

## FOR 274: Forest Measurements



### Where We Measure

- North American Biomes
- Forest Descriptions

Principal source: Barbour and Billings (2000)

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## North American Biomes: Introduction

A biome is a large geographic area with similar or unique plants, soils, animals, and climate.



Many different biome definitions exist. We will briefly cover:

- Arctic Tundra and Polar Desert Biome
- The Taiga and Boreal Forest
  - Alaskan Taiga
  - Cordillera (northern Rockies)
  - The Interior Forest
  - Canadian Shield
  - Gaspé-Maritime
  - Labrador-Ungava
  - Northward Forest Border
- Rocky Mountain Forests and Meadows
- Pacific Northwest Forests

See FOR 320 for more detail.

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## Arctic Tundra and Polar Desert Biome

### Fast Facts:

- Arctic is generally considered to be the area above the climatic limit of boreal forest and treeline (although small pockets of trees present).
- 20% of North America is contained in this biome (Canada: 2.5M km<sup>2</sup>, Alaska: 0.3 M km<sup>2</sup>, and Greenland: 2.0 M km<sup>2</sup>).



Tundra: vegetation ranging from tall shrubs (<5m) to graminoid-moss.

Vegetation cover: 80-100%

Arctic divided into Low Arctic (mainly tundra) and High (mainly polar deserts) Arctic.

Barbour and Billings (2000) and National Geographic (image)

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Barbour and Billings (2000) and National Geographic (image)

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## The Taiga and Boreal Forest

### Fast Facts:

- The North American boreal forest is a continuous high latitude belt of vegetation. This coniferous forest (or taiga [Russian]) is part of a larger circumpolar boreal forest.
- Taiga: coniferous northern forest with only the non-conifer species *Betula* and *Populus* generally present
- Width in places spans 10° of latitude.



The North American boreal forest is usually divided into 7 regions

- Northward Forest Border
- Alaskan Taiga
- Cordillera (northern Rockies)
- The Interior Forest
- Canadian Shield
- Gaspé-Maritime
- Labrador-Ungava

Barbour and Billings (2000) and National Geographic (image)

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## The Taiga and Boreal Forest: Northwest Forest Border

### Fast Facts:

- Sometimes called the continental Arctic treeline or the northern tree limit. Dominated by *Picea glauca* [white spruce] and *Picea mariana* [black spruce]. *Larix laricina* [tamarack] is found around bogs.



Barbour and Billings (2000)

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### The Taiga and Boreal Forest: Alaskan Taiga

#### Fast Facts:

- Upland and lowland forests dominated by *Picea glauca* [white spruce], *Picea mariana* [black spruce], *Betula papyrifera* [paper birch], and *Populus tremuloides* [quaking aspen]



Barbour and Billings (2000) and NRCS (images)

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### The Taiga and Boreal Forest: Cordillera

#### Fast Facts:

- This region spans across the Mackenzie and Richardson Mountains of the Yukon and Northwest Territories



Barbour and Billings (2000)

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### The Taiga and Boreal Forest: The Interior Forest

#### Fast Facts:

- Mainly comprised of *Picea mariana* [black spruce], *Picea glauca* [white spruce], *Pinus banksiana* [jack pine], *Pinus Contorta* var. *latifolia* [lodgepole pine], *Populus tremuloides* [quaking aspen] and *Populus balsamifera* [balsam poplar]



Barbour and Billings (2000) and NRCS (images)

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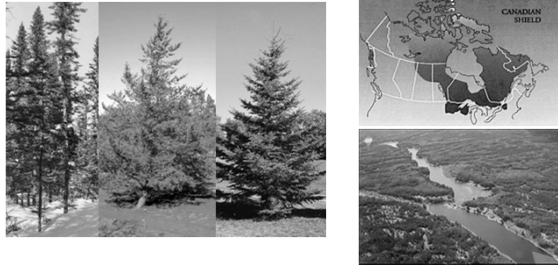
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### The Taiga and Boreal Forest: Canadian Shield

**Fast Facts:**

- Species composition shifts from north to south. *Picea mariana* [black spruce] is dominant in the north with *Picea glauca* [white spruce] and *Pinus banksiana* [jack pine] more dominant in the south.



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### The Taiga and Boreal Forest: Gaspé-Maritime

**Fast Facts:**

- Boreal forests found in eastern Canada. Variable mixture of different compositions. Single species stands of *Picea mariana* [black spruce] is rare. *Abies balsamea* (balsam fir) is dominant.



Barbour and Billings (2000) and NRCS (images)

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### The Taiga and Boreal Forest: Labrador-Ungava

**Fast Facts:**

- Dominated by *Picea glauca* [white spruce] and *Picea mariana* [black spruce]. Other common species include: *Abies balsamea* (balsam fir), *Larix laricina* [tamarack], *Betula papyrifera* [paper birch], *Populus balsamifera* [balsam poplar], *Pinus banksiana* [jack pine] and *Thuja occidentalis* [white cedar]



Barbour and Billings (2000) and NRCS (images)

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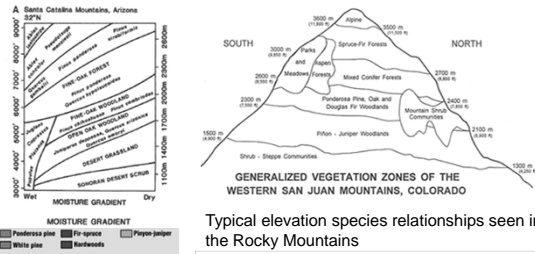
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## Rocky Mountain Forests and Meadows

### Fast Facts:

- Rocky Mountain forests extend from 65° latitude (Yukon) to 19° latitude (Mexico).
- Although latitude variation of species - major vegetation types occupy elevation zones. Conifers are dominant.




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## Rocky Mountain Forests and Meadows



- The major vegetation types of the Rocky Mountains are:
- Riparian and Canyon Forests
  - Pygmy Conifer Woodland
  - Ponderosa Pine Woodland
  - Pine-Oak Woodland
  - Douglas Fir Forest
  - Cascadian Forests
  - Montane Seral Forests
  - Spruce-Fir Forests
  - Subalpine White Fir Forests
  - Treeline Vegetation
  - Meadows and Parks
- See FOR 320 for more detail.

Barbour and Billings (2000)

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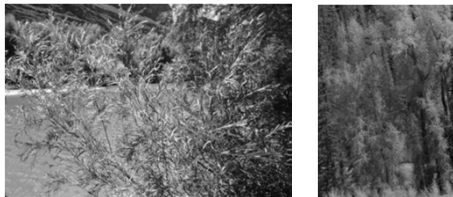
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## Rocky Mountains: Riparian and Canyon Forests

### Fast Facts:

- These are found at low elevations and are characterized by broadleaf deciduous trees and shrubs.
- *Salix spp.* [willows] and *Populus augustifolia* and similar [i.e., Cottonwoods] can be found along riparian channels.



Barbour and Billings (2000), plants.usda.gov

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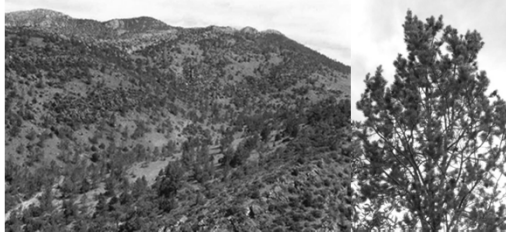
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### Rocky Mountains: Pygmy Conifer Woodland

**Fast Facts:**

- Usually the transition zone between montane forests and grasslands / deserts.
- *Junipers* and *pinyon pines* are dominant in these landscapes. These are low height trees (<10m) that look like shrubs



Barbour and Billings (2000), tarleton.edu

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### Rocky Mountains: Ponderosa Pine Woodland

**Fast Facts:**

- Range extends from Canada to Mexico.
- North of Wyoming and East of the continental divide, the woodland mainly only exists on the eastern edge of the Rocky Mountains (exceptions include Black Hills).
- Prior to fire suppression, woodlands were savannah-like; following suppression its common to have more mixed stands.



Barbour and Billings (2000)

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### Rocky Mountains: Pine-Oak Woodland

**Fast Facts:**

- In Arizona and at lower latitudes, *Pinus ponderosa* woodlands are replaced by pine-oak woodlands
- Pine-oak woodlands are diverse ecosystems. Leopold (1950) wrote that 112 species of *Quercus spp.* [oak] and 39 species of *Pinus spp.* [pine] could be found in the Mexican Plateau. Fule and Covington (1996) found 20 tree species within a few hectares of western Mexico.



Barbour and Billings (2000)

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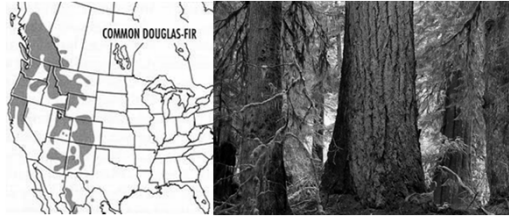
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### Rocky Mountains: Douglas-fir Forest

**Fast Facts:**

- Range extends across the entire montane zone from Canada to Mexico. As the name suggests, *Pseudotsuga menziesii* [Douglas-fir] is dominant.
- Often associated with shade-intolerant seral (intermediate) species like *Pinus contorta* [lodgepole pine], *Pinus ponderosa* [ponderosa pine], and *Larix occidentalis* [western larch]



Barbour and Billings (2000), NPS

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### Rocky Mountains: Cascadian Forests

**Fast Facts:**

- Found in the Cascade Mountains in Oregon, Washington, and British Columbia. Also found in the northern Idaho Panhandle and edge of Glacier NP.
- Airstream from the Pacific breaks through the Cascades providing heavy rain with moderate temperatures to the western Rocky Mountain slopes.
- Climax species include: *Thuja plicata* [western red-cedar], *Tsuga heterophylla* [western hemlock], *Abies grandis* [grand fir], *Taxus brevifolia* [Pacific yew], *Tsuga mertensiana* [mountain hemlock], and *Larix lyallii* [subalpine larch]



Barbour and Billings (2000), plants.usda.gov

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### Rocky Mountains: Montane Seral Forests

**Fast Facts:**

- Frequent fires can enable fire adapted seral species to dominate a landscape and produce single species stands. Examples: *Pinus contorta* [lodgepole pine] and *Populus tremuloides* [quaking aspen]
- *Populus tremuloides* occurs across the whole Rocky Mountain region and beyond. However the species is in broad decline throughout the region – the reason is not known (but there are lots of guesses)



Barbour and Billings (2000), wikipedia

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### Rocky Mountains: Spruce-Fir Forests

**Fast Facts:**

- These forests exhibit similar flora to the boreal conifer forests. Dominant species include *Picea engelmannii* [Engelmann spruce] and *Abies lasiocarpa* [subalpine fir].
- Above 54°N latitude *Picea engelmannii* [Engelmann spruce] is replaced by *Picea glauca* [white spruce]. (Exception is in Black Hills, where *Picea glauca* is present).
- Typically few herbaceous species are present. Moss is common.



Barbour and Billings (2000)

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### Rocky Mountains: Subalpine White Fir Forests

**Fast Facts:**

- Exposed dry ridges in the subalpine zone support forests comprised of the white pine subgroup: *Pinus* subgenus *Haploxylon*, which are tolerant of poor environmental conditions. At lower elevations, white pine can be out-competed by *Picea* and *Abies* species.
- Central Rockies have *Pinus albicaulis* [whitebark pine]. The Southern Rockies are dominated by *Pinus aristata* [bristlecone pine].



Barbour and Billings (2000)

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### Rocky Mountains: Treeline Vegetation

**Fast Facts:**

- As you move south from the southern Yukon, the elevation of the treeline in the Rocky Mountains increases by 100m per 1° of latitude
  - Southern Yukon: 1400m treeline; Northern Mexico: 3600m treeline
- *Picea engelmannii* [Engelmann spruce], *Abies grandis* [grand fir], and *Pinus flexilis* [limber pine] are dominant.
- Snow depth, snow duration, and wind are important for growth.
- Standing dead trees are common as wood decomposition rates are low.



Limber Pine

Engelmann Spruce

Barbour and Billings (2000), <https://alpine.ucmerced.edu>

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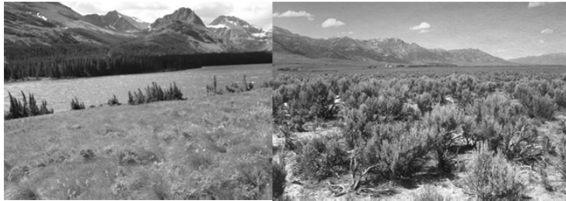
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### Rocky Mountains: Meadows and Parks

**Fast Facts:**

- Treeless areas often dominated by grasses, sedges, forbs, and sage.



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### Pacific Northwest Forests

**Fast Facts:**

- These forests extend 20° latitude from Alaska to northern California.
- They are within 100 miles of the Pacific Ocean and the mild maritime climate results in large forests dominated by evergreen conifers.



**Dominant species include:**

- *Pseudotsuga menziesii* [Douglas-fir]
- *Tsuga heterophylla* [western hemlock]
- *Thuja plicata* [western red cedar]
- *Picea sitchensis* [Sitka spruce]
- *Sequoia sempervirens* [coast redwood]

Barbour and Billings (2000)

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### North American Biomes: Summary

Question: What are the main drivers that control where these different species occur?

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### North American Biomes: Summary

The occurrence of the different vegetation in the biomes are highly controlled by climatic and topographic variables



#### High Arctic

Growing season: 1.5-2.5 months  
Mean July temp: 3-6 °C  
Annual net radiation: 300 MJ m<sup>-2</sup> yr<sup>-1</sup>  
Mean annual precip: 50-200 mm

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### North American Biomes: Summary

The occurrence of the different vegetation in the biomes are highly controlled by climatic and topographic variables



#### Low Arctic

Growing season: 3-4 months  
Mean July temp: 8-12 °C  
Annual net radiation: 670 MJ m<sup>-2</sup> yr<sup>-1</sup>  
Mean annual precip: 100-700 mm

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### North American Biomes: Summary

The occurrence of the different vegetation in the biomes are highly controlled by climatic and topographic variables



#### The Taiga and Boreal Forests – Canadian Shield

Growing season: 4 months  
Mean July temp: 13°C  
Annual net radiation:  
Mean annual precip: 400-1600 mm

Glaciers have caused the draining in these systems to be very poor leading to lowland marshes and bogs

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### North American Biomes: Summary

The occurrence of the different vegetation in the biomes are highly controlled by climatic and topographic variables



#### The Taiga and Boreal Forests - Labrador

Growing season: 2-3 months  
Mean July temp: 7.5 °C  
Annual net radiation:  
Mean annual precip: 500 mm

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### North American Biomes: Summary

The occurrence of the different vegetation in the biomes are highly controlled by climatic and topographic variables



#### Rocky Mountain Forests and Grasslands

Growing season: 5-7 months  
Mean July temp: 18 °C (1603m)  
Annual net radiation:  
Mean annual precip: 400-1000 mm

Disturbances are widespread in this biome (insects, fire, humans, etc)

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### Forest Descriptions: Introduction

The forests we measure are usually described by common terminology.

- Stand: A contiguous group of trees sufficiently uniform in some way (age distribution, composition, structure) and growing on a site of sufficiently uniform quality, to be a distinguishable unit
- Cohort: A distinct aggregation of trees originating from a single natural event or regeneration activity, or a grouping of trees
- Rotation: The period of time required for an entire stand to be successfully established, grown, harvested, and re-established.
- Succession: A series of dynamic changes by which organisms succeed one another through a series of plant community (seral) stages leading to potential natural community or climax
- Stand Structure: Often described by the 4 stage Oliver and Larson (OL) model of stand initiation, stem exclusion, understory re-initiation, and old growth.

Definitions from: [http://oak.snr.missouri.edu/silviculture/silviculture\\_terminology.htm](http://oak.snr.missouri.edu/silviculture/silviculture_terminology.htm)  
Free online silviculture book:  
<http://forestry.sfasu.edu/faculty/jstovall/silviculture/index.php/silviculture-textbook>

O'Hara et al (1996), <http://forestry.sfasu.edu/faculty/jstovall/silviculture>

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### Forest Descriptions: Stand Initiation

**Fast Facts:**

- Generally produced following a stand-replacement disturbance.
- At the end of the stand initiation phase the growing space is completely occupied.
- Generally one cohort with a single canopy stratum, although may have gaps
- Cohort is young and trees per acre generally very high.
- Live crown ratios ~ 100%.
- At start no nutrient or growth limitations present.



O'Hara et al (1996), <http://forestry.sfasu.edu/faculty/jstovall/silviculture>

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### Forest Descriptions: Stem Exclusion

**Fast Facts:**

- The young / large trees per acre cohort will reach a point where no new individuals establish and some of the older trees die.
- In Open Stem Exclusion competition by sub-canopy species causes breaks in the dominant species canopy cover by limiting the establishment of new dominant trees. In Closed Stem Exclusion new trees are generally limited by lack of light due to near complete canopy closure.
- Live crown ratios drop below 100% and understory becomes very shaded.
- Mortality is driven by density and nutrient limitations.



O'Hara et al (1996), <http://forestry.sfasu.edu/faculty/jstovall/silviculture>

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### Forest Descriptions: Understory Re-initiation

**Fast Facts:**

- As the stand growth continues, a new cohort initiates in the understory as gaps appear in the canopy of the older cohort. These gaps occur from density independent mortality (e.g., fire, insects, wind throw, etc.).
- Multi-story stand, with overstory of snags, poles, or large trees and understory of seedlings and saplings.
- Snags and large woody debris often present.
- Shade tolerant species become established.



O'Hara et al (1996), <http://forestry.sfasu.edu/faculty/jstovall/silviculture>

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### Forest Descriptions: Old Growth

**Fast Facts:**

- Late in the lifecycle of a stand, old trees will die off allowing some trees in a younger cohort to also occupy the overstory
- Live trees with large branches and large diameters present
- Large amounts of snags and large woody debris present
- Disease and rots present in many trees



O'Hara et al (1996), <http://forestry.sfasu.edu/faculty/jstovall/silviculture>

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