NPP Boreal Forest: Kuusamo, Finland, 1967-1972, R1

Get Data

Revision Date: July 15, 2013

Summary:

This data set contains three files (.txt format). One file provides stand characteristics, biomass, and production allocation data for an old-growth boreal forest near Kuusamo, Finland. The research was conducted during the 1967-1972 growing seasons. The other two files provide climate data from a weather station about 60 km south of the forest. One record contains precipitation and mean average temperature data for the 1961-1994 period (excluding 1971-1980) and the other contains precipitation data for 1908-1994.

The Kuusamo research site is located just south of the Arctic Circle (66.37 N 29.32 E) and belongs to the northern boreal zone of taiga forests. The forest is an old *Hylocomium-Myrtillus* type spruce forest which has remained in a natural state and reached climatic climax long ago. The average age of the dominant spruces (*Picea abies*) is about 260 years. There is a well-developed ground layer of vegetation, chiefly dwarf scrub and mosses (dominant species: *Vaccinium myrtillus*, *V. vitis-idaea*, *Hylocomium splendens*, and *Pleurozium schreberi*).

The northerly location of the forest and the age of its trees are the main factors responsible for low biomass and net production figures in comparison with spruce forests further south. Total above-ground biomass (including tree, understory, and moss layers) was determined by harvest methods and estimated to be 10,194 g/m^2. Below-ground tree biomass estimates, also determined by harvest methods, are less reliable, at 3,753 g/m^2. Total net primary productivity (NPP) for this site was estimated to be 441 g/m^2/yr (421 g/m^2/yr above-ground, 20 g/m^2/yr below-ground).

Figure 1. A summertime view of the Kussamo boreal forest site, Finland. (Photograph taken about August 1975 by Prof. P. Havas, University of Oula, Finland).

Revision Notes:

The NPP data file **kms_npp_r1.txt** was revised to correct the temporal coverage of the reported data and to add new data from published sources. All other values in the data files are consistent with published sources. Please see the Data Set Revisions section of this document for detailed information.

Additional Documentation:

The NPP data collection contains field measurements of biomass, estimated NPP, and climate data for terrestrial grassland, tropical forest, temperate forest, boreal forest, and tundra sites worldwide. Data were compiled from the published literature for intensively studied and well-documented individual field sites and from a number of previously compiled multi-site, multi-biome data sets of georeferenced NPP estimates. The principal compilation effort (Olson et al., 2001) was sponsored by the NASA Terrestrial Ecology Program. For more information, please visit the NPP web site at http://daac.ornl.gov/NPP/npp_home.html.

Data Citation:

Cite this data set as follows:

Havas, P. 2013. NPP Boreal Forest: Kuusamo, Finland, 1967-1972, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/466

This data set was originally published as:

Havas, P. 1999. NPP Boreal Forest: Kuusamo, Finland, 1967-1971. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA

Table of Contents:

1. Data Set Overview:

Project: Net Primary Productivity (NPP)

Productivity was determined for an old-growth boreal forest (age 260 years) at the Kuusamo site for the period 1967 to 1972. The research was carried out as part of the International Biological Program (IBP), and results contributed toward contemporary work on modeling forest ecosystem processes. *Picea abies* (sometimes described incorrectly as *Picea excelsa*) dominates the upper story, and shrubs (*Vaccinium myrtillus*, *Vaccinium vitis-idaea*) and mosses (*Hylocomium splendens*, *Pleurozium schreberi*) dominate the open spaces between the trees.

The Kuusamo study site (66.37 N 29.32 E) is located at the Oulanka Biological Station in Oulanka National Park, Finland, approximately 60 km north of the town of Kuusamo. This area has a mean annual temperature of 0 C and an annual amplitude of 28-29 C for mean monthly temperatures. The mean annual precipitation of 500 mm and low overall temperatures result in saturated or moist soil conditions for most of the year.

Table 1. ANPP, BNPP, and TNPP values reported by various published data sources

File Name or Description	Data Source(s)	Sub-Site	ANPP	BNPP	TNPP
			gC/m^2/year		
ksm_npp_r1.txt	DeAngelis et al. (1981); Havas and Kubin (1983)[1,2]	ksm	210.4	10	na
ods_xls.csv	Esser (1998) based on Havas and Kubin (1983)[1]	#2402	210.4	10	220.5
woodland.txt	DeAngelis et al. (1997); DeAngelis et al. (1981)[1]	#10	210.4	10	na

NPP_Multibiome_EnvReview_Table_A1_R1.xls	Scurlock and Olson (2012) based on DeAngelis et al. (1981); Havas and Kubin (1983)[1]	ksm	210.4	10	220.5
GPPDI_ClassA_NPP_162_R2.csv	Olson et al. (2012a) based on Havas (1973) and ORNL calculations	Class A 146 (MI 173)	210	-999	368
GPPDI_ClassB_NPP_2363_R1.csv	Olson et al. (2012a) based on Esser (1998)	Class B 1578 (MI 2239)	200	10	210
	Olson et al. (2012a) based on Site #10 of DeAngelis et al. (1981) by ORNL calculation	Class B 1579 (MI 2330)	210	-999	370
	Olson et al. (2012a) based on site ksm of ORNL	Class B 1579 (MI 2331)	200	10	210
EMDI_ClassA_NPP_81_R2.csv	Olson et al. (2012b) based on Havas (1973) and ORNL calculations	Class A 146	210	-999	368
borfornpp2.csv	Gower et al. (2001; 2012) based on Havas (1973)	Class II Oulu, Finland[7]	210	NA	NA

Notes: NA = Not available. MI = Measurement identification number.

The differences in NPP values reported in this table are mainly due to differences in calculation methods, as explained in these notes.

Please consult original references for details.

Please see the Data Set Revisions section of this document for detailed information on the revised data sets (R1, R2, etc.).

[1]For this table, NPP data from the original data source were converted from grams of dry weight per meter square per year to grams of carbon per meter square per year using a conversion factor of 0.5.

[2]ANPP estimates are based on sum of annual production of stemwood, living branches with bark, cones, bushes, and epiphytic lichens + litterfall.

The basis for BNPP estimates is not identified by source but presumably related to fine root biomass (p. 136, Havas and Kubin, 1983).

IBP-forest in Oulanka (Hylocomium-Myrtillus-type)
Foto: Paavo Havas

Figure 2. Another summertime view of an old-growth Norway Spruce forest (*Picea abies*, with *Hylocomium-Myrtillus* type of understory) at the Kuusamo boreal forest site, Finland. (Photograph taken about August 1975 by Prof. P. Havas, University of Oulu, Finland).

Figure 3. Winter view of the Kuusamo boreal forest site, Finland. Since the tips of the longest branches of tall spruces often reach nearly to the ground, not much snow is accumulated under the trees in the winter. (Photograph taken winter 1975 by Prof. P. Havas, University of Oulu, Finland).

2. Data Description:

This data set contains three text files. One file provides stand characteristics, biomass, and production allocation data for an old-growth boreal forest near Kuusamo, Finland. The research was conducted during the 1967-1972 growing seasons. The other two files provide climate data from a weather station about 60 km south of the forest. One record contains precipitation and mean average temperature data for the 1961-1994 period (excluding 1971-1980) and the other contains precipitation data for 1908-1994.

Spatial Coverage

Site: Kuusamo, Finland

Site Boundaries:(All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Elevation (m)
Kuusamo, Finland	29.32	29.32	66.37	66.37	270

Site Information

The Kuusamo site in Finland is located in the northern half of the country, at just south of the Arctic Circle (66.37 N 29.32 E). This area belongs to the northern boreal zone of taiga forests. The Kuusamo research site is an old *Hylocomium-Myrtillus* type spruce forest which has remained in a natural state and reached a climatic climax situation long ago. The average age of the dominant spruces (*Picea abies*) is about 260 years, and their average height 16 meters.

There is a relatively poor potential for timber yield; cubic volume of tree stems is approx. 125 m^3/ha. The trees are situated some distance apart and have short branches, so that about 70% of the forest floor remains beyond the protection of the branches. *P. abies* occupies about 88% of the forest with *Betula pubesccns* comprising the rest. There is a well-developed ground layer of vegetation, chiefly dwarf scrub and mosses (dominant species: *Vaccinium myrtillus*, *V. vitis-idaea*, *Hylocomium splendens*, and *Pleurozium schreberi*).

The micro-topography of the plot is characterized by the presence of numerous hummocks, with relatively little level ground between them. The ground cover is distributed in a mosaic pattern with some vegetation occurring on the hummocks and under the spruce branches (accounting for slightly less than half of the forest area) and the rest growing on the open areas between the trees.

Winter in northern Finland is long and dark, but otherwise not particularly severe. The climate at Kuusamo is nearly continental with a mean annual temperature is 0 degrees C and an annual amplitude of mean monthly temperature of 28-29 degrees C. Annual rainfall is scant (500 mm). A permanent snow cover occurs from around November 1 to around May 15. The length of the growing season is about 129 days. The seasonal variation in the rhythm of solar radiation, similar to an arctic rhythm, has an impact on the ecology of the forest plants. The vegetation of northern forests is slow-growing, but largely evergreen and xeromorphic.

The soil is a podsol gley in which the A horizon is markedly thin. The illuvial horizon (B) is thick throughout, its lower part grading progressively into unaltered subsoil. Water permeability is poor as a consequence of the dense illuvial horizon, and this is in part the reason for the thick raw humus layer and the thin eluvial horizon. The soil at the Kuusamo site generally remains quite moist and the thick peat-like layer of raw humus (mor) frequently tends to be swampy. During the dry spells of the summer the water occasionally goes down to the depth of over one meter, but rises rapidly during periods of abundant rain. In the shadow of the trees, the humus generally remains quite moist even in the summer.

Spatial Resolution

The study area was 30 x 30 m in size. Sixteen spruces and 3 birches were harvested to estimate tree biomass. The ground vegetation cover and phytomass were measured along 8 transects of 2 m in width across the plot, using quadrats of 2 x 2 m. Pythons measurements were performed by the harvesting method using 0.5 x 0.5 m subplots for shrubs and 0.25 x 0.25 m subplots for the moss layer. Litter was collected in small litter traps (apron. 15 x 10 cm).

Temporal Coverage

Phytomass samples were collected during the 1967-1972 growing season, from the end of May or beginning of June to the end of September or beginning of October. The data in this data set are mean values of composite samples of material derived from different quadrats, reported as of 1971. Two climate records are available; one record for precipitation amount and mean average temperature from 1961/01/01 through 1994/12/31 period (excluding 1971-1980) and the other for precipitation amount from 1908/07/01 through 1994/06/30.

Temporal Resolution

Ground vegetation samples were collected on a total of 48 occasions during the period 1967-1972. Harvesting took place at approximately two-week intervals throughout the growing seasons, although the exact number of times varied slightly from year to year. Tree biomass was determined by felling 16 spruces and 3 birches in late summer.

All NPP estimates are based on plant dry matter accumulation, expressed as g/m^2/year (dry matter weight). Climate data are expressed as monthly and annual precipitation amounts (mm) and monthly and annual average temperature (C).

Data File Information

Table 2. Data files in this data set archive

FILE NAME	TEMPORAL COVERAGE	FILE CONTENTS
ksm_npp_r1.txt	1967/05/01-	Stand characteristics, above- and below-ground biomass, and above- and below-ground production

	1972/10/31	allocation data for an old-growth boreal forest near Kuusamo, Finland
ksm1_cli.txt	1961/01/01-1994/12/31 (excluding 1971-1980)	Mean monthly and annual precipitation amount and mean monthly and annual average temperature data from a weather station at Kuusamo, Finland
ksm2_cli.txt	1908/07/01-1994/06/30	Monthly and annual precipitation amount from a weather station at Kuusamo, Finland

NPP Data: NPP estimates for the Kuusamo, Finland site are provided in one text file (.txt format; Table 2). The variable values are delimited by semicolons. The first 18 lines are metadata; data records begin on line 19. The value -999.9 is used to denote missing values. Biomass and NPP units are in g/m^2 and g/m^2/year (dry matter weight), respectively.

Sample NPP Data Record

```
Site; Treatmt; Year; Month; Day; parameter; amount; units; Reference/comments

ksm ; none; 1971; -999.9; -999.9; height; 16.2; m; All measurements from
ksm ; none; 1971; -999.9; -999.9; age; 260; years; IBP Woodlands Data Set
ksm ; none; 1971; -999.9; -999.9; basal_area; 22.2; m2/ha; DeAngelis_et_al.(1981)
ksm ; none; 1971; -999.9; -999.9; num_density; 550; trees/ha; unless otherwise
ksm ; none; 1971; -999.9; -999.9; LAI; 4.9; m2/m2; stated
ksm ; none; 1971; -999.9; -999.9; basal_area_incr; 0; m2/ha;
ksm ; none; 1971; -999.9; -999.9; leaves; 661.8; g/m2; ...
```

Table 3. Column headings in NPP file

COLUMN HEADING	DEFINITION	UNITS
Site	Site where data were gathered (code refers to site identification)	Text
Treatmt	Long term management of site are described in metadata in data file	Text
Year	Year in which data were collected	Numeric
Month	Month in which data were collected	Numeric
Day	Day on which data were collected	Numeric
parameter	Parameters measured (see definitions in Table 3)	Text
amount	Data values	Numeric
units	Unit of measure	Text
References / comments	Primary references plus explanatory comments	Text

Table 4. Parameter definitions in NPP file

COLUMN HEADING	DEFINITION	UNITS	SOURCE
height	Forest canopy height	m	p. 582, DeAngelis et al. (1981)
age	Estimated age of stand	years	
basal_area	Basal area of plot when measurements were made	m^2/ha	
num_density	Stocking density when measurements were made	trees/ha	
LAI	Leaf area index of the forest, excluding mosses. The tree layer (including a half of the total surface area of the needles) accounts for approx. 3.6 and the dwarf shrubs (including a half of the total surface area of the green stems of *Vaccinium myrtillusi* a mean value of 1.2.	m^2/m^2	p. 582, DeAngelis et al. (1981); p. 125, Havas and Kubin (1983)
basal_area_incr	Increment in actual stemwood[1]	m^2/ha	p. 582, DeAngelis et al. (1981); p. 137, Havas and Kubin (1983)

leaves	Needle biomass	g/m^2	p. 582, DeAngelis et al. (1981); Table 16, Havas and Kubin (1983)
frtflowers	Cone biomass		
branches	Biomass of living branches with bark		
trunks	Biomass of stemwood with bark and phloem		
trunk_bark	Biomass of stem bark and phloem		
trunk_wood	Biomass of stemwood		
stdead	Biomass of standing dead trees		
Understory	Biomass of understory shrubs		p. 582, DeAngelis et al. (1981)
herb_layer	Biomass of herbs and grasses		
epiphytes	Biomass of mosses		
AGbiomass	Total above-ground biomass		by addition
totroots	Total root biomass	g/m^2	p. 582, DeAngelis et al. (1981)
coarseroots	Biomass of coarse roots		
fineroots	Biomass of fine roots		
org_horizon	Soil top organic matter		
org_horizon_N	Nitrogen content of the humus layers (0-10 cm depth)	g/m^2	Table 9, Havas (1973)
org_horizon_P	Phosphorus content of the humus layers (0-10 cm depth)		
litter	Litter falling from trees in summer of 1972(sum of litter falling between and under spruce and birch trees)	g/m^2	Table 21, Havas and Kubin (1983)
litterfall	Annual litter accumulation	$g/m^2/yr$	p. 582, DeAngelis et al. (1981); Table 16, Havas and Kubin (1983)
ANPP	Annual above-ground net primary production (sum of annual production of stemwood, living branches with bark, cones, bushes, and epiphytic lichens + litterfall)		
BNPP	Annual below-ground net primary production		

Notes:

[1]The increment in actual stem wood in this forest was practically negligible, on account of the extreme age of the trees, and must have even been exceeded at times by the natural wastage in the form of litter, fallen trees, dead branches, etc. Relying mainly on measurements of annual rings, a figure of only 0.3 % was obtained for the relative growth of stemwood and bark combined, although such a calculation should admittedly be approached with some caution.

Climate Data. The climate data for the Kuusamo, Finland site are provided in two text files (.txt format; Table 2). The first 18 lines are metadata; data records begin on line 19. The variable values are delimited by semi-colons. The value -999.9 is used to denote missing values.

Sample Climate Data Record [ksm1_cli.txt]

```
Site;Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year
ksm ;mean;prec; 36.5; 28.5; 36.5; 32.8; 46.5; 68.7; 74.0; 71.1; 57.5; 56.1; 46.2; 39.3; 594.3
ksm ;mean;tavg; -14.1; -12.9; -8.2; -2.1; 4.9; 11.2; 13.8; 11.4; 6.1; 0.3; -5.6; -11.3; -0.6
ksm ;numb;prec; 24; 24; 24; 24; 24; 24; 23; 23; 23; 23; 23; 23; 23
ksm ;numb;tavg; 23; 23; 24; 24; 24; 24; 24; 24; 24; 24; 23; 24; 22
ksm ;stdv;prec; 17.4; 14.8; 13.7; 15.9; 20.5; 35.8; 34.1; 28.0; 25.3; 27.3; 19.7; 16.4; 88.9
ksm ;stdv;tavg; 4.9; 4.9; 3.9; 2.1; 2.1; 2.0; 1.4; 1.4; 1.7; 2.9; 3.0; 4.0; 1.2
ksm ;1961;prec; 42.0; 37.0; 43.0; 26.0; 57.0; 76.0; 80.0; 78.0; 35.0; 57.0; 58.0; 45.0; 634.0
ksm ;1961;tavg; -9.1; -7.3; -6.0; -4.3; 3.3; 14.2; 15.9; 11.8; 6.1; 5.8; -3.0; -13.1; 1.2
ksm ;1962;prec; 61.0; 46.0; 20.0; 60.0; 62.0; 67.0; 78.0; 66.0; 58.0; 63.0; 54.0; 34.0; 669.0
ksm ;1962;tavg; -12.1; -11.0; -14.9; 0.5; 5.1; 9.2; 11.3; 10.0; 6.1; 1.4; -2.3; -13.7; -0.9 …

Where,
Temp (temporal) - specific year or long-term statistic:
  mean = mean based on all years
  numb = number of years
  stdv = standard deviation based on all years
Parm (parameter):
```

```
prec = precipitation for month or year (mm)
tavg = mean average temperature for month or year (C)
```

Sample Climate Data Record [ksm2_cli.txt]

```
Site;Temp;Parm; Jan; Feb; Mar; Apr; May; Jun; Jul; Aug; Sep; Oct; Nov; Dec; Year
ksm ;mean;prec; 36.2; 29.4; 31.1; 34.1; 40.8; 65.0; 67.5; 72.4; 60.4; 52.3; 46.0; 39.1; 574.1
ksm ;numb;prec; 84; 84; 84; 85; 86; 86; 86; 86; 85; 85; 84; 85; 82
ksm ;stdv;prec; 15.8; 13.8; 13.9; 18.0; 22.4; 29.2; 35.1; 31.3; 26.9; 28.7; 19.1; 16.6; 92.5
ksm ;1908;prec; -999.9; -999.9; -999.9; -999.9; -999.9; -999.9; 50.0; 39.0; 103.0; 14.0; 3.0; -999.9; -999.9
ksm ;1909;prec; -999.9; -999.9; -999.9; -999.9; 33.0; 27.0; 58.0; 74.0; 28.0; 134.0; -999.9; 36.0; -999.9
ksm ;1910;prec; 79.0; 37.0; 35.0; 72.0; 19.0; 58.0; 83.0; 19.0; 97.0; 37.0; 69.0; 34.0; 639.0
ksm ;1911;prec; 25.0; 22.0; 29.0; 31.0; 7.0; 69.0; 81.0; 107.0; 19.0; 56.0; 70.0; 22.0; 538.0
ksm ;1912;prec; 10.0; 29.0; 58.0; 12.0; 28.0; 95.0; 15.0; 126.0; 103.0; 17.0; 44.0; 37.0; 574.0
ksm ;1913;prec; 16.0; 24.0; 43.0; 14.0; 37.0; 67.0; 37.0; 67.0; 53.0; 38.0; 38.0; 36.0; 470.0
ksm ;1914;prec; 28.0; 41.0; 18.0; 40.0; 89.0; 63.0; 107.0; 53.0; 38.0; 6.0; 26.0; 51.0; 560.0
ksm ;1915;prec; 36.0; 37.0; 26.0; 31.0; 24.0; 65.0; 67.0; 69.0; 44.0; 28.0; 44.0; 20.0; 491.0
ksm ;1916;prec; 42.0; 23.0; 12.0; 8.0; 14.0; 58.0; 75.0; 98.0; 34.0; 36.0; 41.0; 46.0; 487.0
ksm ;1917;prec; 37.0; 13.0; 18.0; 47.0; 111.0; 57.0; 28.0; 51.0; 114.0; 102.0; 77.0; 32.0; 687.0 ...

Where,
Temp (temporal) - specific year or long-term statistic:
 mean = mean based on all years
 numb = number of years
 stdv = standard deviation based on all years
Parm (parameter):
 prec = precipitation for month or year (mm)
```

3. Data Application and Derivation:

The accumulation of biomass, or NPP, is the net gain of carbon by photosynthesis that remains after plant respiration. While there are many fates for this carbon, this data set accounts for above-ground growth, litterfall, and root mass accumulation. These are considered the major components of NPP.

This study was undertaken to describe the vegetation, growth, ecology, and organic matter content in an old-growth spruce forest (*Picea abies*) of the *Hylocomium-Myrtillus* type in northern Finland. The research was carried out as part of the International Biological Program (IBP), and results contributed toward contemporary work on modeling forest ecosystem processes.

The biomass dynamics data for the Kuusamo, Finland site are provided for comparison with models and estimation of NPP. Climate data are provided for use in driving ecosystem/NPP models.

4. Quality Assessment:

The forest studied here corresponds in its tree cover to the pattern that is typical of natural growing sites in the north possessing a thick raw humus horizon. The northerly location of the forest and the age of its trees are the main factors responsible for the fact that the tree layer biomass and net production figures are both low by comparison with spruce forests further south. Broadly similar biomass figures have been obtained in a 140-year old spruce forest slightly further south. In contrast, spruce biomass in central and southern Scandinavia and Estonia tend to be more than three times greater.

Sources of Error

Measurement of the biomass of roots and other underground parts was rendered quite difficult in forests of this type by the thick and peat-like layer of mor. Thus underground biomass was roughly estimated and far from being accurate.

5. Data Acquisition Materials and Methods:

Understory and Ground Layer: Plant species composition, density, and phytomass of understory shrubs and ground layers were determined in a plot of 30 x 30 m. Percentage cover estimates for the field-layer vegetation were obtained for a total of 8 transects of 2 m in width across this plot, using quadrats of 2 x 2 m. Fifty percent of the quadrats were located totally or partially beneath the branches of the trees and the rest in open spaces between the trees (data were combined for this data set). Measurements were performed by the harvest method. Samples were collected on a total of 48 occasions during the period 1967-1972, harvesting around ten 0.5 x 0.5 m quadrats for shrubs and 0.25 x 0.25 m for the moss layer on each occasion. Harvesting took place at approximately two-week intervals throughout the growing season, from the end of May or beginning of June up to the end of September or beginning of October, although the exact number of times varied slightly from year to year.

The moss layer plants were cut off at the border between the living mosses and the humus layer. The second dividing line was the upper extent of the living moss layer. This was employed when cutting the herbs and dwarf shrubs from the larger quadrats (0.5 x 0.5 m), although the parts of these found growing within the mat of living mosses were also counted within their aerial biomass.

All the material was dried in an oven at approx. 90 C and the resulting dry weights determined. The results were calculated per hectare by assessing separately the areas occupied by the forest canopy and open spaces, and also by bare patches and areas containing only *Sphagnum* stands. The area occupied by the bases of the trees was also estimated from the breast-height diameters by direct conversion to the corresponding diameters at stump height together with an addition of a further 10 cm to allow for the widening of the trunk towards the base.

Bush and Tree Layers: The maximum (later summer) biomass figures were determined by felling 16 spruces selected with reference to the size-class distribution of the whole population in the forest plot, and 3 birches. A disc 10 cm thick was cut from each meter-long section of the trunk of each of the spruces, together with any branches appearing at the points in question. On account of the forking of their trunks and the irregular distribution of their branches, the birches were sampled by selecting representative sections amounting to approx. 10 % of the total material. These samples were used in the laboratory for determining the dry weights of the various parts of the trees separately. Special attention was paid to the measurement of the extent of new growth.

Below-ground Biomass: Measurement of the underground parts of the plants (roots, rhizomes, etc.) proved so laborious that relatively rough estimates had to be made with attempts being made to determine largely the maximum underground biomass. Thus little importance was attached to assessing the proportions of the various species in this biomass other than to the obtaining of a general impression of the relative contributions of the trees and the field-layer vegetation (only root biomass is presented in the data set). The roots of harvested trees were gathered in a series of concentric zones working outwards from the stump to a distance of 2 m away, each zone being 0.5 m in width. The roots were also dug out of the mineral soil whenever this was feasible. The stump itself, i.e. that part of the tree which had not yet branched out to form the root system, was included in the aerial biomass of the tree.

Tree Height and Radial Growth: The mean lengths of the aerial parts of the trees were measured in fallen trees. Radial growth was measured by studying the thickness of the annual rings in cross-sections in three directions using a microscope.

Litter and Humus: The extent of the litter produced was assessed partly using fairly small litter traps (approx. 15 x 10 cm). and partly by estimating the amount of litter from the biomass and production results, the latter method having proved more reliable than the use of traps. The amounts of litter of different size classes were determined by extracting this component from the raw humus samples and analyzing it by differential sieving. The dry weight of the raw humus was determined from the same samples as were used for the size classification of the litter, after extraction of this litter and the root material. Each sample was divided into an upper and a lower layer at the point at which it fell apart most naturally, before the roots had been extracted from it. This dividing line represented the boundary between the two degrees of humification. The humus samples naturally also contained the fungal mycelia, with the exception of those attached to the root systems of the plants.

Climate: The climate record for this data set was obtained from the weather station at Kuusamo, about 60 km south of boreal forest study site (65.97 N 29.18 E elevation 263 m). One data file [ksm1_cli.txt] provides monthly and annual precipitation amount and mean average temperature for the 1961-1994 period (excluding 1971-1980). The second file [ksm2_cli.txt] provides monthly and annual precipitation amount for the 1908-1994 period.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive Center:

Contact for Data Center Access Information:
E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

DeAngelis, D.L., R.H. Gardner, and H.H. Shugart. 1981. Productivity of forest ecosystems studied during the IBP: the woodlands data set (Oulu/ Kuusamo site, p. 582). In: Reichle, D.E., ed. Dynamic Properties of Forest Ecosystems, IBP 23. Cambridge University Press, Cambridge. 683 pp.

Havas, P. 1973. IBP Forests in Finland: report on a spruce forest ecosystem in the northern boreal zone. pp. 96-113. In: Kern, L., ed. Modelling Forest Ecosystems, Report EDFB-IBP-73-7, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. 19 pp.

Havas, P., and E. Kubin. 1983. Structure, growth and organic matter content in the vegetation cover of an old spruce forest in northern Finland. Annales Botanici Fennici 20, 115-149.

Olson, R.J., K.R. Johnson, D.L. Zheng, and J.M.O. Scurlock. 2001. Global and Regional Ecosystem Modeling: Databases of Model Drivers and Validation Measurements. ORNL Technical Memorandum TM-2001/196. Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA

Additional Sources of Information:

DeAngelis, D.L., R.H. Gardner, and H.H. Shugart. 1997. NPP Multi-Biome: Global IBP Woodlands Data, 1955-1975. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/198

Esser, G. 1998. NPP Multi-Biome: Global Osnabrück Data, 1937-1981. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/214

Gower, S.T., O. Krankina, R.J. Olson, M. Apps, S. Linder, and C. Wang. 2001. Net Primary Production and Carbon Allocation Patterns of Boreal Forest Ecosystems. Ecological Applications. 11:1395-1411.

Gower, S.T., O. Krankina, R.J. Olson, M. Apps, S. Linder, and C. Wang. 2012. NPP Boreal Forest: Consistent Worldwide Site Estimates, 1965-1995, R[evision]1. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/611

Havas, P. 1985. Winter and the boreal forests. Aquilo, Ser. Botanica 23, 9-16.

Havas, P., and E. Mäenpää. 1972. Evolution of carbon dioxide at the floor of a *Hylocomium Myrtillus* type spruce forest. Aquilo, Ser. Botanica 11, 4-22.

Kubin, E. 1983. Nutrients in the soil, ground vegetation and tree layer in an old spruce forest in northern Finland. Annales Botanici Fennici 20, 361-390.

Olson, R.J., J.M.O. Scurlock, S.D. Prince, D.L. Zheng, and K.R. Johnson (eds.). 2012a. NPP Multi-Biome: Global Primary Production Data Initiative Products, R2. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/617

Olson, R.J., J.M.O. Scurlock, S.D. Prince, D.L. Zheng, and K.R. Johnson (eds.). 2012b. NPP Multi-Biome: NPP and Driver Data for Ecosystem Model-Data Intercomparison, R2. Data set. Available on-line [http://daac.ornl.gov] from the Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/615

Scurlock, J.M.O., and R J. Olson. 2002. Terrestrial net primary productivity - A brief history and a new worldwide database. Environ. Rev. 10(2): 91-109. doi:10.1139/a02-002

Scurlock, J.M.O., and R.J. Olson. 2012. NPP Multi-Biome: Grassland, Boreal Forest, and Tropical Forest Sites, 1939-1996, R1. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA doi:10.3334/ORNLDAAC/653

8. Data Set Revisions:

Revision Summary:

The NPP data file, **ksm_npp.txt**, has been revised to correct the temporal coverage and to add new data from published sources. All other values in the data files are consistent with published sources.

Data File Changes:

Temporal coverage of **ksm_npp_r1.txt** has been revised to incorporate new data.

Uncorrected in ksm_npp.txt	Corrected in ksm_npp_r1.txt
Years	
1967-1971	1967-1972

Litter falling from trees in the summer of 1972 has been added to **ksm_npp_r1.txt** from Havas and Kubin (1983).

Parameter Field*	Uncorrected in ksm_npp.txt	Corrected in ksm_npp_r1.txt
	g/m^2	
litter (summer of 1972)	NR	29.3

Notes: NR: Not reported. *See data set Guide document for parameter definitions.

The data values in **kms_npp_r1.txt** are now correct.

Data User Action: If you downloaded this data set from the ORNL DAAC on-line archive before July 15, 2013, you should download it again from the ORNL DAAC.

Revision History:

Original Citation

Havas, P. 1999. NPP Boreal Forest: Kuusamo, Finland, 1967-1971. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA