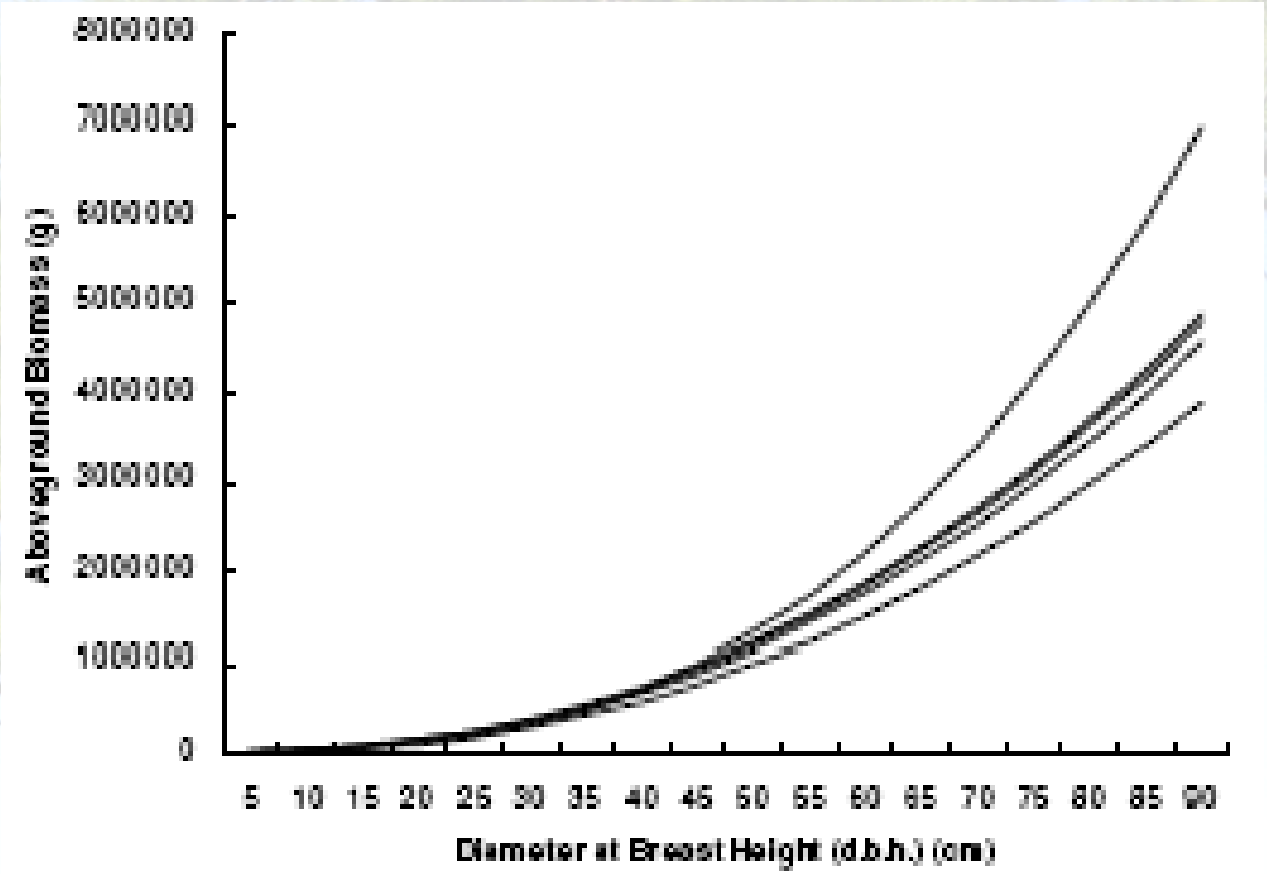
(Jenkins, 2003)

How Jenkins Equations Created

- Compiled all available diameter-based equations for total aboveground and component biomass for trees in the US
- Developed a set of national-scale aboveground biomass regression equations for U.S. species from predictions by equations in these literatures.
- Equations for other biomass of tree components were developed as proportions of total aboveground biomass

See detail in Jenkins: Forest Science 49 (1) 2003 or GTR-NE-319

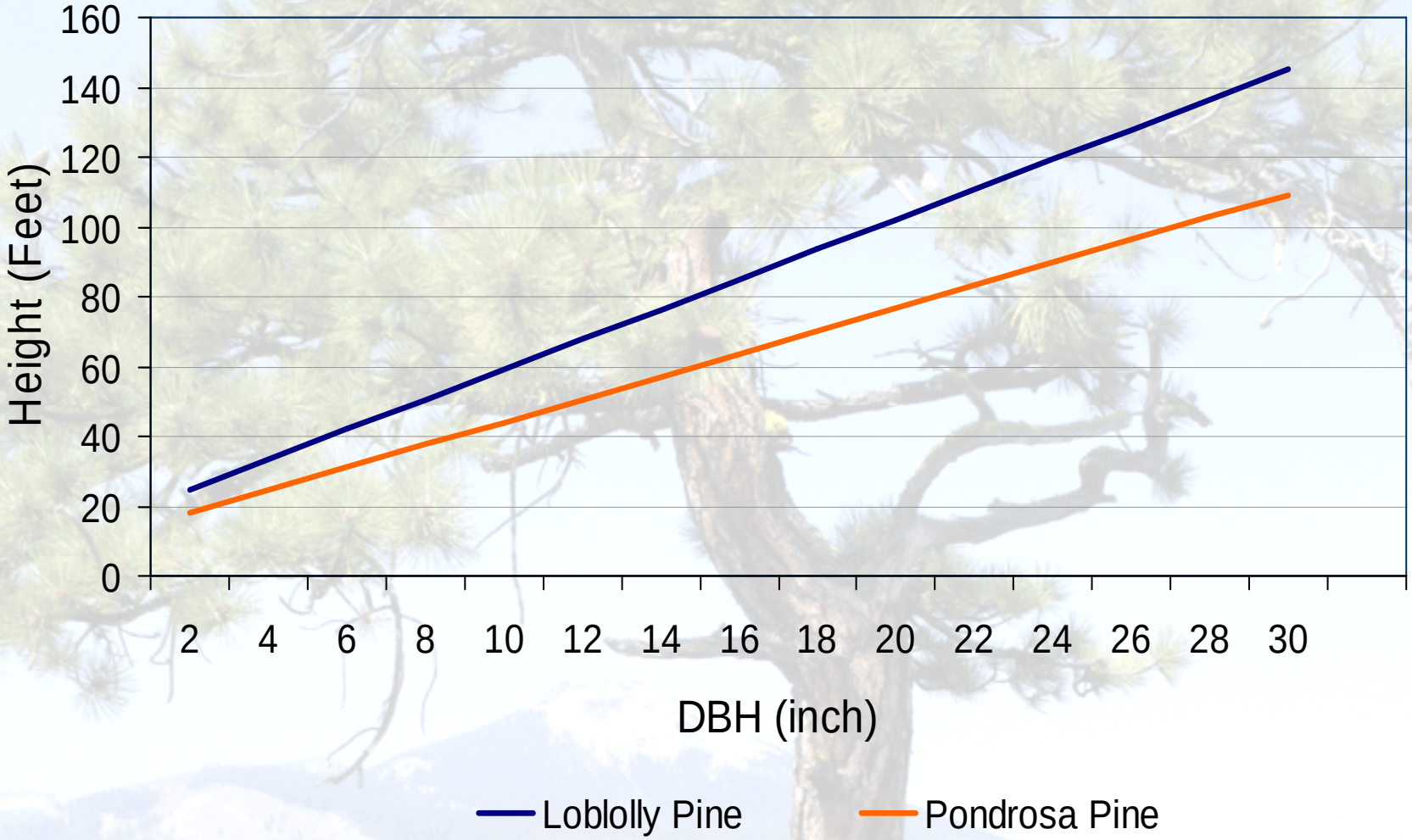
Building the National Equation
(Example of Douglas-fir 6 equations)



Concerns about the Jenkins equations

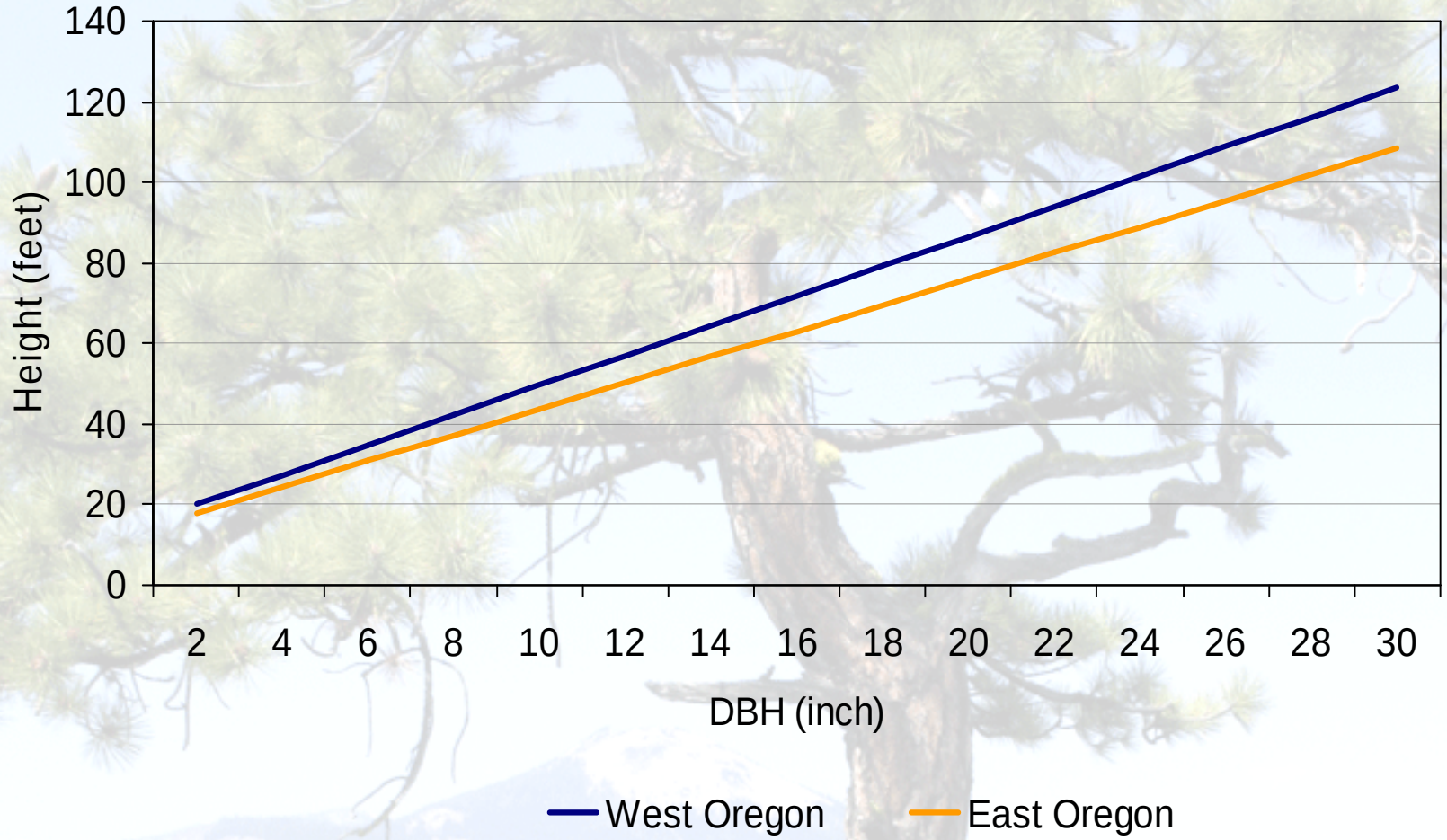
- Too broad tree species groups --- leads to large variance, e.g. ponderosa pine in PNW is in the same group of loblolly pine in the south
- The equation only has diameter as explanatory variable and ignores the taper of the trees
- Wood specific gravity --- for groups of species, the value is the average of specific gravity values for species that make up the group

Loblloy Pine vs Ponderosa Pine
(Height vs DBH)



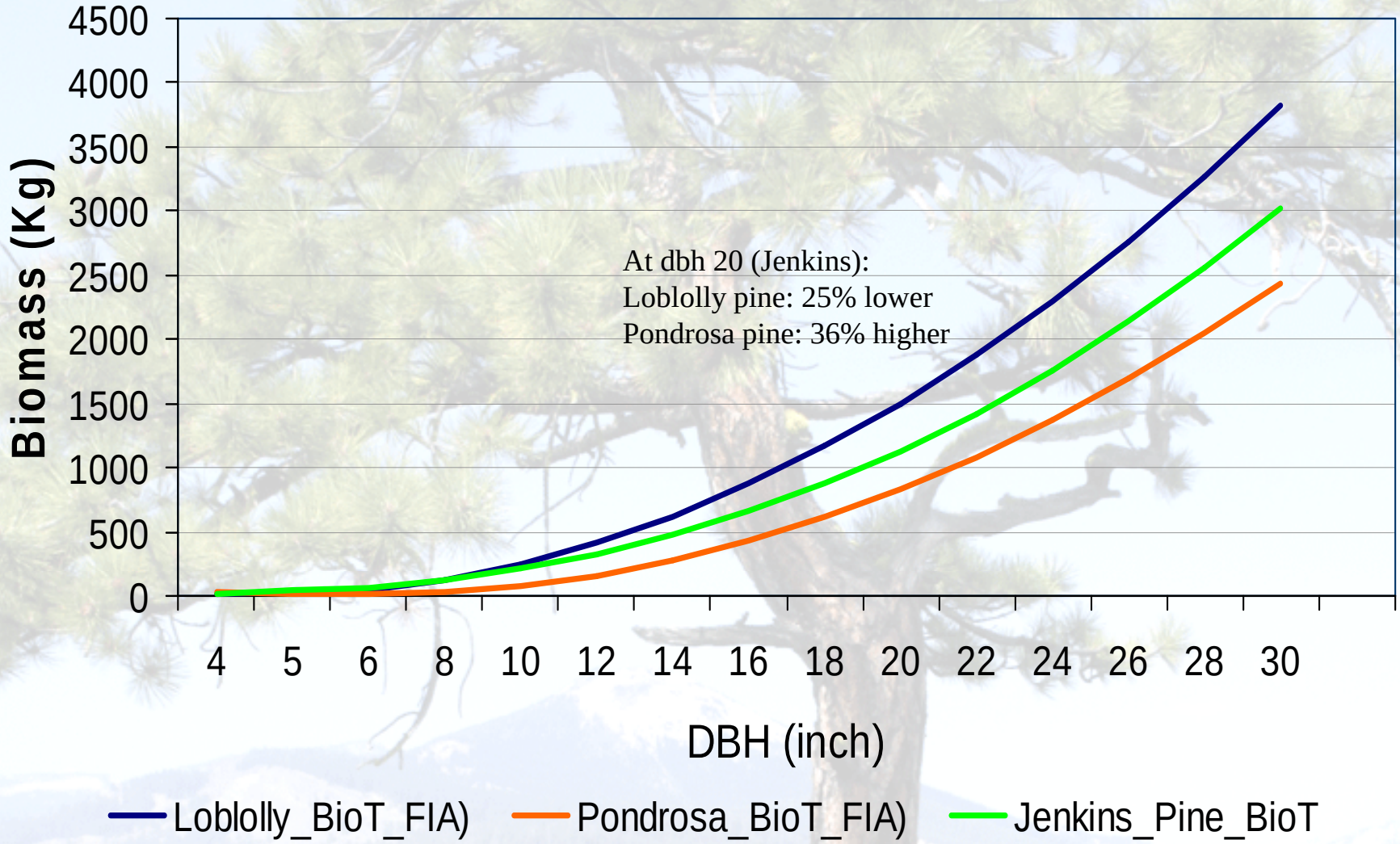
West Oregon vs. east Oregon

(Ponderosa Pine --- Height vs DBH)



Loblloy Pine vs Ponderosa Pine

(Total Aboveground Biomass in kg)



Wood gravity concern

- Use average of specific gravity values from literature for species that make up that group (Jenkins, 2004)
- For example, the pine group, the wood specific gravity ranges from 0.34 (sugar pine in west) to 0.54 (longleaf pine in the south)

Local equations (e.g PNW)

- Tree specific --- equation to each major tree species
- Branch, bark and volume equations are dbh and height related
- Tree bole biomass is calculated from the cubic volume estimate and the wood density factors as:

  Bole Biomass in tons = (cubic volume * wood density) / 2000

- Total biomass is the sum of bole, branch and bark (usually foliage is not included so far)

Ponderosa Pine Biomass Equation
(WA and East Oregon)

Bark equation (eq.9):

$$BB = \exp(-3.6263 + 1.34077 \times \log(DBH) + 0.8567 \times \log(HT))$$

Branch equation (eq.7):

$$BLB = \exp(-4.1068 + 1.5177 \times \log(DBH) + 1.0424 \times \log(HT))$$

Volume of the total stem

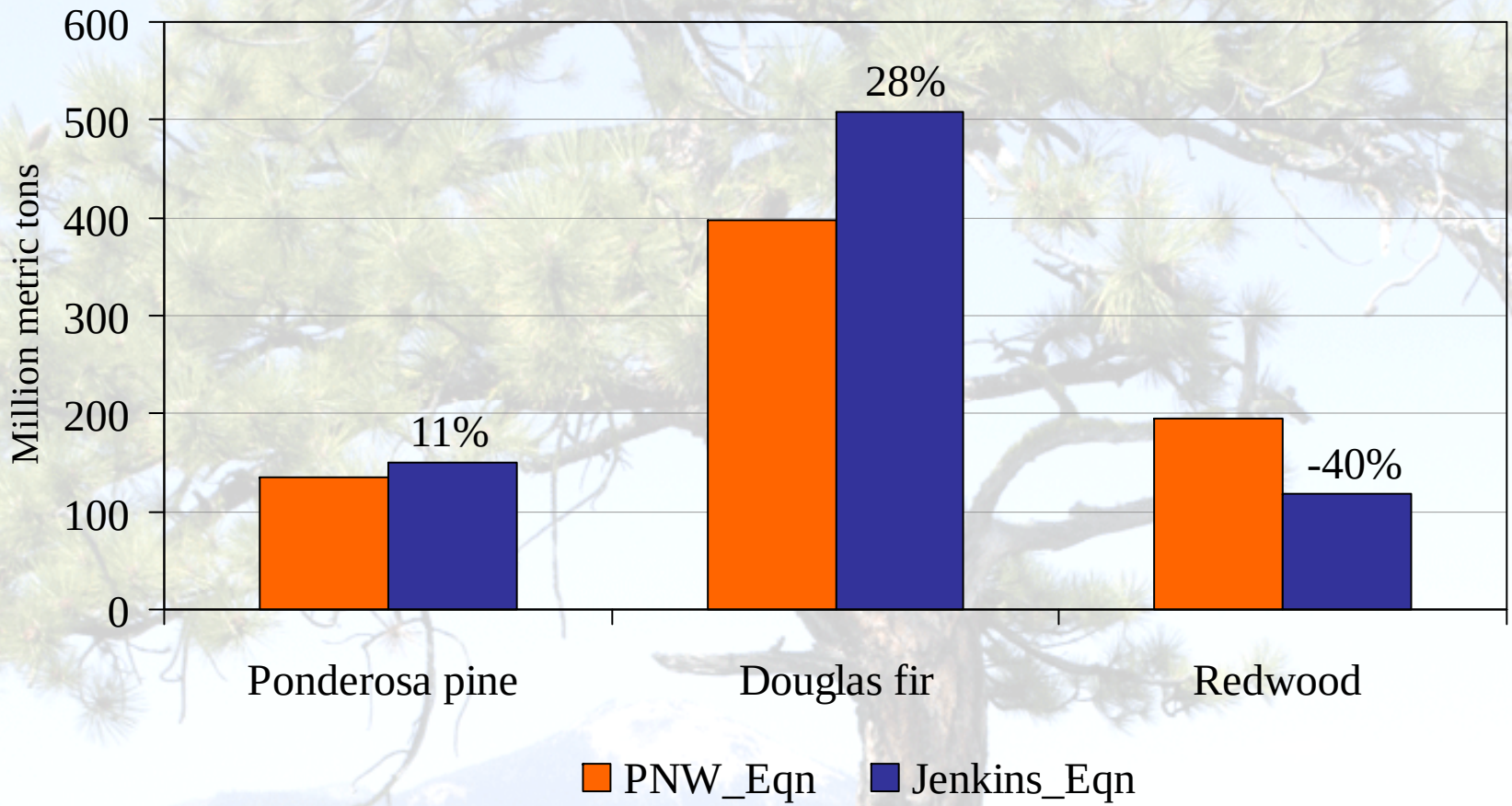
(ground to tip and db>=1 inch) (eq.4):

$$CVTS = \exp[-8.521558 + 1.977243 \times \ln(DBH) - 0.105288 \times (\ln(HT))^2 + \frac{136.0489}{HT^2} + 1.99546 \times \ln(HT)]$$

Equation source: PNW-FIA Program

(All weights in kilograms-oven-dry weight)

Aboveground Live Tree Biomass by Species (California)



Aboveground live tree biomass

(California NIMS data)

Ownership	Forest Land Group	Area	PNW	Jenkins	Diff. %
NFS					
	Timberland	9.3	709	850	20
	Other Non_reserved	2.3	41	54	32
	Other Reserved	3.4	231	285	23
Other Pub					
	Timberland	0.9	63	68	8
	Other Non_reserved	1.3	18	20	22
	Other Reserved	2.5	226	235	4
Private					
	Timberland	8.9	610	659	8
	Other Non_reserved	4.3	103	134	30
	Other Reserved	0	0	0	

Area in million acres and Biomass in Million metric tons

Conclusion

- Jenkins publication (Jenkins 2003) provides good source of references for biomass related studies
  (Forest Science 49 (1) 2003 or GTR-NE-319)
- Significant difference for biomass with different calculation methods
- Jenkins equations were developed for the national estimates of biomass and may not be suitable for local species


Thank You

PNW-GTR-750

Forest inventory-based estimation of carbon stocks and flux in California forests in 1990.

By Jeremy Fried and Xiaoping Zhou

http://www.fs.fed.us/pnw/pubs/pnw_gtr750.pdf