Potential effects of climate change on rare native species in Oregon: An assessment with climate driven population models.

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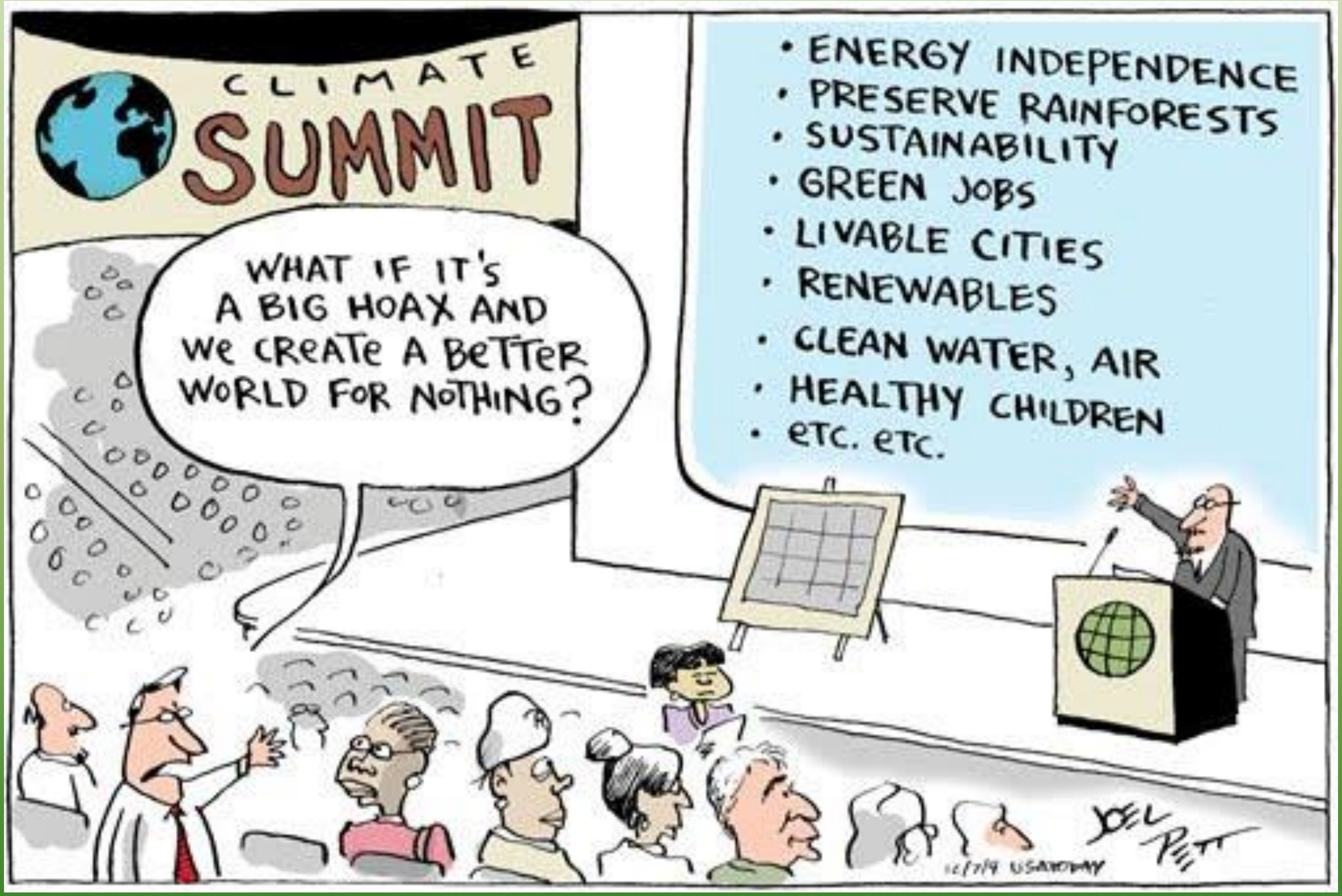
Joel Pett – USA Today



Climate change effects on rare species

- Climate appears to be changing
- Some species may already be responding to these changes
  - Range shifts poleward, upward
- Urgent need to understand this process, identify species most at risk

Cook’s lomatium

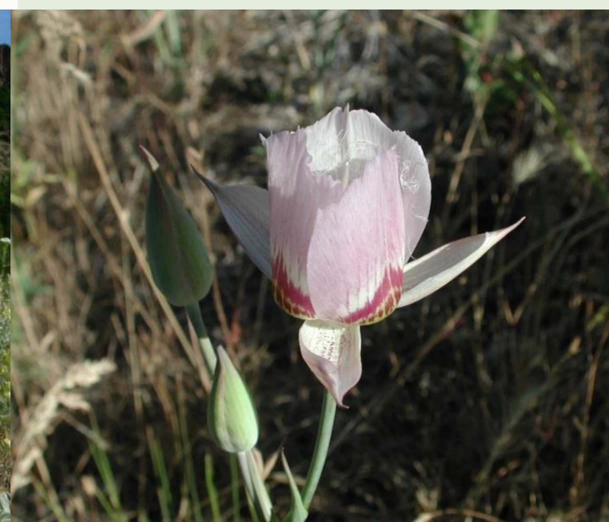
Bradshaw’s lomatium

Shaggy horkelia

Study species

Tygh Valley milkvetch

Greene’s mariposa lily



Snake River goldenweed

Fender’s blue butterfly

Implications for rare species

- How will changing climate affect rare species?
  - Increase vulnerability to extinction?
  - Decrease vulnerability to extinction?
  - No effect?

- We used a demographic approach

Objectives

1) Forecast the effects of climate change on populations of rare species

Process

1) Determine climatic drivers of population vital rates
2) Link these climatic drivers with vital rates in a population model (e.g., IPM)
3) Project populations linked to drivers using GCM forecasts

Methods

Objectives

Forecast the effects of climate change on populations of rare species

Process

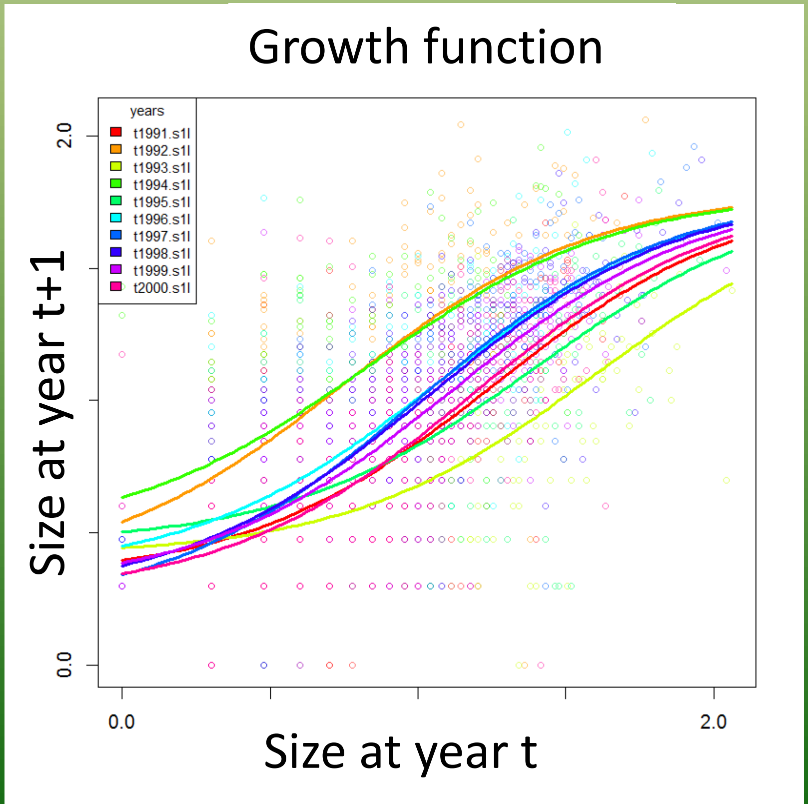
- Build a model for a population based on vital rates (e.g., IPM)
- Find correlations between population vital rates and weather variables
- Link these vital rates to weather variables in a climate driven population model
- Project the population forward in time under different climate scenarios (GCM forecasts)

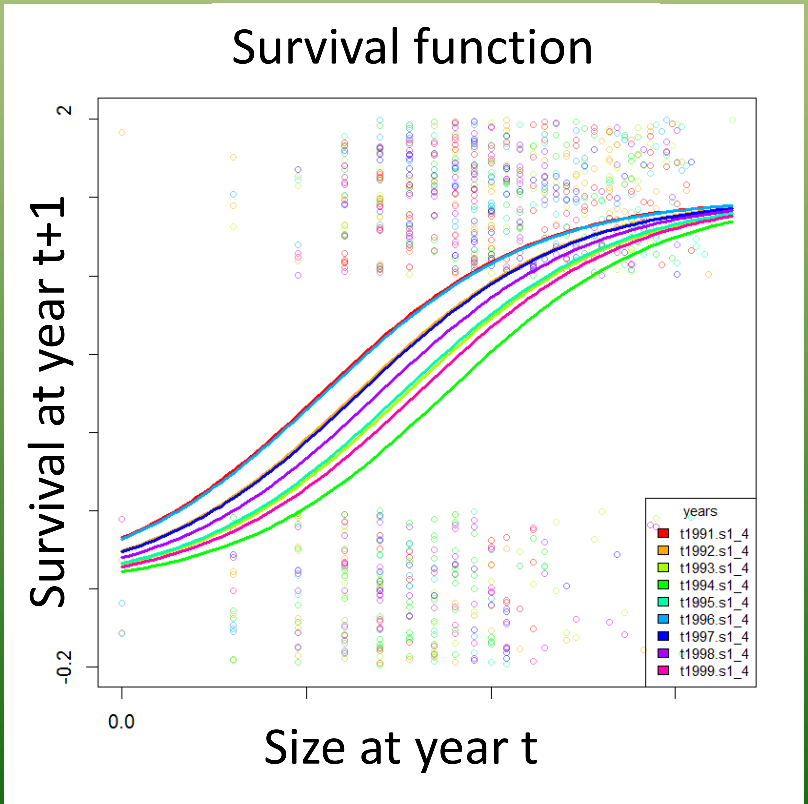
Methods

- Climate data
  - Observed (Interpolated Stations from UI Gridded Surface Met Data)
    - 4 Km resolution
    - 1979-2013
      - (Abatzoglou 2012)
  - Projected (MACA Statistically Downscaled Data)
    - 4 Km resolution
    - 1950-2005 (baseline)
    - 2006-2100 (forecast)
      - (Abatzoglou & Brown 2011)

Methods

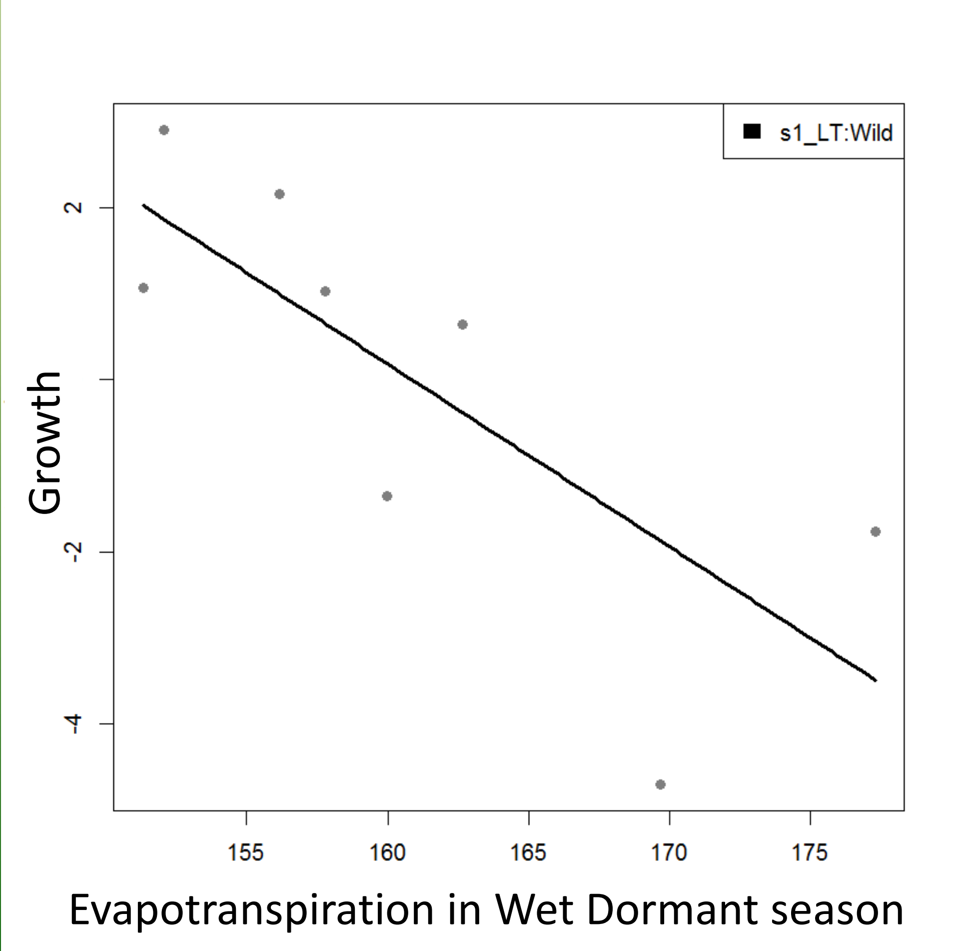
- Build population model for each species
  - IPM
  - Matrix (*Lomatium* spp.)
  - Count based (Fender's blue butterfly)





Methods

- Identify climatic drivers of vital rates
  - Precipitation [**PPT**]
  - Potential evapotranspiration [**PET**]
    - Penman Monteith (1965)
  - Net moisture [**NET**]
    - NET = PPT – PET



Methods

- Climate driver selection
  - Best single predictor of random year effect (BIC)
  - Linear regression (non-linear regr. is possible)
- Vital rate parameter estimation
  - Cross-correlated residual errors sampled from multivariate normal
  - Bounded by 95% distribution limits with stretched Beta transformations
    - Morris & Doak 2002

Methods

- GCMs [CMIP5/MACA] (Rupp *et al.* 2013)
  - CanESM2 (Canada)
  - CNRM-CM5 (France)
  - GFDL-ESM2G (USA)
  - GFDL-ESM2M (USA)
  - HadGEM2-ES (United Kingdom)
  - HadGEM2-CC (United Kingdom)
  - MIROC5 (Japan)
- RCP 4.5 scenario (moderate action)
- RCP 8.5 scenario (no climate action)

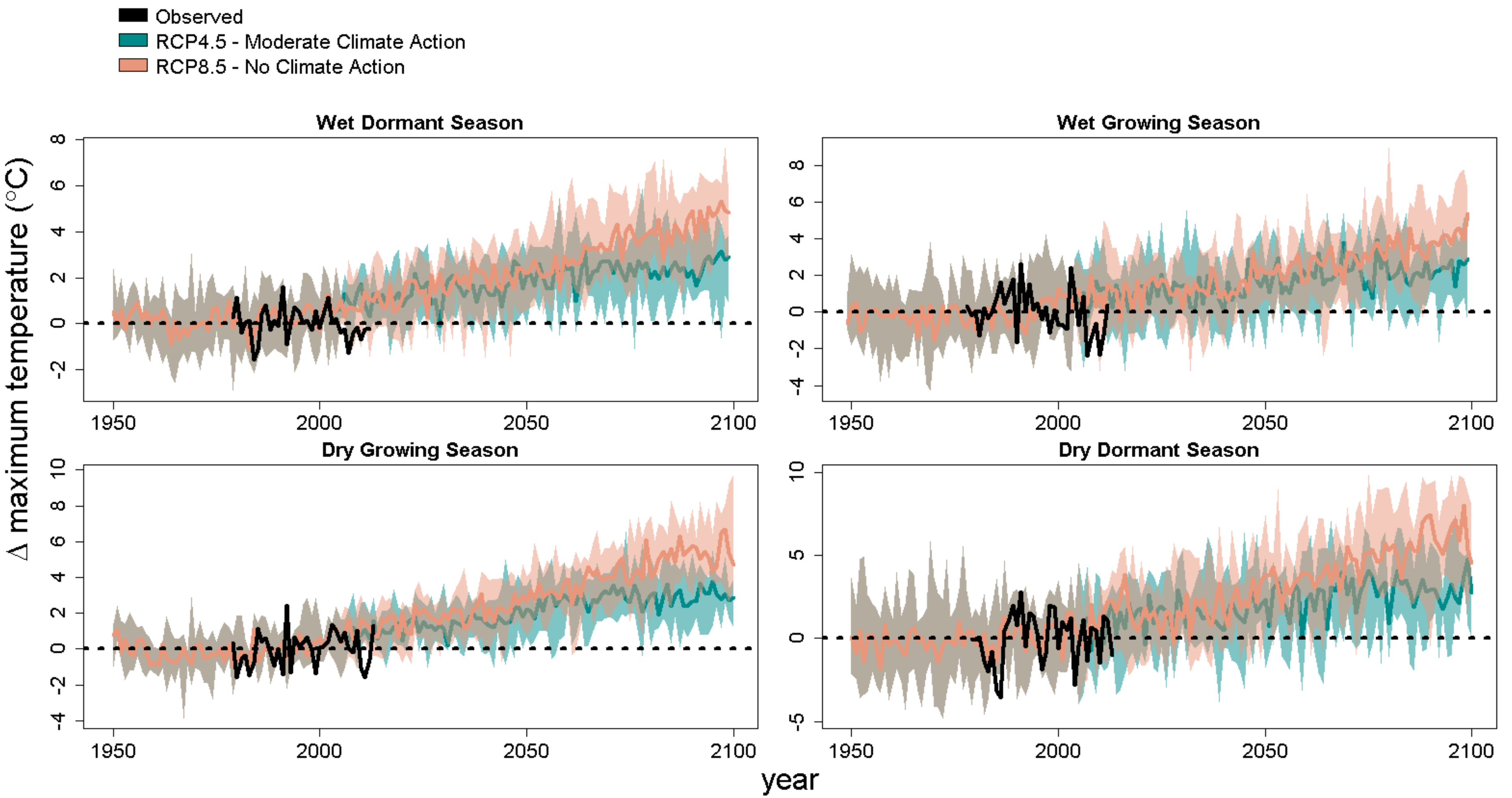
Methods

- Stochastic population growth (λ_s)
  - 100 iterations from initial obs. year to 2099
  - Stable emissions scenario
    - Random year from obs. period (IID years)
    - Not in this analysis?
  - Rising emissions scenario
    - Random selection of GCM each year (IID GCMs)

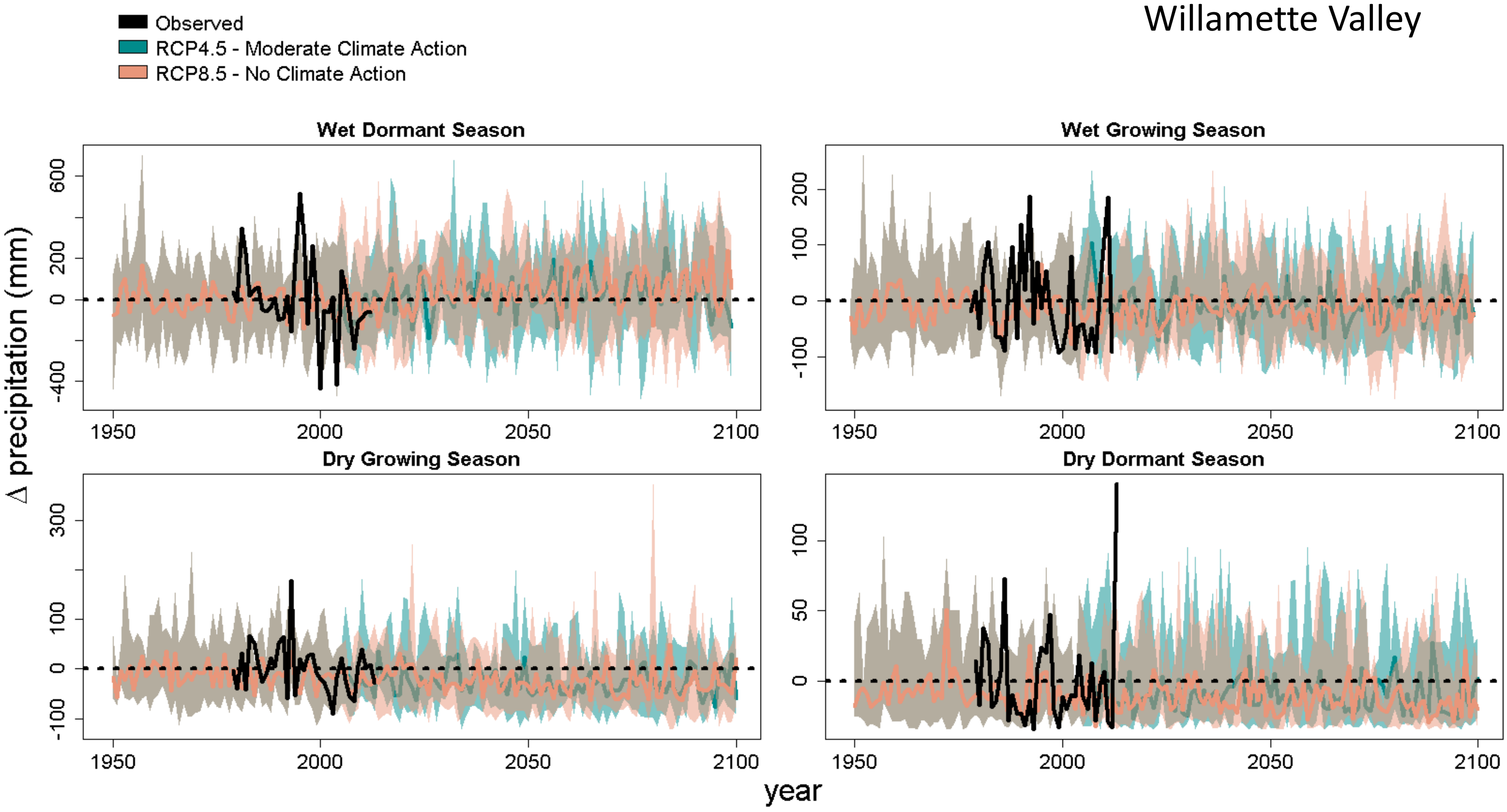
Bioseasons and weather variables

			Growing		Dormant	
species	month monitored	drivers	**Wet**	**Dry**	**Dry**	**Wet**
Shaggy horkelia	May		Mar-Apr	May-Aug	Sep	Oct-Feb
		ppt (mm)	116 - 391	36 - 303	0 - 82	594 - 1267
		pet (mm)	116 - 159	514 - 647	101 - 127	151 - 177
		tmax (°C)	14 - 17	23 - 27	23 - 27	10 - 12
		tmin (°C)	3 - 6	9 - 11	8 - 12	2 - 4
		dtr (°C)	9 - 13	13 - 16	13 - 18	8 - 9

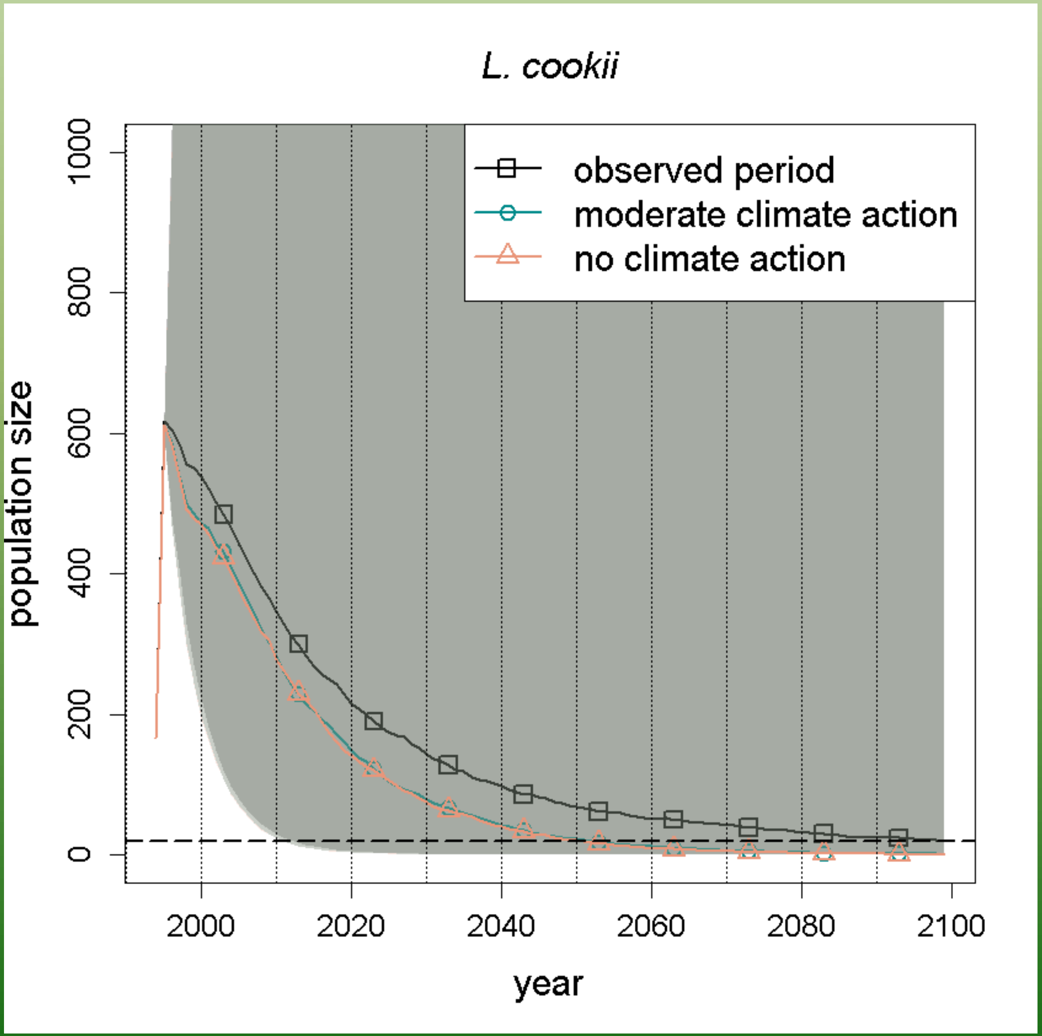
Bioseason projections



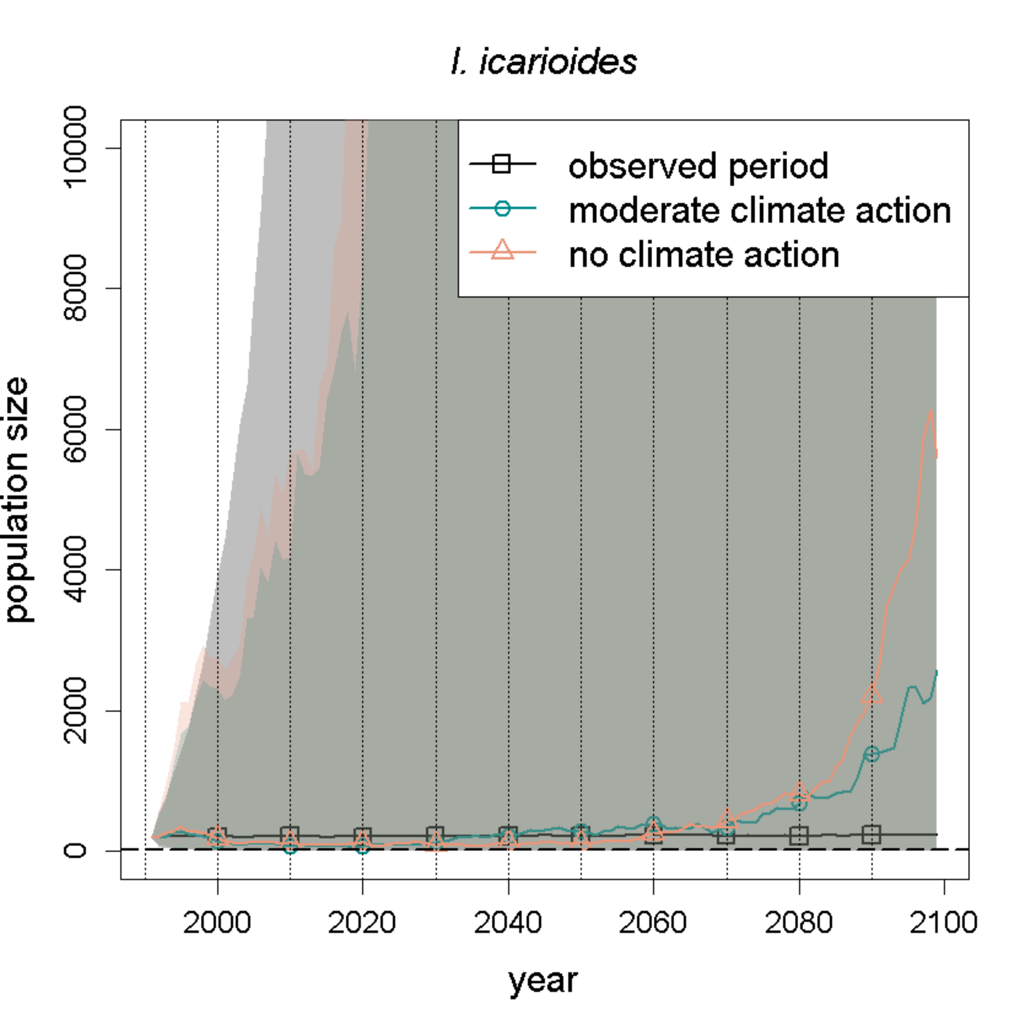
Bioseason projections



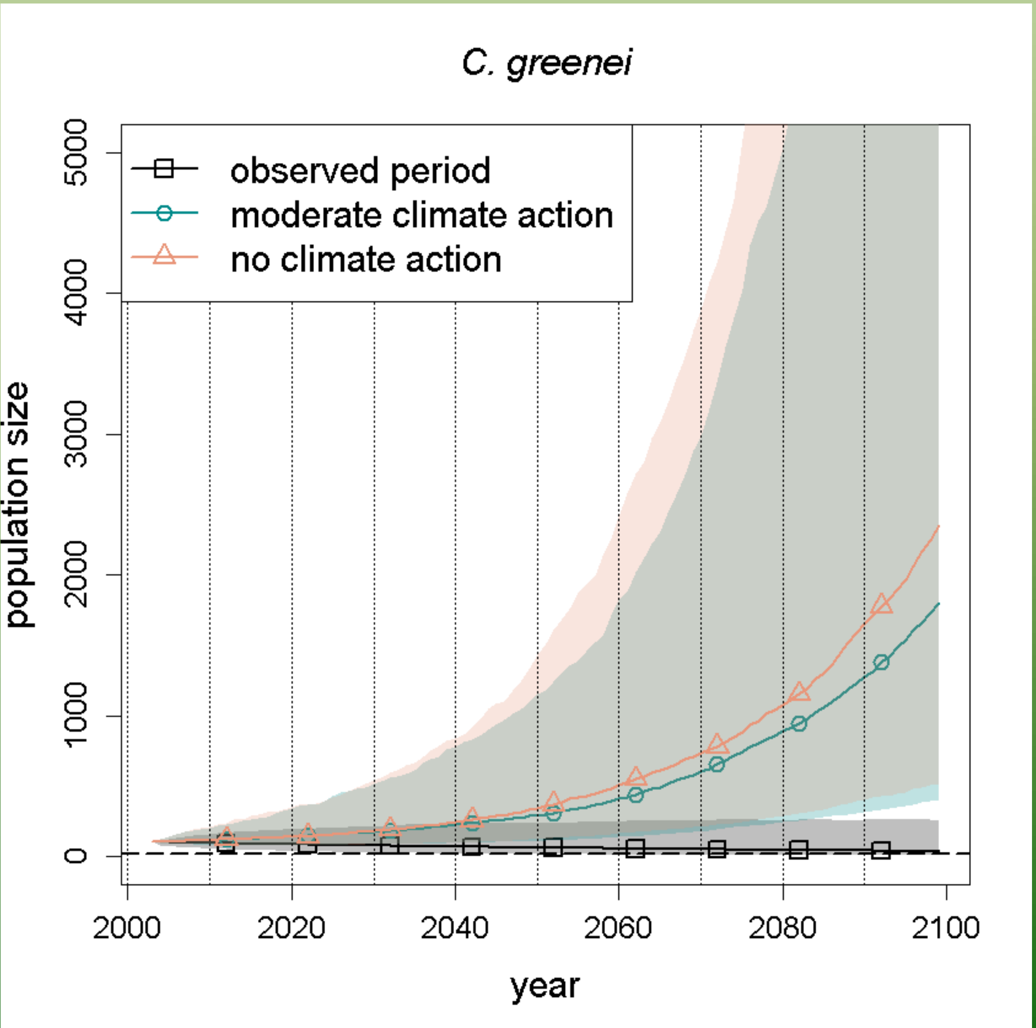
Results
Cook's Lomatium (MPM)

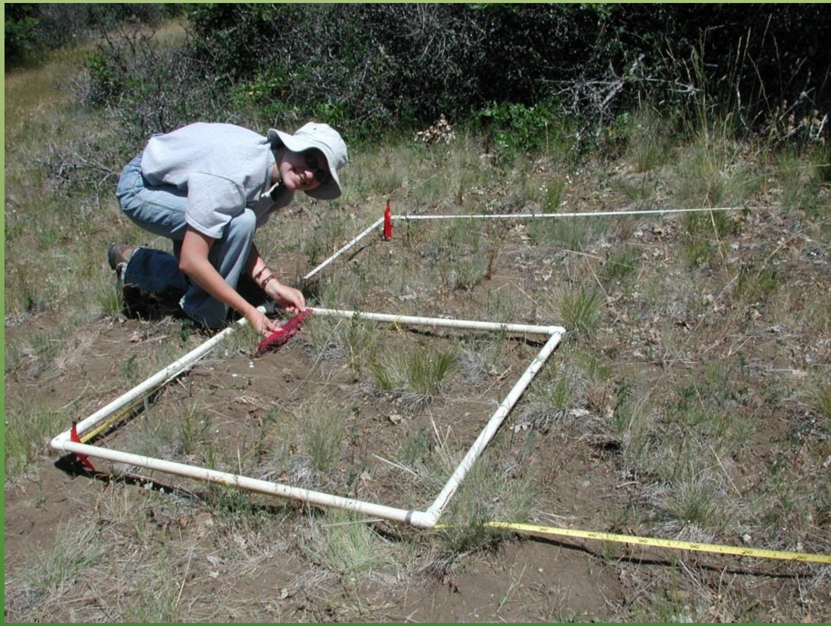


Results
Fender's blue butterfly (CPM)

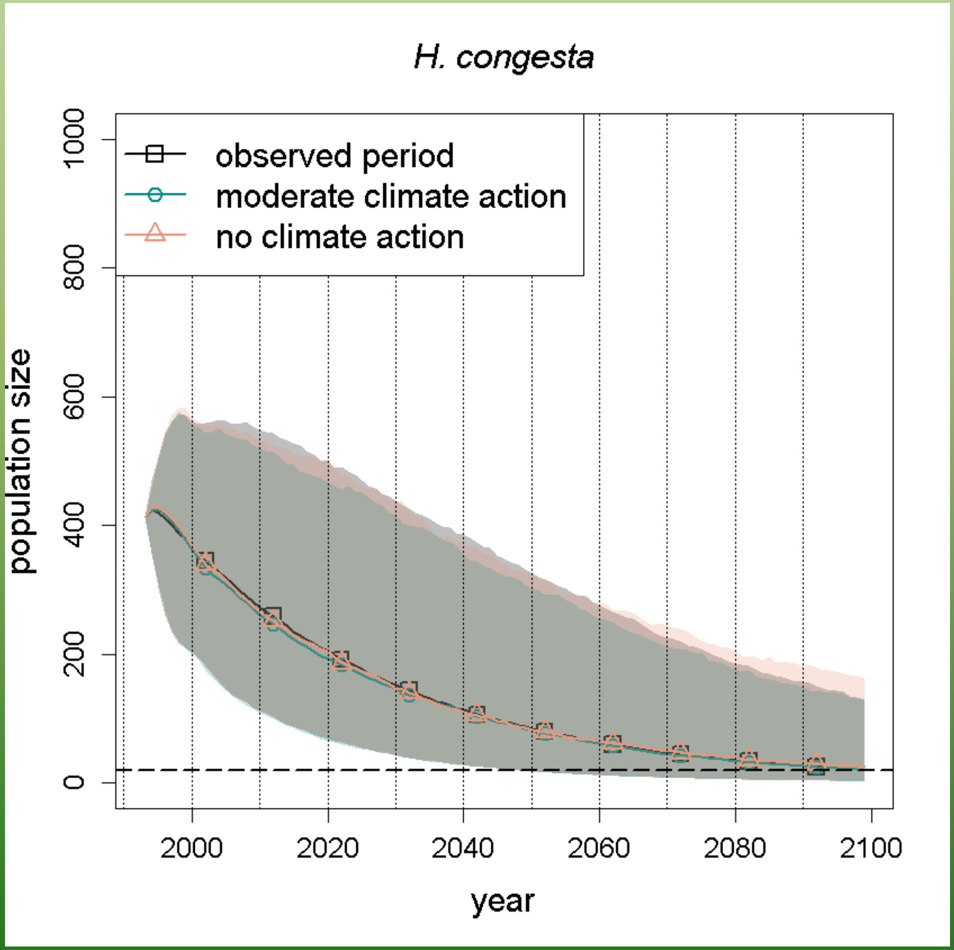


Results
Green's mariposa lily (IPM)

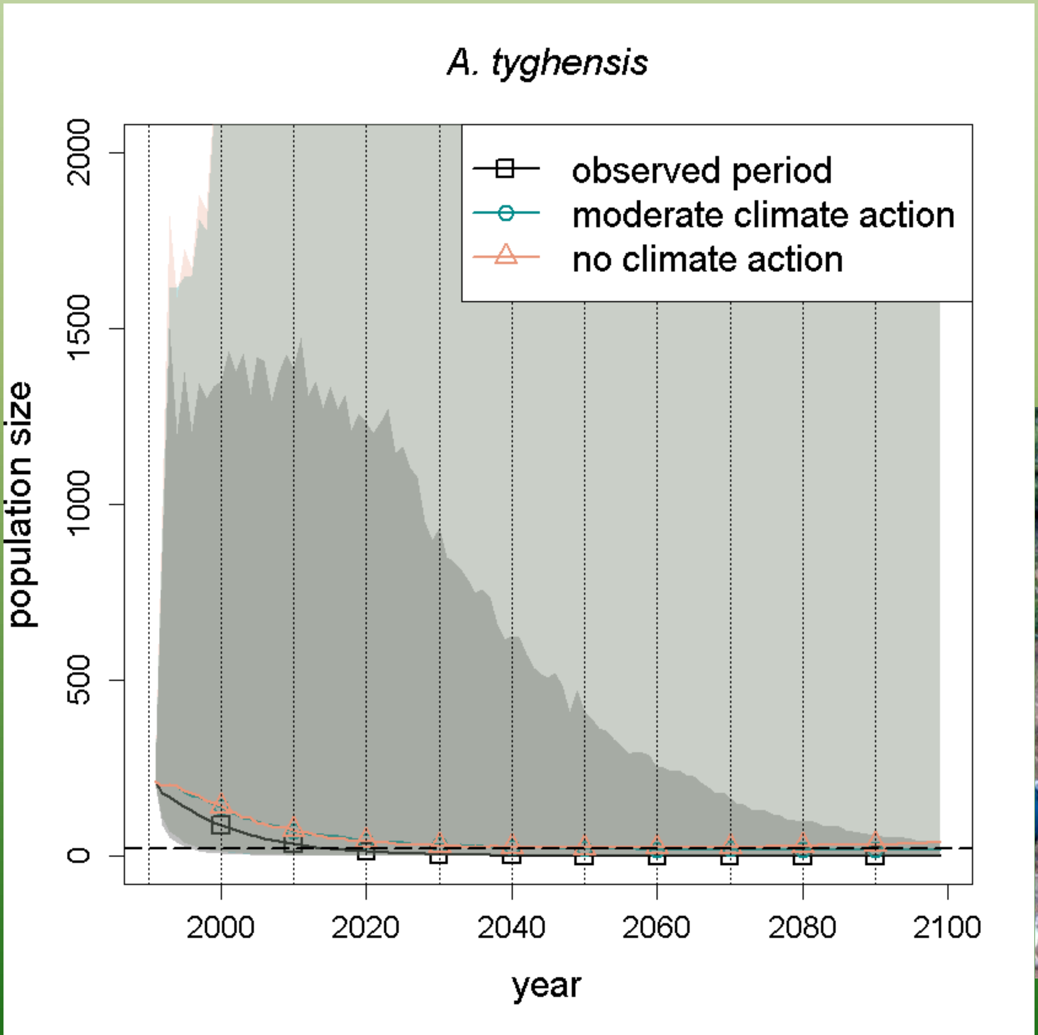




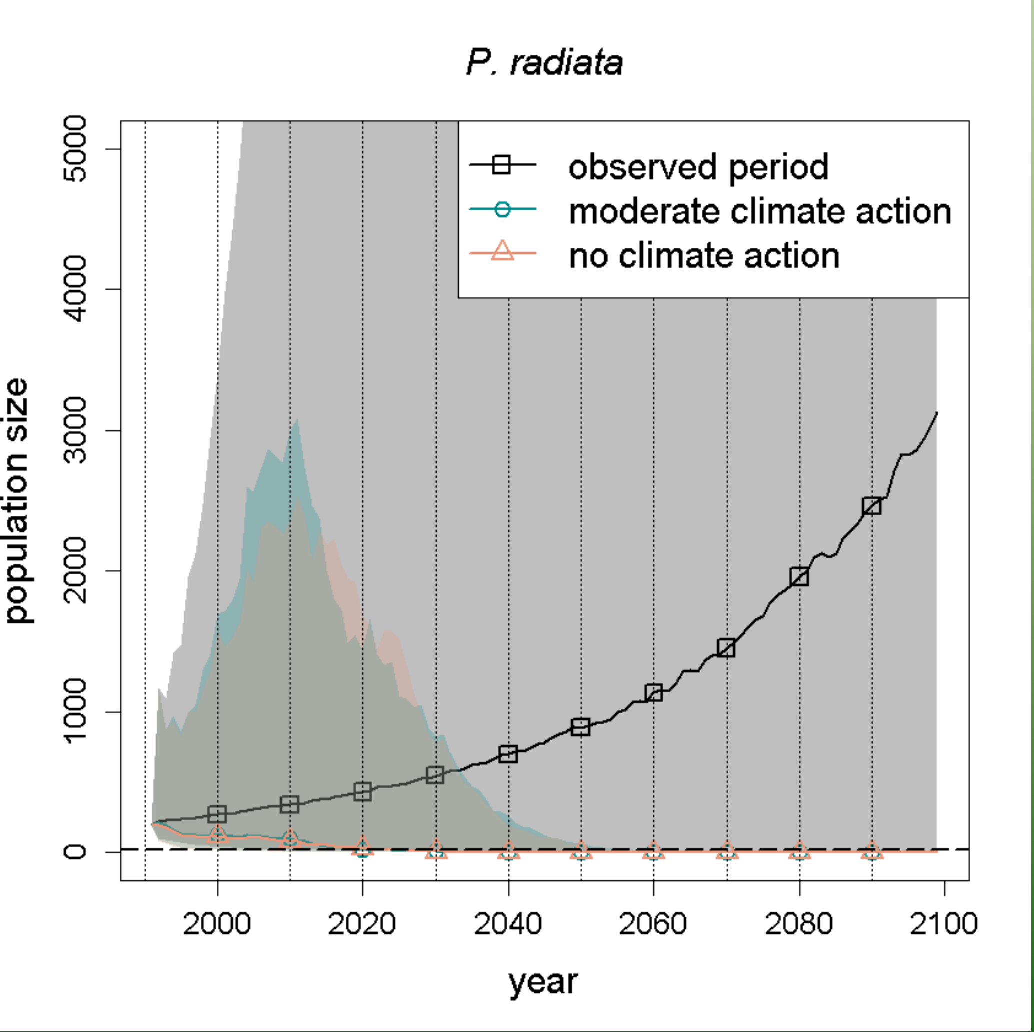
Results
Shaggy horkelia (IPM)

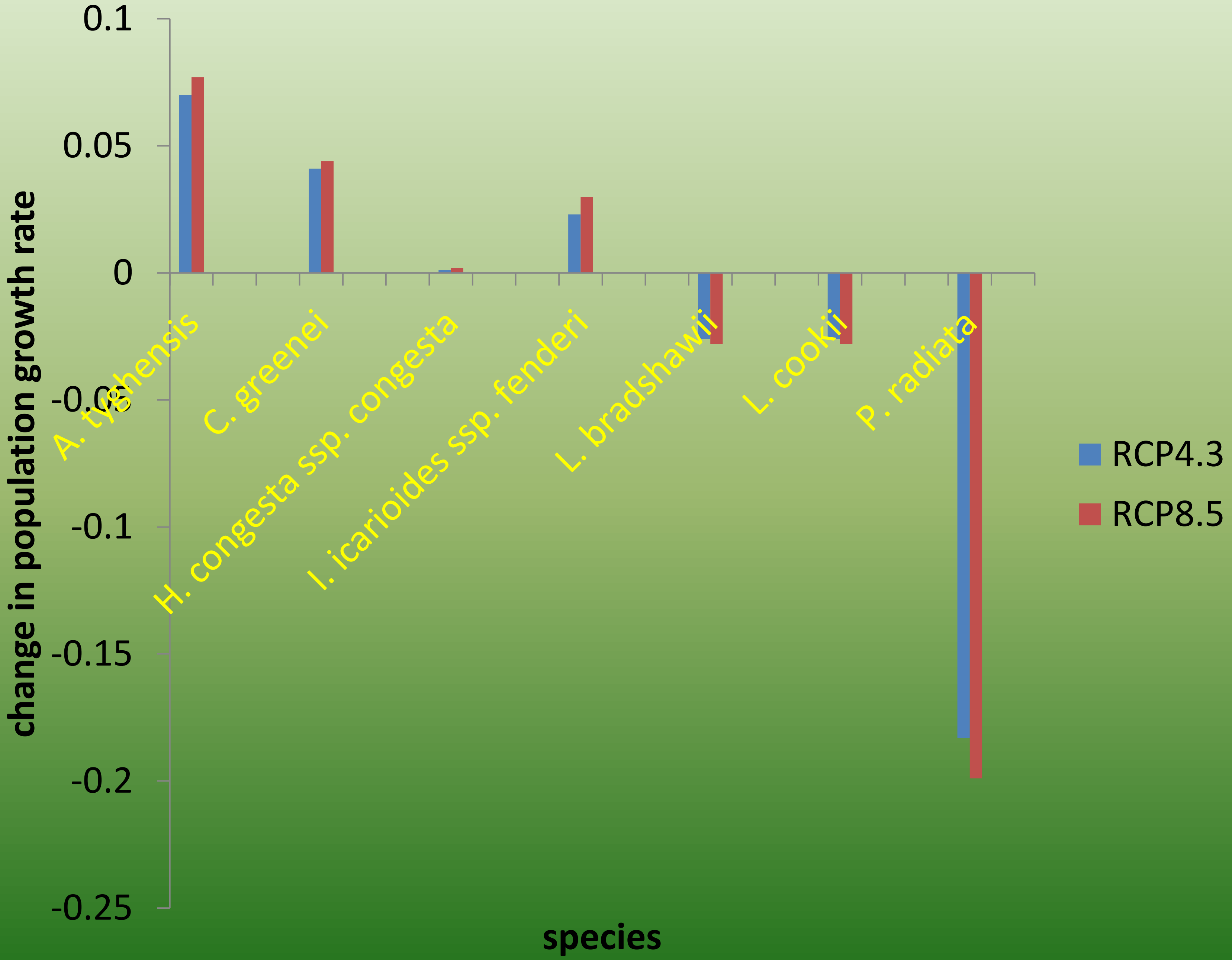


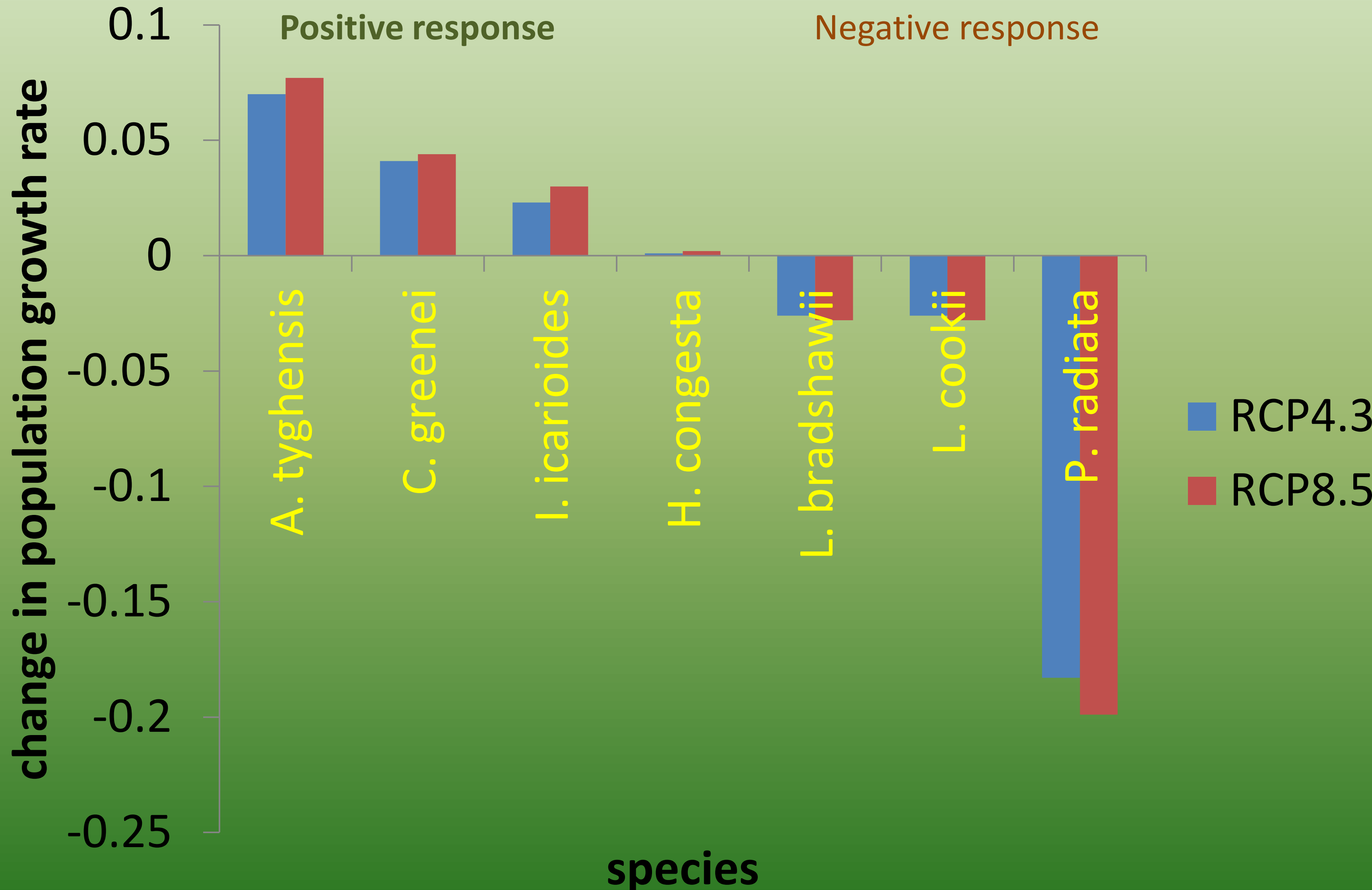
Results
Tygh Valley milk vetch (IPM)



Results
Snake River goldenweed (IPM)




0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
change in population growth rate
A. tyghensis
C. greenei
H. congesta ssp. congesta
I. icarioides ssp. fenderi
L. bradshawii
L. cookii
P. radiata
species
RCP4.3
RCP8.5

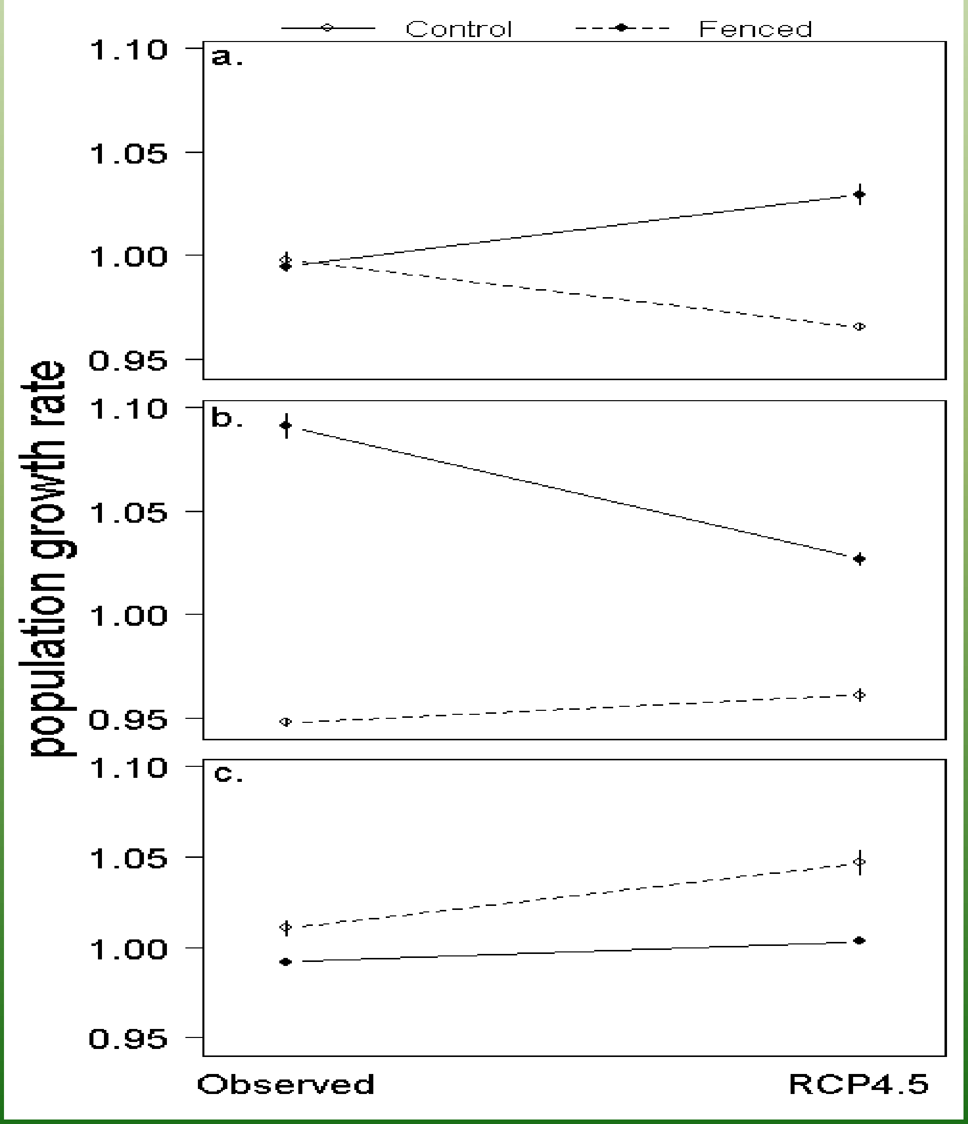


Positive response
Negative response
change in population growth rate
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
A. tyghensis
C. greenei
I. icarioides
H. congesta
L. bradshawii
L. cookii
P. radiata
species
RCP4.3
RCP8.5

Continuing research: Variation among sites

species	Total pop’n	No change	Increased risk	Decreased risk
A. tyghensis	5	2	2	1
C. greenii	3	2	1	
I. icarioides	7			7
L. bradshawii	2	1	1	
P. radiata	4	2	2	
TOTAL	**23**	**8**	**6**	**9**

Continuing research: Interactions with herbivores



Conclusion

- Climate change may have negative, positive or neutral effects on rare species populations
  - this approach helps us rank species vulnerability
- These effects may differ among populations within the same species
- Climate change effects may be affected by natural and human disturbances, such as grazing

Acknowledgments

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