IS 562 SP20

Team Carsen

TREE

Data Dictionary v1.0

TREE Org

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Contents

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PREMIS Data Dictionary, Version 3.0

INTRODUCTION

The TREE Data Dictionary is a complete resource for the implementation of the TREE Schema in the management of in-field tree identification metadata. The schema's purpose is to guide users in the creation of their own, unique field guides. In honor of April being Citizen Science Month, the schema has been created for "citizen scientists" with a passion for tree identification and a desire to catalog their observations using descriptive metadata. The Data Dictionary provides users with semantic units and terms to record detailed identification information about trees. Several units require enumerated terms that can be found within controlled vocabularies; while users are permitted to source their own preferred vocabularies, there are several controlled vocabularies suggested within the Data Dictionary. The dictionary provides a degree of flexibility that allows for varying levels of user implementation. The Data Dictionary defines descriptive-metadata characteristics broadly through the following four categories:

- Botanical terms
- Morphology/Physiology
- Growth Requirements
- Reproduction

Each semantic unit defined in the Data Dictionary is mapped to an entity that is organized within a simple data model. A semantic unit can, therefore, be understood as a property of an entity. The semantic units defined in the Data Dictionary pertain to established characteristics that are crucial to the identification of trees.

Each element described attempts to encapsulate the most relevant features of a tree, including botanical terms for reference and the general anatomy of plants and their biology.

Characteristics such as a tree's leaves, reproductive mechanisms, barks, and roots, have elements of their own, with further subelements for additional descriptive granularity. Also included, are location and habitat elements for the specimen, to record its topography. Additionally, an image element for the record exists to provide a space for image files.

The TREE Data Dictionary is a guide developed to support the efforts of citizen scientists in the exploration and curation of their arboreal discoveries. Many of these elements are optional but provide resource guidance on essential features that ought to be acknowledged in tree identification.

TREE DATA DICTIONARY Version 1.0

The TREE Data Dictionary includes semantic units. The template for each entry includes a place for notes about how to create or use the semantic unit. Semantic units may or may not contain semantic components, which are defined as semantic units in their own right. A semantic component's repeatability and obligation may vary from its containing semantic unit. Each semantic unit entry in the Data Dictionary includes the following attributes:

- **Name of the semantic unit**: Names are meant to be descriptive and unique within the Data Dictionary.
- **Semantic components**: The semantic components each have their own entries later in the Data Dictionary. A semantic unit that has semantic components does not have any value of its own. Only semantic units at the lowest level have values.
- **Definition**: The meaning of the semantic unit.
- **Rationale**: Why the semantic unit is needed, if not self-evident from the definition.
- **Data constraint**: How the value of the semantic unit should be encoded. Some common data constraints are:
    - *Container* – The semantic unit is an umbrella for two or more semantic components and has no value of its own.
    - *Enumerations* – See **Examples** for allowed values.
    - *None* – The semantic unit can take any form of value.
    - *Value should be taken from a controlled vocabulary* – While there are recommended vocabularies listed, individuals using this schema should choose (and record) vocabularies that are meaningful to them.
- **Repeatability**: A semantic unit that is repeatable can be repeated if, and as needed.
- **Obligation**: Whether a value for the semantic unit is Mandatory or Optional. Values for optional semantic units are recommended, but not required.
- **Creation/Maintenance notes**: Notes about how the values for the semantic unit may be obtained and/or updated.
- **Examples**: One or more examples of values for the semantic unit.

Semantic Units

Root element: Tree

1. name
    - 1.1. scientific
        - 1.1.1. kingdom
        - 1.1.2. family
        - 1.1.3. genus
        - 1.1.4. species
    - 1.2. common
    - 1.3. alternative
    - 1.4. symbol
2. description
    - 2.1. features
    - 2.2. cultivation
3. form
    - 3.1. contour
        - 3.1.1. crownShape
        - 3.1.2. branchingType
    - 3.2.measurement
        - 3.2.1. height
        - 3.2.2. diameter
4. leaf
    - 4.1. complexity
    - 4.2. color
    - 4.3. shape
    - 4.4. arrangement
    - 4.5. retention
5. twigs
    - 5.1. color
    - 5.2. contour
    - 5.3. budArrangement
        - 5.3.1. terminal
        - 5.3.2. lateral
    - 5.4. leafscar
6. reproduction
    - 6.1. category
        - 6.1.1. simple
        - 6.1.2. extended
    - 6.2. mode
        - 6.2.1. fruitProduction
            - 6.2.1.1. category
            - 6.2.1.2. color
            - 6.2.1.3. shape
        - 6.2.2. flowerProduction
            - 6.2.2.1. category
            - 6.2.2.2. color
            - 6.2.2.3. shape
7. bark

7.1. color
7.2. shape
7.3. texture

8. wood
    8.1. category
    8.2. growthRingFormation
9. rootSystem
    9.1. category
    9.2. architecture
        9.2.1. radialGrowthRate
        9.2.2. rootCollar
10. range
    10.1. location
    10.2. habitat
    10.3. zone
11. image
    11.1. identifier
    11.2. creator
    11.3. title
    11.4. rights
    11.5. description

Semantic unit	1 name
Semantic components	1.1 scientific 1.2 common 1.3 symbol
Definition	This element identifies the different names used to identify the tree that is being described.
Rationale	Trees are identified by their scientific, common, and alternate names.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/Maintenance notes	N/A

Semantic unit	1.1 scientific
Semantic components	1.1.1 kingdom 1.1.2 family 1.1.3 genus 1.1.4 species
Definition	This element identifies the scientific names used to identify the tree that is being described.
Rationale	The scientific name provides a unique identifier for the tree within the scientific community.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/Maintenance notes	Suggested controlled vocabulary for the official scientific name of the tree available at the NRCS State Plants Lists: https://plants.sc.egov.usda.gov/dl_nrcs_state_plants.html
Examples	N/A

Semantic unit	1.1.1 kingdom
Semantic components	None
Definition	This element identifies the kingdom names used to identify the tree that is being described.
Rationale	See container rational.
Data constraint	String data type.
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	See container for suggested controlled vocabulary.
Examples	Plantae

Semantic unit	1.1.2 family
Semantic components	None
Definition	This element identifies the family names used to identify the tree that is being described.
Rationale	See container rational.
Data constraint	String data type.
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	See container for suggested controlled vocabulary.
Examples	Plantanacae, Cupressaceae

Semantic unit	1.1.3 genus
Semantic components	None
Definition	This element identifies the genus names used to identify the tree that is being described.
Rationale	See container rational
Data constraint	String data type.
Repeatability	No
Obligation	Mandatory
Creation/Maintenance Notes	See container for suggested controlled vocabulary.
Examples	Plantanus, Abies

Semantic unit	1.1.4 species
Semantic components	None
Definition	This element identifies the species names used to identify the tree that is being described.
Rationale	
Data constraint	String data type
Obligation	Mandatory
Repeatability	No
Creation/Maintenance Notes	Controlled vocabulary for the official scientific name of the tree. Taken from database such as the NRCS State Plants Lists. https://plants.sc.egov.usda.gov/dl_nrcs_state_plants.html
Examples	occidentalis, koreana

Semantic unit	1.2 common
Semantic components	None
Definition	This element identifies the different common names used to identify the tree that is being described.
Rationale	The common name for a tree helps to identify the tree in everyday speech.
Data constraint	String data type
Obligation	Mandatory
Repeatability	Yes
Creation/Maintenance Notes	Consult a tree identification guide or encyclopaedia.
Examples	American Sycamore, Pacific Madrone

Semantic unit	1.3 alternative
Semantic components	None
Definition	This element identifies alternative, regional, or nick names that may not be recognized as common names.
Rationale	Trees may have more specific regional names or nick names that are not widely used enough to be considered “common names”
Data constraint	String data type
Obligation	Optional
Repeatability	Yes
Creation/Maintenance Notes	Can be a unique vernacular name.
Examples	Ye Ole Tall Boi, Strawberry Tree

Semantic unit	1.3 symbol
Semantic component	None
Definition	Standardized identifier assigned by the USDA’s PLANTS Database.
Rationale	Provides a simplified alternative and standardized identifier within the record.
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	Can be found at: https://plants.usda.gov by entering the tree name in the search box on the upper left of the USDA website. The symbol will be a 4-6 alphanumeric
Examples	QUAL, THOC2

Semantic unit	2 description

Semantic Components	2.1 features 2.2 cultivation
Definition	General information about a specific tree species, used for identification.
Rationale	Specific tree species can often be identified through written representations of its shape, appearance, and key features.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Consult a tree identification guide or encyclopaedia.

Semantic unit	2.1 features
Semantic Components	None
Definition	A brief account of a specific tree's key features, usually visual, but olfactory or tactile details may also be used.
Rationale	Each tree species has different key features that may be used for identification. Narrative may draw from other elements and subelements.
Data constraint	String data type
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Preference for unprescribed authoritative resource. Resource citation is recommended.
Examples	Planted, deciduous tree with straight trunk and open, pyramid-shaped crown, becoming wide-spreading and irregular with age; without flowers or fruit. -National Audubon Society

Semantic unit	2.2 cultivation
Semantic Components	None
Definition	A brief account of a specific tree species' history and use.
Rationale	A specific species of tree may be identified through its historic use, origin, or surrounding lore.
Data constraint	String data type
Repeatability	No
Obligation	Optional

Creation/maintenance notes	Preference for unprescribed authoritative resource. Resource citation is recommended.
Examples	Ginkgo is best known as a living fossil related to conifers and the sole survivor of its ancient family. This sacred tree was preserved from extinction by Buddhist priests on temple grounds in China, Japan, and Korea. The seeds are eaten in the Orient. - National Audubon Society

Semantic unit	3 form
Semantic Components	3.1 contour 3.2 measurement
Definition	Description of the shape and measurements (height and diameter) of a tree species.
Rationale	Specific tree species can often be identified through shape and dimension specifications.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Visual analysis

Semantic unit	3.1 contour
Semantic Components	3.1.1 crownShape 3.1.2 branchingType
Definition	Description of the Crown Shape and Branching Type, which informs the tree's shape.
Rationale	Trees can be identified by their crown shape, and branching type.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Visual analysis

Semantic unit	3.1.1 crownShape
Semantic Components	None
Definition	Measure for the height and diameter of mature specimen under favourable growing conditions.
Rationale	Trees can be identified by their crown shape, i.e. shape of their outline or silhouette.
Data constraint	*Enumerations*
Repeatability	No

Obligation	Mandatory
Creation/maintenance notes	Refer to "Fig. 8. Tree crown shapes" for controlled vocabulary. https://extension.tennessee.edu/publications/Documents/W227.pdf
Examples	*Enumerations*: Oblong; Round; Oval; Vase; Pyramidal; Weeping

Semantic unit	3.1.2 branchingType
Semantic Components	None
Definition	Description of a tree's branching type.
Rationale	Trees come in a variety of forms based on their branching patterns.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Refer to following link for controlled vocabulary: https://extension.tennessee.edu/publications/Documents/W227.pdf
Examples	*Enumerations*: Excurrent; Decurrent; Columnar

Semantic unit	3.2 measurement
Semantic Components	3.2.1 height 3.2.2 diameter
Definition	Measure for the height and diameter of mature specimen under favourable growing conditions.
Rationale	Though height and diameter will vary under influence of age, location, and climate, specific tree species can often be identified through dimension specifications.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	ISO 80000-3:2019(en): https://www.iso.org/obp/ui/#iso:std:iso:80000:-3:ed-2:v1:en

Semantic unit	3.2.1 height
Semantic Components	None
Definition	The height measurement, given in meters.
Rationale	N/A
Data constraint	Decimal data type.

Repeatability	No
Obligation	Optional
Creation/maintenance notes	See ISO notes for container. No ranges allowed.
Examples	15; 21; 7.9

Semantic unit	3.2.2 diameter
Semantic Components	None
Definition	The diameter measurement, given in meters.
Rationale	N/A
Data constraint	Decimal data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	See ISO notes for container Measurement is to be taken at breast height.
Examples	0.6; 3.6; 8

Semantic unit	4 leaf
Semantic Components	4.1 complexity 4.2 color 4.3 shape 4.4 arrangement 4.5 retention
Definition	Information about the type of leaves a tree has.
Rationale	Trees have different leaf characteristics that aid in tree identification.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Visual analysis

Semantic unit	4.1 complexity
Semantic Components	None
Definition	Information about the complexity of a tree's leaves.
Rationale	Trees have different leaf characteristics that aid in tree identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Value should be taken from a controlled vocabulary. To use the suggested vocabulary at https://www.wildflower.org/plants, first

	enter a tree into the search bar, at which point the necessary terms will be displayed. Other controlled vocabulary can be used and should be identified in each case.
Examples	Compound, Simple, Needle-like, Toothed, Serrated, Lobed

Semantic unit	4.2 color
Semantic Components	None
Definition	Information about the color of a tree's leaves.
Rationale	Trees have different leaf characteristics that aid in tree identification.
Data constraint	Value is string. Value should be taken from a controlled vocabulary.
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	To use the suggested vocabulary at https://www.wildflower.org/plants, first enter a tree into the search bar, at which point the necessary terms will be displayed. Other controlled vocabulary can be used and should be identified in each case. The color is repeatable so that variations in leaves can be noted; such as in cases where color changes or multifaceted, for example.
Examples	Dark Green above, silvery-green below

Semantic unit	4.3 shape
Semantic Components	None
Definition	Information about the shape of a tree's leaves.
Rationale	Trees have different leaf characteristics that aid in tree identification.
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	To use the suggested vocabulary at https://www.wildflower.org/plants, first enter a tree into the search bar, at which point the necessary terms will be displayed. Other controlled vocabulary can be used and should be identified in each case.
Examples	Oval, Elliptic

Semantic unit	4.4 arrangement

Semantic Components	None
Definition	Information about the positioning of a tree's leaves.
Rationale	Trees have different leaf characteristics that aid in tree identification.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Visual analysis
Examples	*Enumerations*: opposite; alternate; spiral

Semantic unit	4.5 retention
Semantic Components	None
Definition	Describing the seasonal phenotypical characteristics of a tree's leaves.
Rationale	Not all angiosperms are deciduous. (e.g., arbutus trees, which do not drop their leaves in the fall). Conversely, some gymnosperms drop their needles in the fall (e.g., tamarack and larch) So some conifers are, in fact, deciduous
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Visual analysis
Examples	*Enumerations*: deciduous; semi-evergreen; evergreen

Semantic unit	5 twigs
Semantic Components	5.1 color 5.2 contour 5.3 budArrangement 5.4 leafscar
Definition	Description of twigs of specific tree species.
Rationale	The description of a specific species' trigs (or branches) may be used for identification.
Data constraint	Container
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Subelements are optional, fill out as much as desired for identification.

Semantic unit	5.1 color
Semantic Components	None

Definition	A brief string of text describing the color of the tree twigs.
Rationale	The colors observed in a twig may be used for identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Controlled vocabulary can be used. Vocabulary for detailed colors here http://www.getty.edu/vow/AATHierarchy?find=color&logic=AND&note=&subjectid=300131648 ...or simple colors are here https://www.wildflower.org/plants Repeatable to describe variations of color observed.
Examples	Light grey; light brown; reddish

Semantic unit	5.2 contour
Semantic Components	None
Definition	A brief string of text describing the stoutness of the tree twigs.
Rationale	N/A
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	No constraints, simply describe what you observe.
Examples	stout; thin; thick; thorny; hairy; prickly; smooth

Semantic unit	5.3 budArrangement
Semantic Components	5.3.1 terminal 5.3.2 lateral
Definition	The species leaf-bud arrangement on deciduous trees may be used for identification.
Rationale	Observations regarding the terminal and lateral bud arrangements can be helpful in identifying tree types.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	For more information about bud arrangement see: https://extension.tennessee.edu/publications/

	Documents/W227.pdf or https://ohioplants.org/twiginfo/

Semantic unit	5.3.1 terminal
Semantic Components	None
Definition	Buds found on the end of deciduous trees are called terminal buds.
Rationale	This element may be used to describe characteristics of the terminal buds.
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	See container for reference
Examples	Scaly; pairs; overlapping; facing; naked

Semantic unit	5.3.2 lateral
Semantic Components	None
Definition	Buds found on the along the twig of deciduous trees are called lateral buds.
Rationale	Alternate leaf attachments have one unique leaf at each leaf node and typically alternate direction along the stem. Opposite leaf attachments pair leaves at each node. Whorled leaf attachment is where three or more leaves attach at each point or node on the stem.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	See container for reference
Examples	*Enumerations*: alternate; opposite; spiral

Semantic unit	5.4 leafscar
Semantic Components	None
Definition	This is a scar located on the twig evidencing a previous leaf attachment. When the leaf drops, a scar is left just under the bud and it can be unique.
Rationale	Some trees can be easily identified by their leaf scars.
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	This is simply a description of what you see: lobes, a count of bundle-scars

	evidencing veins that once attached leaf, shape or size of scar, etc.
Examples	3-lobed [hickory; shield-shaped [ash]; and leaf scar encircles the twig [dogwood]

Semantic unit	6 reproduction
Semantic Components	6.1 category 6.2 mode
Definition	Information about the reproductive mechanism(s) of the tree.
Rationale	Trees have different reproductive capabilities, which can aid in tree identification.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Values of subunits should be taken from a controlled vocabulary.

Semantic unit	6.1 category
Semantic Components	6.1.1 simple 6.1.2 extended
Definition	Information about the reproductive mechanism(s) of the tree.
Rationale	Trees can be classified into two broad reproduction types.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Based on user's level of specification, metadata can be recorded in the simple and/or the extended subelement.

Semantic unit	6.1.1 simple
Semantic Components	None
Definition	A simple characterization of the reproduction category of the tree.
Rationale	Trees are classifiable in two reproduction types.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	A tree can only be either angiosperm or gymnosperm. Used to denote if a tree is a seed-bearing flowering plant or a seed-bearing non-flowering plant.

Examples	*Enumerations*: angioSperm; gymnoSperm

Semantic unit	6.1.2 extended
Semantic Components	None
Definition	A high-level characterization of the reproduction category of the tree. Although Trees are classifiable in two reproduction types, these categories can be nuanced here.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	An angiosperm can be classified as eudicot (eudicotyledon), more broadly as a dicot (dicotyledon), or as a monocot (monocotyldeon). A gymnosperm can be classified as conifers, gingkoes, cycads, or gnetophyta.
Examples	*Enumerations*: dicot; eudicot; monocot; gingko; cycad; gnetophyta

Semantic unit	6.2 mode
Semantic Components	6.2.1 fruitProduction 6.2.2 flowerProduction
Definition	Information about the reproductive mechanism(s) of the tree.
Rationale	Trees have different reproductive mechanisms, which can aid in tree identification. Some plants have multiple reproductive modes.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Values should be taken from a controlled vocabulary. A suggested vocabulary is available at: https://www.wildflower.org/plants/ For the purposes of this schema “cones” are designated as fruit.

Semantic unit	6.2.1 fruitProduction
Semantic Components	6.2.1.1 category 6.2.1.2 color 6.2.1.3 shape
Definition	Information about the reproductive mechanism(s) of trees that produce cones.

Rationale	Trees have different reproductive capabilities, which can aid in tree identification. Some plants have multiple reproductive modes.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	To use the suggested vocabulary at https://www.wildflower.org/plants, first enter a tree into the search bar, at which point the necessary terms will be displayed. Other controlled vocabulary can be used and should be identified in each case.

Semantic unit	6.2.1.1 category
Semantic Components	None
Definition	Type of fruit produced by a tree.
Rationale	Trees have fruit bodies, cones, or other structures that contain their seeds and/or attract pollinators.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Value should be taken from a controlled vocabulary. A suggested vocabulary is available at: http://faculty.valenciacollege.edu/tklenk/botany/labs/fruits.htm
Examples	Berry, Cone, Apple

Semantic unit	6.2.1.2 color
Semantic Components	None
Definition	The color of a tree's fruit.
Rationale	Fruit color can help in tree identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	To use the suggested vocabulary at https://www.wildflower.org/plants, first enter a tree into the search bar, at which point the necessary terms will be displayed. Other controlled vocabulary can be used and should be identified in each case. Can be repeated to list all fruit colors, which can vary depending on several factors.
Examples	Red, Orange, Green

Semantic unit	6.2.1.3 shape
Semantic Components	None
Definition	The shape of a tree's fruit.
Rationale	Fruit shape can help in tree identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Value can be taken from a controlled vocabulary. A suggested vocabulary is available at: https://landscapeplants.oregonstate.edu/plants/ Can be repeated to list all fruit colors, which can vary depending on several factors.
Examples	Ovoid, Cuboid

Semantic unit	6.2.2 flowerProduction 6.2.2.1 category 6.2.2.2 color 6.2.2.3 shape
Semantic Components	None
Definition	Type of flower type produced by a tree.
Rationale	Flower type is a useful trait for identifying trees. It can determine whether a tree requires external pollinating factors.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Recommended information, if available.

Semantic unit	6.2.2.1 category
Semantic Components	None
Definition	Type of flower type produced by a tree.
Rationale	• Dioecious have the female and male reproductive organs borne on separate plants (of the same species). • Diclinous (imperfect): plants are only female or only male • Bisexual (Monoclinous, perfect): male & female are part of a single structure in each flower • Monoecious: unisexual reproductive organs or flowers, with the organs or flowers of both sexes borne on a single plant • Synoecious: female & male flowers
Data constraint	*Enumerations*

Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Recommended information, if available. Note that the data is constrained. Some exceptional trees can exhibit varying flower morphologies depending on various factors.
Examples	*Enumerations*: bisexual; dioecious; diclinous; monoclinous; monoecious; synoecious; unisexual

Semantic unit	6.2.2.2 color
Semantic Components	None
Definition	The color of a tree's flowers.
Rationale	Flower color can help in tree identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Can be repeated to list all flower colors, which can vary depending on several factors. Optional, because some trees do not bear flowers.
Examples	Pink, Blue, Violet, Purple

Semantic unit	6.2.2.3 flowerShape
Semantic Components	None
Definition	The shape of a tree's flowers.
Rationale	Flower shape can help in tree identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Can be repeated to list all flower shapes, which can vary depending on several factors. Optional, because some trees do not bear flowers.
Examples	Trumpet, Urn, Disc

Semantic unit	7 bark
Sub element	7.1 color 7.2 shape 7.3 texture
Definition	This element describes the type of bark on the tree.
Rationale	Some trees are easily identifiable by their bark.
Data constraint	Container
Obligation	Optional
Repeatability	Yes

Creation/maintenance notes	Visual analysis

Semantic unit	7.1 color
Semantic components	None
Definition	This sub element describes the color of the bark
Rationale	Identifying the color of the bark can be helpful in tree identification.
Data constraint	String data type
Obligation	Optional
Repeatability	Yes
Creation/Maintenance notes	Can be repeated to list all bark colors, which can vary depending on several factors. Optional, because some trees do not have easily described bark.
Examples	Dark brown, Green

Semantic unit	7.2 shape
Semantic components	None
Definition	This sub element describes the shape of the bark. This optional field can describe bark as it appears if it has a distinct shape from growth, peeling, or simply falling off the tree.
Rationale	Identifying the shape of the bark can be helpful in tree identification.
Data constraint	String data type
Obligation	Optional
Repeatability	No
Creation/Maintenance notes	Optional, because some trees do not have easily described bark.
Examples	Oblong, Diamond

Semantic unit	7.3 texture
Semantic components	None
Definition	This sub element describes the texture of the bark
Rationale	Bark texture can be helpful in tree identification.
Data constraint	String data type
Obligation	Optional
Repeatability	Yes
Creation/Maintenance notes	Can be repeated to list all bark texture, which can vary depending on several

	factors. Optional, because some trees do not have easily described bark.
Examples	Papery, rough, fibrous, smooth

Semantic unit	8 wood
Semantic Components	8.1 category 8.2 growthRingFormation
Definition	Characteristic that aids in tree identification.
Rationale	The makeup of a tree can be important in commercial wood usage.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/maintenance notes	The following site can help to identify this trait: https://www.wood-database.com/

Semantic unit	8.1 category
Semantic Components	None
Definition	The type of wood that a tree is made of.
Rationale	The category element is often predicated by reproduction element, however some are based on the wood structure and wood usage.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	To determine the correct enumeration, first enter a tree into the search bar at: https://www.wood-database.com/ at which point the necessary term will be displayed.
Examples	*Enumerations*: hardwood; softwood

Semantic unit	8.2 growthRingFormation
Semantic Components	None
Definition	Defines the characteristics of the category subunit.
Rationale	Woods have variable growth ring characteristics.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Optional
Creation/maintenance notes	To determine the correct enumeration, first enter a tree into the search bar at: https://www.wood-database.com/ at which point the necessary term will be displayed.

Examples	*Enumerations*: ring-porous; diffuse-porous; incomplete rings; discontinuous rings; missing rings [no wood formed in a given year]; false rings; eccentric rings; fluted rings

Semantic Unit	9 rootSystem
Semantic components	9.1 category 9.2 architecture
Definition	Information about the roots of a tree
Rationale	Plant root systems are essential components of ecosystems and agro-ecosystems. Important in order to understand root functions and interactions with the soil environment.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	Recommended if roots are visible. Information may be available using a tree identification guide.

Semantic Unit	9.1 category
Semantic components	None
Definition	Information about the roots type
Rationale	Plants depend on roots for water and nutrients as well as maintaining structural integrity for the soil. Varying types of roots reflect environment and habitat characteristics of plants.
Data constraint	*Enumerations*
Repeatability	No
Obligation	Mandatory
Creation/Maintenance notes	Suggested controlled vocabulary: https://www.homestratosphere.com/types-of-roots/#Types_of_Roots
Examples	*Enumerations*: tap; fibrous; adventitious; creeping; tuberous; water; parasite

Semantic unit	9.2 architecture
Semantic component	9.2.1 radialGrowthRate 9.2.2 rootCollar
Definition	Measures the tree's root geometric properties and spatial relations. Measurements on the way in which the root

	constituent parts are interrelated or arranged.
Rationale	Knowledge of root system architecture is of importance in understanding key ecosystem processes including tree stability, slope stabilization, erosion control, water and nutrient uptake through fine roots, and root competition.
Data constraint	Container
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	Visual analysis

Semantic unit	9.2.1 radialGrowthRate
Semantic component	None
Definition	Measurement of the whorl(s) of branches around a root.
Rationale	Whorl measurement is a reliable non-intrusive method for determining age of a young coniferous tree.
Data constraint	Integer data type
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	Given as meters/year. Use only for coniferous trees. One really must get close to the tree, look carefully for evidence of bud scars, and know the growth habits of these species. Some suggested reference materials: • http://www.nativetreesociety.org/measure/basic_concepts/radial_growth_calculations.htm • https://www.fs.fed.us/rm/pubs_other/rmrs_1985_swetnam_t001.pdf • https://openoregon.pressbooks.pub/forestmeasurements/chapter/4-4-field-technique-tips-for-counting-whorls/
Examples	1, 5, 20

Semantic unit	9.2.2 rootCollar
Semantic component	None
Definition	Measures the area (circumference) where the tree trunk and tree roots meet, usually

	indicated by an outward flare of major roots. Approximately 1-3 in above ground level.
Rationale	Root collars are important to tree health because they directly impact the tree's intake of nutrients, oxygen, and water. For this reason, tree root collars should be visible and not be buried under soil or mulch.
Data constraint	Decimal data type
Repeatability	No
Obligation	Optional
Creation/Maintenance notes	Measured in meters. ISO 80000-3:2019(en): https://www.iso.org/obp/ui/#iso:std:iso:80000:-3:ed-2:v1:en
Examples	1.2, 4, 5.7

Semantic unit	10 range
Semantic components	10.1 location 10.2 habitat 10.3 zone
Definition	This element identifies the area that the tree can be found.
Rationale	Understanding where a tree is located and the environment that it is in can be helpful for tree identification.
Data constraint	Container
Obligation	Mandatory
Repeatability	No
Creation/Maintenance notes	Geospatial analysis or consult a tree identification guide.

Semantic unit	10.1 location
Semantic components	None
Definition	This sub element describes the geographic region where the tree is located. This can define where the person is viewing the tree.
Rationale	See container rational.
Data constraint	String data type
Obligation	Mandatory
Repeatability	Yes
Creation/Maintenance notes	Use regional, state, city, or other available location descriptions.
Examples	Pacific Northwest, Black Mountain

Semantic unit	10.2 habitat
Semantic components	None

Definition	This sub element describes the type of natural environment that the tree is located.
Rationale	See container rational.
Data constraint	String
Obligation	Optional
Repeatability	Yes
Container/Maintenance notes	Describe the habitat with commonly accepted language for habitats.
Examples	Marshes, swamps, bogs

Semantic unit	10.3 zone
Semantic components	None
Definition	This sub element describes the zone of natural environment that the tree is located.
Rationale	See container rationale
Data constraint	String data type
Obligation	Optional
Repeatability	No
Creation/Maintenance notes	In North America, use hardiness zones as defined by the USDA. ttps://planthardiness.ars.usda.gov/PHZMWeb/
Examples	4, 7-8

Semantic unit	11 image
Semantic Components	11.1 identifier 11.2 creator 11.3 title 11.4 rights 11.5 description
Definition	A link to an image file that documents the identified tree species.
Rationale	The image aids the descriptive metadata by providing an illustration or photo documentation and may be used for identification.
Data constraint	Container
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Use of components follow Dublin Core schema. See http://purl.org/dc/elements/1.1/

Semantic unit	11.1 identifier
Semantic Components	None
Definition	An URI for the image

Rationale	The image aids the descriptive metadata by providing an illustration or photo documentation and may be used for identification.
Data constraint	URI data type
Repeatability	No
Obligation	Mandatory
Creation/maintenance notes	Use of components follow Dublin Core schema.
Examples	- https://landscapeplants.oregonstate.edu/sites/plantid7/files/plantimage/ armen910.jpg - https://cdn.thetreecenter.com/c/uploads/2014/07/Weeping-Willow-Tree-On-Golf-Course.jpg

Semantic unit	11.2 creator
Semantic Components	None
Definition	Name(s) for the author of the image.
Rationale	The image aids the descriptive metadata by providing an illustration or photo documentation and may be used for identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Use of components follow Dublin Core schema.
Examples	Joe Smith; Roberta Smith

Semantic unit	11.3 title
Semantic Components	None
Definition	Heading for the image.
Rationale	The image aids the descriptive metadata by providing an illustration or photo documentation and may be used for identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Optional
Creation/maintenance notes	Use of components follow Dublin Core schema.
Examples	Dogwood, Blackthorn, An Oak in the Field

Semantic unit	11.4 rights
Semantic Components	None
Definition	Copyright information affiliated with the image.
Rationale	The image aids the descriptive metadata by providing an illustration or photo documentation and may be used for identification.
Data constraint	String data type
Repeatability	Yes
Obligation	Mandatory
Creation/maintenance notes	May contain URL. Use of components follow Dublin Core schema. See http://purl.org/dc/elements/1.1/
Examples	CC-by-SA or https://creativecommons.org/licenses/by-sa/2.0/, Courtesy of Western Gallery, all rights reserved

Semantic unit	11.5 description
Semantic Components	None
Definition	A written text that accounts for characteristics, qualities, or events illustrated in the image.
Rationale	Sometimes people want to add notes that are not included anywhere else.
Data constraint	String data type
Repeatability	No
Obligation	Optional
Creation/maintenance notes	Text string, citation should be included if used.
Example	Notice the bright red leaves, I've never seen them like this before!