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# Forest Structure and Biomass Data, La Selva, Costa Rica, 2006

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Revision Date: April 17, 2014

### Summary:

This data set provides field measurements of diameter, tree height, and crown dimensions for 1,513 trees in 30 plots at the La Selva Biological Station in Costa Rica. Fourteen of these plots were in undisturbed primary forest, six were in primary forest which had been selectively logged, seven were secondary forests, and three were abandoned pastures reverting to forest.

The diameter and height data were used to calculate aboveground biomass for each of the 30 plots. The crown measurements were used to estimate a vertical profile for each plot, showing the vegetation volume in 1-meter increments from the ground to the top of the canopy.

There are three comma-delimited data files and two shapefiles with this data set. The files contain the measurements and calculated biomass for the individual stems as well as the summary data at the plot level.

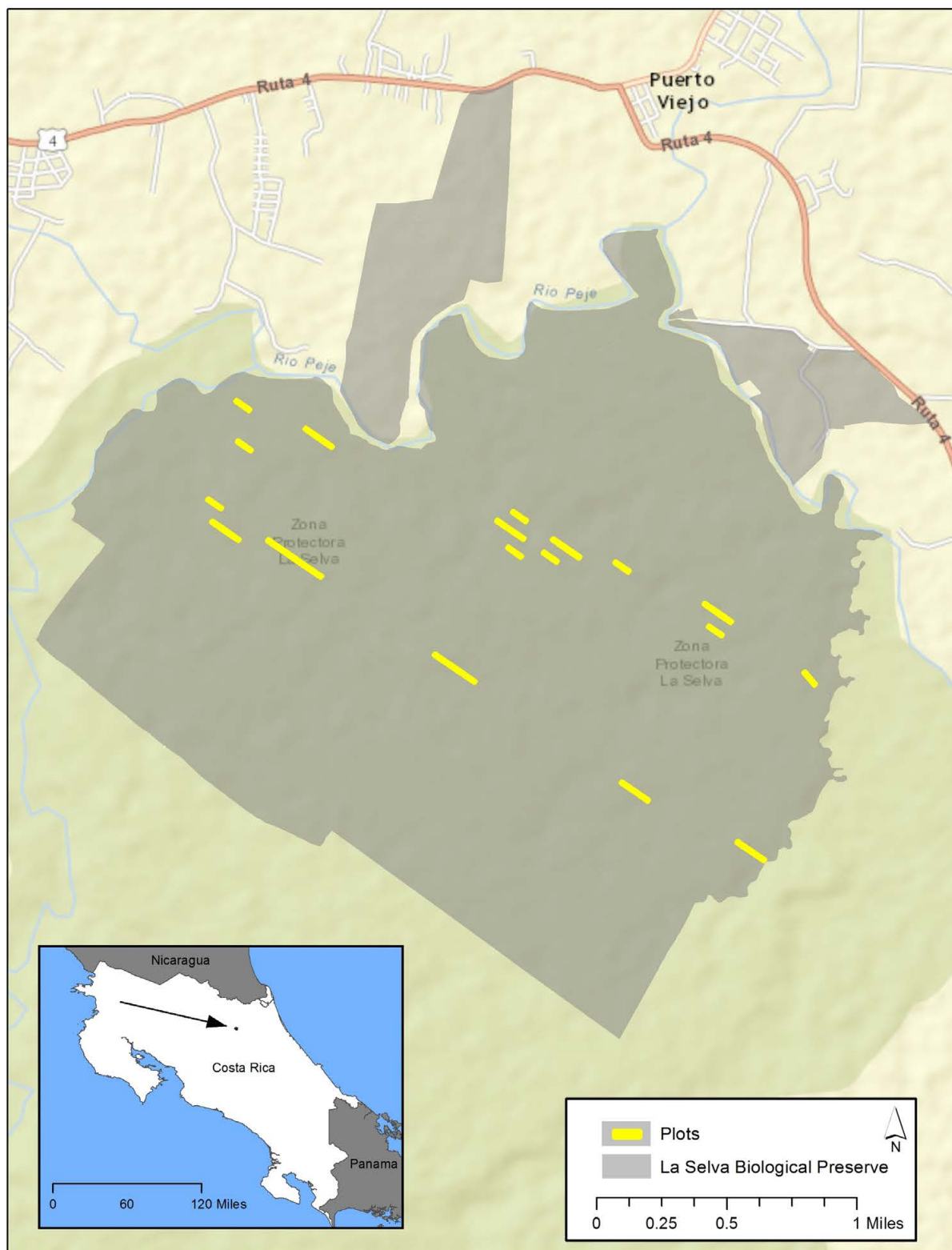


Figure 1. La Selva, Costa Rica sampling locations (sampling locations from the plots.zip shapefile). All 30 locations are included within the yellow areas.

### Data and Documentation Access:

Get Data: [http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds\\_id=1215](http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1215)

### Data Citation:

**Cite this data set as follows:**

Goncalves, F.G., R.N. Treuhaft, J.R. Santos, and P.M.L.A. Graca. 2014. Forest Structure and Biomass Data, La Selva, Costa Rica, 2006. Data set. Available on-line (<http://daac.ornl.gov>) from ORNL DAAC, Oak Ridge, Tennessee, USA. <http://dx.doi.org/10.3334/ORNLDAAC/1215>

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**1. Data Set Overview:**

The estimation of biomass in tropical forests is important because they contain approximately half of the Earth's forested biomass, and their characterization with remote sensing is difficult due to their density and structural complexity. Measurements of standing biomass can be compared over different epochs to determine biomass change and infer rates of atmospheric carbon gain or loss due to land management, disturbance, and regrowth. One approach to improve our ability to use remote sensing and other technologies to accurately estimate forest biomass at spatial scales greater than those feasible by traditional field measurements has been to coordinate campaigns of simultaneous measurements at a single site. La Selva Biological Station in Costa Rica is an ideal site for this type of study as it is a well characterized forest with decades of tree inventory and diameter increment data available and also has a well-established geographic reference grid allowing accurate locations for each stem to be recorded.

Field measurements were made of diameter, tree height, and crown dimensions for 1,513 trees in 30 plots at La Selva. The plots were mainly in old-growth forest, some in old-growth forest which had been selectively logged. Additional plots were in secondary forest of varying ages. Aboveground biomass for each of the 30 plots was calculated from diameter and height data. The crown measurements were used to estimate a vertical profile for each plot, showing the vegetation volume in 1 meter increments from the ground to the top of the canopy. These ground data can and have been used to calibrate and validate remote sensing measurements (e.g. LiDAR and InSAR) taken over the same plots.

The investigators were Dr Robert Treuhaft and Dr Fabio Goncalves.

**2. Data Characteristics:**

There are three comma-delimited data files (.csv) and two shapefiles with this data set. The .csv files contain the measurements and calculated biomass for the individual stems. The shapefiles provide summary data at the plot level.

**2.1. Spatial Coverage**

**Site:** La Selva Biological Station, Costa Rica

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
La Selva Biological Station, Costa Rica	-84.021195	-84.021195	10.421864	10.421864

**2.2. Temporal Coverage**

The data set covers the period 2006/02/11 to 2006/02/23.

**2.3. Data File information**

Field measurements of (1) tree stem diameter, total height, height to the crown base, crown dimensions, (2) calculations of biomass at the plot level, and (3) calculated vegetation density profiles from ground level to the top of the canopy for each plot, are presented in three comma-delimited data files. In addition, two shapefiles are included (each a set of multiple auxiliary files with the same name and different file extensions. These files provide the location of each stem (trees.shp) and the sampling transect plots (plots.shp).

**Files names:**

File #1: Tree\_data.csv

File #2: Plot\_data.csv

File #3: Plot\_profile\_data.csv

File # 4: plots.zip

File # 5: tree\_data.zip

**File #1: Tree\_data.csv****Note:** The location of the trees are in the shapefile (file #5) **tree\_data.zip**

Column	Column Heading	Units/format	Description
1	Plot		Plot identification number
2	DBH	cm	Diameter at breast height (1.3 meters above the ground)
3	Ht_crown	m	Height of crown base in meters
4	Ht_total	m	Total tree height in meters
5	Depth_crown	m	Crown depth in meters
6	Diam_x_crown	m	Crown diameter reported in meters
7	Diam_y_crown	m	Crown diameter in the orthogonal direction to the previous measurement reported in meters

Sample data for File #1

```
Plot,DBH,Ht_crown,Ht_total,Depth_crown,Diam_x_crown,Diam_y_crown
1,26.0,16.7,21.6,4.9,8.4,6.6
1,18.0,10.7,18.6,7.9,5.0,5.5
1,15.5,10.7,16.7,6.0,4.7,7.0
...
14,10.5,10.7,15.7,5,3,5
14,16.5,13.7,24.5,10.8,5.4,4.6
14,13,9.7,17.6,7.9,4.7,4.5
...
30,10.0,2.3,7.6,5.3,6.3,6.3
30,28.0,12.7,19.6,6.9,8.5,9.4
30,13.5,6.6,11.7,5.1,3.8,3.8
```

**File #2: Plot\_data.csv****Note:** The data provided in this .csv file are also provided in the shapefile (file #4) **plots.zip**

Column	Column Heading	Units/format	Description
1	Plot		Plot identification number
2	Plot_name		Plot identification name
3	Date	YYYYMMDD	Inventory date
4	Forest_type		Forest type: old growth, selectively-logged forest or secondary forest with an associated age range
5	Stem_density	trees/ha	Stem density reported in trees per hectare
6	Basal_area	m <sup>2</sup> /ha	Basal area reported in meters squared per hectare
7	Mean_height	m	Mean height of the trees reported in meters
8	AGBM	Mg/ha	Aboveground biomass reported in Megagrams per hectare and calculated using the allometric equation and wood density reported by Chave et al.
9	Elevation	m	Elevation of the sample plot reported in meters above sea level
10	Slope	percent	Mean slope of the sample plot reported in percent
11	Aspect	degrees	Aspect of the sample plot reported in degrees

Sample data for File #2

```
Plot,Plot_name,Date,Forest_type,Stem_density,Basal_area,Mean_height,AGBM,Elevation,Slope,Aspect
1,P1A,20060211,old-growth forest,450,62.8,19.1,392.7,56.2,5.5,215.1
2,P1B,20060211,old-growth forest,300,76.1,18.7,437.9,52.5,5.4,253.6
3,P2,20060211,old-growth forest,490,29.3,20.3,244.6,66.8,2.3,260
...
14,P9,20060216,secondary forest (24-30 yr),700,50.6,23.7,455.7,54.1,48.9,114.4
15,P10A,20060217,selectively-logged forest,370,27.5,22,232.2,83.5,12.1,310.5
16,P10B,20060217,selectively-logged forest,490,30.1,21.4,260.4,81.3,6.9,45.3
...
28,P18B,20060223,selectively-logged forest,390,16.2,20.3,140.8,104.9,14.8,92.3
29,P18C,20060223,selectively-logged forest,450,32.9,21.0,271.5,86.3,6.2,40.4
30,P18D,20060223,selectively-logged forest,500,32.4,19.9,255.6,102.6,11.3,215.1
```

File #3: Plot\_profile\_data.csv

Column	Column Heading	Units/format	Description
1	Plot		Plot identification
2	Plot_name		Plot identification name
3	Height_bin	m	Height bin in meters above the ground: the canopy was divided into 1 meter bins defined by the lower and upper limits
4	Volume	m3	Volume of vegetation (m3) found in the corresponding height bin. Calculations are based on the measurements of crown depth and lateral axes and the assumption that the volume is uniformly filled with leaves

Sample data for File #3:

```
Plot,Plot_name,Height_bin,Volume
1,P1A,0 to 1,0
1,P1A,1 to 2,12.463
1,P1A,2 to 3,25.392
...
16,P10B,0 to 1,0
16,P10B,1 to 2,0
16,P10B,2 to 3,2.3281
...
30,P18D,47 to 48,0
30,P18D,48 to 49,0
30,P18D,49 to 50,0
```

**File #4: Plots.zip:** A shapefile, which when unzipped, contains six files (\*.shx, \*.dbf, \*.prj, \*.sbn, \*.sbx, and \*.shp)

**Note:** The data provided in this shapefile file are also provided in the .csv (file #2) **plots.zip**

Parameters of the shapefile:

Geometry Type: Polygon  
 Projected Coordinate System: WGS\_1984\_UTM\_Zone\_16N  
 Geographic Coordinate System: GCS\_WGS\_1984  
 Datum: D\_WGS\_1984  
 Prime Meridian: Greenwich  
 Angular Unit: Degree  
 Projection: Transverse Mercator  
 False Easting: 500000.00000000  
 False Northing: 0.00000000  
 Central Meridian: -87.00000000  
 Scale Factor: 0.99960000  
 Latitude of Origin: 0.00000000  
 Linear Unit: Meter

#### Attributes:

FID: Internal feature number; sequential unique whole numbers that are automatically generated

Shape: Feature geometry

plot\_id: Plot identification number

plot\_nam\_1: Plot identification name

date: Inventory date

type: Forest type

density: Stem density reported in trees per hectare

basal\_area: Basal area reported in meters squared per hectare

height: Mean height of the trees reported in meters

biomass: Aboveground biomass reported in Megagrams per hectare and calculated using the allometric equation and wood density reported by Chave et al.

elevation: Elevation of the sample plot reported in meters above sea level

slope: Mean slope of the sample plot reported in percent

aspect: Aspect of the sample plot reported in degrees

**File #5: tree\_data.zip:** A shapefile, which when unzipped, contains four files (\*.shx, \*.dbf, \*.prj, and \*.shp).

#### Parameters of the shapefile:

Geometry Type: Point

Geographic Coordinate System: GCS\_WGS\_1984

Datum: D\_WGS\_1984

Prime Meridian: Greenwich

Angular Unit: Degree

#### Attributes

FID: Internal feature number; sequential unique whole numbers that are automatically generated

Shape: Feature geometry

ID: Tree identification number

PARCELA: Plot identification name

X\_UTM: Longitudinal coordinate

Y\_UTM: Latitudinal coordinate

DAP: Diameter at breast height (1.3 meters above the ground) in centimeters

HCOM: Commercial height in meters

HCOP: Height of crown base in meters

HTOT: Total tree height in meters

COPA\_X: Crown diameter reported in meters

COPA\_Y: Crown diameter in the orthogonal direction to the previous measurement reported in meters

### 3. Data Application and Derivation:

Field measurements of forest structure and biomass can be used to calibrate and validate measurements derived from less labor intensive remote sensing techniques such as LiDAR or InSAR. The data can also be used as a baseline for future inventories to assess rates of biomass change in this forest.

### 4. Quality Assessment:

Tree heights were visually estimated and calibrated by clinometer measurements. They were determined to be accurate to 1 m, as described by Gonçalves and Santos (2008).

The assumption of uniform vegetation distribution within the crown is a potential source of error for the profile volume calculations. Alternate models of foliage distribution within crowns and the differences in results depending on the model used are discussed in Treuhaft et al. (2009).

### 5. Data Acquisition Materials and Methods:

#### **Site Characteristics**

La Selva is a tropical wet forest (Holdridge, 1947), characterized by a high diversity of trees, lianas, and epiphytes (McDade et al., 1994). It is comprised of about 55% primary forest. It gets about 4 m/year of rainfall. For this study, field measurements were made along thirty 10 by 100-m transects (plots). Fourteen of these plots were in undisturbed primary forest, six were in primary forest which had been selectively logged, seven were secondary forests, and three were abandoned pastures reverting to forest.

#### **Methods**

Field measurements included the location of each tree in along- and cross-transect coordinates, diameter at breast height, height to the base of the crown, total height, and lateral dimensions of the crown of each tree. All tree heights were estimated visually. For each tree with diameter at breast height greater than 10 cm (greater than 5 cm for the recently abandoned pasture plots), heights were measured by sighting along the arm to subtend angles

from the bottom to the top of the tree. Vantage points were sought which optimized the visibility of the tops of trees. These visual height estimates were calibrated by clinometer measurements (Goncalves and Santos, 2008).

The biomass of each tree,  $M_{field}$  (reported in kilograms), was estimated from measurements of the diameter at breast height or above buttress  $D$  (cm) and total height  $H$  (m), for all trees using the allometric equation for tropical wet forests developed by Chave et al. (2005):

$$M_{field} = 0.0776 * (\rho D^2 H)^{0.940}$$

where  $\rho$  (in g per  $cm^3$ ) is the wood density, assumed to have a linear dependence with diameter class, (Chave et al. 2004). Because species identification was not done, a mean value for density of 0.602 g per  $cm^3$ , from a broad set of measurements of wet tropical forests in Central America (Chave et al., 2006), was associated with the average  $D$  measured at La Selva of 22.4 cm. The biomass was calculated by adding the mass of all trees measured in a transect (plot), and dividing by the area of the transect (plot) for field measurements, 10 by 100 m, or 0.1 ha.

Lateral dimensions of the crowns were estimated by stretching measuring tape between points directly beneath the extrema of the observed crown, in the directions parallel and perpendicular to the transect. From these measurements, the lateral axes of each tree modeled as an ellipsoid were calculated (Nelson, 1997). The volume of each ellipsoid overlapping an altitude bin was assumed to be uniformly filled with leaf area and summed to calculate the leaf area volume for a series of height bins of 1 meter thickness which extended from the ground to maximum canopy height. The assumption of uniformly filled volume may contribute some error to the calculations and an assessment of multiple possible distribution models is discussed in Treuhaft et al. (2009).

## 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](mailto:uso@daac.ornl.gov)

Telephone: +1 (865) 241-3952

## 7. References:

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