Future-proofing underwater forests

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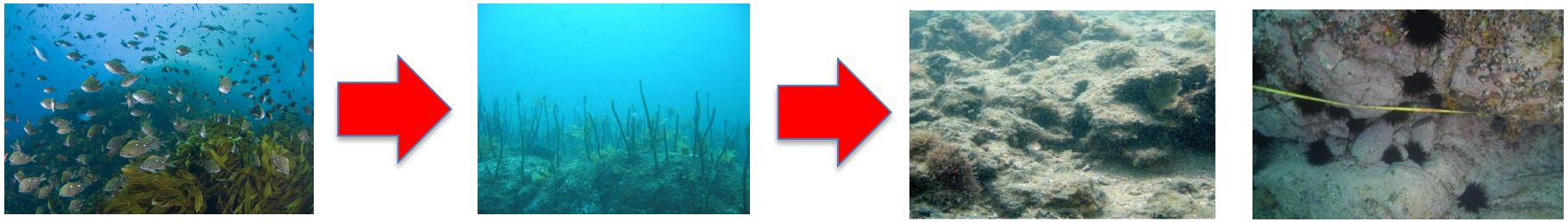
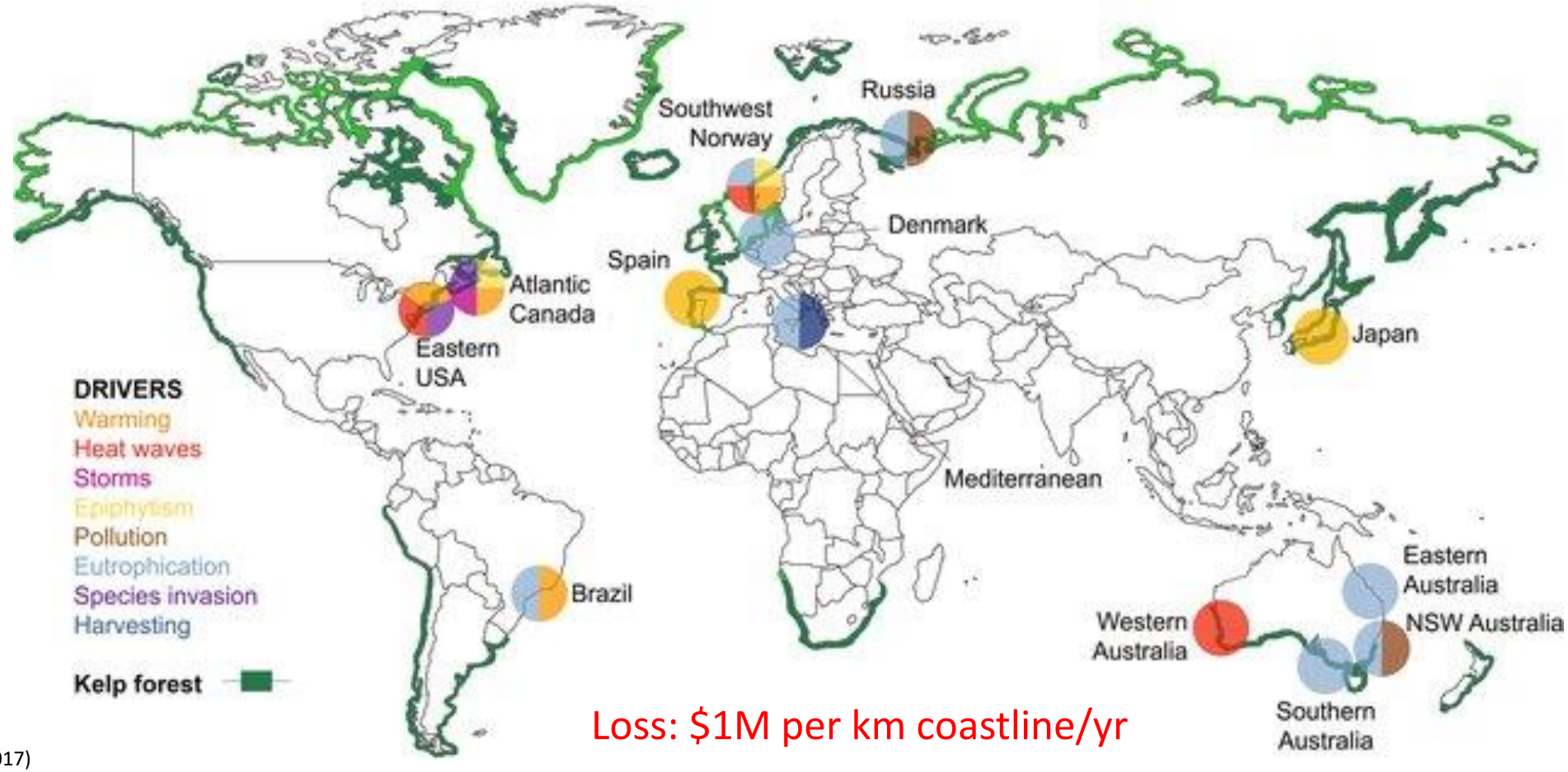
The University of Western Australia

Australian Government Australian Research Council

Photo: Andrew Green

Many kelp forests declining globally





Loss: $1M per km coastline/yr

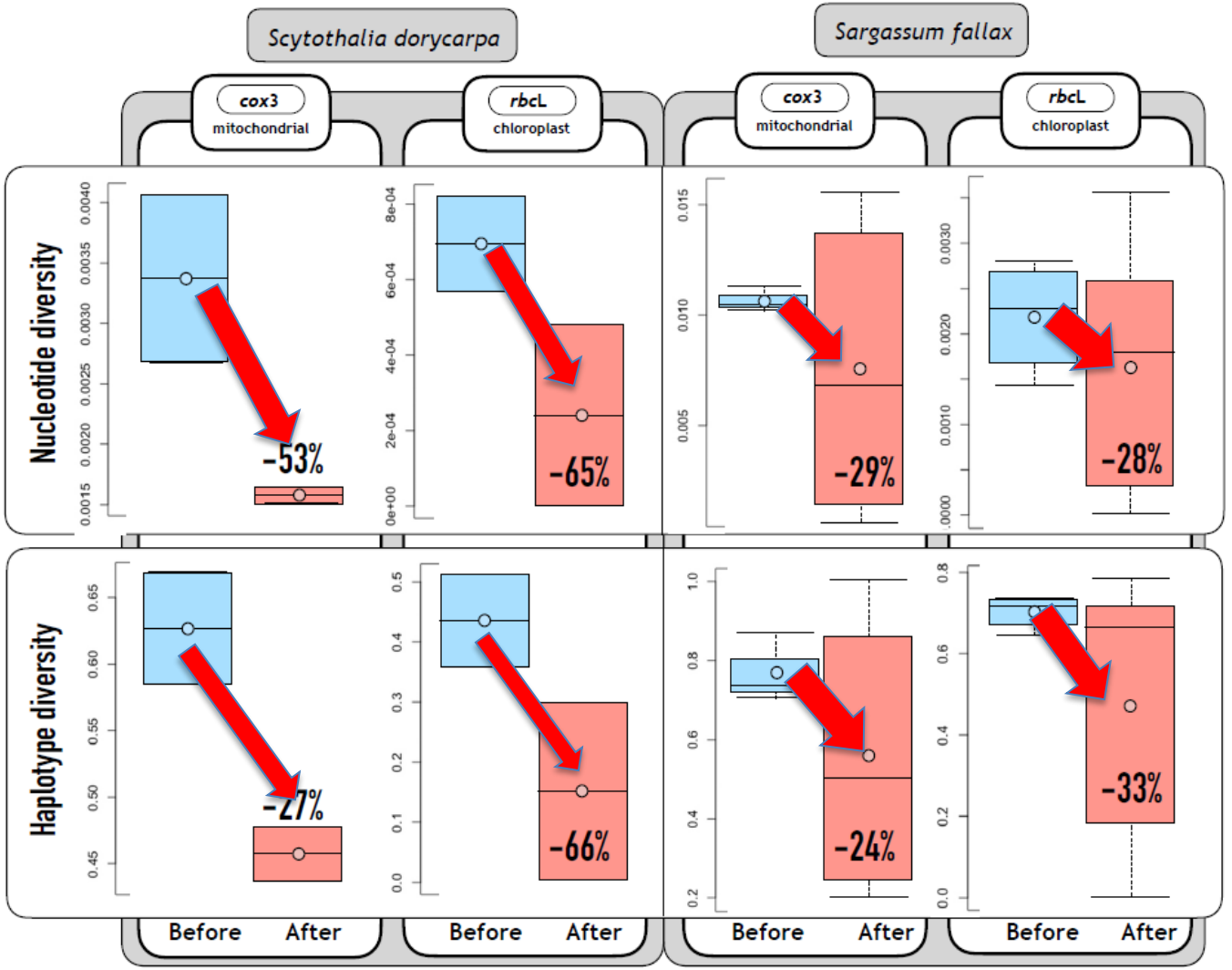
Filbee Dexter & Wernberg (2017)

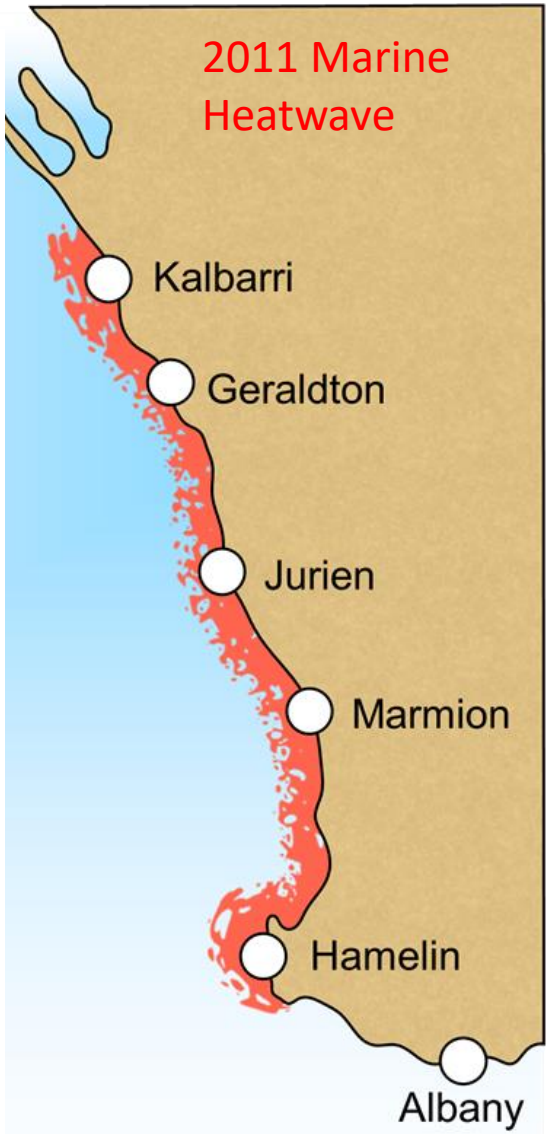
Climate change eroding adaptive capacity

- % cover unchanged
- Massive genetic diversity loss


Sargassum fallax

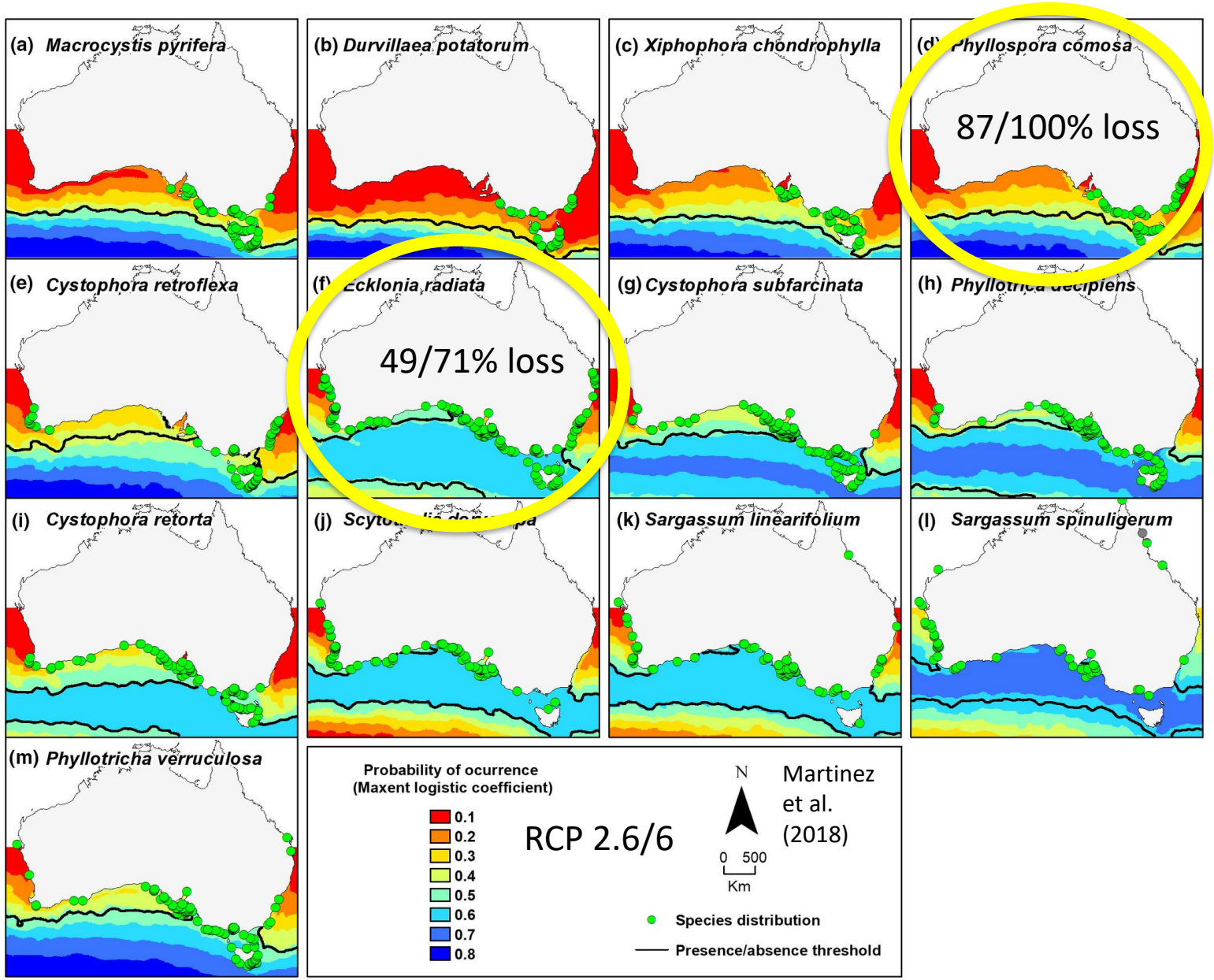

Scytothalia dorycarpa

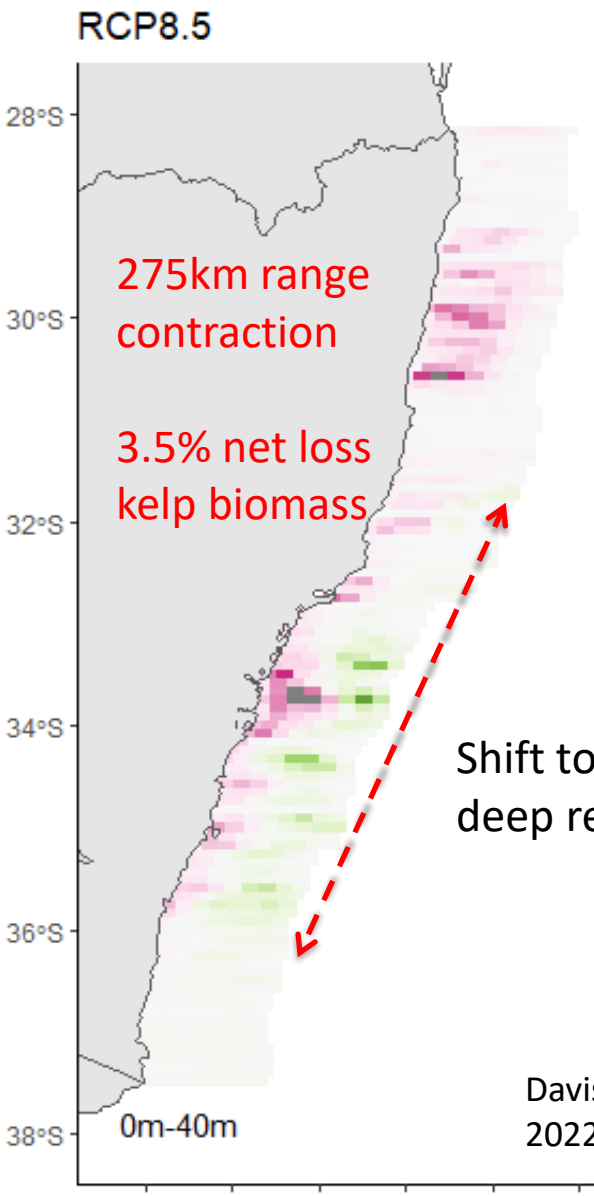




Gurgel et al. (2020)

Climate projections are dire





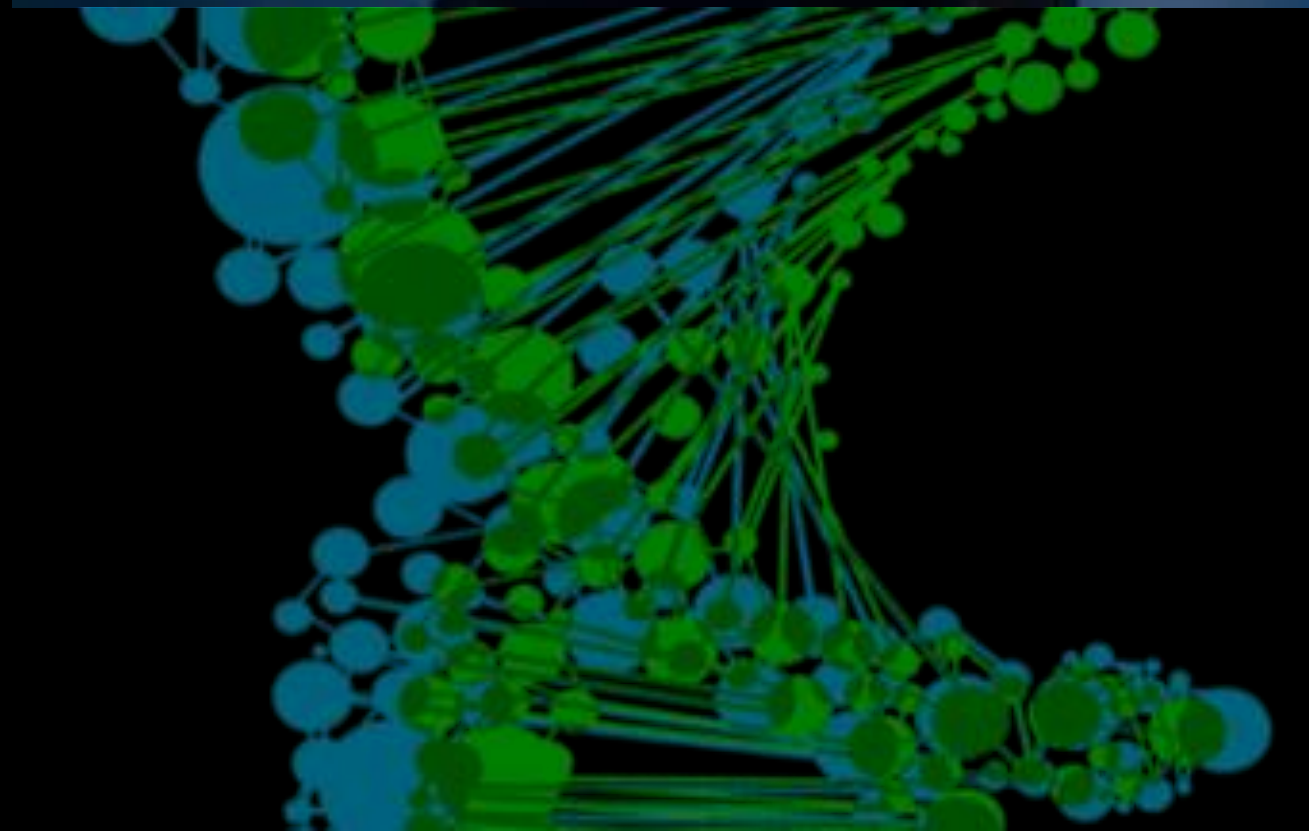
Davis et al. 2021, 2022a, b

Climate change is outpacing adaptation

- Current passive management not sufficient
- Need prompt proactive management
- Anticipate future change
- Future proofing

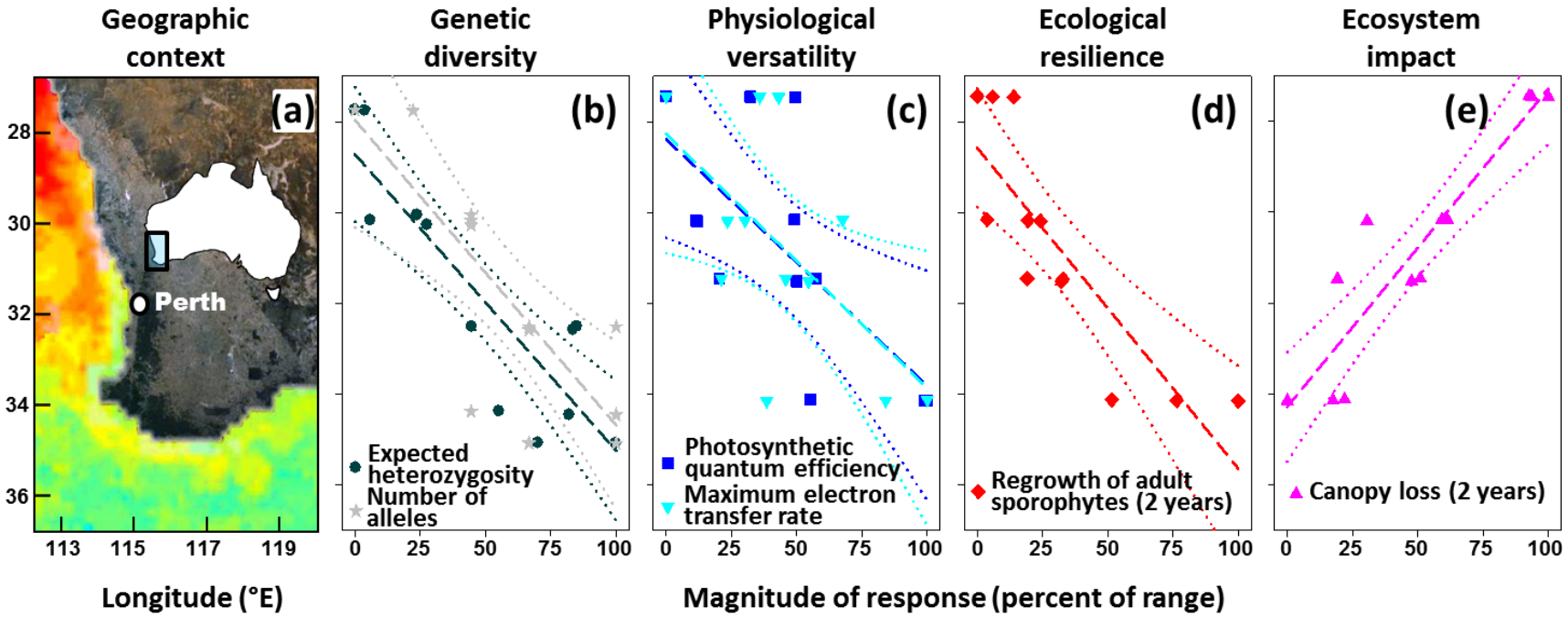
Future-proofing

- Intervention to provide populations and species the ability to resist or adapt to future conditions
- Range of strategies
- Genetic diversity & adaptive capacity



Resilience through genetics

- Genetic diversity – allows adaptive response

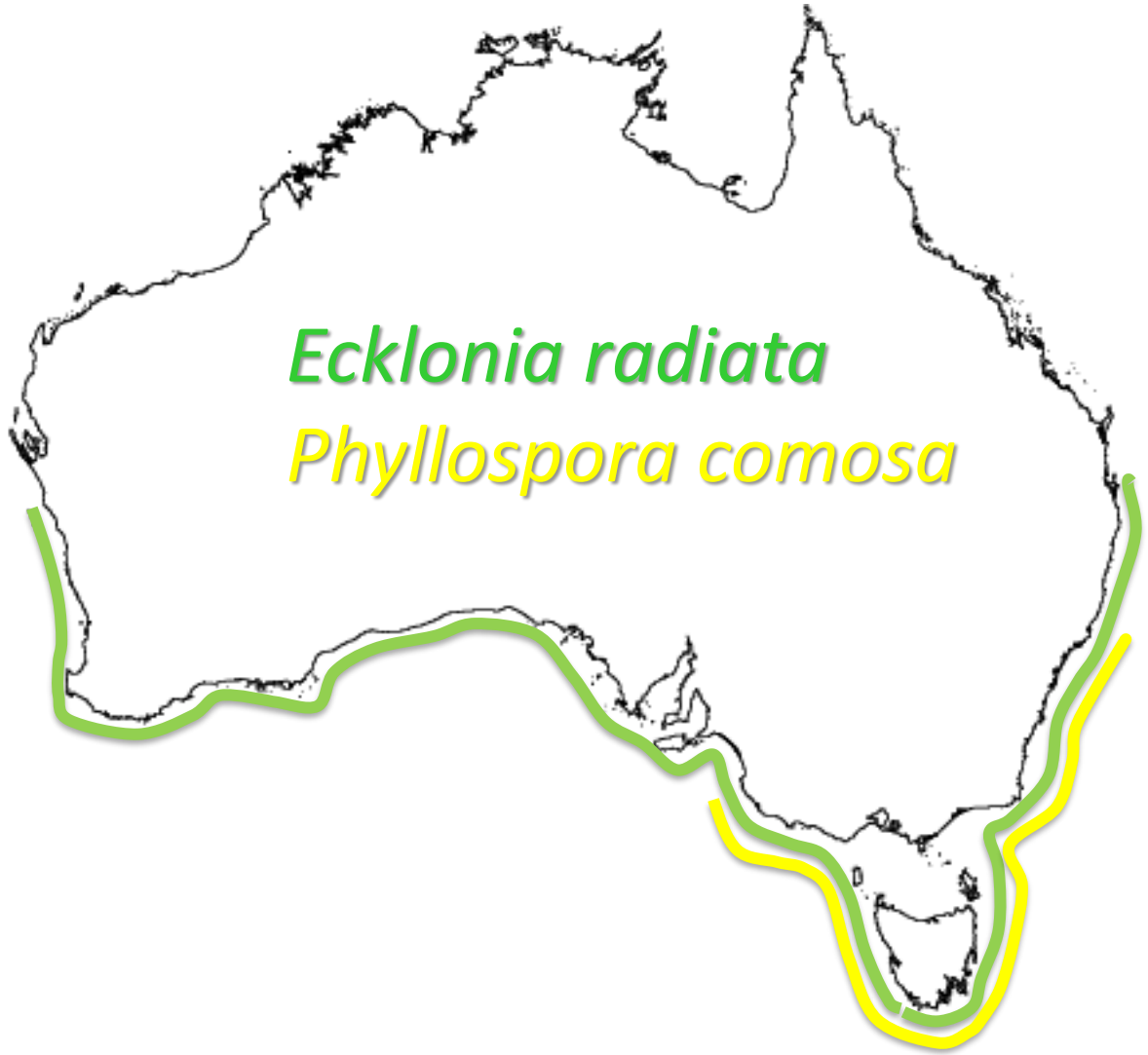


Wernberg, Coleman et al. (2018)

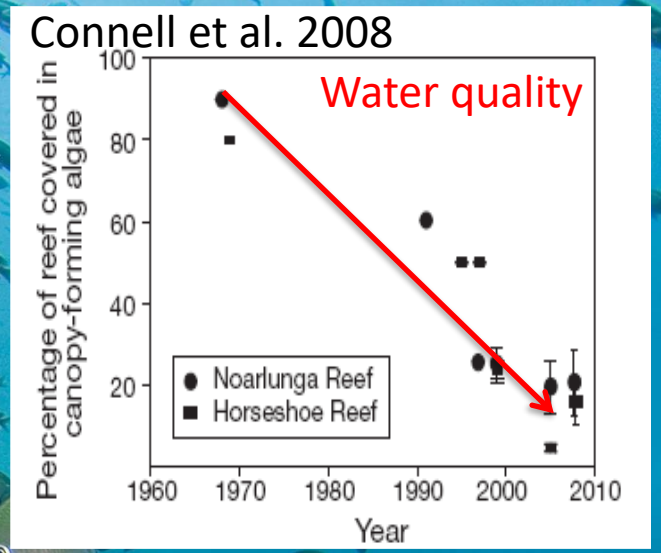
- Genetic composition – certain alleles/genes confer fitness
- Adaptive diversity of kelps – critical knowledge gap

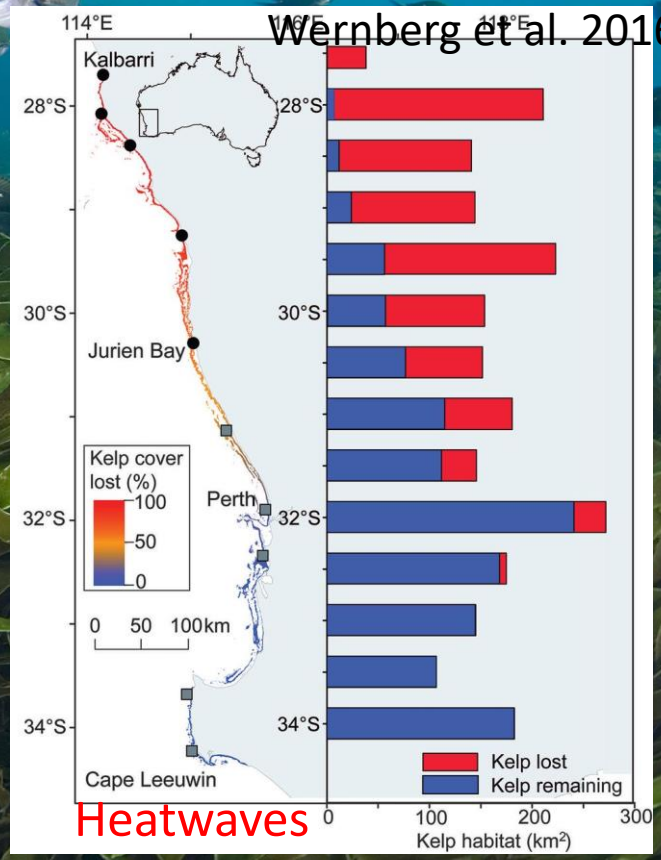
Future proofing Australian kelp forests

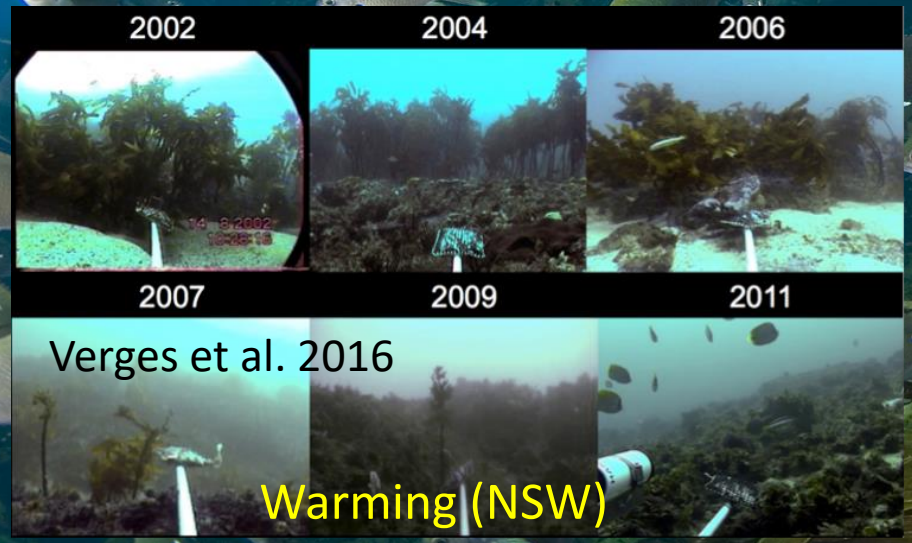
- Characterise genetic diversity, adaptive diversity
- Demonstrate causation: link adaptive diversity to function through genome mapping & experiments
- Predict future mismatches between adaptive diversity and climate
- Inform and enable proactive management and restoration



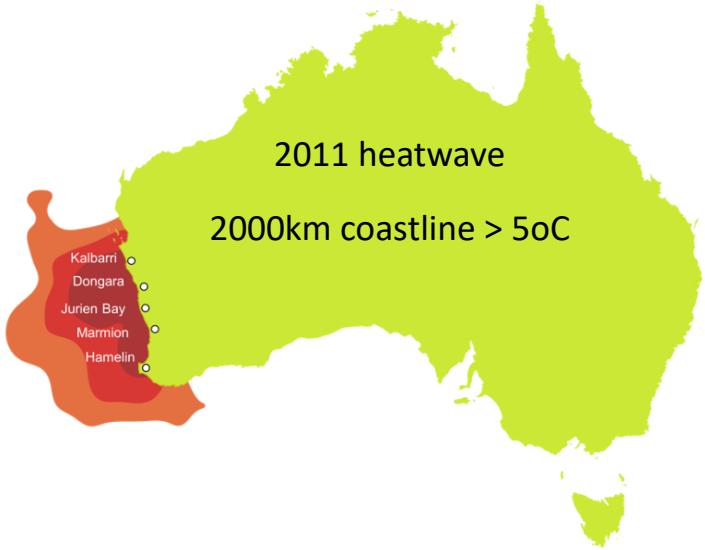
Ecklonia radiata





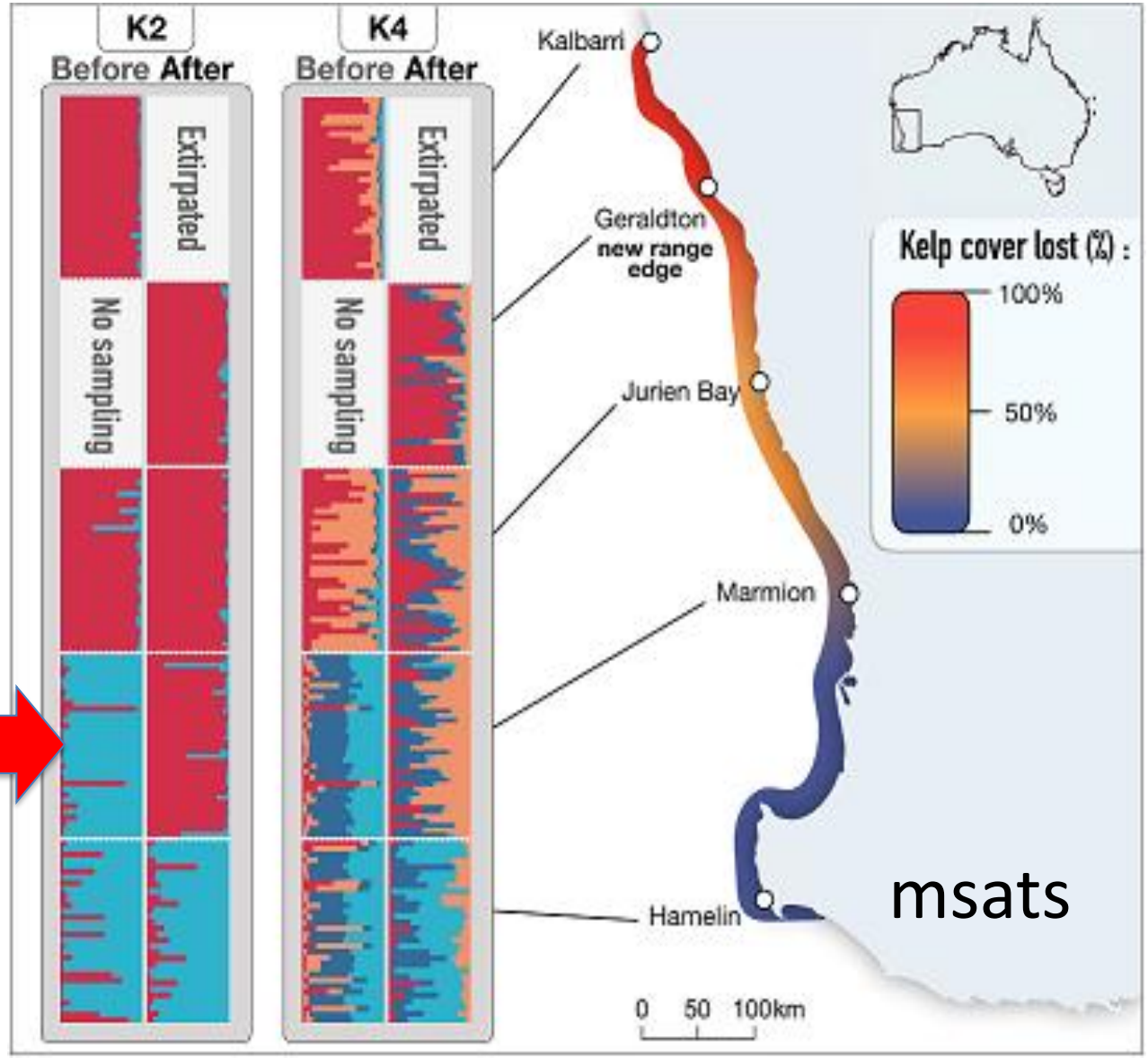


Climate-induced genetic change



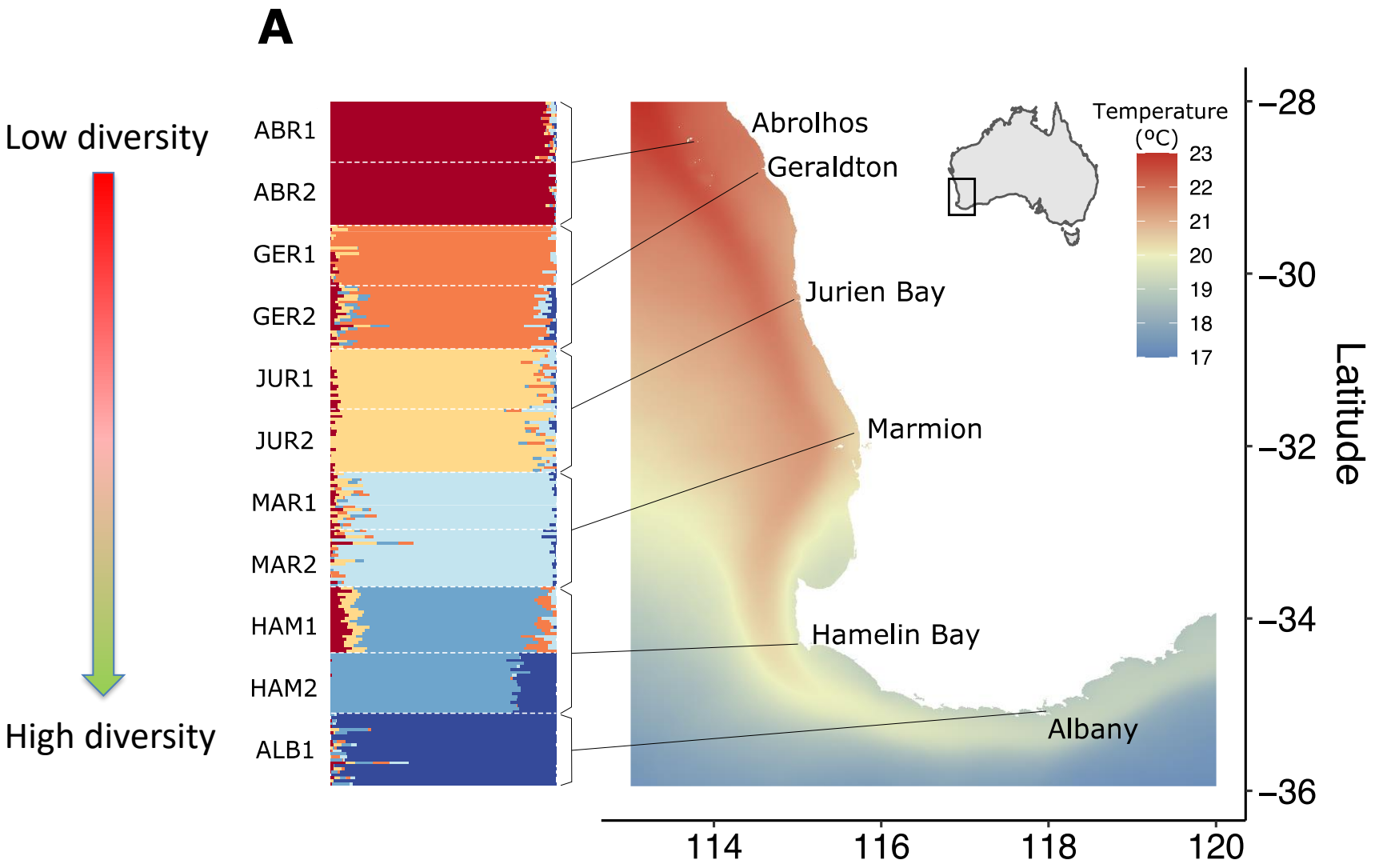
- Genetic “tropicalisation”
- Decline in genetic diversity in some populations
- Allele frequency shifts of many loci
- Adaptive diversity and structure?

Shift in genetic clusters following MHW



Coleman et al. (2020a)

Genetic diversity declines with latitude

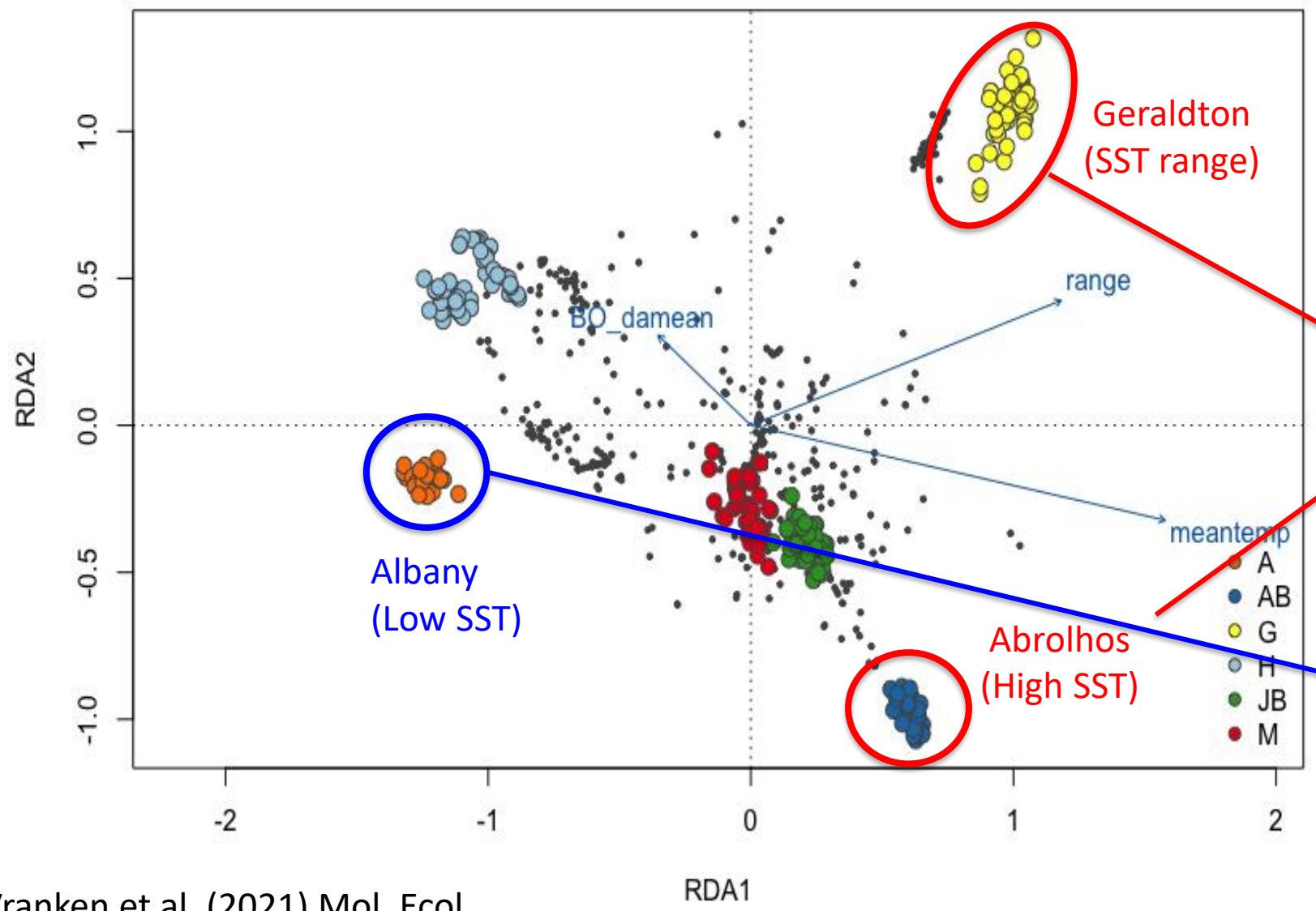


- ddRAD (neutral and adaptive)
- Draft genome

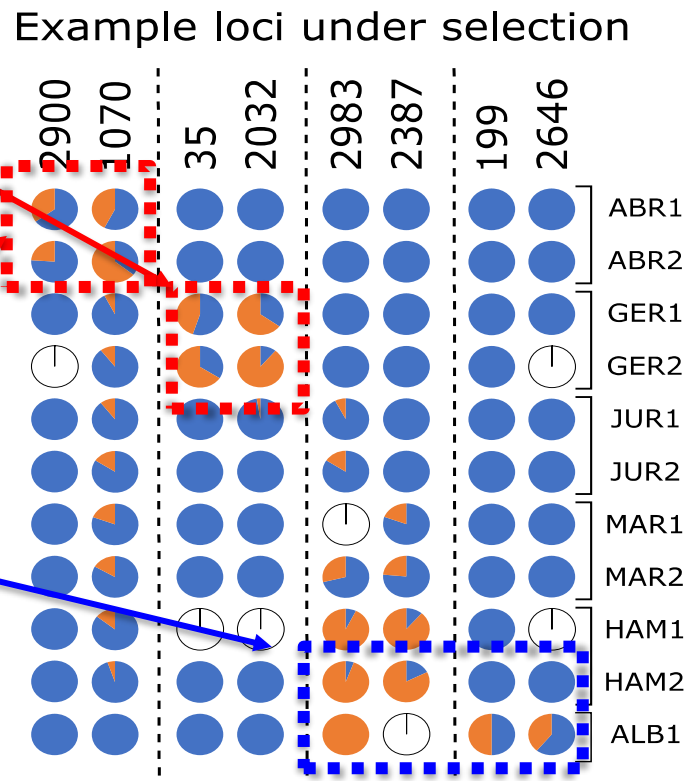
- Diversity declines with latitude
- Adaptive?

Vranken et al. (2021) Mol. Ecol.

Adaptive diversity at range edges

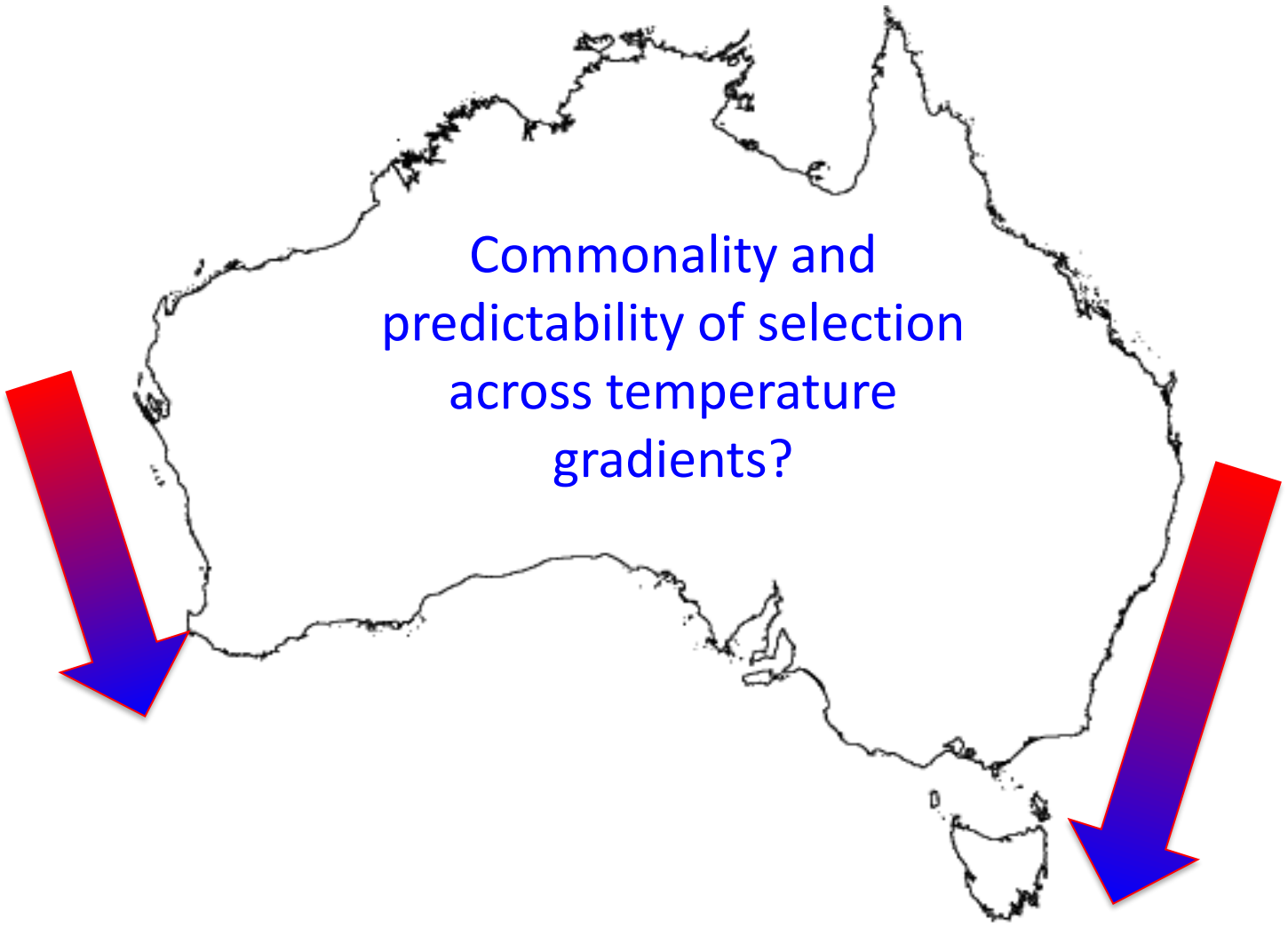


- Draft genome links loci under selection to functional genes including heat shock proteins.

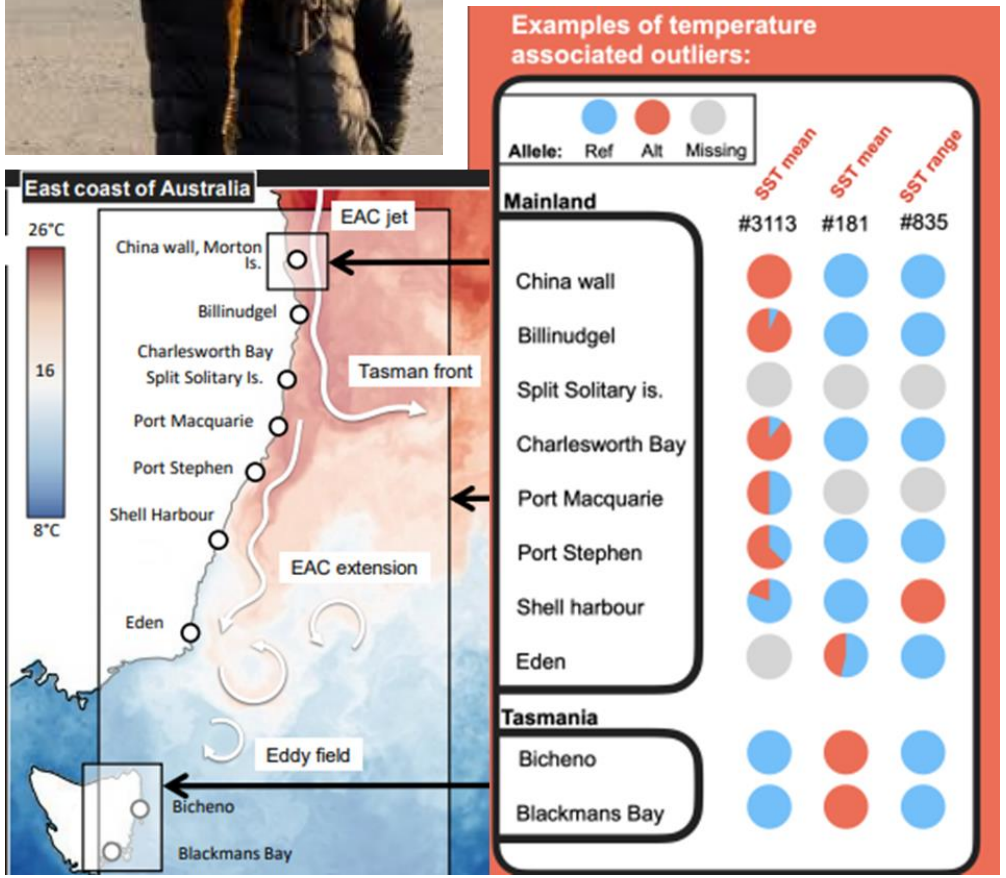


Vranken et al. (2021) Mol. Ecol.

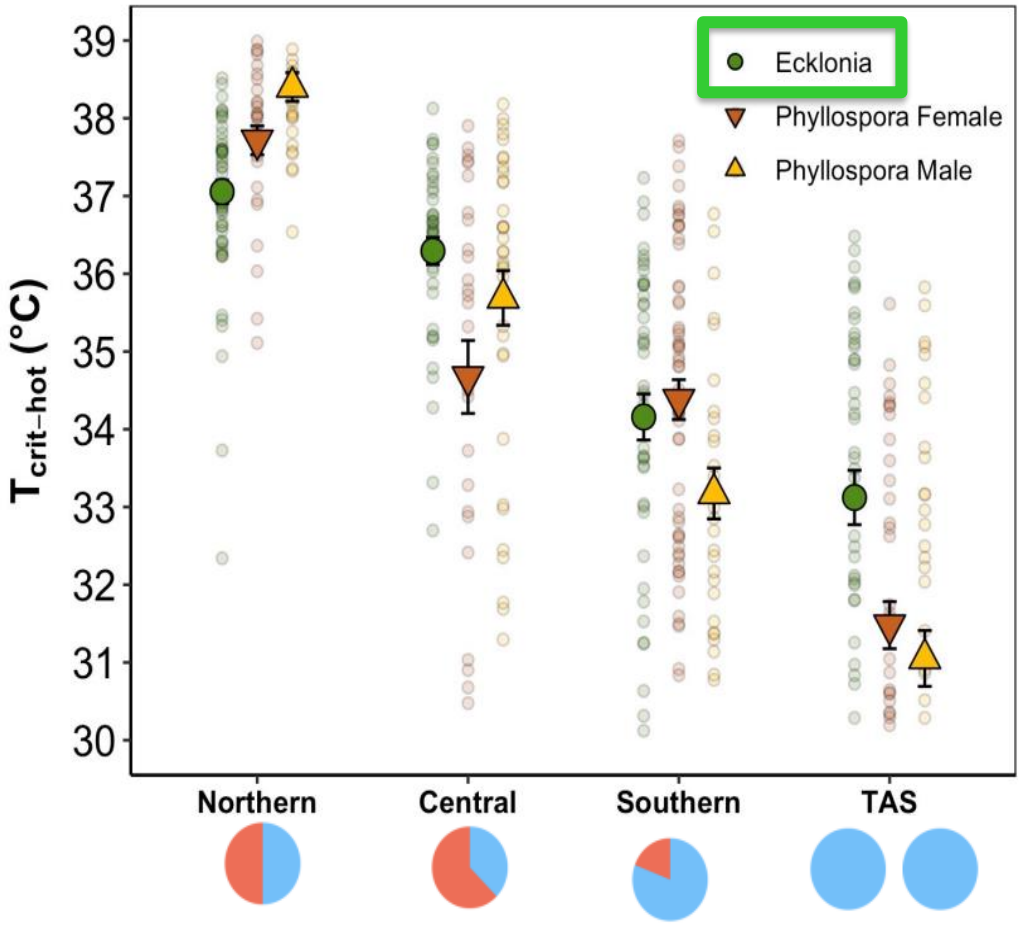
Adaptive seascape genomics across the GSR



Antoine Minne: 2.30 this session!

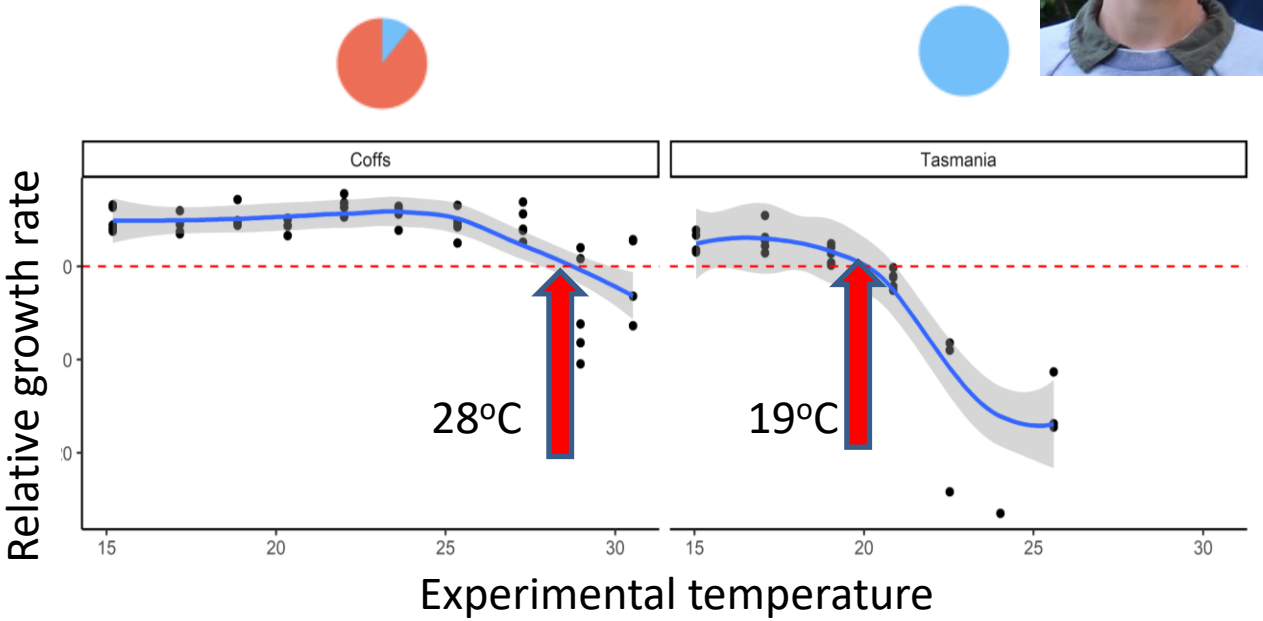


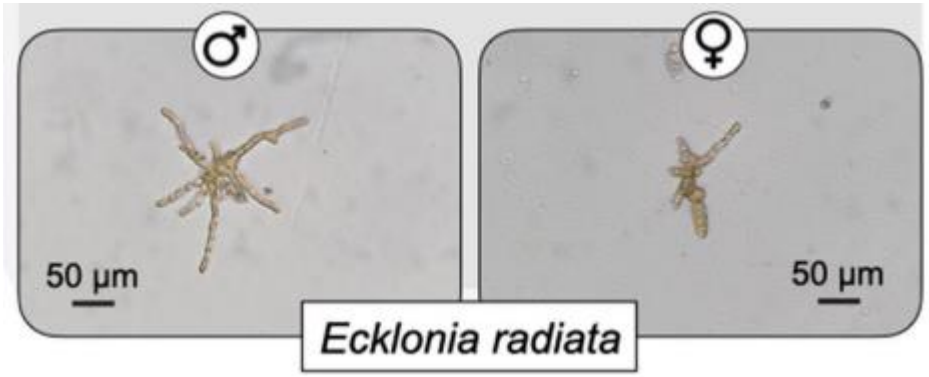
Demonstrating causation



Frequency of high temp associated allele in pop (example locus)

Harris et al. 2022, Harris et al. in prep

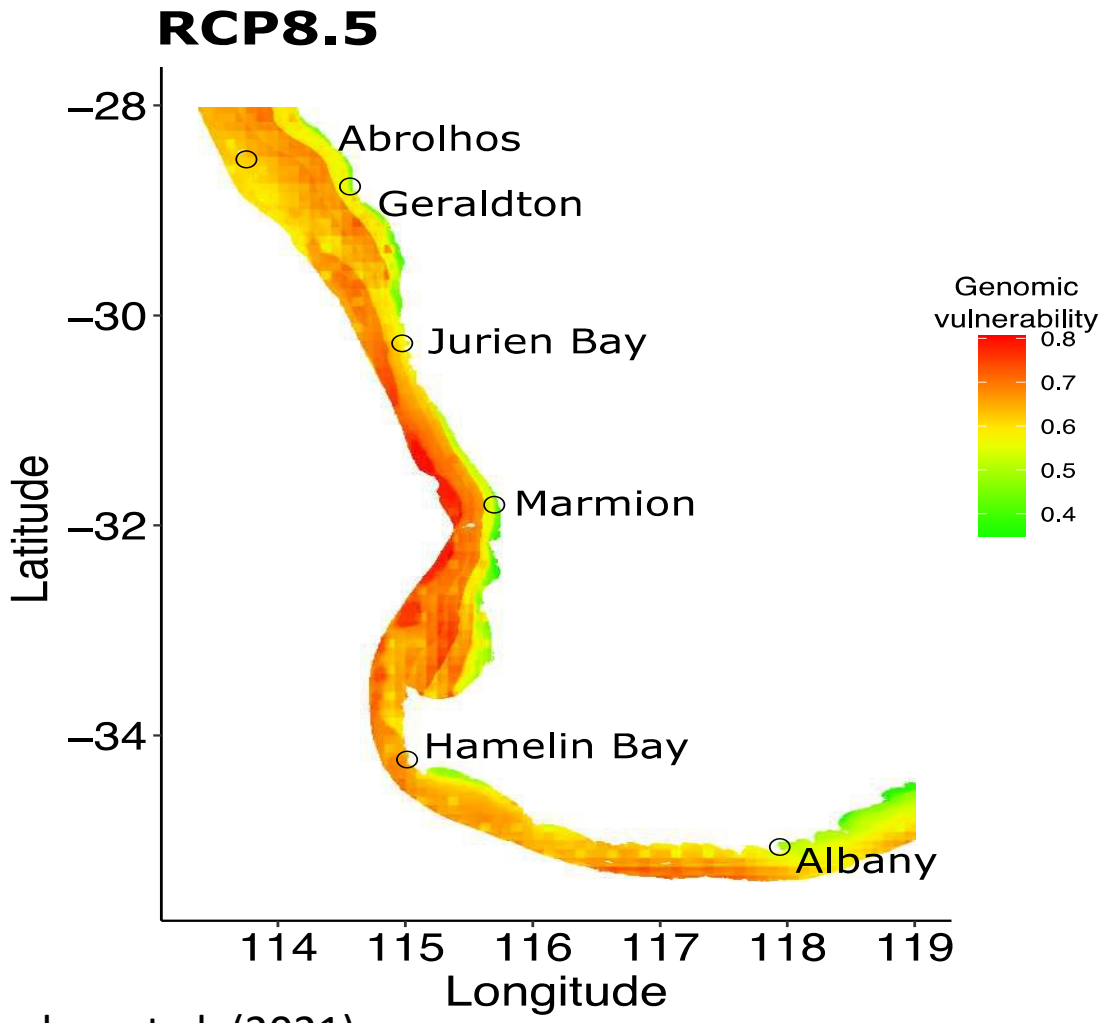




Veenhof et al. in prep

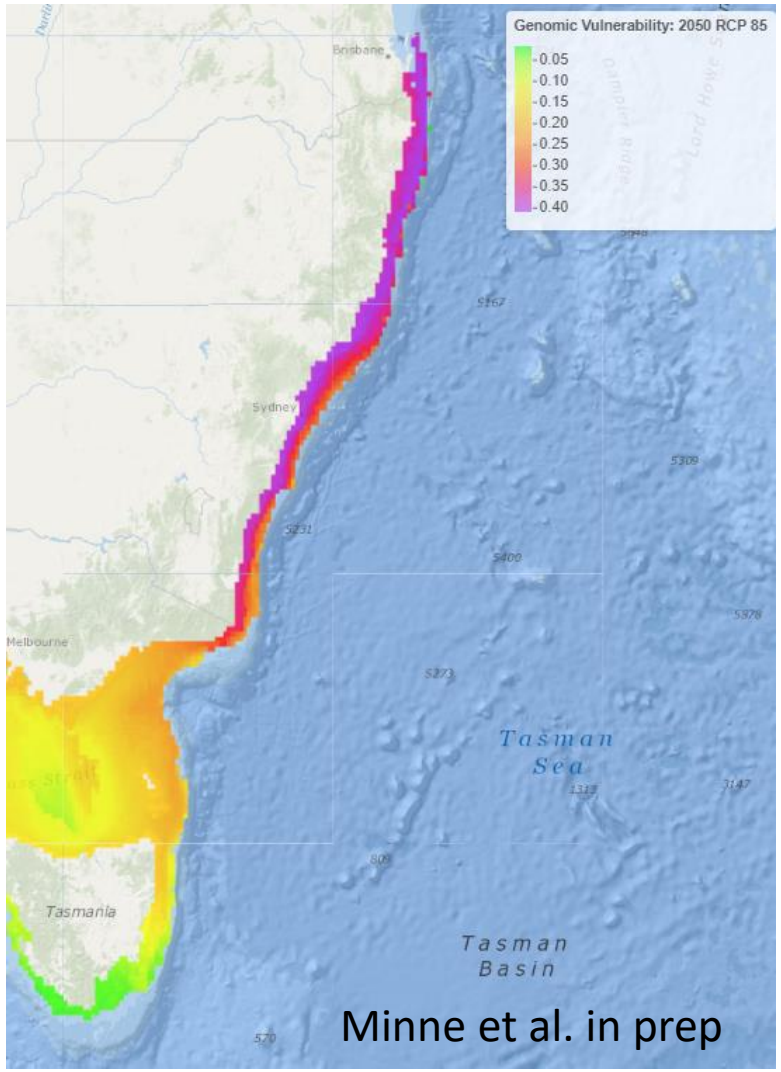
Projecting genomic vulnerability

Western Australia



Vranken et al. (2021)

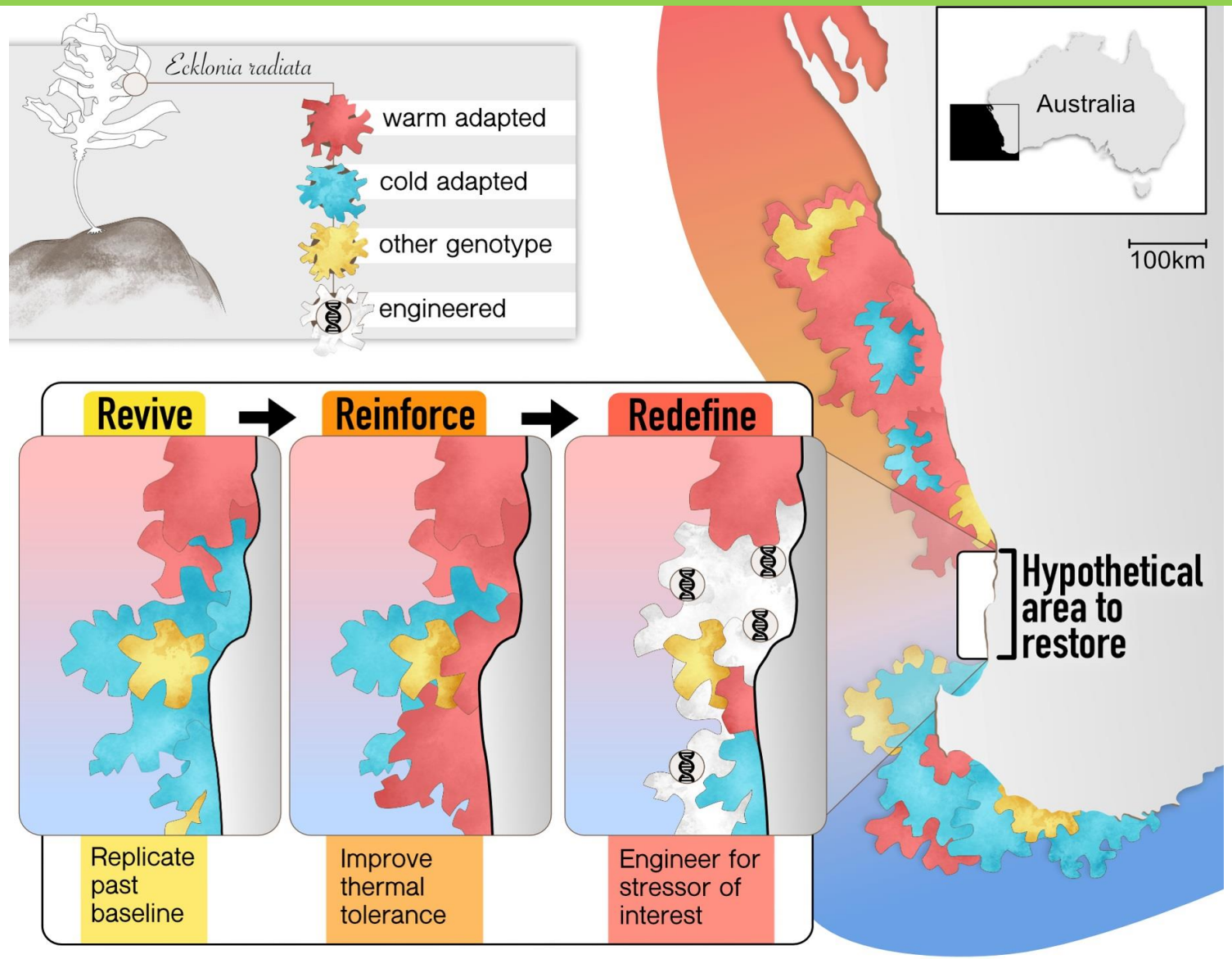
Eastern Australia



Minne et al. in prep

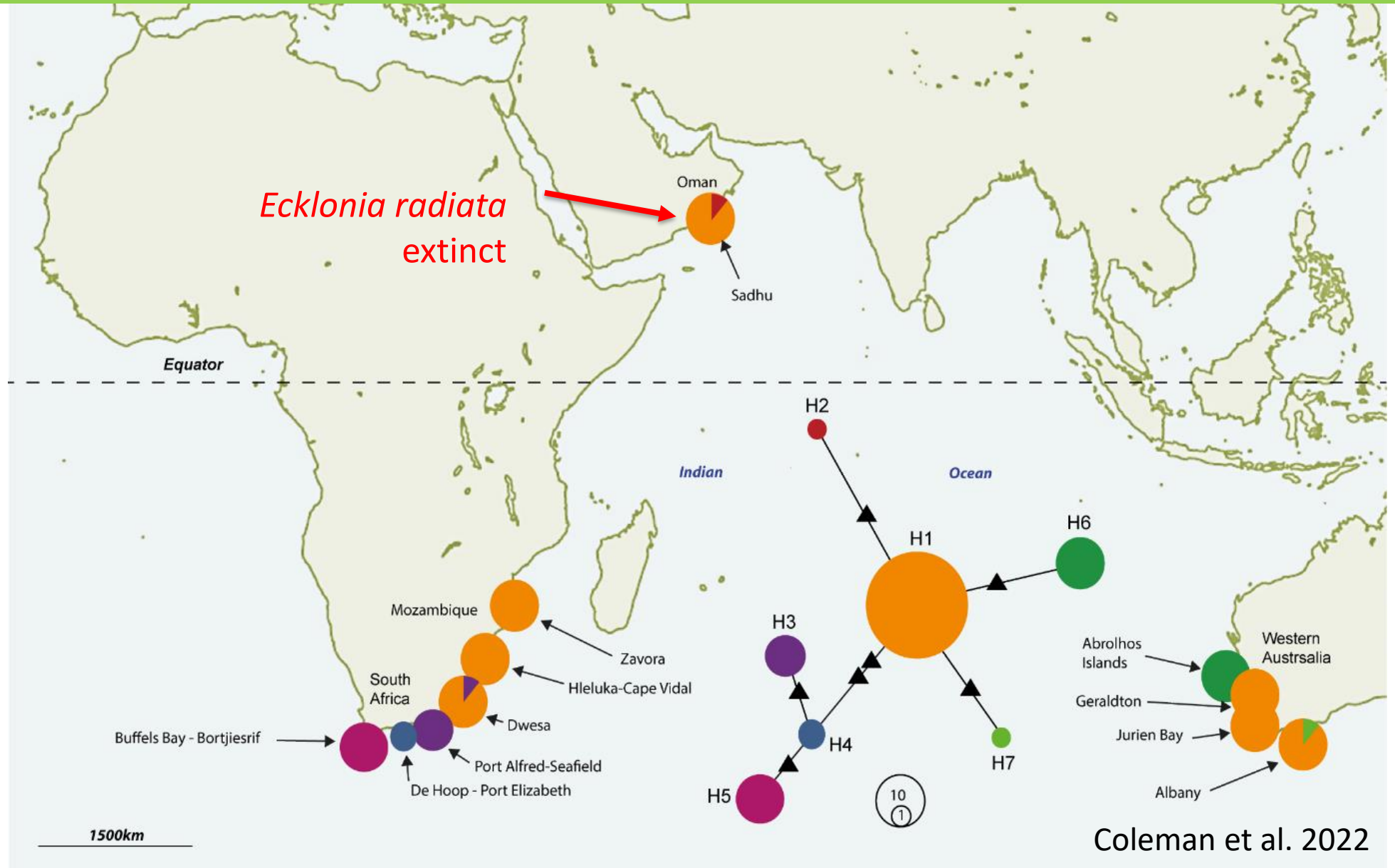
Future proof restoration scenario

Options



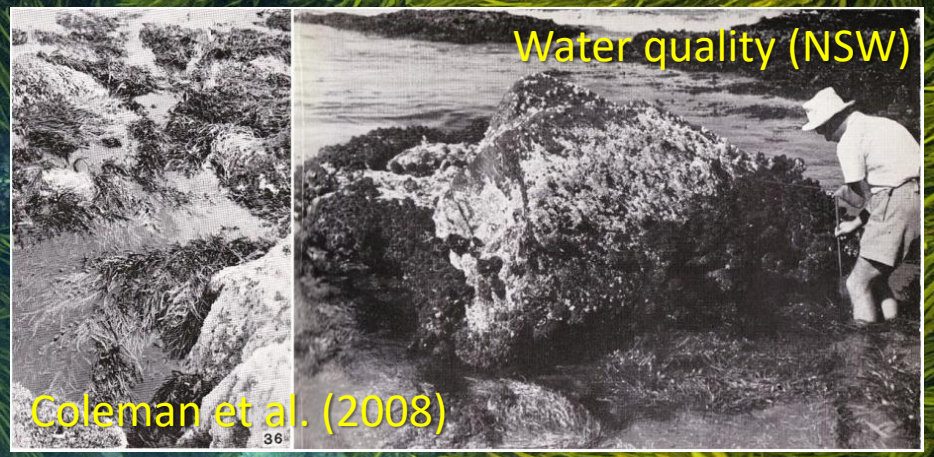
Coleman et al. (2020b)

Unique *Ecklonia* population & diversity already lost

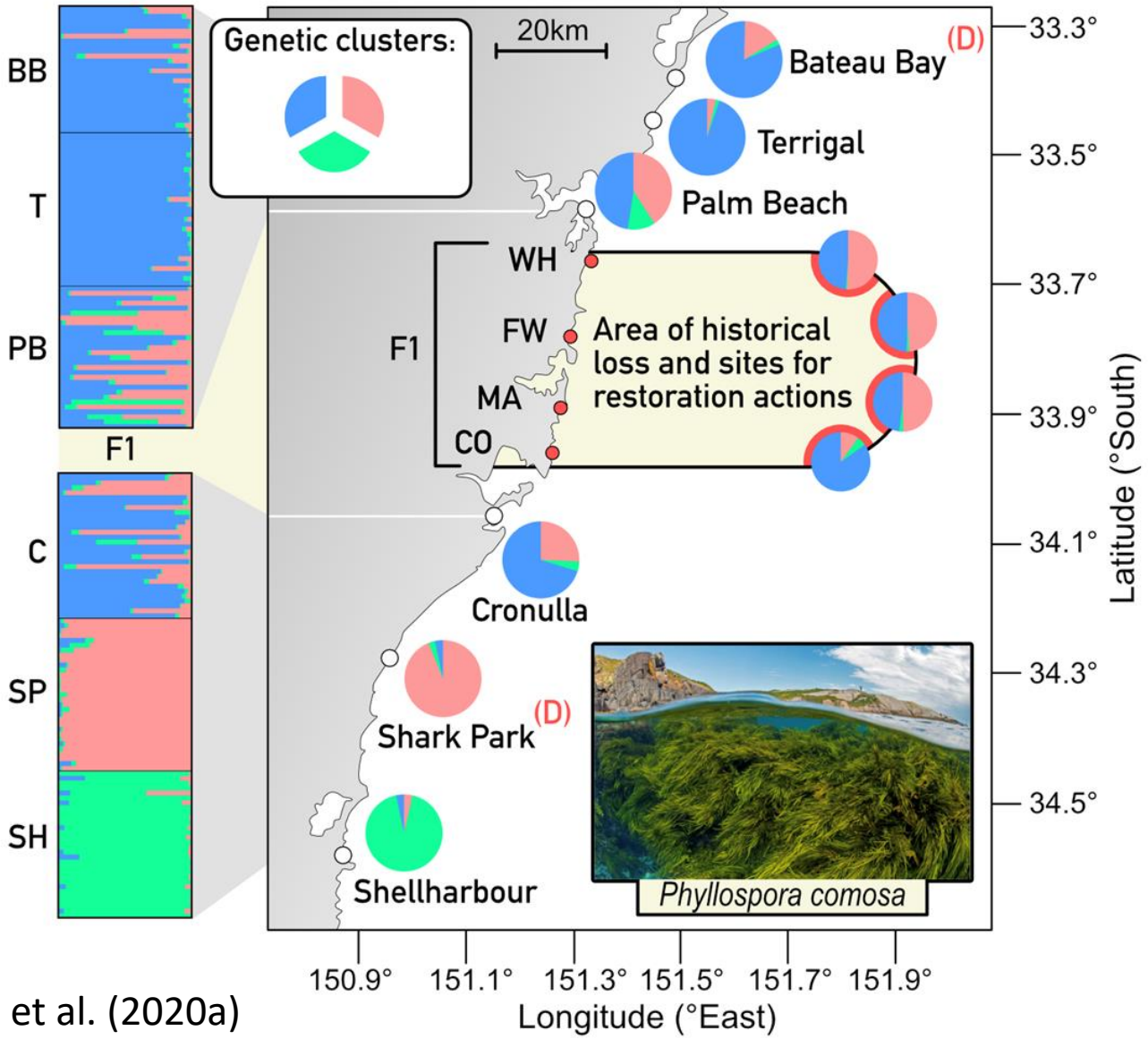


Coleman et al. 2022

Phyllospora comosa - crayweed



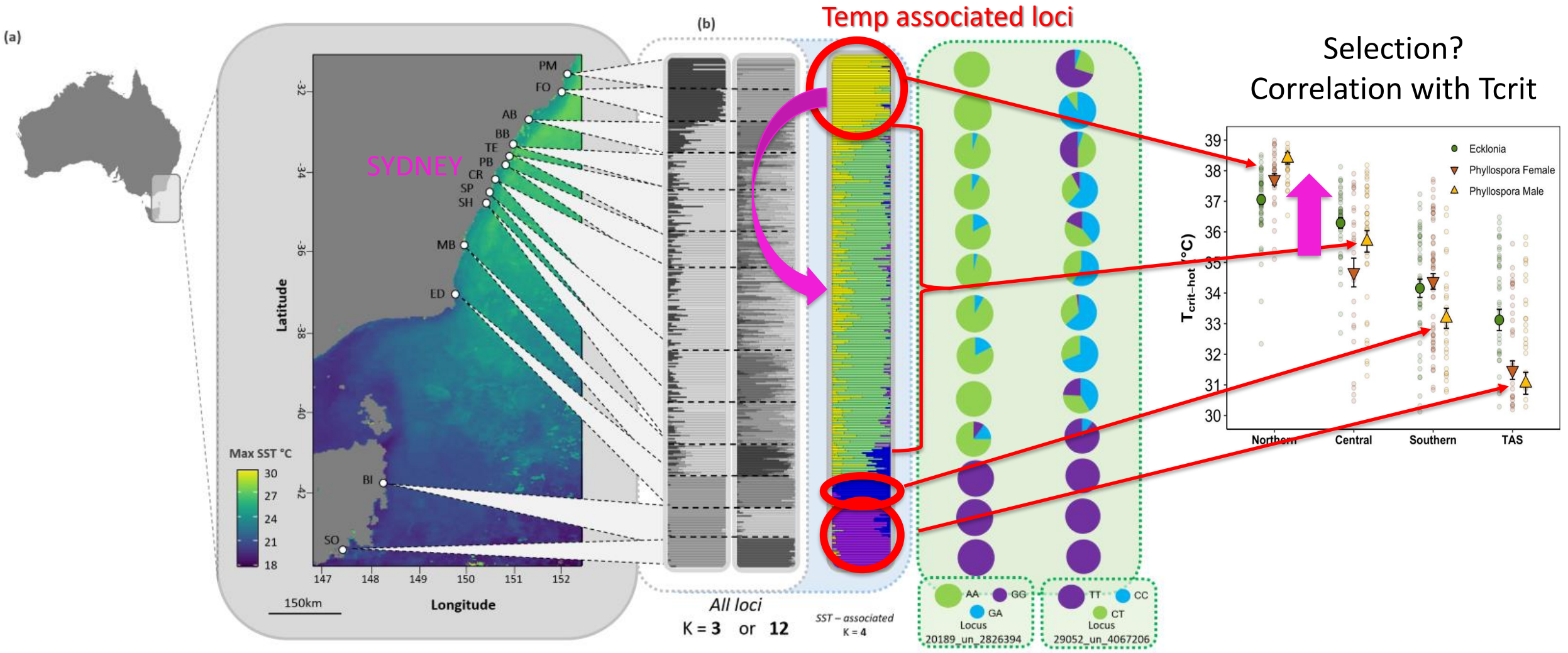
Genomics informed *Phyllospora* restoration



Wood et al. (2020a)

- Extant best practice: restore
- Mimic extant genetic diversity and structure – 11 sites
- Measure success : F1 generation

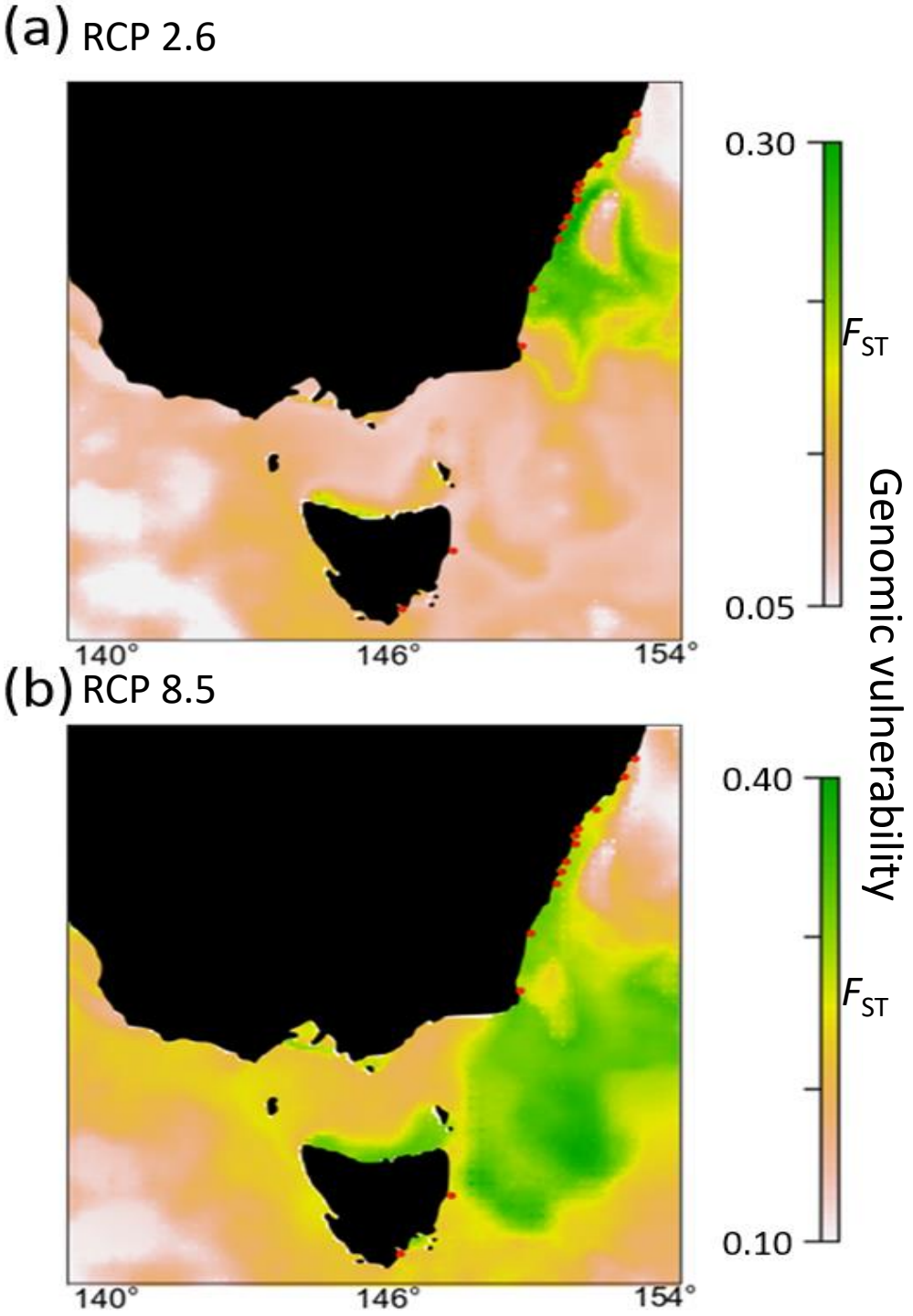
Adaptive diversity in range edges



Wood et al. (2021)

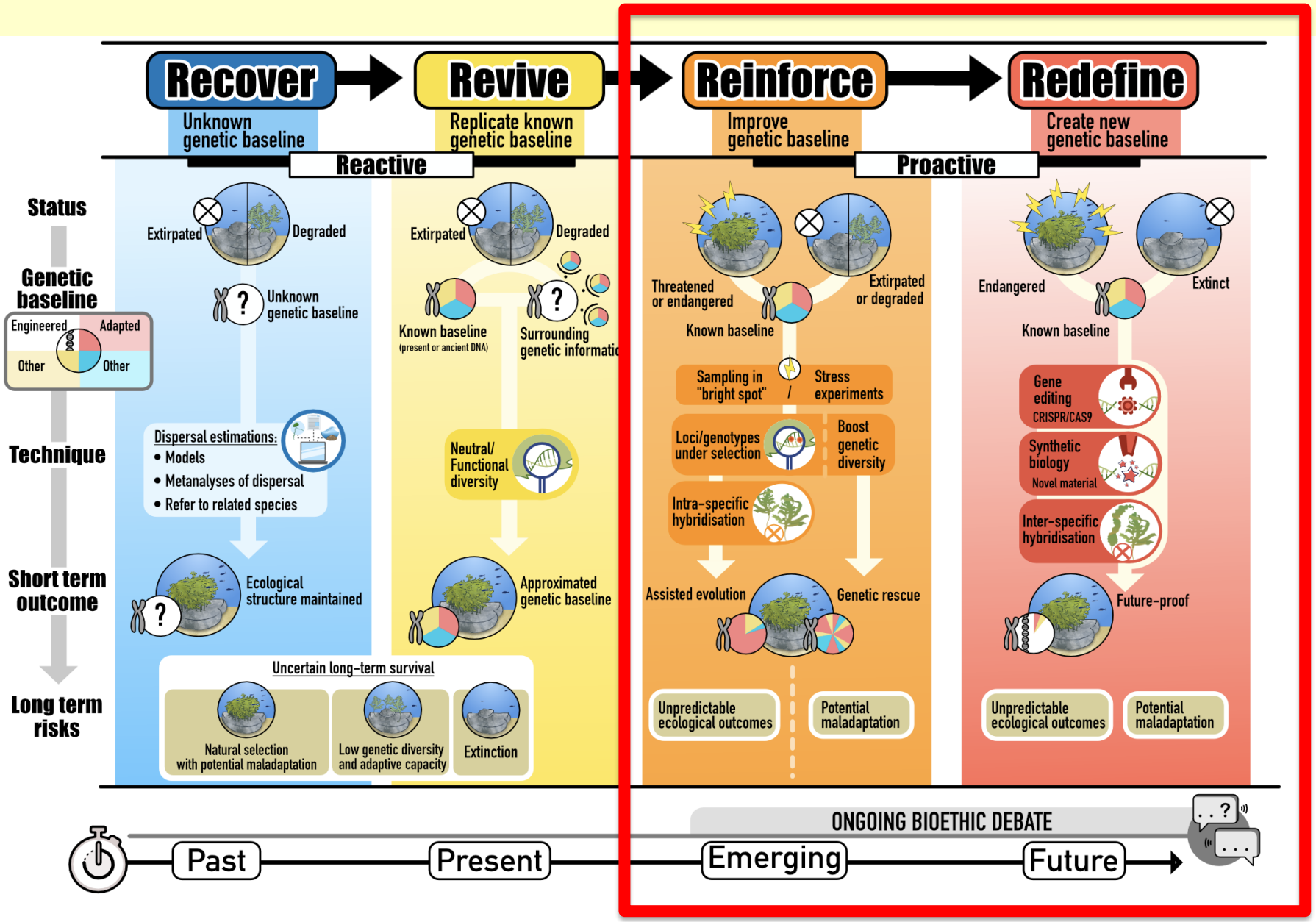
Significant climate mismatch

- Significant mismatch of genomics with climate
- Extends throughout entire distribution under RCP 8.5
- Natural adaptation won't keep pace with climate!
- Impetus for future proofing



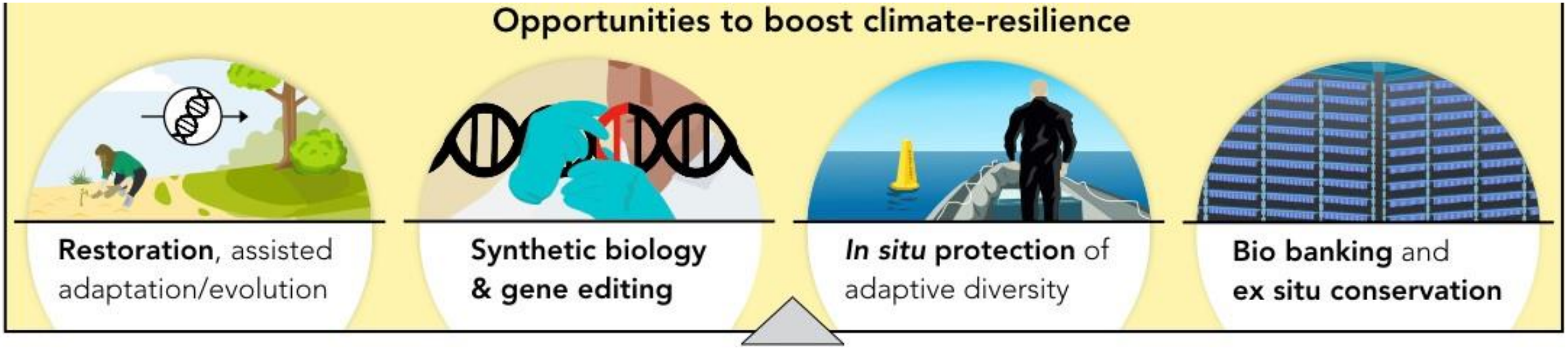
Wood et al. (2021)

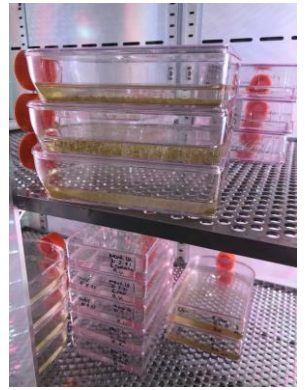
Future-proofing restoration: from reactive to proactive



Coleman et al. (2020b)

Opportunities to boost climate-resilience

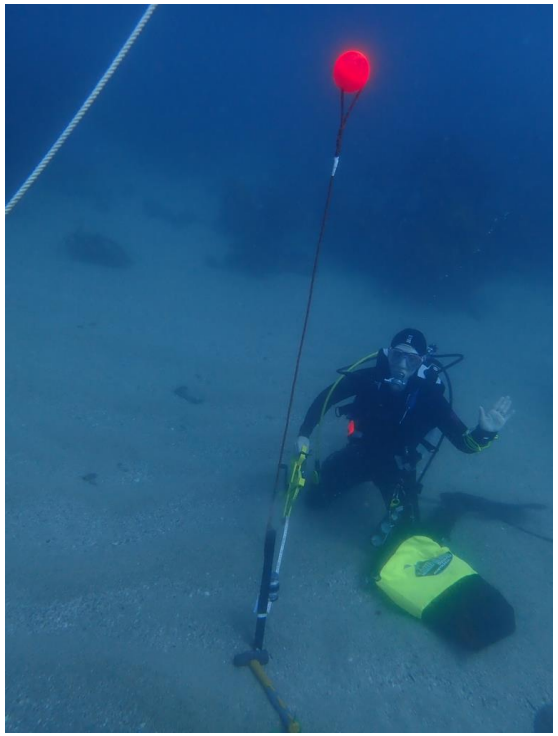




Knowledge gaps to enable future proofing

- More detailed genomic information/unpack polygenic response
- Maladaptation in multi-stressor seascapes?
- Ecological interactions
- Manipulative experiments and modelling to simulate scenarios

- Ethics and community values
- Regulation & policy frameworks



Come work with our team!!

- ONGOING technician position with NSW DPI
- Boating, diving, experiments, lab work
- Super fun team & great location

- iworkfor.nsw.gov.au