www.csiro.au

Potential economic impacts of climate change on Australian wild fisheries

Sean Pascoe Ana, Norman-López and Alistair Hobday

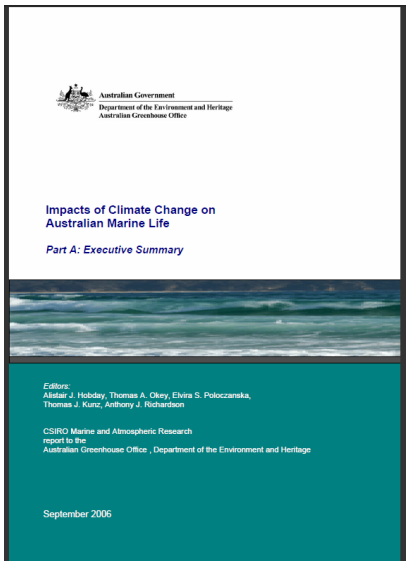
National Research FLAGSHIPS Climate Adaptation

CSIRO

Outline of the presentation

- Background
  - Current understanding of climate change effects on the marine environment
  - Fisheries looked at in the study
- Economic impacts of CC to Australian fisheries (3 steps)
  - Step 1- Estimate effects of changes to fisheries production & associated uncertainties
    - Example: rock lobster fishery
  - Step 2- Link productivity projections and uncertainties to an Input-Output model to investigate effects on the broader economy
  - Step 3 – Monte Carlo simulations on impacts of climate change on fishers' wages, profitability and flow on effects to other sectors in the economy
- Results
- Implications for management and industry

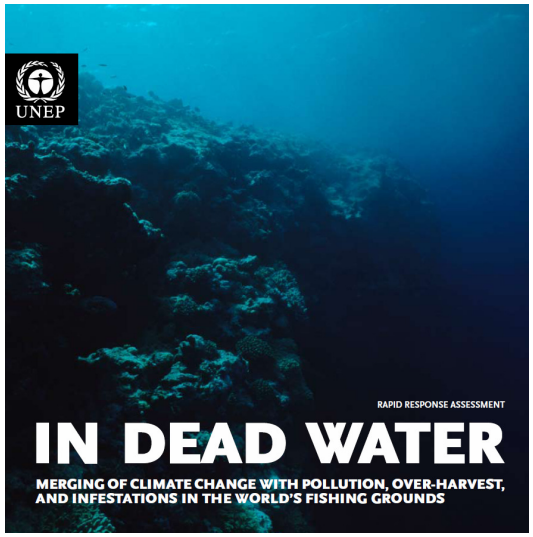
Relatively recent examination of climate change effects in fisheries



CSIRO 2006

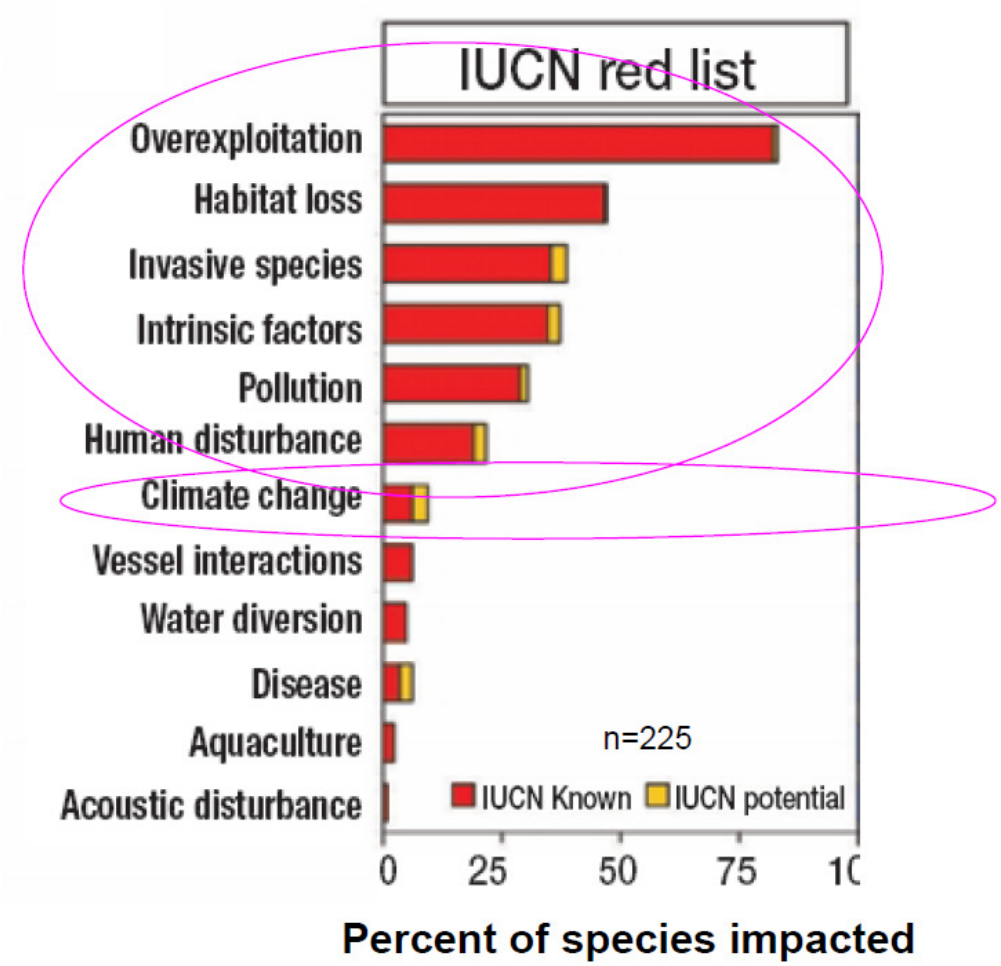
CSIRO 2009

UNEP 2008



National Research FLAGSHIPS Climate Adaptation CSIRO

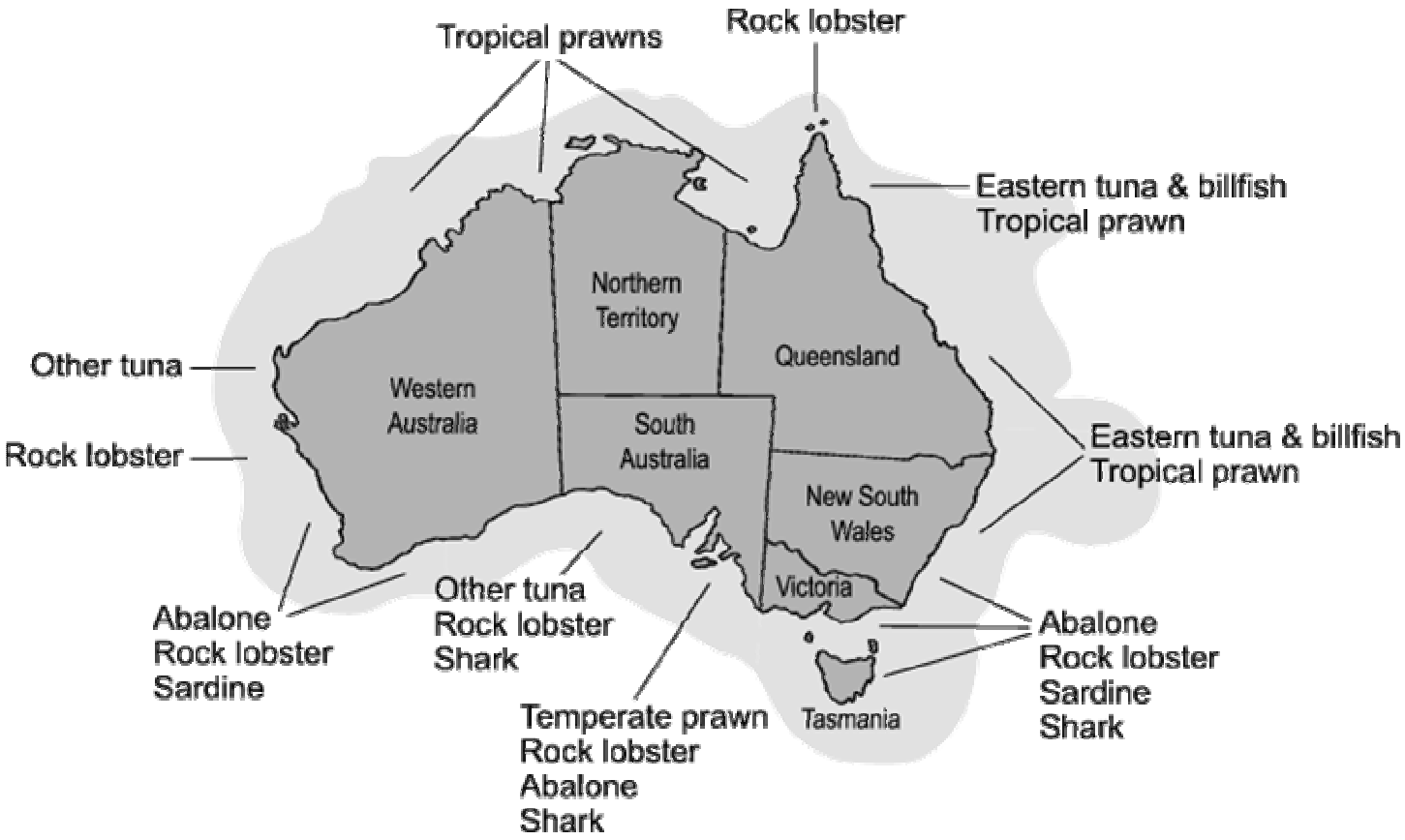
Climate change in perspective: threats to marine life



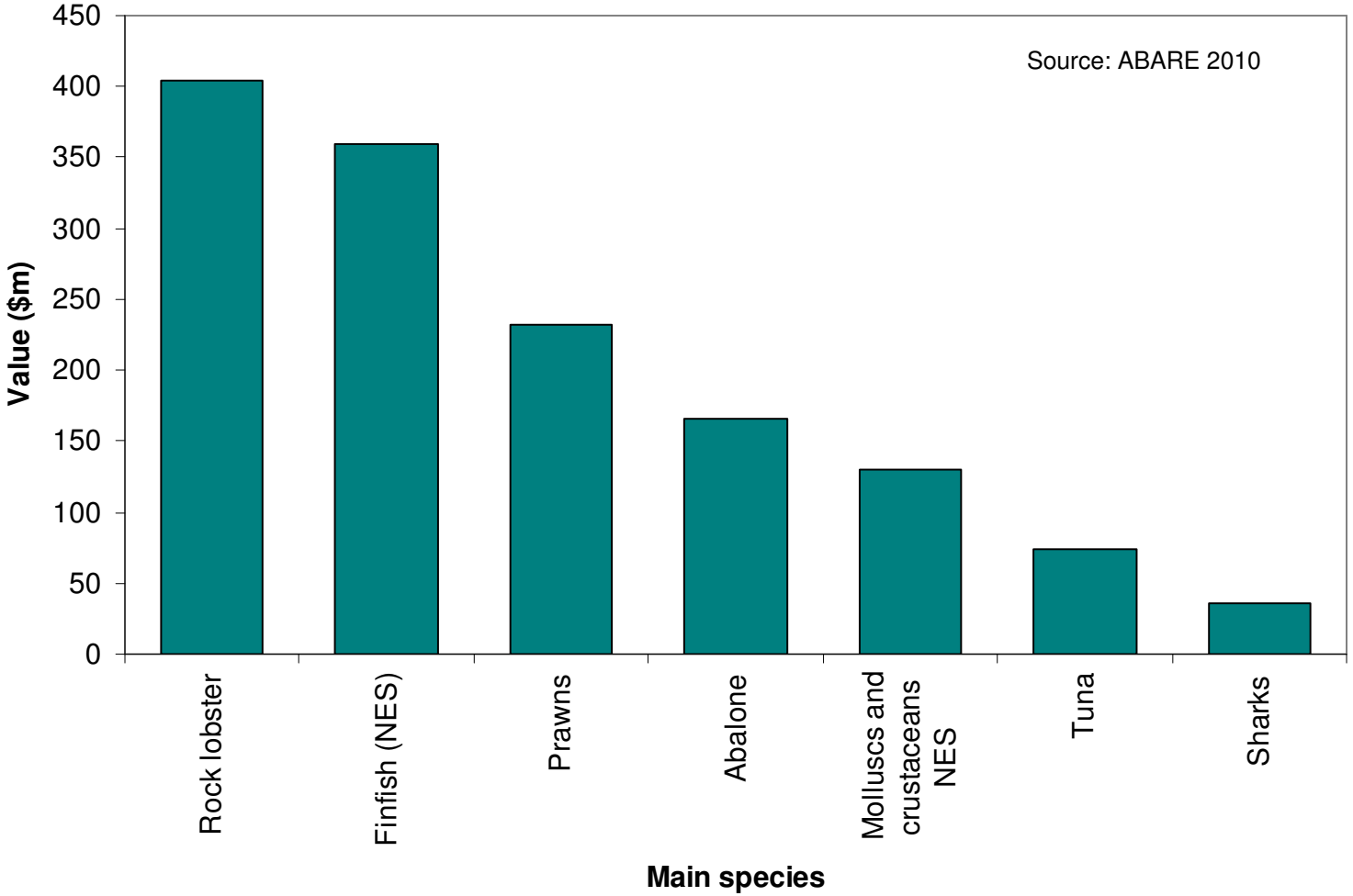
Impacts of climate change considered in the analysis: recapping on Alistair's presentation

- Sea surface temperature (SST)
  - 1-2^{o}C increase in SST with the greatest warming off in the south-east
- Winds / Currents
  - Strengthening of winds will also strengthen the East Australia Current (EAC)
  - Weakening of the Leeuwin current in the West coast
- Acidification
  - A decline in pH by around 0.1 units
- Rainfall
  - On average, rainfall will decrease by 0-5% over most of Australia, although the frequency of storms and cyclones (in the north) is expected to increase
- Sea level
  - Projected to rise by 0.3-0.5 m around Australia
- Primary productivity
  - Flow on effects from primary producers

Fisheries included in the study



Value ($m) Australian fisheries (2008-09)

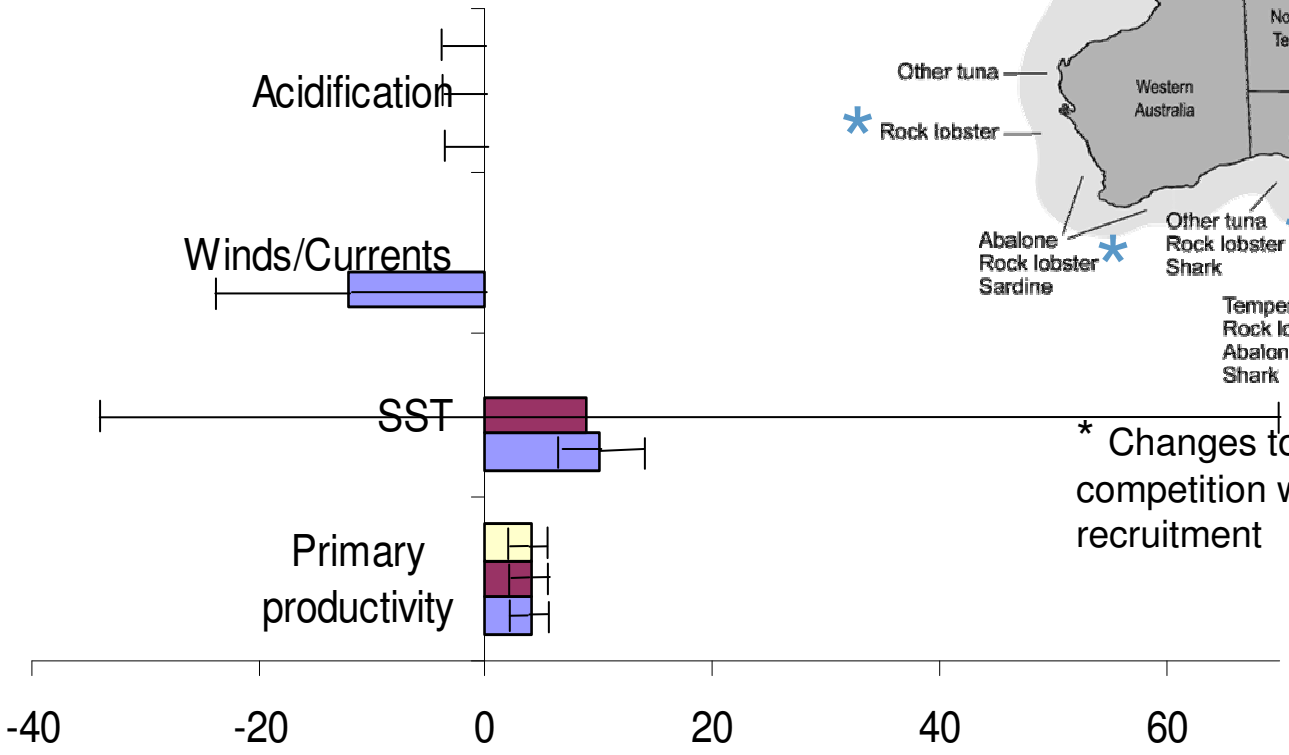


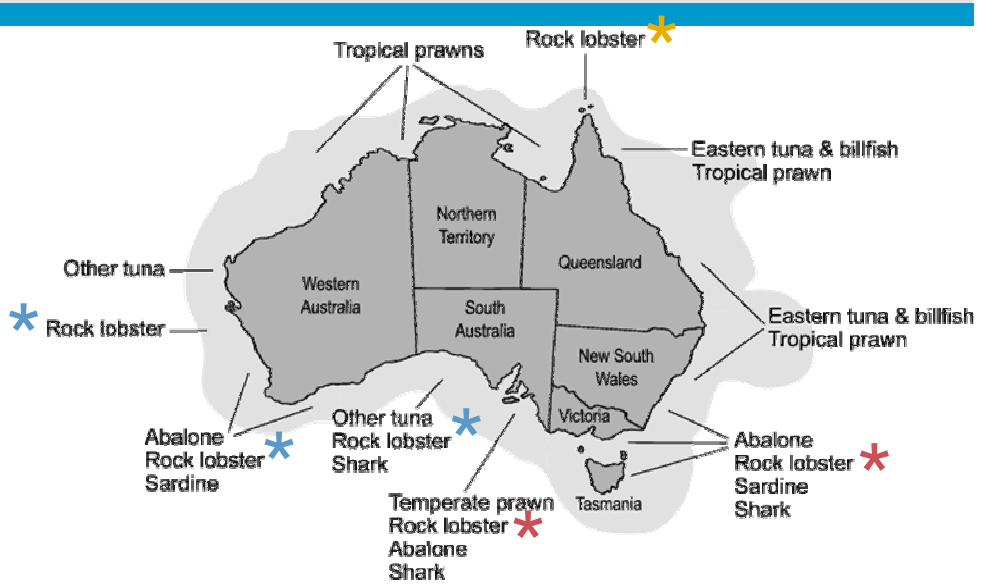
National Research FLAGSHIPS Climate Adaptation CSIRO

Overall direct effects on Australian fisheries

- Difficult to assess the flow on effects that CC will have in Australian fisheries
- Direct effect from physical variables
  - E.g., the timing of spawning, or the tolerance to increased SST
- Range and distribution (including local or global extinction)
- Composition and interaction within communities

Example of specific climatic effects to rock lobster fisheries in North, West and South of Australia





* Changes to catches following SST, EAC, competition with sea urchin, reduction in recruitment

Panulirus cygnus (West) J. edwardsii (South) Trop. Panulirus (North)

% change in productivity to different rock lobster spp following different physical and primary productivity effects from 2004 to 2030

National Research FLAGSHIPS Climate Adaptation CSIRO

Impacts due to multiple factors

Example: Prawn fisheries

Fisheries	Primary Production	Uncert.	Specific spp	Temp.	Uncert	Acidification	Uncert.	Sea level	Uncert.	Cyclone	Uncert.	Rainfall	Uncert.
Temp. prawns	17%	±4.25 %	*M. latisulcatus*	8%	±3%	0%	-3%, 0%	No estimates identified		No estimates identified		No estimates identified	
	Predictions from Brown et al (2009). Assumed +/- 25% uncertainty from predictions			Higher temp. could benefit the popn. (Dixon et al, 2006) as in P. monodon From (Jackson and Wang 1998) model, at 20C the final weight is ~15g. If temp. increase by 1.5C, growth could be 7.5% higher.		Lower impacts in crustaceans than molluscs (Cooley and Doney 2009). Assume this spp. has the same calcification rate as oyster (Crassostreas gigas) (Gazeau *et al.* 2007). Calcification in oysters at pCO2 level= 450ppm is 3% lower							
Tropical prawns	11%	±2.75 %	*P. merguiensis*	8%	±3%	0%	-3%, 0%	6%	±4%	No estimates identified		4%	±12%
				Same explanation as above		Same explanation as above		Expected sea level rise by 17cm (Henessy *et al.* 2006) from this assumed 1to5% increase in mangrove area (400- 2000 ha) (Dowling and MacDonald 1982). Higher catches due to inundation of mangrove swamps (Y=13.79+ 0.129mangrove area) (Loneragan *et al.* 2005)				A 40% increase in rainfall will increase catch by 45% (Rothlisberg *et al.* 1988). Asumed linear relationship between rainfall & catch	
			P. semisulcatus P.esculentus	8%	±3%	0%	(-3% ,0%)	No estimates identified		-1%	±0.03%	No estimates identified	
	Same explanation as above			Same explanation as above		Same explanation as above				Cyclone wind speeds could increase 10% by 2030 (Henessy *et al.* 2006). Preliminary estimates from unpublished model (Sean Pascoe CSIRO pers. comm. July 2009)			

Economic effects of changes in fisheries productivity

- Changes to fisheries productivity with climate change will affect
  - Directly, fishing sector
  - Indirectly, other sectors supplying and demanding inputs/outputs from fisheries sectors
  - Indirectly, flow on effect to other sectors in the economy
  - Indirectly, consumers

- Wider economic implications of climate change to fisheries and other sectors
  - Employment
  - Profitability
  - Household income, changes in income affect expenditure on other goods and services

Input-Output analysis

- Main aim of I-O analysis is to produce multipliers
  - Degree to which a change in one sector will flow on to other sectors, and the cumulative impact in the whole economy
- Step 1: Determine how climate change is likely to impact fishers (direct effect)
- Step 2: Incorporate likely climate change effects into an input-output model of the Australian economy (2004-05)
  - Re-estimate cost-structures of the industries given assumptions about changes in landings
  - Assumes that current management arrangements continue (and current fleet sizes)
  - Estimate impacts on other sectors (indirect effect) and consumers (induced effect)
- Step 3: Undertake Monte Carlo simulations on the basis of the associated uncertainties to climate change projections

Income multipliers

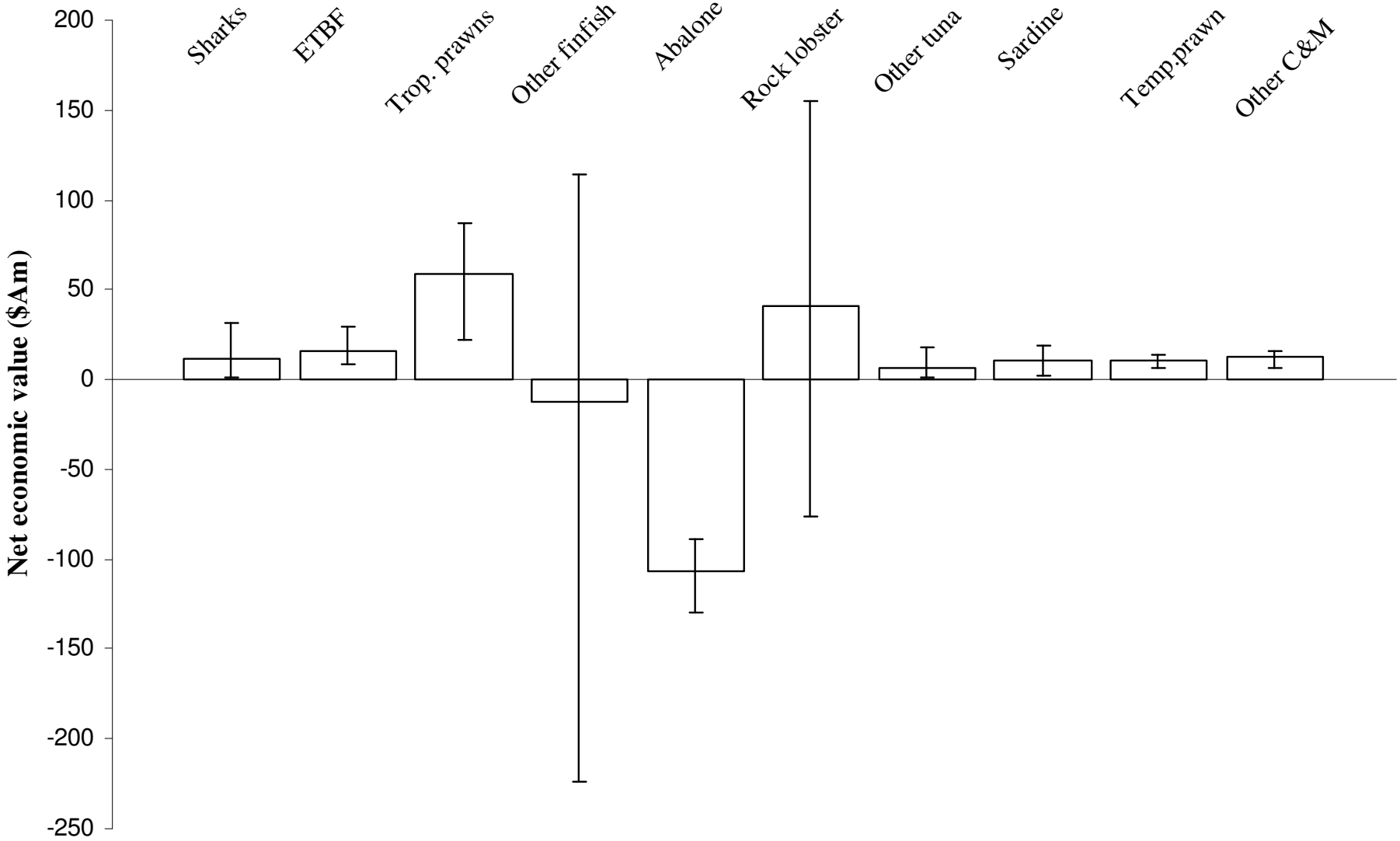
- Total (includes direct, indirect and induced) income multipliers
  - e.g. $1 increased income in the shark fisheries results in $2.12 income in the broader economy (which includes the initial $1 direct impact)

Fishery	Base year (2004-05)	Average CC effects
Sharks	2.12	2.04
ETBF	3.23	2.81
Tropical prawns	3.24	2.94
Other finfish	3.34	3.39
Abalone	2.31	2.70
Rock lobster	2.61	2.54
Other Tuna	2.76	2.61
Sardine	2.09	1.97
Temperate prawns	2.45	2.30
Other C & M	2.98	2.89

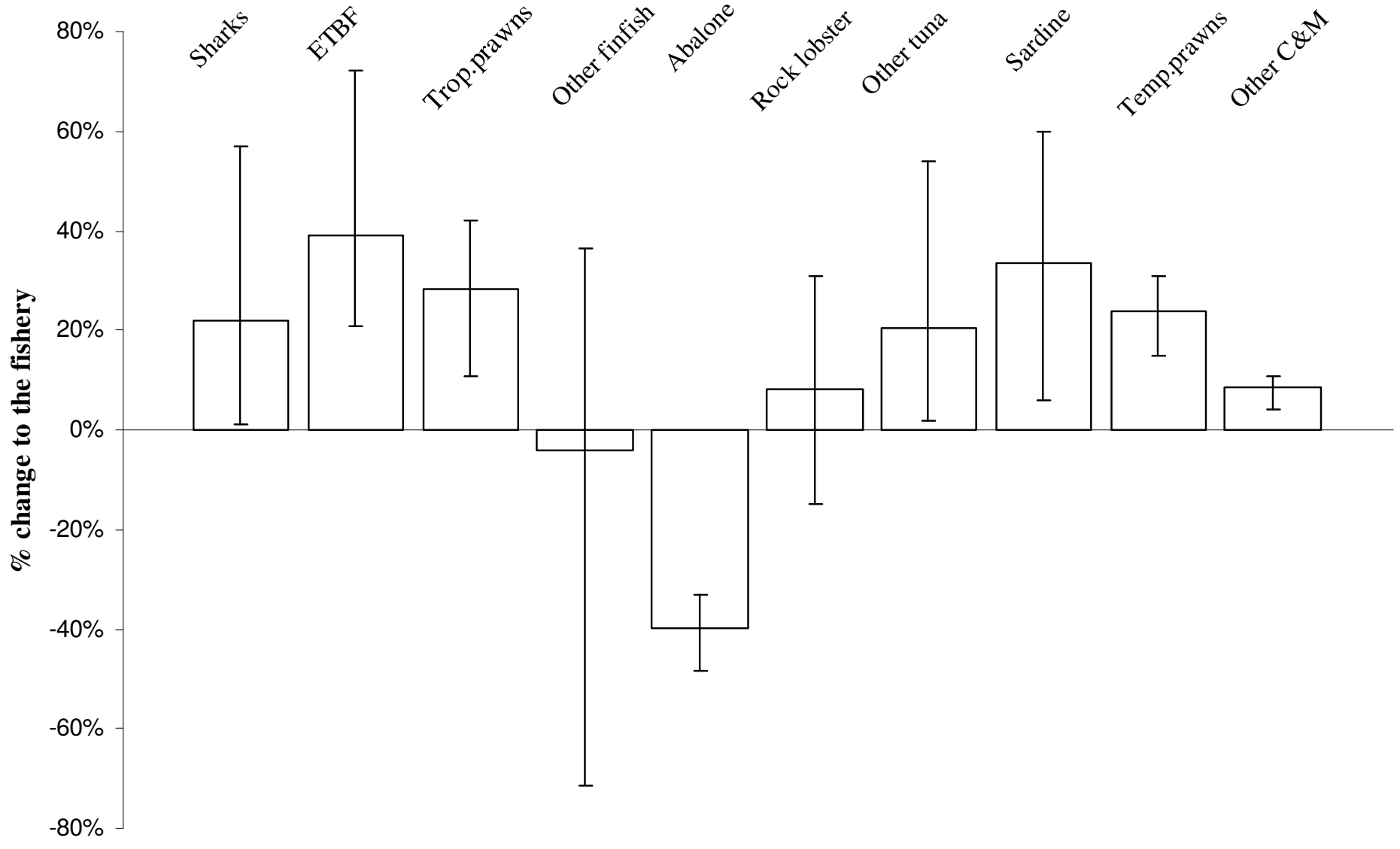
Example - Change in income in the rock lobster fishery, intermediate and final demand sectors

Wild Fisheries	Income effects	Base year (2004-05)	Average CC effects (Monte Carlo simulations)	Coefficient of variation (CV)
Rock lobster	Fisheries Wages	143.4	154.8	10%
	Fisheries Profits	124.5	144.1	19%
	Induced Income	230.9	238.3	4%
	Total	498.8	537.1	9%
	Net Income		**38.3**	

Net economic effect to fisheries from climate change



Percentage change in income from climate change



Summary and caveats

- Results indicate most Australian wild fisheries could see economic benefits as a result of climate change by 2030 although there are large uncertainties surrounding these results
  - Longer term impacts may differ
    - For example, there are expectations that southern rock lobster will initially improve but decline in the longer term
  - Estimates of CC impacts in Australian fisheries & associated probability distributions were derived from the literature & expert consultations
    - Assume additive relationship between different physical effects
- The analysis provides a reference point for future studies assessing economic benefits and costs of adaptations to climate change and an indicator to key areas where adaptation strategies may be beneficial or essential

What are the implications for fisheries management?

- Fishing is still the main factor affecting the health of Australia's commercial fisheries and the economic benefits it generates for the broader community
  - Management that focuses on ensuring appropriate effort and/or catch controls is essential irrespective of climate change
- In the medium term, many fisheries could benefit from climate change and management strategies need to be developed with flexibility to capture some of these benefits
  - Adaptation strategies should consider minimising losses and maximising the benefits that could be brought by climate change
- Output controls may be more flexible in this regard
  - It is easier to increase a TAC than allow more effort back into a fishery once it has been removed

What are the key messages for industry?

- The future is still highly uncertain in regard to the effects of climate change on fishers' incomes but in most cases is not a "bad-news" story on average
  - at least in the medium term
- Fishers can not rely on any benefits from climate change in the future to solve current problems
  - Any benefits will be at least 10-20 years away while current problems need to be addressed now
- Fishers need to work with managers to help develop flexible management strategies that can capture the benefits when they do emerge and limit costs if they occur
  - While average impacts may be positive, substantial negative impacts may appear in any given year
    - e.g. cyclones, floods
    - e.g. WA Rocklobster

CMAR (Center of Marine and Atmospheric Research)
Sean Pascoe

Email: sean.pascoe@csiro.au
Web: www.csiro.au/

www.csiro.au

Thank you

Contact Us
Phone: 1300 363 400 **or** +61 3 9545 2176
Email: Enquiries@csiro.au **Web:** www.csiro.au

National Research FLAGSHIPS
Climate Adaptation

CSIRO