

Understanding Washington's Ecology

October 2, 2006

The Ecology of Washington

I. Physical & Chemical (Abiotic) Environment of WA

1. Where are we? : Global / Continental Position
2. An Overview of our Place: Regional Geography & Landforms
3. How are Landforms Created?
4. The Importance of Geology at Multiple Scales
5. Climate

II. Ecosystems of WA

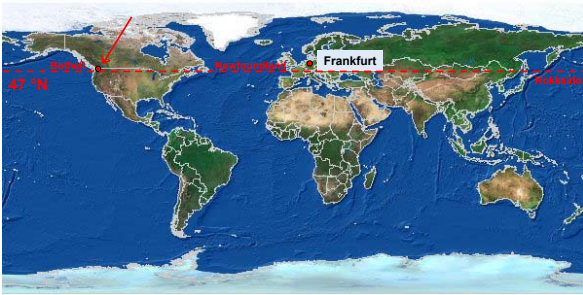
1. Ecoregions
2. Environmental Determinants of Ecoregions

I. Abiotic Environment of WA

1. Global / Continental Position

A) Where are we?

Latitude: 45 – 48.5 °N (UWB ~ 47.5 °N)
Continental Position: Coastal Maritime



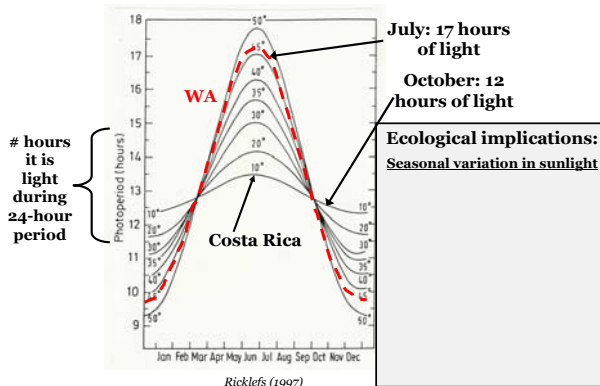
I. Abiotic Environment of WA

1. Global / Continental Position

B) What are the ecological implications of our global position?

- 1) Daylength ; Seasonality
- 2) Present-day Climate
 - Atmospheric circulation
 - Oceanic circulation
 - Maritime influences
- 3) Past Climate
- 4) Geological / tectonic implications

1) Daylength & Seasonality

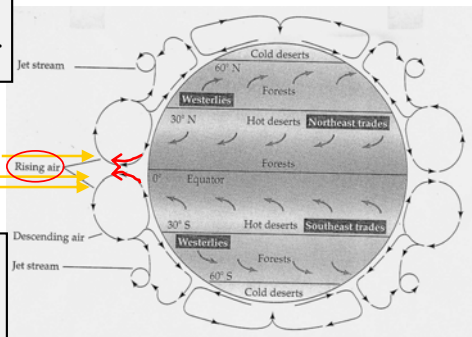


2) Present-day Climate: Atmospheric Circulation

1. Sunlight energy greatest near equator



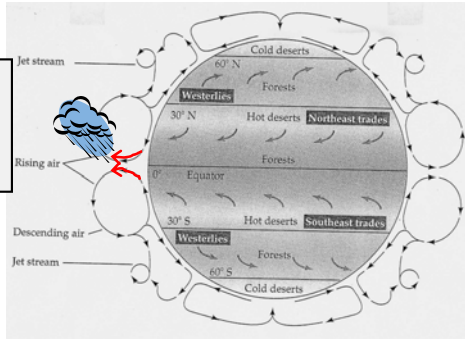
2. Results in warm, rising air at low latitudes



Campbell (2001)

2) Present-day Climate: Atmospheric Circulation

3. Rising air cools and rain falls abundantly at low latitudes



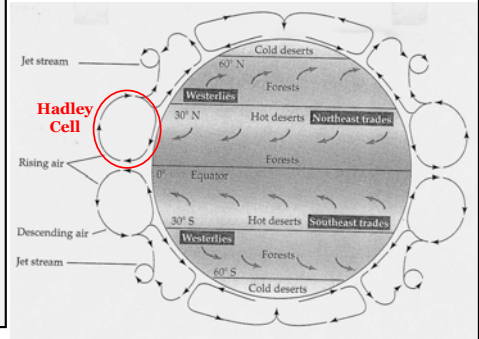
Campbell (2001)

2) Present-day Climate: Atmospheric Circulation

4. Rising air leaves low pressure area behind.

Surface air from N and S flow into area.

Results in large-scale circular flow of air masses (Hadley Cells)

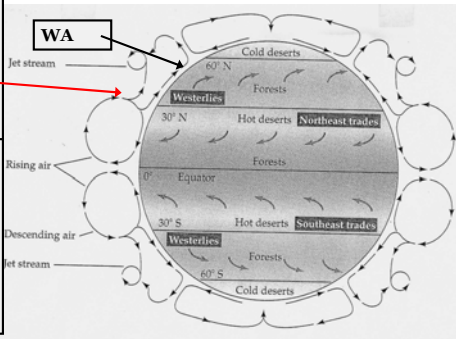


Campbell (2001)

2) Present-day Climate: Atmospheric Circulation

5. Hadley Cells create dry latitudes of descending air around 30° N & S.

WA sits at the edge of another rising air mass region – hence the tendency for higher levels of precipitation.

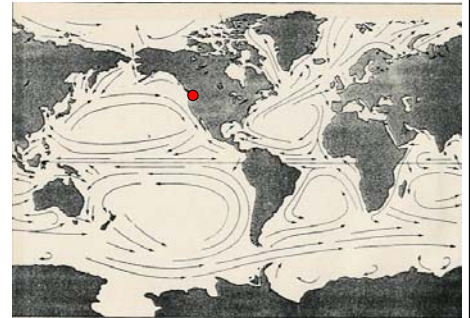


Campbell (2001)

2) Present-day Climate: Oceanic Circulation

Ocean currents determine the temperature of surface waters.

This has large influences on coastal climates



Ricklefs (1997)

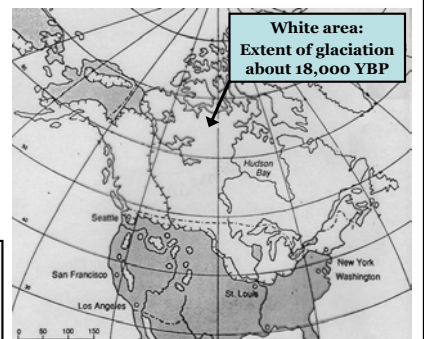
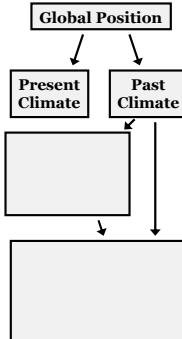
2) Present-day Climate: Maritime Influences

Our coastal location allows large water body to moderate temperature extremes – a _____ climate

Locations further from large water bodies experience larger seasonal temperature fluctuations – _____ climates



3) Past Climate



An analogue for the future: our present is tomorrow's past

I. Abiotic Environment of WA

1. Global / Continental Position

B) What are the ecological implications of our global position ?

- 1) Daylength ; Seasonality
- 2) Present-day Climate
 - Atmospheric circulation
 - Oceanic circulation
 - Maritime influences
- 3) Past Climate
- 4) Geological / tectonic implications – *to come in further sections*

The Ecology of Washington

I. Abiotic Environment

1. Global / Continental Position
- 2. Regional Geography & Features**
3. Forces Behind Landforms
4. Geology
5. Climate

II. Ecosystems of WA

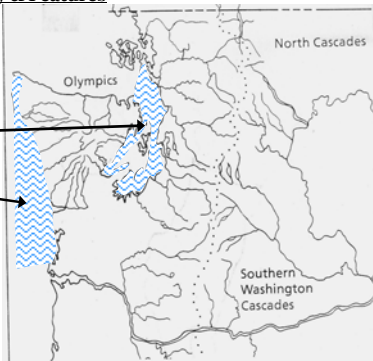
1. Ecoregions
2. Environmental Determinants of Ecoregions

I. Abiotic Environment of WA

2. WA Geography & Features

A) Water Bodies: Marine

Puget Sound
Pacific Ocean



I. Abiotic Environment of WA

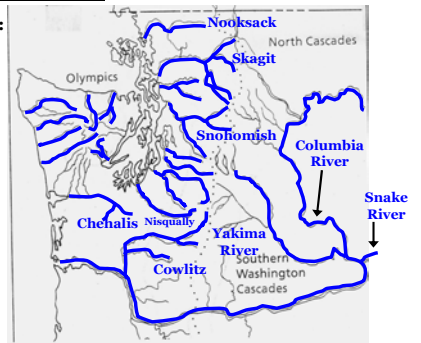
1. WA Geography & Features

A) Water Bodies: Freshwater

Major Streams of WA

East side
Columbia
Snake
Yakima
Spokane
Okanogan

West side
Columbia
Cowlitz
Chehalis
Nisqually
Puyallup
Green
Snoqualmie
Snohomish
Stillaguamish
Skagit
Nooksack
Skokomish
Quinalt
Hoh

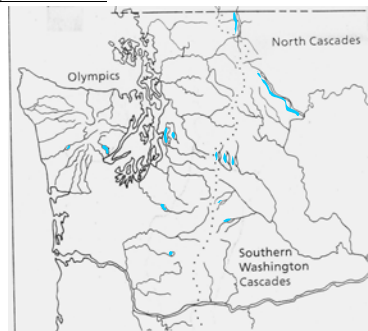


I. Abiotic Environment of WA

2. WA Geography & Features

A) Water Bodies: Freshwater

Major Lakes of Central & Western Washington



I. Abiotic Environment of WA

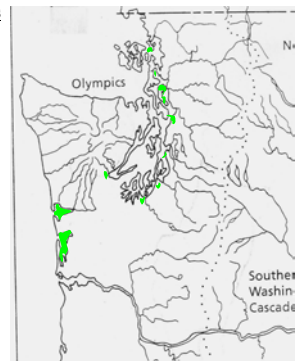
1. WA Geography & Features

A) Water Bodies:

Marine / Freshwater

Major Estuaries of Western Washington

Grays Harbor
(Chehalis River)
Willapa Bay
(Willapa & Naselle Rivers)
Nisqually River
Puyallup River
Cedar / Green River
Snohomish River
Stillaguamish River
Skagit River
Nooksack River
Skokomish River



I. Abiotic Environment of WA

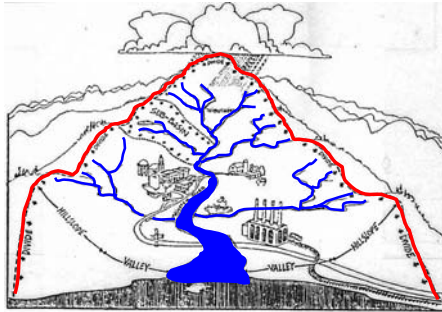


1. WA Geography & Features

B) Landscape Units: Watersheds

WHAT IS A WATERSHED?

WATERSHED



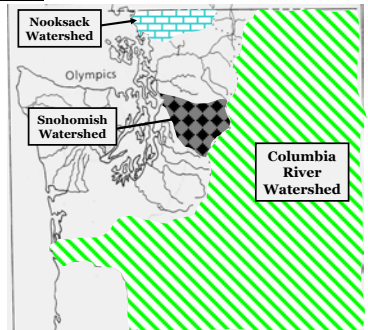
Murdoch & Cheo (1999)

I. Abiotic Environment of WA

1. WA Geography & Features

B) Landscape Units: Major Watersheds of Washington

Columbia
Chehalis
Willapa & Naselle
Nisqually
Puyallup
Cedar / Green
Snohomish
Stillaguamish
Skagit
Nooksack
Skokomish



I. Abiotic Environment of WA

1. WA Geography & Features

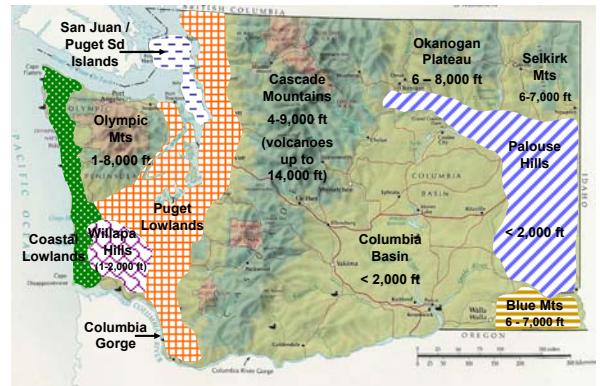
B) Landscape Units: Physiographic Regions

Landscape units based upon major landform divisions

Coastal Lowlands	Okanogan Plateau
Olympic Mountains	Selkirk Mountains
Willapa Hills / Black Hills	Palouse Hills
Puget Lowlands	Columbia Basin
Puget Sound Islands	Blue Mountains
Cascade Mountains	Columbia River Gorge

Note: These are arbitrary physiographic divisions for use in our class. Many different schemes exist.

Physiographic Regions of WA



The Ecology of Washington

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3. Forces Behind Landforms
4. Geology
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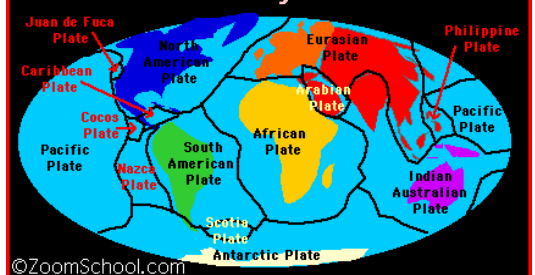
II. Ecosystems of WA

1. Ecoregions
2. Environmental Determinants of Ecoregions

I. Abiotic Environment

3. Forces Behind Landforms

The Earth's Major Plates

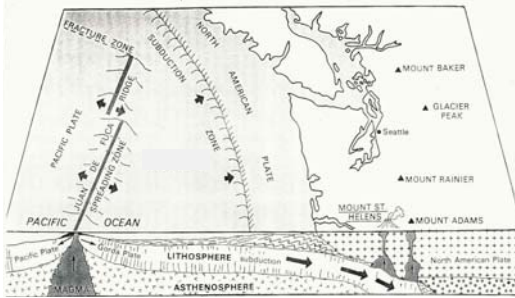


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I. Abiotic Environment

3. Forces Behind Landforms

Subduction – scraping the surface off of the Pacific Plate



Alt & Hyndman (1995)

I. Abiotic Environment

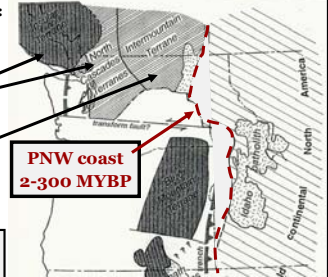
3. Forces Behind Landforms

(A) Tectonic processes create landforms

- 1) The geological base of WA: scraped off bits of crust ("terrane accretion")

Tectonic terrane:

An ecological implication of
Terrane Accretion:



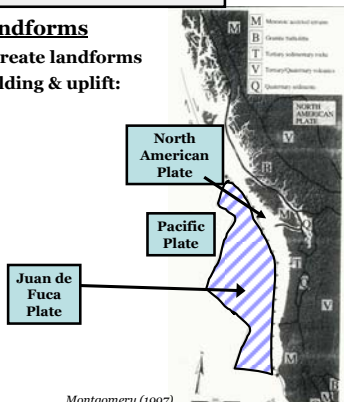
Alt & Hyndman (1995)

I. Abiotic Environment

3. Forces Behind Landforms

(A) Tectonic processes create landforms

- 2) Plate collision / folding & uplift:



Montgomery (1997)

I. Abiotic Environment

3. Forces Behind Landforms

(A) Tectonic processes create landforms

3) Volcanism



Alt & Hyndman (1994)

Old Basin & Range Basalt Flows:
13 - 16 MYBP

Modern Cascade Volcanoes:
3 - 500,000 YBP

I. Abiotic Environment

3. Forces Behind Landforms

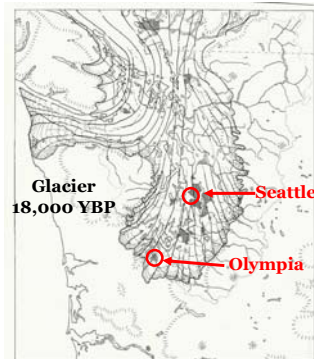
(B) Ice modifies landforms

- 1) Continental glaciation

1.

2.

3.



Kruekeberg (1991)

I. Abiotic Environment

3. Forces Behind Landforms

(B) Ice modifies landforms

- 2) Mountain glaciation

- Mountain carving
- Moraines



I. Abiotic Environment

3. Forces Behind Landforms

(C) Water modifies landforms

- 1) Hill & valley local topography
- 2) Mountain valley topography
- 3) Eastern WA scablands & coulees



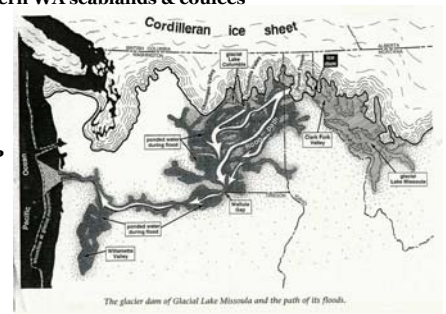
I. Abiotic Environment

3. Forces Behind Landforms

(C) Water modifies landforms

3) Eastern WA scablands & coulees

Lake
Missoula
Floods
15,000 YBP



Alt & Hyndman (1995)

I. Abiotic Environment

3. Forces Behind Landforms

(C) Water modifies landforms

- 1) Hill & valley local topography
- 2) Mountain valley topography
- 3) Eastern WA scablands & coulees
- 4) Columbia river gorge
- 5) River deltas (estuaries):

A.

B.

I. Abiotic Environment

3. Forces Behind Landforms

(D) Wind modifies landforms

1) Wind-blown deposits :



The Ecology of Washington

I. Abiotic Environment

1. Global / Continental Position
2. Regional Geography & Features
3. Forces Behind Landforms
4. **Geology**
5. Climate

II. Ecosystems of WA

1. Ecoregions
2. Environmental Determinants of Ecoregions

I. Abiotic Environment

4. Geology: influences ecological systems at different spatial scales

Large scale: Tectonics

Medium scale: Regional

Small scale: microhabitats

Modified from Montgomery (1997)

The Ecology of Washington

I. Abiotic Environment

1. Global / Continental Position
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3. Forces Behind Landforms
4. Geology & Soils
5. Climate

II. Ecosystems of WA

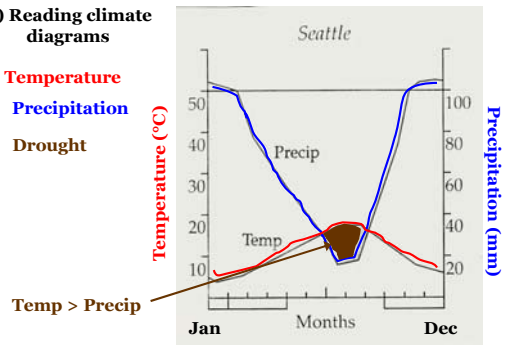
1. Ecoregions
2. Environmental Determinants of Ecoregions

I. Abiotic Environment

5. Climate

A) Reading climate diagrams

1. Temperature
2. Precipitation
3. Drought

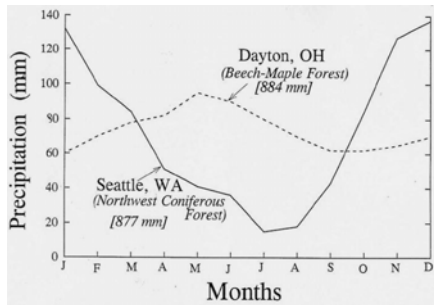


I. Abiotic Environment

5. Climate

B) WA State Climate Patterns

WA State: _____ Climate



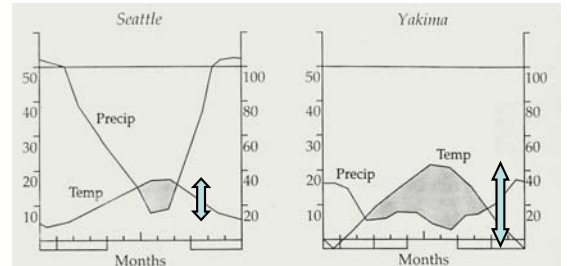
I. Abiotic Environment

5. Climate

B) WA State Climate Patterns

Western WA:
Maritime Climate

Eastern WA:
Continental Climate



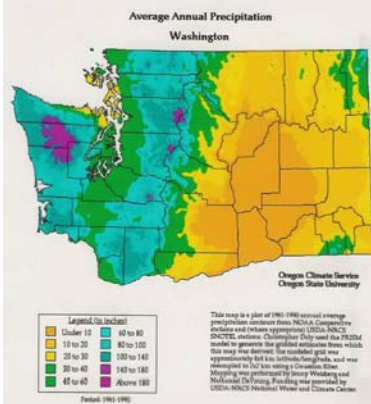
Why are these different?

Kruekeberg (1991)

I. Abiotic Environment

5. Climate

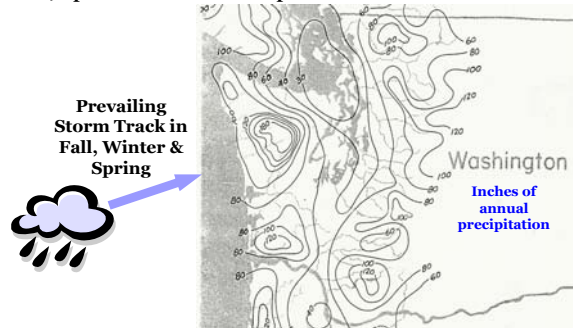
C) Spatial Patterns in Precipitation – across WA State



I. Abiotic Environment

5. Climate

C) Spatial Patterns in Precipitation – across WA State

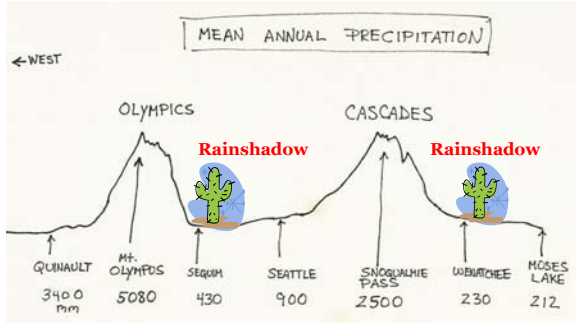


Kruekeberg (1991)

I. Abiotic Environment

5. Climate

C) Spatial Patterns in Precipitation – across WA State

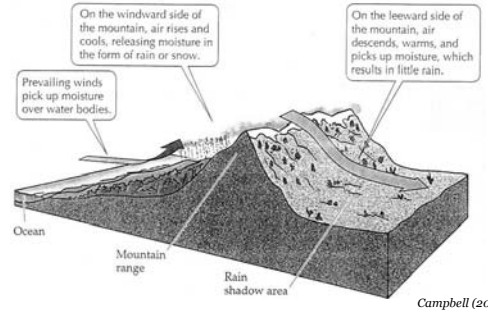


I. Abiotic Environment

5. Climate

C) Spatial Patterns in Precipitation – across WA State

What causes these rainshadows?

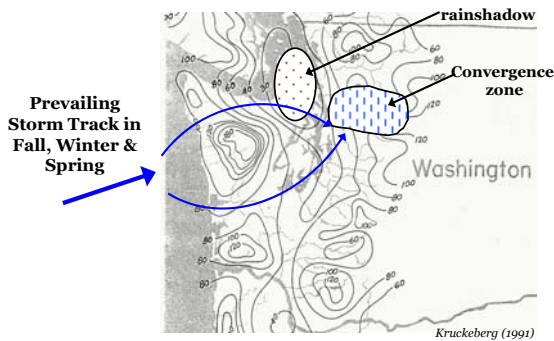


Campbell (2001)

I. Abiotic Environment

5. Climate

C) Spatial Patterns in Precipitation – local variation



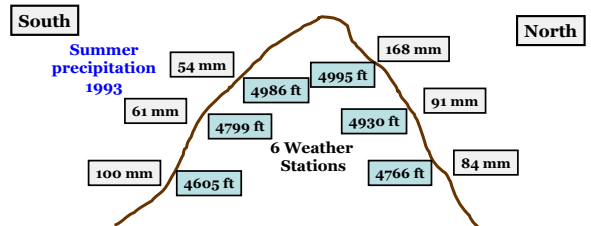
Kruekeberg (1991)

I. Abiotic Environment

5. Climate

C) Spatial Patterns in Precipitation – local variation

Olympic Mountain Study – Andrea Woodward



Bottom Line:

II. Ecosystems of WA

1. Ecoregions

2. Environmental Determinants of Ecoregions

II. Ecosystems of WA

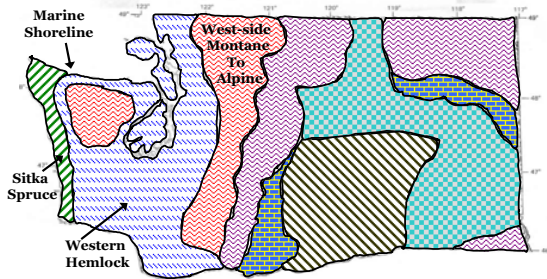
1. Ecoregions

Region defined by uniformity of the form of the dominant plant community. Each ecoregion contains a variety of ecosystems.

11 Ecoregions of Washington State

- Marine Shoreline
- Sitka Spruce
- Western Hemlock
- Silver Fir
- Mountain Hemlock
- Subalpine Fir
- Alpine
- Douglas-fir / Grand Fir
- Ponderosa Pine
- Shrub Steppe
- Palouse Prairie

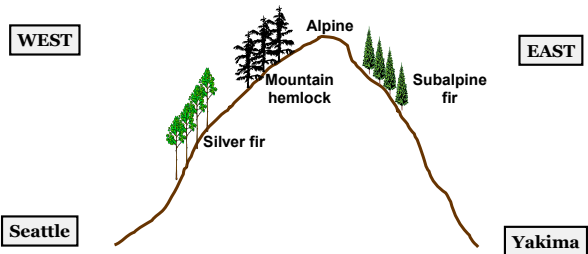
Washington State Ecoregions



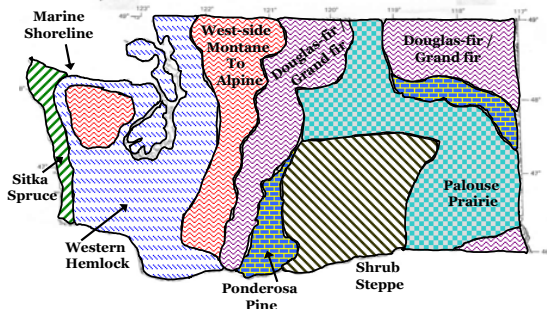
West-side Montane – Alpine: Silver fir; Mountain hemlock; Subalpine fir; Alpine

Washington State Ecoregions

Montane to Alpine Ecoregions



Washington State Ecoregions



West-side Montane – Alpine: Silver fir; Mountain hemlock; Subalpine fir; Alpine

Washington State Natural Regions



Similar scheme to that we are using.
Note some prominent differences:

- Eastern WA prairie / shrub-steppe distribution
- Distinction of prairie woodland mosaic in western WA
- Discontinuity of high elevation forests/alpine

WA Dept. of Natural Resources 1998

Ecology of Washington

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II. Ecosystems of WA

1. Ecoregions
2. Environmental Determinants of Ecoregions

II. Ecosystems of WA

2. Environmental Determinants of Terrestrial Ecoregions

Ecoregion	Elevation Range (ft.)	Avg. Annual Temp (°F)	Avg annual precip (cm)
(Seattle) for reference	0	53	86
Sitka Spruce	0 – 500	52	200 – 300
Western Hemlock	0 – 2500	47	150 – 300
Silver Fir	1900 – 4200	42	220 – 280
Mountain Hemlock	4200 – 5900	39	160 – 280
Subalpine Fir	4200 – 5800	39	100 – 150
Alpine	>5000 - >7000	37.5*	46*
Douglas-fir/Grand Fir	2000 – 5000	46	60 – 110
Ponderosa Pine	2000 – 4000	47	40 – 70
Shrub Steppe	150 – 2000	50	15 – 25
Palouse Prairie	< 3000	48	40 – 70

* Data from Paradise R.S. on Mt. Rainier (subalpine zone) / precip includes average snowfall of 256 cm

II. Ecosystems of WA



2. Environmental Determinants of Terrestrial Ecoregions

Bottom Line

Major determinants of ecoregion distribution:

I. Precipitation

- Amount
- Timing

II. Temperature

- Direct effects

III. Interactive Effects of Temperature & Moisture

