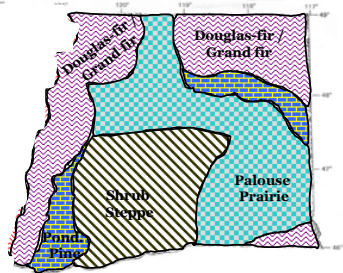
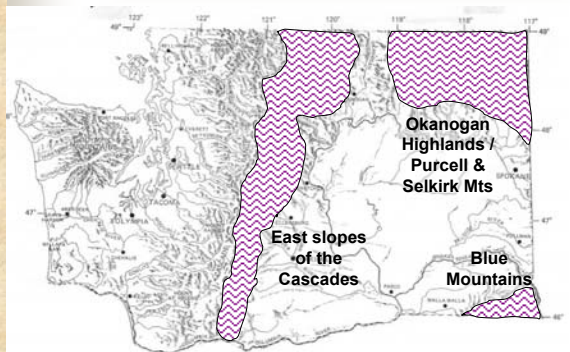


Washington State Ecoregions: East-Side



Douglas-fir / Grand fir Ecoregion



Douglas-fir / Grand fir Ecoregion: Climate

General Environment : warm & relatively dry

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

What mean values do not reveal is: _____

Douglas-fir / Grand fir Ecoregion: Climate

This east-side forest ecoregion is more continental in climate:
Greater temperature extremes for similar mean values

Air Temperature

Station	Ecoregion	Elevation (ft)	Mean annual (°F)	Mean Jan min (° F)	Mean Jul max (° F)
Tonasket	Doug-fir / Grand fir	960	49.4	22.7	87.2
Darrington	Western Hemlock	550	49.1	27.7	77.3
Snoqualmie Falls	Western Hemlock	440	50.4	32.9	75.4
Republic	Doug-fir / Grand fir	2,600	43.2	15.1	81.4
Greenwater	Western Hemlock	1,700	45.6	26.0	73.1
Snoqualmie Pass	Western Hemlock	3,000	42.1	21.1	70.4

What are the effects of this difference in temperature extremes on precipitation?

Data from the Western Regional Climate Center <http://www.wrcc.dri.edu/>

Douglas-fir / Grand fir Ecoregion

Focus on diverse forest ecosystems

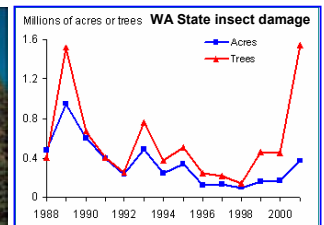
Most diverse forests in terms of trees:

- Grand fir
- Douglas-fir
- Engelmann spruce
- Subalpine fir
- Ponderosa pine
- Lodgepole pine
- Western white pine
- Whitebark pine
- Western larch
- Alpine larch

Okanogan Highlands

Disturbance in the Douglas-fir / Grand fir Ecoregion: Pests

Insect damage to WA forests can be intense and it varies through years



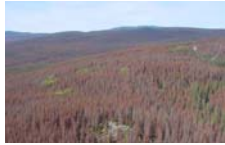
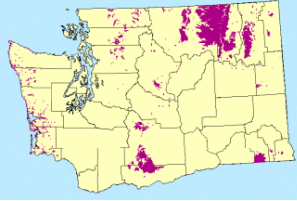
USDA Forest Service
<http://www.fs.fed.us/r6/nr/fid/health/2001highlights-wa.shtml>

Disturbance in the Douglas-fir / Grand fir Ecoregion: Pests

Insect damage to east-side forests is common

and _____

WA State insect defoliation rate 1989 - 1993



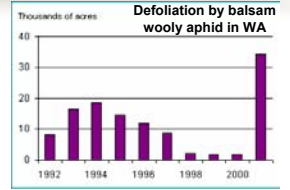
Mtn pine beetle infestation, British Columbia
<http://www.for.gov.bc.ca/hre/bc/mpb/>

USDA Forest Service

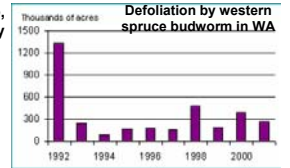
<http://www.fs.fed.us/r6/nr/fid/health/2001highlights-wa.shtml>

Disturbance in the Douglas-fir / Grand fir Ecoregion: Pests

Insect damage by certain species varies through time



Specific conditions (climate, biological) for outbreak vary for each different pest through time



USDA Forest Service

<http://www.fs.fed.us/r6/nr/fid/health/2001highlights-wa.shtml>

Disturbance in the Douglas-fir / Grand fir Ecoregion: Pests

- massive outbreak of the mountain pine beetle in BC has killed 100 billion board feet (~ 9 yrs of harvest)



How will climate change influence the _____



Info courtesy of A Snover, UW Climate Impacts Group

Photos from <http://www.for.gov.bc.ca>

Disturbance in the Douglas-fir / Grand fir Ecoregion: Fire

Fire is also frequent and extensive (and interacts with insect damage)

Fire cycle: _____

(compare to Western hemlock; Sitka spruce; & Silver fir from previous classes)

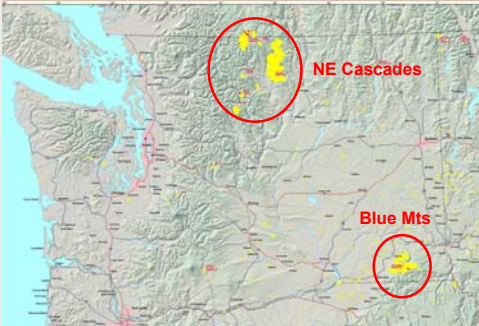


Data: Agee 1993

Disturbance in the Douglas-fir / Grand fir Ecoregion: Fire

This ecoregion is disproportionately affected by fire

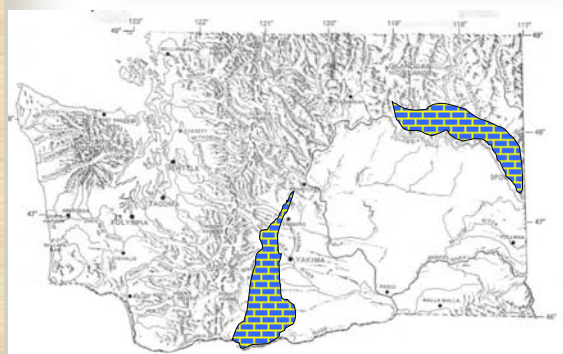
MODIS Active Fire Detections - September 11, 2006



USDA Forest Service

<http://activefiremaps.fs.fed.us/activefiremaps.php>

Ponderosa Pine Ecoregion



Ponderosa Pine Ecoregion: Climate

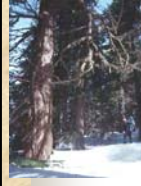
General Environment : warm & quite dry

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
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Ponderosa Pine	2000 – 4000	47	40 – 70
Shrub Steppe	150 – 2000	50	15 – 25
Palouse Prairie	< 3000	48	40 – 70

What mean values do not reveal is: _____

Ponderosa Pine Ecoregion

Focus on mature Ponderosa Pine Forest ecosystem



1.

2.



Pinus ponderosa

Ponderosa Pine Ecoregion

Ponderosa Pine is well adapted for fire (and drought)



Acidic litter deters tall undergrowth, promoting low intensity ground fires



No lower branches to carry fire upward



Thick, fire-resistant bark

Pinus ponderosa

Ponderosa Pine Ecoregion

Insect damage to forests of this ecoregion can also be serious



Photo: Northern Arizona University

Data: USDA Forest Service <http://www.fs.fed.us/r6/nr/rid/health/2001highlights-wa.shtml>

Shrub Steppe Ecoregion



Shrub Steppe Ecoregion: Climate

General Environment : HOT & VERY dry

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
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Palouse Prairie	< 3000	48	40 – 70

What mean values do not reveal is: _____

Shrub Steppe Ecoregion



Big sagebrush (*Artemisia tridentata*)

Low elevation hot, arid shrub and grass dominated ecosystems:



Shrub Steppe Ecoregion



Bluebunch wheatgrass (*Pseudoroegneria spicata*)



Grass dominated steppe and pothole wetlands



Shrub Steppe Ecosystem Productivity

Shrub Steppe productivity:
105 - 166
g C / m² / yr

Grassland Steppe productivity:
239 - 368
g C / m² / yr

Daubenmire 1988
10 - 15 % NPP of west-side ecosystems

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 and 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

Disturbance in the Shrub Steppe Ecoregion: Invasive Species

Non-native Species

20% WA Shrub Steppe plants are non-native

The horror of

Cheatgrass (*Bromus tectorum*)

Covers nearly 100 million acres of Columbia Basin

Outcompetes natives

Germinates in ALL seasons, taking advantage of transient moisture

Produces huge # of seeds



Cheatgrass Fire Cycle

Produces huge amount of flammable biomass (4x NPP of native sagebrush community)
Fire frequency & extent increase
Colonizes rapidly after fire – positive feedback cycle



Disturbance in the Shrub Steppe Ecoregion: Fire

Fire is a frequent natural feature

24-Command Fire at Arid Lands Ecology Reserve (July 2000)

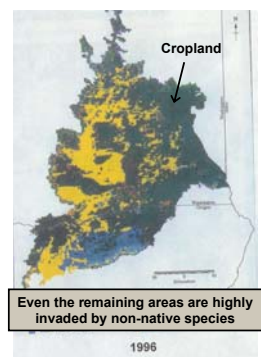
164,000 acres in 6 days

Effect on cheatgrass:

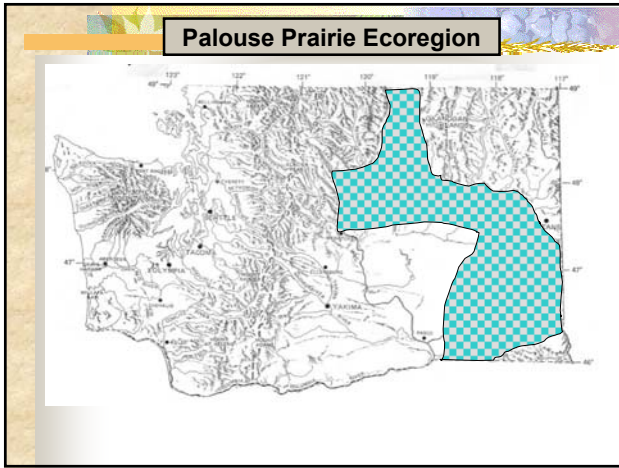


Disturbance in the Shrub Steppe Ecoregion: Land Use

Little Pristine Shrub Steppe Remains



Even the remaining areas are highly invaded by non-native species



Palouse Prairie Ecoregion: Climate

General Environment : Hot & somewhat dry

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
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What mean values do not reveal is _____

