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science for a changing world

Assessing risk with changing climate: what to consider with correlative species distribution models

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- **Species distribution models are often created with readily available data.**

- **What is the sensitivity of models to climatic time period?**

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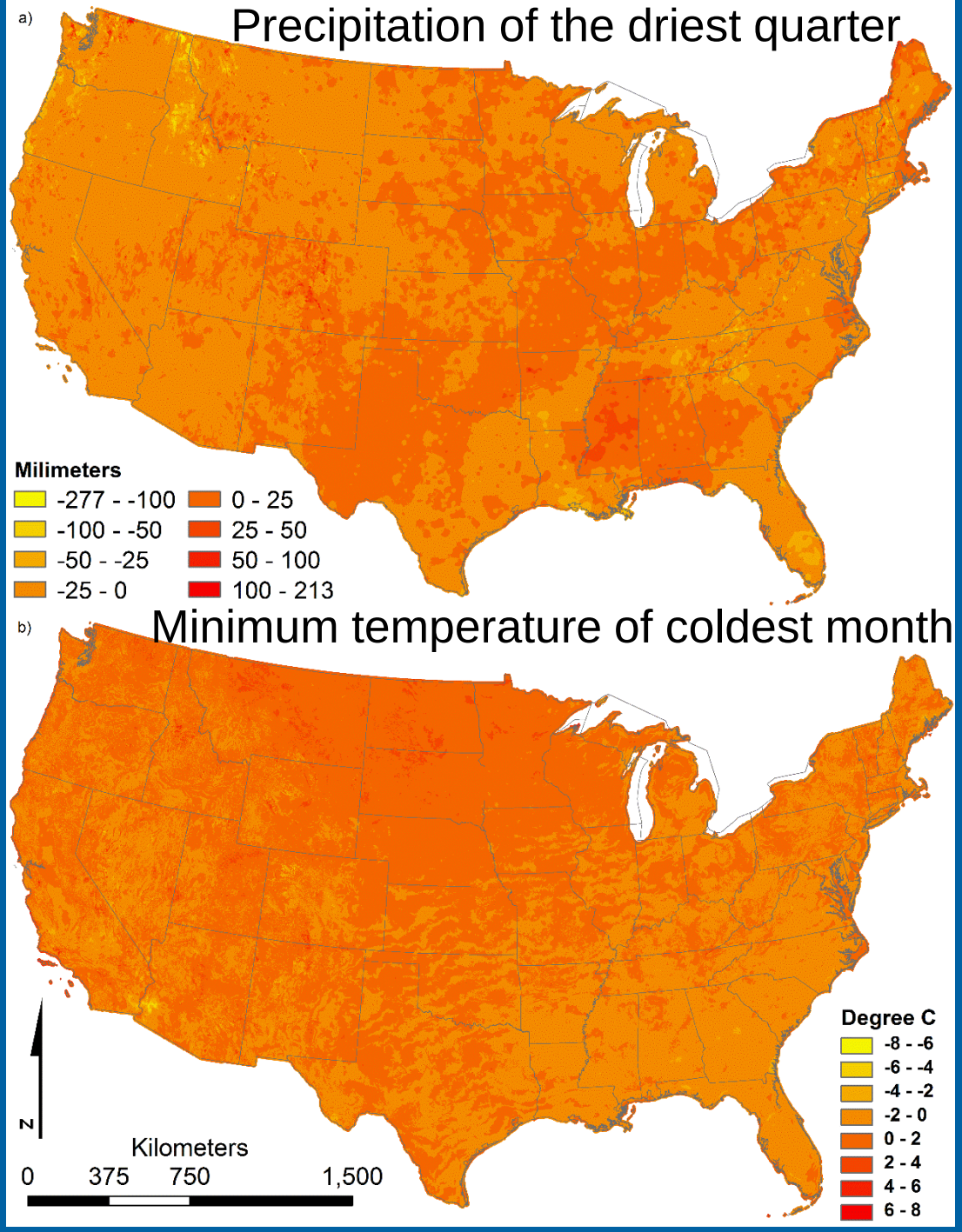
What climate data to use?

- PRISM 30 year climate normals
  - 1971 to 2000
  - 1981 to 2010
- Regional heterogeneity in differences



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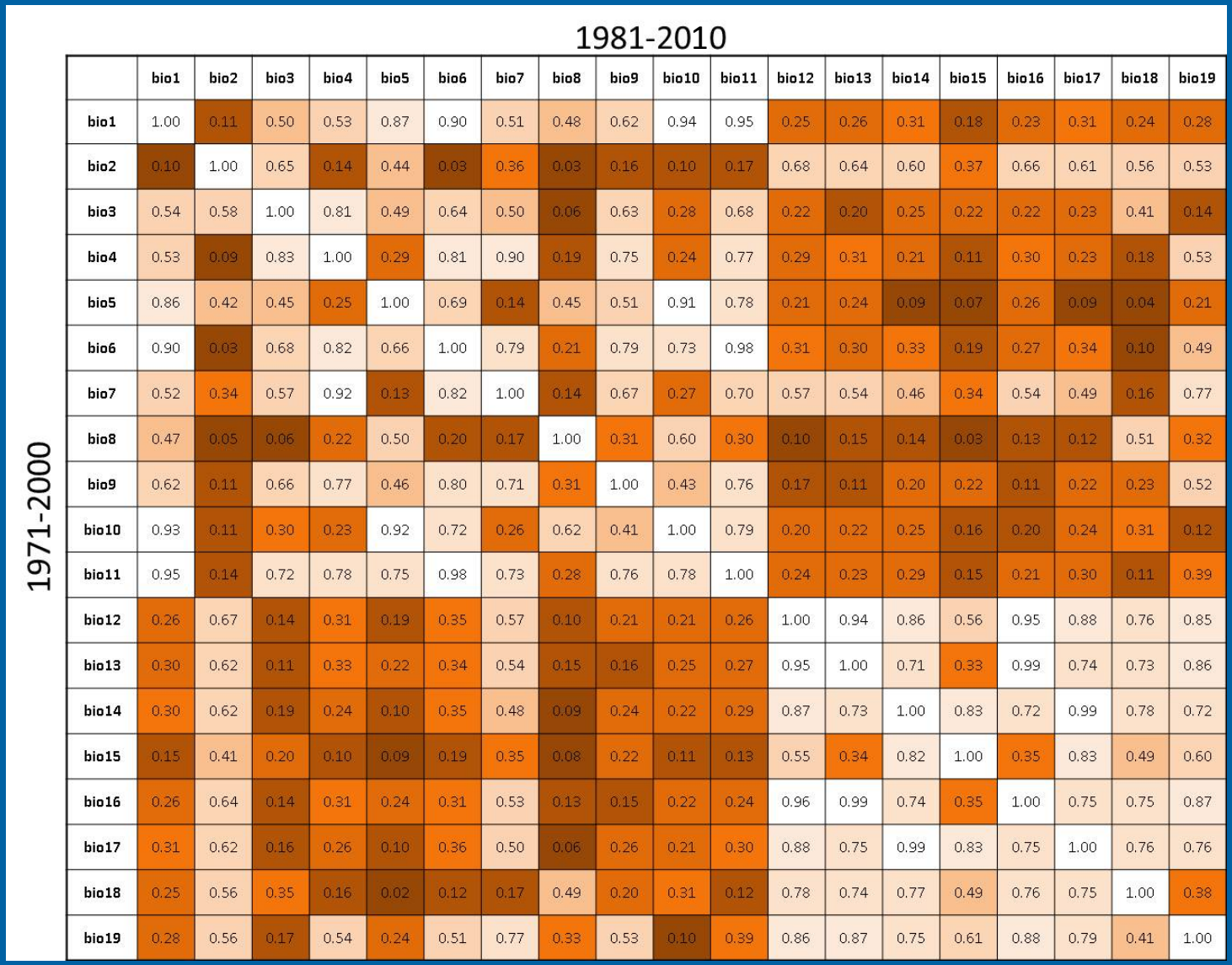
Correlation structure is similar…



1981-2010

1971-2000

	bio1	bio2	bio3	bio4	bio5	bio6	bio7	bio8	bio9	bio10	bio11	bio12	bio13	bio14	bio15	bio16	bio17	bio18	bio19
bio1	1.00	0.11	0.50	0.53	0.87	0.90	0.51	0.48	0.62	0.94	0.95	0.25	0.26	0.31	0.18	0.23	0.31	0.24	0.28
bio2	0.10	1.00	0.65	0.14	0.44	0.03	0.36	0.03	0.16	0.10	0.17	0.68	0.64	0.60	0.37	0.66	0.61	0.56	0.53
bio3	0.54	0.58	1.00	0.81	0.49	0.64	0.50	0.06	0.63	0.28	0.68	0.22	0.20	0.25	0.22	0.22	0.23	0.41	0.14
bio4	0.53	0.09	0.83	1.00	0.29	0.81	0.90	0.19	0.75	0.24	0.77	0.29	0.31	0.21	0.11	0.30	0.23	0.18	0.53
bio5	0.86	0.42	0.45	0.25	1.00	0.69	0.14	0.45	0.51	0.91	0.78	0.21	0.24	0.09	0.07	0.26	0.09	0.04	0.21
bio6	0.90	0.03	0.68	0.82	0.66	1.00	0.79	0.21	0.79	0.73	0.98	0.31	0.30	0.33	0.19	0.27	0.34	0.10	0.49
bio7	0.52	0.34	0.57	0.92	0.13	0.82	1.00	0.14	0.67	0.27	0.70	0.57	0.54	0.46	0.34	0.54	0.49	0.16	0.77
bio8	0.47	0.05	0.06	0.22	0.50	0.20	0.17	1.00	0.31	0.60	0.30	0.10	0.15	0.14	0.03	0.13	0.12	0.51	0.32
bio9	0.62	0.11	0.66	0.77	0.46	0.80	0.71	0.31	1.00	0.43	0.76	0.17	0.11	0.20	0.22	0.11	0.22	0.23	0.52
bio10	0.93	0.11	0.30	0.23	0.92	0.72	0.26	0.62	0.41	1.00	0.79	0.20	0.22	0.25	0.16	0.20	0.24	0.31	0.12
bio11	0.95	0.14	0.72	0.78	0.75	0.98	0.73	0.28	0.76	0.78	1.00	0.24	0.23	0.29	0.15	0.21	0.30	0.11	0.39
bio12	0.26	0.67	0.14	0.31	0.19	0.35	0.57	0.10	0.21	0.21	0.26	1.00	0.94	0.86	0.56	0.95	0.88	0.76	0.85
bio13	0.30	0.62	0.11	0.33	0.22	0.34	0.54	0.15	0.16	0.25	0.27	0.95	1.00	0.71	0.33	0.99	0.74	0.73	0.86
bio14	0.30	0.62	0.19	0.24	0.10	0.35	0.48	0.09	0.24	0.22	0.29	0.87	0.73	1.00	0.83	0.72	0.99	0.78	0.72
bio15	0.15	0.41	0.20	0.10	0.09	0.19	0.35	0.08	0.22	0.11	0.13	0.55	0.34	0.82	1.00	0.35	0.83	0.49	0.60
bio16	0.26	0.64	0.14	0.31	0.24	0.31	0.53	0.13	0.15	0.22	0.24	0.96	0.99	0.74	0.35	1.00	0.75	0.75	0.87
bio17	0.31	0.62	0.16	0.26	0.10	0.36	0.50	0.06	0.26	0.21	0.30	0.88	0.75	0.99	0.83	0.75	1.00	0.76	0.76
bio18	0.25	0.56	0.35	0.16	0.02	0.12	0.17	0.49	0.20	0.31	0.12	0.78	0.74	0.77	0.49	0.76	0.75	1.00	0.38
bio19	0.28	0.56	0.17	0.54	0.24	0.51	0.77	0.33	0.53	0.10	0.39	0.86	0.87	0.75	0.61	0.88	0.79	0.41	1.00

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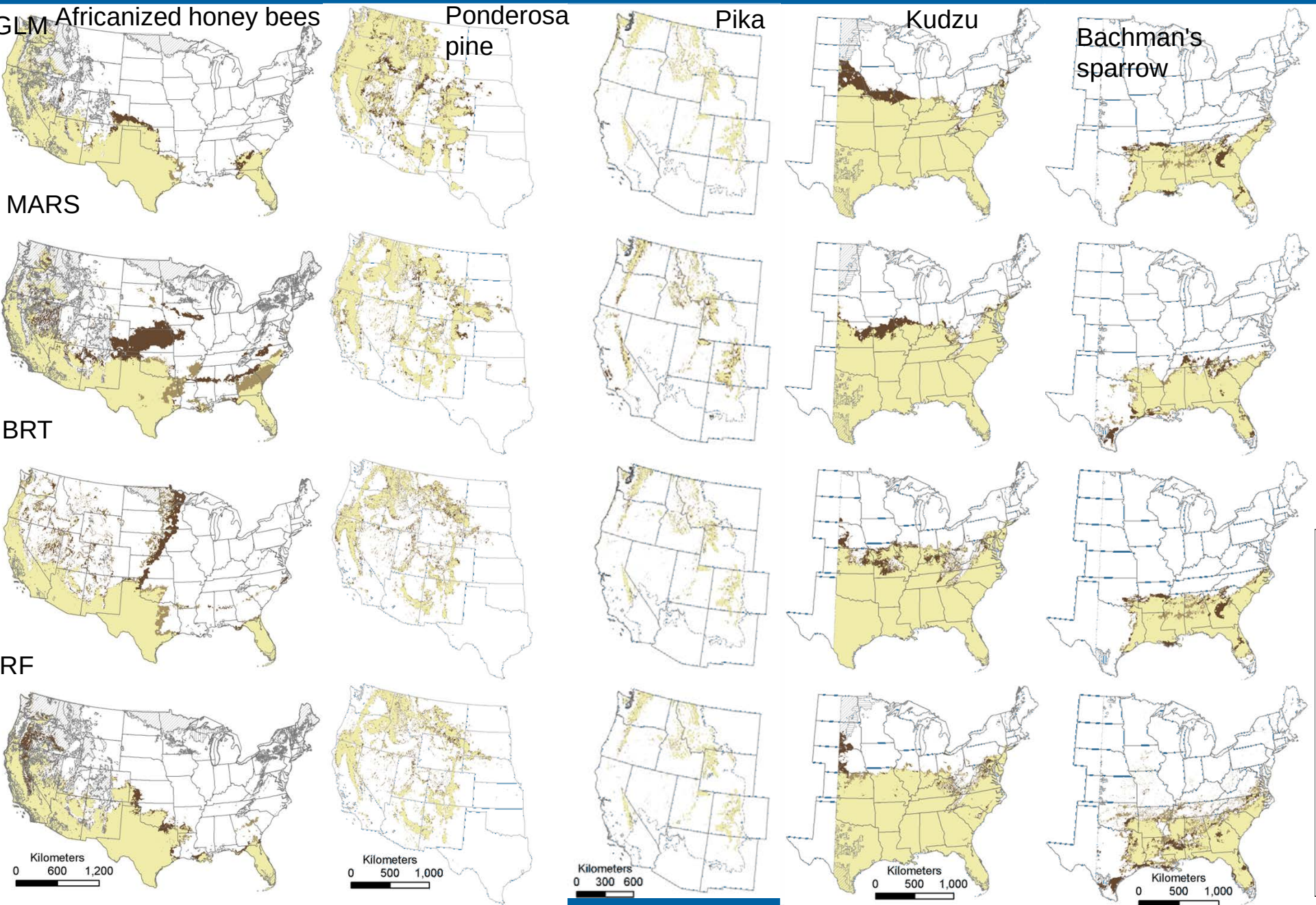
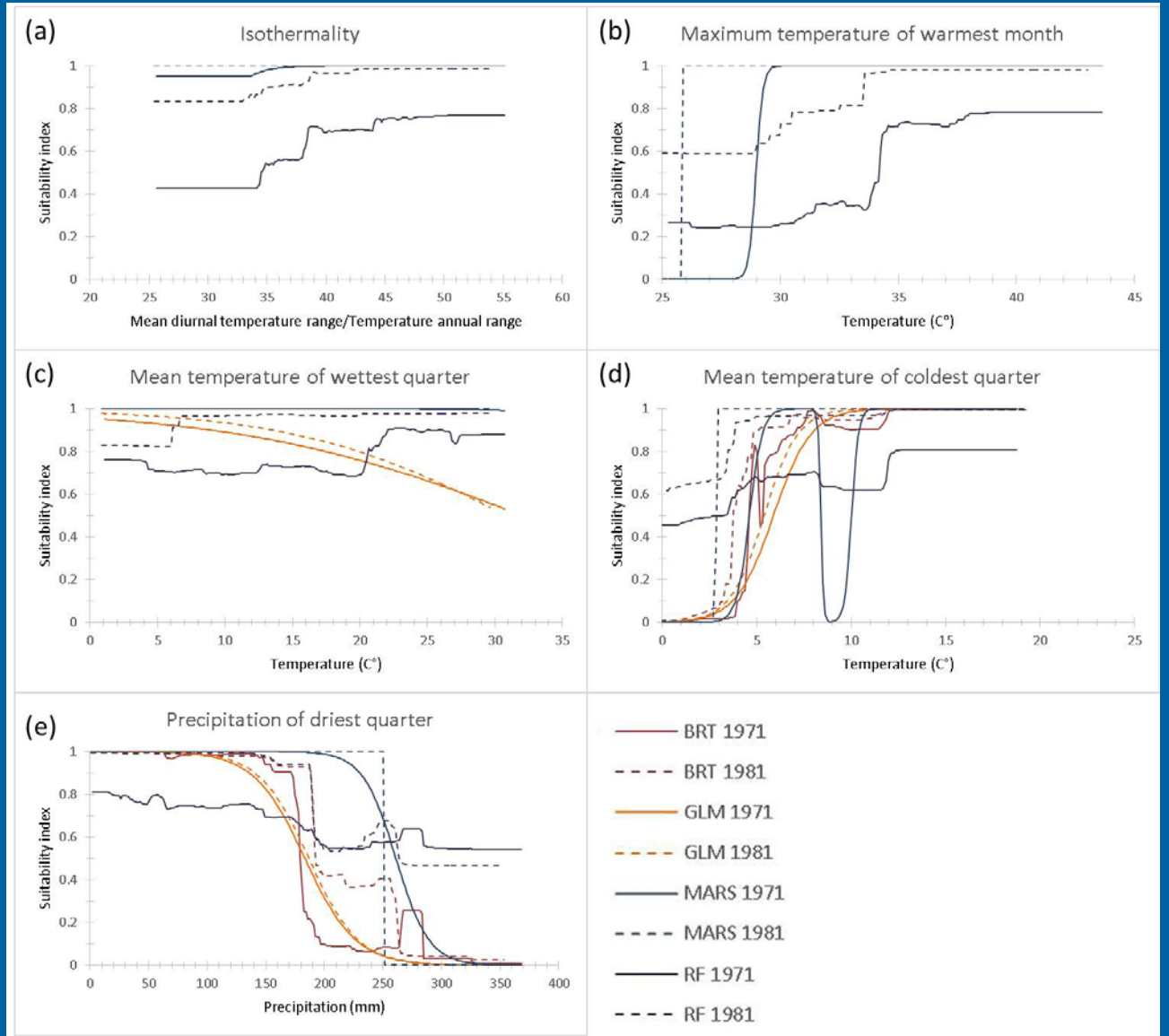
…but models still differ



Predictor variables

- Differences would be exacerbated by forecasts.
- Retained variables not consistent, either.



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Time period effect

- Model choice caused greater disagreement in predictions, but time period had an effect.

- Effect existed regardless of species, study extent, niche breadth, life span and nativity.

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Changing climate

- **Evaluate and compare the utility of using a *simplistic* eco-physiological based model and a correlative model to predict current and future distribution.**

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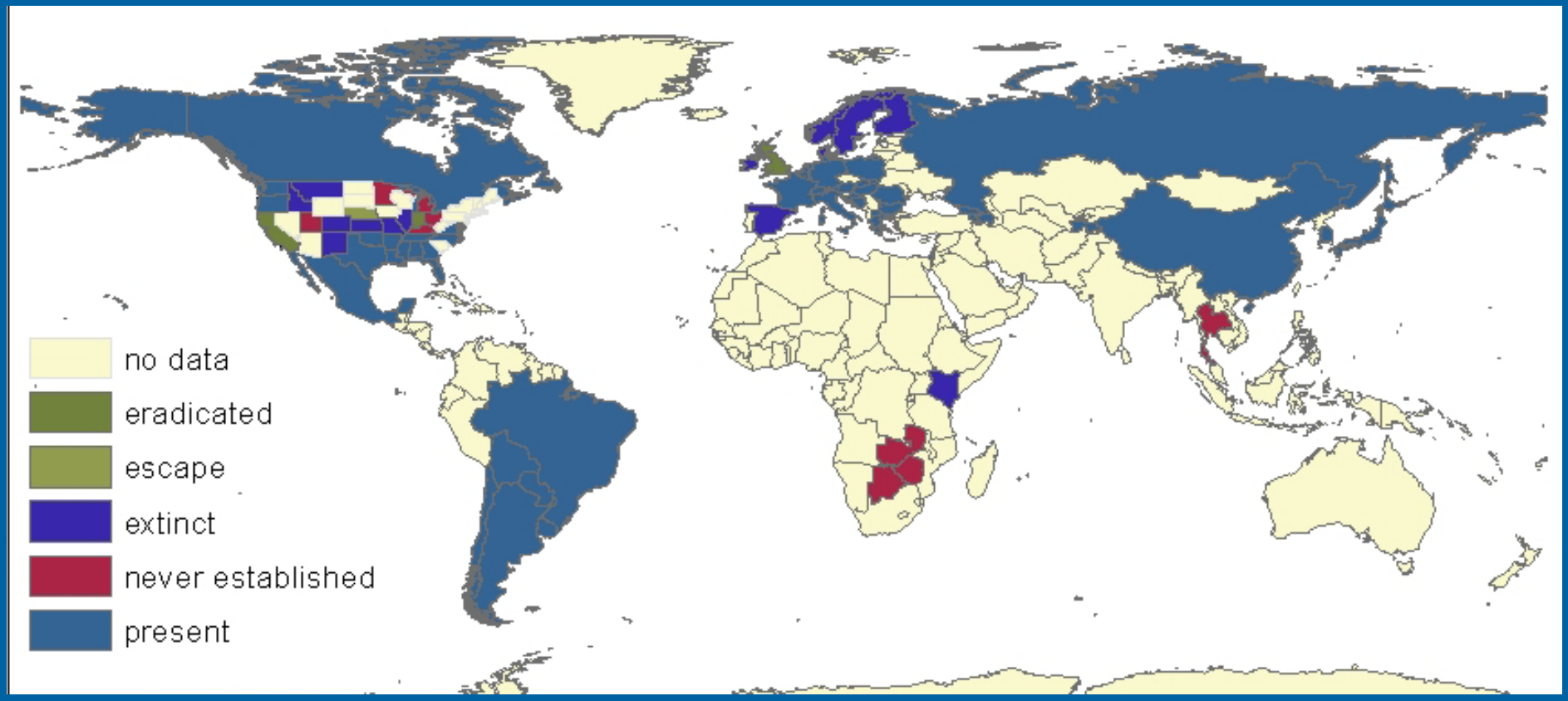
Worldwide distribution



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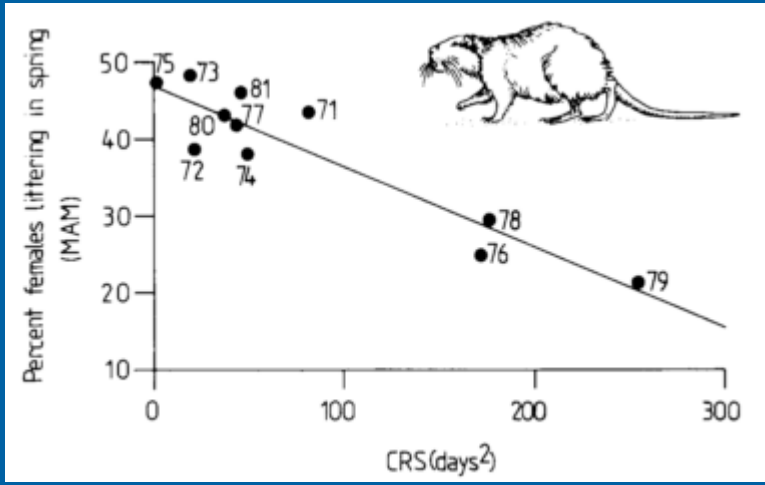
Carter and Leonard 2002

Eco-physiological model: population simulation models

- Weighted sequence of freezing days (CRS)
  - Min temp < 0^0C and max temp < 5^0C
- Inverse relationship with:
  - Percent of females littering (r=-0.93)
  - Change in adult female numbers (r=-0.59)
  - Fatness of adult males (r=-0.85)



1. Mostly effects birthrate and juvenile survival
2. Adult mortality in very severe years

Gosling et al. 1983, EPPO Bulletin 13:183-192

Correlative SDM

- Generalized linear model (implemented with VisTrails:SAHM)
- Six bioclimatic variables
- Two pseudo-absence approaches
  - Random within countries with presence
  - Targeted background (Phillips et al. 2009)

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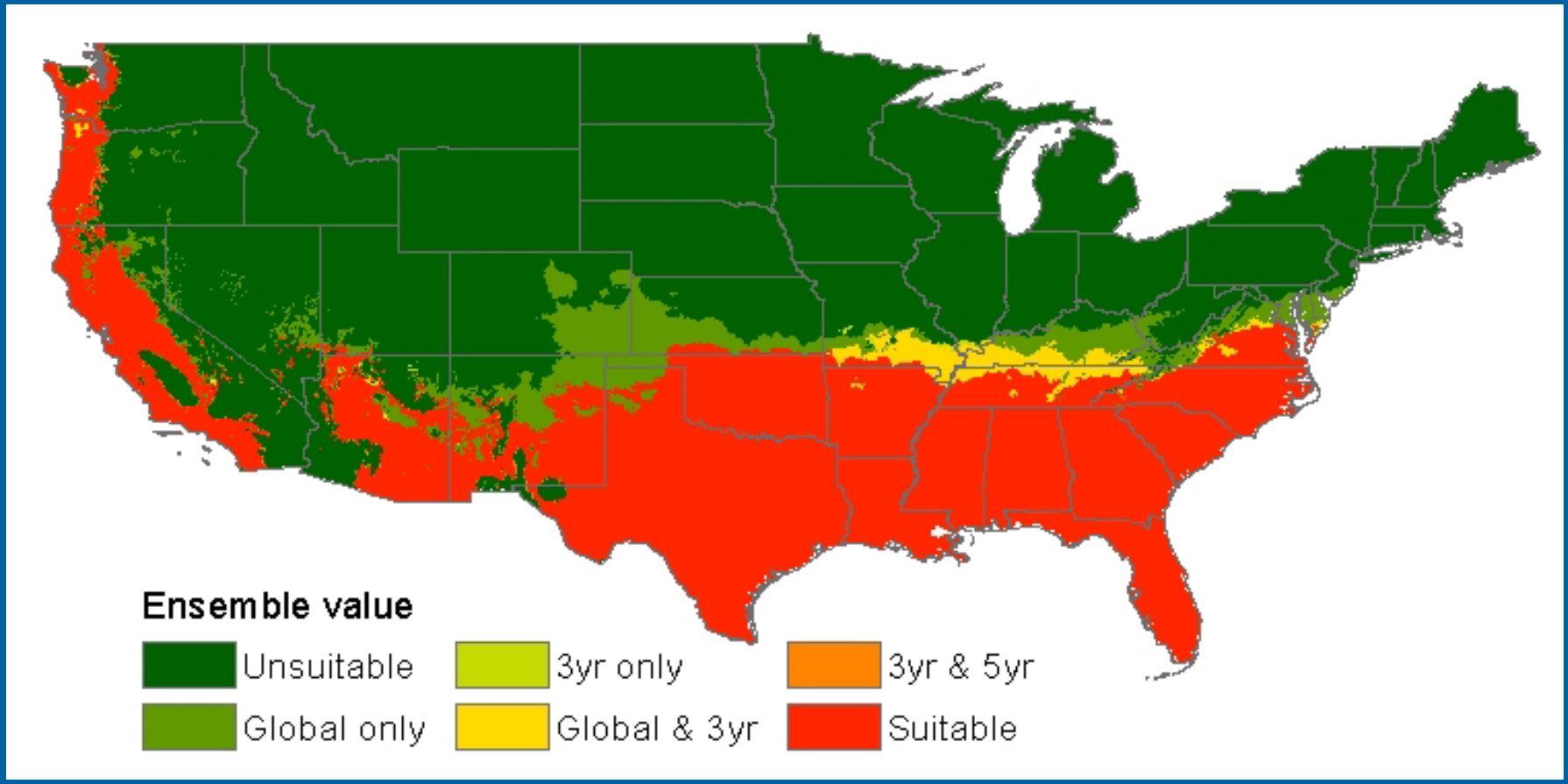
Eco-physiological model results



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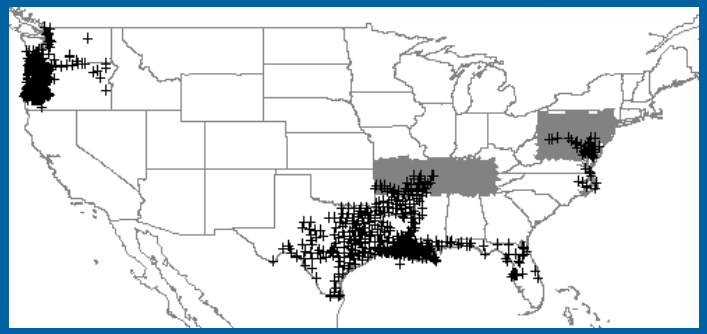
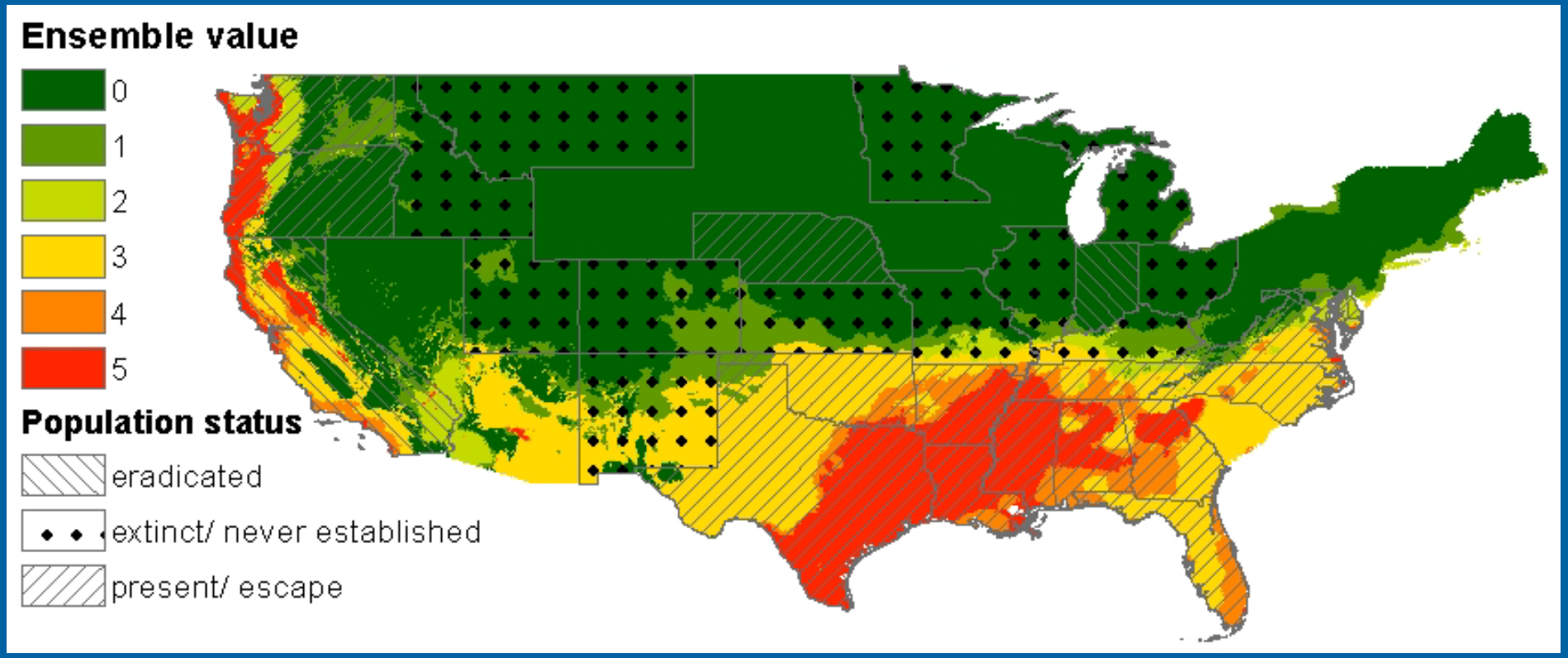
+ Correlative models





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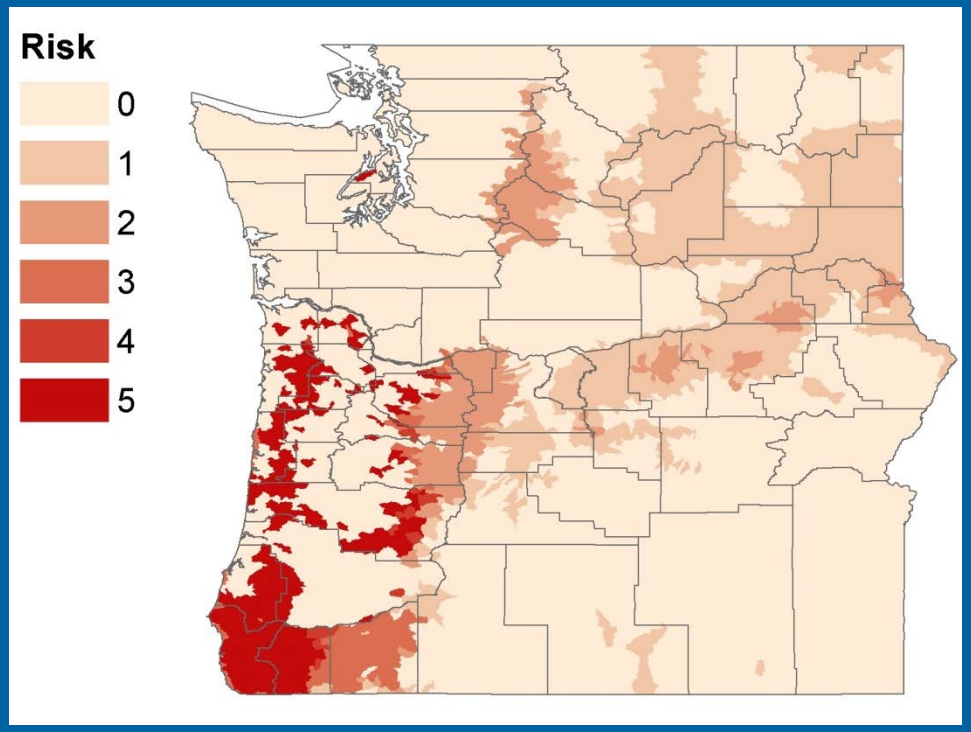
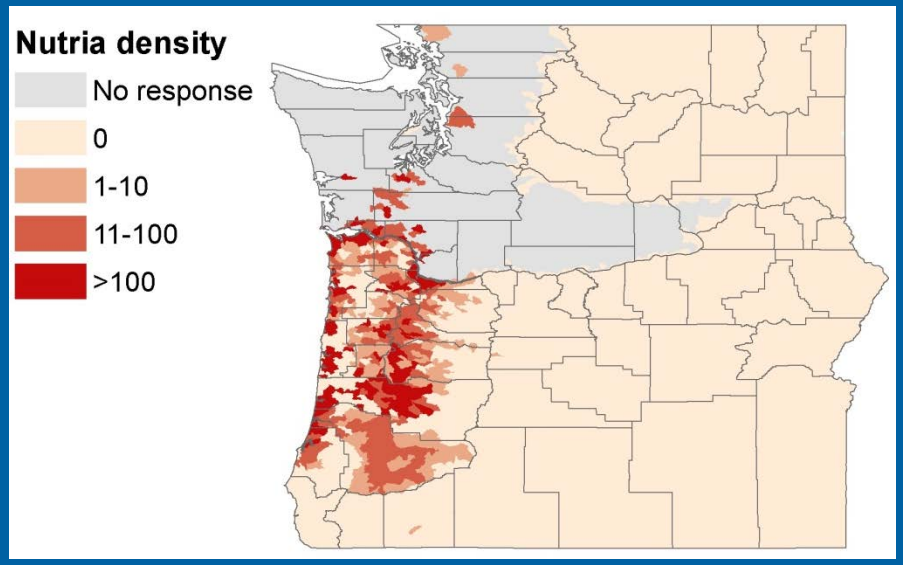
Management Application

Percent with suitable habitat by density class

	>100	11-100	1-10	0
GLM - country	100	100	93	16
GLM - targeted	100	100	94	35
global	100	98	87	15
US 2005-7	100	99	91	12
US 2003-7	100	99	89	12





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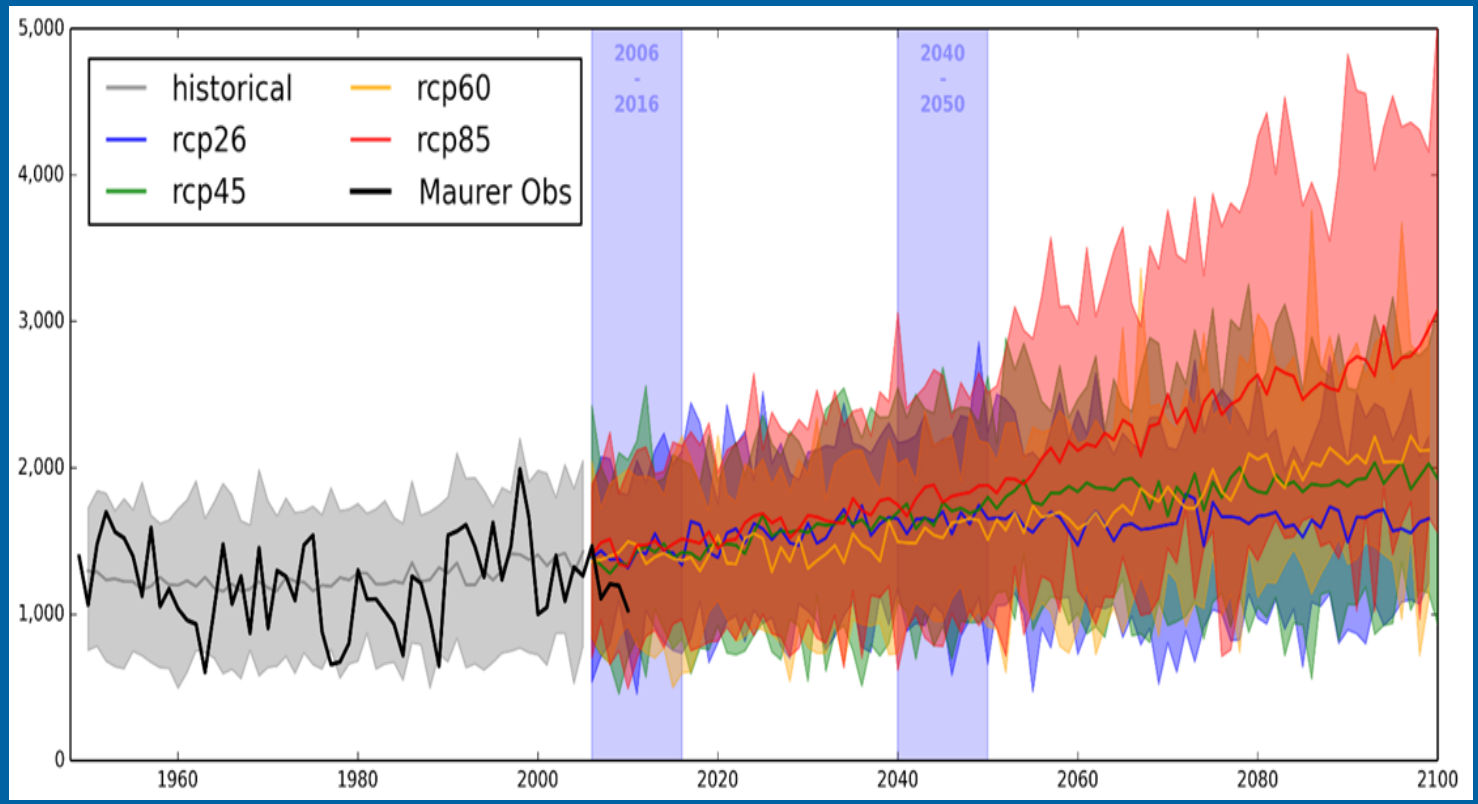
Climate change impact assessment



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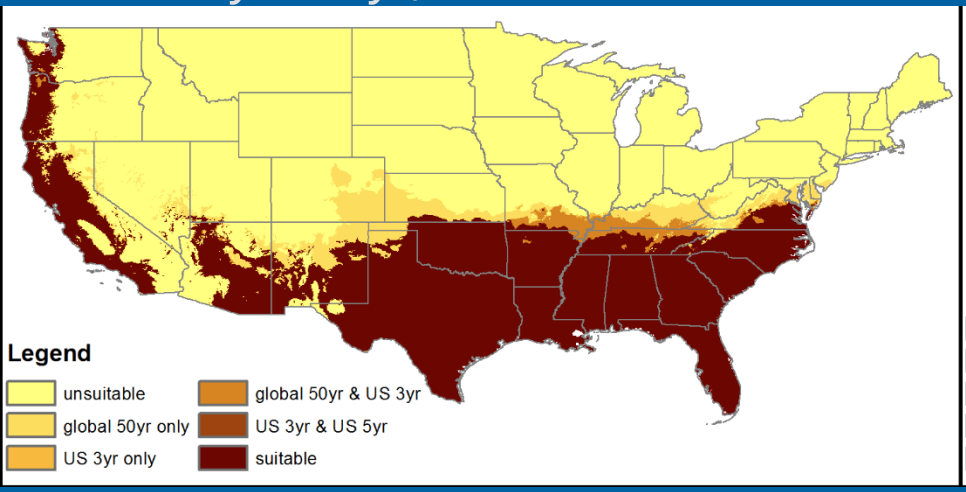
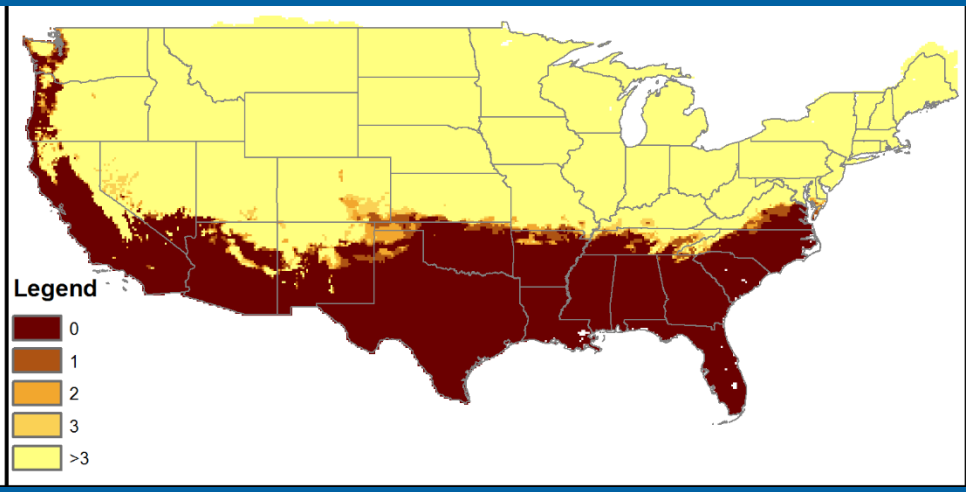
Climate change impact assessment

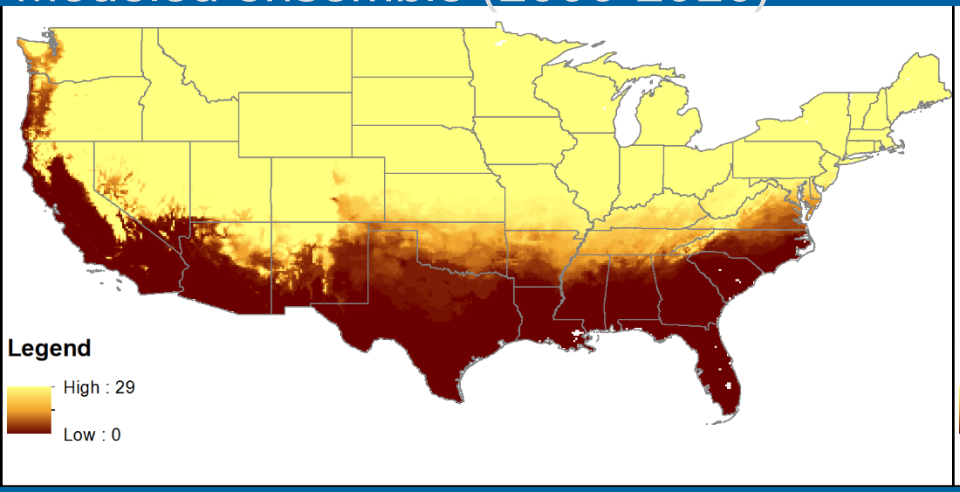
PRISM 3yr & 5yr, WorldClim



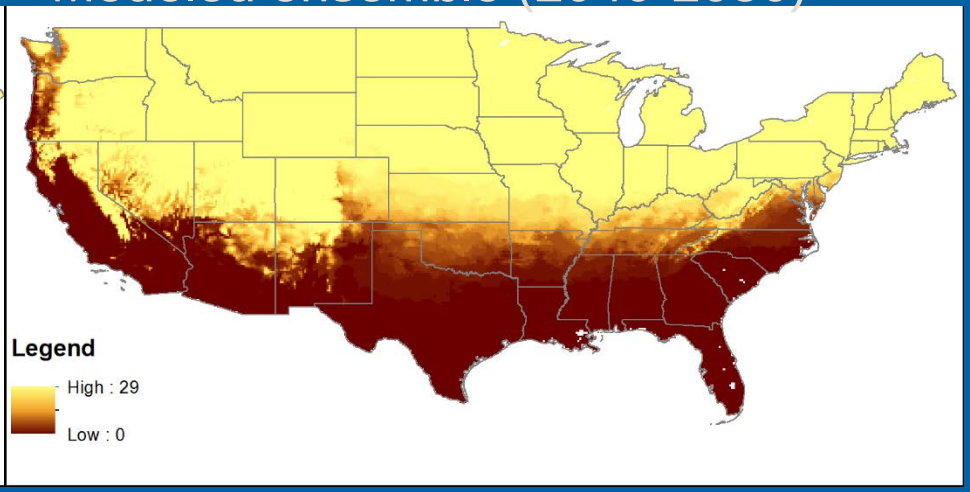
Maurer 2001-2010



Modeled ensemble (2006-2016)



Modeled ensemble (2040-2050)



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Conclusions

- Choice of climate data matters: the time period, time span, and the climate product.
- Ecophysiological and correlative models were similar in some regions, but correlative predicted less suitable habitat.
- Ranges are dynamic – even in the short term.

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Questions?

- **Thanks to the USGS invasive species program and all my collaborators:**

  Paul Evangelista (CSU), Jacoby Carter (USGS), Trevor Sheffels (USFWS), Mark Systma (PSU), Colin Talbert (USGS)

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