Climate change implications for Torres Strait island fisheries:

assessing vulnerability to inform adaptation

David J. Welch
Johanna Johnson

C_2O Fisheries
Coasts | Climate | Oceans

About us

C_2O Fisheries
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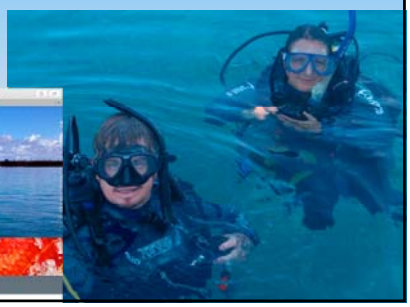
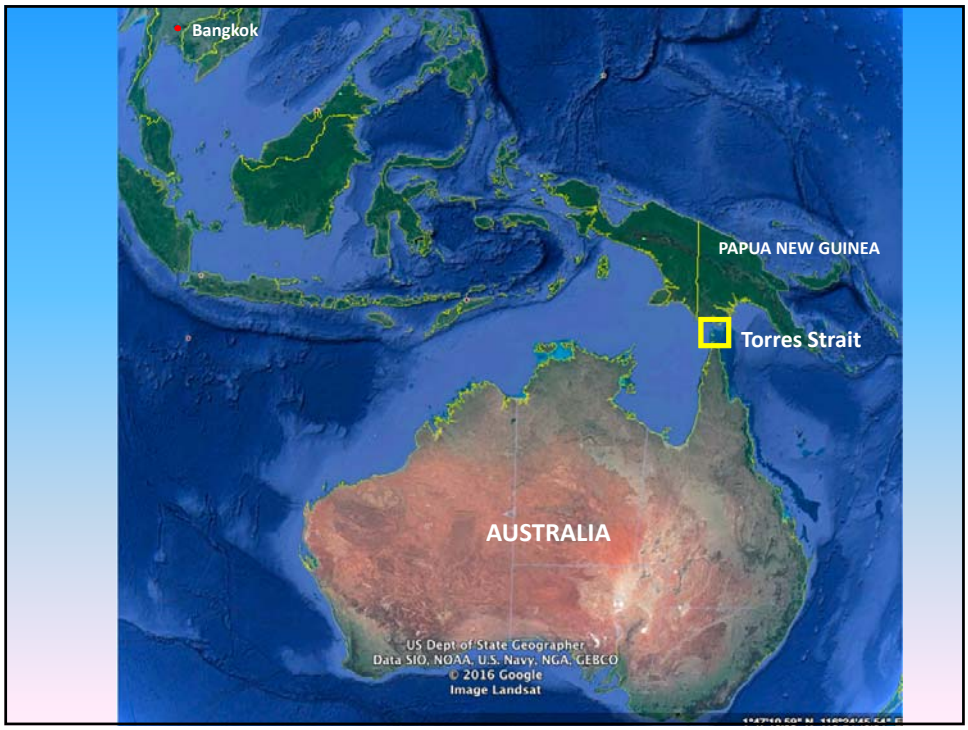
C_2O (Coasts, Climate, Oceans) Fisheries

- Based in Cairns, Australia
- Partner organisation with C_2O Consulting
- Specialise in marine fisheries research and management
- Work throughout Australia, Asia-Pacific, Indian Ocean
- Multiple international and national agencies (government, NGO, industry, stakeholders)
- www.c2ofisheries.net.au





Torres Strait

- Area of 48,000km^2 between tip of Cape York & PNG
- Shallow tropical waters with significant seagrass, coral reef and mangrove habitats
- Shared governance under the Torres Strait Treaty
- Melanesian islander background
- Significant cultural, social and economical dependence on fisheries resources

Major project objective

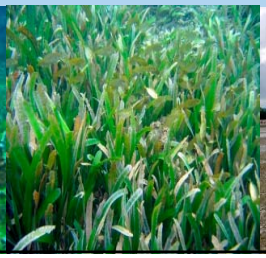
1. Determine the Torres Strait fisheries likely to be vulnerable (at highest risk) to climate change, and the influencing climate factors to inform adaptation





METHODS: General approach

1. Identify key local fishery species for assessment
2. Review & collate relevant information to inform the assessment
3. Determine relative vulnerability using the IPCC vulnerability assessment framework
4. Identify high priority species to focus adaptation efforts
5. Identify key drivers of vulnerability to further inform adaptation

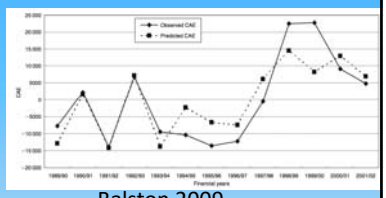



Fishery species

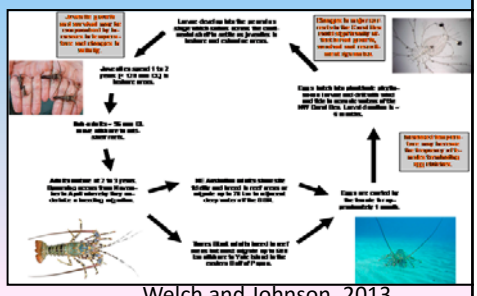
Common name	Scientific name	Fishery type
Brown tiger prawn	*Penaeus esculentus*	Commercial
Blue endeavour prawn	*Metapenaeus endeavouri*	Commercial
Tropical rock lobster	*Panulirus ornatus*	Commercial, subsistence
Mud crab	*Scylla serrata*	Commercial, subsistence
Gold-lipped pearl oyster	*Pinctada maxima*	Commercial
Black-lipped pearl oyster	*Pinctada margaritifera*	Commercial
Trochus (topshell)	*Trochus niloticus*	Commercial, subsistence
Spanish mackerel	*Scomberomorus commerson*	Commercial, subsistence, recreational
Common coral trout	*Plectropomus leopardus*	Commercial, subsistence, recreational
Bar-cheek coral trout	*Plectropomus maculatus*	Commercial, subsistence, recreational
Passionfruit coral trout	*Plectropomus areolatus*	Commercial, subsistence, recreational
Sandfish	*Holothuria scabra*	Commercial
Black teatfish	*Holothuria whitmaei*	Commercial
Dugong	*Dugong dugon*	Subsistence/traditional
Turtle	Principally *Chelonia mydas*	Subsistence/traditional

Relevant information

- Species life history
- Fisheries characteristics
- Species environmental sensitivity
- Down-scaled climate projections
- Predicted habitat impacts
- Islander interviews



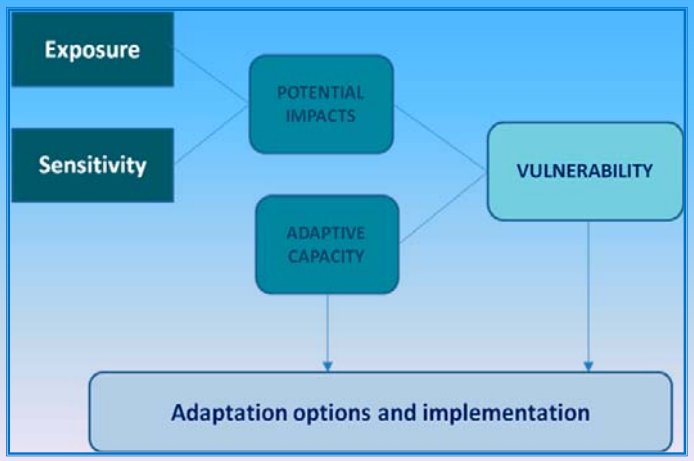
Balston 2009



Welch and Johnson, 2013

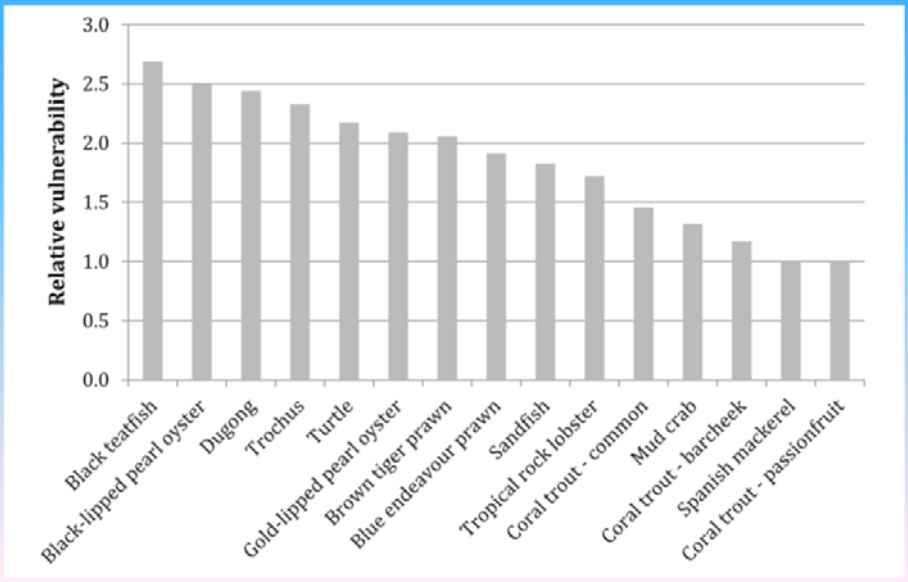
Vulnerability assessment

- IPCC framework
  - Semi-quantitative approach



Johnson, J. and Welch, D.J. (2016) Climate change implications for Torres Strait fisheries: assessing vulnerability to inform adaptation. Climatic Change, 135: 611-624. DOI 10.1007/s10584-015-1583-z.

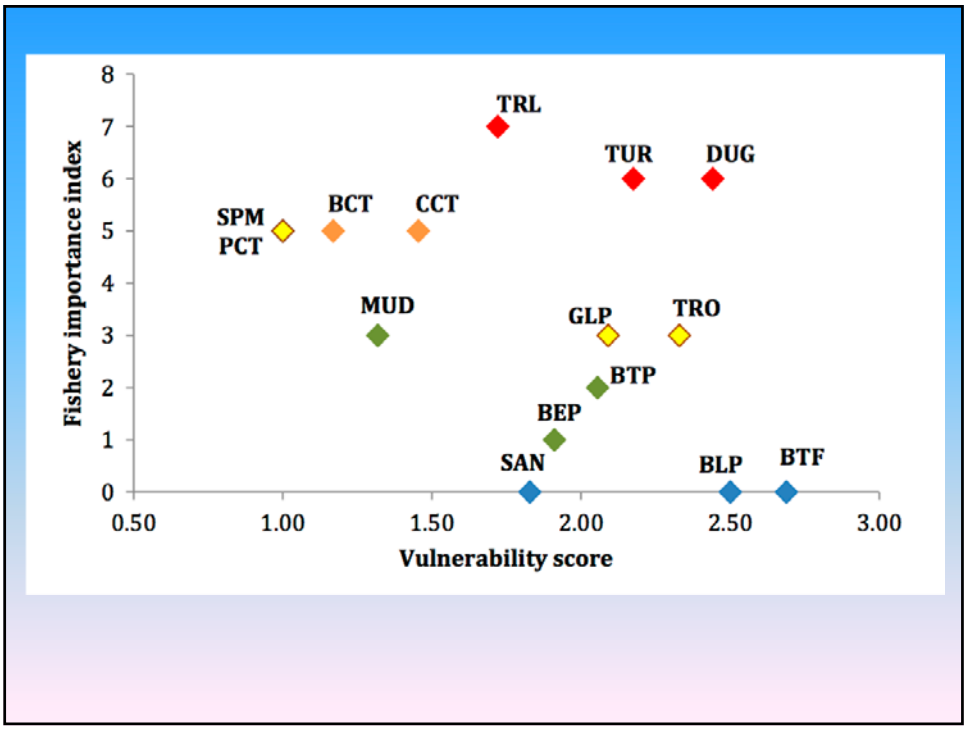
RESULTS: overall relative vulnerability



Prioritising species further…

• Need to consider vulnerability AND the relative 'importance' of the fishery

Species	Economic value	Cultural value	FI Index	Value $M (based on last 2 yrs)
Tropical rock lobster	3	2	7	19.1
Dugong	0	3	6	0
Turtle	0	3	6	0
Coral trout - common	1	2	5	0.45
Coral trout - barcheek	1	2	5	0.45
Spanish mackerel	1	2	5	0.76
Coral trout - passionfruit	1	2	5	0.45
Trochus	1	1	3	~0
Gold-lipped pearl oyster	1	1	3	~0
Mud crab	1	1	3	~0
Brown tiger prawn	2	0	2	2.93
Blue endeavour prawn	1	0	1	0.58
Black teatfish	0	0	0	0
Black-lipped pearl oyster	0	0	0	0
Sandfish	0	0	0	0



Key drivers & adaptations

- **Tropical rock lobster**

Increased SST

- Reduced spawning biomass (modeling)
- Reduced catchability (movement to deeper water)

Altered ocean currents

- Changes in settlement areas
- Changes in recruitment rates

ADAPTATION OPTIONS

- Reduce TAC
- Reduce recreational harvest
- New fishery areas (south of Torres Strait)
- Change fishing practices (dive deeper)

Key drivers & adaptations

- **Turtles**

Habitat (seagrass) impacts

- Increased mortality – less food
- Reduced catchability – lower population sizes & movement other areas

Increase in intense storms

- Increased stranding mortality

Sea level rise (also more intense storms and rainfall extremes)

- Decrease in available nesting sites/disrupt successful nesting

Increased air temperature

- Female biased populations

ADAPTATION OPTIONS

- Key habitat protection
- Reduce take
- Nesting beach rehabilitation

Key drivers & adaptations

- **Dugong**

Habitat (seagrass) impacts

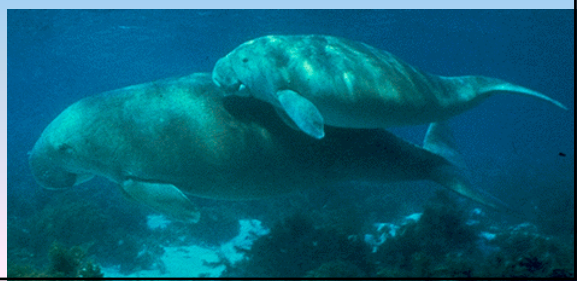
- Increased mortality – less food
- Reduced catchability – lower population sizes & movement to alternate areas

Increase in intense storms

- Increased stranding mortality

ADAPTATION OPTIONS

- Reduce take
- Seagrass protection



Many outcomes

- Improved understanding of what climate changes means for the Torres Strait region
- Documented the potential impacts of climate change on Torres Strait fishery species and supporting habitats
- Identified which fisheries and species are most vulnerable to climate change and the source of vulnerability
- Identified important information gaps
- Information for TS communities and management to prepare for the potential impacts (positive and negative) of climate change

Key Outcomes

Better preparedness for climate-induced fishery changes:

- Key species/fisheries for priority action identified
- Information to inform appropriate actions (adaptation)

Next steps required:

- Community engagement
- Agree on appropriate adaptation actions
- Government commitment

Acknowledgements

- Australian Fisheries Management Authority
- Torres Strait Regional Authority
- Torres Strait fishers
- Expert scientists & reviewers

Semi-quantitative approach

- Vulnerability assessment (based on 2030)
  - Used a range of 'Indicators' for each of:
    - EXPOSURE
    - SENSITIVITY
    - ADAPTIVE CAPACITY

	Indicator	Rationale
Exposure	Surface temperature increase +0.62 to +1.27 °C	Based on climate projections for Torres Strait (Suppiah et al. 2010)
Sensitivity	Reliance on environmental cues (for spawning, breeding or settlement)	Phenology indicator assessing the interaction between climate variables and biological processes that influence the timing of species life-cycle events (Pecl et al. 2011a)
Adaptive Capacity	Species mobility	Ability to avoid short-term disturbances, such as periods of high SST, by temporarily moving to alternative locations with more favourable conditions (e.g. cooler deeper waters)

Semi-quantitative approach

- Each indicator was scored (high, medium, low) based on different criteria
- Gave an overall ranking of the relative vulnerability of each species

	Indicator	Low=1	Medium=2	High=3
Exposure	Surface temperature increase +0.62 to +1.27 °C	spends <50% of time in surface (<25 m) waters	spends 50-80% of time in surface (<25 m) waters	spends 80-100% of time in surface (<25 m) waters
Sensitivity	Reliance on environmental cues (for spawning, breeding or settlement)	No apparent correlation to environmental variable	Weak correlation to environmental variable	Strong correlation to environmental variable
Adaptive Capacity	Species mobility	low mobility; can travel <2 km/day	moderately mobile; can travel 2-10 km/day	highly mobile; can travel >10 km/day

Results: climate projections

	2030 (A2 & A1FI)	2070 (A2)	2070 (A1FI)
Mean SST (°C)	+0.62 to +1.27	+1.65 to +2.56	+1.94 to +3.01
Rainfall change (%)	-2.97 to +5.33	-3.49 to +6.27	-7.57 to +14.09
Sea level rise (cm)	+5 to +15	+20 to +60 by 2090	
Tropical cyclones (wind speed intensity)	+3 to +11% by 2100		
Ocean chemistry (pH units)	-0.1	-0.2 to -0.3 by 2100	
Solar radiation (%)	-0.31 to -0.43	-0.79	-1.1

Results: habitats in TS

Coral reefs: 1,200
Mangroves: 31,390 ha

Seagrass meadows: 17,206 km^2

Results: habitat projections

	SST	Rainfall/ riverflow	Sea level*	Cyclones and storms	Ocean pH	Solar radiation	Productivity & circulation
Coastal wetlands	very low	moderate	very high	moderate	very low	low	moderate
Seagrass	high	moderate	moderate	high	very low	high	moderate
Coral reefs	very high	high	low	high	very high	low	moderate

Results: interviews

Higher tides with sand covering reefs and more coastal erosion

Willingness to target other species but viable alternatives and fuel costs are limiting factors

Recommendations

- Improving assessment accuracy:
  - Review assessment through local workshops
  - Further Islander input
  - Governance benchmarking
- Extension of results:
  - Use local workshops to ground-truth, educate and raise awareness
  - Identify appropriate adaption strategies

Recommendations

- Research to address knowledge gaps:
  - Long-term habitat monitoring
  - Impacts of habitat loss on fishery species and catch rates (esp. seagrass and coral reefs)
  - Determine temperature cues for key species (e.g. spawning) and thermal tolerance limits (e.g. rock lobster)
  - Critical pH thresholds for key species
  - Inter-generational adaptive capacity of key fishery species
  - Thermal thresholds of rock lobster as well as fishery characteristics to inform future adaptation options

Types of fishery impacts

Species	Key potential impacts of climate change (based on 2030 projections)
Coral trout – common/barcheek/ passionfruit	• Reduced catchability due to storms • Reduced survival/development of early life stages due to higher SST • Adult movements due to higher SST • Impacts on coral reef habitat may affect juvenile survival
Blue endeavour prawn & Brown tiger prawn	• Impacts on seagrass may decrease juvenile growth and survival • Compromised growth and survival due to higher SST (near northern limit)
Spanish mackerel	• Possible links between SST and larval survival but generally unknown

Types of fishery impacts

Species	Key potential impacts of climate change (based on 2030 projections)
Trochus	• Unknown and previously assessed as minor
Sandfish	• Generally unknown
Black teatfish	• Reproductive success may be compromised (winter spawner) with higher SST
Mud crab	• Higher catch rates due to higher SST • Possible population increases due to increases in rainfall
Gold-lipped pearl oyster	• Reduced larval growth due to increased rainfall/lower salinity
Black-lipped pearl oyster	• Lower abundance due to upper thermal limits of ~32° C for adults and reduced larval growth > 29° C