

Biomass and stem volume equations for tree species in Europe

Zianis, D., Muukkonen, P., Mäkipää, R. & M. Mencuccini. *Biomass and stem volume equations for tree species in Europe*. Accepted for revision in *Silva Fennica*.

A joint project with
Finnish Forest Research Institute and
University of Edinburgh
in co-operation with COST E21 Action



Objective

to compile database of tree-wise equations for

1. whole tree biomass
2. biomass of different components (e.g. foliage, branches, stump, roots)
3. stem volume

according to diameter at breast height and/or height
for common European tree species



Database

Biomass & volume equations

- $f(\text{dbh}, h)$
- Format

Additional information:

- Location
- Dependent variable
- The number of sampled trees
- Coefficient of determination
- The **min** and **max** diameter and height of the sampled trees
- Type of error estimate (e.g. RMSE, SEE)
- Contact person



Database, example

Scientific name	Location	Dependent variable	Format of equation	a	b	c
Picea abies	Germany, Saxonia, Thuringia	AB	$a+b*D+c*D^2$	-142,6088	13,63896	0,12593
Picea abies	Germany, Saxonia, Thuringia	SB	$a+b*D+c*D^2$	-6,55127	0,75517	0,02156
Picea abies	Austria, Carinthia, control	FL	$a+b*D+c*D^2$	-1.9745	0,039	0.00382
Picea abies	Austria, Carinthia, fertile	FL	$a+b*D+c*D^2$	-0.7095	0,0011	0.00142
Picea abies	Austria, Carinthia, control	BR	$a*\exp(b*D)$	5.3727	0.00876	-
Picea abies	Austria, Carinthia, fertile	BR	$a*\exp(b*D)$	1,325	0.0135	-
Picea abies	Finland	ST	$a*D^b$	0.12269	2.3272	-
Picea abies	Finland	BR	$a*D^b$	0.0022	2.9122	-
Picea abies	Finland	FL	$a*D^b$	0.00445	2.2371	-
Picea abies	Finland	FL(1)	$a*D^b$	0.00394	2.1534	-
Picea abies	Finland	FL(2)	$a*D^b$	0.00083	2.4074	-
Picea abies	Finland	RC	$a*D^b$	0.33989	1.4728	-
Picea abies	Denmark, Klosterheden	ln(FL)	$a+b*LOG(D^2*H)$	-4.24	0.67	-
Picea abies	Denmark, Klosterheden	ln(FL)	$a+b*LOG(D^2*H)$	-4.85	0.81	-
Picea abies	Denmark, Klosterheden	ln(BR)	$a+b*LOG(D^2*H)$	-5.88	1.02	-



Scientific name	TB	AB	ABVST	SW	SB	FL	FL(i)	FC	FE	BR	BC	BE	TW	DB	CR	CS	CW	CO	RC	RS	RF	RT	SR	SU	Total	
<i>Abies balsamea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	4	
<i>Acer pseudoplatanus</i>	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<i>Alnus glutinosa</i>	-	2	1	3	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	
<i>Alnus incana</i>	-	2	-	2	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	
<i>Arbutus unedo</i>	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	
<i>Betula pendula</i>	-	1	1	2	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	9	
<i>Betula pubescens</i>	-	1	-	3	-	2	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	9	
<i>Betula pubescens ssp.</i>	-	-	-	1	-	-	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4	
<i>Betula spp.</i>	-	-	4	1	5	4	2	-	-	2	-	-	-	5	3	-	-	-	-	-	-	1	-	1	28	
<i>Eucalyptus spp.</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Fagus crenata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Fagus moesiaca</i>	-	1	-	1	-	-	1	-	1	1	1	1	-	-	-	1	1	-	-	-	-	-	-	1	11	
<i>Fagus sylvatica</i>	-	7	4	4	2	2	6	-	-	6	-	-	-	-	2	-	-	-	1	1	1	4	-	-	40	
<i>Fraxinus excelsior</i>	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
<i>Picea abies</i>	3	15	1	15	12	16	28	-	-	25	-	-	3	14	16	-	-	-	2	3	-	5	-	1	159	
<i>Picea rubens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Pinus banksiana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Pinus contorta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2	
<i>Pinus pinaster</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Pinus radiata</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3	
<i>Pinus sylvestris</i>	-	15	4	11	13	15	22	2	-	19	-	-	-	11	12	-	-	4	7	1	1	6	4	2	149	
<i>Pinus taeda</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Populus tremula</i>	-	1	-	1	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	
<i>Pseudotsuga menziesii</i>	-	3	1	1	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	5	-	-	13	
<i>Pseudotsuga spp.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Quercus ilex</i>	-	10	1	6	-	-	6	-	-	8	-	-	-	-	1	-	-	-	3	3	-	4	-	-	42	
<i>Quercus petraea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
<i>Quercus pyrenaica</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<i>Quercus spp.</i>	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
<i>Tilia cordata</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Total	3	63	27	51	33	39	74	2	1	1	72	1	1	3	31	37	1	1	4	13	8	2	41	4	5	518

Biomass

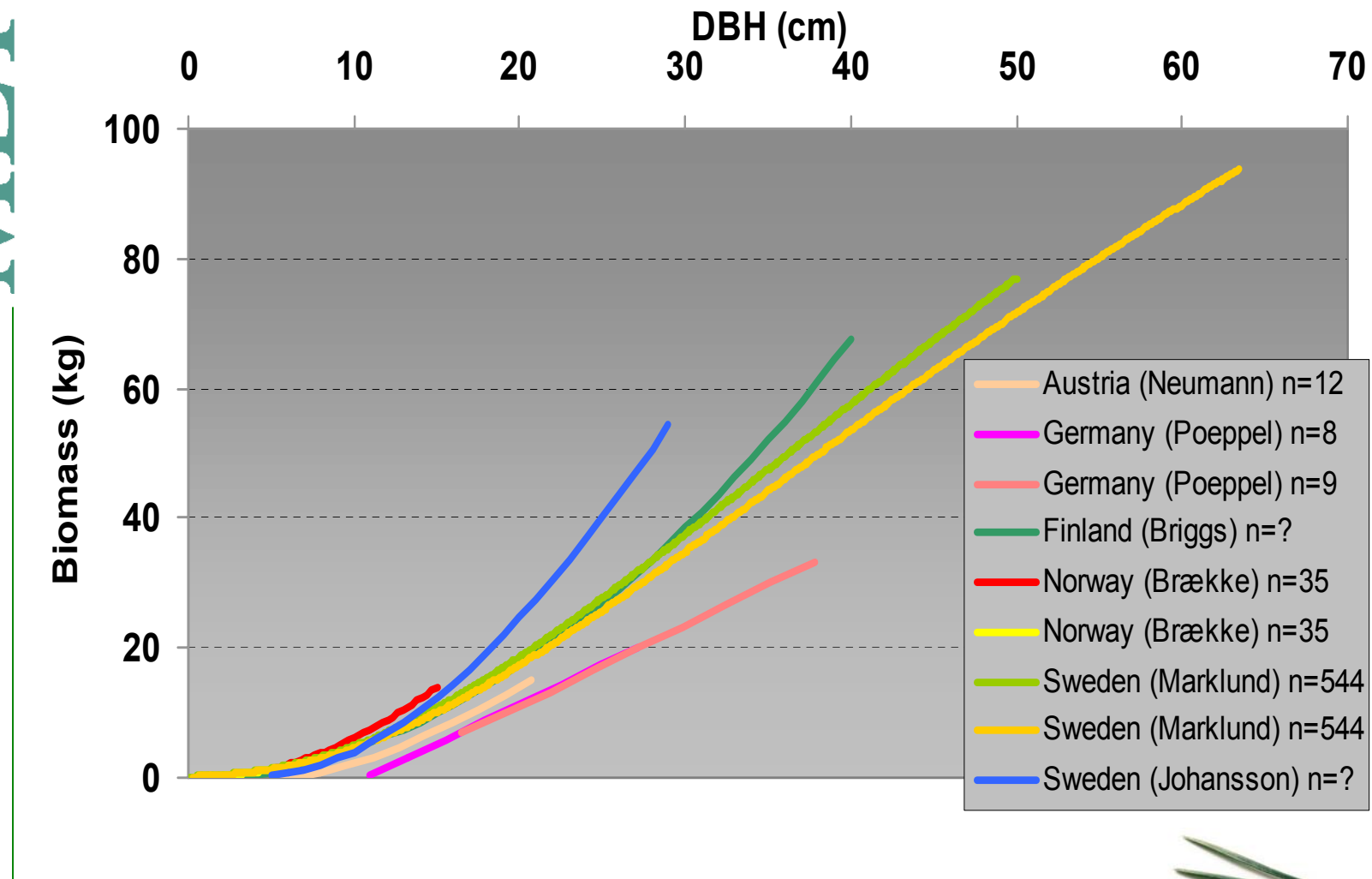
Scientific name	Austria	Belgium	Czech republic	Denmark	Finland	France	Germany	Greece	Italy	Netherlands	Norway	Poland	Portugal	Spain	Sweden	UK	Europe	n/a	Total
<i>Abies balsamea</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4
<i>Acer pseudoplatanus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
<i>Alnus glutinosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	3	-	-	11
<i>Alnus incana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	8
<i>Arbutus unedo</i>	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3
<i>Betula pendula</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	3	-	2	9
<i>Betula pubescens</i>	-	-	-	-	4	-	-	-	-	-	-	-	-	-	5	-	-	-	9
<i>Betula pubescens ssp.</i>	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
<i>Betula spp.</i>	-	-	-	-	10	-	-	-	-	-	-	-	-	-	14	4	-	-	28
<i>Eucalyptus spp.</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
<i>Fagus crenata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
<i>Fagus moesiaca</i>	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	11
<i>Fagus sylvatica</i>	1	3	-	-	-	9	2	-	6	1	-	-	-	4	5	-	-	-	40
<i>Fraxinus excelsior</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
<i>Picea abies</i>	4	5	16	8	19	-	59	-	-	-	12	-	-	-	36	-	-	-	159
<i>Picea rubens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
<i>Pinus banksiana</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
<i>Pinus contorta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
<i>Pinus pinaster</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
<i>Pinus radiata</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	3
<i>Pinus sylvestris</i>	-	6	8	-	43	-	-	-	-	-	28	17	-	-	3	11	3	3	149
<i>Pinus taeda</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
<i>Populus tremula</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4
<i>Pseudotsuga menziesii</i>	-	-	-	-	-	-	-	-	1	7	-	-	-	-	-	-	-	5	13
<i>Pseudotsuga spp.</i>	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
<i>Quercus ilex</i>	-	-	-	-	-	-	-	-	5	-	-	-	-	37	-	-	-	-	42
<i>Quercus petraea</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Quercus pyrenaica</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
<i>Quercus spp.</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	5
<i>Tilia cordata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Total	6	14	24	8	80	10	61	11	18	18	40	17	1	41	114	30	3	22	518

Volume

Scientific name	Austria	Belgium	Czech rep	Finland	Germany	Iceland	Italy	Netherland	Norway	Poland	Romania	Sweden	Total
Abies alba	-	-	-	-	-	-	-	-	-	-	-	-	-
Abies grandis	-	-	-	-	-	-	-	-	-	-	-	-	-
Abies sibirica	-	-	-	-	1	-	-	-	-	-	-	-	-
Abies spp.	2	-	-	-	-	-	-	-	-	-	-	-	2
acacia spp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Acer pseudoplatanus	-	1	-	-	-	-	-	-	-	-	-	-	1
Alnus alba	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus glutinosa	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus incana	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus nigra	-	-	-	-	-	-	-	-	-	-	-	-	-
Alnus spp.	1	-	-	-	-	-	1	-	-	-	-	-	1
Arbutus unedo	-	-	-	-	-	-	-	1	-	-	-	-	1
Betula pendula	-	-	1	-	-	-	-	-	-	-	-	-	1
Betula spp.	-	-	-	4	-	-	-	-	-	-	-	-	4
Carpinus spp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Chamaecyparis lawsoniana	-	-	-	-	-	-	-	1	-	-	-	-	1
Corylus avellana	-	-	-	-	-	-	-	-	1	-	-	-	1
Fagus spp.	2	-	-	-	-	-	-	-	-	-	-	-	2
Fagus sylvatica	-	1	-	-	2	-	-	2	-	-	-	-	5
Fraxinus excelsior	-	1	-	-	-	-	-	1	-	-	1	-	3
Fraxinus spp.	-	-	-	-	-	-	-	-	1	-	-	-	1
Larix decidua	2	-	-	-	-	-	-	1	-	-	-	-	3
Larix hybrid	-	-	-	-	-	-	-	1	1	-	-	-	2
Larix kaempferi	-	-	-	-	-	-	-	1	1	-	-	-	2
Larix sibirica	-	-	-	-	-	2	-	-	1	-	-	-	3
Larix spp.	-	-	-	2	-	-	-	3	1	-	-	-	6
Picea abies	2	1	-	7	2	-	-	5	12	2	-	6	39
Picea sitchensis	-	-	-	-	-	-	-	1	3	-	1	-	4
Picea spp.	-	-	-	-	-	-	-	-	-	-	-	-	1
Pinus contorta	-	-	-	-	-	-	-	1	-	-	-	-	1
Pinus nigra var maritima	-	-	-	-	-	-	-	1	-	-	1	-	2
Pinus nigra var nigra	-	-	-	-	-	-	-	1	-	-	-	-	1
Pinus spp.	-	-	-	-	2	-	-	3	8	-	1	6	20
Pinus sylvestris	1	2	-	8	1	-	1	4	8	-	2	6	32
Populus spp.	1	-	-	-	-	-	-	3	2	-	1	-	6
Populus tremula	-	-	-	-	-	-	-	-	-	-	-	-	-
Prunus avium	-	1	-	-	-	-	-	-	1	-	-	-	1
Pseudotsuga menziesii	-	1	-	-	-	-	-	1	1	-	1	-	4
Pseudotsuga spp.	-	-	-	-	-	-	-	3	-	-	-	-	3
Quercus grisea	-	-	-	-	-	-	-	-	-	-	1	-	1
Quercus ilex	-	-	-	-	-	-	1	-	-	-	1	-	2
Quercus laevis	-	-	-	-	-	-	-	-	-	-	1	-	1
Quercus pubescens	-	-	-	-	-	-	-	-	-	-	1	-	1
Quercus robur	-	-	-	-	-	-	-	1	-	-	-	-	1
Quercus rubra	-	1	-	-	-	-	-	1	-	-	-	-	2
Quercus spp.	2	1	-	-	-	-	-	3	-	-	1	1	7
Salix caprea	-	-	-	-	-	-	-	-	1	-	-	-	1
Salix spp.	-	-	-	-	-	-	-	-	-	-	2	-	2
Sorbus aucuparia	-	-	-	-	-	-	-	-	1	-	-	-	1
Thuja pilicata	-	-	-	-	-	-	-	-	1	-	-	-	1
tilia cordata	-	-	-	-	-	-	-	-	1	-	1	-	2
Tsuga heterophylla	-	-	-	-	-	-	-	-	1	-	1	-	2
Ulmus spp.	-	1	-	-	-	-	-	-	-	-	-	-	1
Total	195												



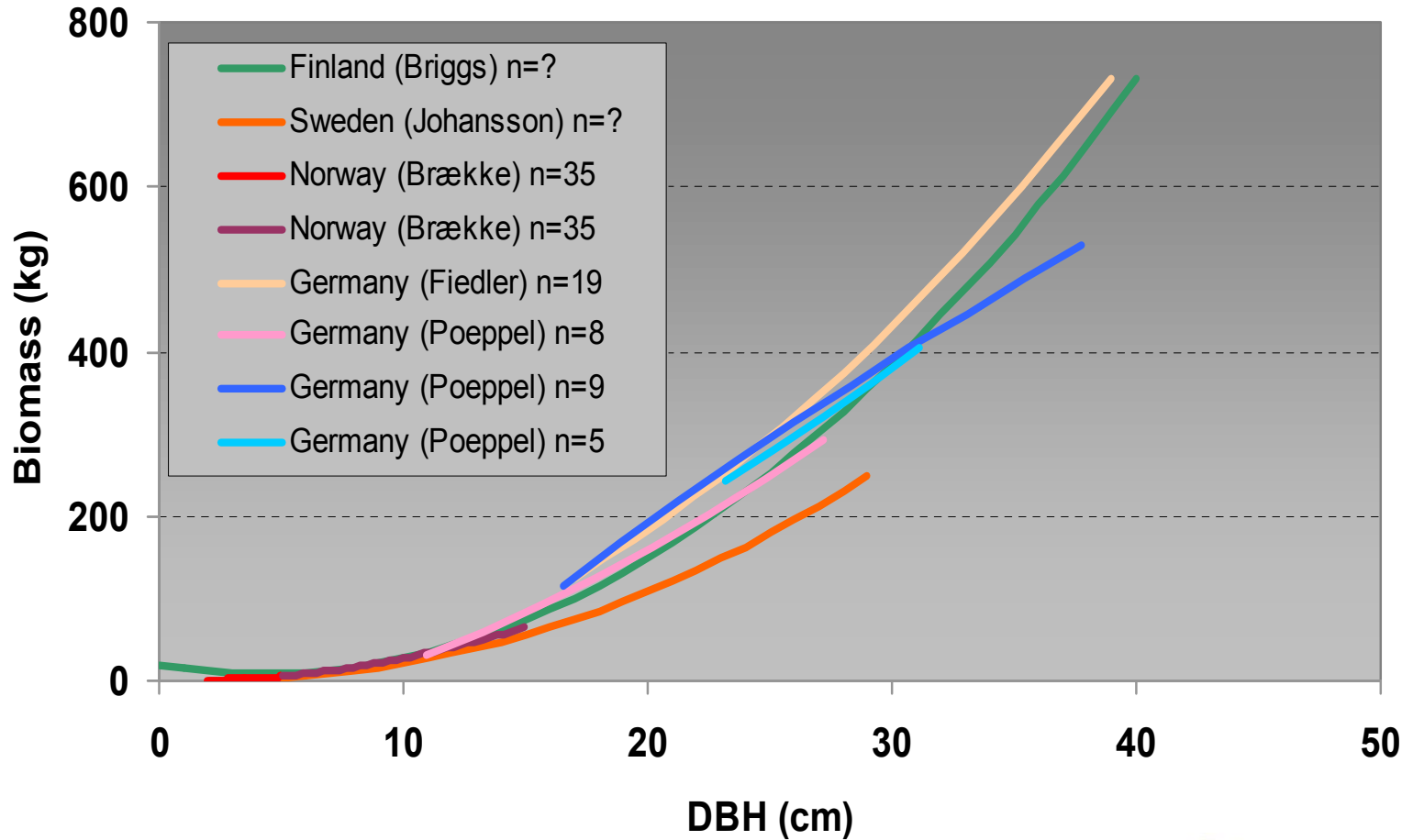
Foliage biomass of Norway spruce (*Picea abies*)



14-9-2004



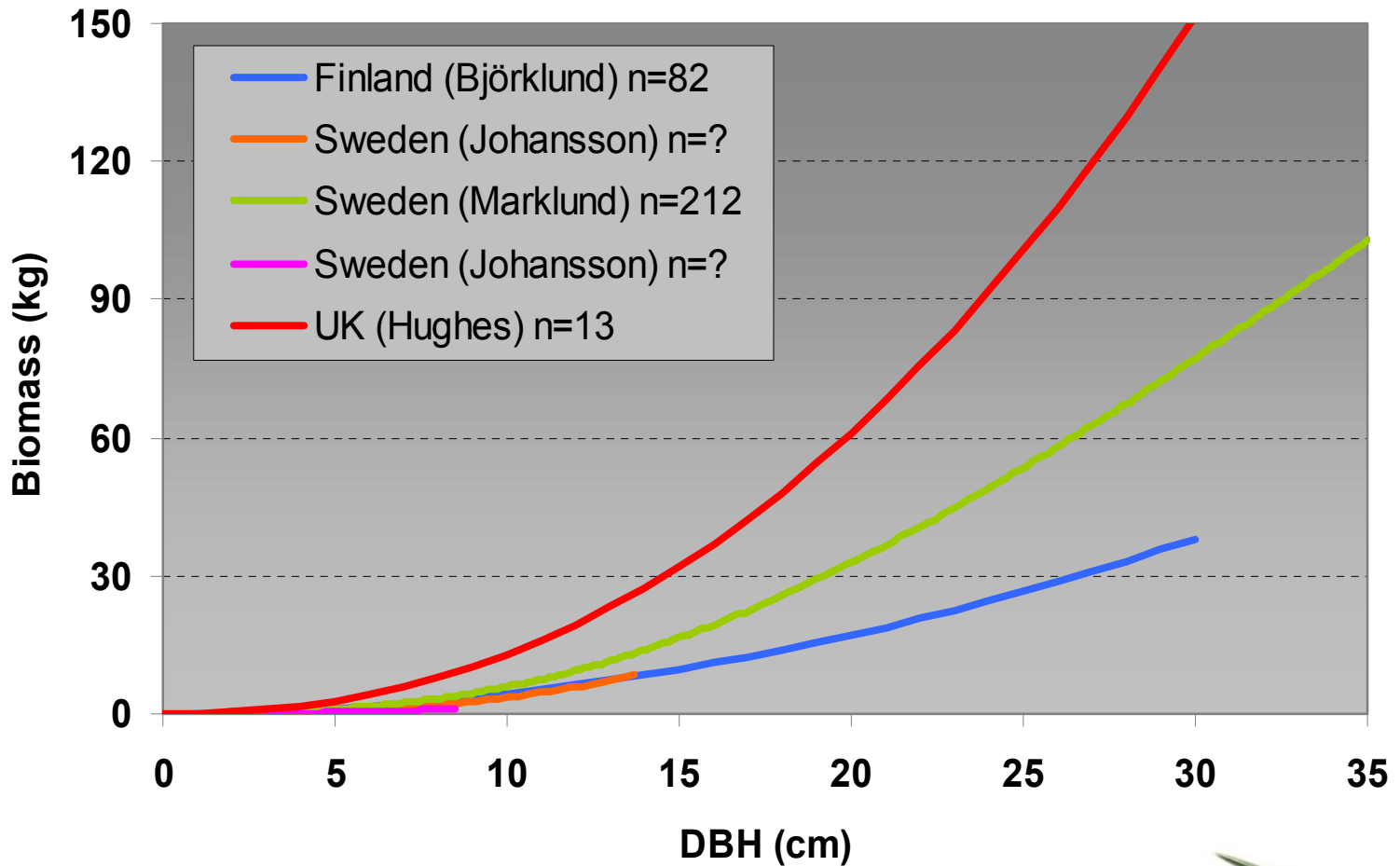
Aboveground biomass of Norway spruce (*Picea abies*)



14-9-2004



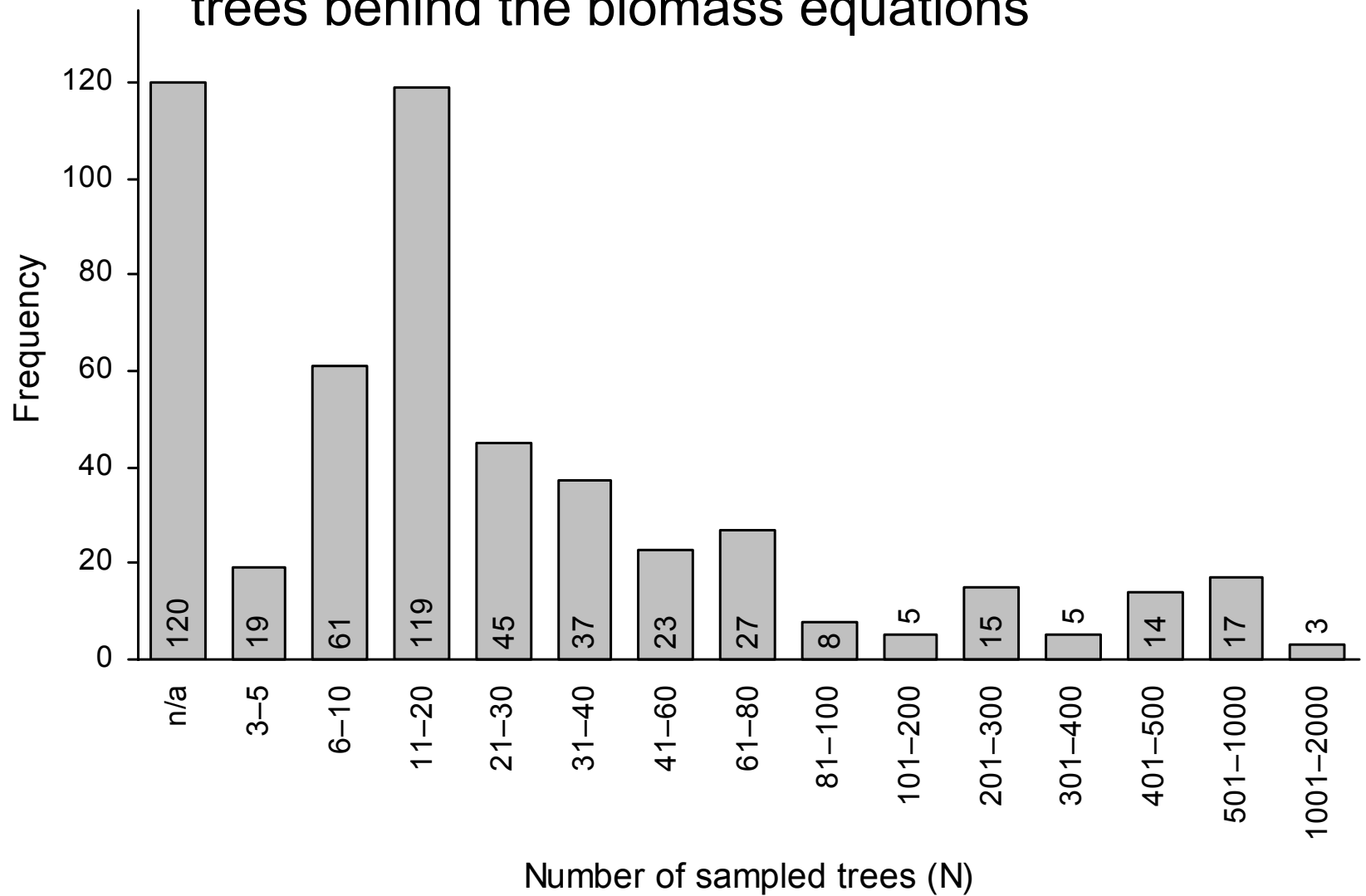
Branch biomass of birch (*Betula* spp.)



14-9-2004



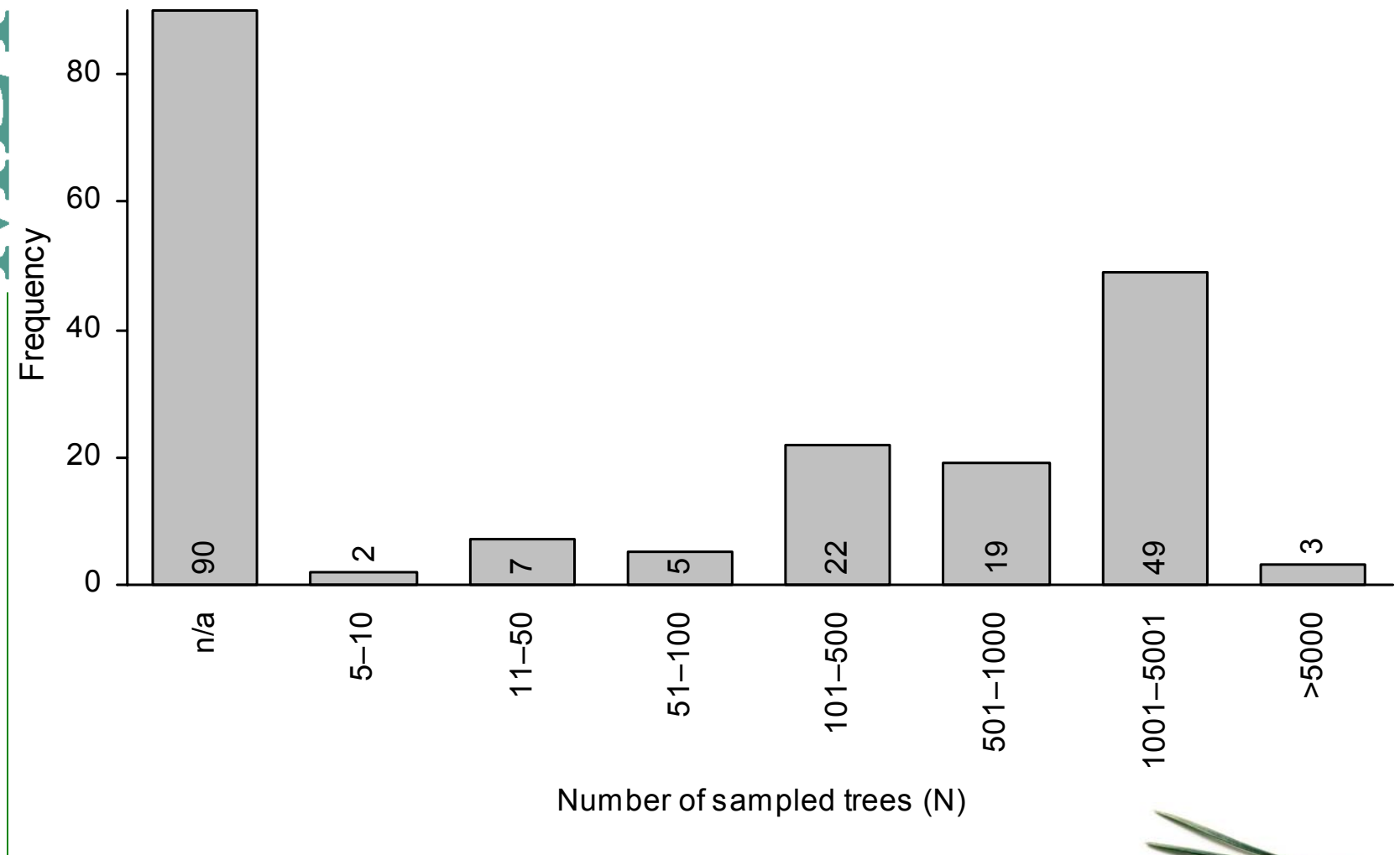
The histogram presenting number of sample trees behind the biomass equations



14-9-2004



The histogram presenting number of sample trees behind the volume equations



14-9-2004



Applications

- Formulation of stand level biomass expansion (BEF) factors for major tree species of Europe
- Studies on allometry of trees
- Examination of nutrient and carbon cycling in forest ecosystem
- Ecophysiological studies



Download information

You can download the database (excel-file) for your own use from the web page:

<http://www.metla.fi/hanke/3306/tietokanta.htm>

