Future Washington BIS 358 Winter 2008

Understanding Washington's Ecology

January 9, 2008

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. Ecological Zones of WA (Jan. 14)

1. Ecoregions
2. Environmental Determinants of Ecoregions

The Ecology of Washington

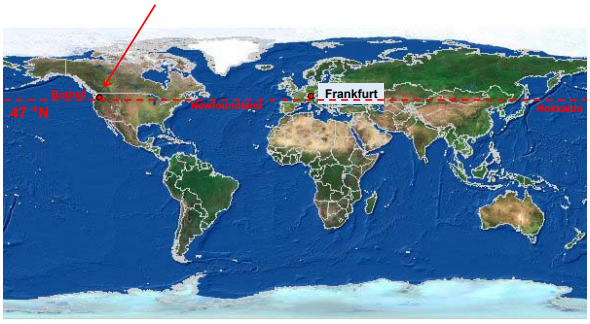
I. Abiotic Environment of WA

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

I. Abiotic Environment of WA

1. Global / Continental Position

A) Where are we ? Latitude: _____

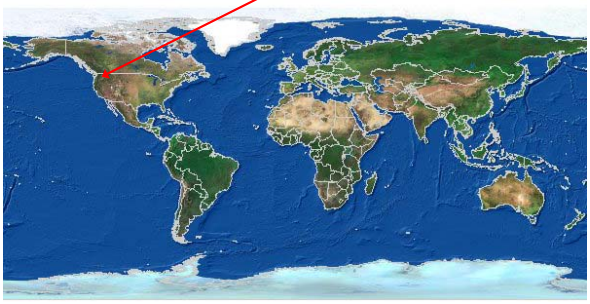


I. Abiotic Environment of WA

1. Global / Continental Position

A) Where is WA ?

Continental Position: Coastal Maritime



Global / Continental Position

B) What are the ecological implications of our position?

It affects our

I. Present-day Climate

1) Precipitation & Temperature
2) Daily & Seasonal Changes

II. Past Environment

1) Past Climate
2) Geological history

(and hence present day geology)

Global / Continental Position

B) What are the ecological implications of our position?

It affects our

I. Present-day Climate

1) Precipitation & Temperature
   - A. Atmospheric circulation
   - B. Oceanic circulation
   - C. Maritime influences

2) Daily & Seasonal Changes

II. Past Environment

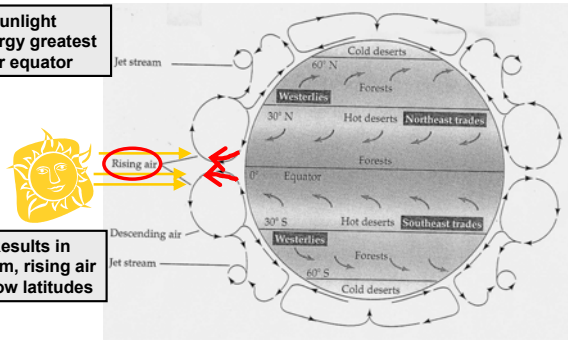
1) Past Climate

2) Geological history

Atmospheric Circulation is a major determinant of global precipitation & temperature patterns

1. Sunlight energy greatest near equator

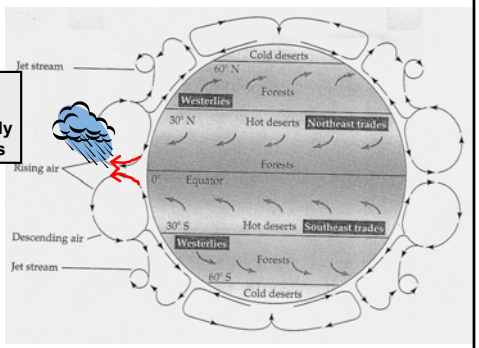
2. Results in warm, rising air at low latitudes



Campbell (2001)

Atmospheric Circulation is a major determinant of global precipitation & temperature patterns

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



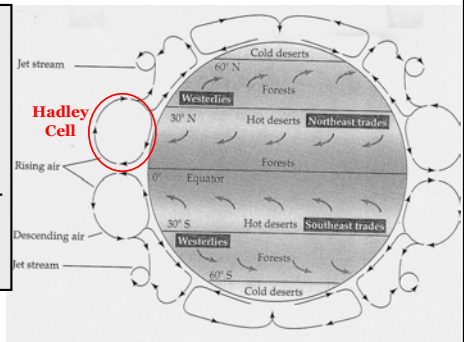
Campbell (2001)

Atmospheric Circulation is a major determinant of global precipitation & temperature patterns

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)

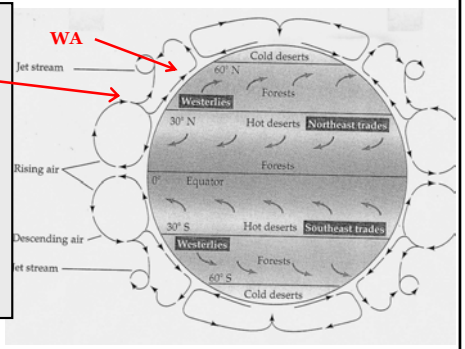


Campbell (2001)

Atmospheric Circulation is a major determinant of global precipitation & temperature patterns

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

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

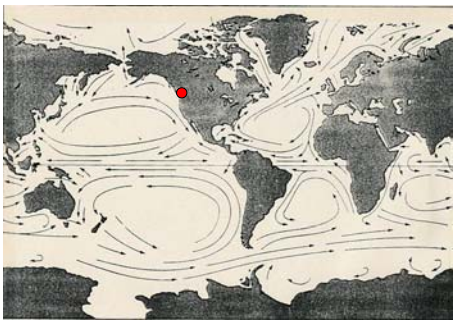


Campbell (2001)

Oceanic Circulation can be a major determinant of regional precipitation & temperature patterns

Ocean currents determine the temperature of surface waters.

This has large influences on coastal climates



Ricklefs (1997)

ENSO: El Nino – Southern Oscillation Events

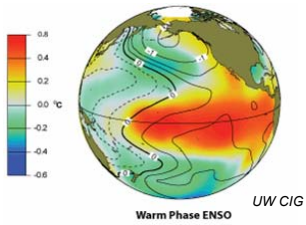
ENSO Events

El Niño *(warm phase)*

Warm surface water in the central & eastern Pacific

La Niña *(cool phase)*

Cool surface water in the central & eastern Pacific



UW CIG

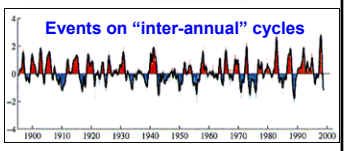
ENSO PNW Climate Impacts

El Niño *(warm phase)*

Warmer & drier winter

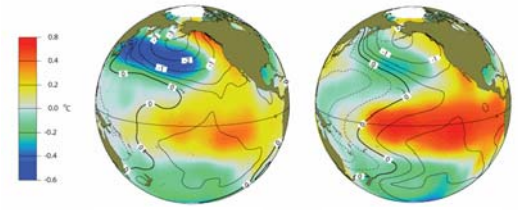
La Niña *(cool phase)*

Cooler & wetter winter



PDO: Pacific Decadal Oscillations

Similar to El Niño events, warm-phase PDO events show cooling of north Pacific; warming of central, eastern Pacific



PDO – warm phase **ENSO – warm phase**

UW CIG

PDO: Pacific Decadal Oscillations

But PDO Oscillations are decades – long; rather than the annual variations of ENSO

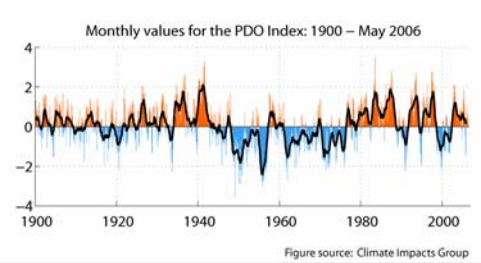
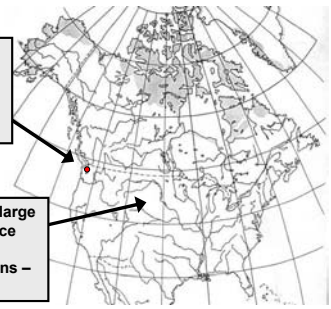


Figure source: Climate Impacts Group

Our coastal position results in strong maritime influences on our regional precipitation & temperature patterns

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

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



Global / Continental Position

B) What are the ecological implications of our position?

It affects our

I. Present-day Climate

1) Precipitation & Temperature

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II. Past Environment

1) Past Climate

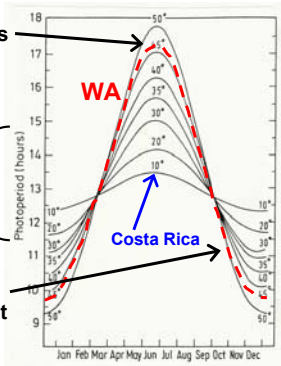
2) Geological history

Daylength & Seasonality

July: 17 hours of light

 # hours it is light during 24-hour period

October: 12 hours of light



Ricklefs (1997)

Ecological implications

of seasonal variation in daylength

Global / Continental Position

B) What are the ecological implications of our position?

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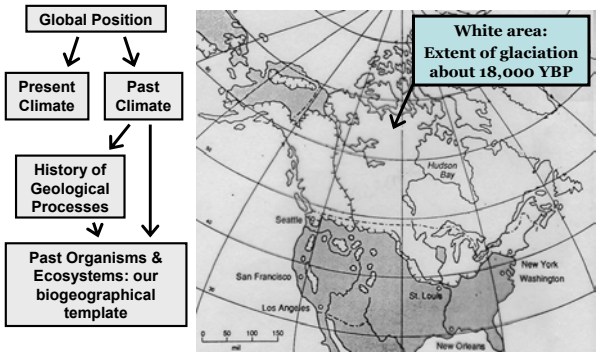
II. Past Environment

1) Past Climate

2) Geological history

Our location defines our past environments



Global / Continental Position

B) What are the ecological implications of our position?

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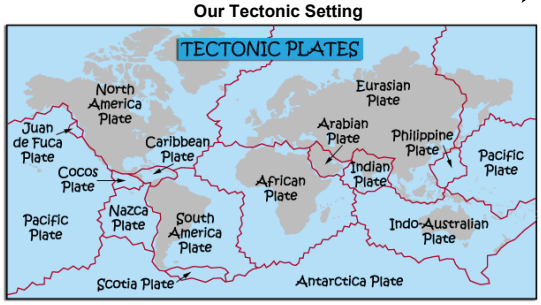
1) Past Climate

2) Geological history

Our location defines our past geological history

Our Tectonic Setting



Geological History

The Ecology of Washington

I. Abiotic Environment of WA

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

Regional Geography

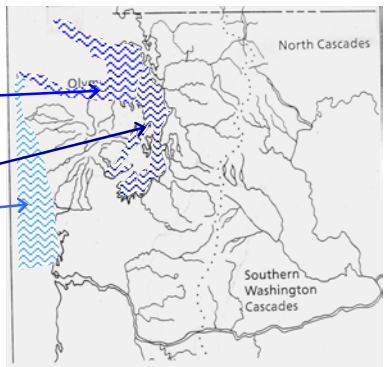
A) Water Bodies:

Marine

Strait of Juan de Fuca
San Juan Islands
Strait of Georgia

Puget Sound

Pacific Ocean



Regional Geography

A) Water Bodies:
Freshwater

Major Streams of WA

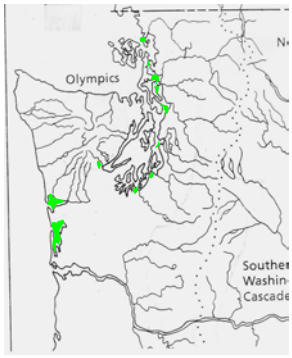
East side	West side
Columbia	Columbia
Snake	Cowlitz
Yakima	Chehalis
Spokane	Nisqually
Okanogan	Puyallup
	Green
	Snoqualmie
	Snohomish
	Stillaguamish
	Skagit
	Nooksack
	Skokomish
	Quinault
	Hoh

Regional Geography

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

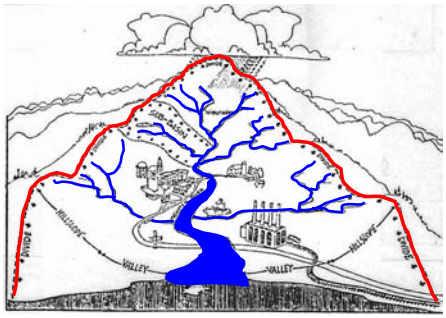
1. WA Geography & Features

B) Landscape Units:
Watersheds

WHAT IS A WATERSHED?

Watersheds

WHAT IS A WATERSHED?



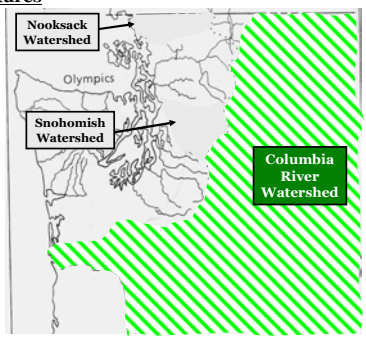
Murdoch & Cheo (1999)

I. Abiotic Environment of WA

1. WA Geography & Features

B) Landscape Units:
Watersheds

Major Watersheds of Washington
Columbia
Chehallis
Willapa & Naselle
Nisqually
Puyallup
Cedar / Green
Snohomish
Stillaguamish
Skagit
Nooksack
Skokomish



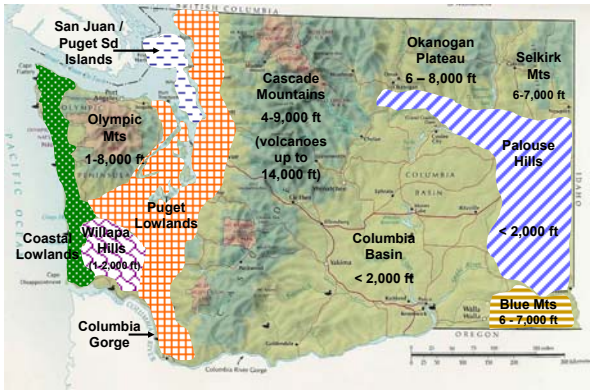
I. Abiotic Environment of WA

1. WA Geography & Features

B) Landscape Units: Physiographic Regions

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

Physiographic Regions of WA



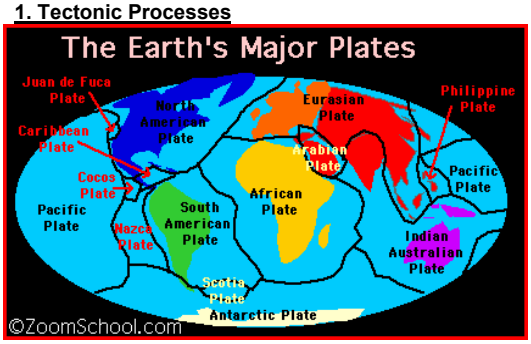
The Ecology of Washington

I. Abiotic Environment of WA

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

Forces That Shape Our Land

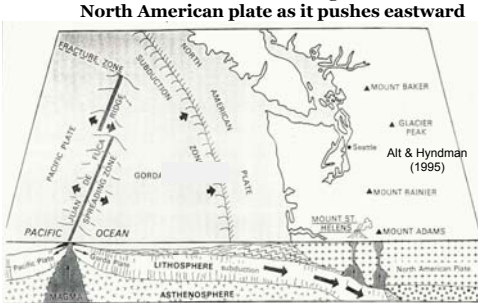
1. Tectonic Processes



Forces that Shape our Land

1. Tectonic Processes

Subduction – the Pacific Plate is being forced down under the North American plate as it pushes eastward



Alt & Hyndman (1995)

Protruding pieces of crust on the Pacific Plate are scraped off and accrete onto the shoreline

Forces that Shape our Land

1. Tectonic Processes

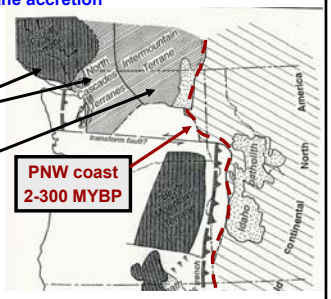
(A) Creating Landforms: terrane accretion

Tectonic terrane:
A piece of crustal rocks separated from its original plate

Terrane accretion

↓

Complex geology

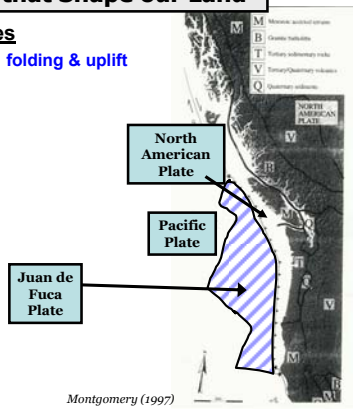


Alt & Hyndman (1995)

Forces that Shape our Land

1. Tectonic Processes

(B) Creating Landforms: folding & uplift

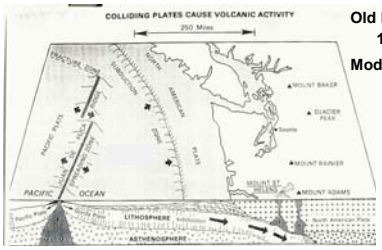


Montgomery (1997)

Forces that Shape our Land

1. Tectonic Processes

(C) Creating Landforms: volcanism



Alt & Hyndman (1994)

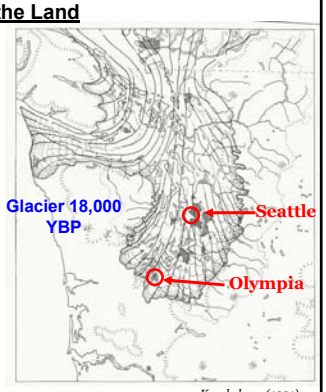
Old Basin & Range Basalt Flows:
13 - 16 MYBP

Modern Cascade Volcanoes:
3 – 500,000 YBP

Forces that Shape our Land

2. Processes Reshaping the Land

(A) Continental Ice



Kruckeberg (1991)

Forces that Shape our Land

2. Processes Reshaping the Land

(B) Mountain Glaciers

- Mountain carving
- Moraines

Forces that Shape our Land

2. Processes Reshaping the Land

(C) Water

1) Hill & valley local topography

2) Mountain valley topography

3) Eastern WA scablands & coulees

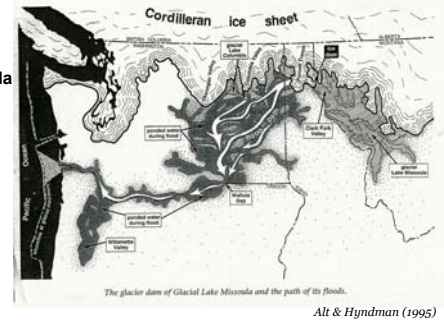
Forces that Shape our Land

2. Processes Reshaping the Land

(C) Water

Great Floods reshaping the lands of Eastern WA

Lake Missoula Floods
15,000 YBP



The glacier dam of Glacial Lake Missoula and the path of its floods.

Alt & Hyndman (1995)

Forces that Shape our Land

2. Processes Reshaping the Land

(C) Water

1) Hill & valley local topography

2) Mountain valley topography

3) Eastern WA scablands & coulees

4) Columbia River gorge

5) River deltas (estuaries):
   rivers bring in and take away sediment
   tides take away sediment

Forces that Shape our Land

2. Processes Reshaping the Land

(D) Wind

The Ecology of Washington

I. Abiotic Environment of WA

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

I. Abiotic Environment

4. Geology: influences ecological systems at different spatial scales

Large scale: Tectonics	**Landform creation**
Medium scale: Regional	**Landform modification** **Groundwater – surface water connections** **Surface rock diversity weathers into diverse soils**
Small scale: microhabitats	**Boulders create unique microsites** **Influences on erosion** **Soil chemistry**

Modified from Montgomery (1997)

The Ecology of Washington

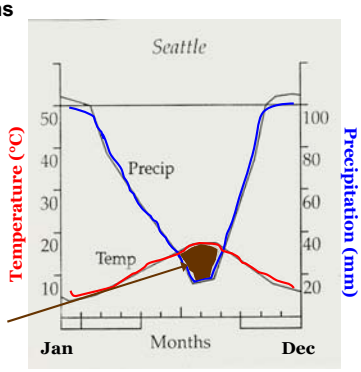
I. Abiotic Environment of WA

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

Washington Climate

1) Climate diagrams

1. **Temperature**
2. **Precipitation**
3. **Drought**

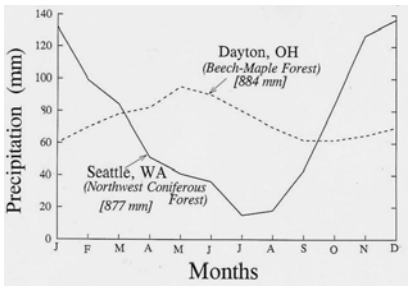


Temp > Precip

Washington Climate

2) Climate patterns

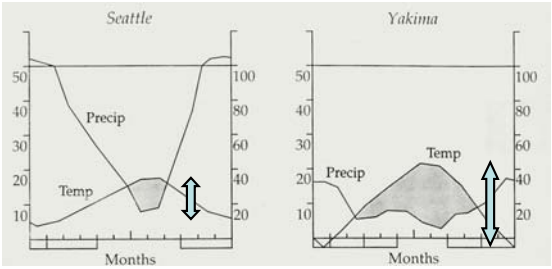
WA State: Climate



Washington Climate

2) Climate patterns

Western WA: Maritime Climate | **Eastern WA: Continental Climate**



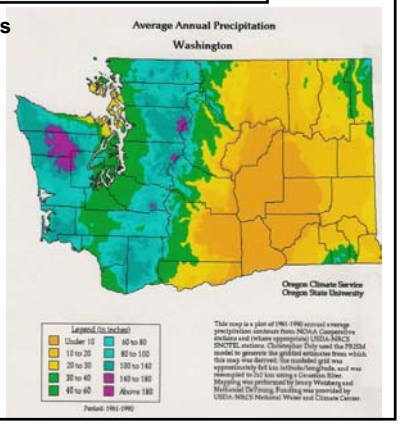
Why are these different ?

Kruckeberg (1991)

Washington Climate

2) Climate patterns

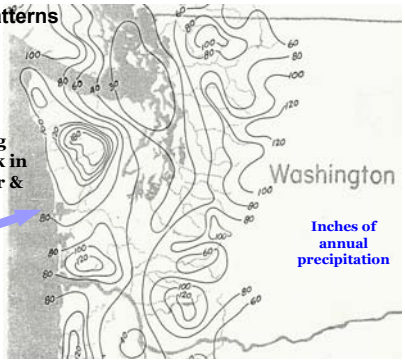
Spatial patterns in precipitation – across WA State



Washington Climate

2) Climate patterns

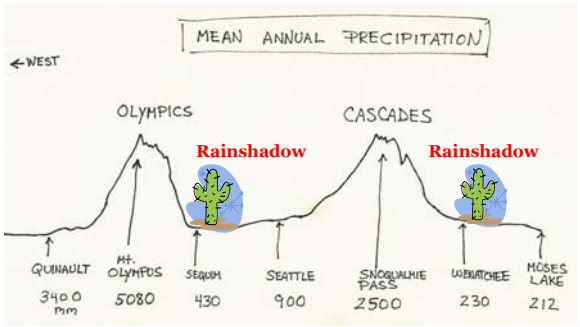
Prevailing Storm Track in Fall, Winter & Spring



Kruckeberg (1991)

Washington Climate

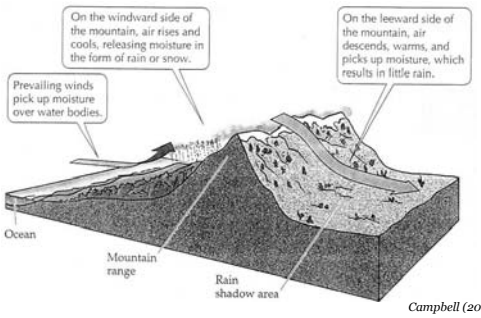
2) Climate patterns



Washington Climate

2) Climate patterns

What causes these rainshadows?

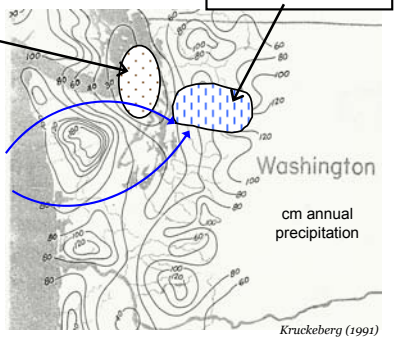


Campbell (2001)

Washington Climate

3) Local variations in climate patterns

Prevailing Storm Track in Fall, Winter & Spring



Kruckeberg (1991)

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1. Where are we? : Global / Continental Position
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II. Ecological Zones of WA

1. Ecoregions
2. Environmental Determinants of Ecoregions

II. Ecological Zones of WA

January 14, 2008

1. Ecoregions

2. Environmental Determinants of Ecoregions

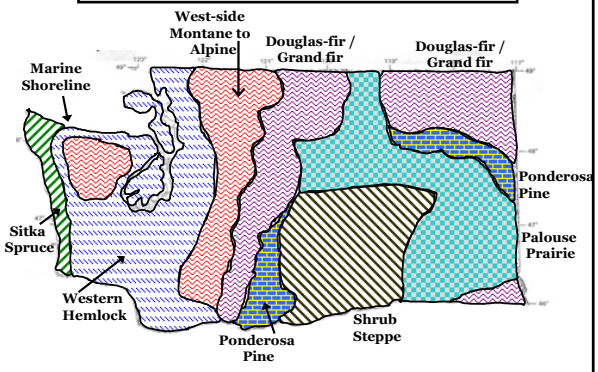
II. Ecosystems of WA

1. Ecoregions

11 Ecoregions of Washington State

1. Marine Shoreline
2. Sitka Spruce
3. Western Hemlock
4. Silver Fir
5. Mountain Hemlock
6. Subalpine Fir
7. Alpine
8. Douglas-fir / Grand Fir
9. Ponderosa Pine
10. Shrub Steppe
11. Palouse Prairie

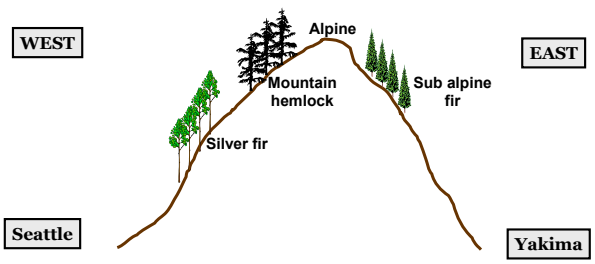
Washington State Ecoregions



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

Washington State Ecoregions

Montane to Alpine Ecoregions



Washington State 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

II. Ecosystems of WA

2. Environmental Determinants of Terrestrial Ecoregions

Bottom Line

Major determinants of ecoregion distribution:

I. Precipitation

- Amount
- Timing

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

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II. Ecosystems of WA

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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

BEWARE OF MEAN VALUES!

II. Ecosystems of WA

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III. Interactive Effects of Temperature & Moisture

- Moisture effects ability to cope with temperature

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