

Metadata for Yasuni wood densities (17 April 2024; updated 10 December 2024)

**Wood density and bark thickness for 613 tree species from the 50-ha Forest Dynamics Plot
at Yasuni, Ecuador**

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The data include wood density and bark thickness for 613 tree species from the Yasuni Biological Station focusing on species present in the Yasuni 50-ha Forest Dynamics Plot. The Yasuni Biological Station is in the Yasuni National Park and Biosphere Reserve, Ecuador. The Yasuni 50-ha plot is located at 0°41' S latitude, 76°24' W longitude. Elevation is approximately 300 m. Air temperatures average 24.8 °C, annual rainfall averages 3100 mm, and the minimum mean monthly rainfall is 152 mm (Hietz et al. 2013. *Functional Ecology* 27: 684–692). The Yasuni flora is hyper-diverse, with more than 1,100 tree species recorded from the western 25-ha of the 50-ha plot (Valencia et al. 2004. *Journal of Ecology* 92: 214–229).

Five of us collected wood cores from 1,626 trees of 562 species to determine wood specific gravity (henceforth wood density) between March and August 2010. Trees were outside but near the Yasuni 50-ha plot and were in good condition. Trees with heart rot were excluded. Pablo Alvia and Milton Zambrano collected cores and determined fresh volumes and dry masses. Pablo, Milton, and Álvaro Pérez identified trees. Renato Valencia facilitated permits, helped with logistics, and advised where to find selected species. S. Joseph Wright taught Pablo and Milton protocols; worked with Pablo, Milton, and Álvaro for two weeks, and curated the data. Affiliations can be found on the final page.

Hietz et al. (2013. *Functional Ecology* 27: 684–692) described methods as follows. We collected one core to the center of each tree with standard 5-mm diameter increment borers. Starting at the cambium, we split each core into 5-cm segments, but segments were sometimes smaller when the core broke during sampling. We recorded the radial position, length, fresh volume, and dry mass of each segment. We placed the segments in sealed plastic straws inside plastic bags with slightly moistened paper towels and held them on ice until fresh volume was determined within 24 h of collection. Fresh volume (to 0.1 mm³) was determined by the water displacement method, dry mass (to 0.1 mg) was measured after drying to constant mass at 60 °C and then 100 °C, and wood density was defined as dry mass divided by fresh volume. We calculated wood density for each segment and then, for each tree, calculated mean wood density over segments weighted by the area of the annulus represented by each segment assuming a cylindrical trunk. The area of the annulus was calculated from the positions and lengths of the segments along each core.

Carolina Altamirano collected wood cores from 415 individuals of 51 species. Methods were the same as those described above, except cores were not broken into segments so that the estimated wood density is not corrected for any radial (from pith to bark) gradient in wood density.

The data are in eight files as follows:

1. "Yasuni_Wood_Density_Data_20101025.xlsx" holds the raw data collected by Alvia, Perez, Wright, and Zambrano, including descriptions of each cored tree (first worksheet) and determinations of fresh volume and dry mass (second worksheet). Collection identification numbers link the two raw data worksheets.
2. "Carolina_Altamirano.xlsx" holds the data collected by Altamirano, including descriptions of each cored tree and the fresh volume and dry mass of each core.
3. "Nomenclature.csv" links a six-letter species mnemonic recorded in the field to family, genus, and species.
4. "Yasuni_Wood_Density_Tree_Descriptions.csv" holds the diameter at breast height, canopy position, and location of each cored tree.
5. "Yasuni_Wood_Density_Bark_Thickness.csv" holds the thickness of the bark for each cored tree. Bark was lost during the coring process for many trees.
6. "Yasuni_Wood_Density_Sub-individual_Densities.csv" holds the radial position, length, and wood density of each segment.
7. "Yasuni_Wood_Density_Individual_Tree_Densities.csv" holds wood density for each tree calculated as a mean wood density over segments weighted by the area of the annulus represented by each segment assuming a cylindrical trunk.
8. "Yasuni_Wood_Density_Species_Mean_Densities.csv" holds species-level mean wood densities, standard deviations, and sample sizes (number of individual trees).

Finally, the annotated R script "Yasuni_Wood_Density.R" uses files 1 and 3 to create files 4 through 8. The R script should be run after the user specifies the directory in the `setwd()` function.

The remainder of this document provides definitions of variables in the eight data files. Throughout missing values are represented by NA.

1a. Variable definitions for “Yasuni_Wood_Density_Data_20101025.xlsx” worksheet 1. Includes descriptions of each cored tree. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree preceded by the initials of Pablo Alvia Z and Milton Zambrano. The initials will be removed.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

"canopy" – Values are 1 for canopies that only receive direct light from sunflecks, 2 for canopies whose foliage is oriented towards a nearby canopy gap that is not directly overhead, 3 for canopies that receive direct sunlight from a canopy gap directly overhead (i.e., trees in treefall gaps), 4 for canopies that are part of the continuous fully sun-exposed forest canopy, and 5 for canopies that emerge above their neighbors and receive direct sunlight from the sides as well as directly above.

"S_degrees" – degrees south of the equator (always 0)

"S_minutes" – minutes of latitude (always 40)

"S_seconds" – seconds of latitude

"W_degrees" – degrees of longitude west (always 76)

"W_minutes" – minutes of longitude

"W_seconds" – seconds of longitude

"comment" – Qualitative Spanish language assessment of hardness of wood. Trees with holes above the core are also noted (“HUECO”).

"habit" - uncertain

"date" – date core collected in YYYYMMDD format.

"trail" – Many cores were collected along trails maintained by the Yasuni Biological Station. Entries are trail names.

1b. Variable definitions for “Yasuni_Wood_Density_Data_20101025.xlsx” worksheet 2. Includes determinations of fresh volume and dry mass. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree preceded by the initials of Pablo Alvia Z and Milton Zambrano. The initials will be removed.

"letra" – A letter that preserves the radial position of each segment within its core or “CORTEZA”, which is Spanish for bark.

"largo" – the length of the segment or the width of the bark. Units are mm.

"diametro1" – Not used. We sampled one tree with dbh < 10 cm that could not be cored. We collected a 10-cm branch segment from this tree. “diametro1” is its diameter at one end. We discarded this tree.

"diametro2" - Not used. We sampled one tree with dbh < 10 cm that could not be cored. We collected a 10-cm branch segment from this tree. “diametro2” is its diameter at one end. We discarded this tree.

"volumen" – Fresh volume determined by Archimedes principal (water displacement on a balance). Units are grams of water displaced. Units are grams or cm³ of water displaced.

"fecha_vol" – Not used. The date “volumen” was determined in YYYYMMDD format.

"peso60" – Dry mass after drying at 60 °C in a forced air oven. Units are grams. Preliminary measurements determined that constant mass was achieved after 24 hours.

"fecha_60" – Not used. The date “peso60” was determined in YYYYMMDD format.

"peso100" – Dry mass after drying at 100 °C in a forced air oven. Units are grams. Preliminary measurements determined that constant mass was achieved after 24 hours.

"fecha_100" – Not used. The date “peso100” was determined in YYYYMMDD format.

"pagina" – Not used. Reference to the page number of the sample in the field notebook.

2. Variable definitions for “Carolina_Altamirano.xlsx”. Holds descriptions of each cored tree and the fresh volume, dry mass, and estimated wood density for each core. There are no missing values.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. Thirteen values of sp6 recorded by Carolina Altamirano lack matches in “Nomenclature.csv” so that their species identification can no longer be recovered.

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

“volume” - Fresh volume determined by Archimedes principal (water displacement on a balance). Units are grams of water displaced. Units are grams or cm^3 of water displaced.

“mass” - Dry mass after drying at 60 °C in a forced air oven. Units are grams.

“wsg” – Wood species gravity (the variable mass divided by the variable volume). Units are grams cm^{-3} .

3. Variable definitions for “Nomenclature.csv”. Links a six-letter species mnemonic recorded in the field to species names. Throughout missing values are represented by NA.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. We created new values of “sp6” that begin with ‘ZZ’ for 26 trees we could only identify to family and that we believe are not present in the Forest Dynamics Plot.

"family" – name of plant family. We identified every cored tree to family.

"genus" – name of genus. We identified 536 cored trees to genus. The value of “genus” is ‘uniden’ for the 26 cored trees not identified to genus. The value of “sp6” begins with ‘ZZ’ for these 26 trees.

"species" – name of species.

We identified 532 species recognized by Álvaro Pérez and previous botanists for the 50-ha Forest Dynamics Plot. The value of “species” is ‘uniden’ for 26 trees only identified to family (see “sp6” and “genus” for further explanation). The value of “species” is enclosed in single quotes for 4 trees. These temporary values of “species” should be replaced with values of “species” recognized by the Forest Dynamics Plot using the value of “sp6”.

The 532 species recognized by botanists for the 50-ha Forest Dynamics Plot includes an additional 167 species whose value of “species” is ‘uniden’. Botanists working on the Forest Dynamics Plot recognize these 167 species as being distinct, but they had not yet been formally identified in 2010. The remaining 365 species were identified to described species as of 2010.

"subspecific" – Not used. Subspecies (begins with ‘ssp.’) or varieties (begins with ‘var.’) for a handful of species.

4. Variable definitions for “Yasuni_Wood_Density_Tree_Descriptions.csv”. Includes the diameter at breast height, canopy position, and location of each cored tree. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree preceded by the initials of Pablo Alvia Z and Milton Zambrano. The initials will be removed.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"family" – name of plant family. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"genus" – name of genus. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"species" – name of species. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"date" – date core collected in YYYYMMDD format.

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

"canopy" – Values are 1 for canopies that only receive direct light from sunflecks, 2 for canopies whose foliage is oriented towards a nearby canopy gap that is not directly overhead, 3 for canopies that receive direct sunlight from a canopy gap directly overhead (i.e., trees in treefall gaps), 4 for canopies that are part of the continuous fully sun-exposed forest canopy, and 5 for canopies that emerge above their neighbors and receive direct sunlight from the sides as well as directly above.

"trail" – Many cores were collected along trails maintained by the Yasuni Biological Station. Entries are trail names.

"S_degrees" – degrees south of the equator (always 0)

"S_minutes" – minutes of latitude (always 40)

"S_seconds" – seconds of latitude

"W_degrees" – degrees of longitude west (always 76)

"W_minutes" – minutes of longitude

"W_seconds" – seconds of longitude

5. Variable definitions for “Yasuni_Wood_Density_Bark_Thickness.csv”. Holds the thickness of the bark for cored trees. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree. Stored as a character variable to preserve leading zeros.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"family" – name of plant family. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"genus" – name of genus. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"species" – name of species. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

"largo" – width of bark. Units are mm.

6. Variable definitions for “Yasuni_Wood_Density_Sub-individual_Densities.csv”. Holds the radial position, length, and wood density of each segment. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree. Stored as a character variable to preserve leading zeros.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"family" – name of plant family. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"genus" – name of genus. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"species" – name of species. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

"largo" – length of the segment. Units are mm.

"letra" – A letter that preserves the radial position of each segment within its core or “CORTEZA”, which is Spanish for bark.

"volumen" – Fresh volume determined by Archimedes principal (water displacement on a balance). Units are grams of water displaced.

"peso60" – Dry mass after drying to constant mass at 60 °C in a forced air oven. Units are grams. Preliminary measurements determined that constant mass was achieved after 24 hours.

"peso100" – Dry mass after drying to constant mass at 100 °C in a forced air oven. Units are grams. Preliminary measurements determined that constant mass was achieved after 24 hours.

"wsg60" – equals “peso60” / “volumen”. Units are g cm⁻³.

"wsg100" – equals “peso100” / “volumen”. Units are g cm⁻³.

7. Variable definitions for “Yasuni_Wood_Density_Individual_Tree_Densities.csv”. Holds wood density for each tree. Throughout missing values are represented by NA.

"id" – unique four-digit number assigned to each cored tree. Stored as a character variable to preserve leading zeros.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"family" – name of plant family. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"genus" – name of genus. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"species" – name of species. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"dbh" – diameter at breast height (1.3 m) of the cored tree. Units are cm.

"wsg60" – wood density after drying to constant mass at 60 °C. Units are g cm⁻³.

"wsg100" – wood density after drying to constant mass at 100 °C. Units are g cm⁻³.

8. Variable definitions for “Yasuni_Wood_Density_Species_Mean_Densities.csv”. Holds species-level mean wood densities, standard deviations, and sample sizes. Throughout missing values are represented by NA.

"sp6" – a six-letter mnemonic used to identify tree species in the Yasuni 50-ha Forest Dynamics Plot. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"family" – name of plant family. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"genus" – name of genus. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"species" – name of species. For further explanation, see the page that starts 2. *Variable definitions for “Nomenclature.csv”*.

"wsg60_mean" – mean wood density after drying to constant mass at 60 °C. Units are g cm⁻³.

"wsg60_sd" – one standard deviation of wood density after drying to constant mass at 60 °C. Units are g cm⁻³.

"wsg60_N" – sample size for “wsg60_mean” and “wsg60_sd”. Number of trees cored.

"wsg100_mean" – mean wood density after drying to constant mass at 100 °C. Units are g cm⁻³.

"wsg100_sd" – one standard deviation of wood density after drying to constant mass at 100 °C. Units are g cm⁻³.

"wsg100_N" - sample size for “wsg100_mean” and “wsg100_sd”. Number of trees cored.