

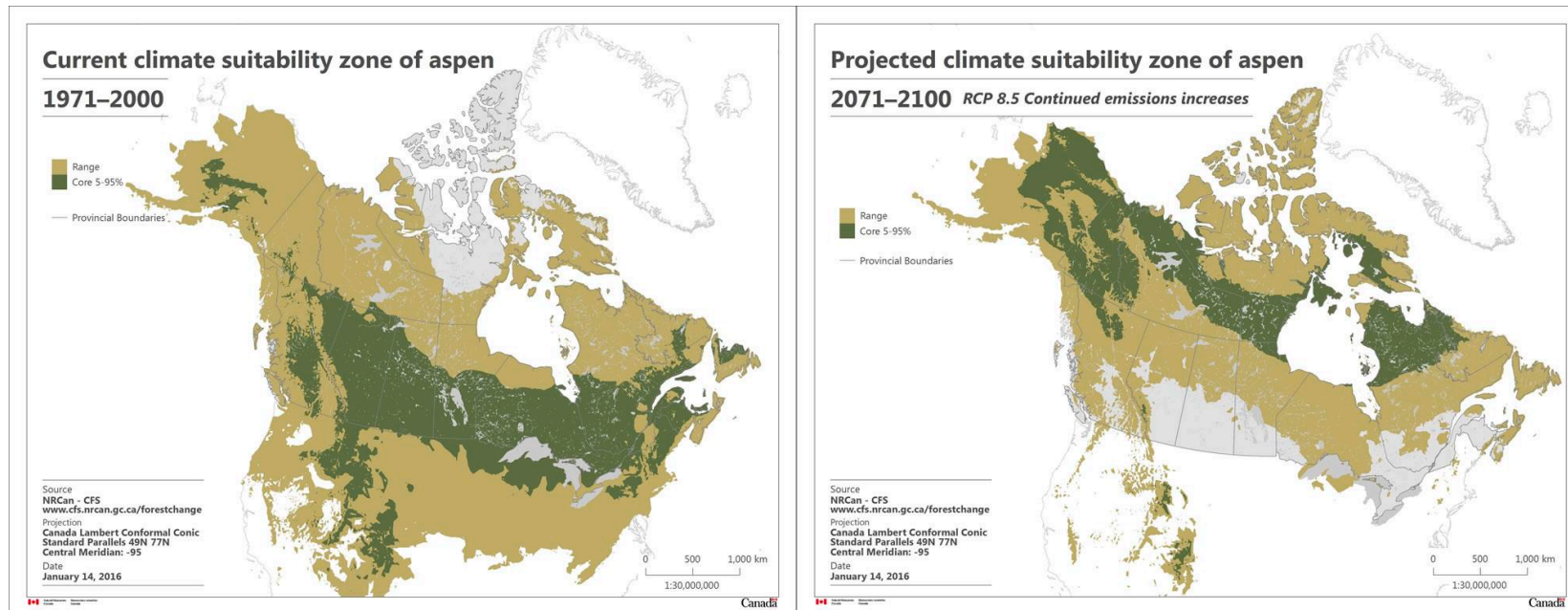
Adaptive Capacity and Range Edge Dynamics

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Evolving Seas RCN Meeting

August 20, 2019

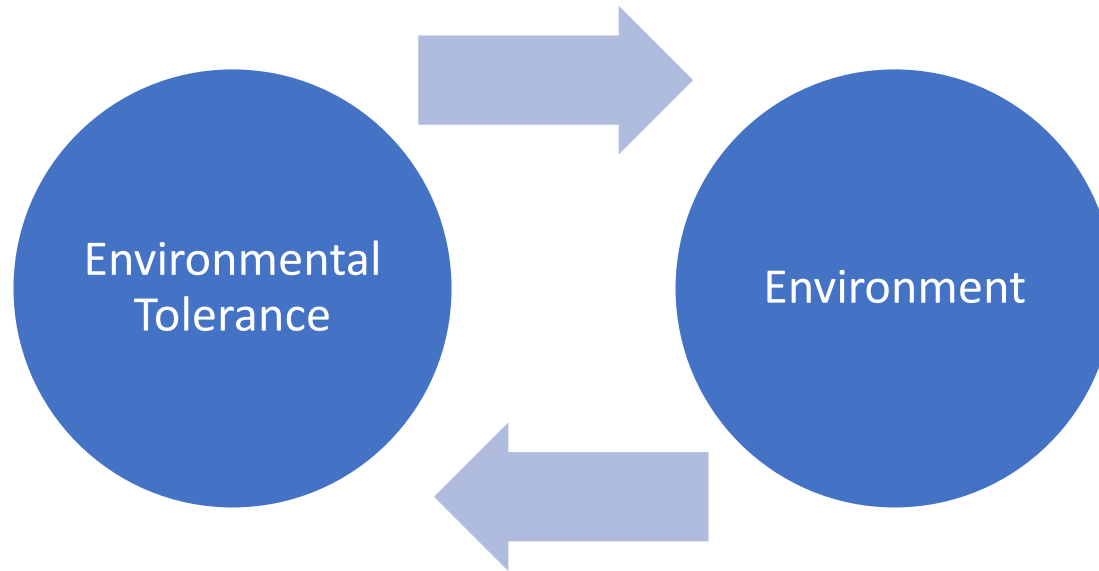
Species distributions in a changing climate



“The ***climate suitability zone*** is the current climate across the current distribution of a species...”

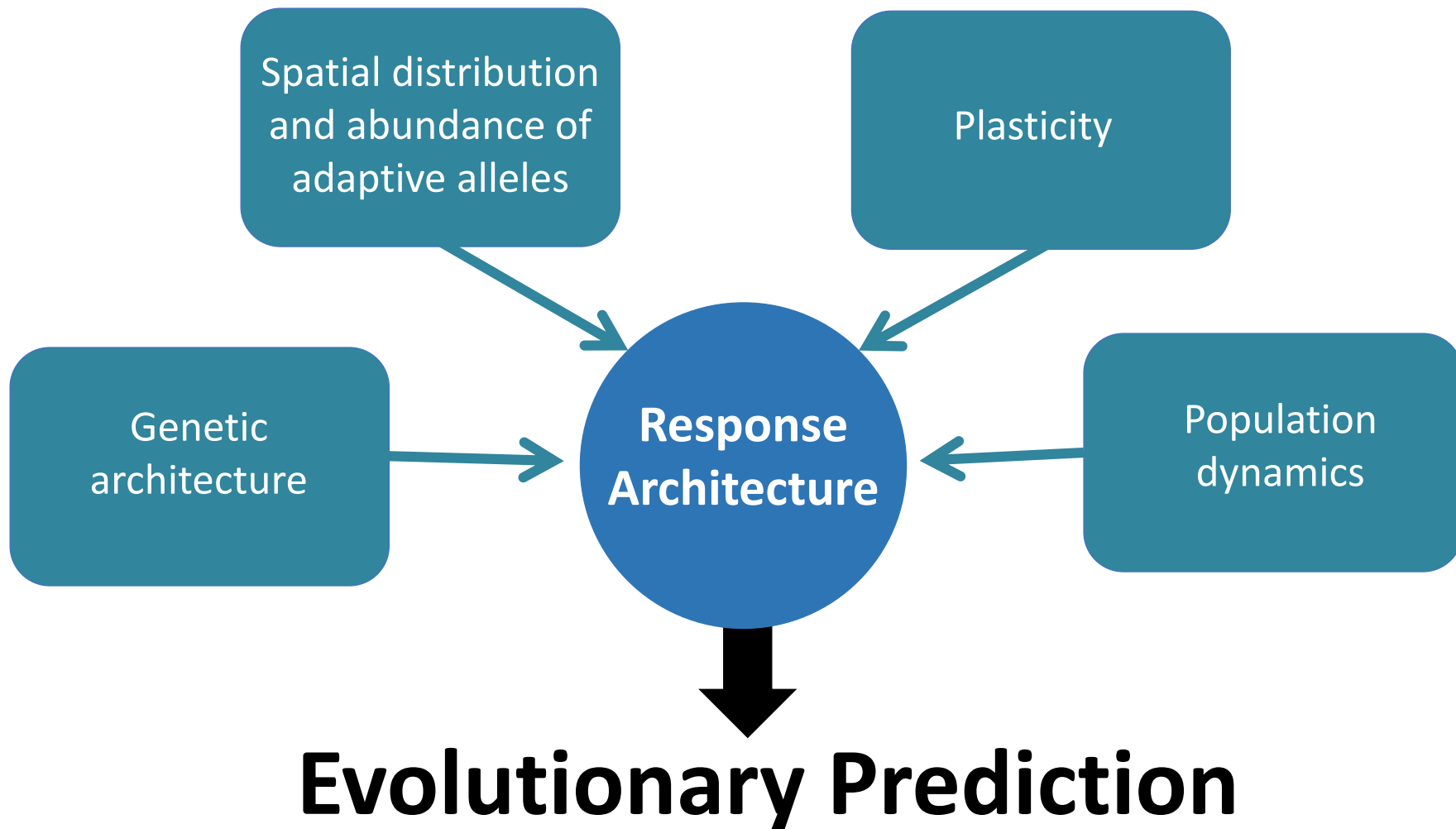
Natural Resources Canada (cfs.nrcan.gc.ca)

Evolution in a changing environment



- ***Adaptive capacity*** – the ability to maintain positive population growth rate under changing environmental conditions
- Ultimately, adaptive capacity is a ***prediction*** of how evolution might proceed under a given scenario

Evolutionary predictions

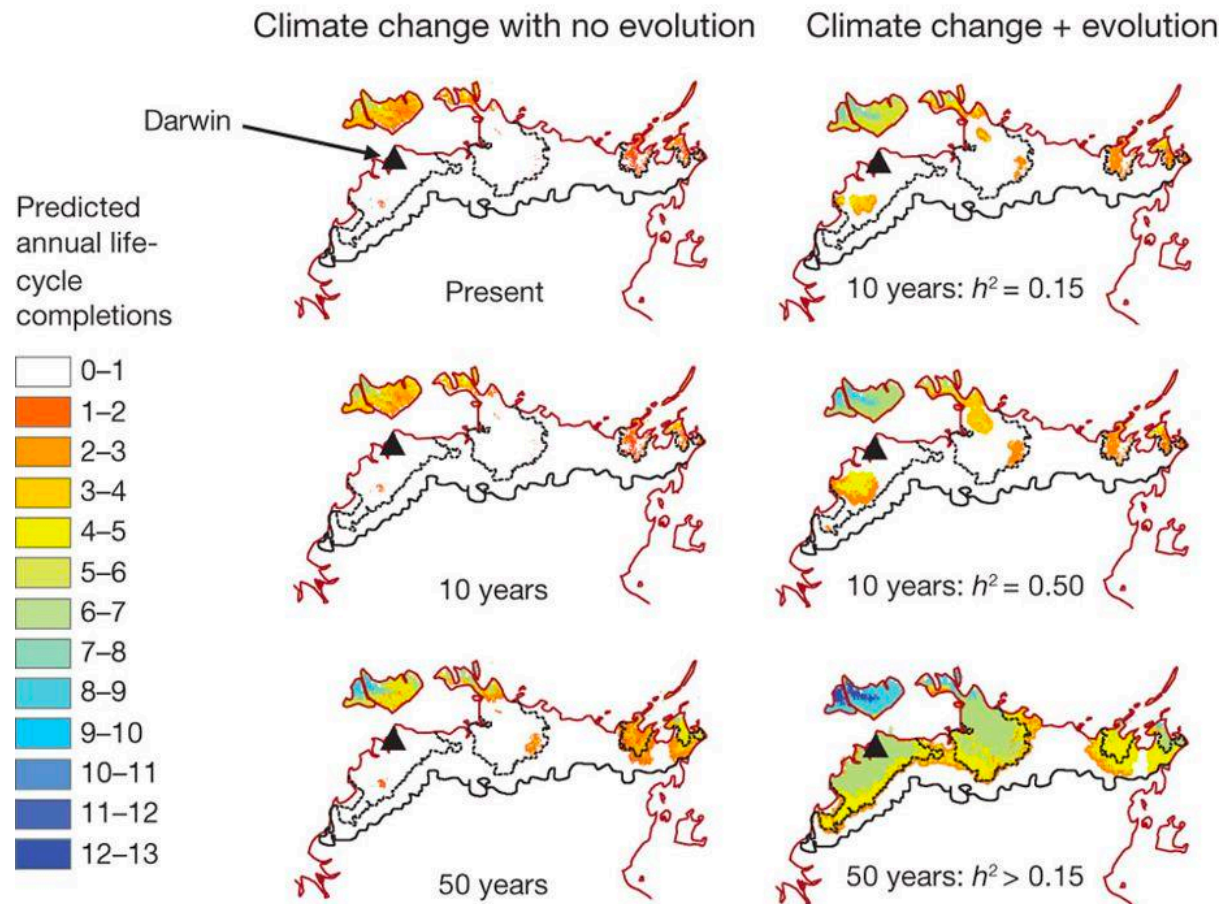


Bay*, Rose* et al. 2017. *The American Naturalist*

How do we measure adaptive capacity?

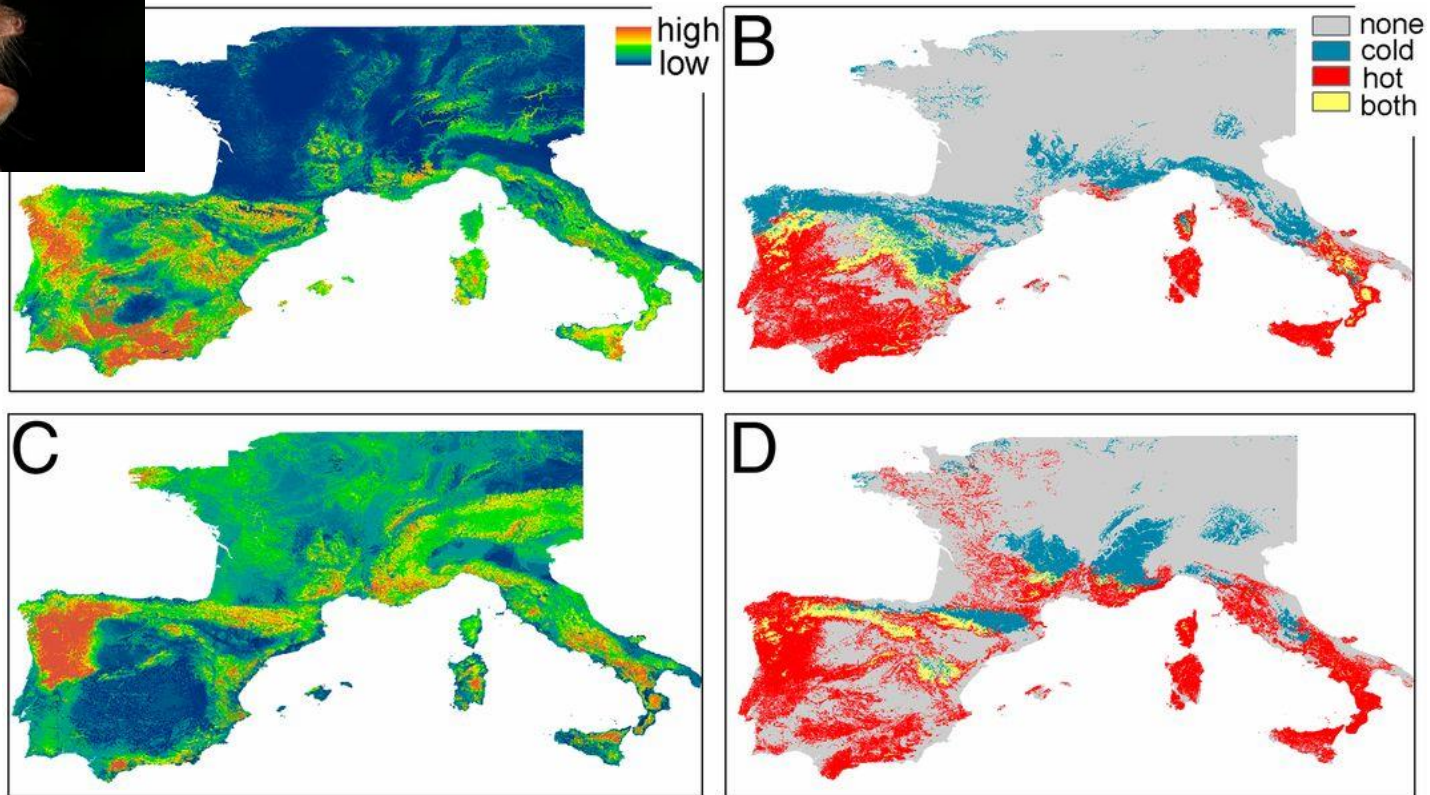
- Quantitative genetic variation
 - Natural populations
 - Selection experiments
- Neutral genetic variation
- Adaptive genetic variation
 - Genotype environment associations, Genome-wide association studies
 - Candidate genes

Integrating adaptive capacity changes predicted outcomes



Kearney et al. 2009. *Functional Ecology*

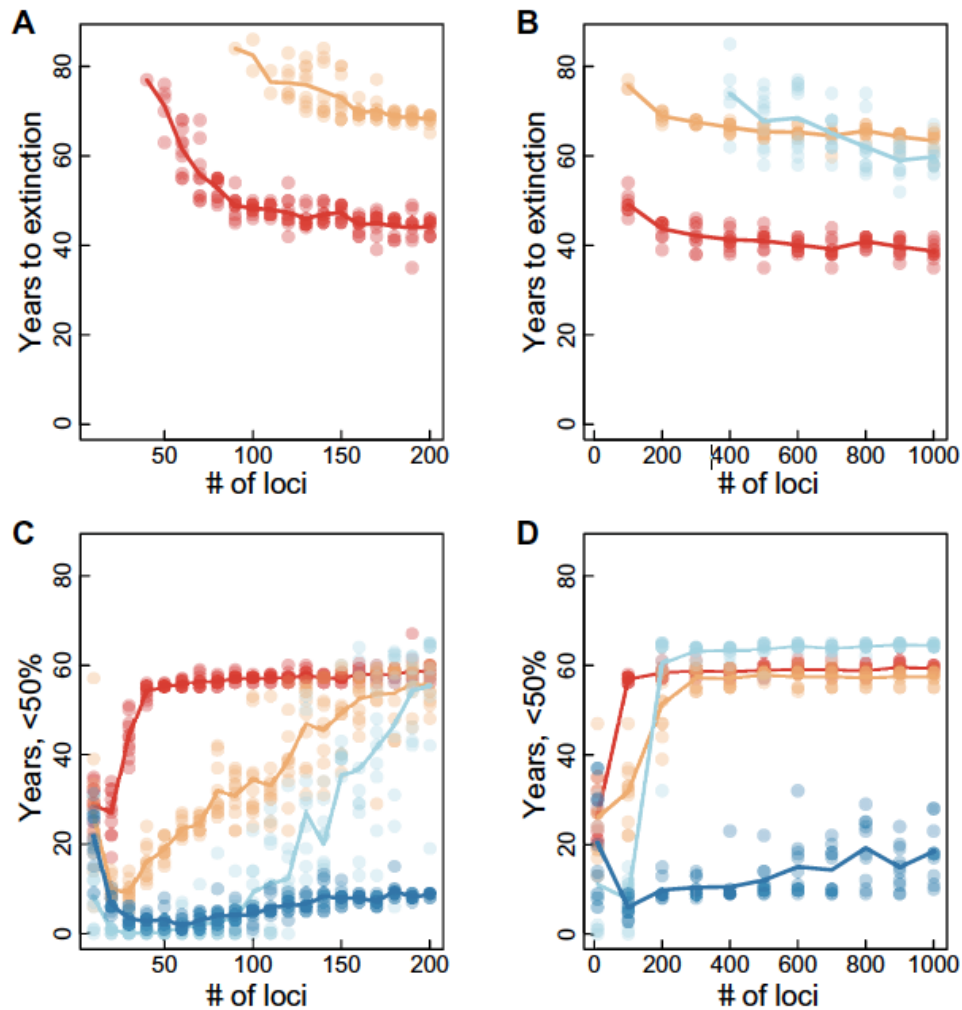
Integrating adaptive capacity changes predicted outcomes



Issues with measuring adaptive capacity

- Choice of target traits/environments
 - Which traits are important?
 - What about trait covariation? Life history?
 - Trait and heritability measurements are environmentally-dependent
- Genetic basis
 - Neutral vs. adaptive genetic variation
 - Power/accuracy of genome scans to identify adaptive variation
 - Plasticity

Genetic architecture affects predictions

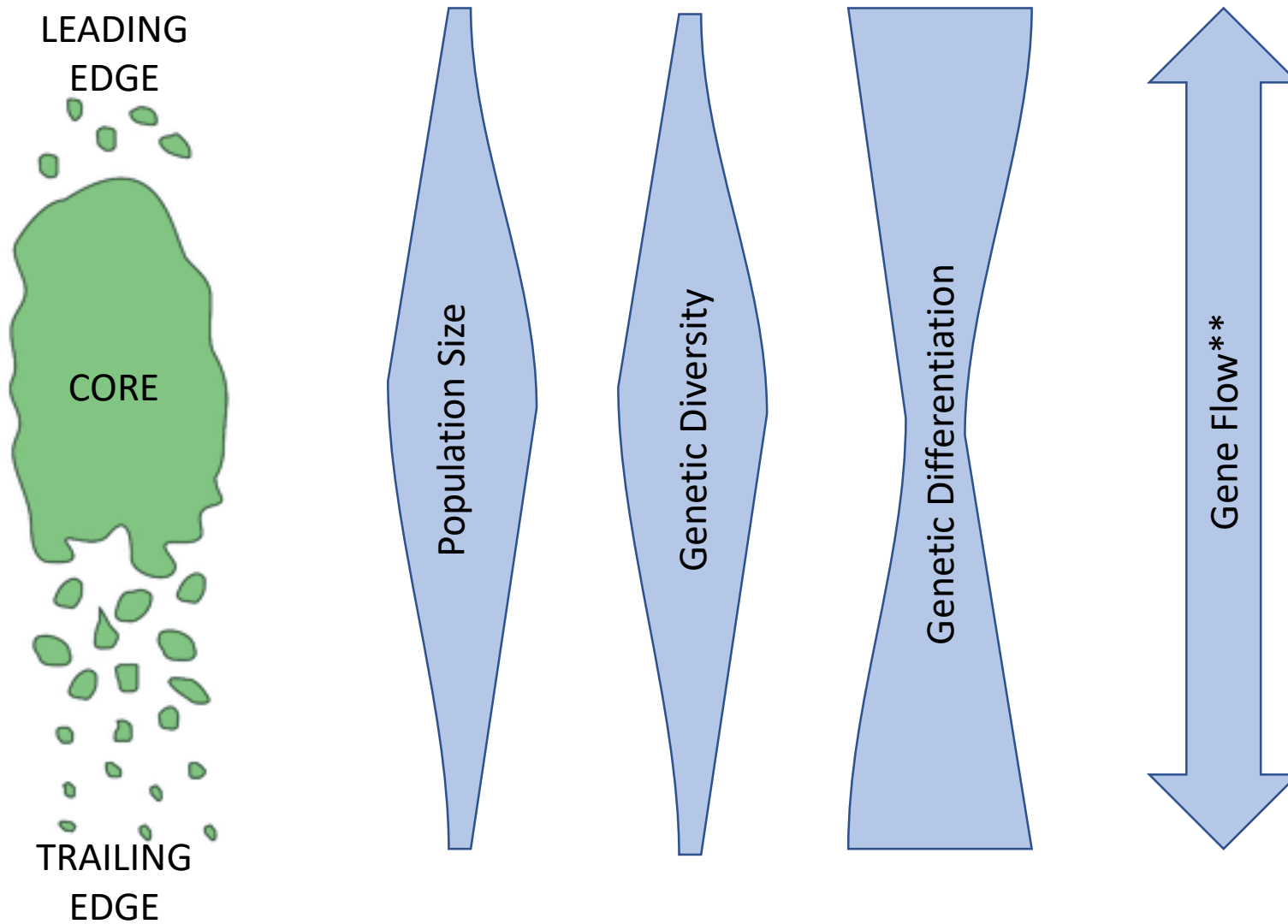


Bay et al. 2017. *Science Advances*

What limits species ranges?

- Classically, species ranges are thought to be limited by the balance between selection and gene flow
- Gene flow can bring ***maladaptive*** alleles to the range edge, impeding further adaptation
- Alternatively, ***differentiation*** and ***small population size*** at the range decrease overall genetic diversity, limiting adaptation
- Range edge populations provide a system to study adaptive dynamics in real time!

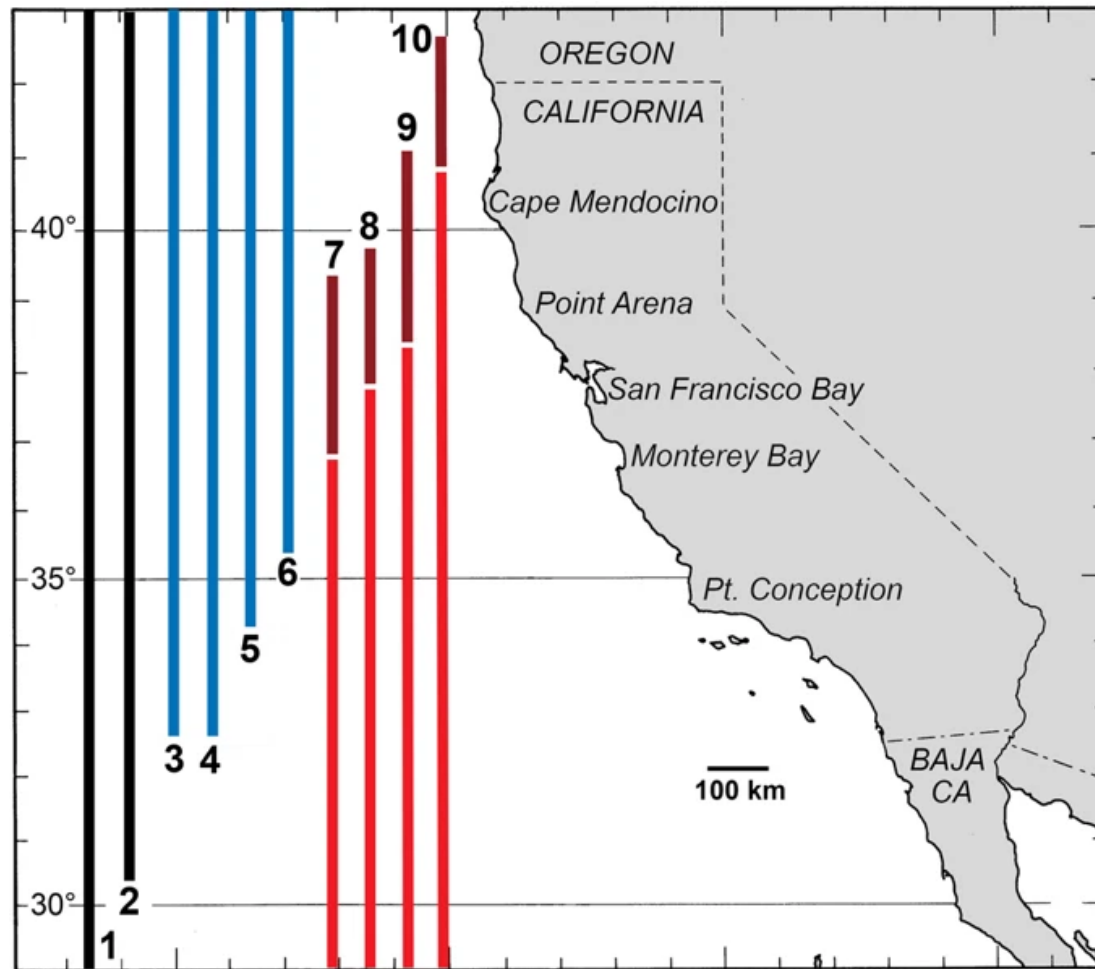
Range edge populations



Marine range shifts

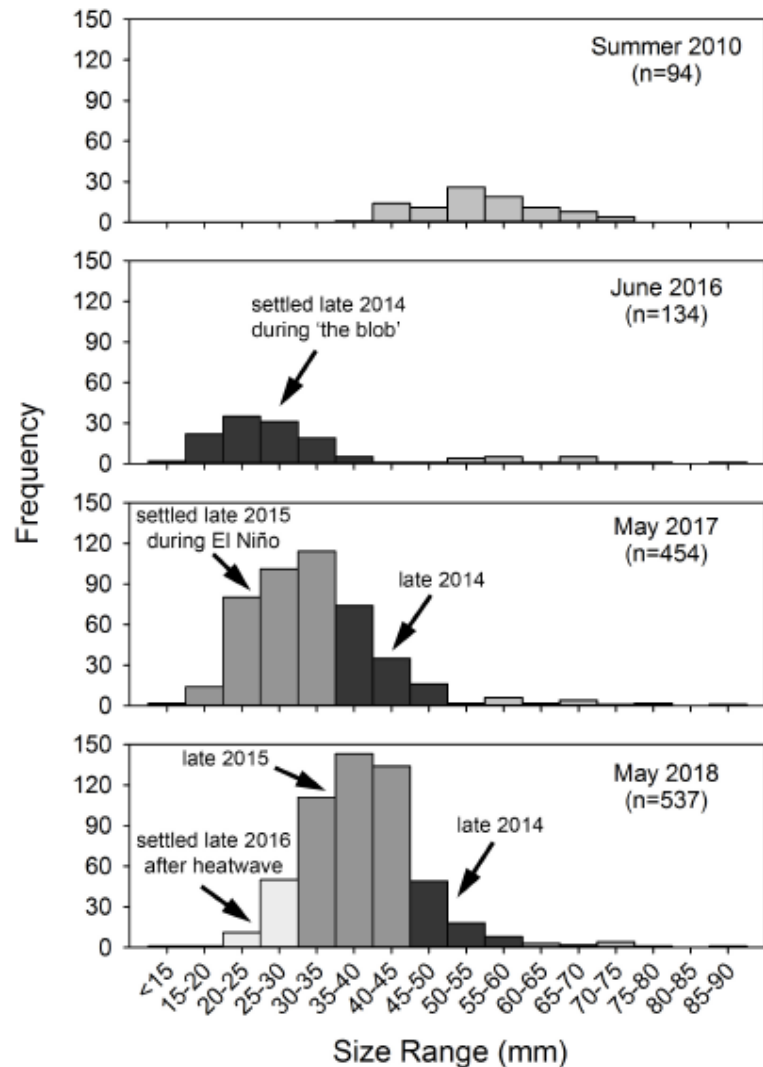
- The ability of range edge populations to acclimate or adapt to novel conditions will determine range shift dynamics
- Marine species:
 - Often have pelagic larvae leading to high dispersal potential
 - Have larger ranges (fewer geographic barriers) (Sunday et al. 2012)
 - Fill out thermal niches more completely (Sunday et al. 2012)
 - Have shown faster poleward expansions (Poloczanska et al. 2013, Donelson et al. 2109, Sanford et al. 2019)

Climate anomalies provide insight into range shift dynamics



Sanford et al. 2019. *Scientific Reports*

Climate anomalies provide insight into range shift dynamics



Sanford et al. 2019. *Scientific Reports*

Outstanding issues and future directions

- How do we combine “adaptive capacity” with traditional niche modelling
- Why do some species exhibit range shifts?
 - Size? Life history? Geography? Biotic interactions?
- How do short-term fluctuations relate to long-term shifts?
- Eco-evolutionary dynamics at range boundaries