Climate change, ecological impacts and managing biodiversity

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A globally coherent fingerprint of climate change impacts across natural systems

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We know that species are responsive to climate and change habitat occupancy in response to climate change.

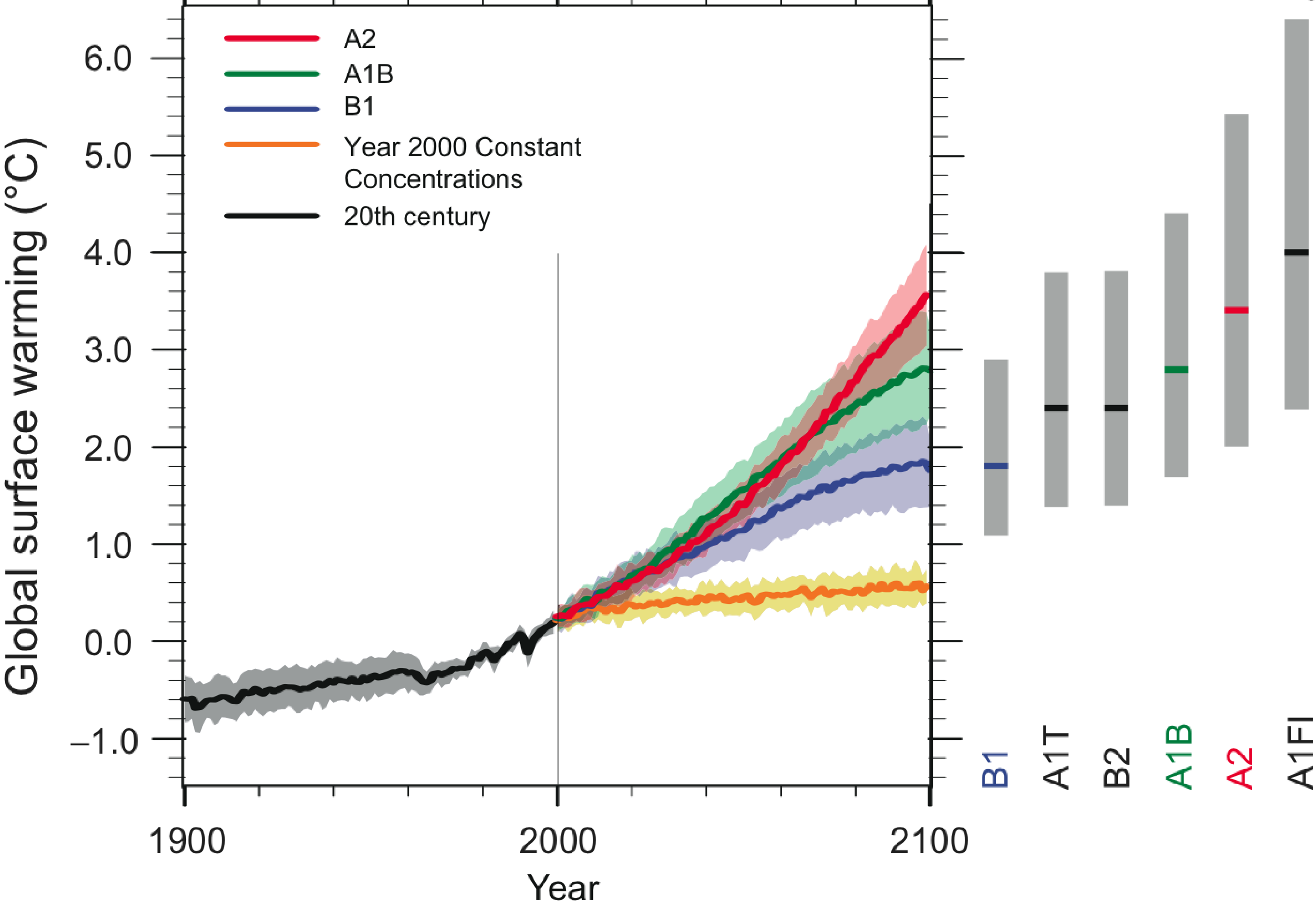
We know these changes will disrupt communities and ecosystems. We need robust plans to buffer these changes.

Table 2 Summary statistics and synthetic analyses derived from Table 1

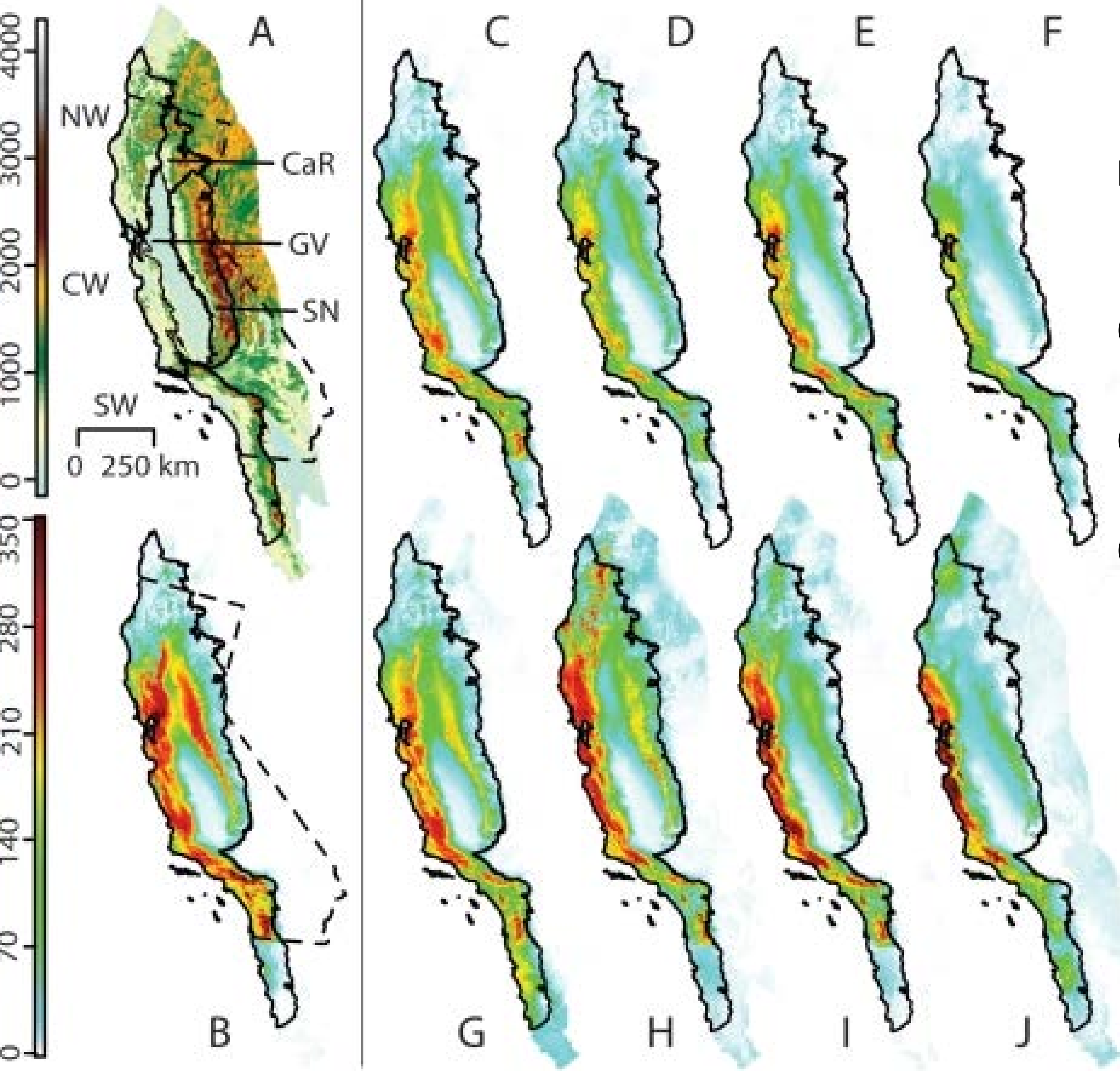
Type of change	Changed as predicted	Changed opposite to pre
Phenological (*N* = 484/(678))	87% (*n* = 423)	13% (*n* = 61)
Distributional changes		
At poleward/upper range boundaries	81%	19%
At equatorial/lower range boundaries	75%	25%
Community (abundance) changes		
Cold-adapted species	74%	26%
Warm-adapted species	91%	9%
N = 460/(920)	81% (*n* = 372)	19% (*n* = 88)
Meta-analyses		
Range-boundaries (*N* = 99)	6.1 km m^{-1} per decade northward/upward shift*	
Phenologies (*N* = 172)	2.3 days per decade advancement*	

Data points represent species, functional groups or biogeographic groups. *N*, number of statistically or biologically significant changes/(total number s
abundance processes). The no prediction category is not included here.
* Bootstrap 95% confidence limits for mean range boundary change are 1.26, 10.87; for mean phenological shift the limits are −1.74, −3.23.

Ensemble modeling



Leading us to believe that we can predict the future….



Different maps represent different:

(a) 2 emissions scenarios

(b) 2 climate models; and

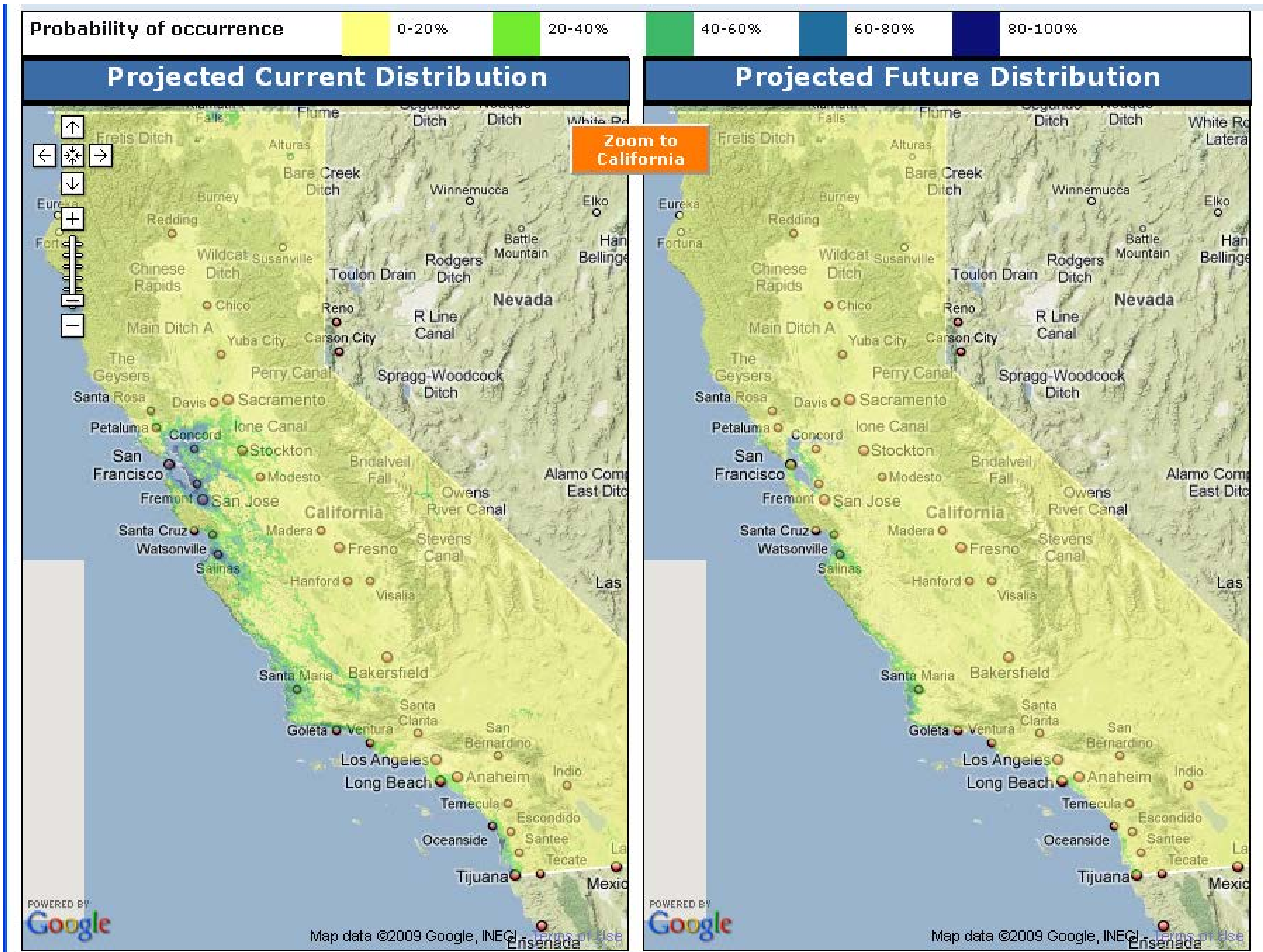
(c) 2 dispersal capacity assumptions

Loarie et al. 2008

Modeling species response to climate change

- Collect observations of presences
- Fit climate surface to current distributions top find correlated climatic variables.
- Predict distribution of future climates
- Project species distributions onto future climates.
- Estimate extinction risk
  - No dispersal or full dispersal

PRBO, Savannah Sparrow projection

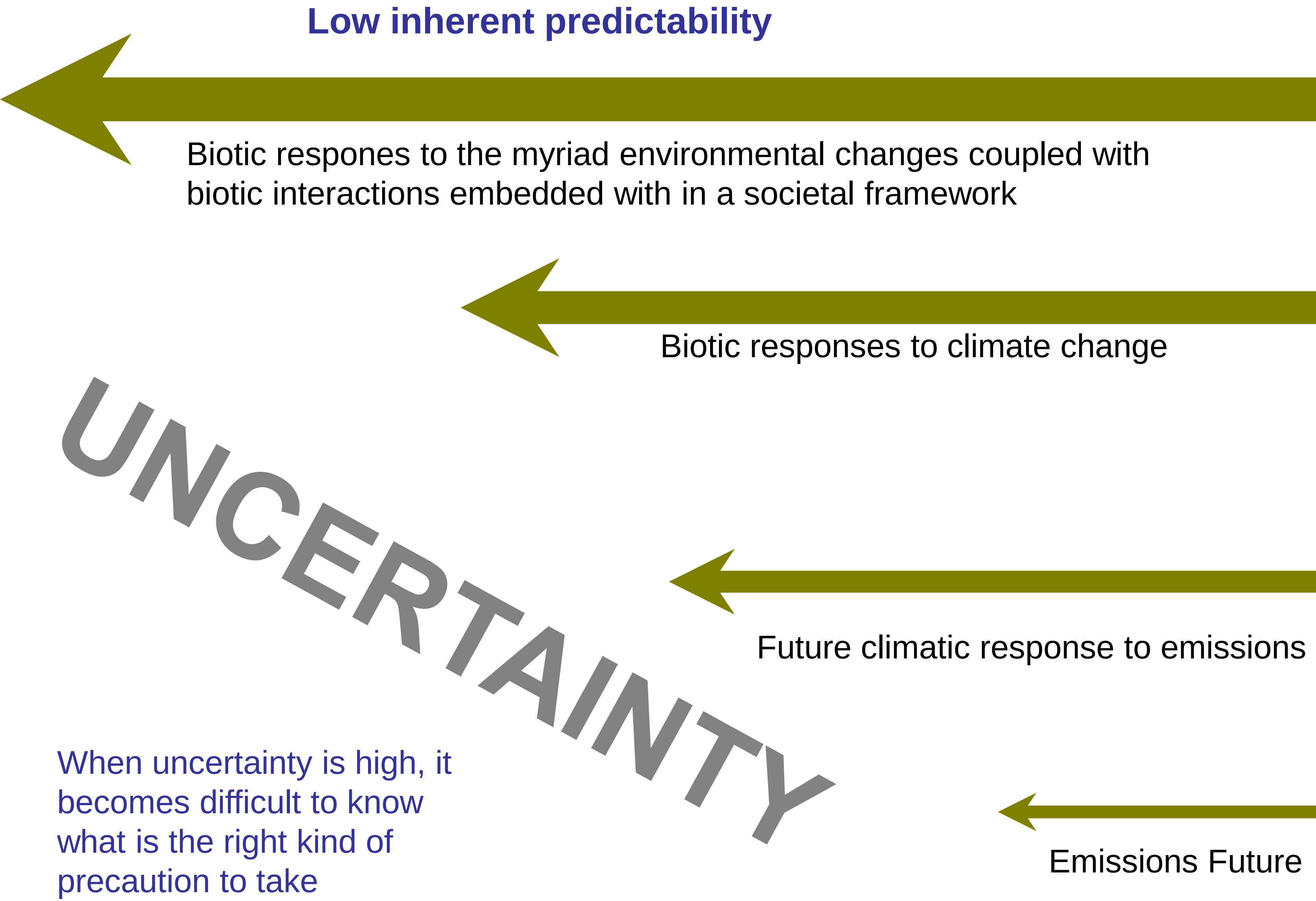


HOW MANY EXTINCTIONS WOULD PREDICT?

- 1950. You a redicting 2009 plant diversi fornia.
  - Population, ll add ~5 million per decade to 37 million,
  - Driving hab ation, degradatior …
  - Exacerbatir s, plant disease, wildfire, N c pesticides and herbicides.

KNOWN SPECIES EXTINCTIONS 1950 to present?:

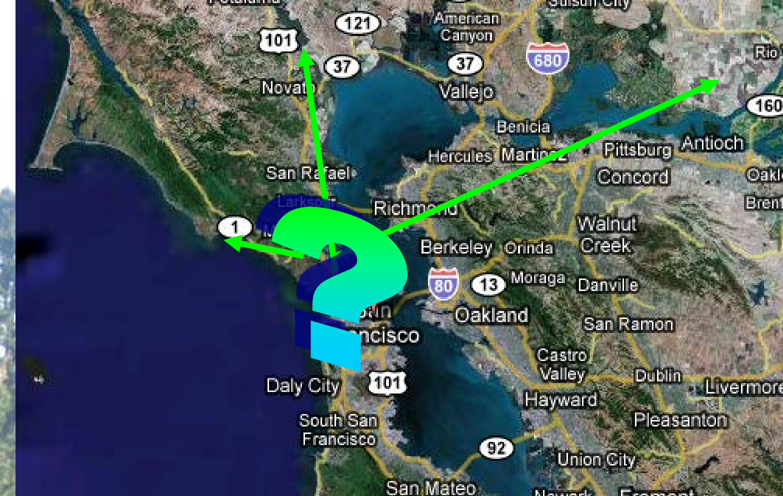
Castilleja uliginosa is only taxa observed on the presumed extinct list (GX, GH; n=20) observed since 1945 (1946).

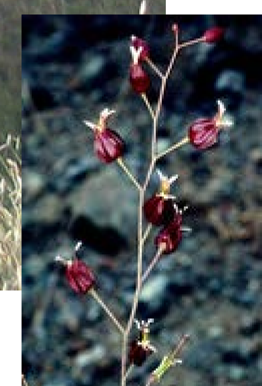

Low inherent predictability
Biotic respones to the myriad environmental changes coupled with biotic interactions embedded with in a societal framework
Biotic responses to climate change
UNCERTAINTY
Future climatic response to emissions
When uncertainty is high, it becomes difficult to know what is the right kind of precaution to take
Emissions Future

Seven Issues of Concern

- When applying SDM's to protect biodiversity
  - **I. Adaptation to changing conditions**
  - **II. Biotic limitations on distribution**
  - **III. Non-analog environments**
  - **IV. Endemicity and dispersal limitation**
  - **V. Response lags**
  - **VI. Uncertainty magnification**
  - **VII. Power, and sampling bias issues**

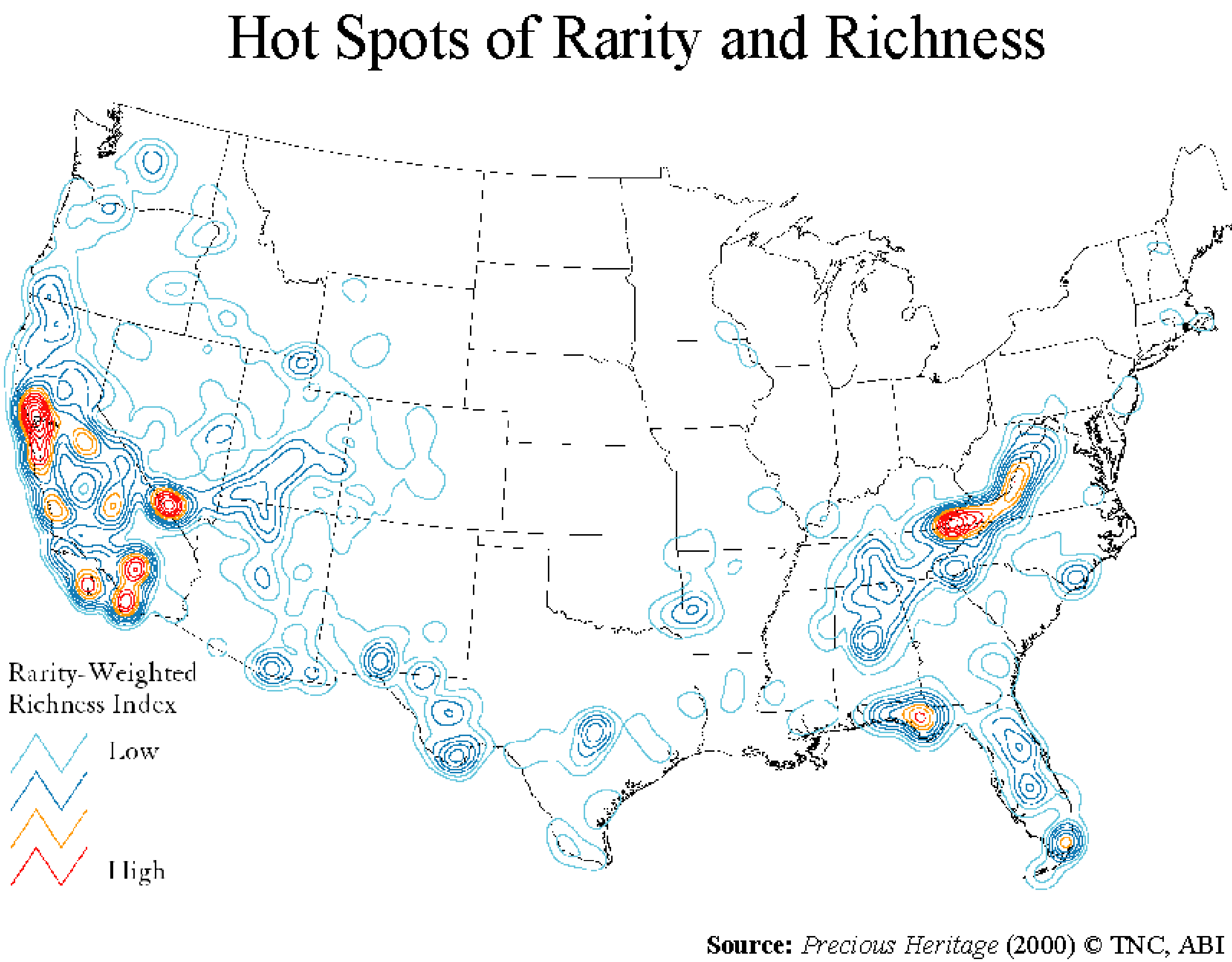
Many of these can lead to over-prediction of response and extinction risk

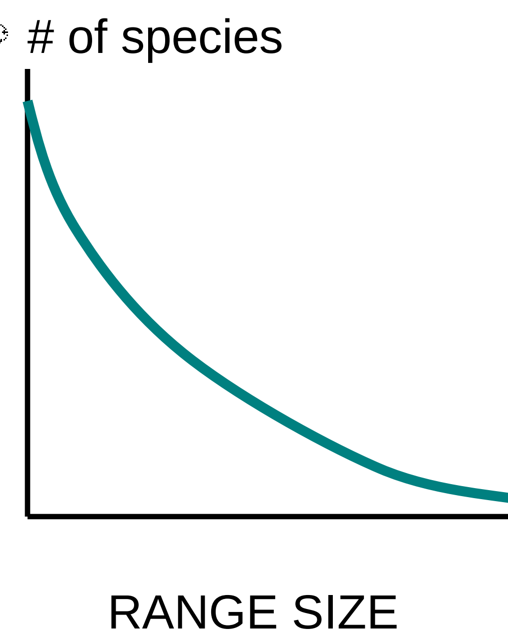




What do we do? **Nothing? Status quo? Managed relocation?**

Problems with modeling are most frequent in narrowly distributed taxa. Most taxa are narrowly distributed. This is doubly true for species of concern. The problem of 'giving up' on species (triage) modeled to be 'committed to extinction' may be as extensive a problem as losing species to warming.





If climate change is likely to drive distribution shifts and extinctions, how do we do conservation planning?

- **Option A**. Panic. If we believe these models to be correct, then current reserves are seriously miscast for the future.
- **Option B**. Triage. Cut our losses and decide to not manage species that are perceived at too high a risk of extinction.
- **Option C**. Really, really panic. Other factors beyond climate change means that we have a future with low predictability.
- **Option D**. **Plan for change.** – retain reserves, expand representation, manage for resilience, create corridors, implement ex situ strategies….. (see Mawdsley et al 2009. Conservation Biology)

Other factors may trump direct impacts of climate change

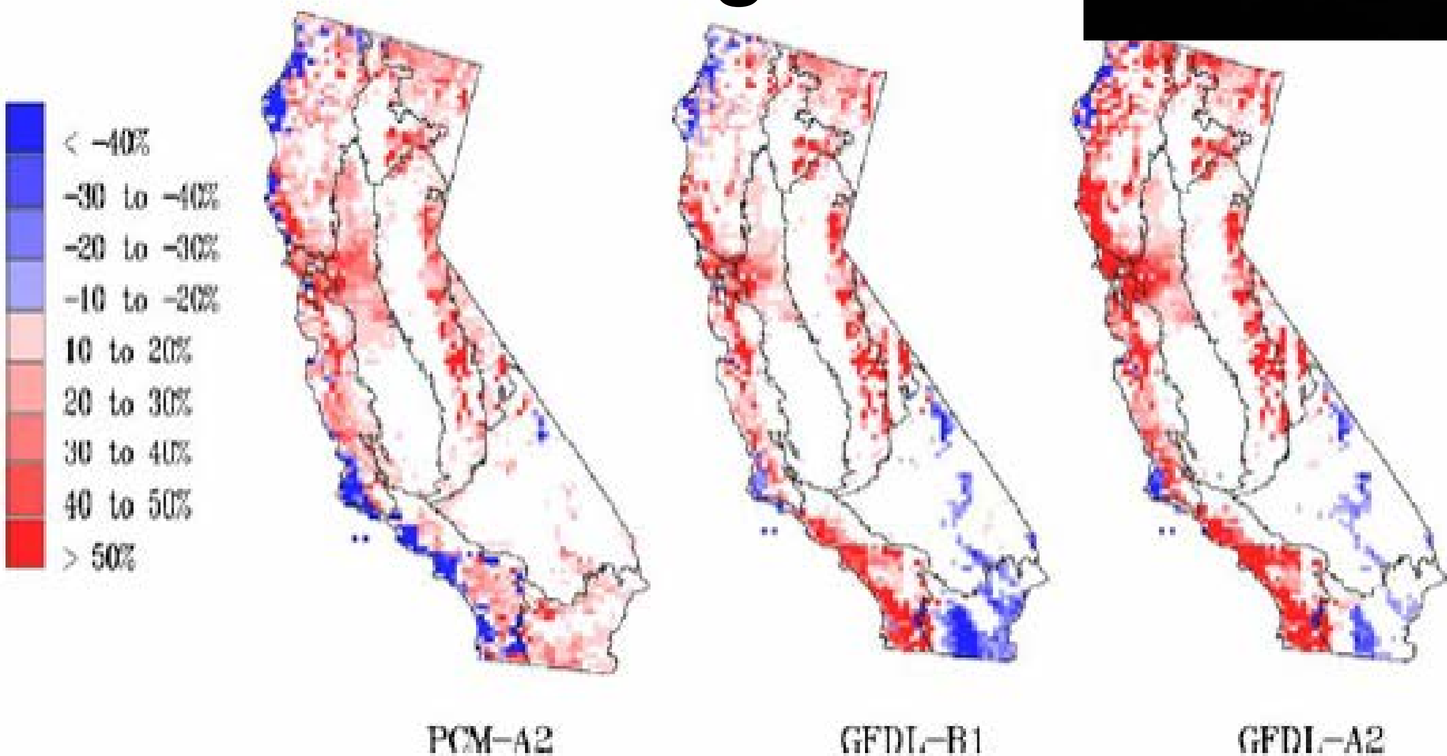


Fig. 8 Percent change in mean annual area burned for the 2050–2099 future period relative to the mean annual area burned for the historical period (1895–2003)

Springer

From Lenihan et al. 2008. Climatic Change.

Unprecedented management challenges

- In response to changing climate, do we:
  - Redistribute managed ecosystems? (*a new restoration ecology paradigm*)
  - Manage ecosystem properties (e.g., disturbance) to facilitate community change (e.g., changing fire regimes)? (*ecological engineering*)
  - Introduce species to new locations in order to alleviate dispersal limitations and keep pace with climatic shifts? (***assisted migration***)

See also: Mawdsley et al. 2009. Conservation Biology 23: 1080-1089

Advice?

- Uncertainty is very high; challenges to data, from both sides, are expected.
  - Frame plans in terms of risk assessment, robust decision-making, minimizing the risk of maximum regret.
- A *precautionary* approach dictates protecting habitat for species *even if they are modeled to vacate that location.*
- A *prospective* approach dictates capturing movement corridors as well as habitat for species that might not yet occupy the region.