NCEAS WG: Towards an Understanding of Marine Biological Impacts of Climate Change

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National Research FLAGSHIPS Climate Adaptation
CSIRO

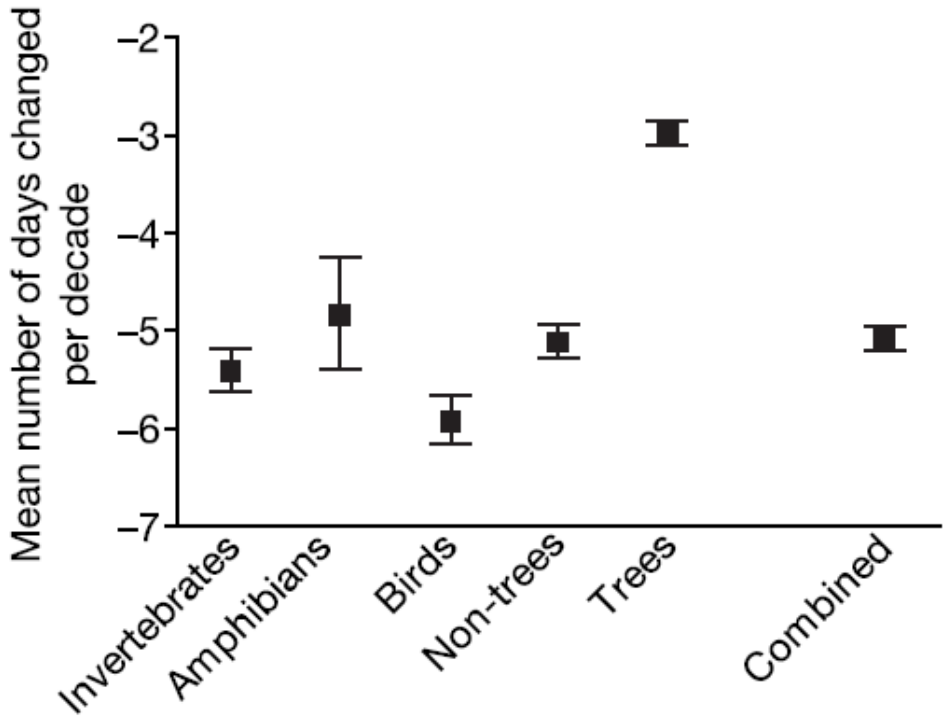
Outline

- Who we are
- Background
- Key questions
- Work in progress…

Who we are

Anthony Richardson, *CSIRO, Australia*
Keith Brander, *National Institute of Aquatic Resources, Denmark*
Chris Brown, *University of Queensland, Australia*
John Bruno, *University of North Carolina, USA*
Lauren Buckley, *University of North Carolina, USA*
Mike Burrows, *Scottish Association for Marine Science, UK*
Carlos Duarte, *IMEDEA, Spain*
Ben Halpern, *NCEAS, USA*
Carrie Kappel, *NCEAS, USA*
Wolfgang Kiessling, *Humboldt University, Germany*
Pippa Moore, *Aberystwyth University, UK*
Mary O'Connor, *University of British Columbia, Canada*
Camille Parmesan, *University of Texas, USA*
John Pandolfi, *University of Queensland, Australia*
Dave Schoeman, *University of Ulster, UK*
Bill Sydeman, *Farallon Inst. for Advances Ecosystem Research, USA*

Fingerprints of global warming on wild animals and plants



Root et al 2003 Nature

- 10 yrs + of data
- Trait of at least one species changed over time
- Temporal change in temp or strong association between species trait and temperature

143 studies

1468 species

81% of species that changed were consistent with climate change

Fingerprint of Climate Change

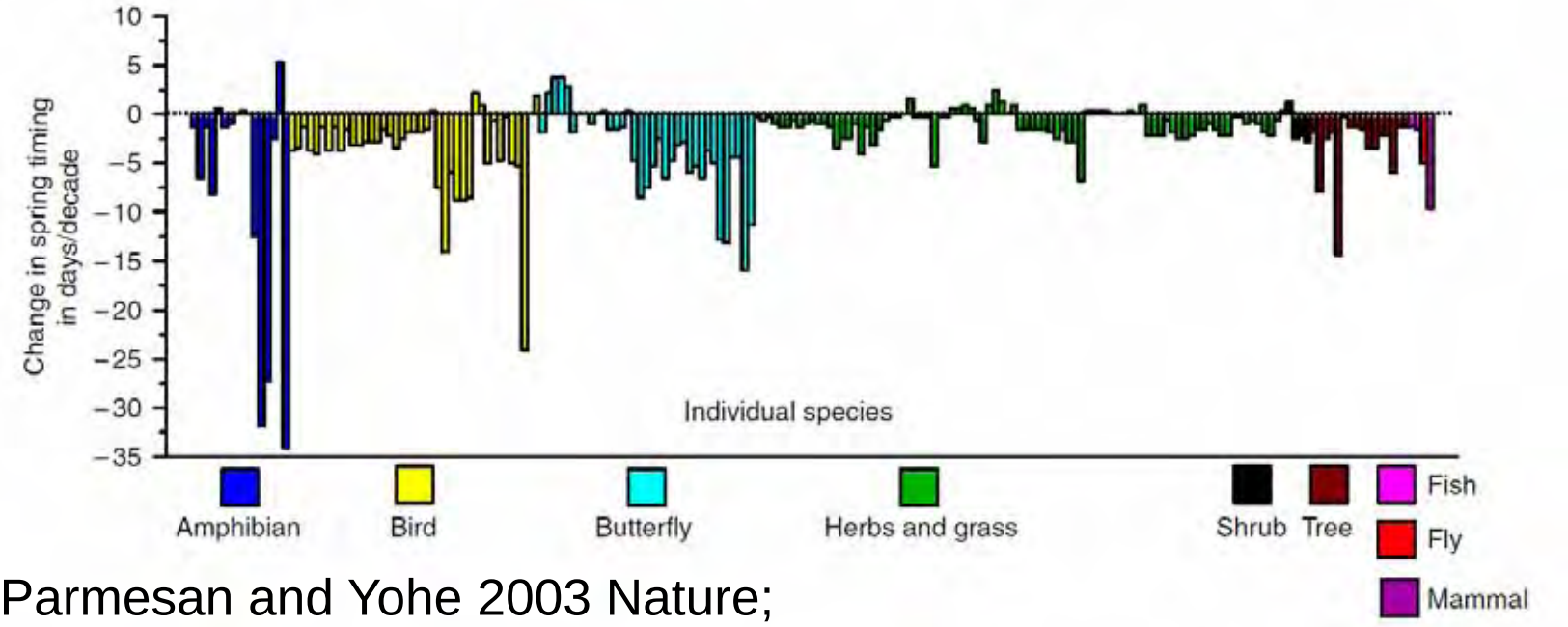
Northern Hemisphere

6.1km decade polewards (80%)

2.3 days earlier per decade (62%)

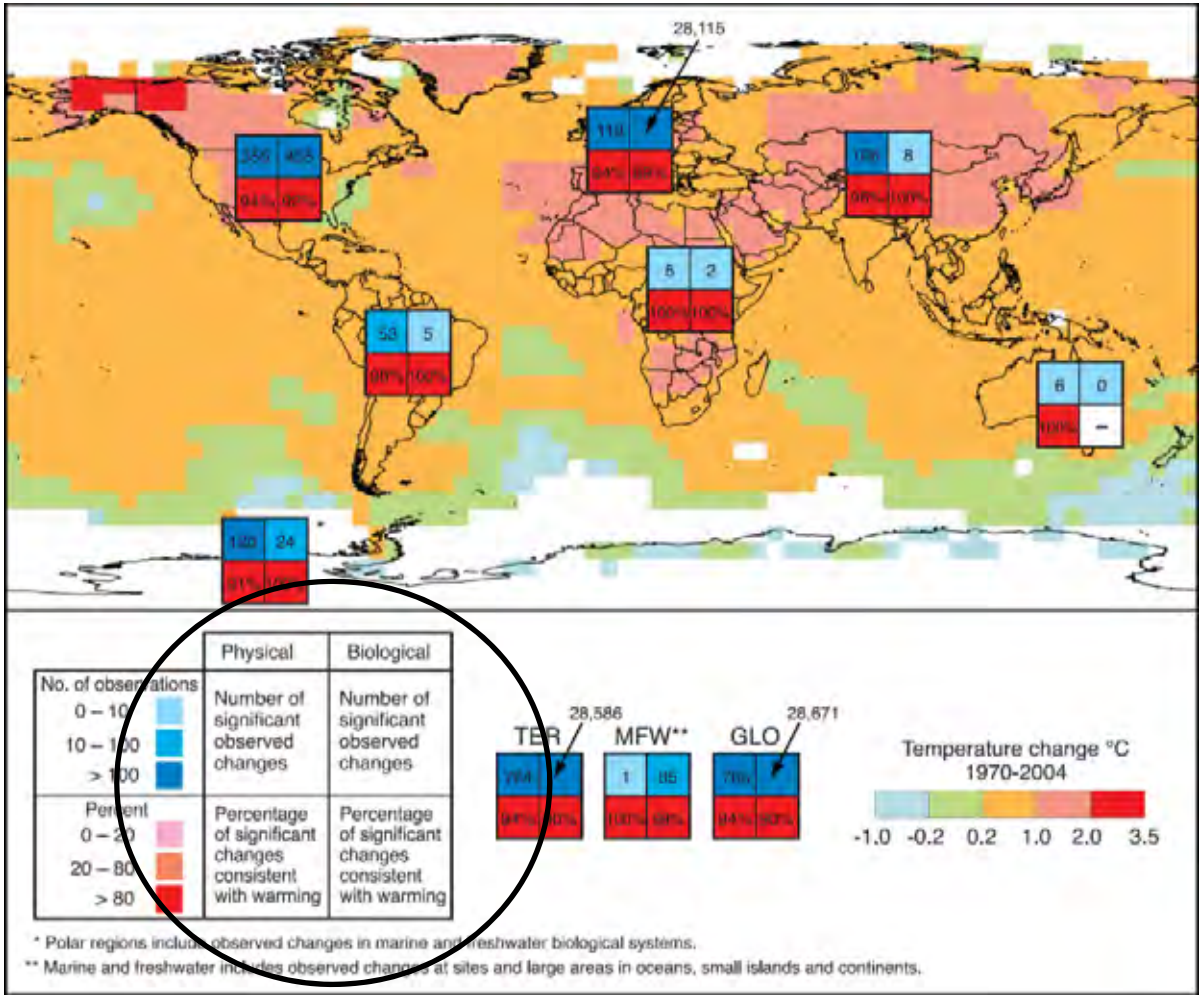
But 20-70% species, depending on location, showed little or no response

- >20 yrs data
- Cover large geographic region and/or multi-species assemblage



Parmesan and Yohe 2003 Nature;
Parmesan 2007 Global Change Biology

IPCC 4th Assessment, 2007 (also see Rosenzweig et al 2008 Nature)



Terrestrial

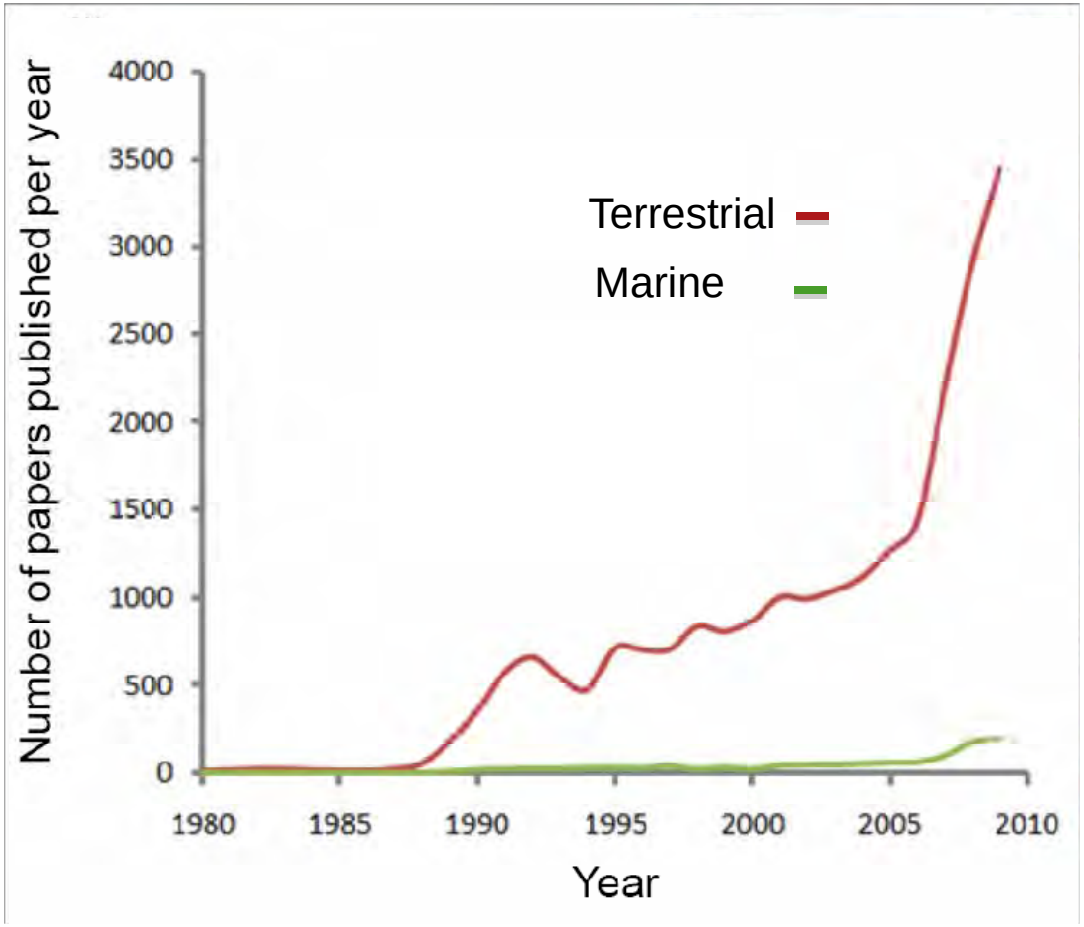
764	28586
94%	90%

Marine and Freshwater

1	85
100%	99%

Figure SM-1.4. *Changes in physical and biological systems and surface temperature used in chapter synthesis assessment in Section 1.4.*
At the global scale TER = Terrestrial; MFW = Marine and Freshwater, and GLO = Global.

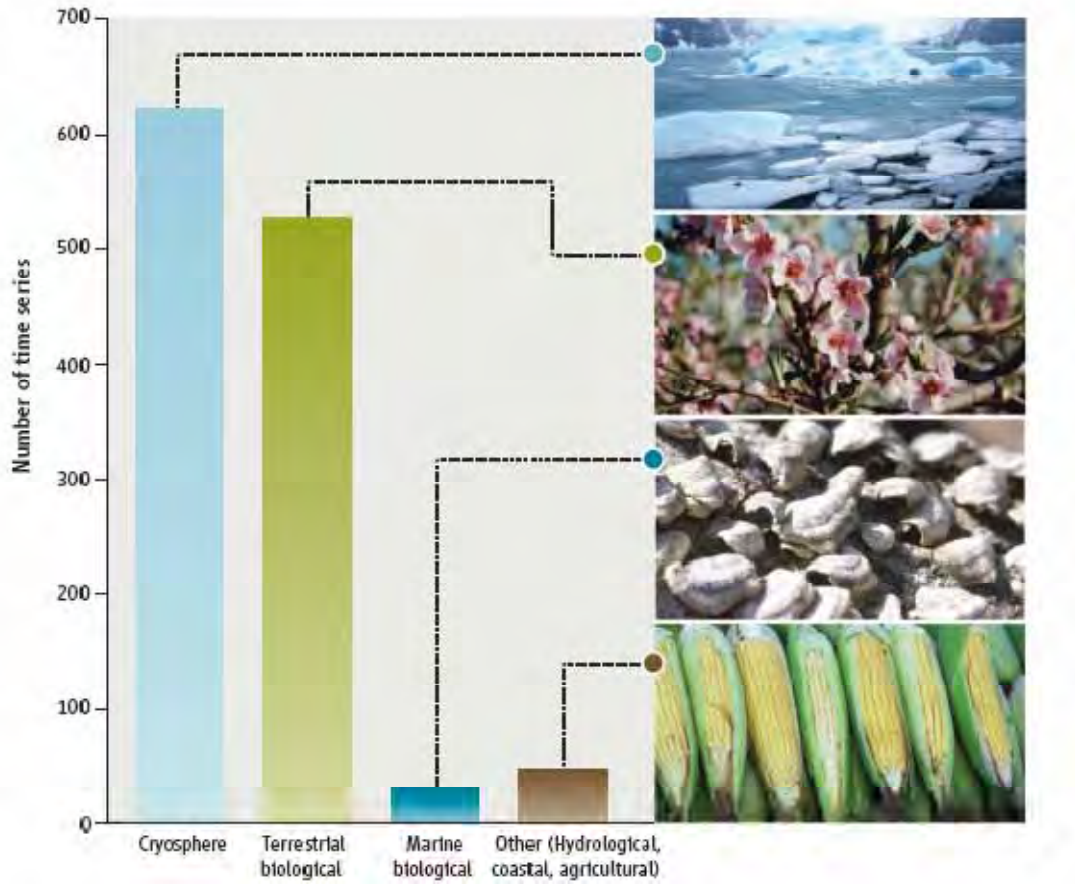
Climate change ecology papers



- Marine under-sampled
- Distribution of global science funding (10% rule)

Hoegh-Guldberg & Bruno (2010)

Time series



- Disentangling multiple stressors
- IPCC criteria: 20 years data minimum, end 1990 or later
- Few marine specialists

Richardson & Poloczanska (2008)

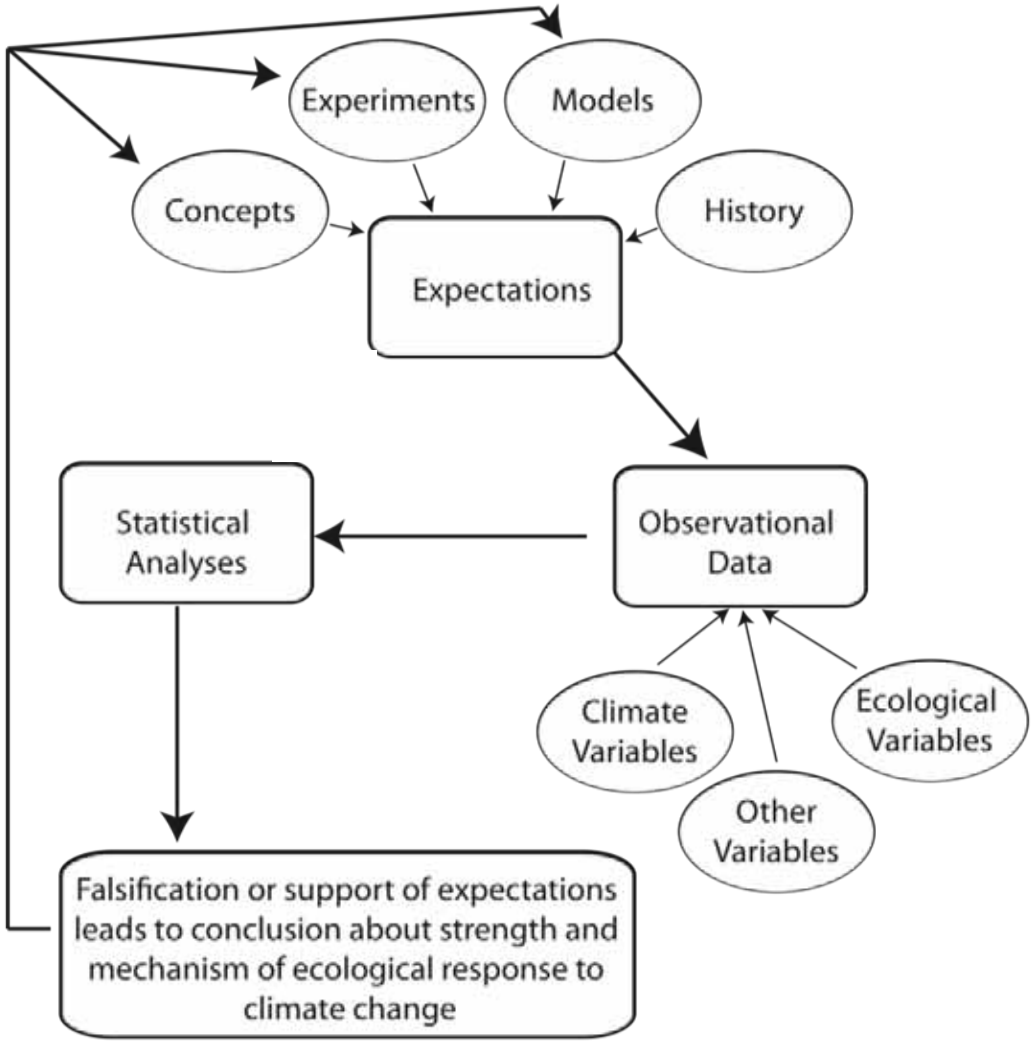
NCEAS WG: key questions

1. What are the similarities and differences in types and rates of responses between marine and terrestrial systems?
2. Which marine species, groups and systems are most sensitive?
3. What are the types and rates of responses in tropical, temperate and polar seas?
4. Are species and habitats under multiple human stresses more vulnerable to climate change?
5. Can we attribute change in marine ecosystems to climate change?

1. Generating expectations: CC ecology

- Climate change ecology: an emerging discipline
- Impacts & mechanisms of human CC on ecosystems
- Public spotlight
- *A priori* expectations and testing multiple hypotheses

1. Generating expectations: a framework



O'Connor et al. (submitted)

1. Generating expectations: examples

Expectation	Theory	Experiment	Paleoecological
Warming will cause species range shifts to higher latitudes and deeper water			
Ranges constrained by physiological temperature dependence		✓	✓
Range limits are more dependent on currents than temperature	✓		
Species geographic ranges will change as species interactions at the range borders change	✓	✓	
OA will reduce abundance of calcifiers			
OA will lead to reduced calcification and dissolution of shells in marine calcifiers	✓	✓	✓
OA will affect calcifiers with aragonite and high Mg-calcite forms of $CaCO_3$ than those with low Mg-calcite forms		✓	?
Calcifiers regulating pH at calcification site will be able to maintain rates		✓	✓

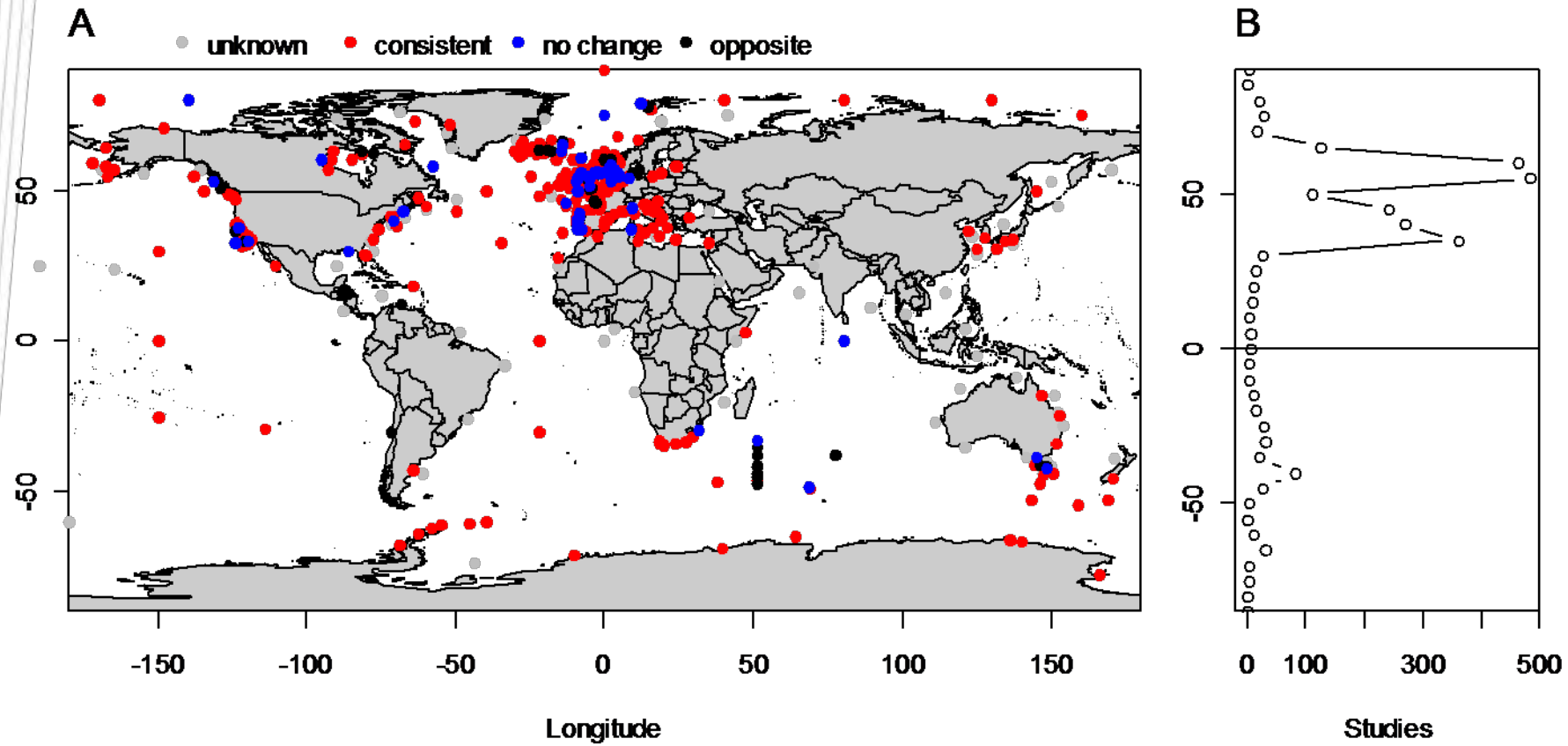
O'Connor et al. (submitted)

3. Integrating global impacts

- Studies from peer-reviewed and grey literature where **authors** have assessed climate change impacts
- No restriction on time series length
- Only observations (no models, no experiments, no future projections)
- Consider changes in abundance, community composition, condition, distribution, growth, phenology, survival
- Test against general expectations
- Confidence in study will be weighted based on size of study and statistics used

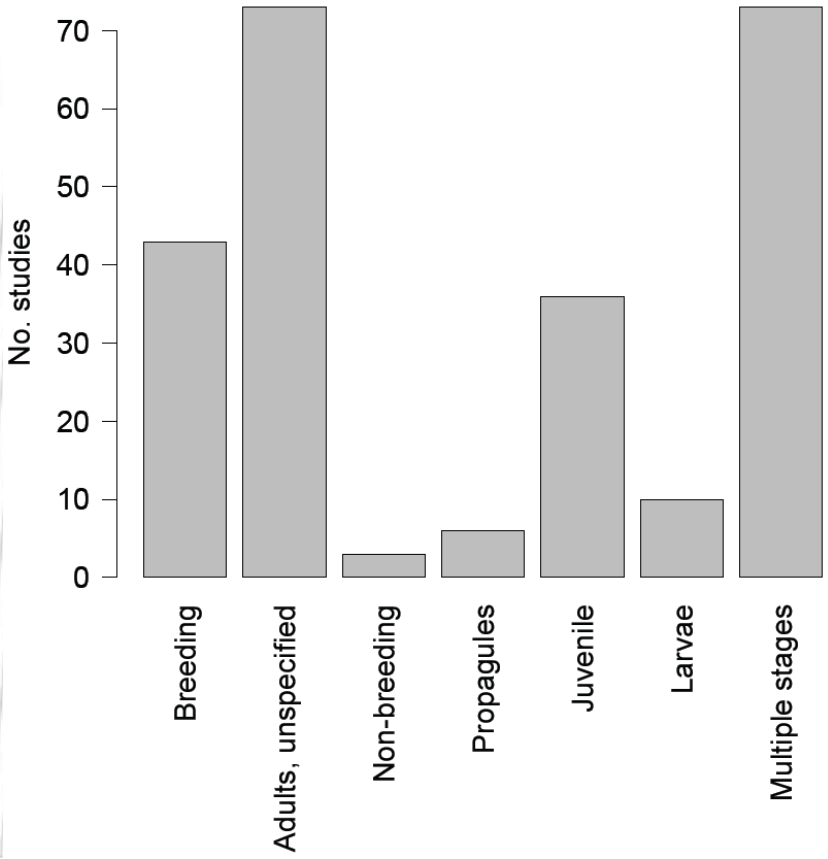
3. Global impacts: database

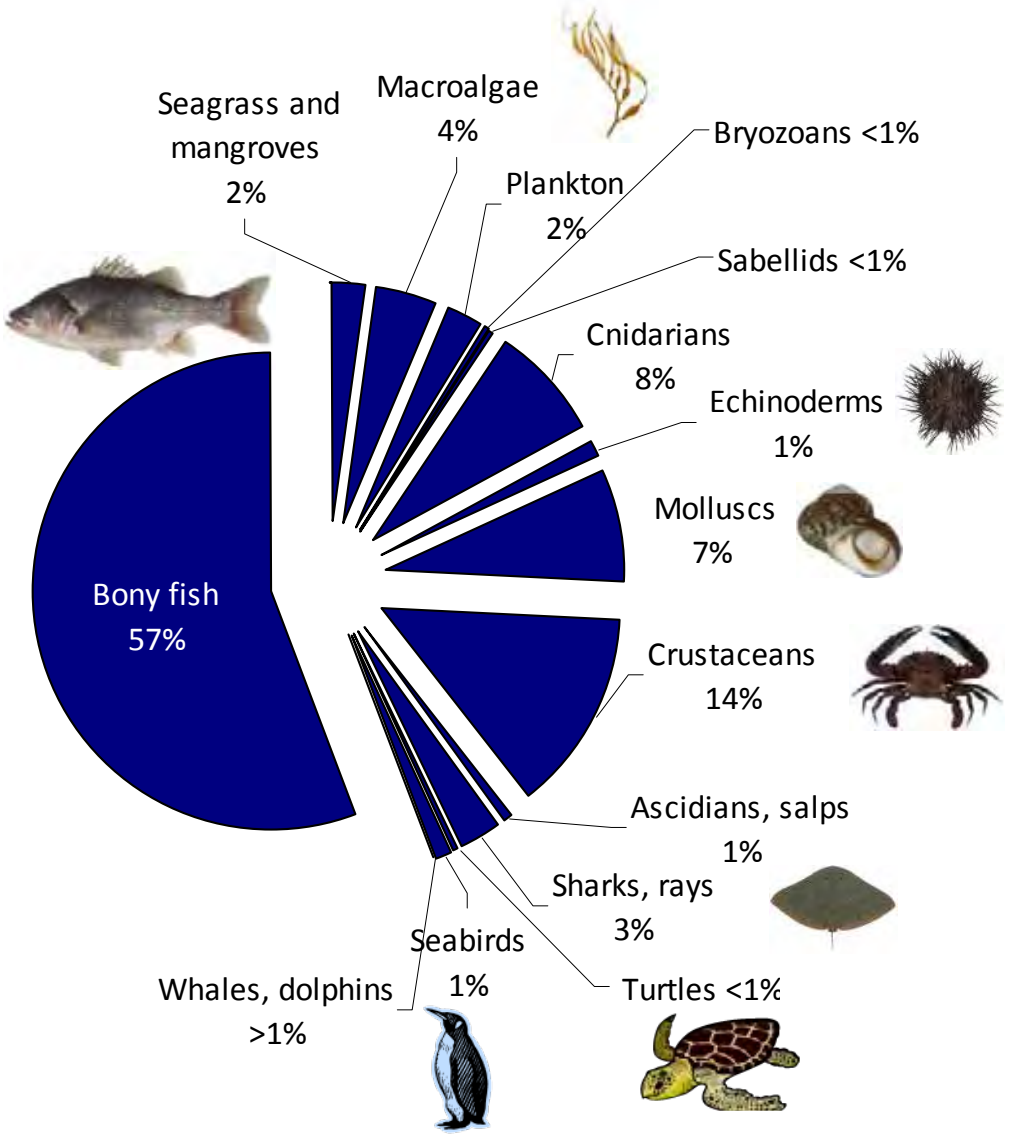
- Database has 3,937 observations from 260 studies



3. Global impacts: taxa

Intertidal/ Coastal	44%
Pelagic Continental Shelf	26%
Pelagic >1000m	2%
Demersal Continental Shelf	26%



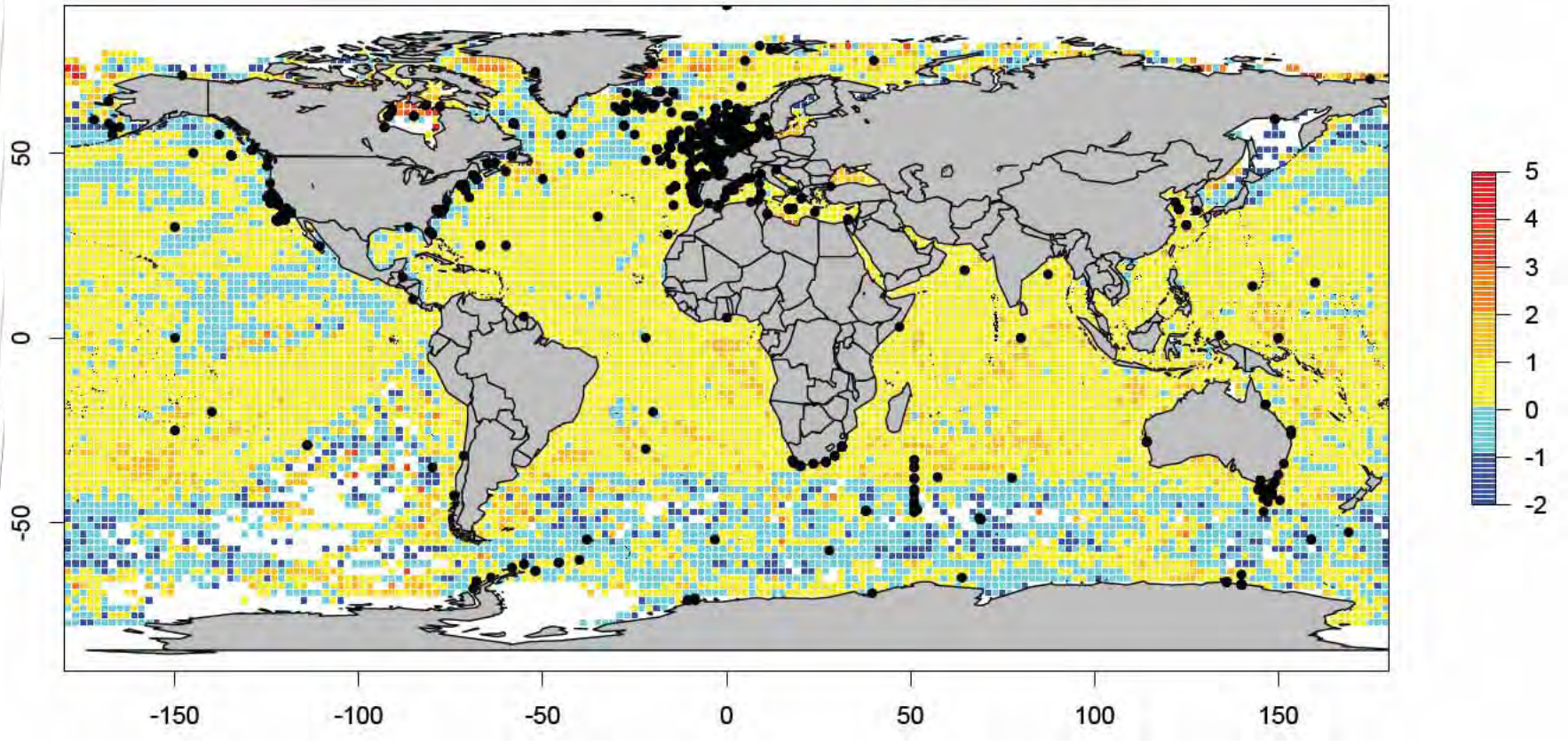


3. Global impacts: overall expectations

Expectations

1. Strength of response will vary geographically with warming rates
2. Response will vary based on species physiological temperature range

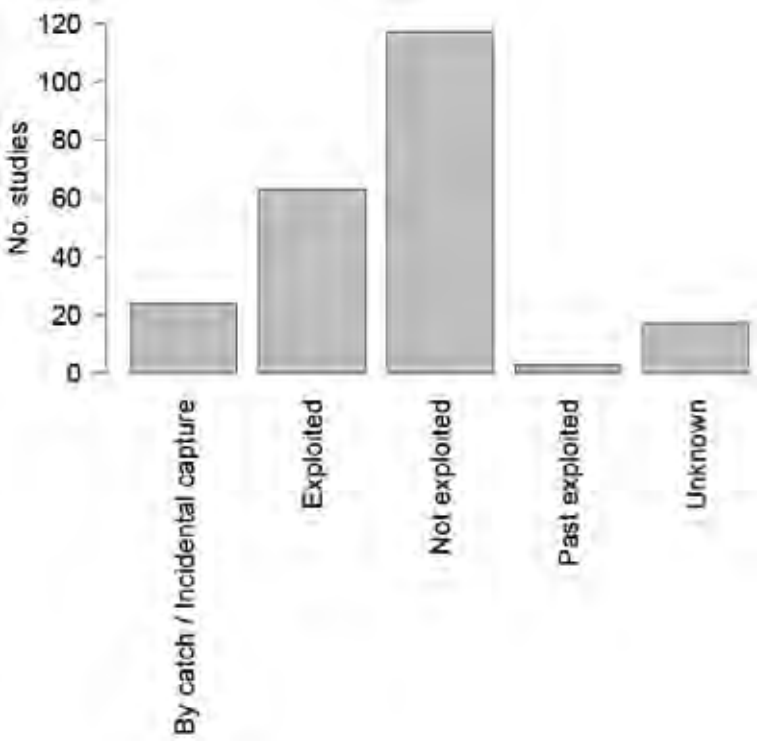
50 yr change in temperature

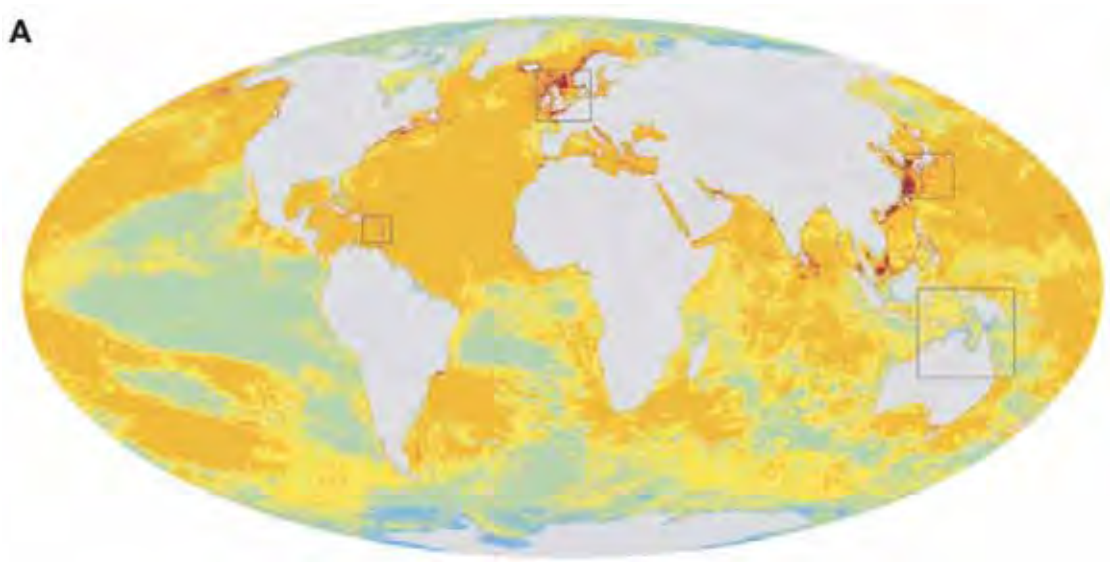


3. Global impacts: resilience to CC

Expectations

1. Exploited species more sensitive to CC
2. Heavily impacted areas more sensitive to CC





Halpern et al. (2008)

Finally…

- More complex task than first considered!
- 2 more WG meetings to go
- Hope to interact with other NCEAS WGs (currently with WGs on Jellyfish and Environmental Layers)
- For more information:

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