NACP New England and Sierra National Forests Biophysical Measurements: 2008-2010

Summary:

This data set includes biophysical measurements collected in 2009 from five New England experimental forest stations: Bartlett Experimental Forest, Harvard Forest, Howland Research Forest, Hubbard Brook Experimental Forest, and the Penobscot Experimental Forest. Howland measurements were repeated in 2010 and one site in the Sierra National Forest, California, was surveyed in 2008.

Biomass in respective measurement plots was calculated with allometric equations using measured diameter at breast height (DBH) for trees greater than 10 cm and species identification. Within selected subplots, the number of stems with diameters less than 10 cm were counted and classified to allow for an estimate of biomass for these stems. There are 16 data files provided that present the biophysical measurement results and the biomass estimates in ASCII comma-separated format.

For a subset of sites and plots (Bartlett Experimental Forest, Harvard Forest and Howland Research Forest), more intensive inventories were done in coordination with Echidna lidar imaging (Strahler et al., 2008). In these intensive collections, the stem location, species, DBH and live/dead status were recorded for all stems with total stem height and canopy dimensions recorded for every tenth stem. In addition, for stems below 10 cm DBH, species and count were recorded in a subplot of each intensive inventory plot. See the related data set Strahler et al., 2011.

Investigators from Federal and university laboratories conducted these field campaigns to make estimates of forest biophysical attributes that will prove useful in comparisons with airborne lidar (LVIS) and UAVSAR remote sensing acquisitions.

The North American Carbon Program (NACP) is a multi-disciplinary research program designed to obtain scientific understanding of North America's carbon sources and sinks and of the changes in carbon stocks needed to meet societal concerns, and to provide tools for decision makers. NACP began in 2002 and continues to date. The NACP data collection contains continental carbon budgets, dynamics, processes, and management of the sources and sinks of carbon dioxide, methane, and carbon monoxide in North America and in adjacent ocean regions.

Data and Documentation Access:

Description and Links to Companion Files and Supplemental Information:

Get Data: NACP New England and Sierra National Forests Biophysical Measurements: 2008-2010

Related Data Sets:

Strahler, A.H., C. Schaaf, C. Woodcock, D. Jupp, D. Culvenor, G. Newnham, R. Dubayah, T. Yao, F. Zhao, X. Yang. 2011. Echidna Lidar Campaigns: Forest Canopy Imagery and Field Data, U.S.A., 2007-2009. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1045

Data Citation:

Cite this data set as follows:

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Biomass in respective measurement plots was calculated with allometric equations using measured diameter at breast height (DBH) for trees greater than 10 cm and species identification. Within selected subplots, the number of stems with diameters less than 10 cm were counted and classified to allow for an estimate of biomass for these stems.

2. Data Characteristics:

There are 16 data files with the results of the biophysical measurement and the biomass estimates in ASCII comma-separated format. The descriptions are organized by measurement type.

Spatial Coverage

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

These coordinates are the general locations of the experimental forest sites. The measurement plot locations for the New England sites are specifically identified in the Georeference Points Data file. The Sierra National Forest plots are included in Section 5. Measurement subplot coordinates for all sites are included in the Subplot Summary Data file.

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Harvard Forest, Massachusetts, USA	-72.17	-72.17	42.53	42.53	WGS84
Howland Research Forest, Maine, USA	-68.73	-68.73	45.20	45.20	WGS84

Hubbard Brook Experimental Forest, New Hampshire, USA	-71.45	-71.45	43.56	43.56	WGS84
Bartlett Experimental Forest, New Hampshire, USA	-71.16556	-71.16556	44.04417	44.04417	WGS84
Penobscott Experimental Forest, Maine, USA	-68.65056	-68.65056	44.86861	44.86861	WGS84
Sierra National Forest, California, USA	-118.83	-118.83	36.72	36.72	WGS84

Site Information

Harvard Forest is an ecological research area of 1,200 ha owned and managed by Harvard University and located in Petersham, Massachusetts. The property, in operation since 1907, includes one of North America's oldest managed forests, educational, and research facilities. The forest stands are in the transition hardwoods - white pine - hemlock zone and are comprised mainly of red oak (*Quercus rubra*), red maple (*Acer rubrum*), yellow birch (*Betula allleghaniensis*), white birch (*B. papyrifera*), black birch (*B. lenta*), beech (*Fagus grandifolia*), white pine (*Pinus strobus*), and eastern hemlock (*Tsuga canadensis*). The study plots are located in the Prospect Hill tract. The soils are mainly sandy loam glacial till and are moderately to well drained. The climate is cool, moist temperate. July mean temperature is 20 C and January mean temperature -7 C. The annual mean precipitation of 1,066 mm is distributed fairly evenly throughout the year. Harvard Forest Website: http://Harvard Forest.fas.harvard.edu/.

Howland Research Forest is a 558 acre tract of mature, lowland evergreen forest located in central Maine, about 35 miles north of Bangor. The natural stands in this boreal-northern hardwood transitional forest consist of hemlock-spruce-fir, aspen-birch, and hemlock-hardwood mixtures ranging in age from 45 to 130 years. Dominant species composition includes red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), balsam fir (*Abies balsamea*), white pine (*Pinus strobus*), and northern white cedar (*Thuja occidentalis*). The land was designated as research forest in 1986 by the former owner, International Paper, and was purchased by Northeast Wilderness Trust in 2007, protecting the forest from any future logging activities. The terrain is flat to gently rolling with a maximum elevation of less than 68 m. Soils throughout the forest are glacial tills, acid in reaction, with low fertility and high organic composition. The climate is temperate continental. Howland Research Forest Website: http://Howland Forest.org/.

Bartlett Experimental Forest is a 1,052 ha tract within the U.S. Forest Service, White Mountain National Forest in New Hampshire. Research activities began at the Experimental Forest when it was established in 1931. Bartlett Experimental Forest extends from the village of Bartlett in the Saco River valley at 210 m to about 915 m at its upper reaches. The terrain is rolling to mountainous; aspects across the forest are primarily north and east. The primary forest cover is the sugar maple-beech-yellow birch association. The upper elevations support stands of spruce and fir. There are areas of old-growth northern hardwoods with beech (*Fagus grandifolia*), yellow birch (*Betula allleghaniensis*), sugar maple (*Acer saccharum*), and eastern hemlock (*Tsuga canadensis*) being the dominant species. Even-aged stands of red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), and aspen (*Populus tremuloides*) occupy sites that were once cleared. Red spruce (*Picea rubens*) stands cover the highest slopes. Eastern white pine (*Pinus strobus*) is confined to the lowest elevations. The soils at the Bartlett Experimental Forest are spodosols, developed on glacial till derived from granite and gneiss. The soils are moist but, for the most part, well drained. The climate in the Bartlett area includes warm summers and cold winters with mean January temperatures of 9.8 C and mean July temperatures of 19.8 C. Mean annual precipitation is 1,300 mm, distributed throughout the year. Bartlett Experimental Forest Website: http://www.fs.fed.us/ne/durham/4155/bartlett.htm.

Sierra National Forest encompasses more than 24,000 km^2 between 274 m and 4,263 m in elevation on the western slope of the central Sierra Nevada in the state of California. The forest was placed under U.S. Forest Service protection and management in 1893. Distributions of species are largely governed by climate, which is strongly dependent on altitude. The biotic zones include the foothill woodland zone from 300 to 910 m (interior live oak), the lower montane zone from 910 to 2,100 m (yellow pine), the upper montane zone from 2,100 to 2,700 m (lodgepole pine/red fir), the subalpine zone from 2,700 to 2,900 m (whitebark pine), and the alpine zone from 2,900 m (above the tree line). In addition, some 1,550 km^2 of the forest are old growth, containing lodgepole pine (*Pinus contorta*) and red fir (*Abies magnifica*). Sierra National Forest Website: http://fs.usda.gov/sierra.

Hubbard Brook Experimental Forest is in the southern part of the White Mountain National Forest in central New Hampshire. It lies in the towns of Ellsworth, Thornton, Warren and Woodstock, all in Grafton County, and is near the village of West Thornton. The climate is predominantly continental. The diverse character of the air masses which influence central New Hampshire produces climate which is highly variable from week-to-week, month-to-month and year-to-year. Annual precipitation averages about 1,400 mm, of which about one third to one quarter is snow. The National Forest has mainly deciduous northern hardwoods: sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch (*Betula allegheniensis*), and some white ash (*Fraxinus americana*) on the lower and middle slopes. Hubbard Brook Experimental Forest Website: http://www.hubbardbrook.org/.

Penobscot Experimental Forest is located towns of Bradley and Eddington, Maine, across the Penobscot River from Orono and the University of Maine. State Highway 178 parallels the eastern bank of the river and provides access to the Forest. There are presently 46 individual Forest Service research areas comprising about 445 ha (1,100 acres). The climate is cool and humid. The 30 year (1951-1980) normal (i.e. mean annual) temperature for nearby Bangor, Maine, is 43.9 F (6.6 C). February, the coldest month, has an average daily temperature of 19.3 F (7.1 C) while July, the warmest, averages 68.0 F (20.0 C). Normal precipitation is 41.7 inches (1060 mm), with 48 percent falling from May through October. Annual snowfall averages 94 inches (239 cm). Average growing season is 156 days. It is dominated by mixed northern conifers, including eastern hemlock (*Tsuga canadensis*); spruce, mostly red (*Picea rubens*) with some white (*P. glauca*); balsam fir (*Abies balsamea*); northern white cedar (T*huja occidentalis*); eastern white pine (*Pinus strobus*); and, infrequently, tamarack (*Larix laricina*) or red pine (P. resinosa). The most common hardwoods are red maple (Acer rubrum); paper birch (Betula papyrifera); gray birch (B. populifolia) and aspen, both quaking (Populus tremuloides) and bigtooth (*P. grandidentata*). Penobscot Experimental Forest Website: http://www.fs.fed.us/ne/durham/4155/penobsco.htm.

Temporal Coverage

The data set covers the period 2008/07/16 to 2010/08/31.

Field Measurement Data Descriptions

Large Stem Biometry

The large stem (DBH >10 cm) biometry files contain stem level observations of species identification, live/dead status, diameter at breast height, tree height measurements, and calculations of biomass for the forest sites identified in the file names.

File names:

Bartlett_large_stem_biometry_2009_v3.csv
Harvard_Forest_large_stem_biometry_2009_v3.csv
Howland_large_stem_biometry_2009_v3.1.csv

Howland_large_stem_biometry_2010_v2.csv
Hubbard_Brook_large_stem_biometry_2009_v3.csv
Penobscot_large_stem_biometry_2009_v3.csv
Sierra_Nevada_large_stem_biometry_2008_v3.csv

Data Description:

Column Name	Units or Format	Description
Date	yyyy-mm-dd	Date
Site		Site identification: Bartlett, Harvard, Howland, Hubbard Brook, Penobscot, Sierra Nevada
Plot_ID		Plot identification
Subplot_ID		Unique identifier for each subplot
Tree_no		Unique identifier for each tree in the subplot
Status		Live or Dead (L or D)
Species	GGSS	Species codes are based on the first two letters of the genus and first two letters of the species. Source: The USDA NRCS PLANTS Database at http://plants.usda.gov/.
DBH	cm	Diameter at breast height (DBH)(1.3 m) in centimeters (cm)
Height	m	Height in meters (m)
Biomass_Jenkins	Mg	Biomass in megagrams (Mg) of identified stems of DBH >= 10 cm calculated according to Jenkins et al. 2004.
Notes		Field observations
Biomass_Young	Mg	Biomass in megagrams (Mg) of identified stems of DBH >= 10 cm calculated according to Young et al. 1980 with equations developed specifically for sites in Maine. For species not included in the Young et al. study the Jenkins equations were used. Note this was not calculated for the Sierra sites.

Example Data Records: (Bartlett_large_stem_biometry_2009_v3.csv)

```
Date,Site,Plot_ID,Subplot_ID,Tree_no,Status,Species,DBH,Height,Biomass_Jenkins,Notes,Biomass_Young,
yyyy-mm-dd,none,none,none,none,none,GGSS,cm,m,Mg,none,Mg,
2009-07-11,BEF,13L,L1,1,L,TSCA,16.9,-9999,0.088,None,0.0787,
2009-07-11,BEF,13L,L1,2,L,BEAL,28.8,-9999,0.4179,None,0.4097,
2009-07-11,BEF,13L,L1,3,L,TSCA,18.3,-9999,0.1072,None,0.095,
...
2009-07-16,BEF,NACP,R8,30,L,ACRU,15.1,-9999,0.0908,None,0.0808,
2009-07-16,BEF,NACP,R8,31,L,FAGR,13.7,-9999,0.0781,None,0.0826,
2009-07-16,BEF,NACP,R8,32,L,ACRU,13.8,-9999,0.0734,None,0.0652,
```

Small Stem Biometry

Small stem (DBH from 3 to 10 cm) biometry files contain stem counts in each diameter category and calculated biomass for the four New England sites where small stem data were collected.

File names:

Bartlett_small_stem_biometry_2009_v3.1.csv
Howland_small_stem_biometry_2009_v3.1.csv
Howland_small_stem_biometry_2010.csv
Hubbard_Brook_small_stem_biometry_2009_v3.1.csv
Penobscot_small_stem_biometry_2009_v3.1.csv

Data Description:

Column Name	Units or Format	Description
Site		Site identification: Bartlett, Howland, Hubbard Brook, Penosbscot, no Harvard small stem data
Plot_ID		Plot identification
Subplot_ID		Unique identifier for each subplot
up_to_2_cm		number of stems with DBH between 0 and 2 cm
2_to_5_cm		number of stems with DBH between 2 and 5 cm
5_to_8_cm		number of stems with DBH between 5 and 8 cm
8_to_10_cm		number of stems with DBH between 8 and 10 cm
Biomass_0_2	Mg per subplot	Biomass in megagrams (Mg) of identified stems with DBH between 0 and 2 cm calculated according to Jenkins et al. 2004.
Biomass_2_5	Mg per subplot	Biomass in megagrams (Mg) of identified stems with DBH between 2 and 5 cm calculated according to Jenkins et al. 2004.
Biomass_5_8	Mg per subplot	Biomass in megagrams (Mg) of identified stems with DBH between 5 and 8 cm calculated according to Jenkins et al. 2004.
Biomass_8_10	Mg per subplot	Biomass in megagrams (Mg) of identified stems with DBH between 8 and 10 cm calculated according to Jenkins et al. 2004.

Example Data Records: (Bartlett_small_stem_biometry_2009_v3.1.csv)

```
Date,Site,Plot_ID,Subplot_ID,up_to_2_cm,2_to_5-cm,5_to_8_cm,8_to10_cm,Biomass_
0_2,Biomass 2_5,Biomass 5_8,Biomass 8_10
yyyy-mm-dd,none,none,none,count,count,count,count,Mg per subplot,Mg per subplot,Mg per
subplot,Mg per subplot
2009-07-10,Bartlett,30 AG,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999
2009-07-11,Bartlett,13L,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999
2009-07-12,Bartlett,36 K,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999,-9999
...
2009-07-16,Bartlett,NACP,R6,0,0,2,0,0,0.0038,0,0
```

2009-07-16,Bartlett,NACP,R7,0,3,2,0,0.0003,0.0038,0,0
2009-07-16,Bartlett,NACP,R8,4,4,0,0,0.0003,0,0,0

Crown Data

At the Sierra National Forest and the Penobscot Experimental Forest sites measurements of crown dimensions were collected for select trees. The crown measurement approach was different at each site so separate descriptions and examples are provided.

File names:

Sierra_Nevada_crown_data_2008.csv
Penobscot _crown_data_2009.csv

Data Description: Sierra_Nevada_crown_data_2008.csv

Column Name	Units or Format	Description
Date	yyyy-mm-dd	Date
Site		Site identification: Sierra Nevada
Plot_ID		Plot identification*
Subplot_ID		Unique identifier for each subplot*
Tree_ID		Unique tree number within each subplot*
Crown_along_slope	m	Crown length in meters (m) along slope
Crown_cross_slope	m	Crown length in meters (m) across slope
Crown_form		Geometric approximation of crown form (umbrella, cone, truncated ellipsoid, cylinder, ellipse, semi-cylinder, or not identified)
Crown_base	m	Height to base of crown in meters (m)
Distance	m	Distance from center of plot to stem in meters (m)
Azimuth	decimal degrees	Angle from center of plot to tree

* Plot_ID, Subplot_ID,and Tree_ID may be cross referenced with the **Sierra_Nevada_large_stem_biometry_2008_v3.csv file to obtain tree species.**

Example Data Records: Sierra_Nevada_crown_data_2008.csv

Date,Site,Plot_ID,Subplot_ID,Tree_ID,Crown_along_slope,Crown_cross_slope,Crown_form,Crown_base
,Distance,Azimuth

2008-07-08,Sierra Nevada,23,4,1,-999.9,-999.9,not identified,-9999,12.64,114.1
2008-07-08,Sierra Nevada,23,4,2,-999.9,-999.9,not identified,-9999,13.3,112

2008-07-08,Sierra Nevada,23,4,3,-999.9,-999.9,not identified,-9999,23.53,96.5
...
2008-07-08,Sierra Nevada,801,9,16,-9999,-9999,not identified,-9999,24.85,163.8
2008-07-08,Sierra Nevada,801,9,17,-9999,-9999,not identified,-9999,37.08,176.3
2008-07-08,Sierra Nevada,801,9,18,-9999,-9999,not identified,-9999,23.03,158.3

Data Description: Penobscot _crown_data_2009.csv

Column Name	Units or Format	Description
Date	yyyy-mm-dd	Date
Site		Site identification: Penobscot
Plot_ID		Plot identification
Subplot_ID		Unique identifier for each subplot
Tree_ID		Unique tree number within each subplot
Status	L or D	Live or dead
Species	GGSS	Species codes are based on the first two letters of the genus and first two letters of the species. Source: The USDA NRCS PLANTS Database at http://plants.usda.gov/.
DBH	cm	Diameter at breast height (DBH) (1.3 m) in centimeters (cm)
Ht_total	m	Height in meters (m)
Crown_base_ht	m	Height to base of crown in meters (m)
Crown_Radius_1	m	Radius of crown at widest point in meters (m)
Crown_Radius_2	m	Radius of crown perpendicular to widest point measurement in meters (m)
Crown_Radius_3	m	Radius of crown for irregularly shaped crowns in meters (m)

Example Data Records: Penobscot _crown_data_2009.csv

Date,Site,Plot_ID,Subplot_ID,Tree_ID,Status,Species,DBH,Ht_total,Crown_base_ht,Crown_Radius_1,Crown_Radius_2,Crown_Radius_3

2009-08-18,Penobscot,P5,L1,1,L,TSCA,45.6,19.3,4.1,5.9,4,-9999
2009-08-18,Penobscot,P5,L1,7,L,TSCA,48.9,21.1,4.6,4.7,5.4,-9999
2009-08-18,Penobscot,P5,L1,10,L,PIRU,30,20,8.3,3,4.1,-9999
...
2009-08-21,Penobscot,P11,L2,21,L,TSCA,41.4,21.2,3,4.5,-9999,-9999
2009-08-21,Penobscot,P11,L5,6,L,TSCA,48.2,17.2,4.5,3.5,-9999,-9999
2009-08-21,Penobscot,P11,L5,18,L,BEPA,25,20.9,6.7,4.5,-9999,-9999

Subplot Summary Data

The subplot summary file contains calculated biomass totals and stem numbers for all site subplots as well as coordinates for the subplot locations.

File name: Subplot_summaries_biometry_2008-09_v3.2.1.csv

Data Description:

Column Name	Units or Format	Description
Date	yyyy-mm-dd	Date
Site		Site identification: Bartlett, Hubbard Brook, Harvard Forest, Penobscot, Howland, Sierra
Plot_ID		Plot identification
Subplot_ID		Unique identifier for each subplot
Plot_notes		Field observations. Note that for several subplots: "No field measurements were made in this subplot. Subplot coordinates are provided."
Large_biomass_Jenkins	Mg per subplot	Total biomass of identified stems of DBH >= 10 cm calculated according to Jenkins et al. 2004
Large_biomass_Young	Mg per subplot	Total biomass of identified stems of DBH >= 10 cm calculated according to Young et al. 1980 with equations developed specifically for sites in Maine. For species not included in the Young et al. study the Jenkins equations were used. Note this was not calculated for the Sierra sites
Unidentified_biomass	Mg per subplot	Total biomass of unidentified stems of DBH >= 10 cm calculated according to the equations for mixed hardwoods in Table 1 Jenkins et al. 2004
Small_stem_biomass	Mg per meter squared	Total biomass of stems with DBH <10 cm in a 1 x 25 meter area within the subplot calculated using the mixed hardwoods equation from Table 1 Jenkins et al. 2004 with the midpoint of the diameter class as the DBH times the number of stems in each category
Mean_max_height	m	The mean height in meters (m) of the three tallest trees measured in the subplot
Ht_no	count	The number of trees included in the mean maximum height calculation
Large_stem_no	count	The number of stems with a DBH >= 10 cm in the subplot
Small_stem_density	stems per meter squared	The density of stems with a DBH < 10 cm per meter squared based on the 1 x 25 m sampling strip in the subplot
Average _slope	degrees	Average slope in the subplot
Average_aspect	degrees	Average aspect for the subplot
Long_corner_1	decimal degrees	Longitude for the first corner of the subplot, negative values indicate west
Latitude_corner_1	decimal degrees	Latitude for the first corner of the subplot
Long_corner_2	decimal degrees	Longitude for the second corner of the subplot, negative values indicate west
Latitude_corner_2	decimal degrees	Latitude for the second corner of the subplot
Long_corner_3	decimal degrees	Longitude for the third corner of the subplot, negative values indicate west
Latitude_corner_3	decimal degrees	Latitude for the third corner of the subplot
Long_corner_4	decimal degrees	Longitude for the fourth corner of the subplot, negative values indicate west

Latitude_corner_4	decimal degrees	Latitude for the fourth corner of the subplot

Example Data Records:

```
Date,Site,Plot_ID,Subplot,Plot_notes,Large_biomass_Jenkins,Large_biomass_Young,Unidentified_biomass,
Small_stem_biomass,
Mean_max_height,Ht_no,Large_stem_no,Small_stem_density,Average_slope,Average_aspect,Long_corner
_1,Latitude_corner_1,
Long_corner_2,Latitude_corner_2,Long_corner_3,Latitude_corner_3,Long_corner_4,Latitude_corner_4

2009-07-11,Bartlett,13L,R1,None,15.7932,14.3093,0.8309,-9999,30.55,
1,49,-9999,15.7,356,-71.310195,44.052292,-71.310508,44.052285,
-71.310516,44.05251,-71.310205,44.052516
2009-07-11,Bartlett,13L,R2,None,12.1901,10.9353,0.5146,-9999,30.65,
1,32,-9999,22.4,331,-71.310204,44.052516,-71.310516,44.05251,
-71.310525,44.052735,-71.310213,44.052741
2009-07-11,Bartlett,13L,R3,None,14.8936,13.4735,1.6295,-9999,22.3,
1,39,-9999,-9999,-9999,-71.310213,44.052741,-71.310525,44.052735,
-71.310534,44.05296,-71.310222,44.052966
...
2008-07-08,Sierra,801,7,None,18.2217,-9999,15.3089,-9999,
47.33,3,10,-9999,-9999,-9999,-119.108721,37.021046,
-119.109096,37.02104,-119.109104,37.02134,-119.108729,37.021347
2008-07-08,Sierra,801,8,None,166.3889,-9999,6.4815,-9999,
76.73,3,14,-9999,-9999,-9999,-119.108347,37.021053,
-119.108721,37.021046,-119.108729,37.021347,-119.108355,37.021353
2008-07-08,Sierra,801,9,None,67.2864,-9999,0,-9999,
52.2,2,18,-9999,-9999,-9999,-119.107972,37.02106,
-119.108347,37.021053,-119.108355,37.021353,-119.107981,37.02136
```

Georeference Points Data

The georeference points file provides the coordinates for all measured reference points and estimates of GPS accuracy at the New England sites.

File name:

Georeference_points_field_surveys_2009.csv

Data Description:

Column Name	Units or Format	Description
Site		Site identification: Bartlett, Hubbard Brook, Harvard Forest, Penobscot, Howland
Plot_ID		Plot identification
Point		Location of measurement within plot
Latitude	decimal degrees	Latitude
Longitude	decimal degrees	Longitude
GPS_error	meters plus or minus	GPS error

Bearing	degrees	
Notes		Observations

Example Data Records:

```
Site,Plot_ID,Point,Latitude,Longitude,GPS_error,Bearing,Notes
none,none,none,decimal degrees,decimal degrees,meters plus or minus,degrees,none
Bartlett,36K,NE Corner,44.052408,-71.280991,6,0,None
Bartlett,36K,NW Corner,44.052385,-71.281702,5,0,None
Bartlett,36K,SE Corner,44.054188,-71.281135,7,0,None
...
Howland,11,Center line third point,45.208492,-68.707664,less than 7,-9999,None
Howland,11,Center line second point,45.208437,-68.70797,less than 8,-9999,None
Howland,11,Center line first point ,45.208385,-68.708278,less than 9,-9999,None
```

3. Data Application and Derivation:

Species identification and diameter measurements were used to make estimates of forest biophysical attributes that will prove useful in comparisons with the Laser Vegetation Imaging Sensor (LVIS) (http://lvis.gsfc.nasa.gov) as in Zhao et al. (2011) and the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) (http://uavsar.jpl.nasa.gov/) remote sensing data acquisitions. The transect plots were laid out parallel to the flight paths for UAVSAR remote sensing. Forest types spanned a range of biomass and morphologies that are representative of North American forests.

4. Quality Assessment:

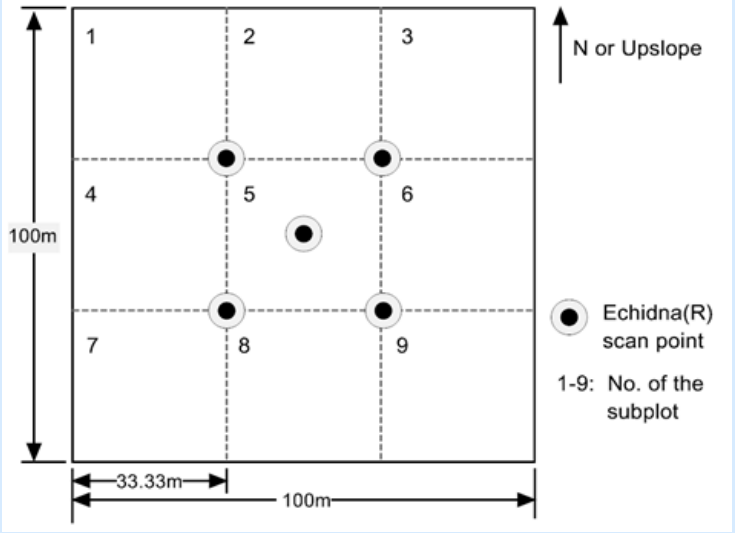
All data have been verified and are final. Estimates of accuracy for the georeference points are included in the Georeference_points_field_surveys_2009.csv data file. Uncertainty estimates of similar measurements in 2007 were estimated and are reported in Yao et al., 2011 and the related data set Strahler et al., 2011.

5. Data Acquisition Materials and Methods:

Plot layout and measurements in the Sierra National Forest 2008

At each location within the Sierra National forest we laid out a 100 m by 100 m plot, which is divided into 9 subplots (3 rows of 3 subplots each). Subplot corners were estimated by creating a template grid and overlaying this in the proper orientation over the existing GPS center points. Coordinates were then extracted at the vertices.

In the subplots, we recorded the diameter at breast height (DBH, measured at 1.3 m), tree species (Table 3) and condition (live or dead) for every tree with a DBH greater than or equal to 10 cm. In addition we measured height for 1-2 trees per subplot. In the central subplot, we recorded the distance from the center point to the tree using a sonar or laser rangefinder, the azimuth of the tree from the center point using a sighting compass, and DBH, tree height and crown diameter. Biomass for each stem was calculated in megagrams (Mg) using the general equations from Table 1 of Jenkins et al. 2004 (Table 1). Subplot biomass was summarized.



Sierra National Forest Plot Center Points, 2008

Plot	Longitude	Latitude
Plot 23	-119.249	37.0979
Plot 99	-119.1879	37.0373
Plot 168	-119.0504	36.961
Plot 301	-119.0568	36.98
Plot 305	-119.0523	36.9796
Plot 338	-119.0561	36.9703
Plot 406	-119.221	37.0959
Plot 801	-119.1085	37.0215

Figure 1. Plot layout and locations in Sierra National Forest 2008

Plot layout and measurements at New England sites in 2009 and 2010

At five well studied sites: Bartlett Experimental Forest, Harvard Forest, Howland, Hubbard Brook and Penobscot we laid out a set of 50 m by 200 m plots, each plot is divided into 16 25 x 25 m subplots (arranged in 8 rows with one subplot on each side of a central axis). In the subplots, we recorded the diameter at breast height (DBH, measured at 1.3 m), tree species (Table 3) and condition (live or dead) for every tree with a DBH greater than or equal to 10 cm. In addition we measured height for the three tallest trees in each subplot.

Biomass for each stem was calculated in megagrams (Mg) using the general equations from Table 1 of Jenkins et al. 2004 (Table 1) and Young et al. 1980 (Table 2) for the New England sites. At four sites (Penobscot, Howland, Bartlett and Hubbard Brook) stems less than 10 cm DBH were counted in a 1 m x 25 m transect along the central plot axis in each subplot. These stems were separated into 4 size classes: 0-2 cm DBH, 2-5 cm DBH, 5-8 cm DBH and 8-10 cm DBH. Stems were not identified to species but total biomass was calculated using the mixed hardwoods equation from Table 1 of Jenkins et al., 2004. Subplot biomass was summarized.

For a subset of sites and plots (Bartlett Experimental Forest, Harvard Forest and Howland Research Forest), more intensive inventories were done in coordination with the Echidna imaging (Strahler et al., 2008). In these intensive collections, the stem location, species, DBH and live/dead status were recorded for all stems with total stem height and canopy dimensions recorded for every tenth stem. In addition, for stems below 10 cm DBH, species and count were recorded in a subplot of each intensive inventory plot.

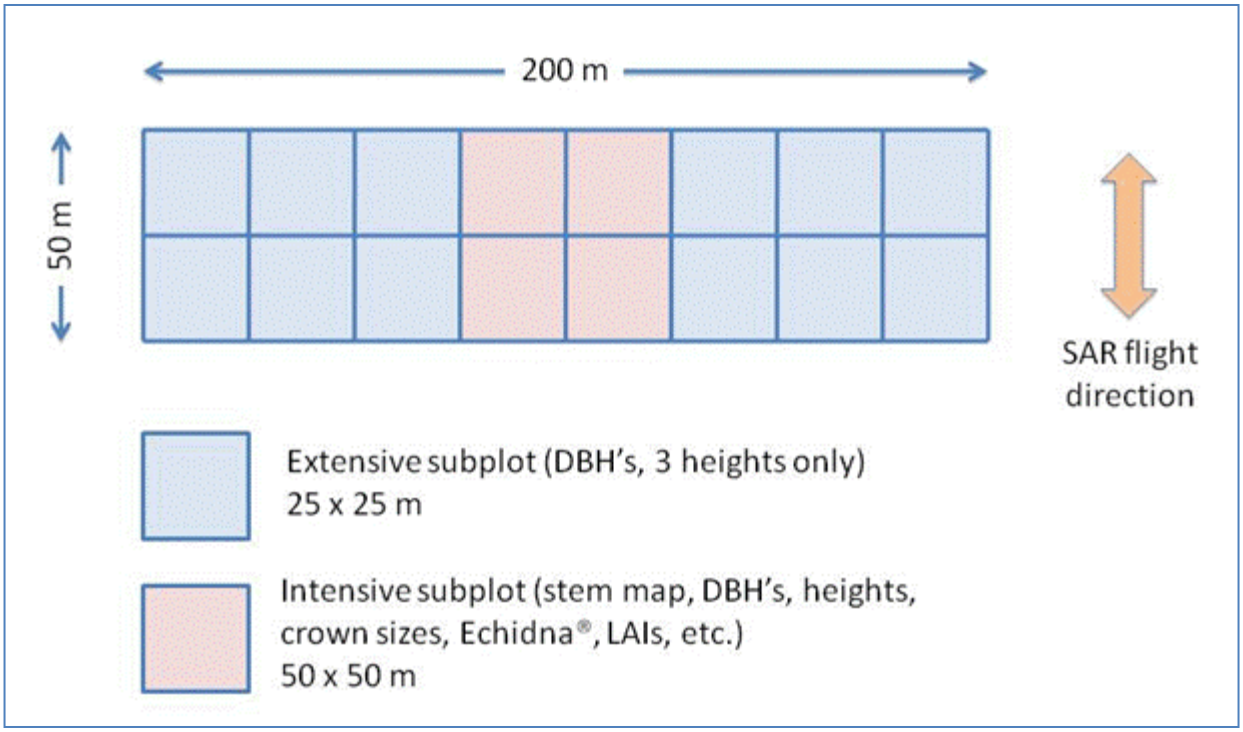


Figure 2. Plot layout at New England Sites.

Georeferencing for Plot Layout at New England Sites

At all sites, handheld GPS units were used to establish the locations of the four corners of the 50 x 200 m transect plot. These data are reported in the Georeference Points data file. Then subplots were delineated using tape measures based on the established points. Subplot coordinates for all sites are included in the Subplot Summary Data file. The number and location of measured georeference points as well as the accuracy of those measurements varied from site to site. At the Howland site GPS measurement errors of +/- 5 to 10 meters were reported due to poor satellite reception. The team used compass bearings and a tape measure in order to establish a more accurately aligned grid. Measurements were collected from most of the nodes, and an ideal sampling grid was fit to these coordinates in a manner that minimized the distance between the nodes and the GPS measurements.

Table 1. Allometric Equations for Biomass Calculations from Jenkins et al. (2004)

Calculation of stem biomass from Table 1 of Jenkins et al. (2004)		
Allometric equation used: biomass (kg)= Exp(B0 + B1(ln(dbh (cm)))		
Tree/Shrub species	**B0**	**B1**
Aspen/alder/willow	-2.2094	2.3867
Soft maple/birch	-1.9123	2.3651
Mixed hardwood	-2.4800	2.4835
Hard maple/oak/beech	-2.0127	2.4342
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
Juniper/oak/mesquite	-0.7152	1.7029
Jenkins, JC, DC Chojnacky, LS Heath and RA Birdsey. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. USDA/ Forest Service GTR-319		

Table 2. Allometric Equations for Biomass Calculations from Young et al. (1980)

Calculation of large stem biomass based on the equations in Young et al. 1980 developed specifically for forests in Maine.		
Calculated only for New England sites. For species not included in these equations, the equations from Jenkins et al. were used to calculate biomass.		
Allometric equations used: ln (lbs)=B0 + B1 (ln(inches dbh))		
Where kg=lbs*0.4536 and cm=inches*2.54		
Tree/Shrub species	**B0**	**B1**
Spruce	0.8079	2.3316
Balsam fir	0.5958	2.4017
White pine	0.408	2.449
Red pine	0.7157	2.3865
Hemlock	0.6803	2.3617
Northern white cedar	1.1182	1.9269
Larch	0.8162	2.2453
Yellow birch	1.1297	2.3376
White birch	0.4792	2.6634
Beech	1.3303	2.2988
Sugar maple	1.2451	2.3329
Red maple	0.9392	2.3804
Aspen	0.4689	2.6087
Gray birch	1.0931	2.3146

Pin cherry	0.9758	2.1948
Choke cherry	1.0539	1.7102
Willow	0.8856	2.0552
Alder	0.7164	2.2087
Young HE, Ribe JH, Wainwright K (1980) Weight tables for tree and shrub species in Maine. Life Sciences and Agriculture Experiment Station, University of Maine at Orono. Miscellaneous Report 230, 84 pp.		

Table 3. Species Code Reference for New England and Sierra National Forests

Species codes: Codes are based on the first two letters of the genus and first two letters of the species.	
The species codes are derived from the USDA NRCS PLANTS Database at http://plants.usda.gov/. The complete list is available for download at http://plants.usda.gov/dl_all.html.	
New England Species List	**Sierra Species List**
Code Genus Species Common name	**Code Genus Species Common name**
ABBA Abies balsamea Balsam fir	ABCO Abies concolor White Fir
ACPE Acer pennsylvanica Striped maple	ABMA Abies magnifica Red Fir
ACRU Acer rubrum Red maple	ACMA Acer macrophyllum Bigleaf maple
ACSA Acer saccharum Sugar maple	ALRH Alnus rhombifolia White alder
ACSP Acer spicatum Mountain maple	ARSP Arctostaphylos spp. Manzanita species
BEAL Betula alleghaniensis Yellow birch	BESP Betula spp. Birch
BELE Betula lenta Black birch	CACH Castanopsis chrysophylla Golden chinquapin
BEPA Betula papyrifera Paper birch	CONU Cornus nuttallii Mountain dogwood
BEPO Betula populifolia Grey birch	FRLA Fraxinus latifolia Oregon ash
CADE Castanea dentata American chestnut	JUOC Juniperus occidentalis Western juniper
FAGR Fagus grandifolia Beech	LIDE Libocedrus decurrens Incense cedar
FRAM Fraxinus americana White ash	PICO Pinus contorta Lodgepole pine
FRNI Fraxinus nigra Black ash	PIJE Pinus jeffreyi Jeffrey pine
FRPE Fraxinus pennsylvanica Green ash	PILA Pinus lambertiana Sugar Pine
LALA Larix laricina Tamarack	PIMO Pinus monticola Western white pine
OSVI Ostrya virginiana Eastern hophornbeam	PIPO Pinus ponderosa Ponderosa Pine
PIAB Picea abies Norway spruce	PISA Pinus sabiniana Gray pine
PIMA Picea mariana Black spruce	POTR Populus tremuloides Quaking aspen
PIREPinus resinosa Red pine	PREM Prunus emarginata Bitter cherry
PIRU Picea rubens Red spruce	PRSU Prunus subcordata Sierra plum
PIST Pinus strobus White pine	PRVI Prunus virginiana Western chokecherry

POBA Populus balsamea Balsam poplar	QUCH Quercus chrysolepis Canyon live oak
POGR Populus grandidentata Big-toothed aspen	QUKE Quercus kellogii Black oak
POTR Populus tremuloides Trembling aspen	SASC Salix scouleriana Scouler's willow
PRPE Prunus pennsylvanica Pin cherry	SEGI Sequoiadendron giganteum Giant sequoia
PRSE Prunus serotina Black cherry	TOCA Torreya californica California nutmeg
QUAL Quercus alba White oak	UNK Unknown
QURU Quercus rubra Red oak	
QUVE Quercus velutina Black oak	
THOC Thuja occidentalis Northern white cedar	
TIAM Tilia americana American basswood	
TSCA Tsuga canadensis Hemlock	
ULAM Ulnus americana Elm	
UNK Unknown	

6. Data Access:

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

Data Archive:

Web Site: http://daac.ornl.gov

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Jenkins, JC, DC Chojnacky, LS Heath and RA Birdsey. 2004. Comprehensive database of diameter-based biomass regressions for North American tree species. USDA/ Forest Service GTR-319.

Strahler, A. H., D.L.B. Jupp, C.E. Woodcock, C.B. Schaaf, T. Yao, F. Zhao, X. Yang, J. Lovell, D. Culvenor, G. Newnham, W. Ni-Meister, and W. Boykin-Morris. 2008. Retrieval of forest structural parameters using a ground-based lidar instrument (Echidna®). Can J. Remote Sensing, 34(Suppl. 2): S426-S440.

Strahler, A., C. Schaaf, C. Woodcock, D. Jupp, D. Culvenor, G. Newnham, R. Dubayah, T. Yao, F. Zhao, X. Yang. 2011. ECHIDNA Lidar Campaigns: Forest Canopy Imagery and Field Data, U.S.A., 2007-2009. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/1045

Yao, T., et al., Measuring forest structure and biomass in New England forest stands using Echidna ground-basedlidar, Remote Sensing of Environment (2011), doi:10.1016/j.rse.2010.03.019

Young HE, Ribe JH, Wainwright K (1980) Weight tables for tree and shrub species in Maine. Life Sciences and Agriculture Experiment Station, University of Maine at Orono. Miscellaneous Report 230, 84 pp.

Zhao, F., et al., Measuring effective leaf area index, foliage profile, and stand height in New England forest stands using a full-waveform ground-based lidar, Remote Sensing of Environment (2011), doi:10.1016/j.rse.2010.08.030