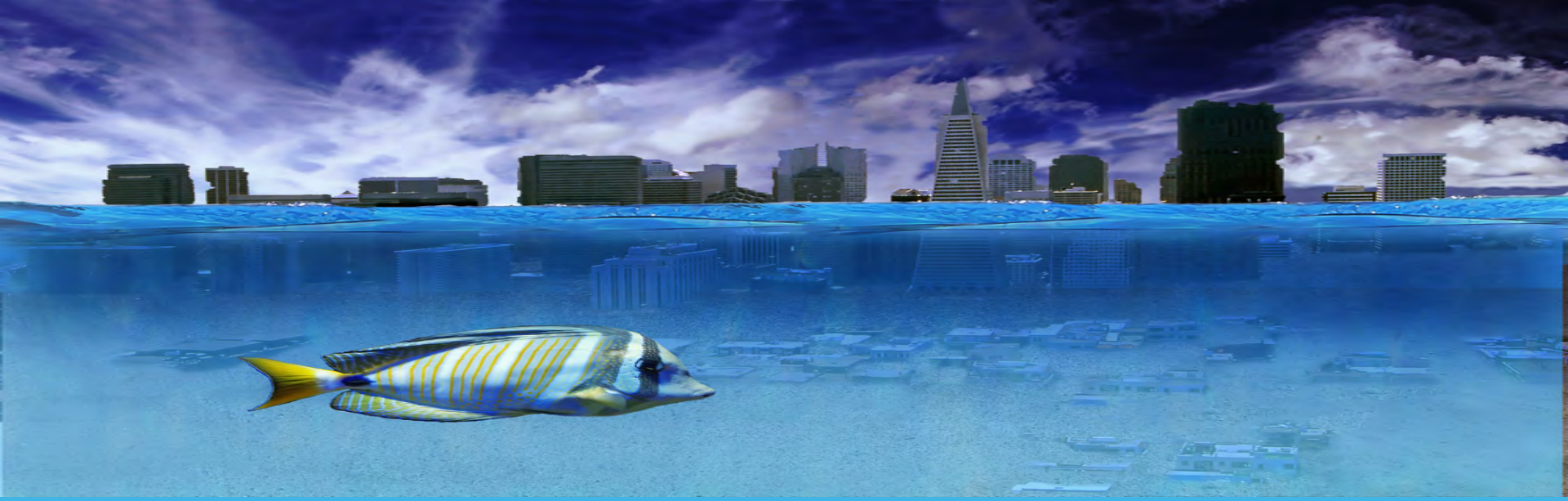


Decadal-scale forecasting of Australian fish and fisheries

Beth Fulton | On behalf of Heidi Pethybridge & the CSIRO-IMAS forecasting team

2018

CSIRO MARINE & ATMOSPHERIC
www.csiro.au

Management Pressure & Confusion

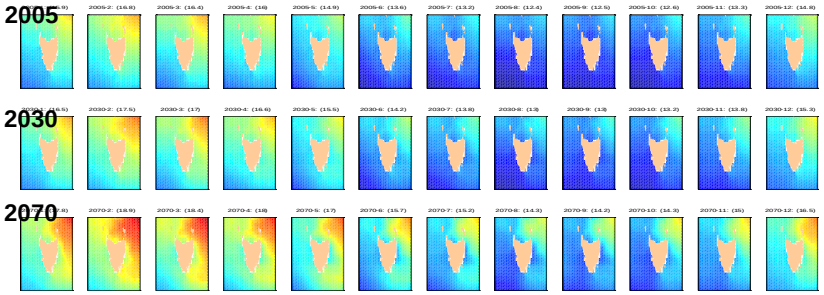
Struggling snapper taken off the table

Fisherman snap at looming bans

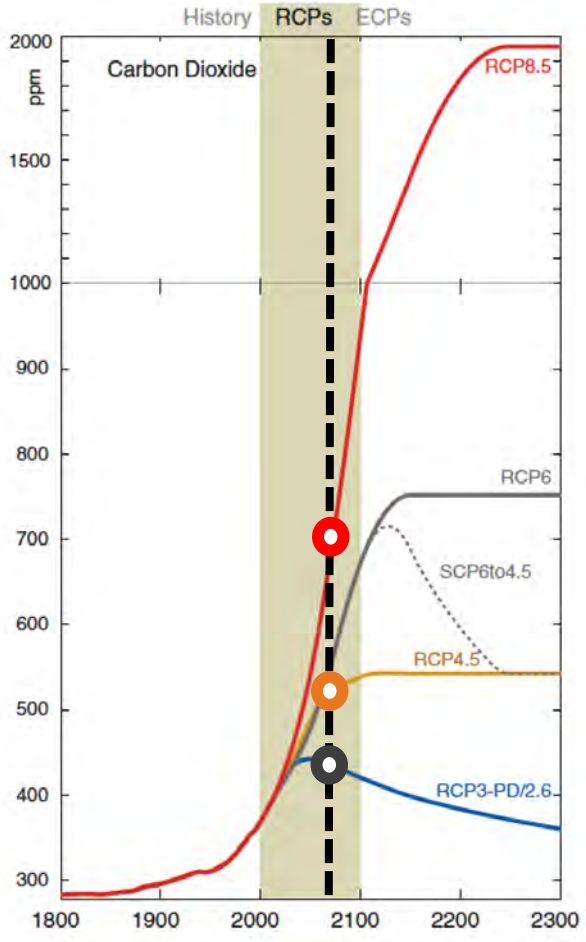
- Climate impacts on fisheries management already exist (all fisheries likely affected in some form)
- Trying to create robust climate rules (initial vulnerability assessments and projections with 5 year review)

Projected changes

- Model based projections
- Future drivers = physical change (RCP), extreme events and change in sectors (fishing, aquaculture, other sectors)



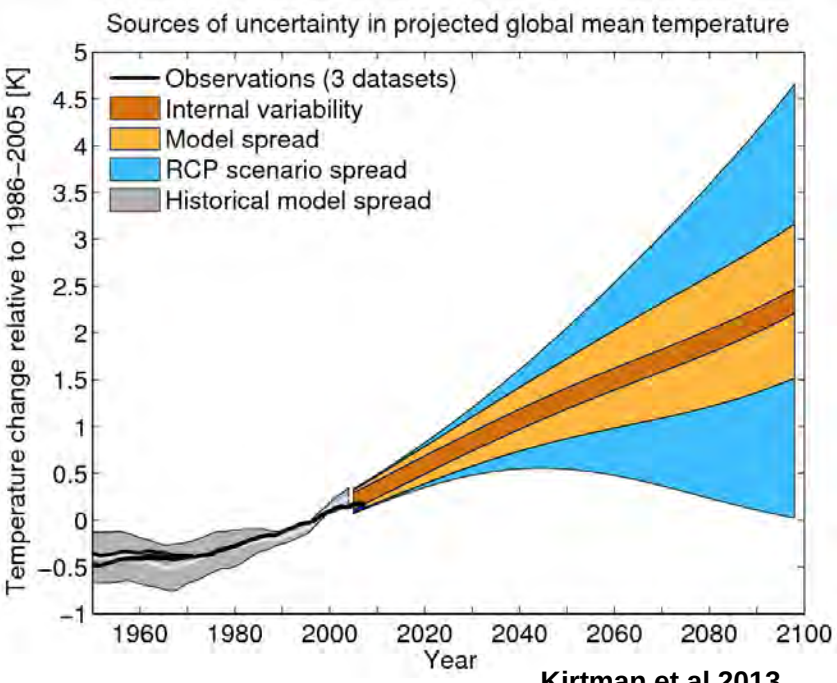
Data: CSIROMk 3.5 in OzClim



Meinshausen et al 2011

Sources of Uncertainty

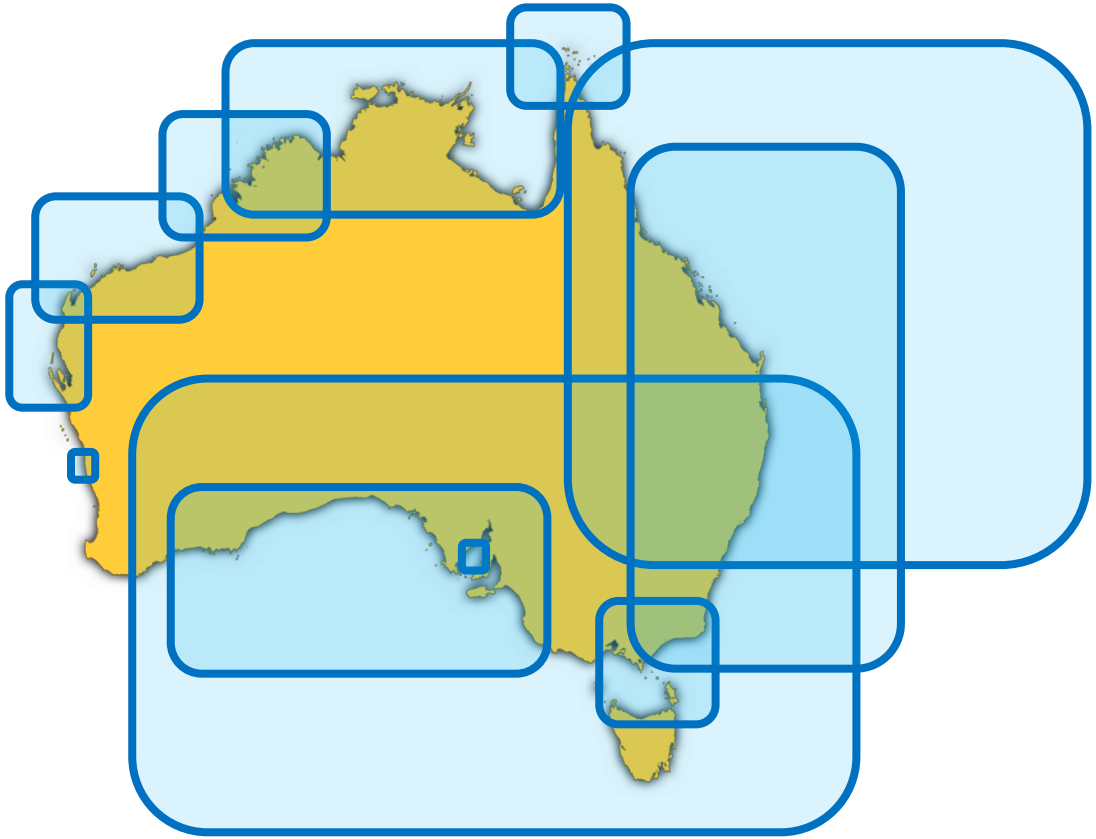
- Parameters (e.g. growth, fecundity)
- Response curves (what effected by climate & how)
- Structural uncertainty (what should be in the model & how connected)
- Used multiple models & variants



Kirtman et al 2013

- Long term (2050) critical components will be evolution, acclimation & **human responses** (if threshold passed, step changes needed)

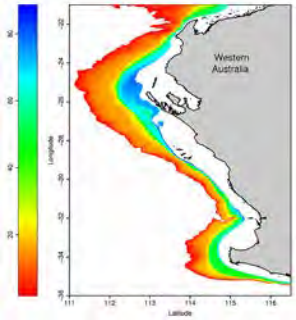
Models



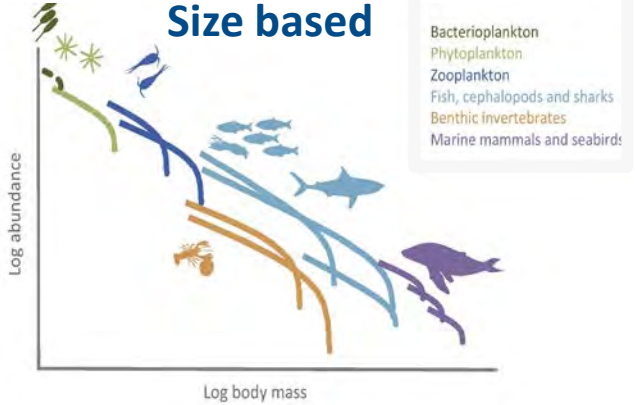
FISHERIES & MARINE ECOSYSTEM
FISH-MIP
MODEL INTERCOMPARISON PROJECT

Diversity of model approaches

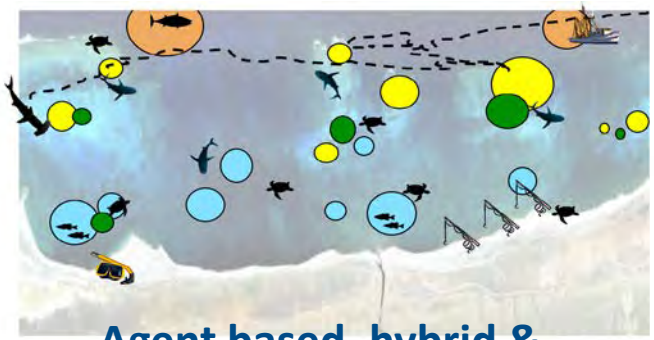
Species distributions



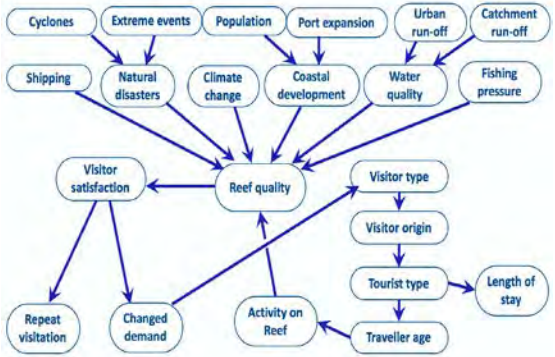
Size based



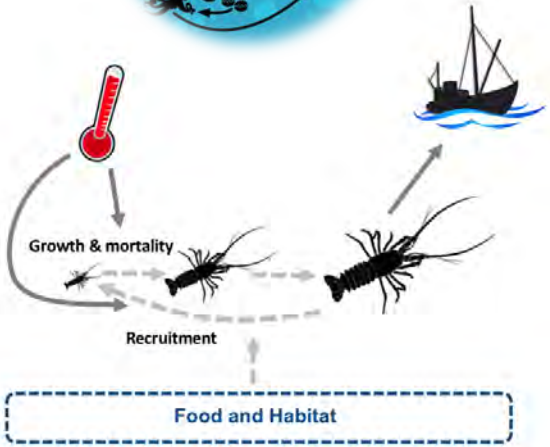
Trophic



Agent based, hybrid & end-to-end models



Bayesian networks



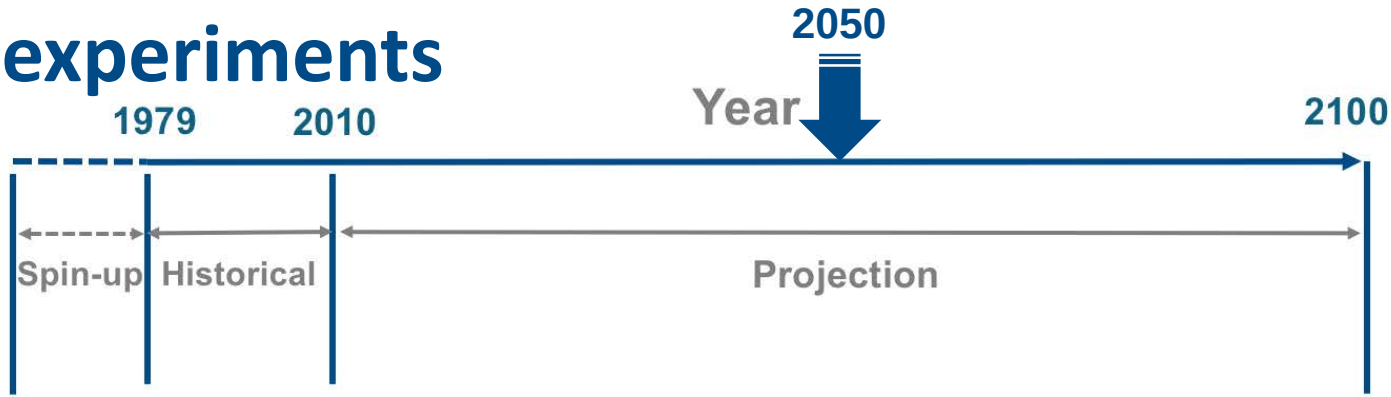
Minimum realistic (MICE)

Christensen & Walters 2004, Travers et al 2008, Fulton 2010, Dunstan & Foster 2011, Blanchard et al 2017, Anthony et al 2013, Cheung et al 2016, Plaganyi et al, WWF

Ecosystem Model Types Used

Property	Distribution Model	Size-based	MICE	Ecopath with Ecosim (EwE)	Atlantis
Forced by physical drivers	✓		✓		✓
Forced with primary production	✓	✓	✓	✓	
Physiological processes	✓				✓
Trophic interactions		✓		✓	✓
Size-based interactions		✓			✓
Habitat interactions	✓				✓
Constant fishing mortality			✓	✓	✓ v1
Dynamic fishing responses					✓ v2
Spatial	✓	✓			✓

Model experiments



Climate forcing

Control (no climate trend or emissions signal)

Current/high emissions (RCP 8.5) scenario

Fisheries forcing

Held at 2010 levels through out

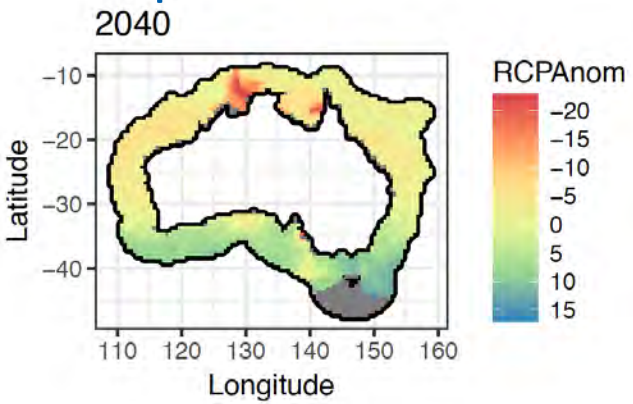
Fully dynamic fishing (effort allocation, targeting & investment decisions, management cycle) + other industries

Model experiments

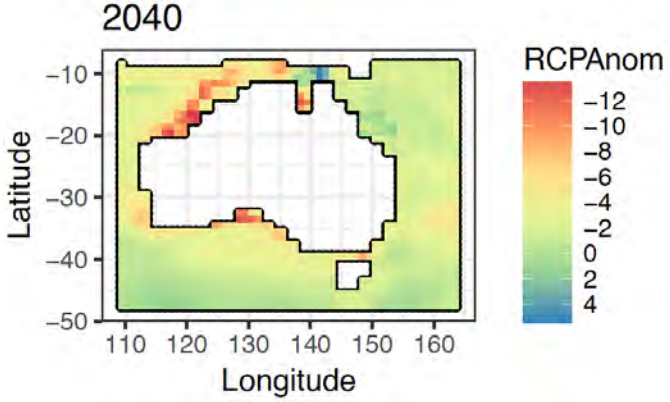
	Control (no climate signal)	Current/High emissions (RCP 8.5)
Constant fishing pressure (2010 Fs)	✓✓	✓✓
Dynamic fishing (& other industries)	✓	✓

Results

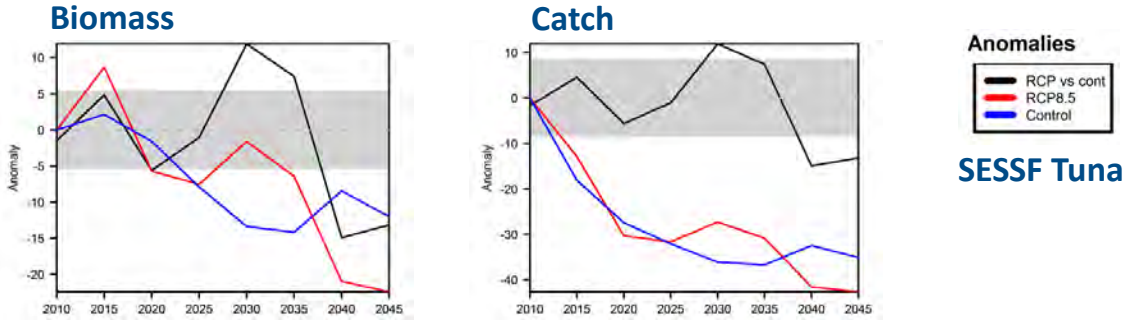
- Per species



- Total biomass



- Trajectories of biomass & catch (species & functional groups)

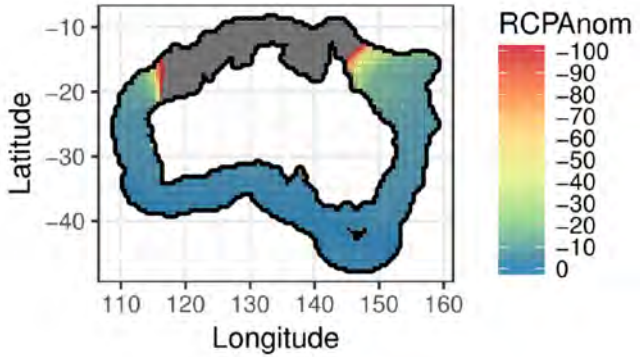


Results – Species distribution models

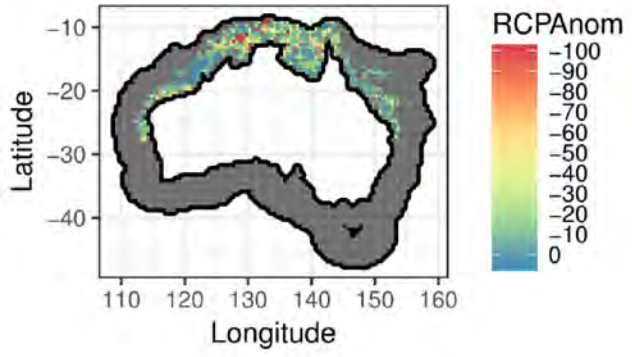
2020

- Per species (~150 species), mixed quality

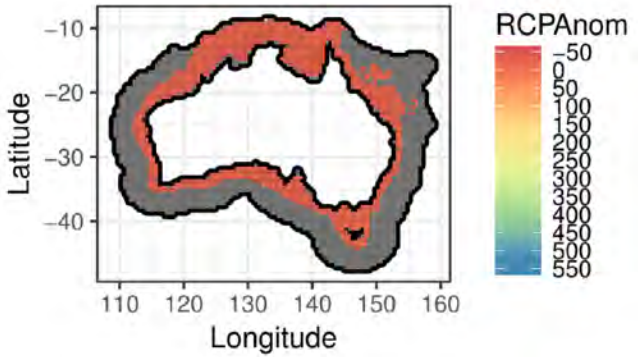
Southern Bluefin Tuna



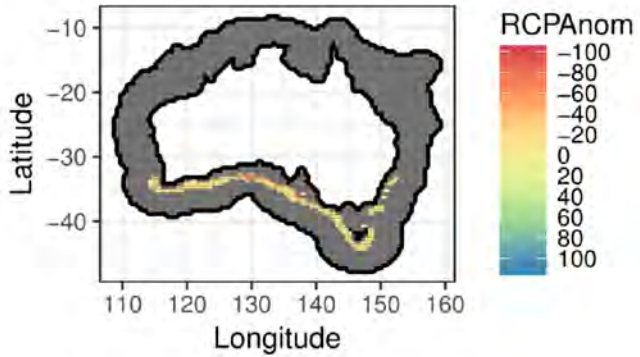
Endeavour Prawn



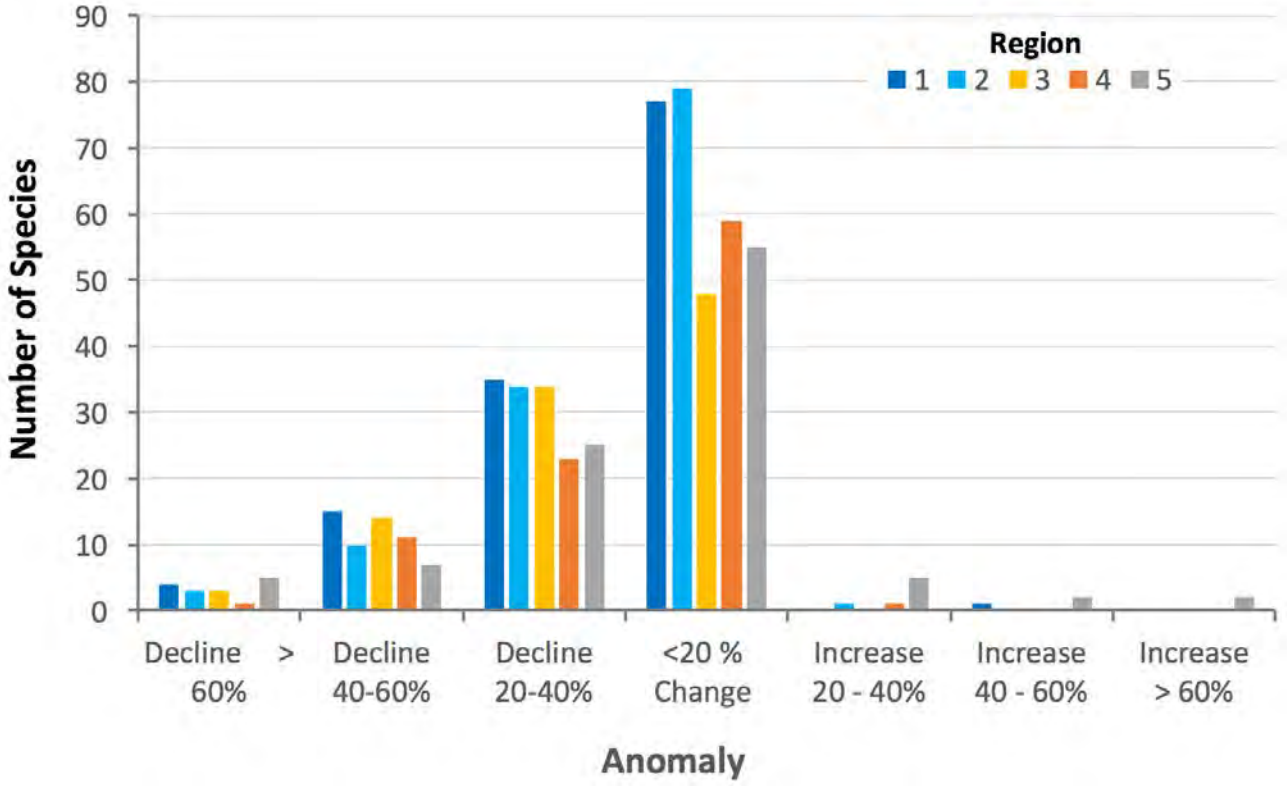
Jack Mackerel



Silver Warehou

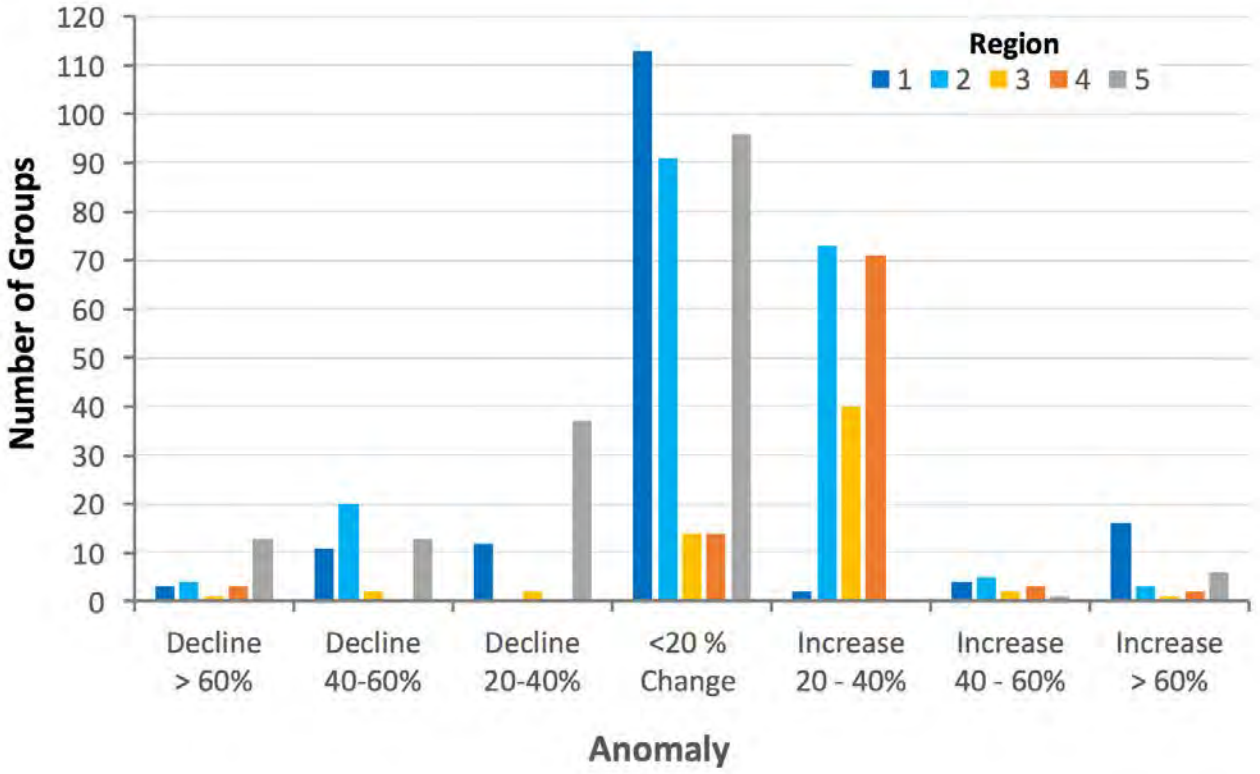


Results – Species distribution models



- Species distribution models based on perferred niches = declines

Results – With trophic connections



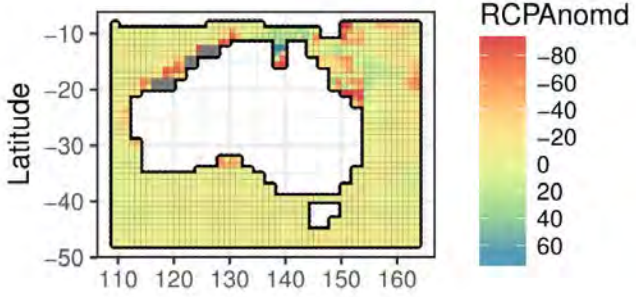
- Trophic interactions show things more complicated than shifts alone

Results - Size-based model

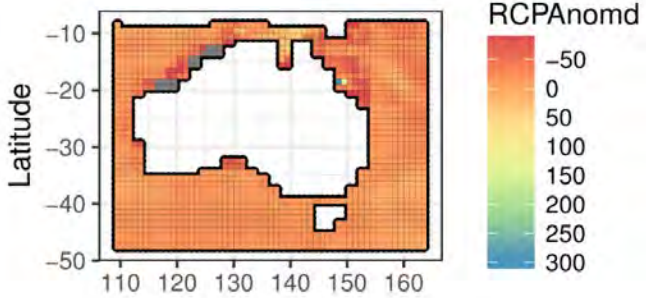
2025

- Not too much change, except in the north

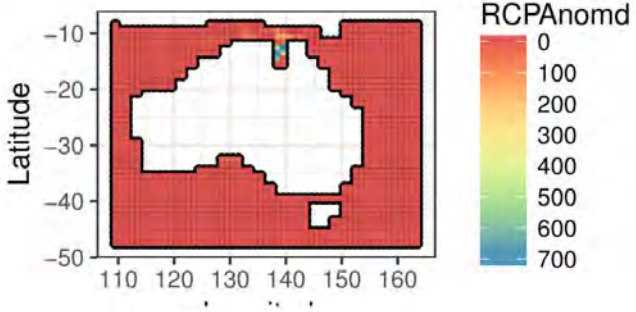
10cm pelagics



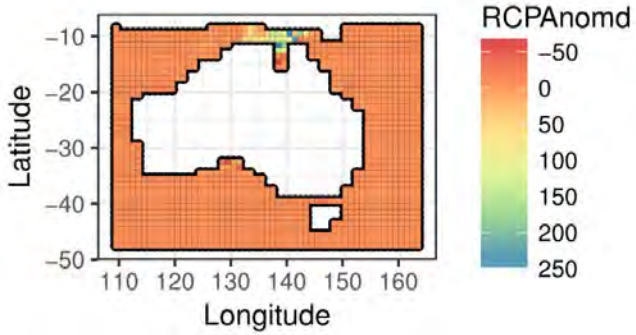
30cm pelagics



10cm benthivores

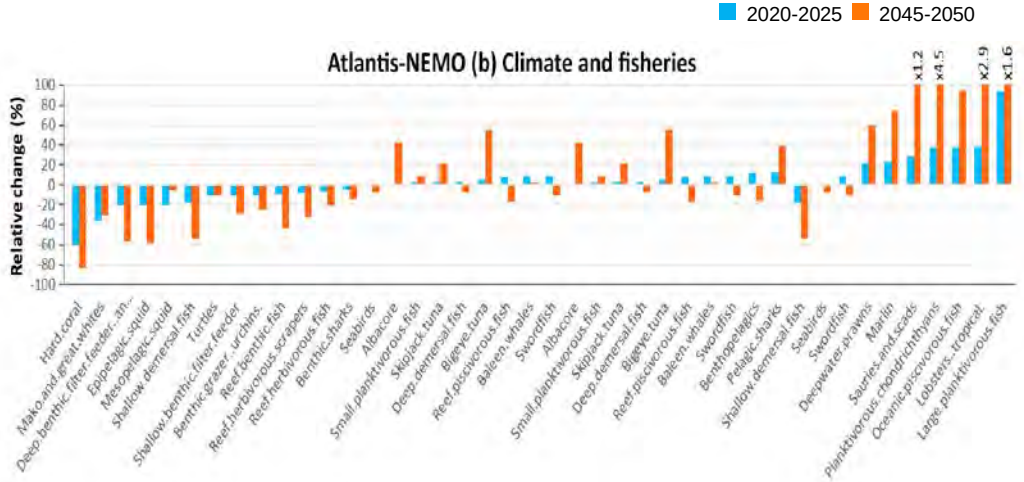


30cm benthivores



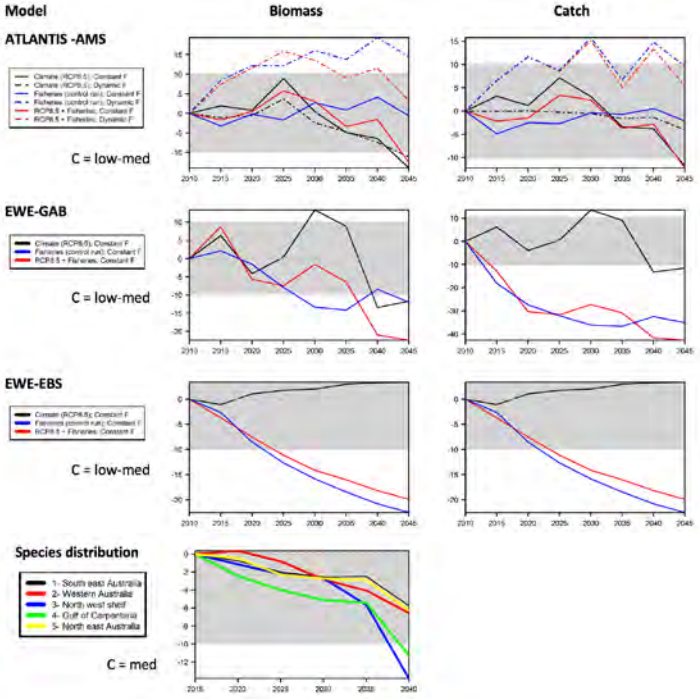
Other Results – trophic models

- Whole of system: lots of variation (some up, some down; changing through time)

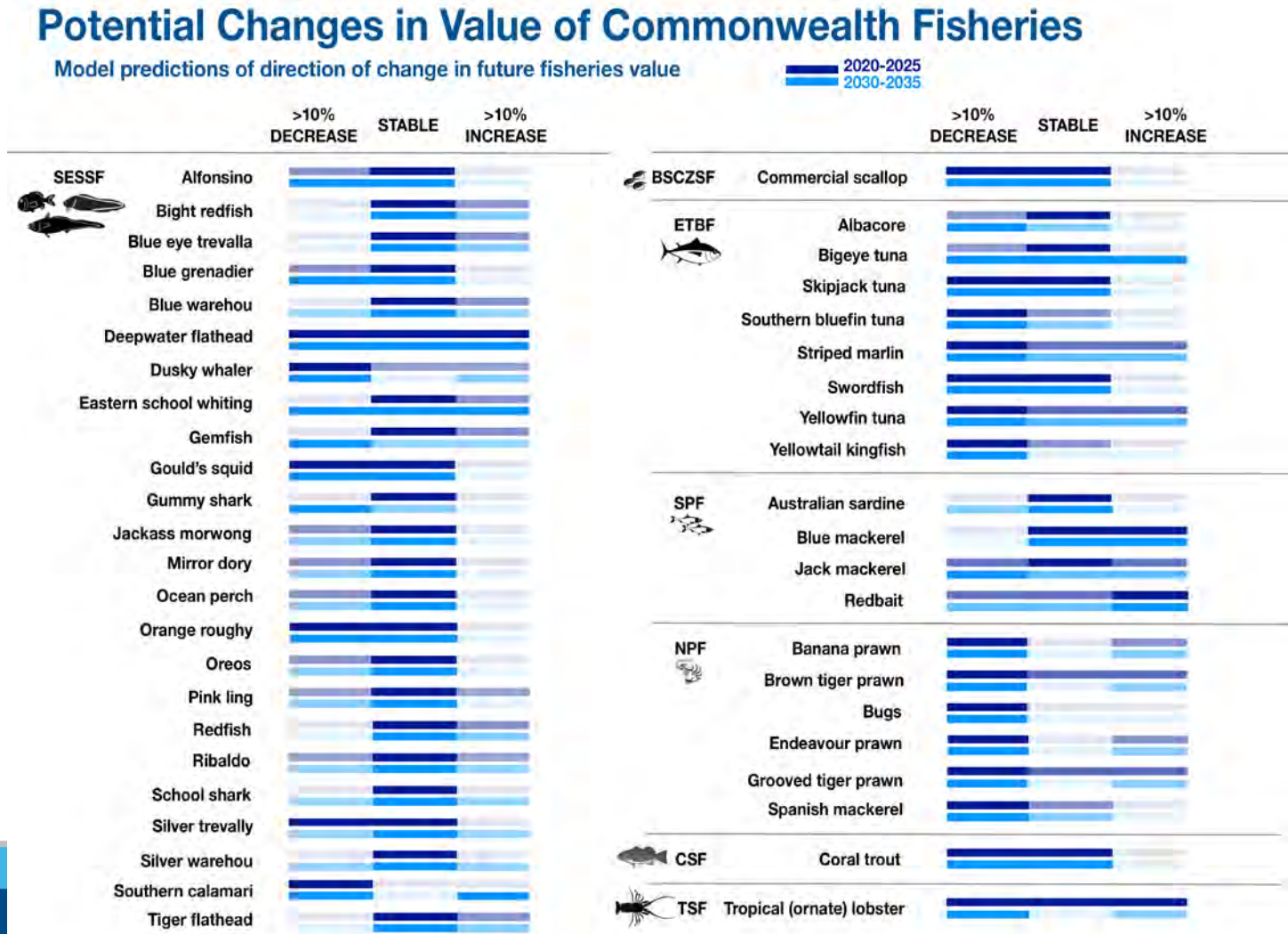


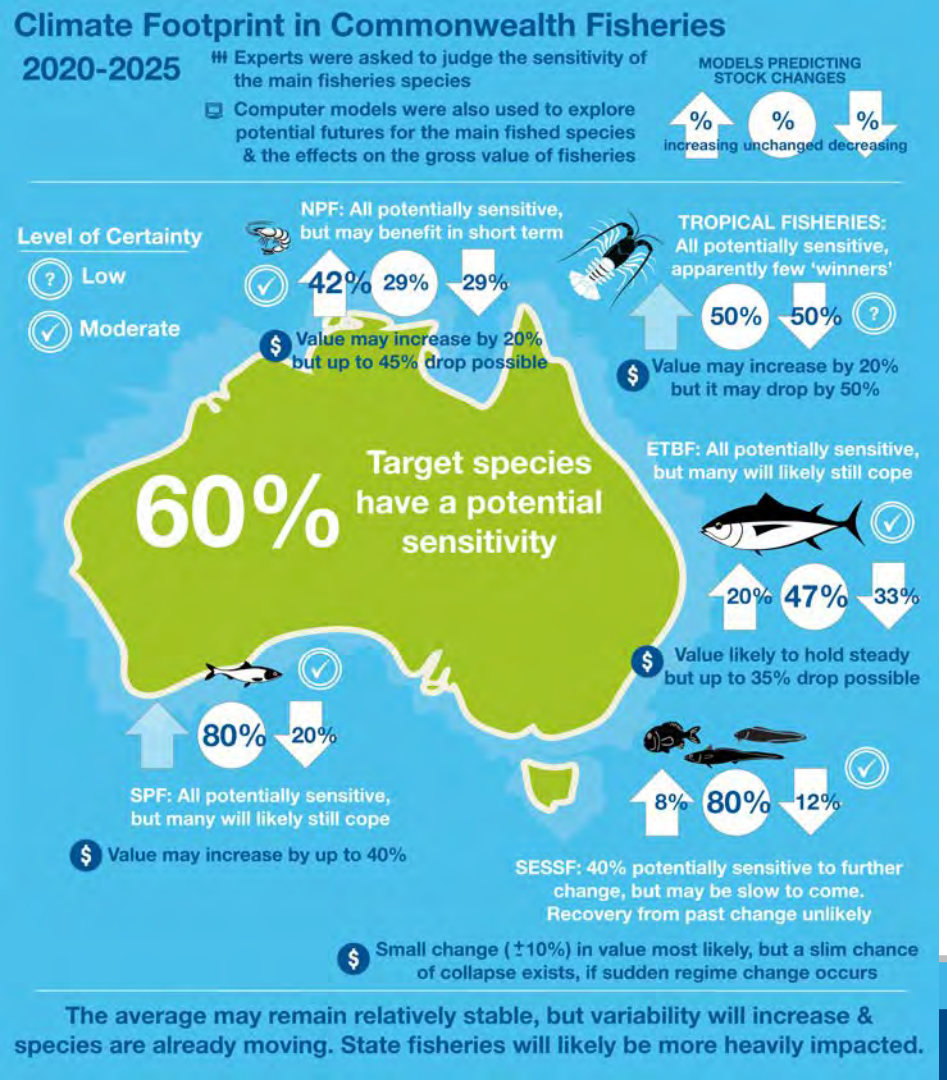
- Multiple trajectories: biomass & catch (all target species, major bycatch, protected species)
- Ensemble of models (agreement & exceptions)

Tuna



Synthesis of Multiple Lines of Evidence

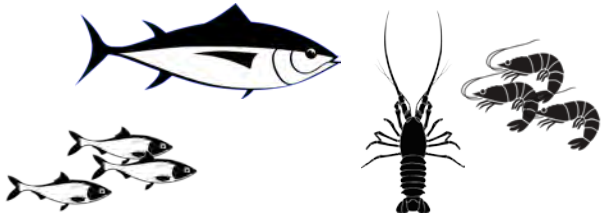




2020: Likely little change, or small shifts

- **Pelagic – mostly stable** or increasing
- **Tropical – winners & losers** (lobsters in trouble)
- **Temperate – mostly stable** or mixed (but **key species** likely **decreasing or failing to recover**)

2050: Bigger changes likely… but messy

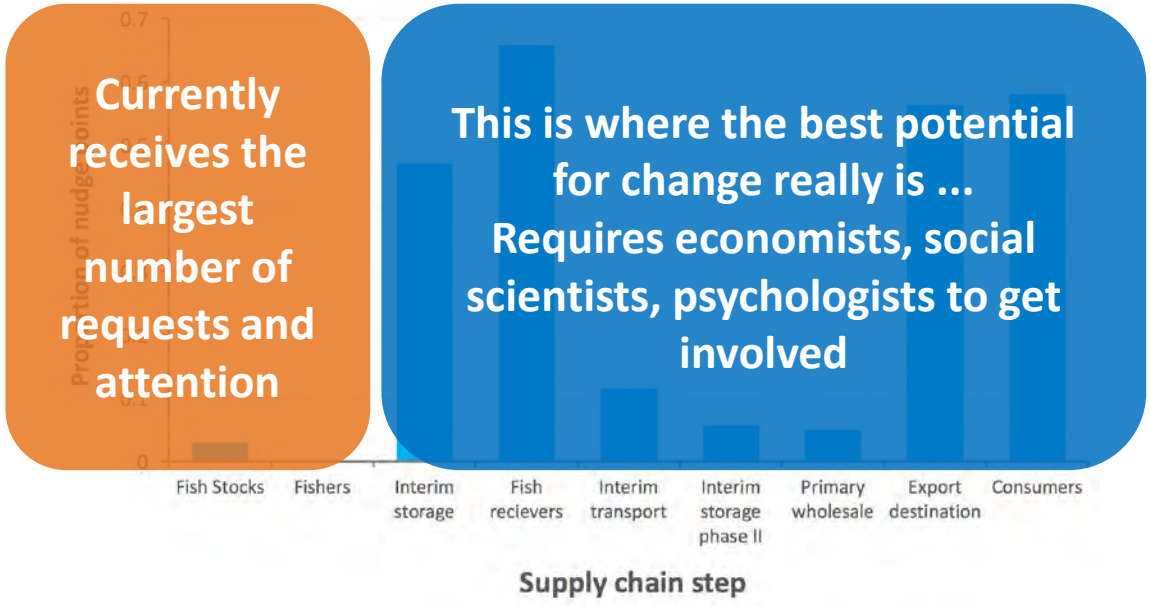


- More uncertainty (model divergence)
- **Pelagics** – begin decreasing
- **Tropical** – Lots of losers
- **Temperate** – Toss a coin… (lots of change or adaptation, models disagree about the outcomes… possible regime shift)

- **Invertebrates & shallow demersal ecosystems more sensitive** (some species already struggling & failing to recover)
- **High variability** in space & time (& between sectors)
- There will be **winners & losers**, winners likely beyond species currently managed

Adaptation options & Barriers

- Most of the proposed options are to do with fishing (but most of these are already being done)
- Rest if the supply chain not thinking about climate yet



Policy

Fishery

Processor

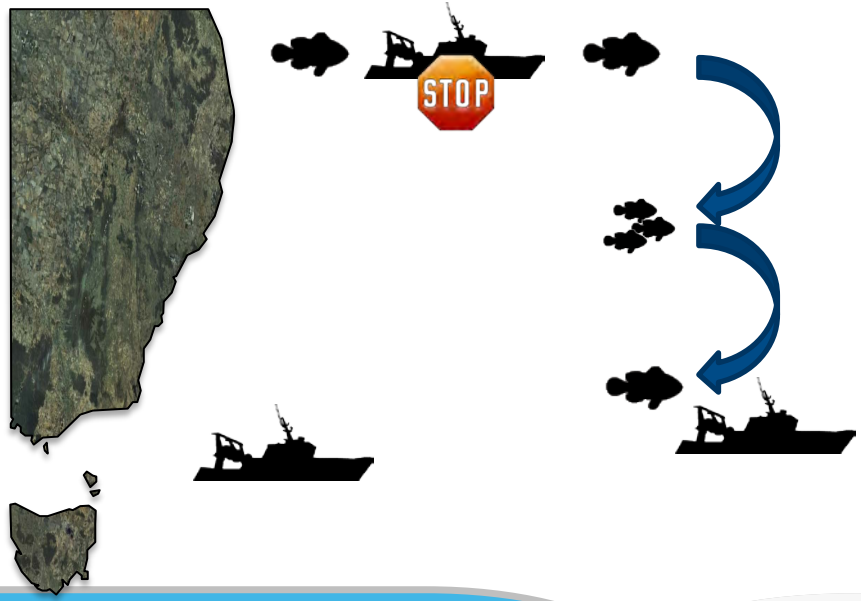
Transport

Sales

Consumers

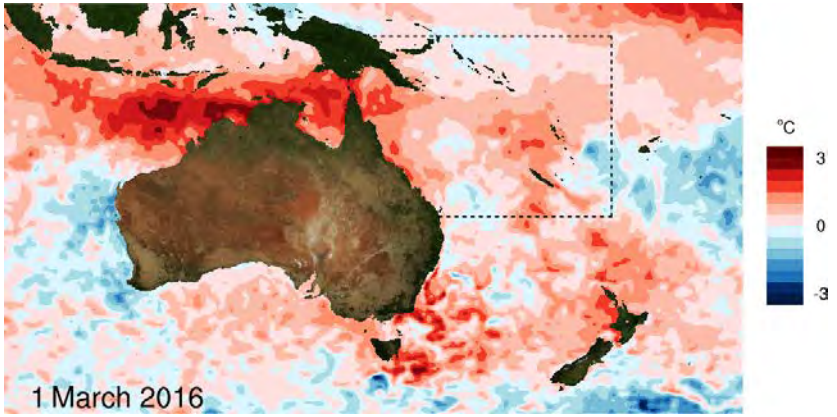
Recommendations

- New tools may need to be discussed (e.g. interventions; frame based management rules)
- Iterative fisheries forecasts (short & long term) will help, but need good supporting data streams
- Cross jurisdiction management coordination
- Plan how to deal with differential outcomes
- Flexible regulations & non-static assessments (and forecasts)



Summary

- Managing in climate context already
- Short term (5-10 years) of far more current interest operationally
- Don’t shy away from structural uncertainty
- Core of short term = stability, but variation important & growing
- Southern change has started, beginning in the north
- Differential outcomes
- Watchwords – Flexibility & Prioritisation



Sea surface temperature anomalies
King et al 2016 using OSSTIA data
UK Met Office Hadley Centre

Thanks

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