What can we expect for vegetation and fire regimes as the climate changes?

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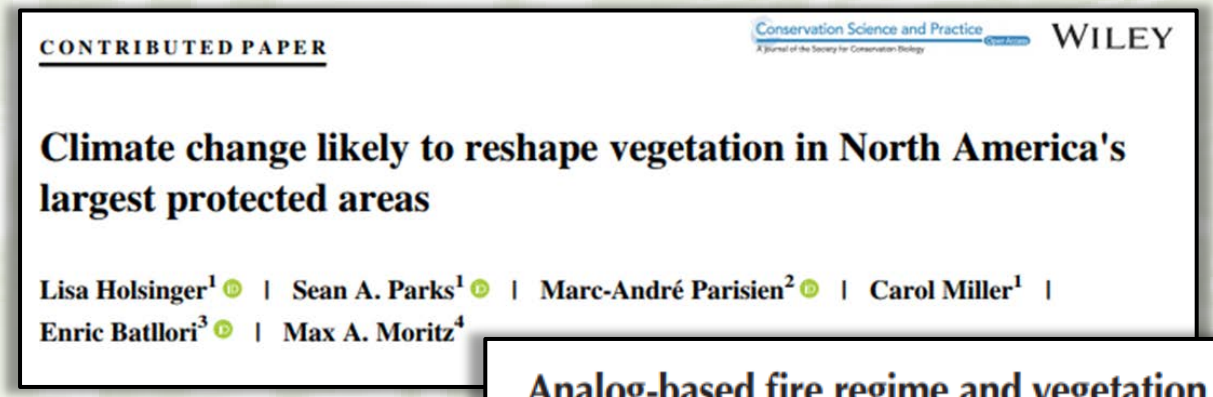


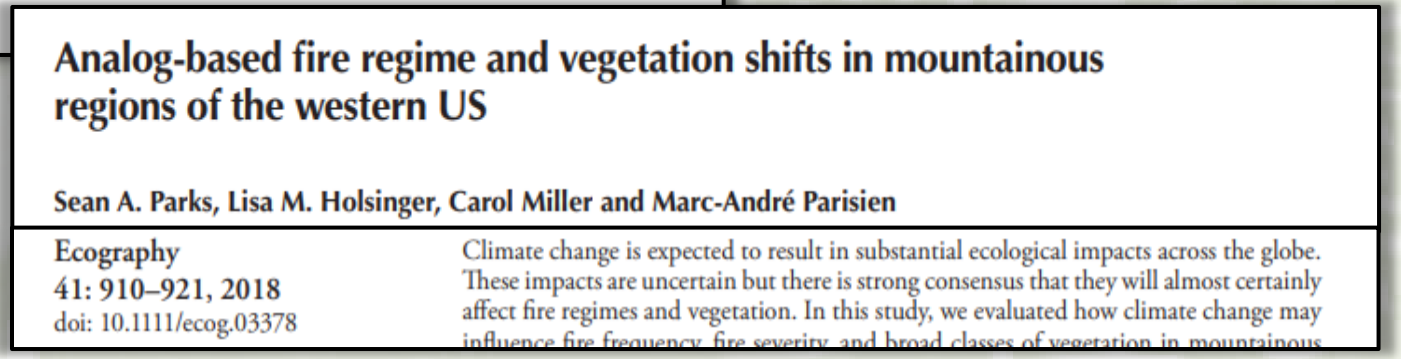
CONTRIBUTED PAPER

Conservation Science and Practice

WILEY

Climate change likely to reshape vegetation in North America's largest protected areas

Lisa Holsinger[1] | Sean A. Parks[1] | Marc-André Parisien[2] | Carol Miller[1] | Enric Batllori[3] | Max A. Moritz[4]



Analog-based fire regime and vegetation shifts in mountainous regions of the western US

Sean A. Parks, Lisa M. Holsinger, Carol Miller and Marc-André Parisien

Ecography
41: 910–921, 2018
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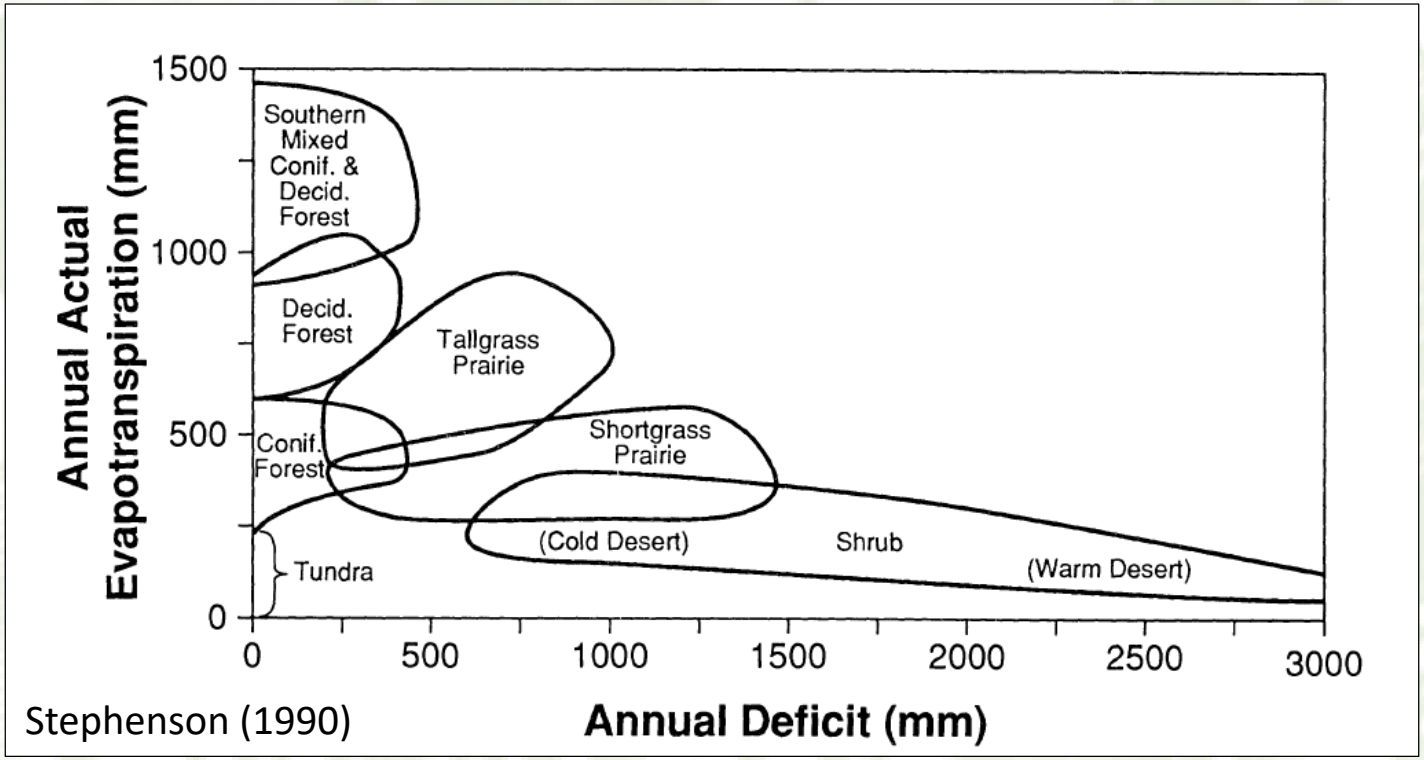
Climate change is expected to result in substantial ecological impacts across the globe. These impacts are uncertain but there is strong consensus that they will almost certainly affect fire regimes and vegetation. In this study, we evaluated how climate change may influence fire frequency, fire severity, and broad classes of vegetation in mountainous

Climate strongly determines vegetation distributions

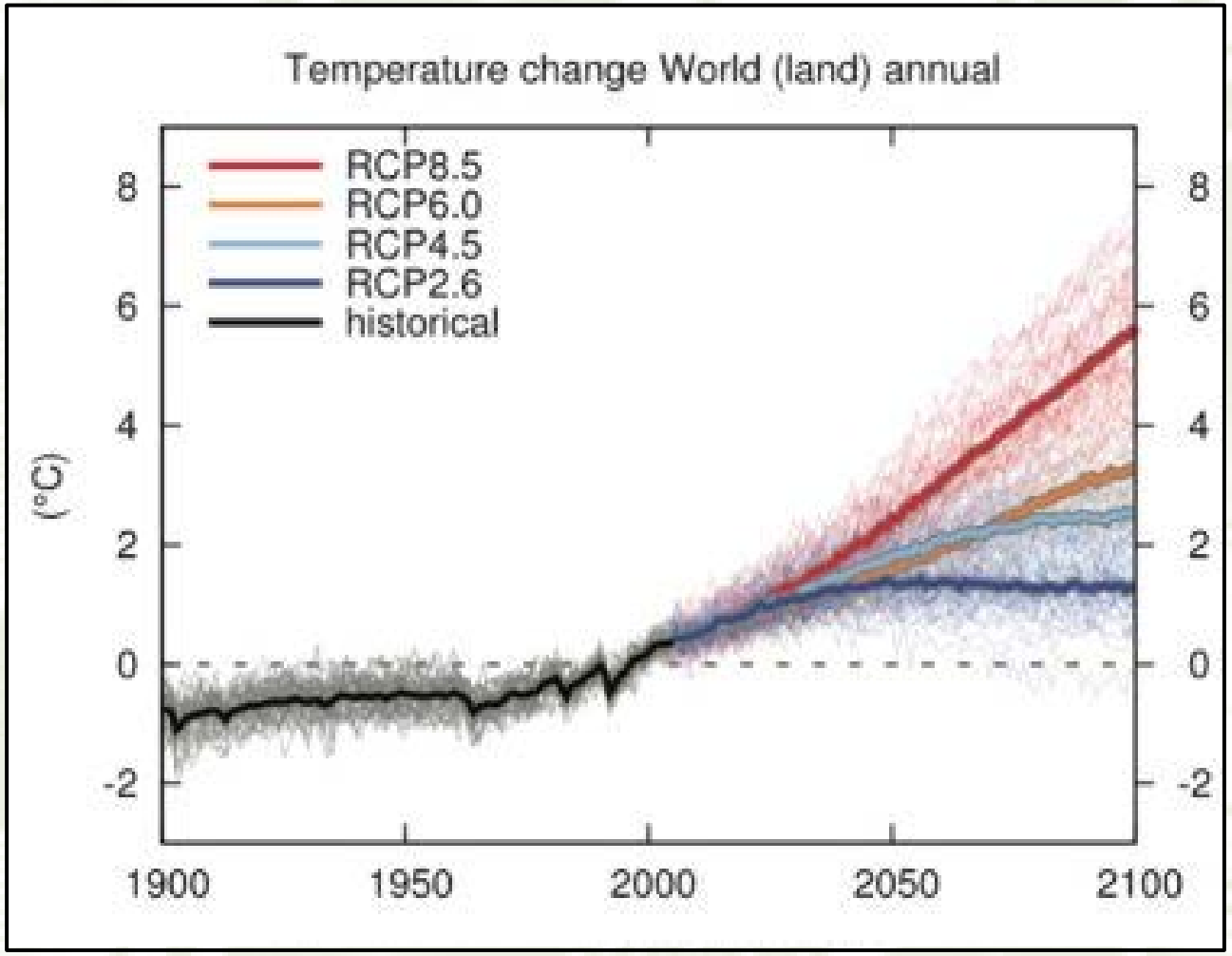


Stephenson (1990)

- AET: quantity of water evaporated & transpired
- Deficit: unmet demand for water (index of potential drought stress)

Climate strongly determines vegetation distributions

and climate is expected to change



What might future vegetation look like in North American Protected Areas?

22 Protected Areas:

- >10,000 km^2
- High IUCN Protection Status

Fine-scale (1-km) vegetation maps:

- mid-century & late-century time periods
- transitions between vegetation types

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Climate Analog Approach

Identifies areas where the climate today is similar (analogous) to the future projected climate for a place of interest

My Site

Where can I find the future climate of my site today

Analog Sites

Infer future vegetation at My Site

Veg at My Site

Assumes places with similar climate will also have similar vegetation

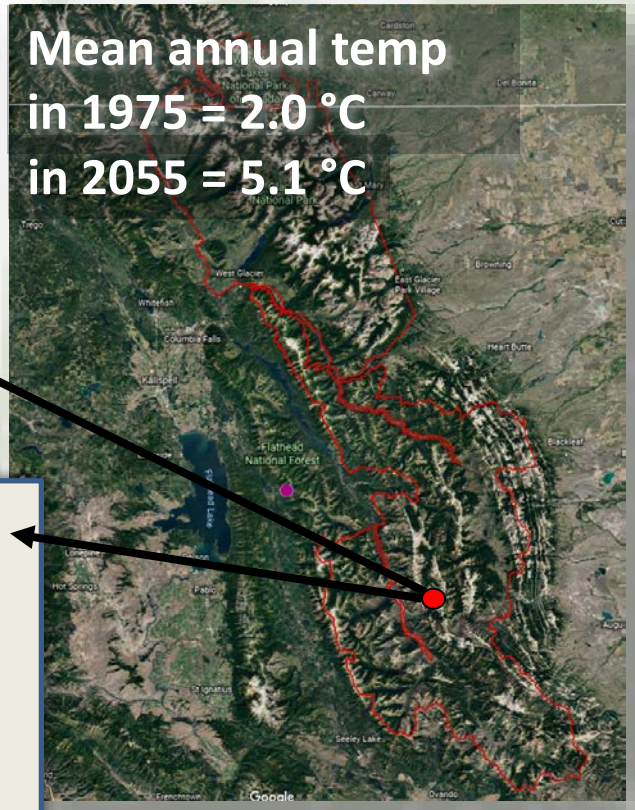
Climate Analog Approach

Identifies areas where the climate today is similar (analogous) to the future projected climate for a place of interest

My Site

1975, 2.0 °C

2055, 5.1 °C



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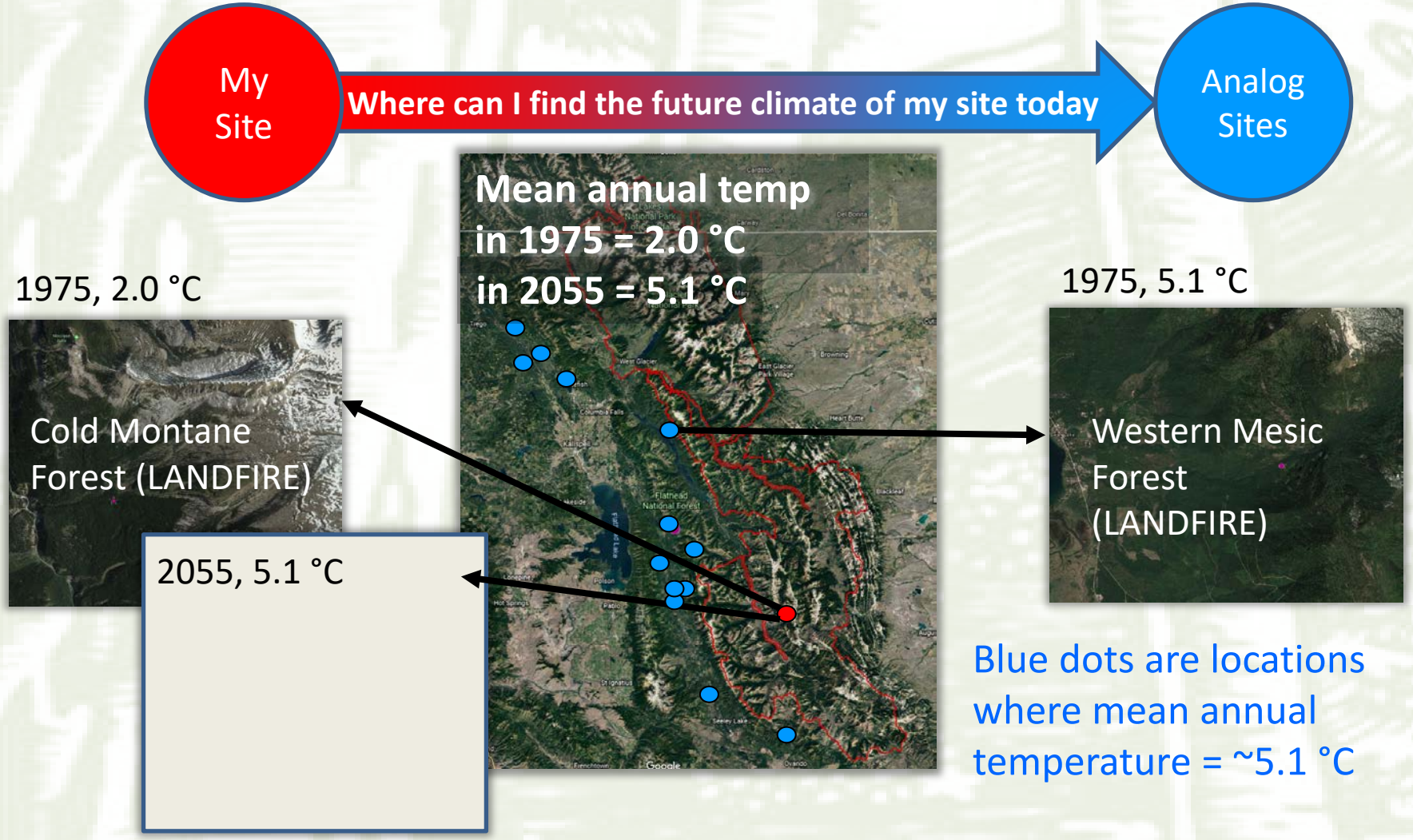

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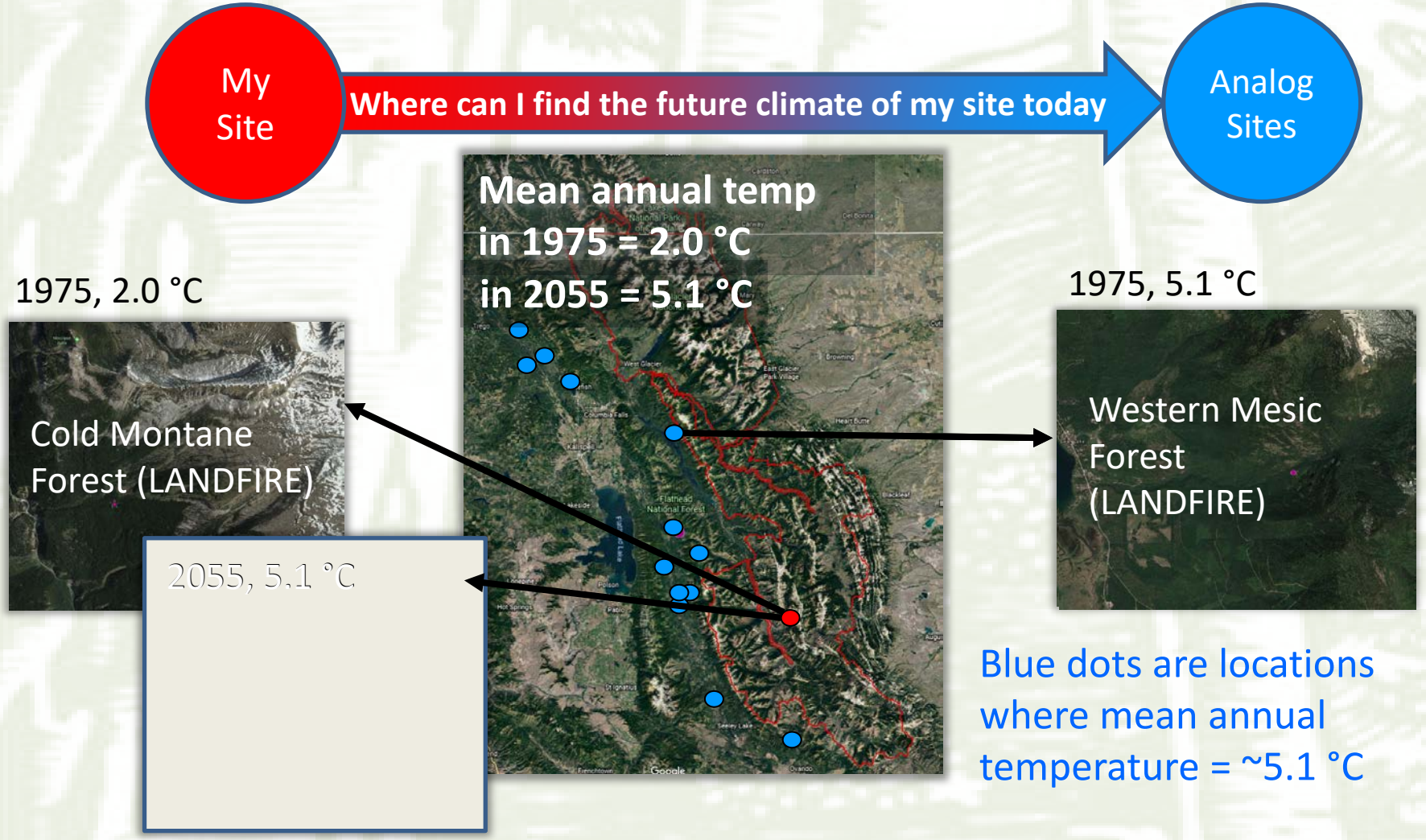


What might future vegetation look like in North American Protected Areas?

Fine-scale (1-km) vegetation maps:

- mid-century & late-century time periods
- transitions between vegetation types (reclassified LANDFIRE)

Climate Variables:

- climate moisture deficit (CMD)
- evapotranspiration (ET)

Analog Pixels:

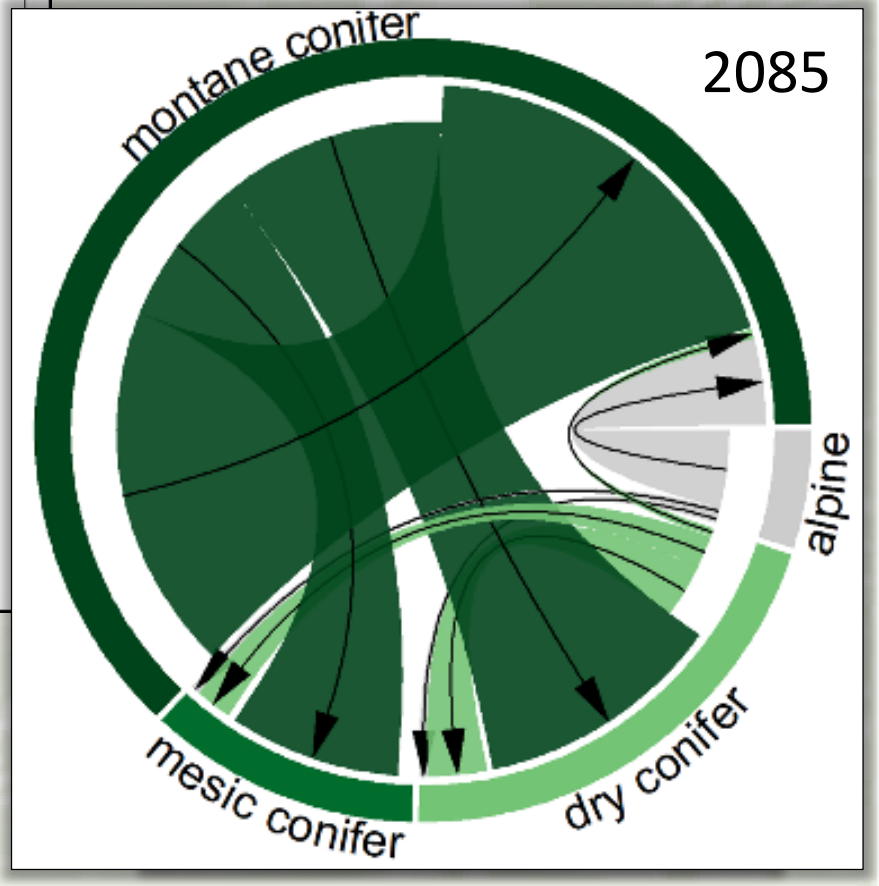
- within ± 1 mm/yr CMD & ET (sq rt transformed)
- majority vegetation of 7 nearest analogs

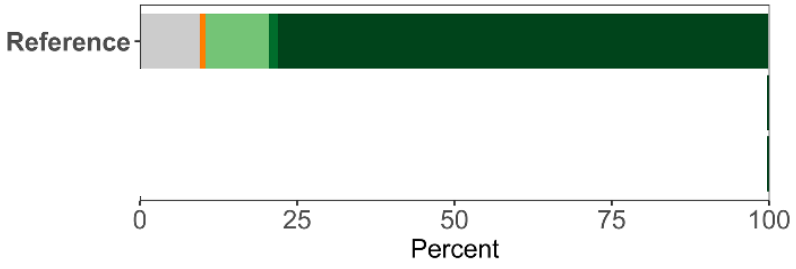
Climate Projections:

- 3 GCMs, MPI-ESM-LR = median level Δ
- RCP8.5 scenario

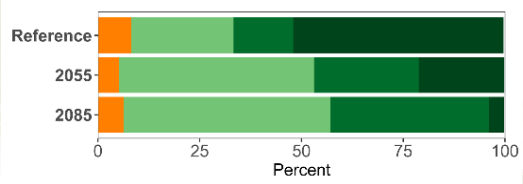
Crown of the Continent

cold montane conifer forest
western mesic conifer forest
western dry conifer forest
shrubland
alpine/sparse/barren/snow/ice
water/wetland

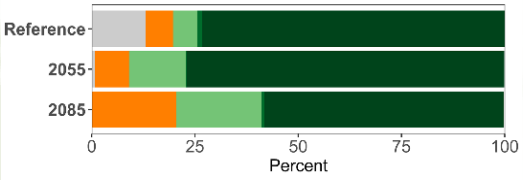




Selway-Bitterroot and Frank Church

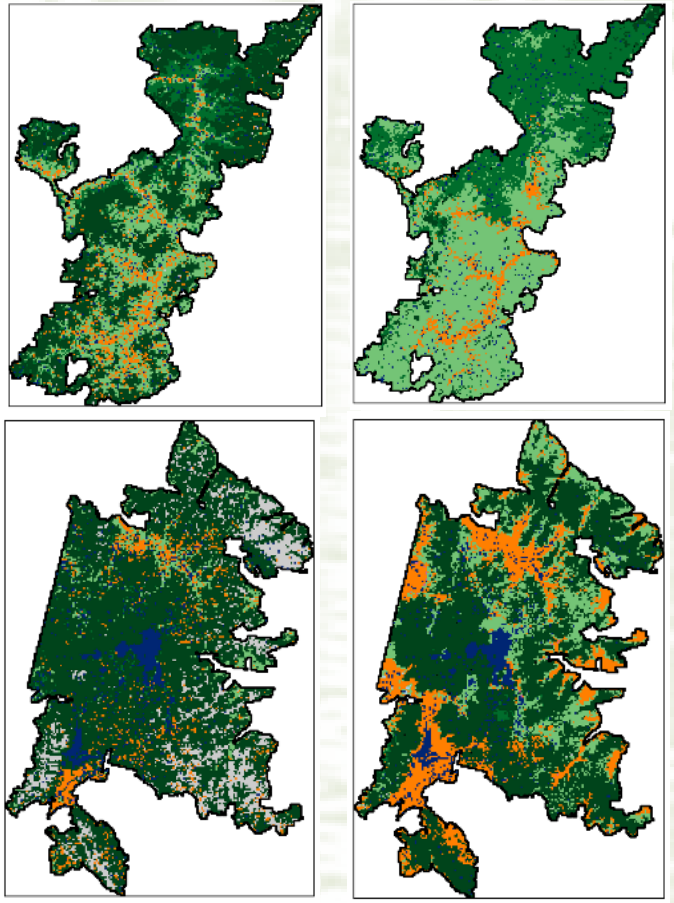


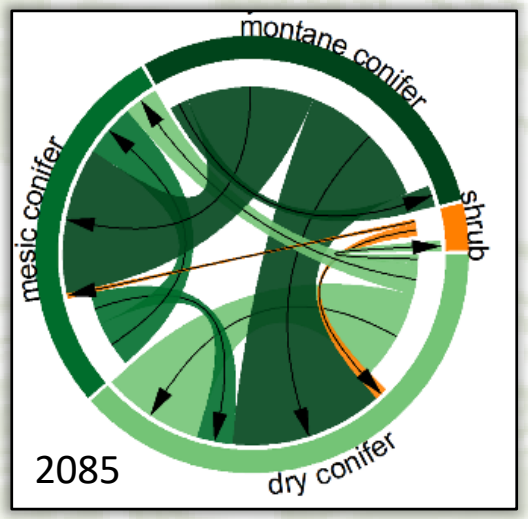
Greater Yellowstone

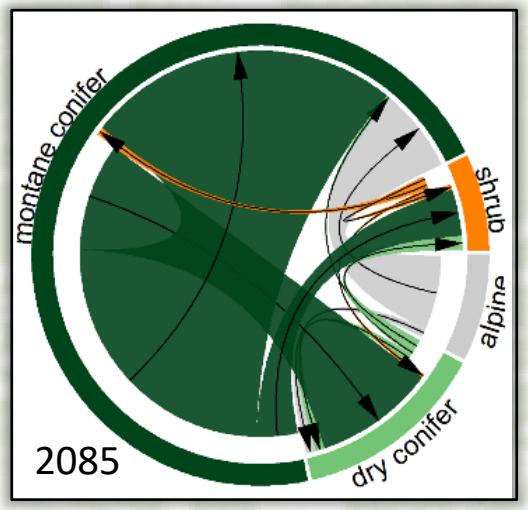


Reference

2085







- cold montane conifer forest
- western mesic conifer forest
- western dry conifer forest
- western deciduous forest
- shrubland
- alpine/sparse/barren/snow/ice
- water/wetland

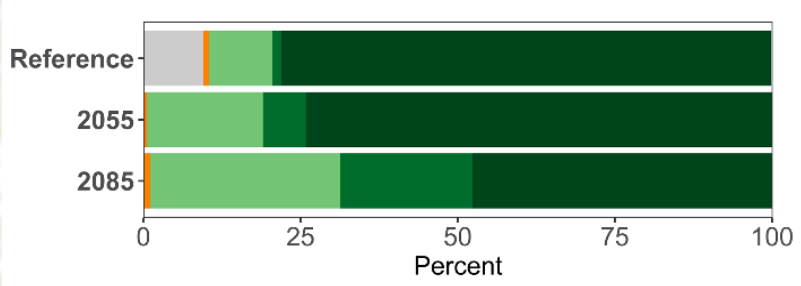
What might future vegetation look like in North American Protected Areas?

Potential redistribution of vegetation

- **Alpine ➡ conifer forest**
- **Cold montane forest ➡ mesic or dry conifer**
- Dry conifer or mixed forests ➡ deciduous forest
- Mesic deciduous & pine forests ➡ oak or dry deciduous
- Low elevation scrub/mesquite/chaparral ➡ upward in elevation

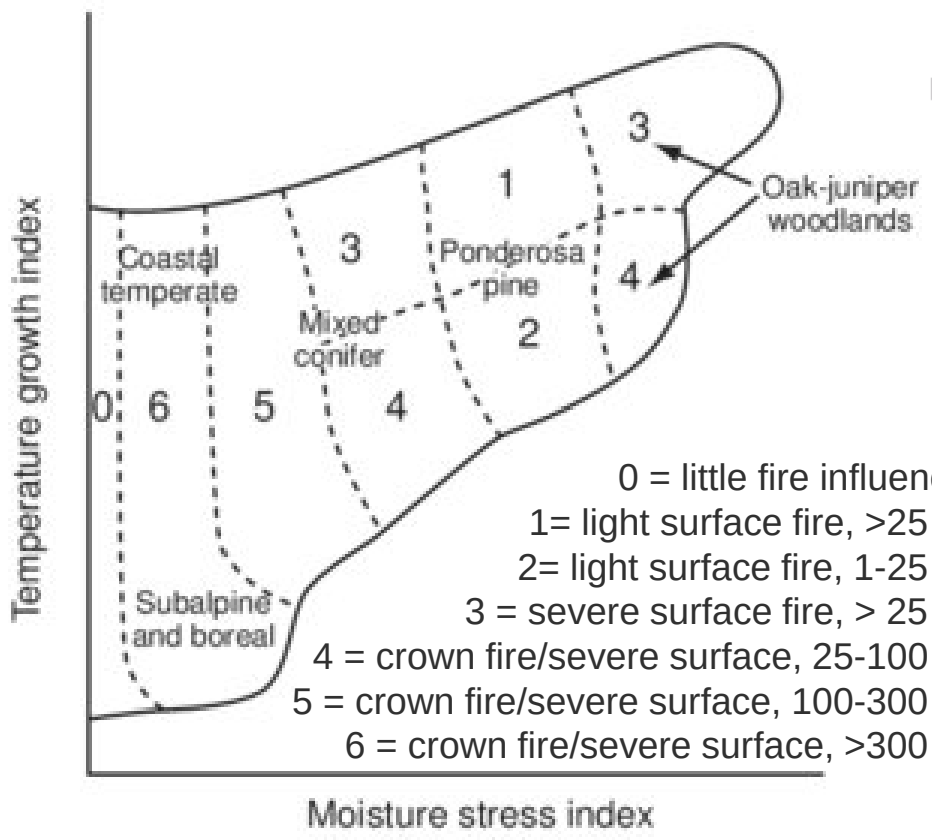
Considerations

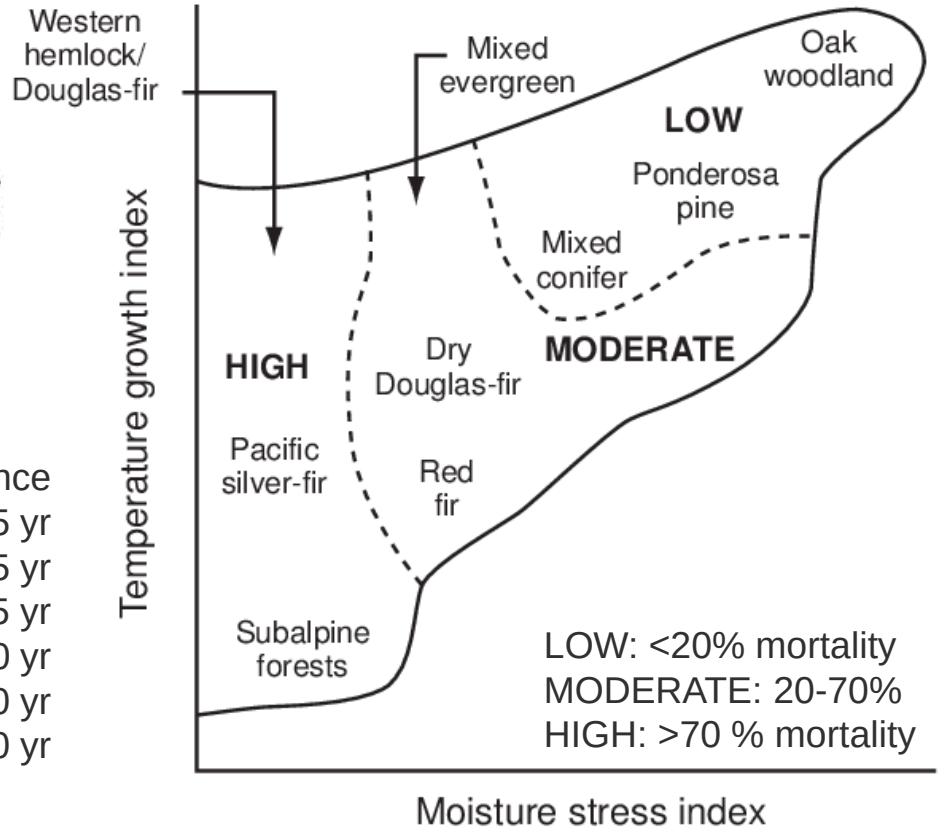
- Broad scale, 1-km pixels
- Best viewed in terms of climatic "suitability"
- High inertia to change due to natural lags in the system
  - species migration limited by dispersal, rate of maturation
  - limitations to colonization related to soils
  - persistence of long-lived trees
- Disturbances (fire) could catalyze abrupt change



Climate strongly determines fire regime distributions

Pacific Northwest fire regimes (Agee 1981)





What might future fire regimes look like in mountainous regions of the western US?

Climate Analog Approach

My Site

Where can I find the future climate of my site today

Analog Sites

LANDFIRE data

Frequency: Fire Return Interval

Severity: Percent Replacement Severity (% of fires with ≥ 75% canopy consumption)

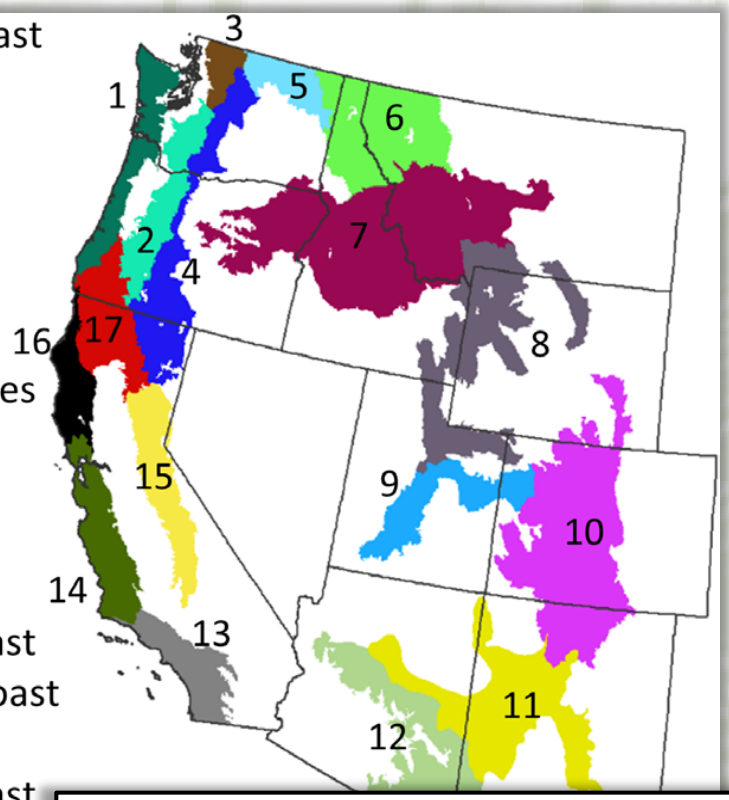
Infer future FIRE REGIMES at My Site

FIRE at My Site

Assumes places with similar climate will also have similar fire regimes

What might future fire regimes look like in mountainous regions of the western US?

1. Pacific Northwest Coast
2. West Cascades
3. North Cascades
4. East Cascades
5. Okanagan
6. Canadian Rockies
7. Middle Rockies
8. Utah-Wyoming Rockies
9. Utah High Plateaus
10. Southern Rockies
11. AZ-NM Mountains
12. Apache Highlands
13. California South Coast
14. California Central Coast
15. Sierra Nevada
16. California North Coast
17. Klamath Mountains



Fine-scale (1-km) maps of frequency & severity:

- early-, **mid-**, & late-century

Climate projections:

- RCP8.5 scenario
- ensemble of 15 GCMs

Analog Pixels:

- ± 3.125 scaled units (CMD & ET)
- average of 3 nearest analogs for frequency & severity

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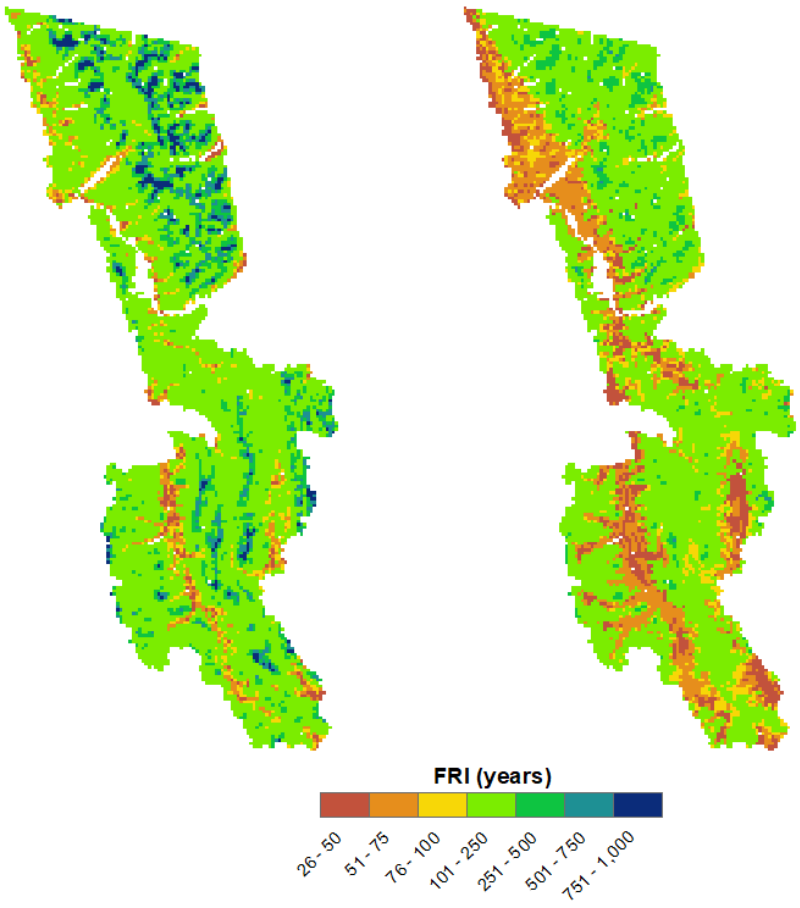
The potential future for fire regimes

Fire return interval (FRI)

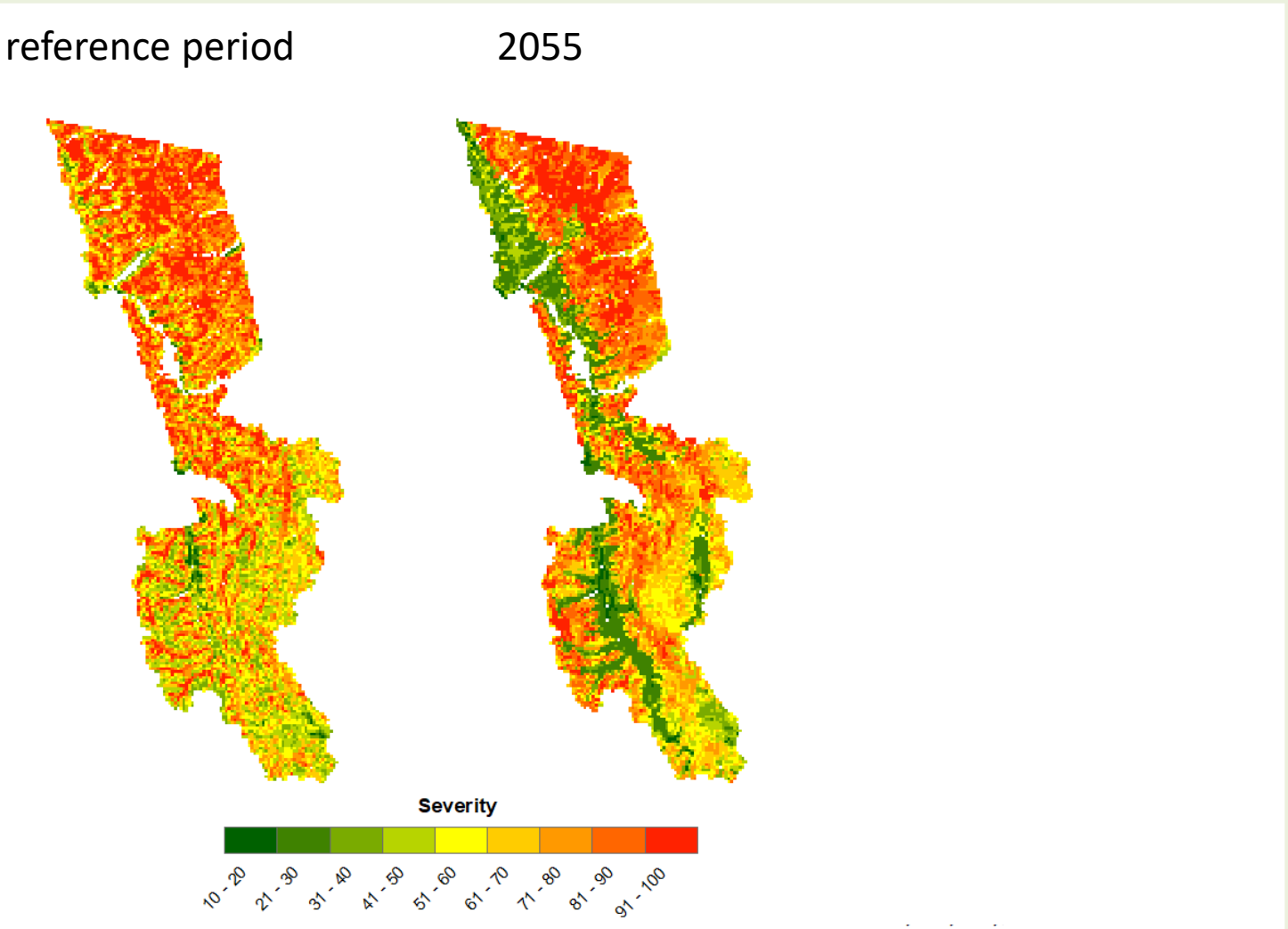
reference period

2055



The potential future for fire regimes

Percent replacement severity (PRS)



What might future fire regimes look like in mountainous regions of the western US?

Potential redistribution of fire regimes

Fire frequency and severity could increase or decrease, depending on bioclimatic domain.

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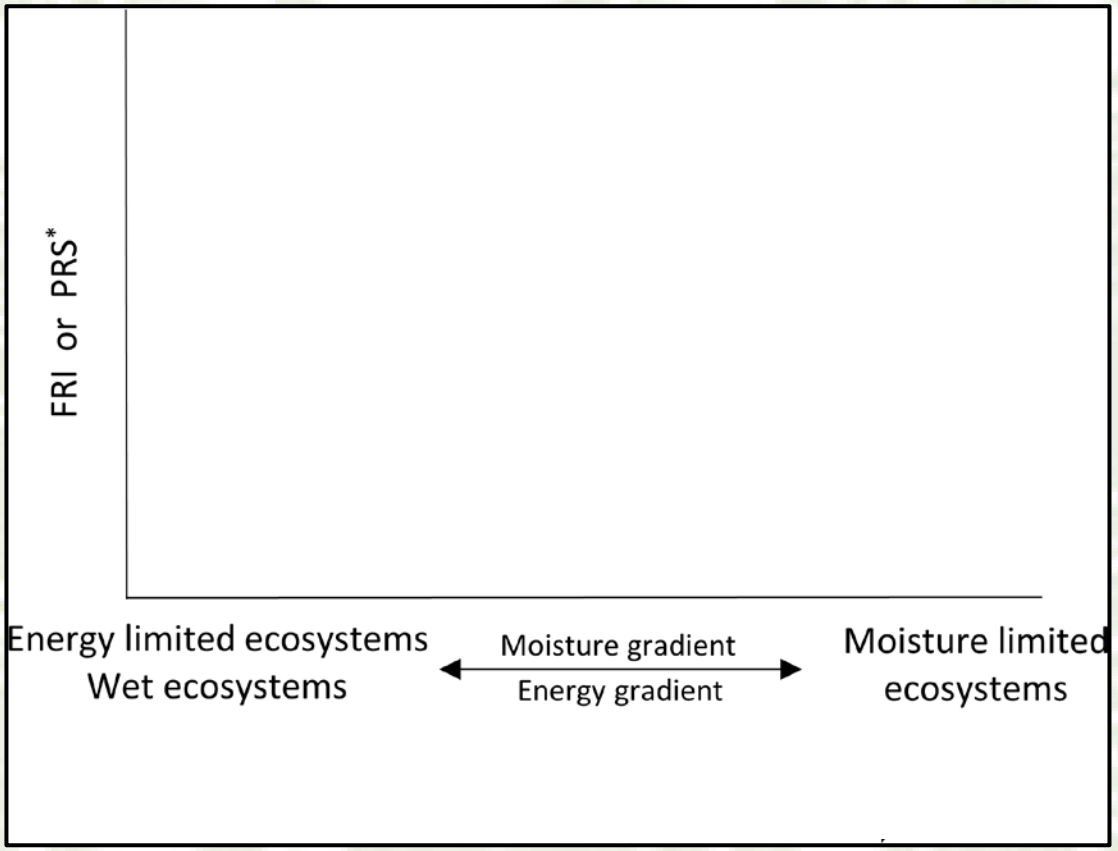

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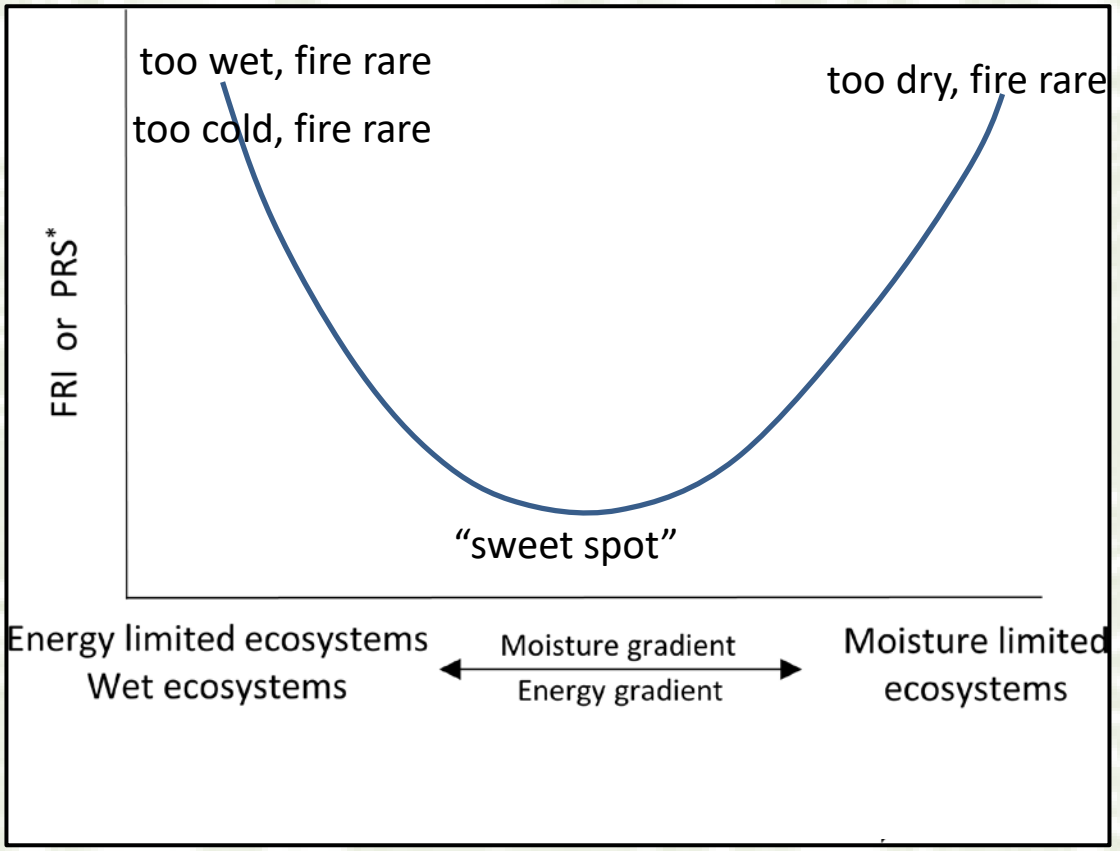


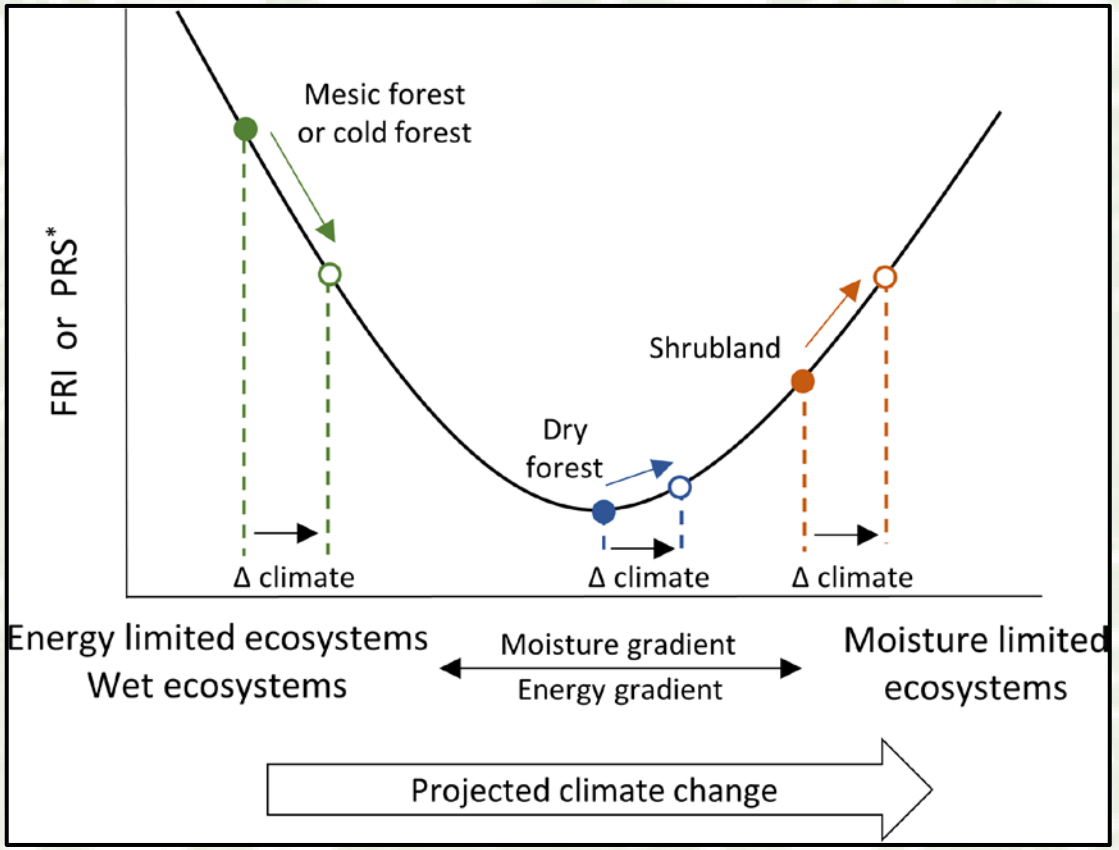
What might future fire regimes look like in mountainous regions of the western US?

Potential redistribution of fire regimes

Fire frequency and severity could increase or decrease, depending on bioclimatic domain.

In general:

- Fires in wet and cold regions (e.g., mesic and cold forest) expected become more frequent but less severe.
- Fires in drier, moisture-limited regions (e.g., shrubland and grassland) expected to have opposite trend.



How might vegetation and fire regimes change?

Away from reference period conditions

- Toward vegetation associated with warmer climate
- Shifts in fire regime depend on bioclimatic environment

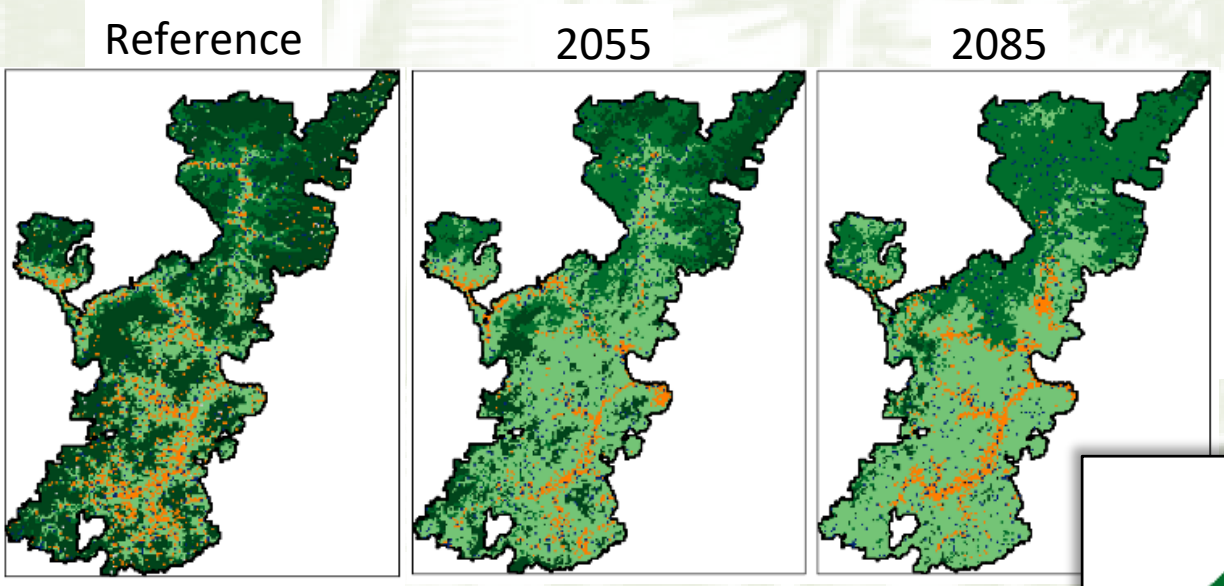
Caveats and assumptions:

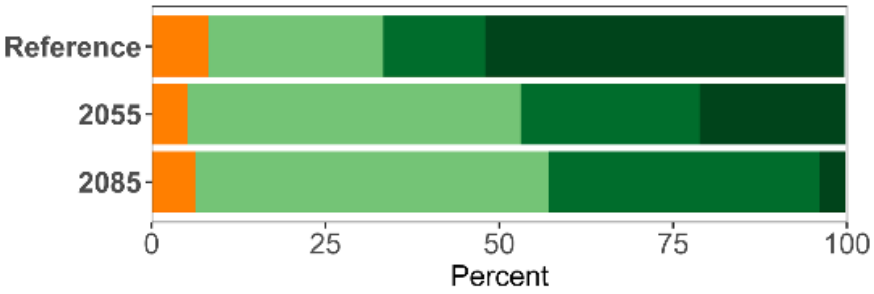
- Global Climate Models, emission scenarios
- LANDFIRE data: BpS, FRI, PRS
- Analog-based approach misses potentially important mechanisms
- Simplified characterization of climate (CMD & ET) ignores seasonal influence
- Assumption that vegetation and fire regimes always keep pace with climate change ignores natural lags and human influence

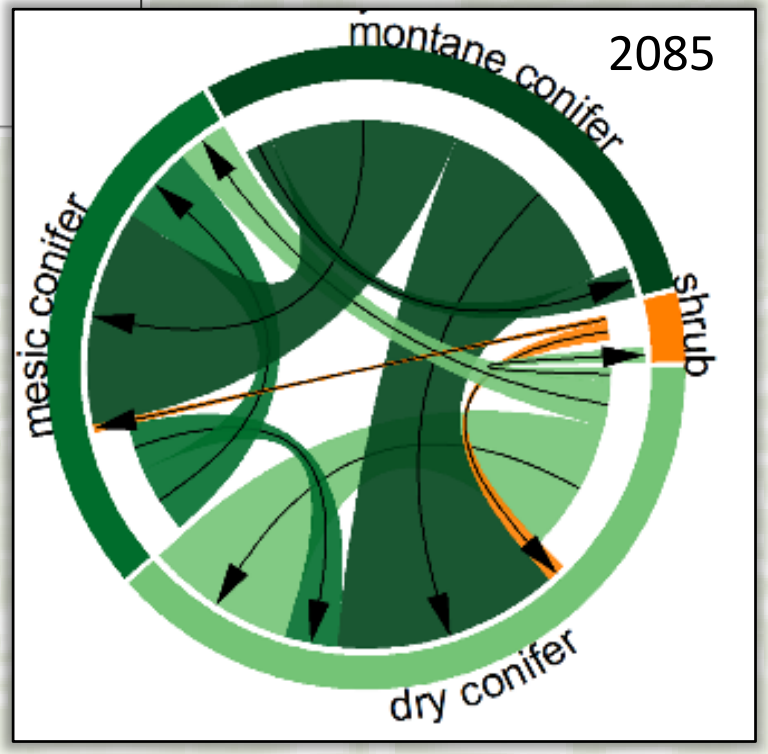
Interpret as maps of climate suitability.
Direction of change, rather than the magnitude or timing.


Thank you!

Selway-Bitterroot and Frank Church







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