

# CLIMATE IMPACTS ON SAGEBRUSH VEGETATION

Martin Holdrege



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John Bradford



Daniel Schlaepfer



Alice Stears



Adam Noel



Gregor Siegmund

# Vegetation components of sagebrush ecosystems

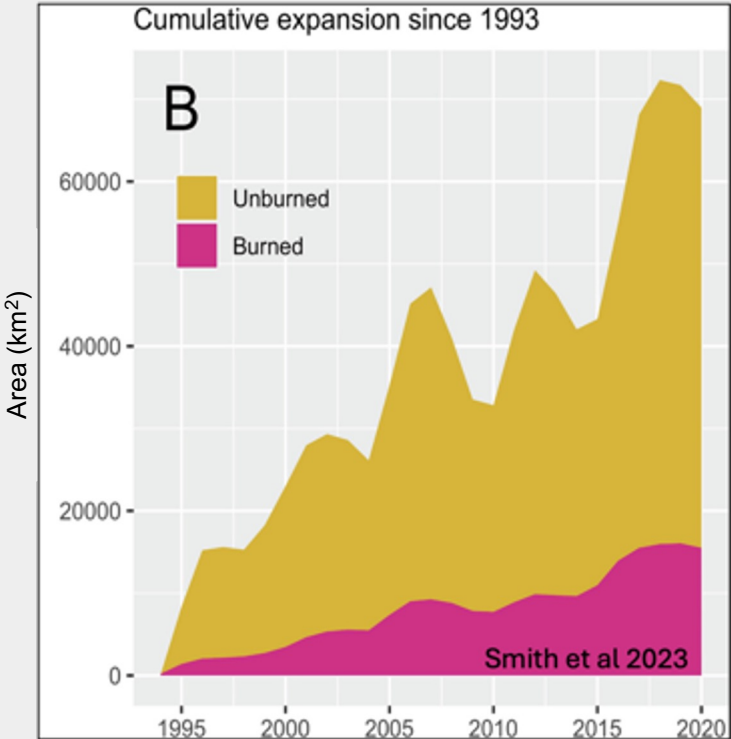
- Big sagebrush
- Perennial grasses
- Forbs
  
- Invasive annual grasses
- Conifers



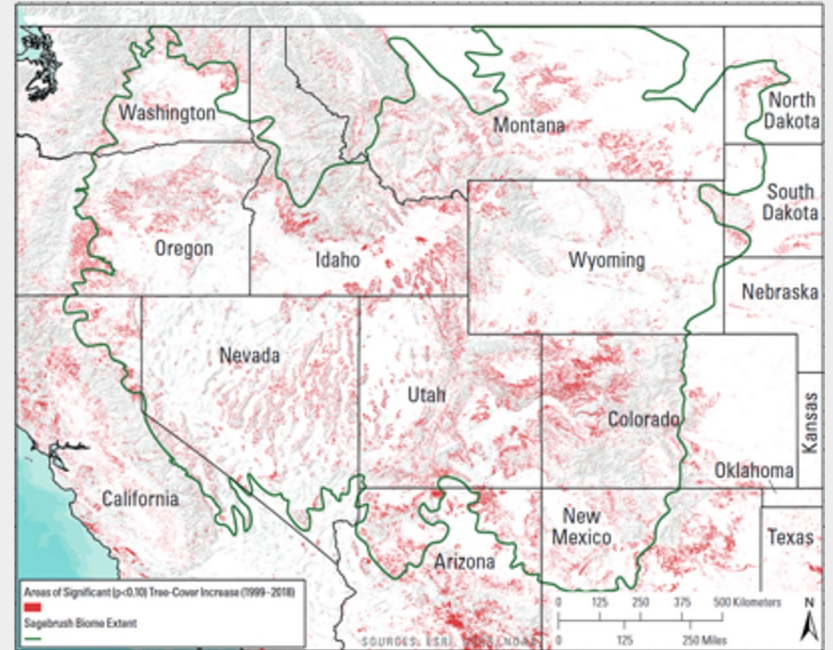
# Outline

- 1. Historical trends in sagebrush vegetation**
- 2. Potential climate impacts on components of sagebrush vegetation**
- 3. Implications for overall sagebrush plant communities & future wildlife habitat**
- 4. Available datasets**

# Invasion by annual grasses



# Encroachment by conifers

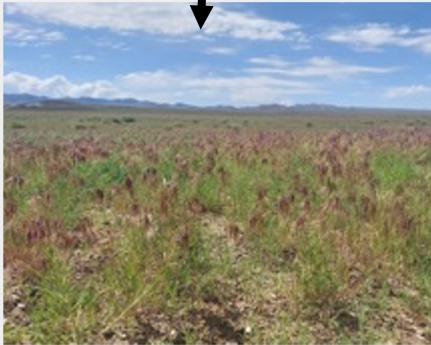


■ Areas of tree cover increase in rangelands

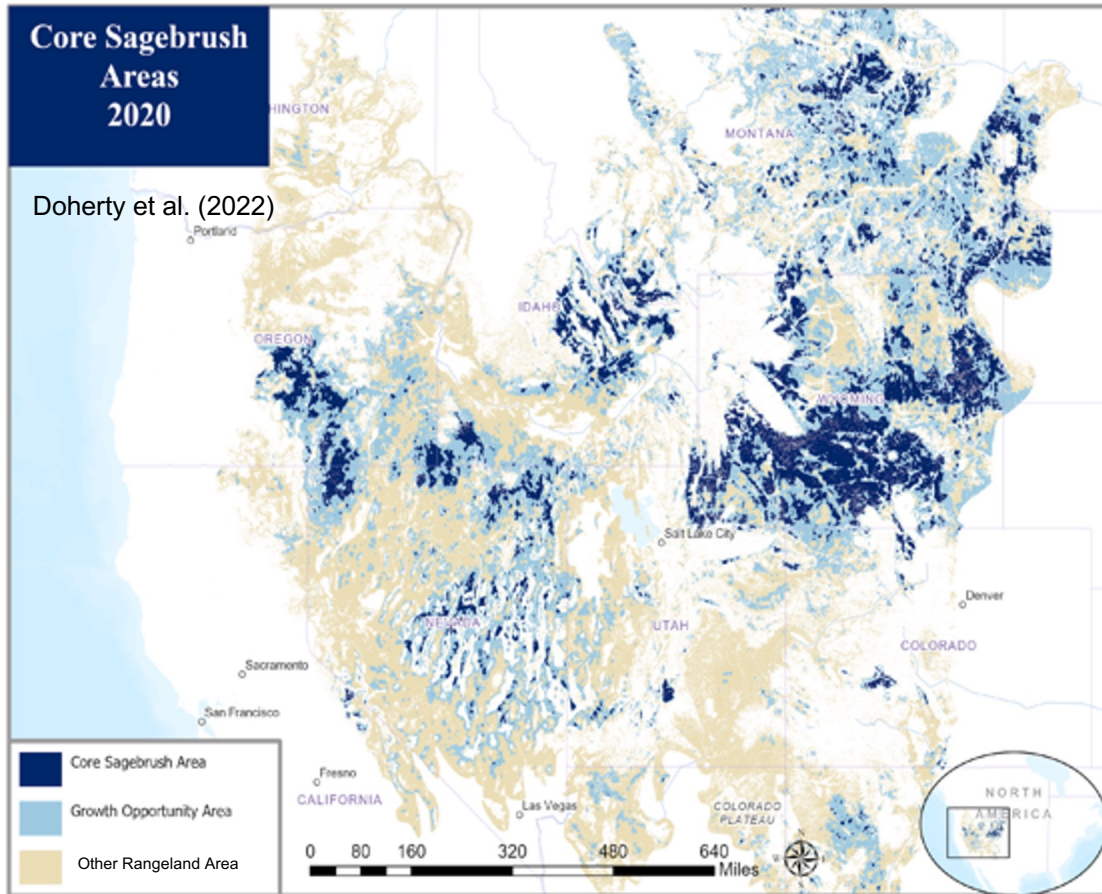
# Sagebrush Conservation Design: Sagebrush Ecological integrity



*SEI ~ Sagebrush (+), Perennials (+),  
Annuals (-), Conifers (-), Human modification (-)*



# Sagebrush ecological integrity



High SEI: Core Sagebrush Area (CSA)



Intermediate SEI: Growth Opportunity Area (GOA)

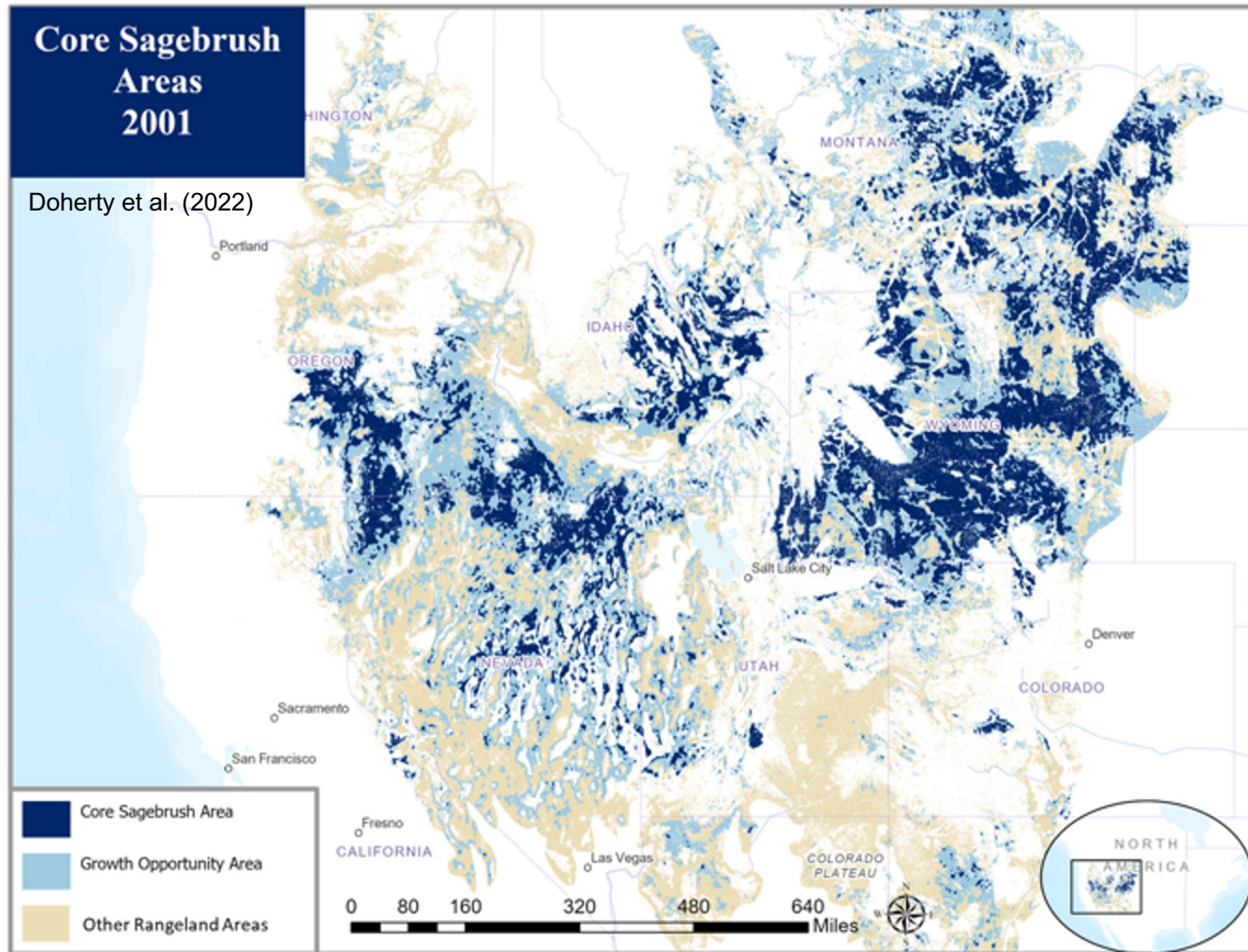


Low SEI: Other Rangeland Area (ORA)



## Core Sagebrush Areas 2001

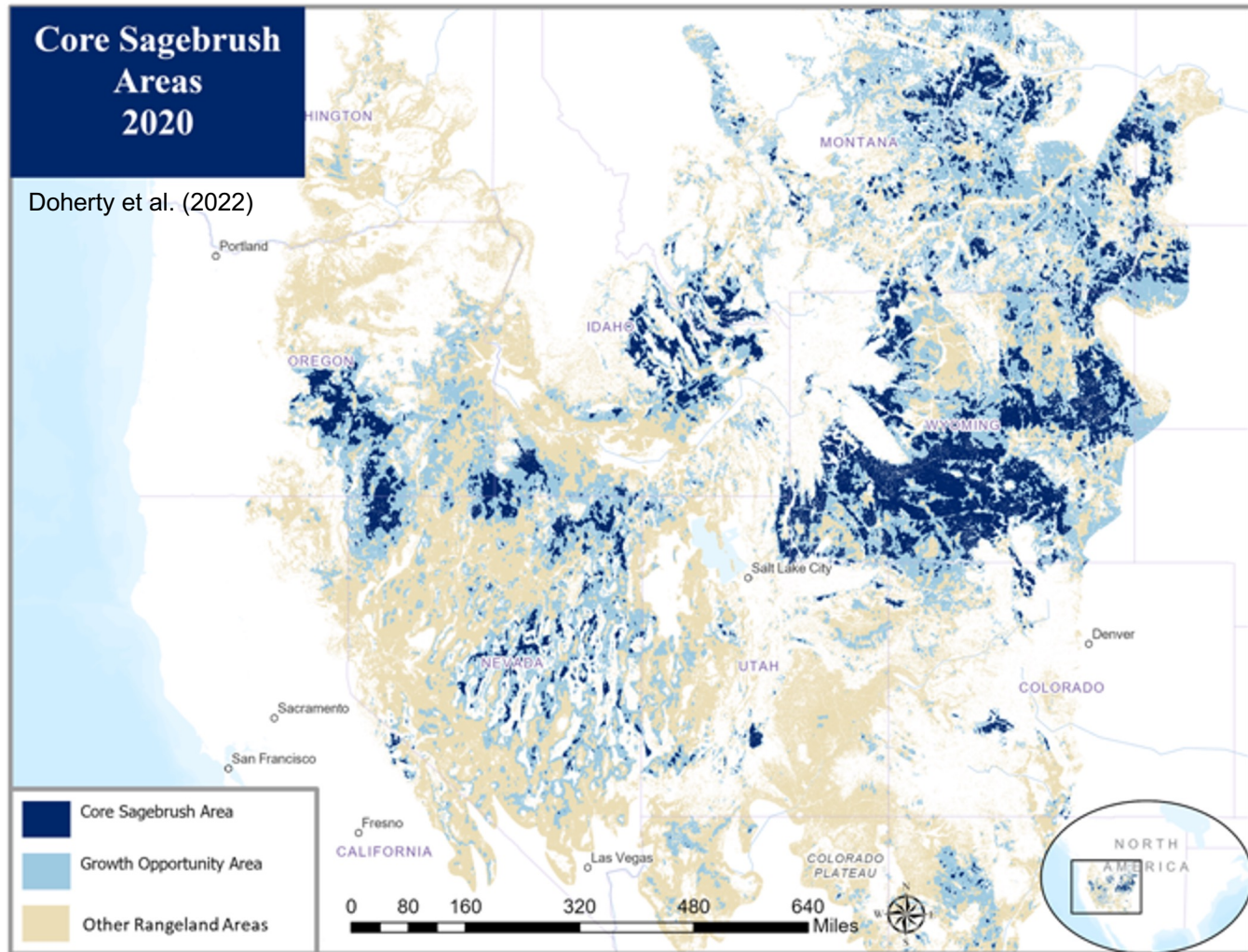
Doherty et al. (2022)





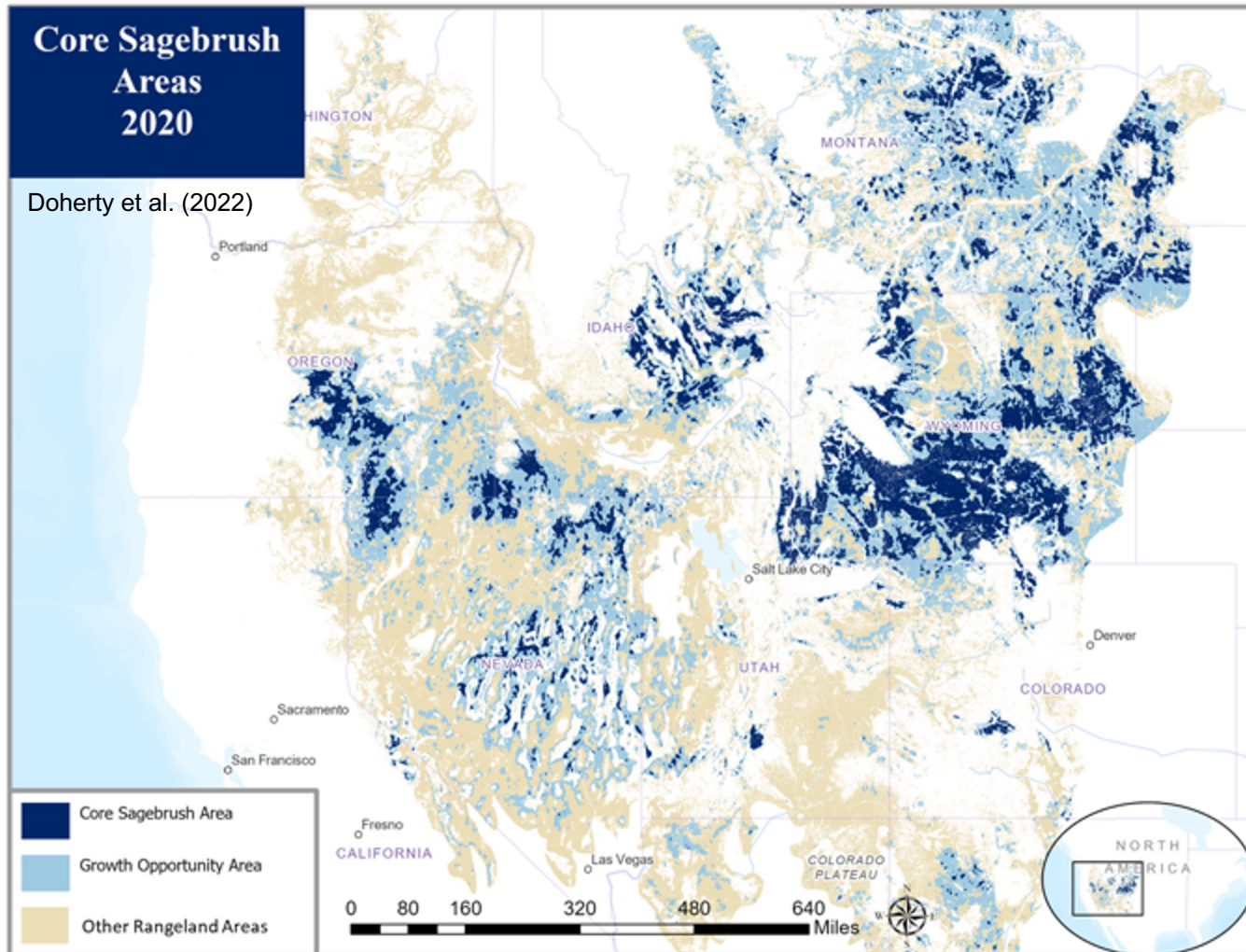
## Core Sagebrush Areas 2020

Doherty et al. (2022)



## Core Sagebrush Areas 2020

Doherty et al. (2022)



**26.8**  
Million acre  
increase in  
**Other  
Rangeland  
Areas**

**6.4**  
Million acre  
loss of  
**Growth  
Opportunity  
Areas**

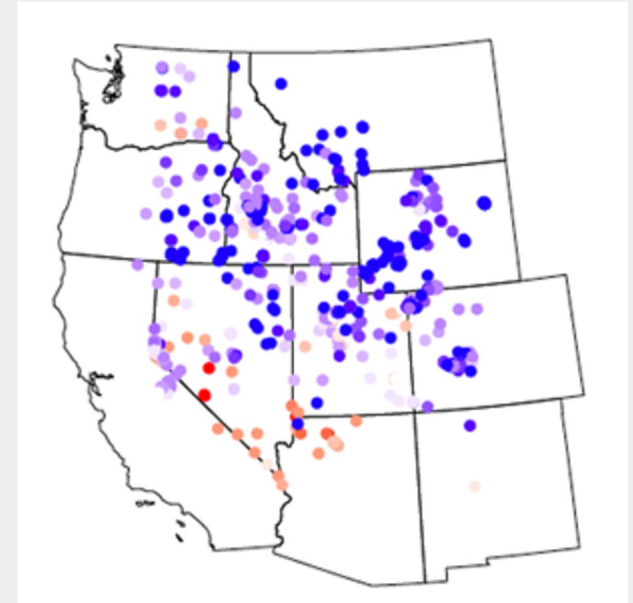
**20.4**  
Million acre  
loss of  
**Core Sagebrush  
Areas**

# Climate change impacts on vegetation components: sagebrush

- Sagebrush currently covers a very wide range in climate so is likely to persist in most places
- However, sagebrush could be lost in the hottest and driest portion of the range

Multi-model comparison of sagebrush performance

**Decreasing** **Increasing**



# Climate change impacts on vegetation components: perennial grasses



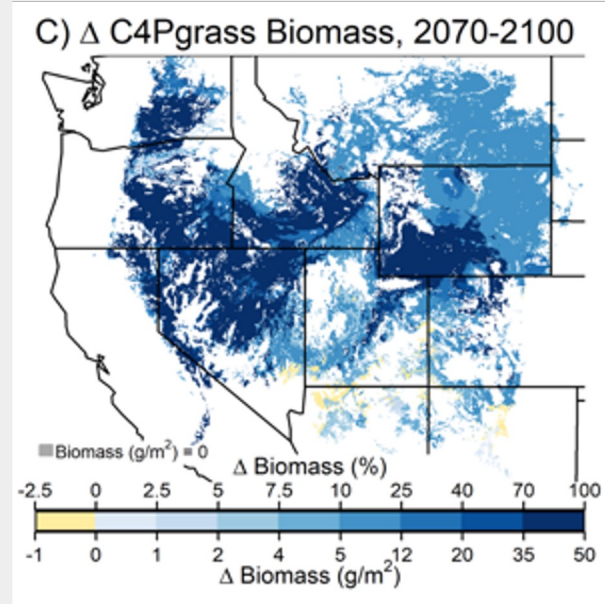
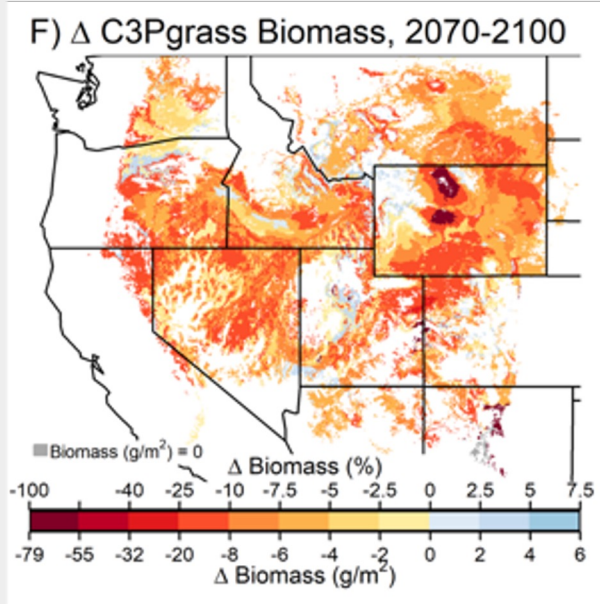
Cool season (C3) grasses



Warm season (C4) grasses

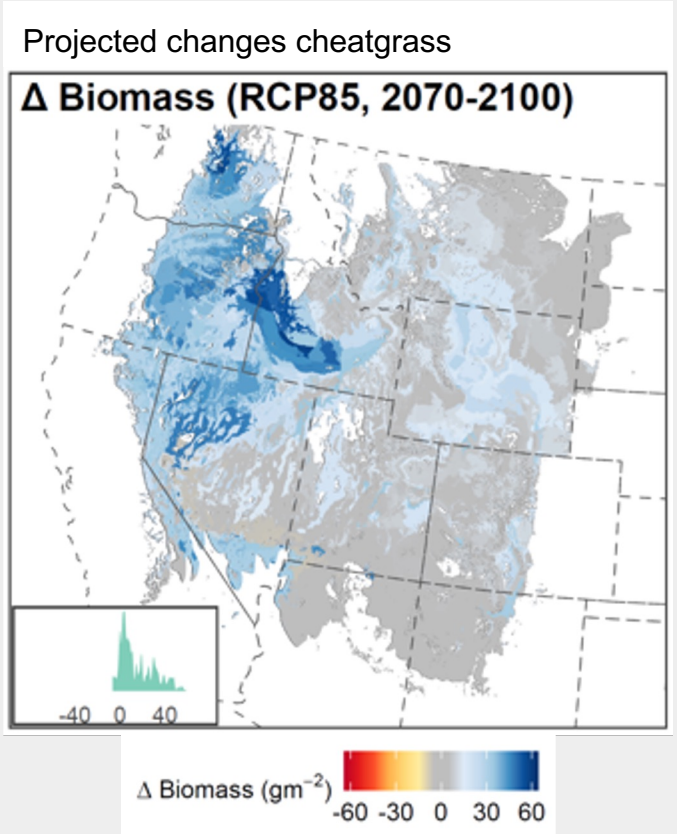
# Climate change impacts on vegetation components: perennial grasses

Climate driven declines in cool season (C3) grasses and increases in warm season (C4) grasses, are likely at least in some areas (Palmquist et al. 2021, Havrilla et al. 2023)



# Climate change impacts on vegetation components: invasive grasses

- Historical trend of cheatgrass invasion is very likely to continue
- Projected increases wildfire frequency (at least in many areas) likely to exacerbate cheatgrass invasion problems



# Climate change impacts on vegetation components: forbs & trees

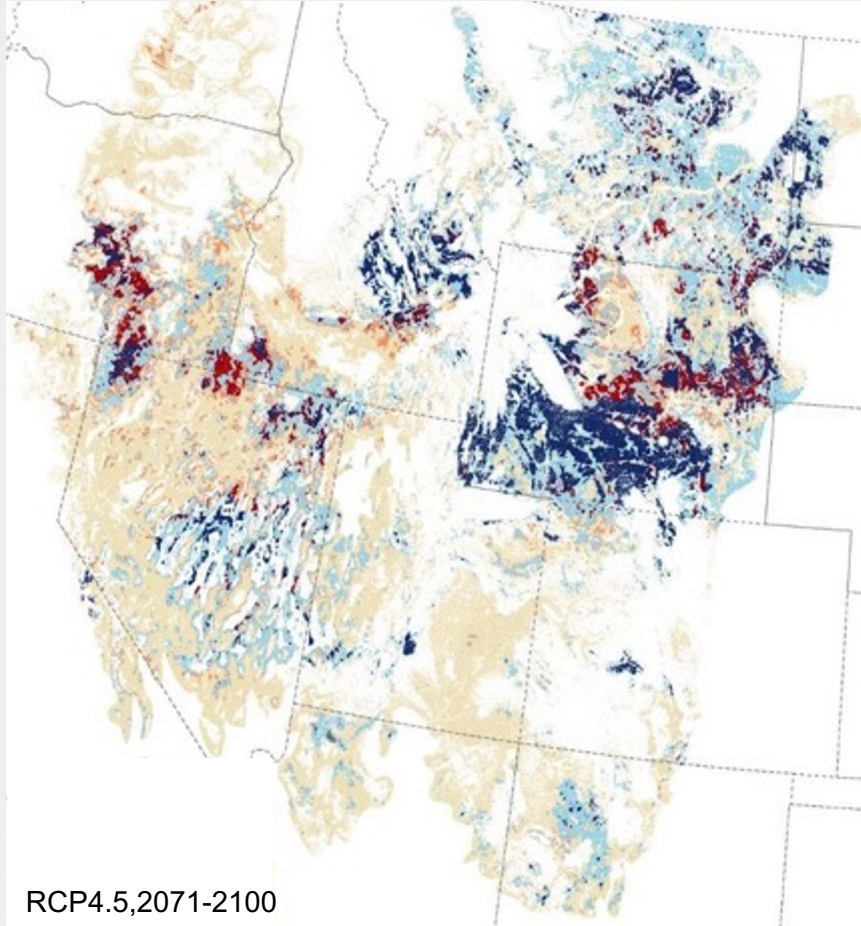
Forbs make up the majority of plant diversity and are important for wildlife, but we know little about their climate vulnerability



Conifer encroachment is expected to continue in many places, but projections of climate impacts are limited (Noel et al. In review)



# Climate change impacts on sagebrush ecological integrity



RCP4.5,2071-2100

	Future		
	Core Sagebrush Area	Growth Opportunity Area	Other Rangeland Area
Current Core Sagebrush Area	Stable	Decline	Decline
Current Growth Opportunity Area	Increase	Stable	Decline
Current Other Rangeland Area	Increase	Increase	Stable

- Large areas of sustained climate suitability in places with high ecological integrity
- Where changes are projected they're primarily declines

Holdrege et al. (In review)



# Available region wide datasets & resources

<a href="#">Palmquist et al. 2021</a>	Projections for vegetation components (process based model). New version being created
<a href="#">Rigge et al. 2021</a>	Projections for vegetation components (statistical model)
<a href="#">Zimmer et al. 2021</a>	Multi-study comparison (direction of trends)
<a href="#">Comer et al. 2019</a>	Habitat climate change vulnerability index
<a href="#">Renwick et al. 2018</a>	Multi-model comparison (fairly robust general trends)
Schlaepfer et al. In review	Projections of resistance and resilience (data not yet published, contact us)
Holdrege et al. In review	Projections of sagebrush ecological integrity (data not yet published, contact us)
Carpenter et al. In review	A report on climate change impacts on sagebrush ecosystems (contact us for a draft)

# Conclusions

Vegetation is changing in sagebrush ecosystems, especially via invasion by annual grasses (happening with and without fire)

Climate change is likely to amplify ongoing threats and accelerate rates of change, including impacts on core sagebrush areas

Impacts of climate change will vary geographically:

- South: increasing vulnerability due to higher temperatures & uncertain PPT
- Northeast: shifting seasonality of moisture may elevate cheatgrass threat
- Northwest: cheatgrass threats unlikely to diminish

Uncertainty about vegetation response to climate change is high, but some locations have more robust signals than other:

- On the positive side: stable intact areas of resilient native vegetation
- On the negative side: degraded rangelands with hot/dry conditions and getting hotter
- However, most of these projections don't really account for increasing climate extremes

# Conclusions

Questions?  
mholdrege@usgs.gov  
www.drylandecology.org

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# Cited literature

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