BES 489

Winter 2009

Western Lowland Forest Ecosystems

Western Lowland Forests

I. Western Washington Forest Zones

II. Forest Community Diversity in the Western Hemlock Zone

III. Lowland Old Growth Forest Communities

IV. Biotic Interactions in Lowland Old Growth Forests

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

I. Western Washington Forest Zones

1. Forest Zonation Schemes

Forest zones table from textbook

Page 123

Table 9. Comparison of Two Schemes of Vegetation Zones, Western Washington to Cascade Crest

Elevation	Vegetation Zones (Franklin and Dyrness 1973)	Merriam's Life Zones (Jones 1936)	Dominant Woody Vegetation
	Alpine	Arctic-Alpine	Treeless; perennial herbs and low shrubs
6000 ft.	Upper (Parkland) subzone		
	Tsuga mertensiana (mountain hemlock)	Hudsonian	Mountain hemlock, Alaska cedar, Pacific silver fir
5000 ft.	Lower (forested) subzone		
4000 ft.	*Abies amabilis* (Pacific silver fir)	Canadian	Pacific silver fir, western hemlock, western red cedar
3000 ft.			
2000 ft.	*Tsuga heterophylla* (western hemlock)	Humid Transition	Western hemlock-western red cedar climax Douglas fir subclimax
1000 ft.			
	Picea sitchensis (Sitka spruce)		Sitka spruce, western hemlock, western red cedar, Douglas fir
Sea level			

Franklin & Dyrness (1973)

I. Western Washington Forest Zones

1. Forest Zonation Schemes

Non-forested

Forest zones table from textbook

Page 123

Table 9. Comparison of Two Schemes of Vegetation Zones, Western Washington to Cascade Crest

Elevation	Vegetation Zones (Franklin and Dyrness 1973)	Our class	Dominant Woody Vegetation
	Alpine	Alpine	Treeless; perennial herbs and low shrubs
6000 ft.	Upper (Parkland) subzone		
	Tsuga mertensiana (mountain hemlock)	Subalpine Mtn hemlock Subalpine fir	Alaska cedar, mountain hemlock, subalpine fir, whitebark pine Mountain hemlock, Alaska cedar, Pacific silver fir
5000 ft.	Lower (forested) subzone		
4000 ft.	*Abies amabilis* (Pacific silver fir)	Silver fir	Pacific silver fir, western hemlock, western red cedar
3000 ft.			
2000 ft.	*Tsuga heterophylla* (western hemlock)	Western hemlock	Western hemlock-western red cedar climax Douglas fir subclimax
1000 ft.			
	Picea sitchensis (Sitka spruce)	Sitka spruce	Sitka spruce, western hemlock, western red cedar, Douglas fir
Sea level			

Lecture emphasis

I. Western Washington Forest Zones

2. Lowland Forests in Perspective

Ecoregion	Elevation (ft.)	Temp (°F)	Precip (cm)
(Seattle)	0	53	86
Sitka Spruce	0 – 500	52	200 – 300
Western Hemlock	0 – 2500	47	70 – 300
Silver Fir	1900 – 4200	42	220 – 280
Mountain Hemlock	4200 – 5900	39	160 - 280
Subalpine Fir	4200 - 5800	*39*	*100 - 150*

I. Western Washington Forest Zones

3. Major environmental controls on ecoregion boundaries

Ecoregion	Elevation (ft.)	Temp (°F)	Precip (cm)
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Major environmental controls on ecoregion boundaries

1. Precipitation
2. Temperature
3. Interaction of Temperature & Precipitation

II. Forest Community Diversity in the Western Hemlock Zone

A) Western hemlock forests

B) Douglas-fir forests

C) Riparian forests

- Western red cedar bottomlands
- Cottonwood / alder gallery forests
- Willow forest – shrub association

D) Deciduous forests

- Cottonwood / alder riparian forests
- Alder / maple disturbance associations
- Birch / alder associations
- Willow riparian forest

III. Lowland Old Growth Forest Communities

1. What is an "Old Growth Forest"?
2. The Structure of Old Growth Forest Communities
3. Structural Elements of Old Growth Forests
4. Old Growth Forest Species

III. Lowland Old Growth Forest Communities

1. What is an "Old Growth Forest" ?

Age – how old does it have to be?

1) Definitions vary

Variation often tied to:

- Basis for definition (species composition, structure)
- Political / social agenda

2) Class definition

III. Lowland Old Growth Forest Communities

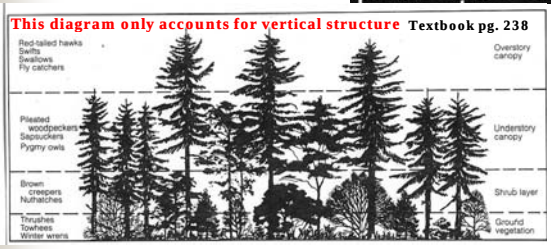
2. The Structure of Old Growth Forest Communities

Stand Structure: physiognomy

Complex overall structure →

habitat diversity (plants & animals)

This diagram only accounts for vertical structure **Textbook pg. 238**



III. Lowland Old Growth Forest Communities

3. Structural Elements of Old Growth Forest Communities

1. Large, old live trees

III. Lowland Old Growth Forest Communities

3. Structural Elements of Old Growth Forest Communities

2. Standing Dead Woody Material ("snags")

III. Lowland Old Growth Forest Communities

3. Structural Elements of Old Growth Forest Communities

3. Dead woody material lying down

Nurse Logs

Nurse logs as hot spots of successful recruitment

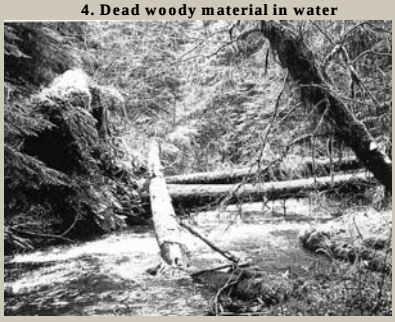
Why?

Nurse logs help to define spatial patterns within forests

III. Lowland Old Growth Forest Communities

3. Structural Elements of Old Growth Forest Communities

4. Dead woody material in water



Importance of Structural Elements in Old Growth Forests

1. Large, old live trees

- Can be up to 800 – 1200 years old
- 200 – 300 ft tall
- Up to 60 million needles
  - ✓ 440 lbs
  - ✓ 30,000 ft^2 surface area

? **Ecological Importance** ?

1.

2.

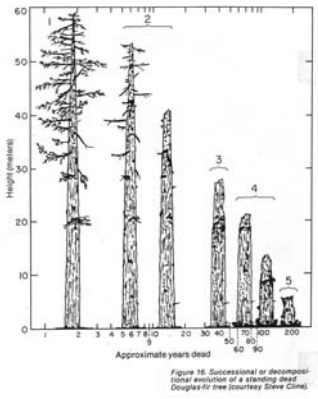
3.

4.

Importance of Structural Elements in Old Growth Forests

2. Snags

- Can be up to 200 + years old
  - ✓ Depending upon species
  - ✓ Nature of snag varies with time



Importance of Structural Elements in Old Growth Forests

2. Snags

? **Ecological Importance** ?

1.

2.

3.

4.

Importance of Structural Elements in Old Growth Forests

3. Horizontal Woody Debris (Nurse Logs)

? **Ecological Importance** ?

1.
2.
3.
4.
5.

Importance of Structural Elements in Old Growth Forests

4. Woody Debris in Water

? **Ecological Importance** ?

1. Physical (structural) habitat
   - ✓ Tree, shrub & other seedlings / mosses, lichens
   - ✓ Alters instream habitat
     - ❖ Create pools (resting places), riffles, etc.
     - ❖ Create shade (↓ °C → ↑ O_2)
     - ❖ Create hiding places
   - ✓ Amphibians, rodents, other animals, microorganisms
     Homes & corridors over streams
   - ✓ Decomposers
2. Food source (decomposers)
3. Nutrient source (C & N input)
   - ✓ CPOM – C source
   - ✓ FPOM – N source
4. Decrease erosion

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

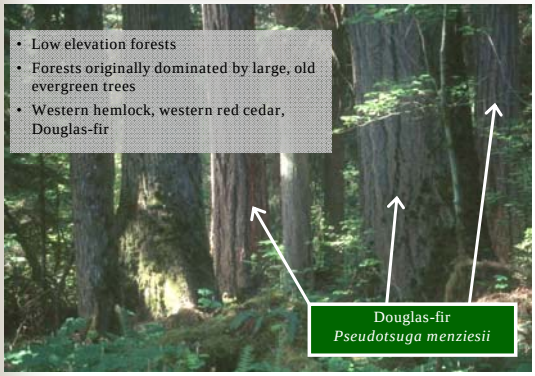
A) Primary Producers - Plants

Evergreen Coniferous Trees

Western hemlock	(*Tsuga heterophylla*)
Douglas-fir	(*Pseudotsuga mensezeii*)
Western red cedar	(*Thuja plicata*)
Sitka spruce	(*Picea sitchensis*)
Grand fir	(*Abies grandis*)

Western Hemlock Forests

- Low elevation forests
- Forests originally dominated by large, old evergreen trees
- Western hemlock, western red cedar, Douglas-fir



Lowland Evergreen Conifers

Douglas-fir (*Pseudotsuga mensezeii*)

Among the 3 largest PNW trees
- Up to 300 ft tall
- 8 – 15 ft diameter

Rapid growth: 170 ft in 72 years

Life span ~ 800 – 1000 years

Comes in early after disturbance; shade intolerant

Pointy buds

Wikipedia images

Lowland Evergreen Conifers

Lowland Evergreen Conifers

Foliage of flattened scales

Western red cedar (*Thuja plicata*)

Among the 3 largest PNW trees
- Up to 200 ft tall
- 8 – 10 ft diameter

Life span ~ 800 – 1000 years

Common later in forest development; shade tolerant

Wet sites (>30 in rain / yr or along streams)

Important ethnobotanical species

Stringy bark

Lowland Evergreen Conifers

Platy bark

Drooping leader

Coastforest.org

Western hemlock (*Tsuga heterophylla*)

"Moderate" size
- Up to 200 ft tall
- 4 – 5 ft diameter

Life span up to 500 yrs

Common later in forest development; shade tolerant

Often on stumps & downed logs

Small, delicate cones

Flattened needles of varying lengths

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

A) Primary Producers - Plants

Evergreen Coniferous Trees

Western hemlock	(*Tsuga heterophylla*)
Douglas-fir	(*Pseudotsuga mensezeii*)
Western red cedar	(*Thuja plicata*)
Sitka spruce	(*Picea sitchensis*)
Grand fir	(*Abies grandis*)

Deciduous Trees

Red alder	(*Alnus rubra*)
Big Leaf Maple	(*Acer macrophyllum*)
Black Cottonwood	(*Populus trichocarpa*)

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

A) Primary Producers - Plants

Understory Shrubs

	Salal	(*Gaultheria shallon*)
	Red huckleberry	(*Vaccinium parvifolium*)
	Evergreen huckleberry	(*Vaccinium ovatum*)
esp. gaps / edges	Salmonberry	(*Rubus spectabilis*)
esp. gaps / edges	Thimbleberry	(*Rubus parviflorus*)
	Cascade Oregon Grape	(*Berberis nervosa*)
	Nootka rose	(*Rosa nutkana*)
	Twinberry	(*Linnea borealis*)

Understory Herbs

	Sword fern	(*Polystichum munitum*)
esp. gaps / edges	Bracken fern	(*Pteridium aquilinum*)
	Bleeding heart	(*Dicentra formosa*)
	Wild ginger	(*Asarum caudatum*)
	Foamflower	(*Tiarella trifoliata*)
	Youth-on-age	(*Tolmiea mensezeii*)
	Fringe-cup	(*Tellima grandiflora*)
	Vanilla leaf	(*Achlys triphylla*)
	Bunchberry	(*Cornus unalaschensis*)

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

B) Consumers - Herbivores

Insects

Foliage feeders:	Lepidoptera (moths, butterflies), sawflies, weevils, leaf miners, etc.
Phloem feeders:	Bark beetles
Seed eaters:	Ants
Root feeders:	Nematodes

Molluscs

Slugs & snails

Birds

Seed / Fruit consumers (chickadees, siskins, etc.)

Mammals

Browsers & Grazers (deer, elk, rabbits, Mtn beavers)

Seed eaters (rodents, squirrels)

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Speceis

B) Consumers (terrestrial)

Omnivores

Bear, raccoon, opossum, crows, etc.

Carnivores

Insects

Beetles, wasps, etc.

Vertebrates

Coyote, mountain lion, weasels, birds (owls), fishers

Parasites

Fungi, bacteria, non-photosynthetic plants, worms, wasps, beetles, etc.

Decomposers

Bacteria, fungi, slime molds

Western Hemlock Forests

Animal Species

~ 210 native vertebrates

Animals strongly tied to mature forest conditions – overall structure & habitat elements

Northern spotted owl

Douglas squirrel (*Tamiasciurus douglasii*)

High number of endemic amphibians

Data: NAS (2000); Bunnell & Chan-McLeod (1997); Johnson & ONeil (2001)

Photos from Mathews (1988)

Western Hemlock Forests

Animal Species

Forests support very high animal diversity for nation

WA + OR

% US Conifer Forest Lands: 6.8

% US Breeding Birds: 37

% US Cavity Nesters: 58

% US Mammals: 42

% US Mammals (> 1 kg): 56

Data: NAS (2000); Bunnell & Chan-McLeod (1997); Johnson & ONeil (2001)

III. Lowland Old Growth Forest Communities

Characteristic Animals

Northern flying squirrel

Northern spotted owl

Pileated woodpecker

Black-tailed deer

Salamanders

Marbeled Murrelet

Photos from Kirk & Franklin (1992)

Drawings from NGS Birds of North America (1983)

III. Lowland Old Growth Forest Communities

Characteristic Animals

Kirk & Franklin (1992)

Fisher

Mathews (1988)

Vaux's swift

Mathews (1988)

Other mammals not pictured:

cougar, Douglas squirrel, raccoon, black bear, etc.

Other birds not pictured:

chestnut-backed chickadee, grey jay, dark-eyed junco, American dipper, etc.

Salamanders

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Speceis

C) Other Key (often overlooked) Players

Mycorrhizal fungi

Nitrogen-fixing lichens

Soil bacteria

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Composition

C) Other Key (often overlooked) Players

Mycorrhizal fungi

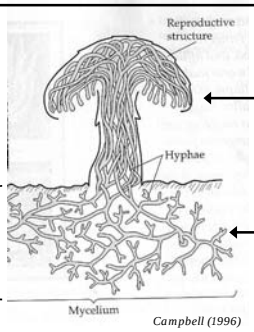
Nitrogen-fixing lichens

Soil bacteria

Mycorrhizae

Mycorrhiza

Fungus



Campbell (1996)

Mycorrhizae

Mycorrhiza

A symbiotic, non-pathenogenic association of a fungus and living plant roots

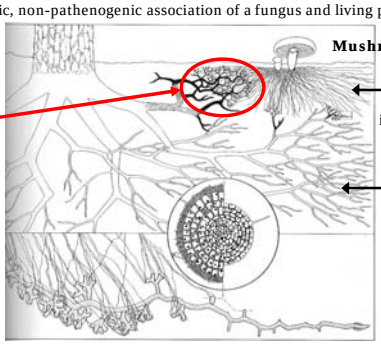


Figure from textbook (page 179)

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

C) Other Key (often overlooked) Players

Mycorrhizal fungi

Nitrogen-fixing lichens

Soil bacteria

Nitrogen Fixation & Lichens

Nitrogen Fixation

Only certain species of bacteria and blue-green bacteria have *NITROGENASE.*

Lichens

Blue-green Bacteria | **Fungus** | **Green algae**

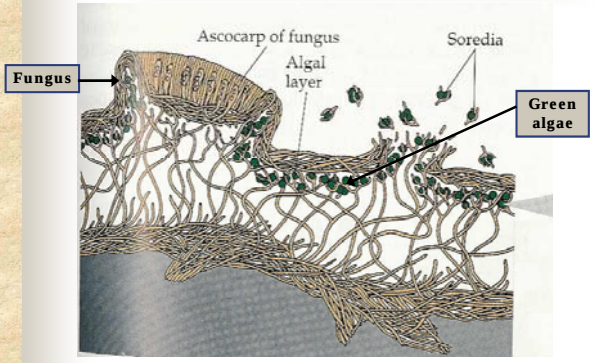
Nitrogen-fixing

Non-nitrogen-fixing

Lichens are not organisms – they are associations

Nitrogen Fixation & Lichens

Lichens



Campbell (1996)

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

C) Other Key (often overlooked) Players

Mycorrhizal fungi

Nitrogen-fixing lichens

Soil bacteria

Dead Organic Material

Fungi, insects, nematodes, etc. ⇩ Decomposition

Decomposed Organic Material

Bacteria ⇩ Mineralization

Inorganic Nutrients

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

D) Species "obligate" to OGF

Species "obligate" to OGF

Northern flying squirrel

Northern spotted owl

Marbeled Murrelet

Some Salamanders

Photos from Kirk & Franklin (1992)

III. Lowland Old Growth Forest Communities

Species "obligate" to OGF

Marten

Kirk & Franklin (1992)

Fisher

Mathews (1988)

Vaux's swift

Mathews (1988)

Lobaria oregana

Several bats (not pictured)

Fungi?
Insects?
Microorganisms?

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Composition E) Species "obligate" to OGF

Why are some species "obligate" to OGF?

1.

Even though mature younger forests may provide enough shade, Spotted owls require a shaded understory environment that is physically open enough for effective hunting (lower stem density than in younger forests).

Marbeled murrelets require tall old trees for nesting sites. Horizontal branches large enough in the upper canopy only develop after trees are quite old.

2.

In many cases it may not be so much the "uniqueness" of the OGF environment, rather the abundance of such an environment.

Organisms whose primary food source is tied to OGF environments (e.g., Spotted owls, martens, fishers, etc.) require large, contiguous areas of deep understory that provides enough habitat for their food source.

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Composition E) Species "obligate" to OGF

Are there any PLANTS "obligate" to OGF?

III. Lowland Old Growth Forest Communities

4. Old Growth Forest Species

E) Characteristic Plants of OGFs

Evergreen Coniferous Trees

Western hemlock (*Tsuga heterophylla*)
Western red cedar (*Thuja plicata*)
Douglas-fir (*Pseudotsuga menziesii*)

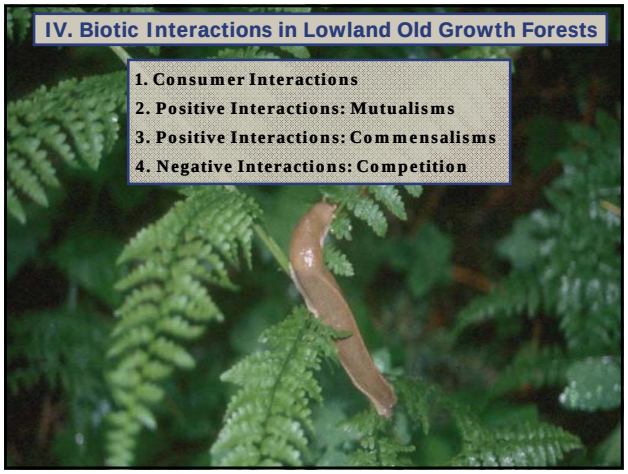
Understory Shrubs

Red huckleberry (*Vaccinium parvifolium*)

Understory Herbs

Foamflower (*Tiarella trifoliata*)

IV. Biotic Interactions in Lowland Old Growth Forests



1. Consumer Interactions
2. Positive Interactions: Mutualisms
3. Positive Interactions: Commensalisms
4. Negative Interactions: Competition

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

A) Elk & Deer – Vegetation Interaction

Black-tailed deer

Page 201 – 207 in textbook

Roosevelt elk

Photos from Kirk & Franklin (1992)

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

A) Elk & Deer – Vegetation Interaction

Exclosure: NO browsing & grazing

Intense browsing & grazing

Elk & deer herbivory alters:

Photos from Kirk & Franklin (1992)

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

A) Elk & Deer – Vegetation Interaction

Salmonberry, elderberry, huckleberry, thimbleberry, trees

Lady fern, oxalis, other shade requiring understory species

Grasses, bracken fern

Maintenance of open meadow patches benefit the herbivores

Creates a balance of food availability (grasses & shrubs)

Photos from Kirk & Franklin (1992)

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

B) Anti-herbivore defenses

Invertebrate grazers (insects, slugs, etc.)

Vertebrate grazers (elk, deer, etc.)

Skunk cabbage

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

Wild ginger photo from Taylor & Douglas (1995)

B) Anti-herbivore defenses

Munch, munch

Wild ginger

Anti-herbivore strategies vary with environment

Wet Sites	Dry Sites
Grow fast, flower early	Defensive chemicals in leaves
↓	↓
Escape herbivory	Escape herbivory

Dry site → low Ps → leaves must live long time → require defense chemicals (cannot grow fast in poor environment)

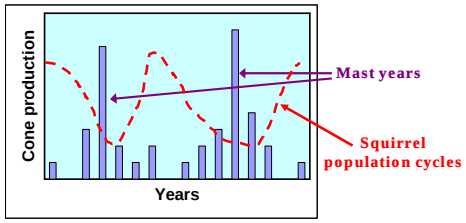
See page 169 in textbook

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions

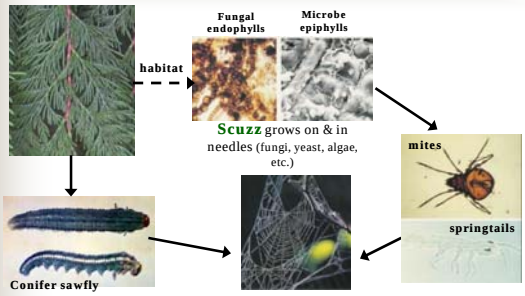
C) Anti-predator defenses: seed predation by squirrels

Strategy: mast year cone production cycles



IV. Biotic Interactions in Lowland Old Growth Forests

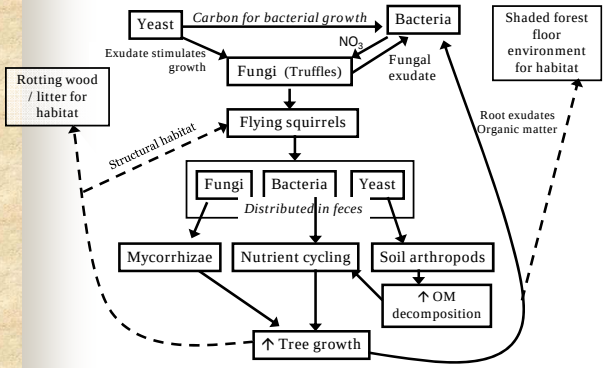
1. Consumer Interactions **D) Food webs in the forest canopy**



- Conifer foliage provides habitat for scuzz , supporting scuzz herbivores
- Predatory Spiders feed on scuzz herbivores – keeping spider populations high
- Spiders also prey on foliage feeders, preventing severe outbreaks

IV. Biotic Interactions in Lowland Old Growth Forests

1. Consumer Interactions **E) Fungi-Tree-Squirrel food web**



IV. Biotic Interactions in Lowland Old Growth Forests

2. Positive Interactions: Mutualisms

A) Maple trees and mosses

Moss gets:

Tree gets:

IV. Biotic Interactions in Lowland Old Growth Forests

2. Positive Interactions: Mutualisms

B) *Lobaria oregana* & big trees

Lichen gets:

Tree gets:

IV. Biotic Interactions in Lowland Old Growth Forests

2. Positive Interactions: Mutualisms

C) *Trillium ovatum* & ants

Trillium gets:
- Seed dispersal

Ants get:
- Food (eliasome)

IV. Biotic Interactions in Lowland Old Growth Forests

2. Positive Interactions: Mutualisms

D) Berry-producing shrubs & birds

Red huckleberry gets:
- Seed dispersal

Birds get:
- Food (fruit)

Hermit thrushes
Robins
Chickadees
Flickers
etc.

USFS

Red elderberry gets:
- Seed dispersal

Birds get:
- Food (fruit)

Hermit thrushes, Robins, Towhees, Finches, Flickers, Waxwings, Nuthatches, etc.

IV. Biotic Interactions in Lowland Old Growth Forests

3. Positive Interactions: Commensalisms

A) Pileated woodpeckers as ecological engineers

Holes used by:

- Owls
- Bats
- Martens
- Flying squirrels
- Vaux's swifts
  and other birds

IV. Biotic Interactions in Lowland Old Growth Forests

4. Negative Interactions: Competition

A) Plant competition

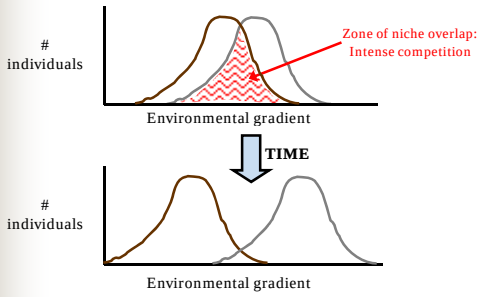
Competition for light drives succession & patterning in lowland old growth forests

Details to come

IV. Biotic Interactions in Lowland Old Growth Forests

4. Negative Interactions: Competition

Habitat Partitioning through competition: niche divergence



IV. Biotic Interactions in Lowland Old Growth Forests

4. Negative Interactions: Competition

pp. 217-221 in textbook

B) Competition among herbivores: squirrels

Douglas squirrel (*Tamiasciurus douglasii*)

Western gray squirrel (*Sciurus griseus*)

Closed canopy forests — **Niche partitioning through competition** — Oak woodlands (scarce)

Girdles conifer seedlings by eating cambium, thus maintaining oak woodland habitat

Photos from Mathews (1988)

IV. Biotic Interactions in Lowland Old Growth Forests

4. Negative Interactions: Competition

pp. 239 in textbook

C) Competition among insectivores: chickadees

Black-capped chickadee

Chestnut-backed chickadee

Niche partitioning through competition

Drawings from textbook

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

2. Ecosystem Function in Old Growth Forests

- **A) Primary Productivity**
- **B) Nutrient Cycling**

3. Lowland Old Growth Forest Landscapes

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

A) Starting the process: disturbance ***What disturbances initiate succession?***

Disturbance in Western Hemlock Forests

Fires return interval of ~ 230 years is much more frequent than Sitka Spruce forests (1,146 years)

- Data possibly inflated by Native American burning

Fire consequences severe

- High fuel loads – stand destroying crown fires usual with fire
- Many species fire avoiders

Wind disturbance significant but not nearly as often or intense as Sitka Spruce forests

Western Hemlock Forests: Human Impacts & Management

Most of our lowland forests are heavily managed for production

Forest harvest Wishkah Valley

Western Hemlock Forests: Human Impacts & Management

Less than 10% of original forests remain at low elevations in western WA

WA DNR 1998

Western Hemlock Forests: Human Impacts & Management

The landscape patterns of harvest are critical for understanding ecological impacts

Western Hemlock Forests: Human Impacts & Management

Plantation forests are not the same ecologically

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

B) The beginning: Pioneer Stage

What determines the early colonists?

1. Dispersal

Organisms that can GET THERE first often define early communities

A. Proximity

B. Ease of dispersal

- Wind dispersed (small seeds) Examples: Fireweed; pearly everlasting
- Animal dispersed (fruits) Examples: huckleberries; serviceberry

2. Tolerance of open (high light) environment

Examples:

Douglas-fir; bracken fern; oceanspray; red elderberry

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

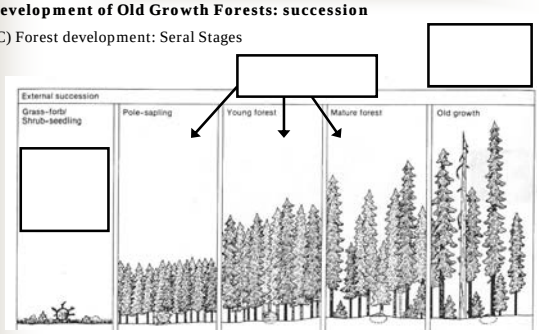
B) The beginning: Pioneer Stage

How do early colonists modify the environment?

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

C) Forest development: Seral Stages



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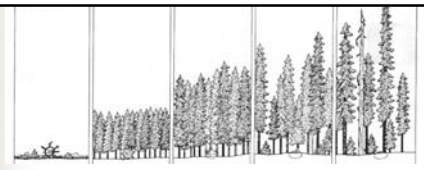
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

C) Forest development: Seral Stages

What happens during the seral stages?



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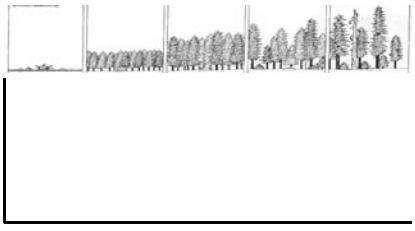
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

C) Forest development: Seral Stages

Increasing structural complexity & species diversity



Time

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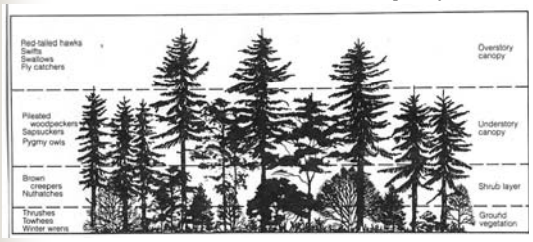
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

C) Forest development: Seral Stages

Species diversity is tied to

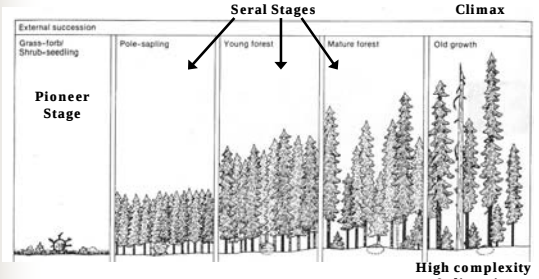
vertical & horizontal structural complexity



V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

D) The endpoint: Climax Stage **Where do we start calling it "old growth"?**



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V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

E) Forest development in Puget Sound Lowlands

Succession & Forest Dynamics in the Puget Lowland
A highly simplified look at forest development

II. The Major Actors

	Douglas-fir	Western Hemlock	Western Red Cedar
Life Span (years)	800 - 1000	500	800 - 1200
Seedling shade tolerance	Poor	Good	Good
Seedling survival & growth in forest clearings	Good	Poor	Poor
Symbol			

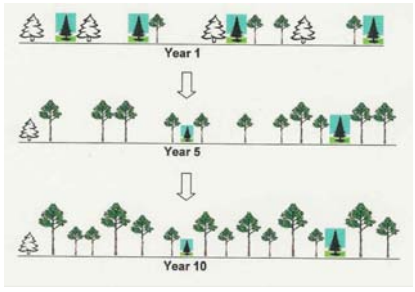
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

E) Forest development in Puget Sound Lowlands

Pioneer & early seral stages

Western red cedar
Douglas-fir
Western hemlock



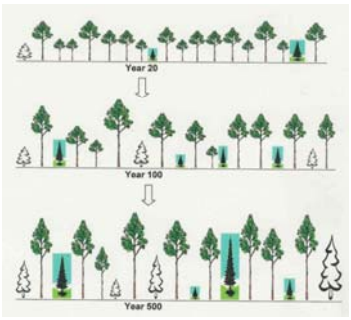
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

E) Forest development in Puget Sound Lowlands

Mid to late seral stages

Western red cedar
Douglas-fir
Western hemlock



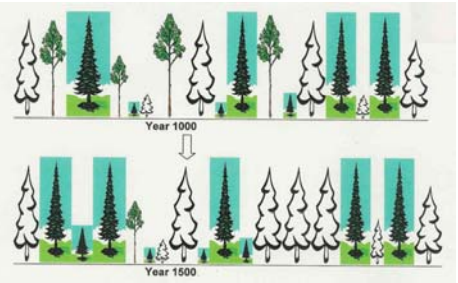
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

E) Forest development in Puget Sound Lowlands

Late seral to climax stages

Western red cedar
Douglas-fir
Western hemlock



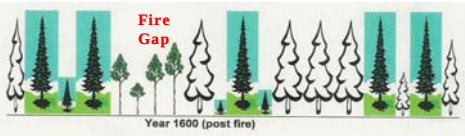
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

E) Forest development in Puget Sound Lowlands

Fire & the Forest Mosaic

Western red cedar
Douglas-fir
Western hemlock



What else maintains the MOSAIC?

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

F) Lessons from Forest development in Puget Sound Lowlands

1 The speed & nature of succession is determined by:

1) Life span of trees involved
- Long-lived trees create slow succession
- Replacement often only after death in later stages

2) Differential shade tolerance of the species involved
- Pioneers (Doug-fir) alter the environment so it is no longer favorable for them.
- Pioneers alter the balance of resources available

Pioneer Stage → **Seral Stage**

- Aboveground resources: abundant
- Belowground resources: scarce

- Aboveground resources: scarce
- Belowground resources: more

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

F) Lessons from Forest development in Puget Sound Lowlands

2 A Non-climax species can be maintained as a common element

Douglas-fir is maintained because

it is LONG-LIVED relative to the FREQUENCY OF DISTURBANCES

We have also seen that Douglas-fir is maintained in the broader landscapes of our lowland forests due to topographic variation (specialized habitats where it is favored)

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

1. Development of Old Growth Forests: succession

F) Lessons from Forest development in Puget Sound Lowlands

3

Vine maple in a forest gap

Primary Productivity

Western Hemlock Forest Ecosystem Productivity

WA WH Forests are HIGHLY productive:

2,000 -3,200

g C / m^2 /yr

Lassoie et al. 1985

Annual Net Primary Productivity of Ecosystems

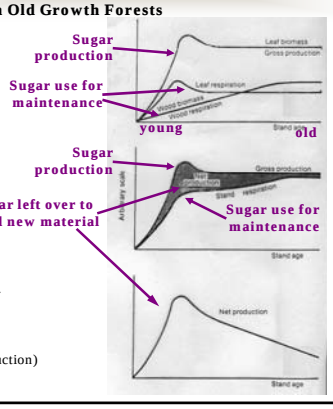
Ecosystem Type	Mean NPP g C / m^2 / yr	Range of NPP g C / m^2 / yr
Terrestrial Uplands		
Tropical rain forest	2,200	1,000 - 3,500
Temperate evergreen forest	1,320	600 - 2,500
Temperate deciduous forest	1,200	600 - 2,500
Boreal forest	800	400 - 2,000
Woodland & shrubland	700	250 - 1,200
Temperate grassland	600	200 - 1,500
Tundra and alpine	140	10 - 400
Desert & semidesert scrub	90	10 - 250
Freshwater Wetlands		
Swamp & marsh	2,000	800 - 6,000
Lake and stream	250	100 - 1,500
Marine		
Algal beds and reefs	2,500	500 - 4,000
Estuaries	1,800	500 - 4,000
Open Ocean	125	2 - 400

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

2. Ecosystem Function in Old Growth Forests

A) Primary Productivity

Are old growth forests "decadent"?



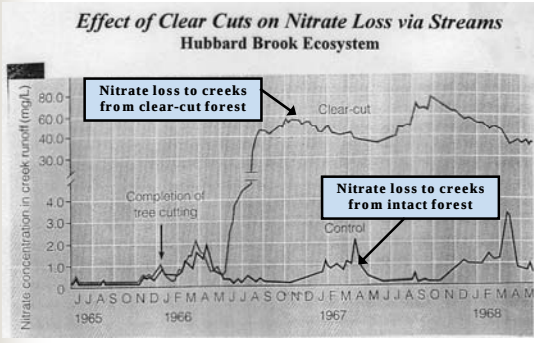
Old Growth Forests

- High gross productivity (total sugar production)
- Low net productivity (rate of new mass production)

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

2. Ecosystem Function in Old Growth Forests

B) Nutrient Cycling: **TIGHT or LEAKY ?**



V. Community & Ecosystem Ecology of Lowland Old Growth Forests

2. Ecosystem Function in Old Growth Forests

B) Nutrient Cycling: **TIGHT or LEAKY ?**

Why do our OGFs retain nutrients so well?

1.

2.

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

3. Lowland Old Growth Forest Landscapes

Are our lowland forest landscapes ecologically
Uniform (creamy) or Variable (chunky) ?

Why are our forests **MOSAICS?**

1. Disturbances are common and they vary in time & space

2. Topography is variable

Steep south facing bluffs and slopes create open forests dominated by Douglas-fir

Doug-fir persists due to environmental variation in space as well as time (disturbance)!

Communities vary within evergreen forests with water availability

3. River corridors

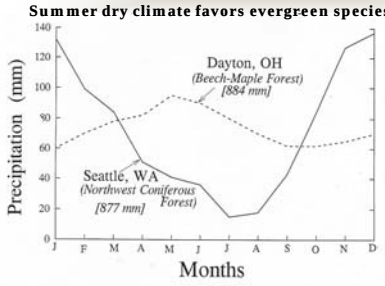
V. Community & Ecosystem Ecology of Lowland Old Growth Forests

3. River corridors

Unusual dominance of deciduous species –
why do they occur so commonly here?

Why are our forests evergreen?

Summer dry climate favors evergreen species



V. Community & Ecosystem Ecology of Lowland Old Growth Forests

3. River corridors

Deciduous dominance – areas of:

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

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3. River corridors
   - Deciduous dominance – areas of high light & summer resources
4. Special edaphic situations

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

4. Special Edpahic Situations

Puget prairies – coarse soils provide severe moisture limitations

Photo from textbook

Why don't trees grow here with dry soils?

Lack of soil moisture

↓

Closed stomata

↓

Lower sugar production & less nutrient uptake

↓

Insufficient extra sugar and nutrients to invest in wood

Non woody species invest only in structures that pay back their own construction costs (leaves)

V. Community & Ecosystem Ecology of Lowland Old Growth Forests

3. Lowland Old Growth Forest Landscapes

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   - Puget prairies – coarse soils provide severe moisture limitations