Western Conifer Forests

Practical Silviculture - ESRM 323

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Western Conifer Forests

- Major forest formations
- Western conifer forest overview
  - Pacific Coastal complex
  - Rocky Mtn. complex
  - Sierra Nevadan complex

Major Forest Formations

- Original forest vegetation (7)
  - Pacific Coastal complex
  - Rocky Mountain complex
  - Sierra Nevadan complex
  - Southwestern broad-leafed woodland
  - Boreal forest
  - Eastern deciduous forest
  - Sub-tropical forest

Major Forest Formations

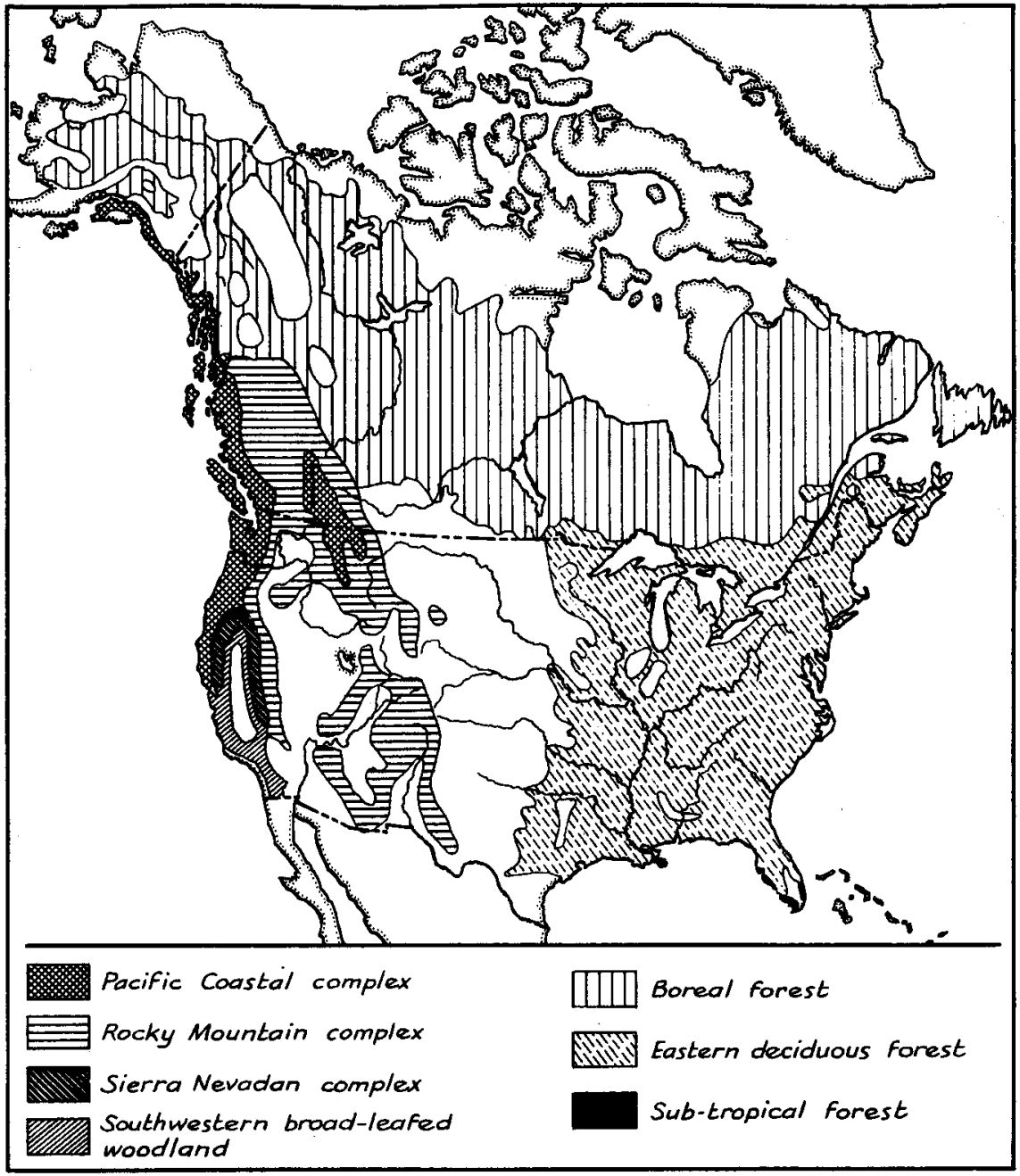


Figure 1-5. *The major formations of the original forest vegetation of the United States and Canada. (Adapted from maps from the USDA For. Serv. and from Rowe, 1959.)*

Pacific Northwest Region

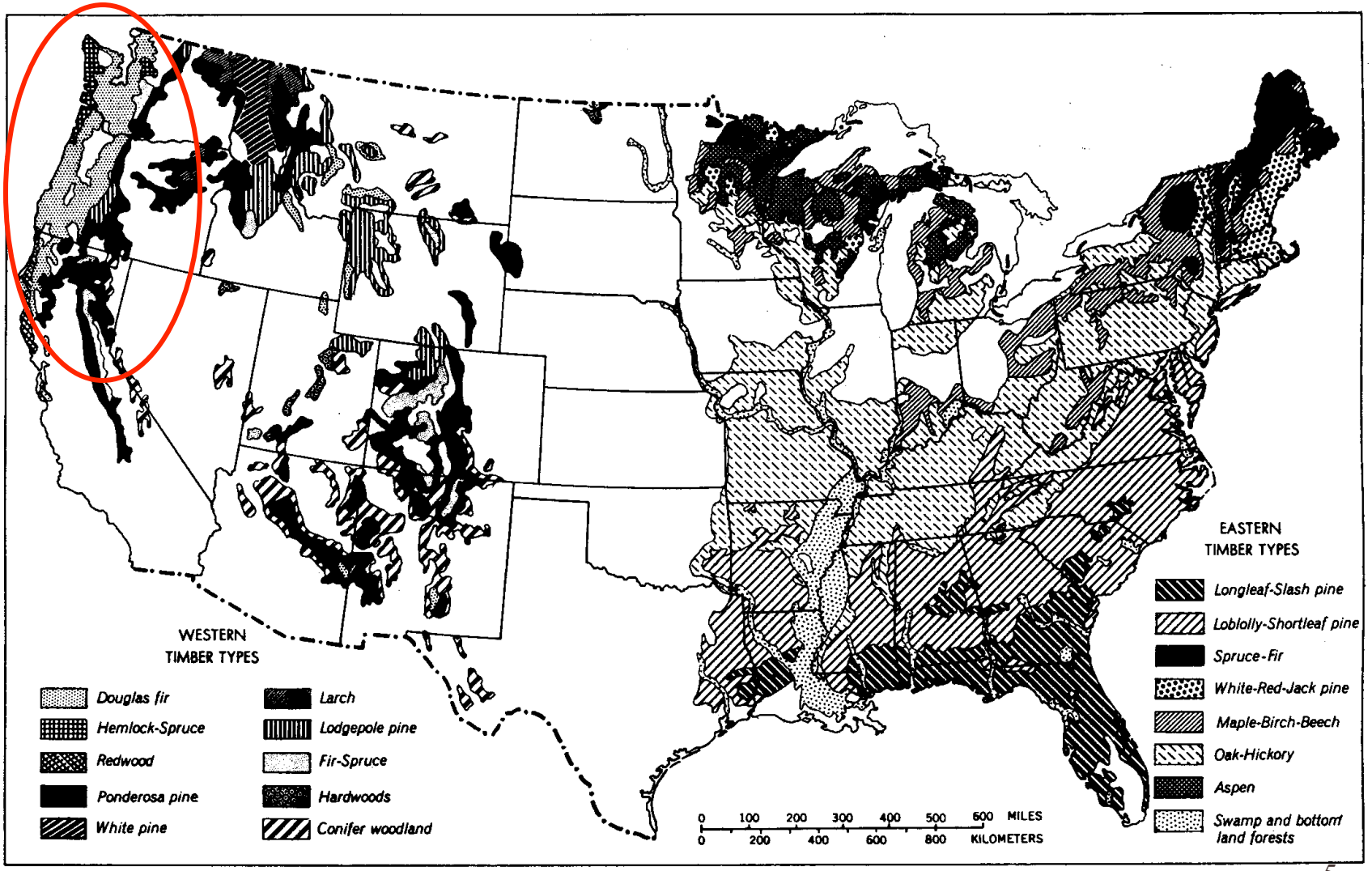


Figure 1-4. *Present distribution of major forest types in the conterminous United States. The different types are designated in terms of the species that make up most of the timber volume. (Adapted from Haden-Guest et al., 1956; based on a map prepared by the USDA Forest Serv., 1949.)*

Western Conifer Forest

- Pacific coastal complex
- Rocky Mountain complex
- Sierra-Nevadan complex

Western Conifer Forest

- Pacific coastal complex
  - West of crest of Cascade Range & Rockies
  - Northern end is south of Alaska Range
  - Coast redwood belt extends southward along CA coast
  - Principal species: Sitka spruce, western hemlock, western red cedar, Douglas-fir
  - Occupies most humid region of western N. America

Western Conifer Forest

- Rocky Mountain complex
  - Forested foothills of eastern Cascades and Sierra Nevada to Great Plains
  - North to Yukon Territory, south to Mexico
  - Principal species: ponderosa pine, Douglas-fir, Engelmann spruce, subalpine fir, lodgepole pine
  - Only species confined to the area is Colorado blue spruce

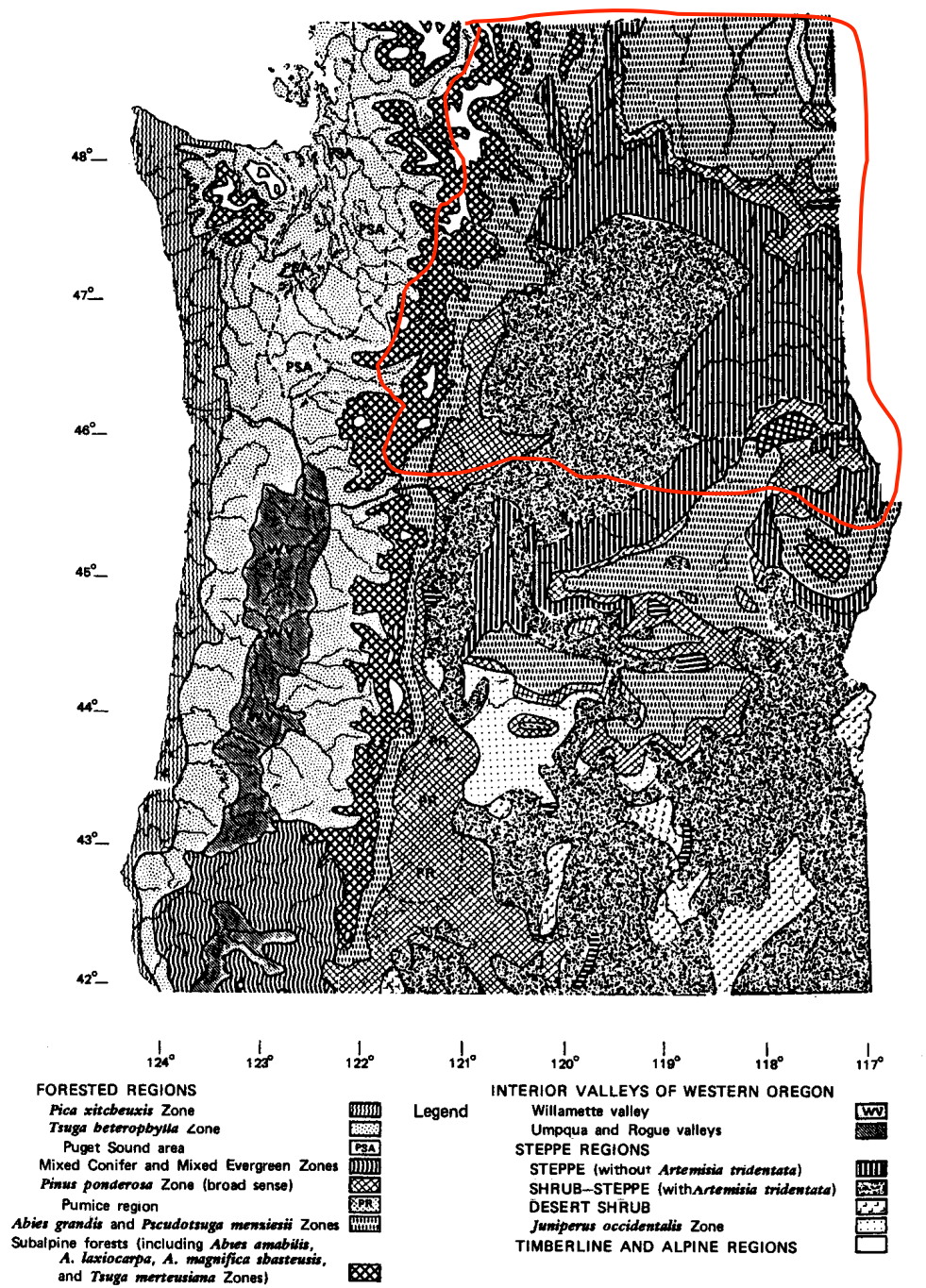


Figure 11-2. *Generalized vegetation map of Oregon and Washington. (From Franklin and Dyrness, 1973.)*

PNW Forests

- Broad forest zones
- From west to east:
  - Coastal Sitka spruce-western hemlock
  - Coastal and inland Douglas-fir
  - Higher elevation mixed-conifer, true fir and mountain hemlock (Cascade Range)
  - Open Ponderosa pine-Western juniper stands
  - Mixed fir-pine-larch (northern Rocky Mountain complex)

East-Side Type Groups of Washington

Physiography

- *Cascade mountains (~ 2700 m)*
- *Columbia Plateau*
  - *rolling topography*
  - *dissected by river canyons (drained by the Columbia River)*

Soils

Spodosols - Alfisols - Mollisols

high elevations-wet low elevations-arid

East-Side Type Groups of Washington

Climate

- Cascade Range ⇨ barrier to eastbound moisture-laden air masses.
- Short and dry summers
- Average precip: 20 inches (as little as 5 – 7”)
- Very cold winters concentrate most of the annual precipitation (snow), ranging up to 30 inches

History and current state of the forests

- ✓ *East-to-west movement of agriculture, farmers and ranchers required wood and more open areas for grazing.*
- ✓ *As a wood-use industry developed, forest utilization progressed to higher elevations.*
- ✓ *Reflect the impacts of many decades of aggressive fire suppression and selective harvesting.*

History and current state of the forests (cont.)

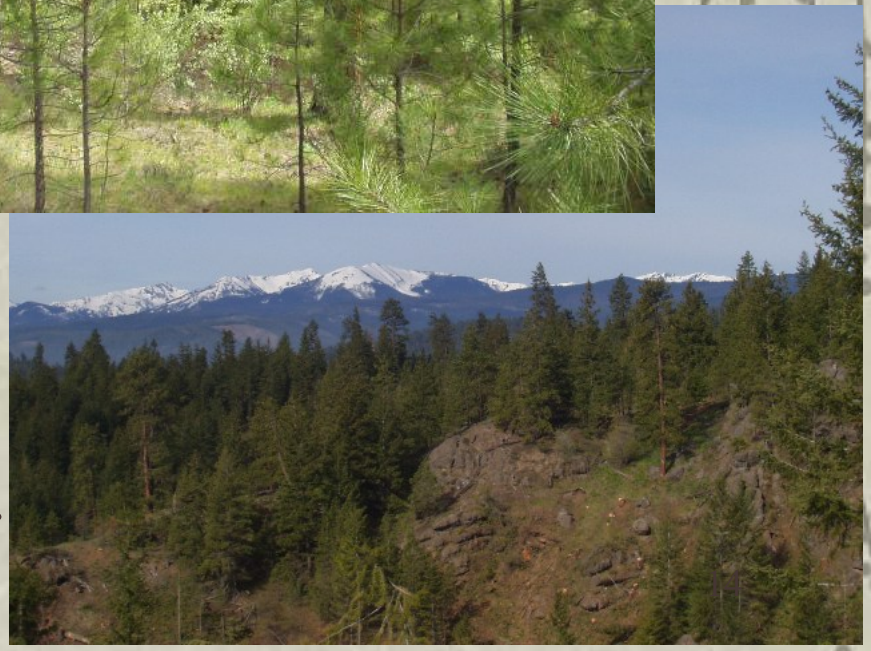
- ✓ *Before the arrival of the European settlers, stands were, in general, very open and composed primarily by shade-intolerant species reflecting frequent low-intensity fires.*
- ✓ *Nowadays, stand structures and landscapes reflect increasing stand density, invasion of more shade tolerant species, and reduced spatial diversity of age classes.*
- ✓ *Led to stressed stands with great susceptibility to insect outbreaks, mortality, and higher-intensity, large-scale fires.*

East-Side Type Groups of Washington

True Fir-
Mountain hemlock

Northwestern Ponderosa Pine

Mixed
Pine-Fir



True Fir-Mountain hemlock

- Forest zones
  - Abies lasiocarpa / Tsuga mertensiana
  - Tsuga heterophylla / Abies amabilis (NW Washington)
- Frequent low-intensity fires, catastrophic replacement ~ 400 yr
- Fire-resistant species (LAOC, PSME, PIPO) form somewhat clumpy arrangements.
- Stocking guides: 50 – 75 % of normality will exhibit growth rates between 50 – 250 ft^3/acre/yr.
- Presence of both shade-intolerant (PIPO, PIMO, PICO, LAOC, ABPR) and relatively shade-tolerant (PSME, ABGR) species.

True Fir-Mountain hemlock

- Sub-alpine fir (very tolerant)

True Fir-Mountain hemlock

- Mountain hemlock (moderately tolerant)

True fir – Mountain hemlock - Cultural Practices

- Mix of species ⇨ flexibility in designing silvicultural systems
- Even-aged systems may be used
  - Shelterwood method and small clearcuts (< 20 acres) most consistently successful regen methods
  - Larger clearcuts are used where artificial regen methods have proven effective
  - Aspect, slope, species
- Uneven-aged systems may be used
  - On extremely severe sites
  - Where maintenance of continuous canopy is desired (recreation areas, etc.)

East-Side Type Groups of Washington

Mixed Pine-Fir

Mixed Pine-Fir forests

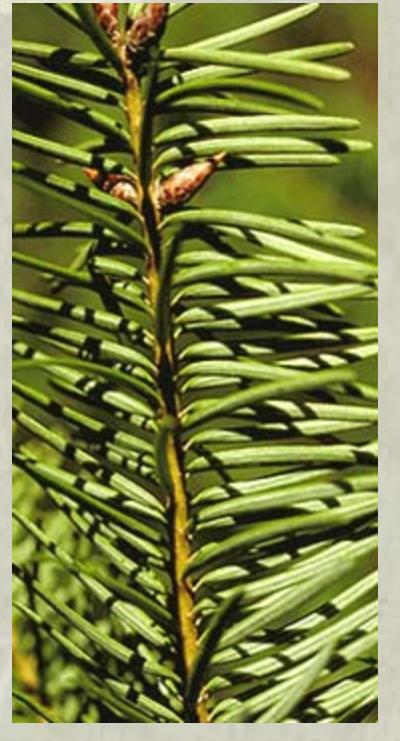
- Forest zones
  - Abies grandis
  - Pseudotsuga menziesii
- Frequent, low-intensity fires
- Fire-resistant species (PIPO, LAOC, PSME) form somewhat clumpy arrangements.
- Growth rates: 50 – 200 ft^3/acre/yr.
- Stocking guides: 50 – 75 % of normality
- Presence of both shade-intolerant (PIPO, PICO, LAOC) and relatively shade-tolerant (PSME, ABGR) species.

Mixed Pine-Fir forests

- Grand fir (moderately tolerant)

Mixed Pine-Fir forests

- Douglas-fir (moderately intolerant)



Mixed Pine-Fir forests

- Lodgepole pine (intolerant)






Mixed Pine-Fir forests - Cultural Practices

- Mix of species ⇨ flexibility in designing silvicultural systems
- Short term ⇨ restore vigor of unhealthy stands.
- Long term ⇨ reducing risk to health-related problems.
- Clearcut w/planting (shifts patchy, degraded stands to more uniform & healthy)
  - Slope, aspect, species
- Some shelterwood and uneven-aged management (more socially acceptable, less soil movement on steep ground, slows unwanted understory)
  - Slope, aspect, health, animal damage

Mixed Pine-Fir forests - Cultural Practices

- Thinning
  - Highest priority: dense stands of LAOC, PICO, PIPO
  - Thin from below, maintaining mixtures
- Water yield
  - Best snow-pack from patch cuts: diameters ranging from 5 to 8 times height of surrounding trees, spaced apart the same
- Big game & livestock habitat
  - Optimized as with water yield: cleared patches provide forage for elk, deer, cattle; adjacent stands provide cover
- Aesthetics
  - Big old growth ponderosa pine

East-Side Type Groups of Washington

Northwestern Ponderosa Pine

Ponderosa pine forests

- Forest zones
  - Pinus ponderosa (2,000 to 4,000 ft. climax at low elev.)
- Frequent, low-intensity fires (~ 5 yr interval) = highly fire-resistant species
- Open, park-like pure stands (even and uneven-aged) in clumpy arrangement.
- Growth rates: 10-80 ft^3/acre/yr.
- Stocking guides: max. of 75 % of Normality
- Rotation: variable (80-140 yrs.)
- Also present: PSME, PICO, LAOC, ABGR.

Ponderosa pine forests

- Ponderosa pine (very intolerant)

Ponderosa pine forests

- Western larch (intolerant)

Ponderosa pine forests - Cultural Practices

- Objectives
  - Short term ⇨ reduced density & competition. Twofold: growth & fire risk.
  - Long term ⇨ reducing risk to health-related problems (insect outbreaks).
- Even-aged: Clearcut w/planting
  - Unit size: 20 to 40 acres
  - Site preparation (seedbed and comp.vege.), key issue in water-limited sites.
- Uneven-aged management (group-selection system, some single-tree), shelterwood (two-storied stands).
  - Stocking level control; PIPO releases up to at least 80 yr.
  - Overstory trees are sensitive to understory

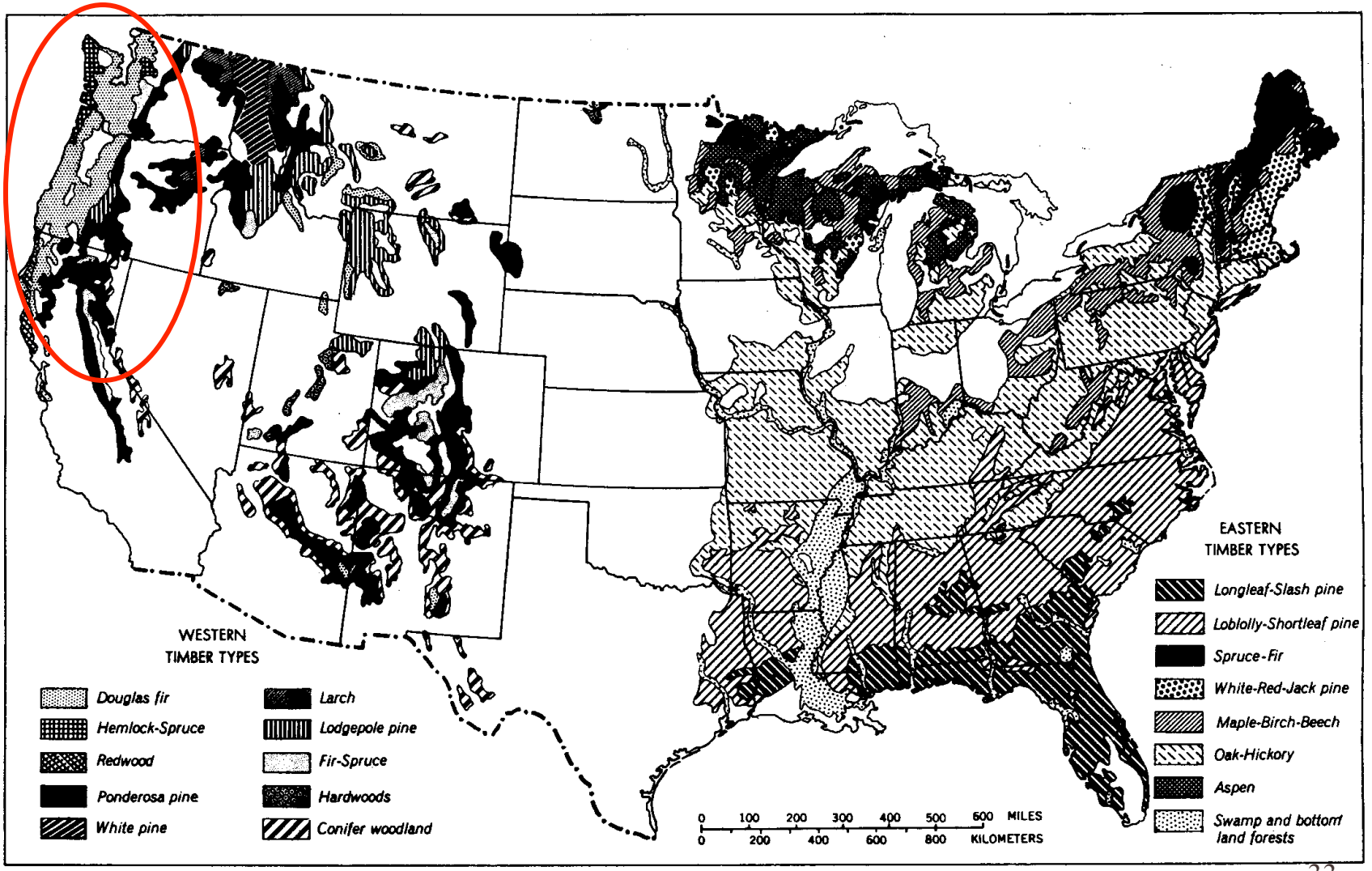
Summary - Key Silvicultural Issues

- ✓ *Fire suppression, selective harvesting, and severe drought have resulted in forest health problems over large areas.*
- ✓ *Greater dominance by more shade-tolerant species and increasing stand biomass have contributed to outbreaks of defoliating insects and bark beetles.*
- ✓ *Mortality and severe fires.*
- ✓ *Key management points: species composition, density and biomass, and reforestation of impacted areas.*

Summary - Key Silvicultural Issues

- ✓ *Thinning and reintroduction of prescribed fire are proposed to recreate historical mosaic of stands, reduce biomass (shade-tolerant understory), and increase vigor of residual overstory trees.*
- ✓ *Artificial regeneration may be required in some situations to ensure more insect-resistant and shade-intolerant species.*
- ✓ *Without site preparation, natural recovery process will be difficult and favor perpetuation of shade-tolerant species.*

Pacific Northwest Region



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Western Conifer Forest

- Sierra Nevadan complex
  - Western slopes of the Sierra Nevada and of the Oregon Cascades
  - Characterized by very heavy winter precipitation, long dry summers, Alfisols
  - Species confined to area: sugar pine, Jeffrey pine, incense-cedar, CA red fir, white fir
  - Ponderosa pine is present & throughout West
  - Intermingles with Pacific coastal complex to north

Sierra Nevadan complex

- Physiography:
  - Enormous tilted fault block
  - Massive granitic outcroppings
- Three major forest zones
  - Lower montane: 1000 to 6000 ft in north, 4000 to 7000 in south; ponderosa pine, Digger pine
  - Upper montane: 6000 to 9000 ft, dep. on lat.; CA red fir, Jeffrey pine, lodgepole pine
  - Subalpine: 8000 to 10000 ft in north, 9500 to 12000 ft in south; mountain hemlock, w. white pine, whitebark, foxtail, limber pines

Sierra Nevadan Complex

Sierra Nevadan complex

- Geology and soils
  - Granitic, metamorphic, and old volcanic in Northern Sierras
  - Conifer growth influenced by depth, texture, permeability, chemical characteristics, drainage
  - Best sites are deep loam, clay loam, some clay soils where precipitation > 40 in. per year
  - Erosion is potential problem, most forests on steep slopes
  - Most easily eroded are coarse textured soils, derived from acidic igneous rocks or from soft or weakly consolidated rocks

Sierra Nevadan complex

- Climate and weather are associated with broad forest types supported
  - Low elevation: CA oak woodland & ponderosa types
  - Mid-elevation: Mixed-conifers type
  - High elevation: True-fir type
  - Winter precipitation ranges from 30 to 90 inches per yr
  - Growing season: 90 days at 10,000 ft, 365 days below 1800 ft.
  - Frostless season: 30 d at 10,000 ft, 255 d sea level

Mixed-conifers Type

- East facing slopes of OR Cascades & west facing slopes of the Sierra Nevada
  - 3000 to 6000 ft elevation
  - 13.6 million acres: largest forest type in CA
  - Growth rates: residual stocking of 150 to 300 sq. ft basal area per acre will yield 150 to 200 cubic ft. per acre per year
  - Conifer species: white fir, incense-cedar, red fir (upper elev.), sugar pine, Douglas-fir, ponderosa, even some giant sequoia (central & southern; 75 stands - protected)

Mixed-conifers Type

- White fir (very tolerant)






Mixed-conifers Type

- Red fir (very tolerant)

Mixed-conifers Type

- Incense-cedar (tolerant)






Mixed-conifers Type

- Sugar pine (intermed. tolerance)

Mixed-conifers Type

- Ponderosa pine (very intolerant)

Mixed-conifers Type

- Big Tree (somewhat intolerant)

Mixed-conifers Type

- Place in ecological succession
  - Low elevation & warmer, south facing slopes predominantly ponderosa pine & incense-cedar
  - Mid elevations, throughout type, Douglas-fir and CA black oak
  - At high elevations, white fir predominates & in cooler north-facing slopes
  - CA red fir at extreme upper elevations & in cold air drainages
  - Sugar pine on more mesic, high quality sites

Mixed-conifers – Ecology …

- Fire plays an important role
  - Natural return interval: 4 to 20 years
  - 8,000 fire starts annually (1 in 5 are arson)
  - 900,000 acres burn annually
- Succession after stand replacing fire
  - Ceanothus, manzanita, Prunus quickly dominate for up to several decades
  - White fir moves in under shrub layer, eventually dominates; shrubs, herbs become minor comp.
  - Douglas-fir, sugar pine populate only if good seed source within 1 to 2 years after disturbance

Mixed-conifers Type

- Silvicultural Systems
  - All silvicultural systems are appropriate choices for many conditions in the type
    - Clearcut regen harvests are on the decline; adequate supply of even-aged stands through wildfire
      - Rotation length 85 to 130 yr
    - Shelterwood system has limited use, mainly on exposed sites
      - More shade that's left, the more white fir & incense-cedar is obtained

Mixed-conifers Type

- Silvicultural Systems
  - Uneven-aged methods (group selection) emerging as predominant system
    - Small groups (1 acre or less) favor return of white fir, incense-cedar
    - Large groups (2 acres or more) favor return of p. pine and Douglas-fir
  - High quality sites may experience invasion by tanoak, madrone, or shrubs regardless of system
  - Must be controlled by hand weeding, spot spraying, or injection with herbicides (so-called "hack & squirt")

Mixed-conifers Type

- Silvicultural practices
  - Extremely variable stocking: from openings to > 350 sq. ft. basal area per acre w/ trees having < 30% LCR
  - Harvesting
    - Usually some type of selection system (irregular uneven-aged management):
      - Sanitation harvests to remove over mature, diseased, suppressed or poorly formed young growth
      - Selection thinning, i.e., thinning of dominants (overstory removal) in two- (or more) storied stands to release next lower stratum to move into next crop position

Mixed-conifers – Silvicultural practices

- Regeneration
  - Accomplished with small patch cuts (group selection method), followed by natural regen or planting
  - Planting
    - Ponderosa pine used most often: high survival on extreme sites
    - White fir and incense-cedar are prolific seeders, end up in stand regardless
    - Mixtures of three or more species often planted: p.pine, DF, white fir, maybe a bit of incense-cedar & Big Tree
    - Big Tree has fastest growth of all conifers in type, at least through ~20 years and appears to be fairly hardy

Mixed-conifers – Silvicultural practices

- Regeneration…
  - Site prep
    - Must deal with annual summer drought to ensure survival
    - Removal of competing vegetation sufficient for survival, but evaporative stress may increase
    - Seedling height growth increases directly with intensity of upper canopy removal

Mixed-conifers – Silvicultural practices

- Regeneration…
  - Slash disposal
    - Windrows: manzanita shrubs tend to come back
    - Broadcast burning: Ceanothus predominates
    - Estimated 3 million viable seeds per acre of shrubs, grasses, other dicots in litter & duff
    - Major causes of seedling mortality are cutworms & drought; frost, rodents, fungi, heat
    - Natural regen still appropriate; need to remove shelterwood to ensure adequate ht. growth of all species, once seedlings are established

Mixed-conifers – Silvicultural practices

- Intermediate treatments
  - Prescribed burning
    - In p.pine plantations where dense shrub cover returns, otherwise p.pine will stagnate; partial mistletoe control
    - Fire exclusion policies have enabled white fir and incense-cedar to increase over historical levels, canopies have closed in, shrubs / herbs have declined
    - 25 to 150 tons per acre of down coarse litter
  - Intermediate cutting mainly to harvest potential mortality, control spp. comp., leave snags

Mixed-conifers – Damage potential

- Douglas-fir
  - Western spruce budworm - defoliator
  - DF beetle - kills weakened trees
  - fir engraver beetle - attacks thin-barked youngsters;
  - bark beetles
  - Dwarf mistletoe; Annosum root disease; shoe-string fungus (Armillaria mellea)
- Incense-cedar
  - Annosus root disease; shoestring fungus; true mistletoe, bark beetles

Mixed-conifers – Damage potential

- White fir
  - fir engraver beetle - kills pole sized to mature trees, round-headed borer, flat-headed borer, bark beetles
  - Dwarf and true mistletoes
  - Gophers can destroy plantations up to 10 ft tall
- Ponderosa pine
  - Mistletoe, *Annosus*, *Armillaria*
  - Porcupines girdle tops of trees; its natural predator the fisher has been overharvested for valuable fur
  - Bark beetles
- Sugar pine
  - White pine blister rust

Mixed-conifers – Damage potential

- Must accept a certain degree of wood production reduction to gain advantages of self-sustaining ecosystem yielding diverse values
- Major threat to productivity is competition from aggressive woody shrubs adapted to forest disturbance

Mixed-conifers – Summary

- Key silvicultural issues
  - Mixed species maintenance
    - High production rates
    - Resistance to disease & insect infestation
  - Prescribed fire use
    - Kills tolerant tree species, competing shrubs
    - Partial mistletoe control
  - Site preparation essential
    - Balance competing shrub death with evaporative stress
    - Balance shelterwood shade w/seedling height growth

Mixed-conifers – Summary

- Key silvicultural issues
  - Aesthetic values protection
    - Highly traveled by recreationists
    - Increased use of shelterwood method, irregular uneven-aged methods
  - Habitat protection
    - Nine wildlife species listed as senstive, rare, or endangered (seven birds, one reptile, one mammal)
  - Stream protection
    - Relatively little grazing is done
    - Stream buffer considerations