

Botany of Trees

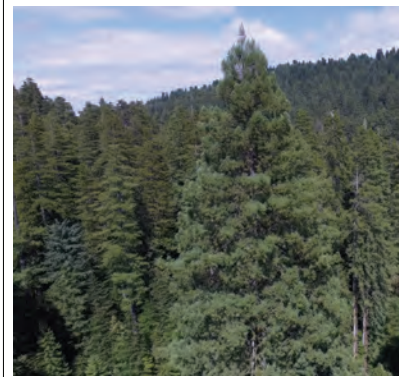
Dr. Matt Ritter



Botany of Trees

- Five part series -Tuesdays, 11 AM to 12:30 PM
- Each will be ~1 hour with 30 minutes of questions

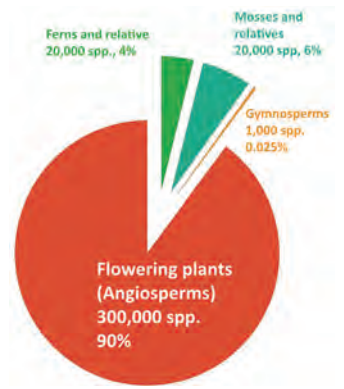
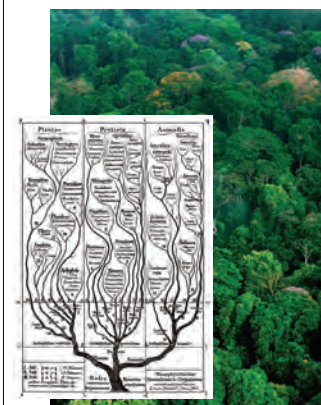
Tuesday, April 14th: Introduction to trees, growth, development, leaves, and morphology



Tuesday, April 21st: Trunks, branches, tree form, branching patterns, and shape, and how wood forms



Tuesday, April 28th: Tree names, diversity, and why names change



Tuesday, May 5th: Water in trees, photosynthesis, and respiration

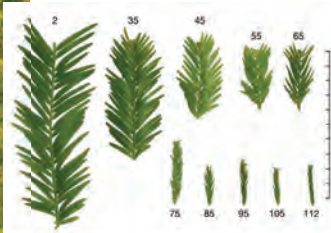
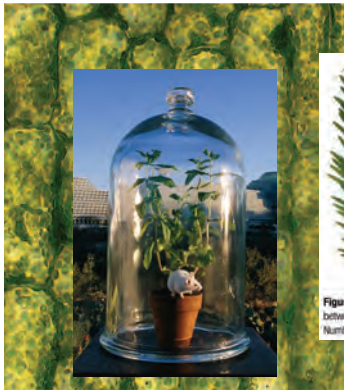
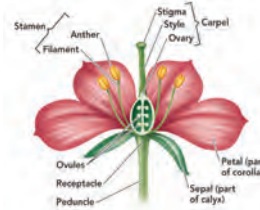


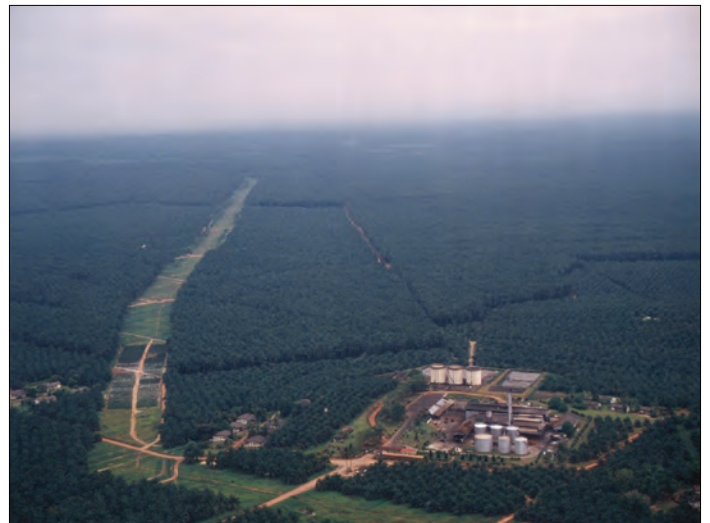
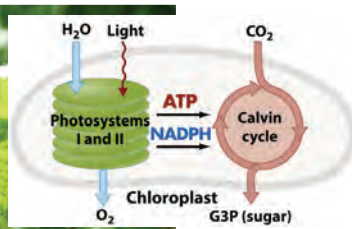
Figure 2 Variation in leaf structure with height in redwood. Leaf length and the angle between the long axis of the leaf and supporting stem segment both decrease with height. Numbers denote the sample height in m. Scale divisions are cm.

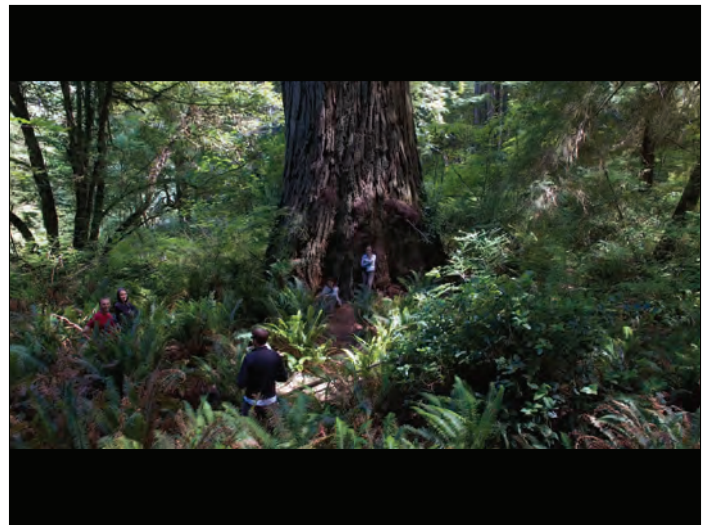
Tuesday, May 12th: Reproduction, flower formation, fruit, and seeds



The Importance of Plants

- Basic human needs are all directly or indirectly provided by plants







An Introduction to Trees

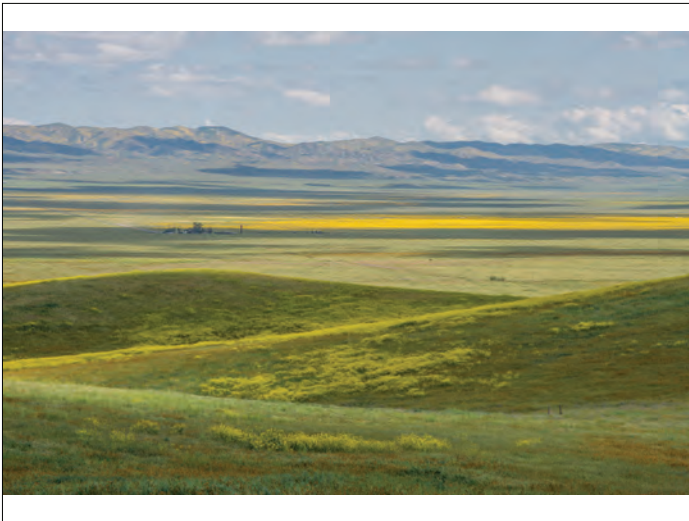
Seasonal Growth Patterns

- **Annuals:**
 - most herbaceous plants that demonstrate only primary growth
 - entire life cycle takes place in one growing season.

Seasonal Growth Patterns



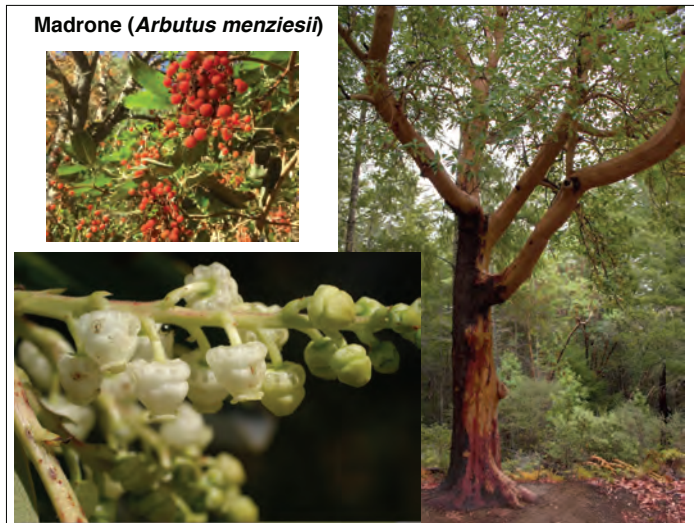
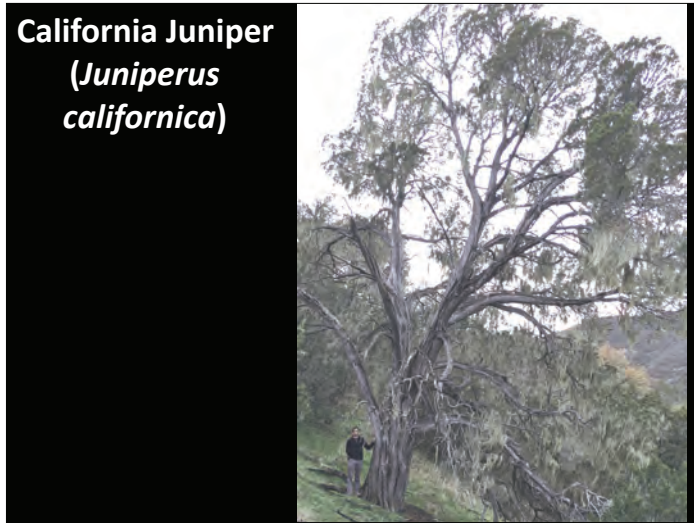
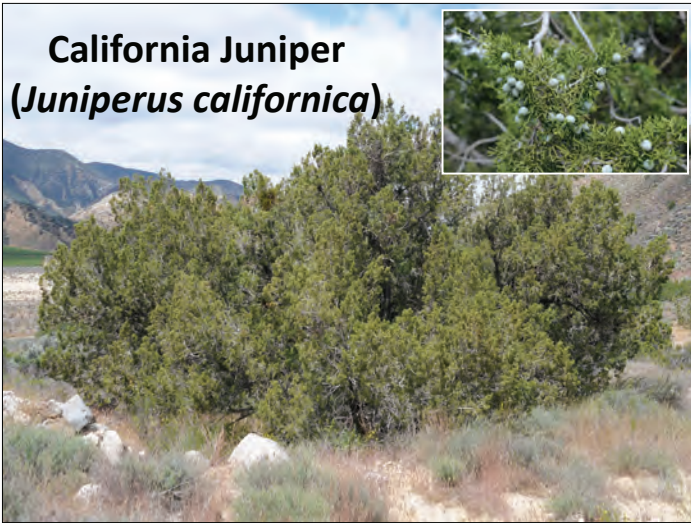
- **Biennials:**
 - need two seasons from germination to seed formation.
- **Perennials:**
 - plants that live year after year.
 - woody plants that display secondary growth (wood formation) in their stems.
 - monocots have NO true secondary growth.



Trees are Hard to Define

- Trees - large, single stem (trunk), raised canopy
- Shrubs - smaller, multi-stemmed, low canopy
- Bushlands, shrublands, scrublands, forests, woodlands, savannas



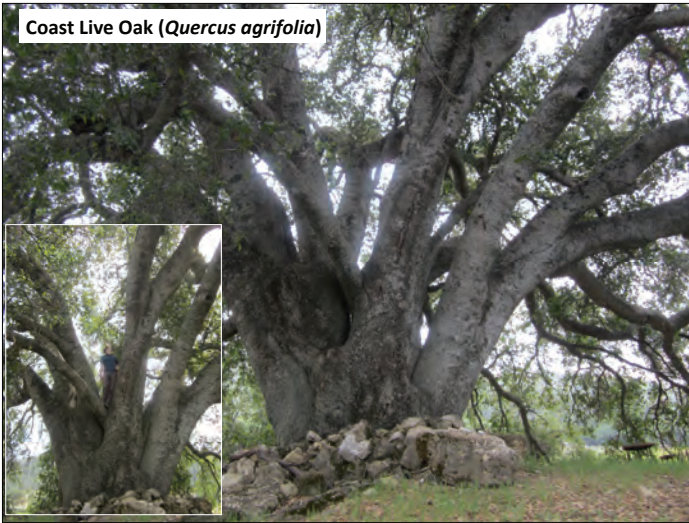




**California Sycamore
(*Platanus racemosa*)**



Bristlecone Pine (*Pinus longaeva*)



Coast Live Oak (*Quercus agrifolia*)



Monterey Cypress (*Hesperocyparis macrocarpa*)



Bluegum (*Eucalyptus globulus*)

How Many Trees Are There?

ARTICLE

September, 2015

doi:10.1038/nature14967

Mapping tree density at a global scale

T. W. Crowther¹, H. B. Glick², K. B. Covey³, C. Bertigogian⁴, D. S. Maynard⁵, S. M. Thomas⁶, J. R. Smith⁷, G. Hinters⁸, M. C. Duguid⁹, L. Amantini¹⁰, M. N. Tamayo¹¹, W. Lei^{12,13}, C. Salas¹⁴, C. Stant¹⁵, J. Pottor¹⁶, R. Toyani¹⁷, S. Groom^{18,19}, G. Bragg²⁰, S. J. Williams²¹, S. K. Wiser²², M. O. Huber²³, G. M. Hengstedt²⁴, G.-J. Nabuurs²⁵, P. Borchardt²⁶, C.-F. Li²⁷, J. W. Poirier²⁸, M. Fischer^{29,30}, A. Hemp³¹, J. Honecker³², P. Cho³³, A. C. Vibrans³⁴, P. M. Umuahy³⁵, S. L. Piao³⁶, C. W. Rowe³⁷, M. S. Ashton³⁸, P. R. Crane³⁹ & M. A. Bealford

The global extent and distribution of forest trees is central to our understanding of the terrestrial biosphere. We provide the first spatially continuous map of forest tree density at a global scale. This map reveals that the global number of trees is approximately 3.04 trillion, an order of magnitude higher than the previous estimate. Of these trees, approximately 1.39 trillion exist in tropical and subtropical forests, with 0.74 trillion in boreal regions and 0.61 trillion in temperate regions. Biome-level trends in tree density demonstrate the importance of climate and topography in controlling local tree densities at four scales, as well as the overwhelming effect of humans across most of the world. Based on our projected tree densities, we estimate that over 15 billion trees are cut down each year, and the global number of trees has fallen by approximately 46% since the start of human civilization.

| Terrestrial biome (number of ground-sourced density estimates) | Total trees (billions ± 95% CI) |
|--|---------------------------------|
| Boreal forests (n = 8,688) | 749.3 (± 50.1) |
| Deserts (n = 14,637) | 53.0 (± 2.9) |
| Flooded grasslands (n = 271) | 64.6 (± 14.2) |
| Mangroves (n = 21) | 8.2 (± 0.3) |
| Mediterranean forests (n = 16,727) | 53.4 (± 1.2) |
| Montane grasslands (n = 138) | 60.3 (± 24.0) |
| Temperate broadleaf (n = 278,395) | 362.6 (± 2.5) |
| Temperate conifer (n = 85,144) | 150.5 (± 1.3) |
| Temperate grasslands (n = 17,051) | 148.3 (± 4.8) |
| Tropical coniferous (n = 0) | 22.2 (± 0.4) |
| Tropical dry (n = 115) | 156.4 (± 63.4) |
| Tropical grasslands (n = 998) | 318.0 (± 35.5) |
| Tropical moist (n = 5,321) | 739.4 (± 24.3) |
| Tundra (n = 2,268) | 94.9 (± 6.3) |
| n = 429,776 | 3,041.2 (± 96.1) |

3.041 trillion trees total = 398 trees per person worldwide

Each year 15 billion trees cut down and not replaced

6.1 trillion trees before the advent of human civilization.

3.04 trillion trees remain.

1.39T tropical and subtropical 0.61T temperate 0.74T boreal



Journal of Sustainable Forestry > Latest Articles

- ~ 300,000 plant species
- 60,065 tree species
- ~ 1,500 species used in worldwide urban forestry

GlobalTreeSearch: The first complete global database of tree species and country distributions

E. Beech¹, M. Rivers^{2,3}, S. Oldfield⁴, and P. P. Smith⁵

¹Heriot-Watt University, Edinburgh, United Kingdom; ²USDA Forest Service, Pacific Southwest Research Station, Berkeley, California; ³USDA Forest Service, Pacific Southwest Research Station, San Francisco, California; ⁴USDA Forest Service, Pacific Southwest Research Station, San Francisco, California; ⁵USDA Forest Service, Pacific Southwest Research Station, San Francisco, California

ABSTRACT: This article presents, for the first time, an overview of all known tree species by scientific name and country-level distribution, and describes an online database—GlobalTreeSearch—that provides access to this information. Based on our comprehensive analysis of published data sources and expert input, the number of tree species currently known to science is 60,065, representing 29% of all angiosperm and gymnosperm plant species. Nearly half of all tree species (43%) are found in just 10 families, with the 3 most tree-rich families being Leguminosae, Rubiaceae, and Myrtaceae. Geographically, Brazil, Colombia, and Indonesia are the countries with the most tree species. The countries with the most country-endemic tree species reflect broader plant diversity trends (Brazil, Australia, China) or islands where isolation has resulted in speciation (Madagascar, Papua New Guinea, Indonesia). Nearly 38% of all tree species are single-country endemics. Our intention is for GlobalTreeSearch to be used as a tool for monitoring and managing tree species diversity, forests, and carbon stocks at a global, regional, and/or national level, and will also be used as the basis of the Global Tree Assessment, which aims to assess the conservation status of all of the world's tree species by 2020.

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60,065 Total Tree Species

Tree Species in Cultivation ~1.7%

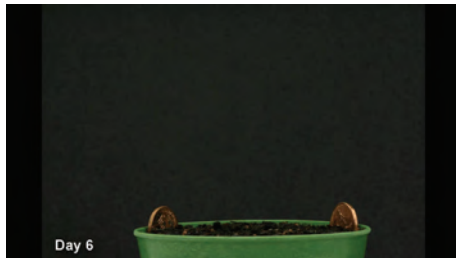
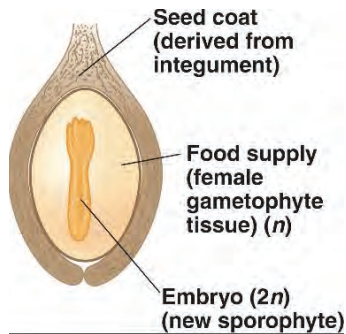
The Beginning of Every Tree



Tree Seeds

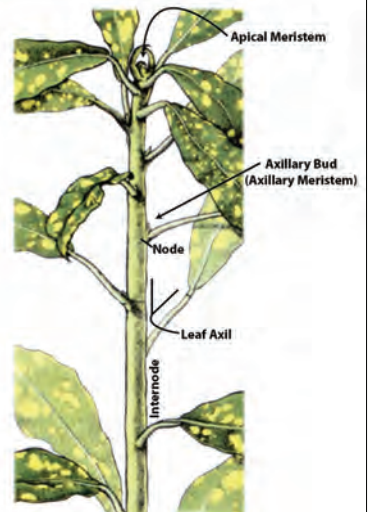
- A seed has 3 parts

- Embryo - made from fusion of sperm and egg
- Nutritive tissue
- Seed coat



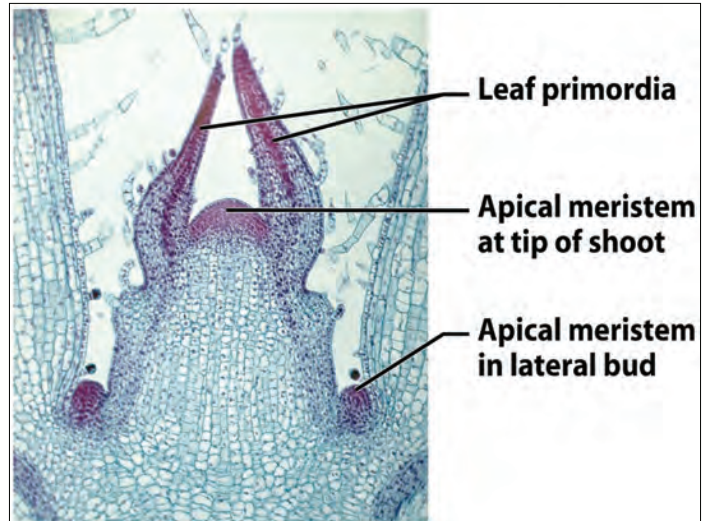
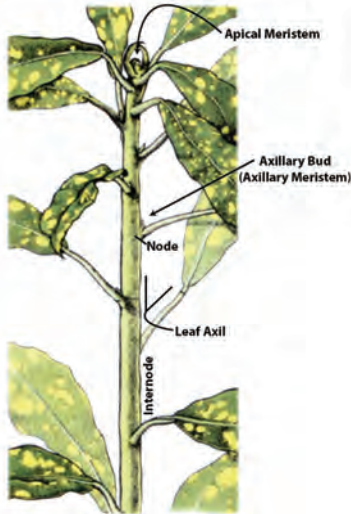
Plant Structure

- Leaves are attached at **nodes**.
- One or more leaves occur at each node.
- **Internodes** are the space between each node.

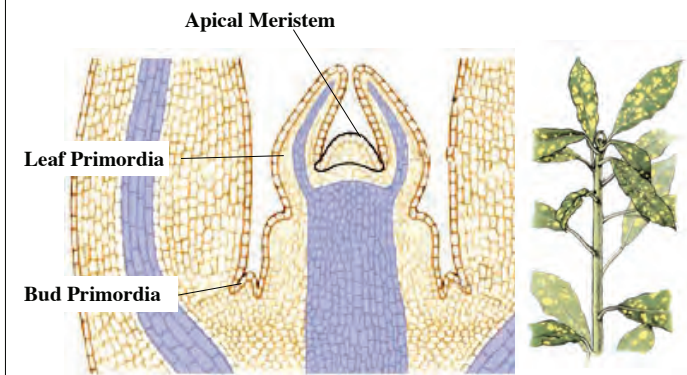


Plant Structure

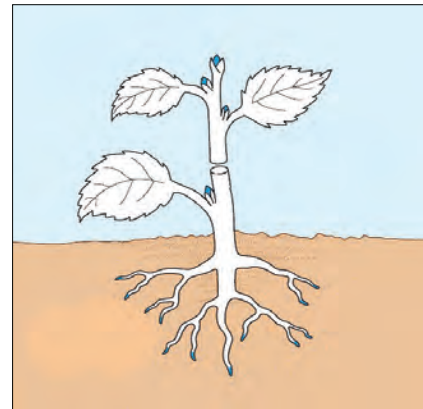
- The **apical meristem** produces tissues that grow into mature stem and leaf tissues.
- A bud (also a meristem) occurs in the axil of each leaf, called the **axillary bud**.
 - Axillary buds grow into new leafy stems or flowers.



Stem, leaves, buds, stem leaves, buds



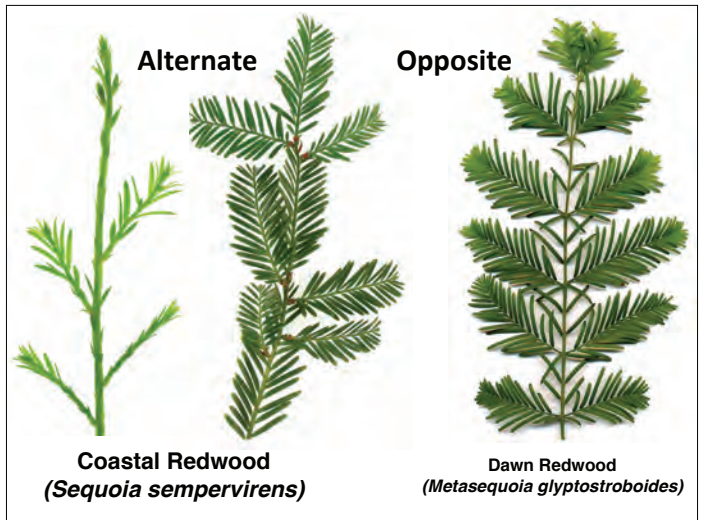
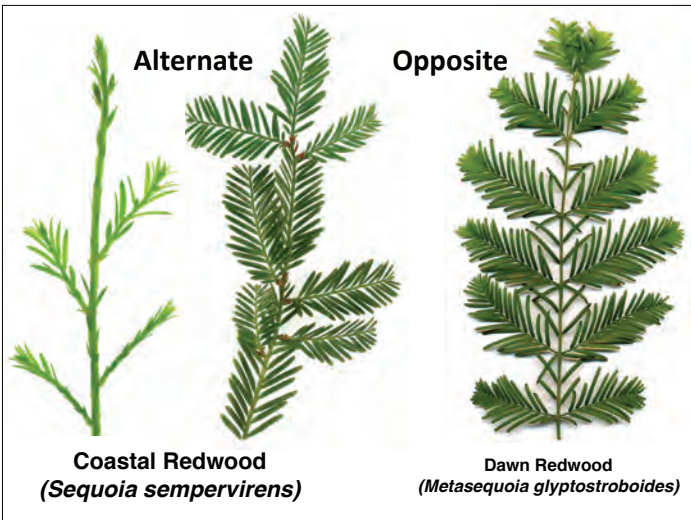
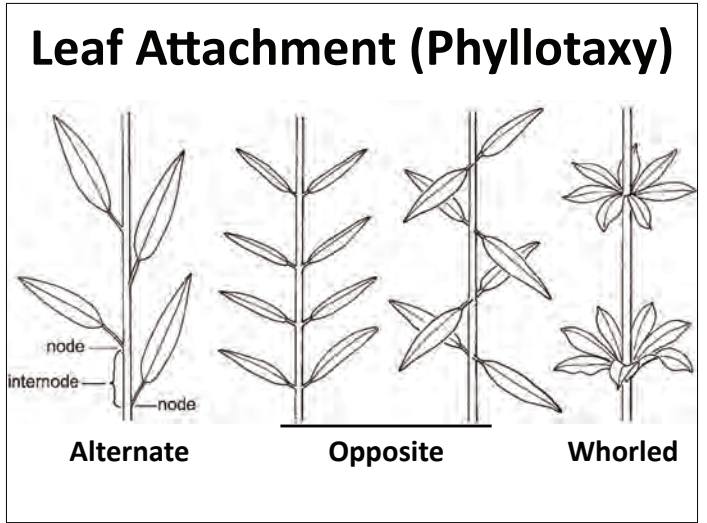
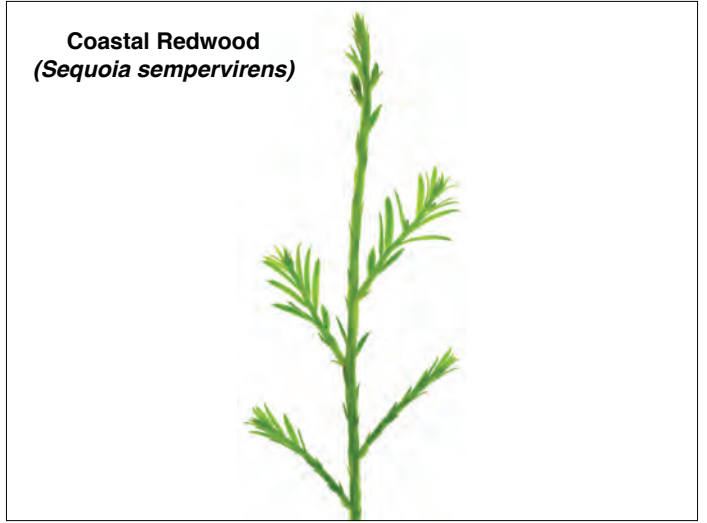
Meristems: where growth occurs

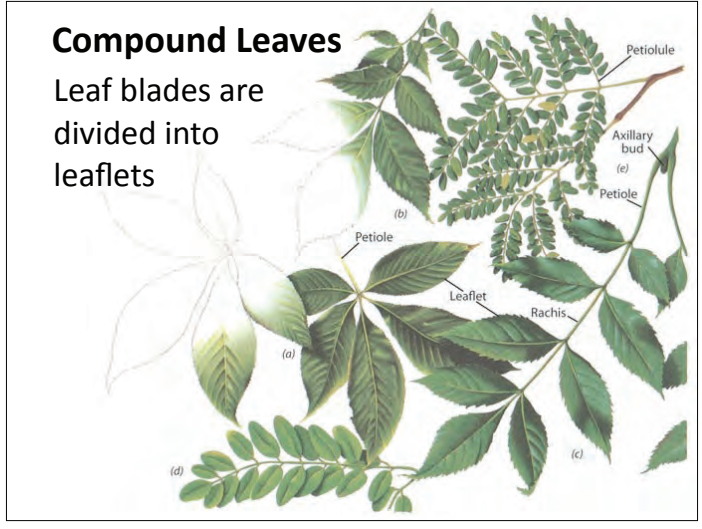
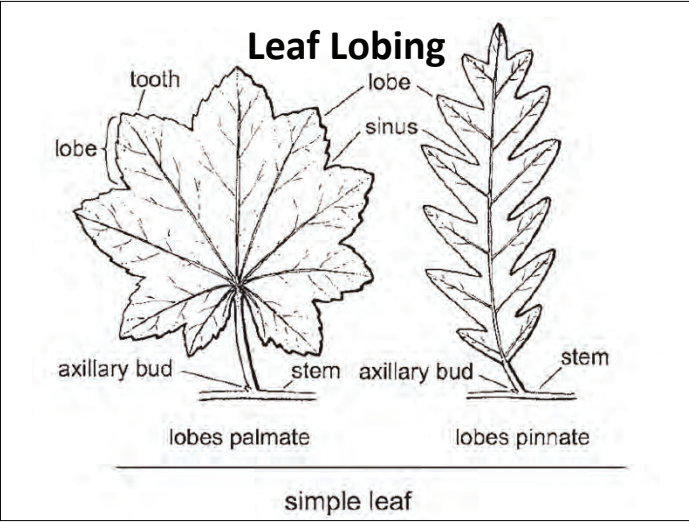
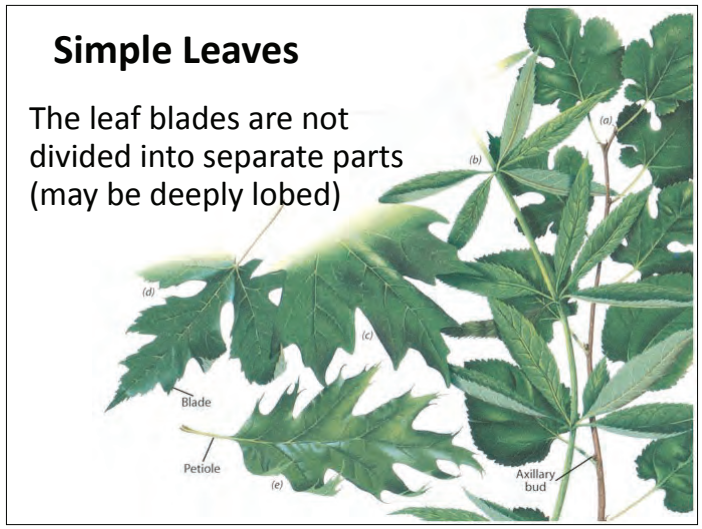
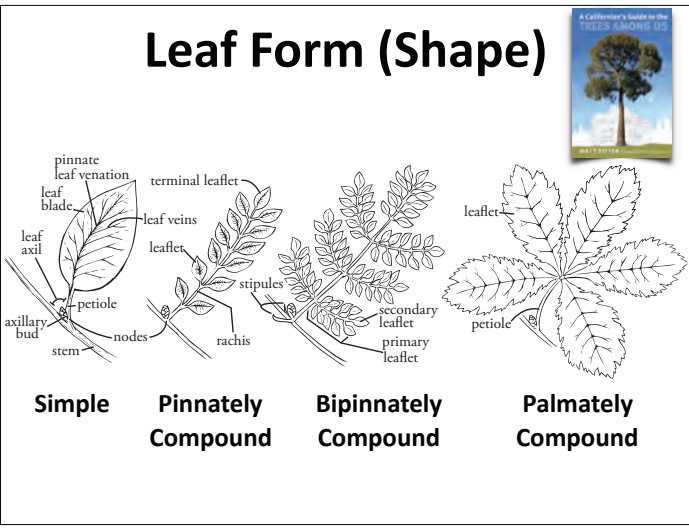
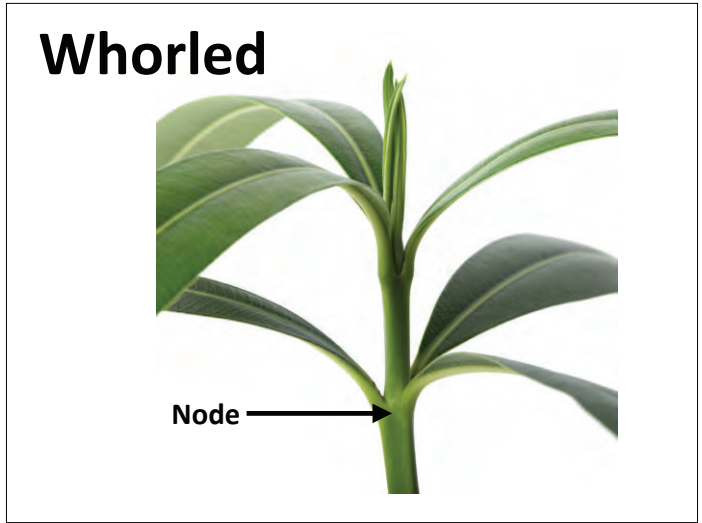
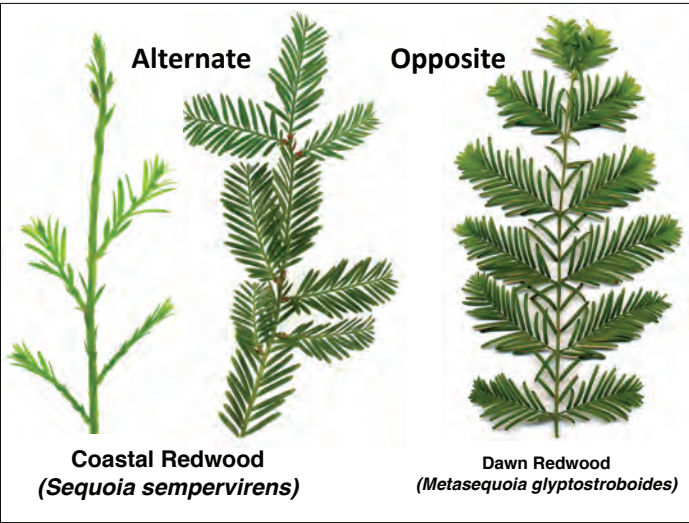


Morphology of a Leaf

- Blade – expanded portion of the leaf
 - Petiole – leaf stalk
 - Stipules – appendages at the base of the petiole
-



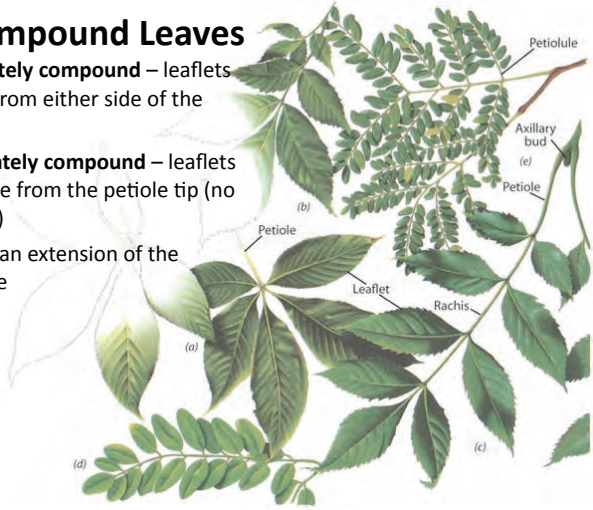




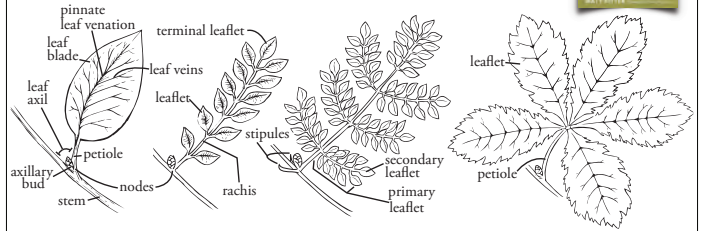
Compound Leaves

1. **Pinnately compound** – leaflets arise from either side of the rachis
2. **Palmately compound** – leaflets diverge from the petiole tip (no rachis)

Rachis – an extension of the petiole



Leaf Form (Shape)



Simple Pinnately Compound Bipinnately Compound Palmately Compound

Oaks have alternate, simple leaves

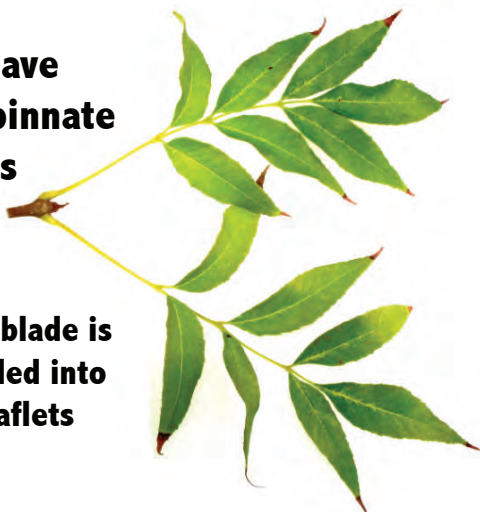


Maples have opposite, simple leaves



Ashes have opposite, pinnate leaves

Leaf blade is divided into leaflets



**Trumpet trees
have opposite,
palmate leaves**



**Acacias have
alternate, bipinnate
leaves**



Sugar Maple



Red Oak



Summary

- Plants are wonderful organisms that carry out complicated chemistry
- Trees are perennial, single-trunked, woody organisms with a raised canopy (or just big plants)
- Everything about the form of a tree is determined by the development of the apical meristem
- Genetically determined characteristics (leaf attachment and leaf shape) are crucial for tree identification

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www.wcisa.net

to register for the next session

April 14th

Introduction to trees, growth, development, leaves, and morphology.

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Trunks, branches, tree form, branching patterns, and shape, and how wood forms

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Tree names, diversity, and why names change

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