The Long Hot Summer: Getting Ahead of the Heatwave

IMAS & CMS special online webinar series

9:10am -10am every morning Mon 11th – Fri 15th December 2023

Fisheries research to support preparedness for climate change

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Dr Alyssa Marshell
Research Fellow – Fisheries Scientist
Wild Fisheries
Scalefish & Cephalopod Team - IMAS

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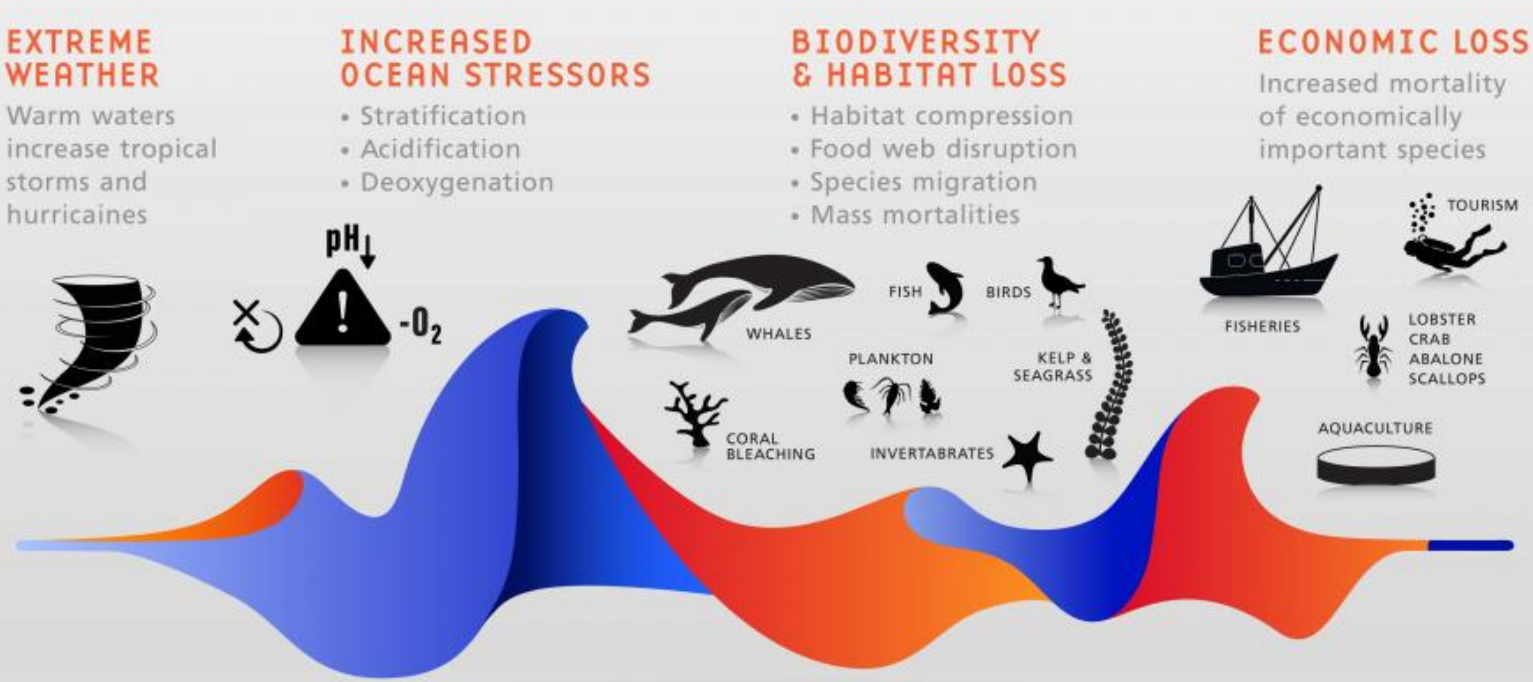
MARINE HEATWAVES

MHW are extended periods of regional ocean warming. They have major impacts on marine life and human society.



10x intensity compared to pre-industrial times

50% increase in MHWs in the past 10 years

20-50 more MHWs by 2100

IUCN

https://www.iucn.org/resources/issues-brief/marine-heatwaves

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MARINE HEATWAVES

+ climate change can have significant impacts on fisheries

Possible changes in: recruitment, catchability, species composition, natural mortality, onset of maturity, growth, post-harvest survival, ecosystem changes, HABs & seafood safety

Fish Distribution & Behaviour

- migrate to cooler waters or change their behaviour
- can affect fishing patterns = challenging to locate/catch certain species.

Impacts on Fish Reproduction & Growth

- affect reproductive cycles -> potential decline in spawning success
- might accelerate metabolic rates - affecting growth rates/size

Shifts in Marine Ecosystems

- disrupt marine ecosystems balance - favour growth of certain species - while impacting others negatively
- can have cascading effects - food web - influencing prey availability for commercially valuable fish species

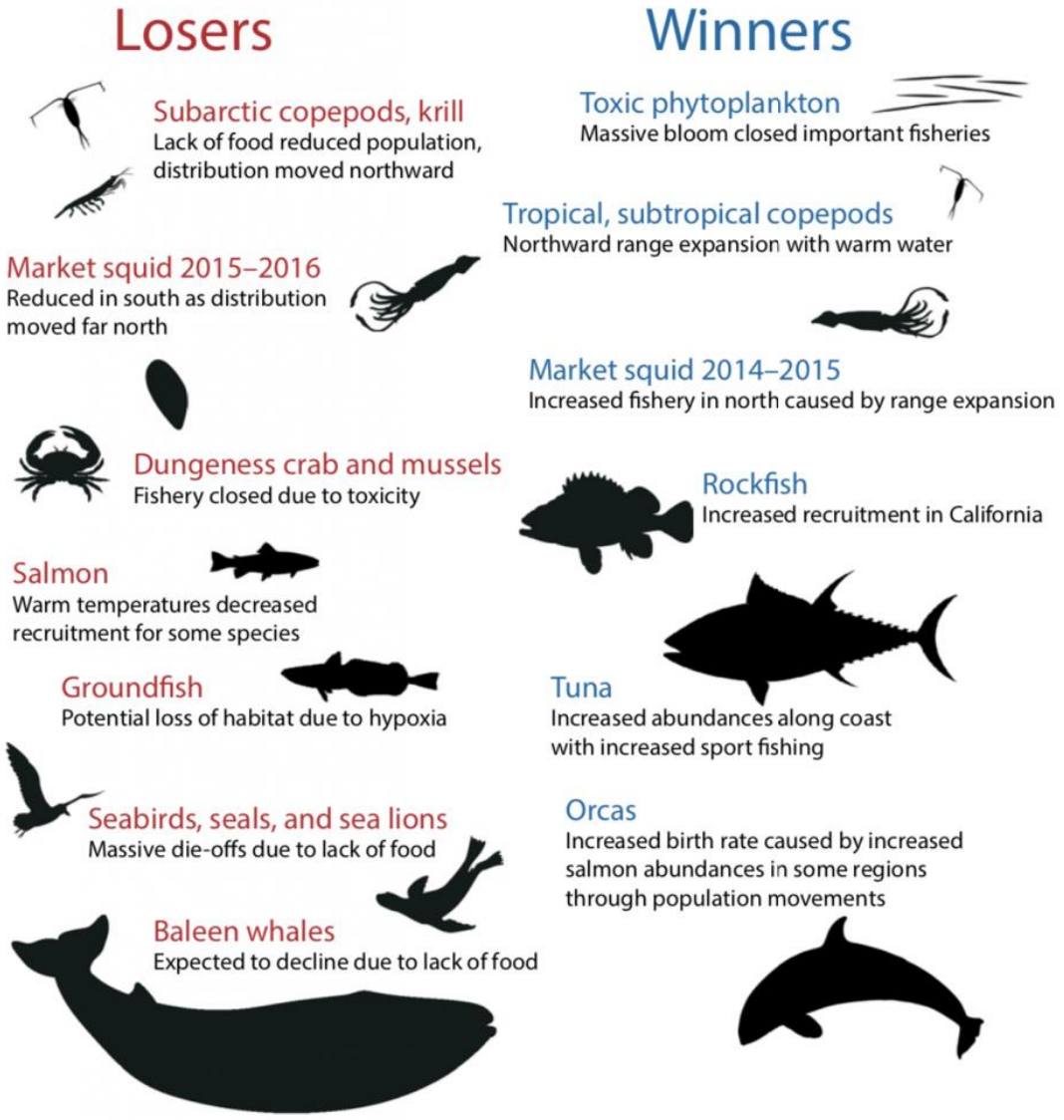
Habitat stress - e.g., reefs, seagrass beds

- nurseries & feeding grounds for many species
- degradation can significantly impact fisheries

Economic Impact - reduced fish stocks & changes in availability of commercially important species = economic consequences for fishing industries and communities that rely on seafood for livelihoods & sustenance

MARINE HEATWAVE

2014-2016 - California



center for Climate Change Impacts and Adaptation

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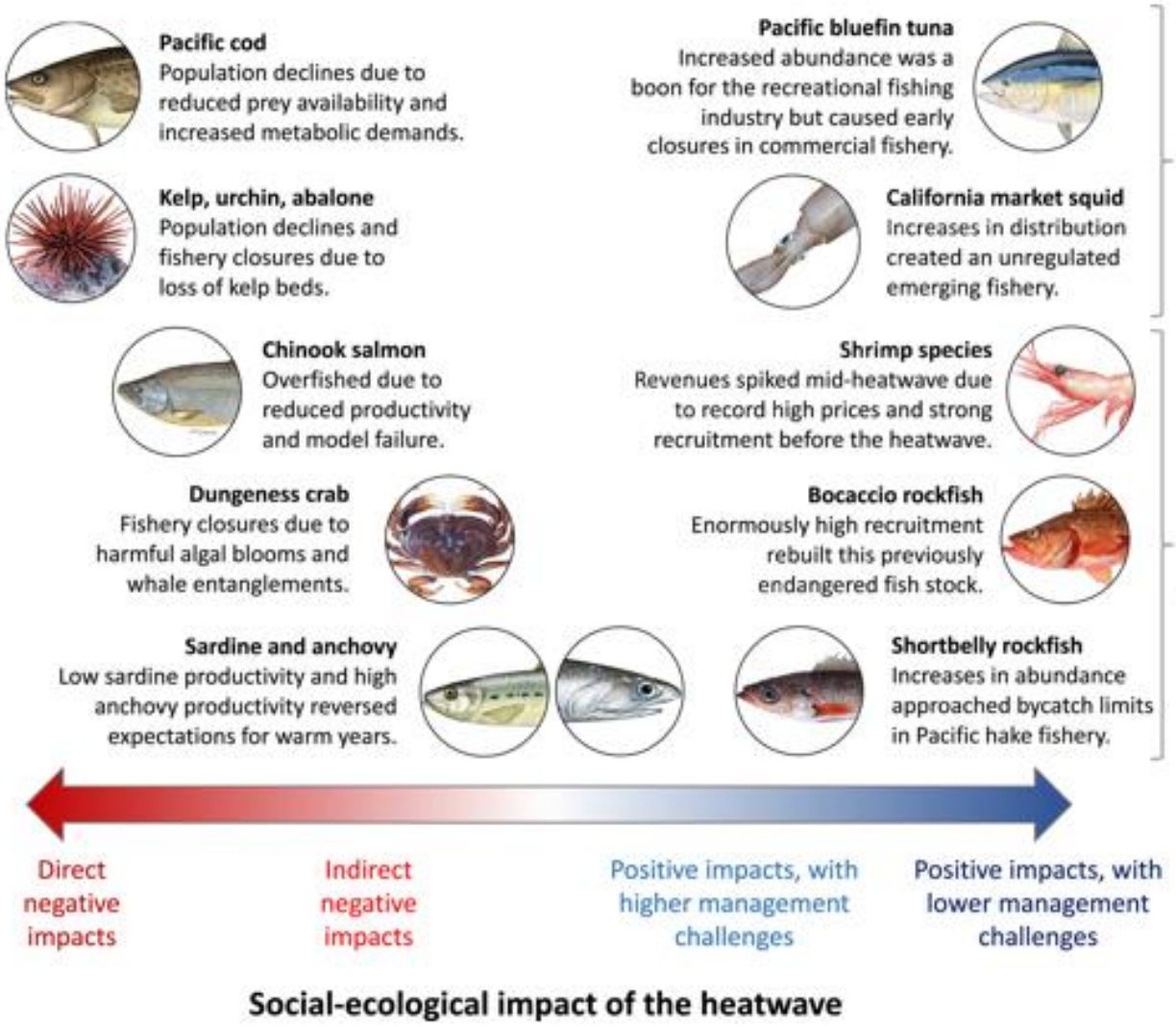
https://climateadapt.ucsd.edu/faq-californias-marine-heatwaves/

MARINE HEATWAVE 2014-2016 – US & Canada West Coast fisheries

Surprises & lessons – key case studies



Social-ecological impact of the heatwave

Range shifts

Recruitment

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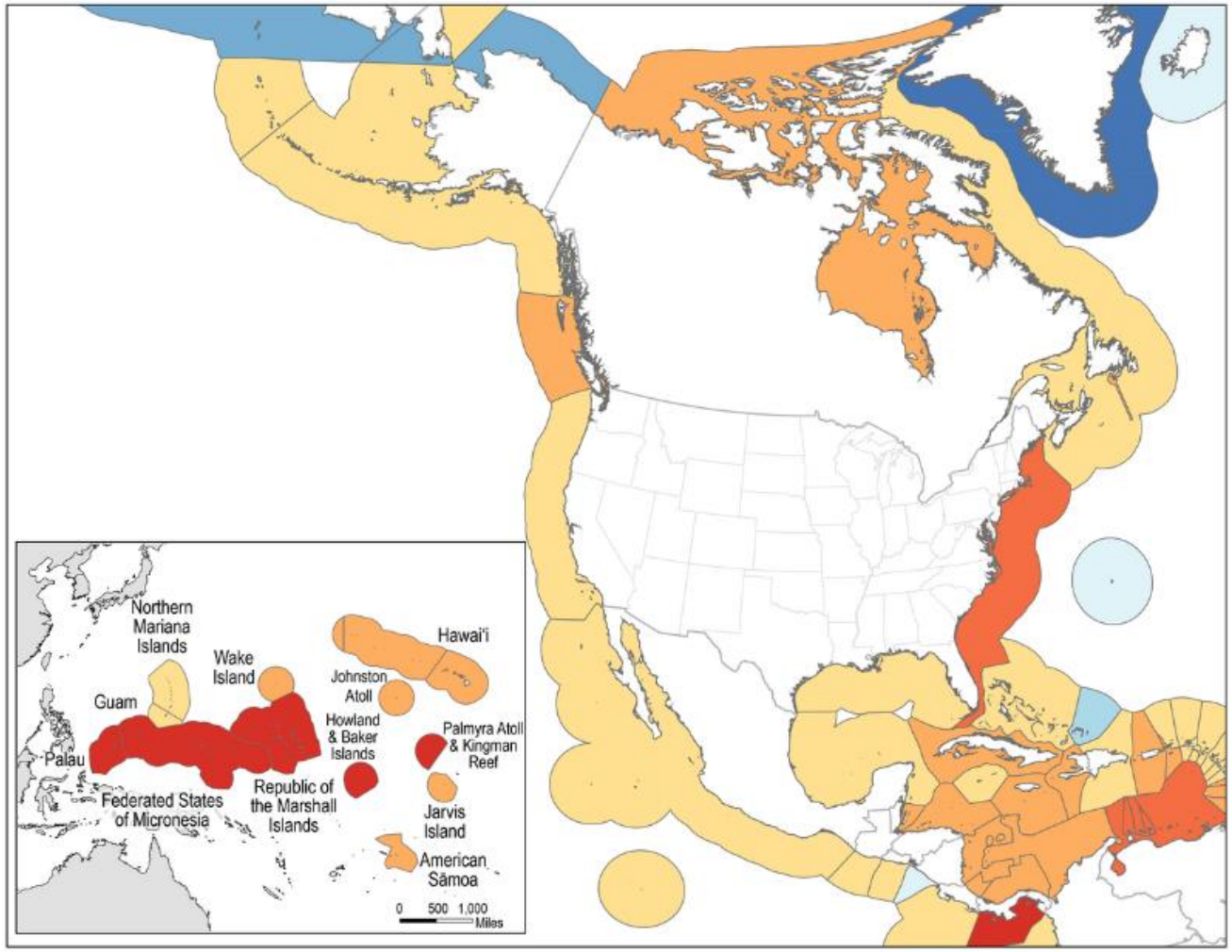
Fish and Fisheries, Volume: 24, Issue: 4, Pages: 652-674, First published: 20 April 2023, DOI: (10.1111/faf.12753)

https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12753

Projected changes in Max. Fish Catch Potential (U.S.A.)

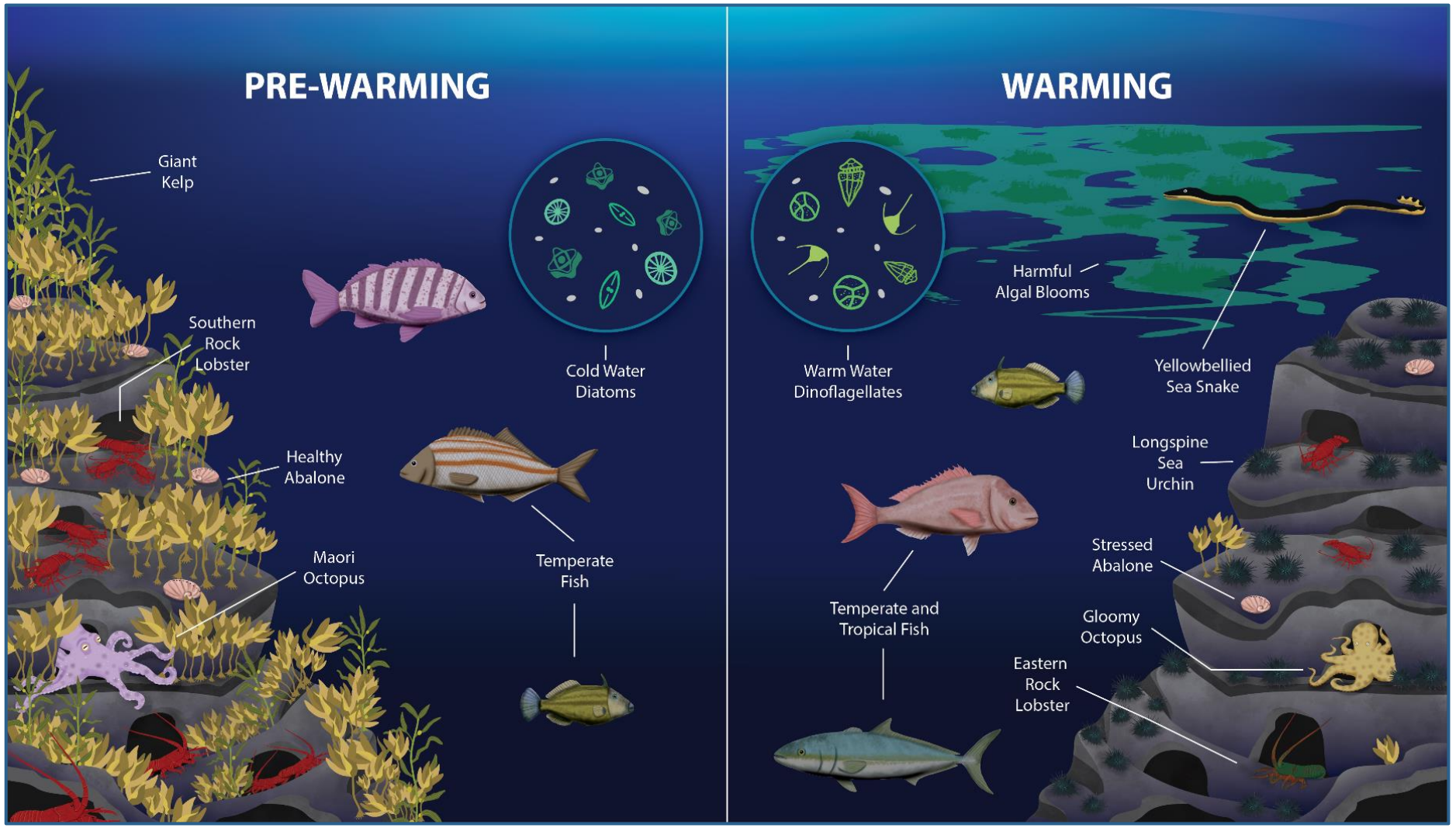


Projected changes: 2041 – 2060 relative to 1991 – 2010

All large U.S.A. marine ecosystems (except Alaska Arctic) are expected to see declining fishery catches

https://nca2018.globalchange.gov/chapter/9/

Significant changes linked to warming on the east coast of Tasmania



- shifts to temperate + tropical fish

- stressed abalone

- harmful algal blooms

- more long-spine sea urchin, gloomy octopus, & eastern rock lobster

- giant kelp loss

Pecl *et al.*, 2019

Fisheries research - supporting preparedness for climate change + MHWs

Understanding Climate Change Impacts: specific impacts of climate change
- including rising sea temperatures, ocean acidification, altered currents, & changing weather patterns
- impacts on fish populations, habitats, & ecosystems
- involves long-term monitoring, data collection & modelling to assess how these changes affect fisheries.

Species Vulnerability Assessment:
- determine which species most at risk due to temp. changes, habitat loss, or shifts in prey availability
- guides management efforts to prioritize species for conservation or management interventions

Ecosystem Modelling & Predictive Tools: essential for forecasting impacts of climate change on fisheries
- simulate potential scenarios under different climate change scenarios
- aids in understanding how fish populations & ecosystems might respond to future conditions.

Adaptive Management Strategies:
- adjusting fishing quotas, altering fishing practices, establishing marine protected areas, & implementing regulations
- account for changing environmental conditions to ensure sustainable exploitation of fish stocks

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Enhancing Resilience & Adaptation: identify strategies to enhance resilience of fisheries and fishing communities
- diversification of fishing practices, promoting ecosystem-based approaches to management, supporting alternative livelihoods, & community engagement in adaptation measures.

International Collaboration & Policy:
- Collaboration among researchers, policymakers, & stakeholders at national/international levels
- Research findings contribute to policy discussions & international agreements aimed at mitigating climate change, reducing carbon emissions, & protecting marine ecosystems

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Dr Camille White & Team

Development of a temperature monitoring framework for Tasmania's seafood industry during marine heatwaves

Summer 2023/24 - Environmental monitoring

Ambient temperature monitoring at industry-relevant locations/depths

= integral part of the MHW response

- Deployment of temp loggers across seafood supply chain
- Octopus, abalone & rock lobster fisheries
- industry-relevant temperature monitoring methods for future MHW events
- data for government/industry - aid in future fisheries management in MHW conditions

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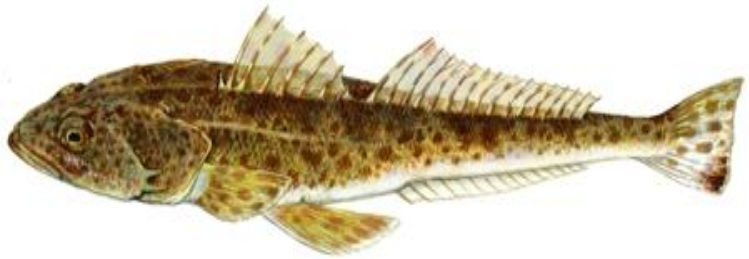
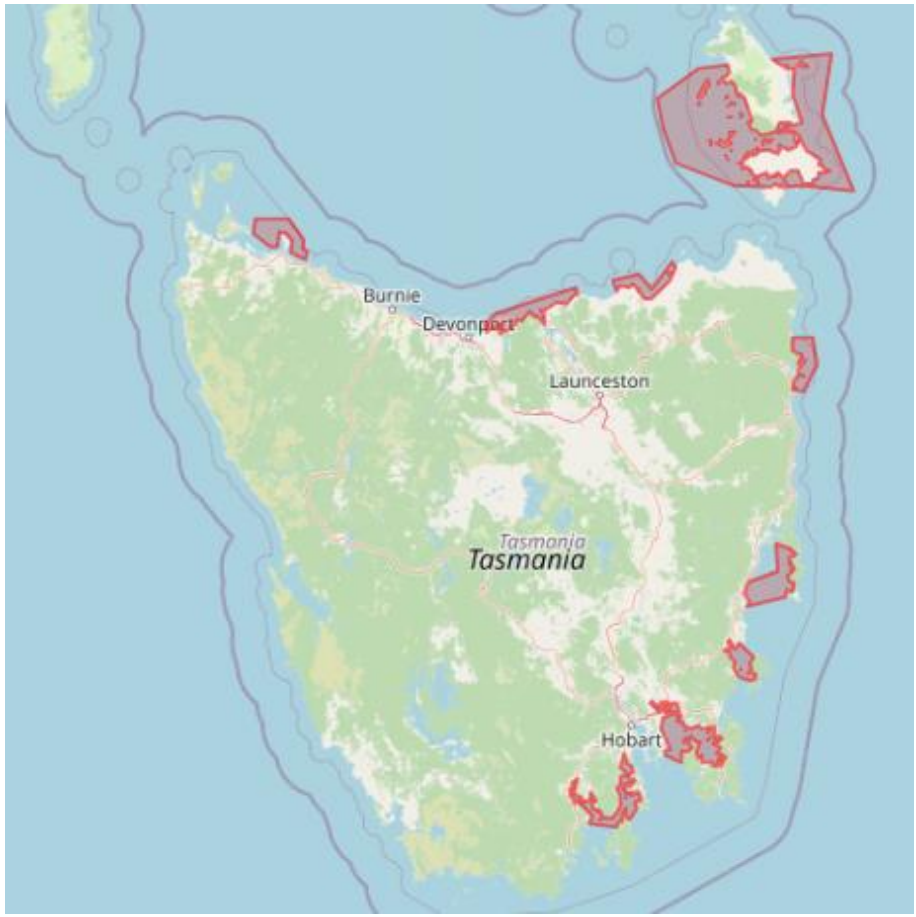
IMAS Fishery Independent Surveys

Annual fish samples from 2012 - 2023

Southern sand flathead –

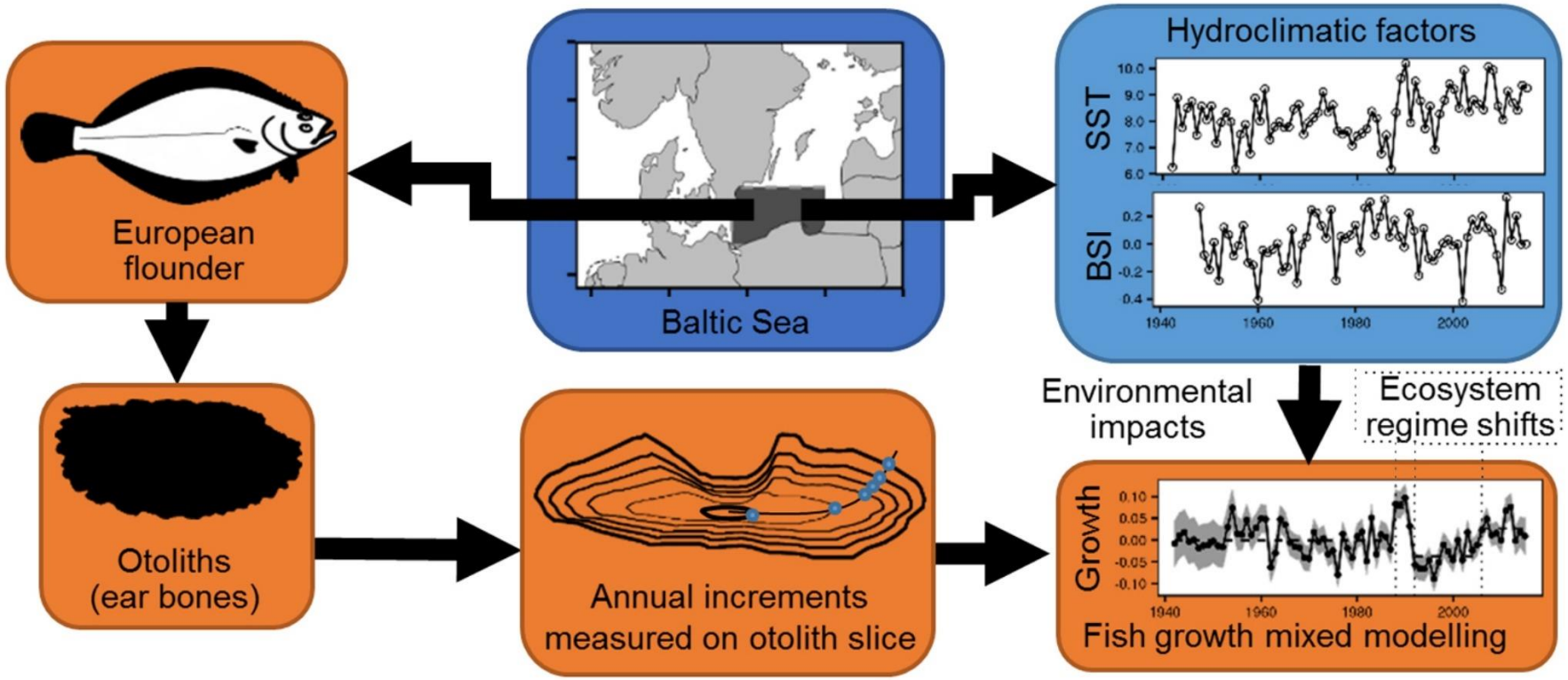
otolith (ear bone) biochronology (time series - biological events)

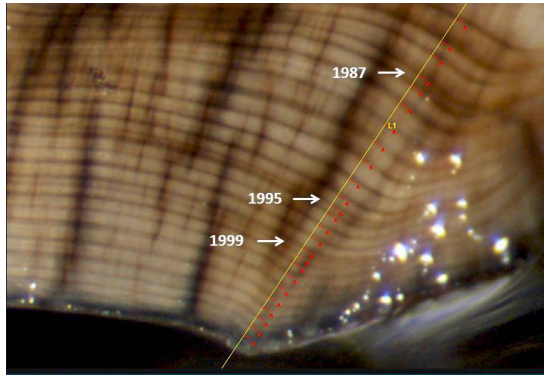




Otolith biochronology

- Indicator of marine fish responses to hydroclimatic conditions & ecosystem regime shifts





https://www.sciencedirect.com/science/article/pii/S1470160X17302042#fig0030

Changes in body size with warming

nature ecology & evolution

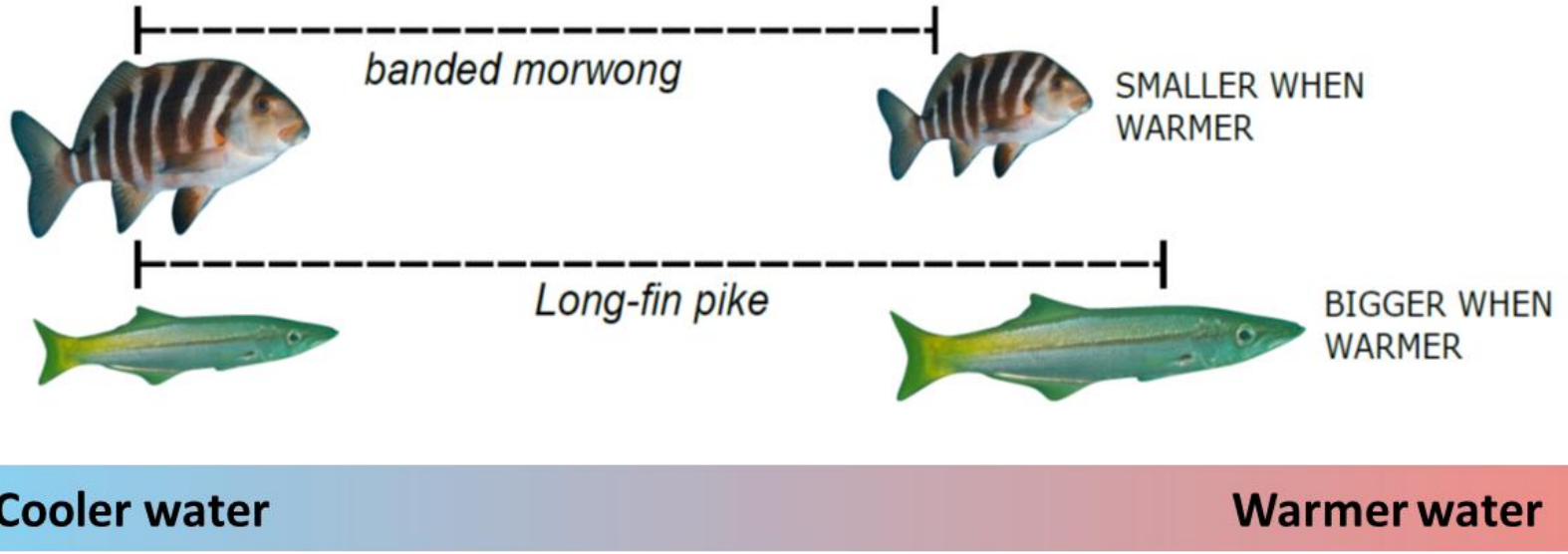
ARTICLES

https://doi.org/10.1038/s41559-020-1171-0

Check for updates

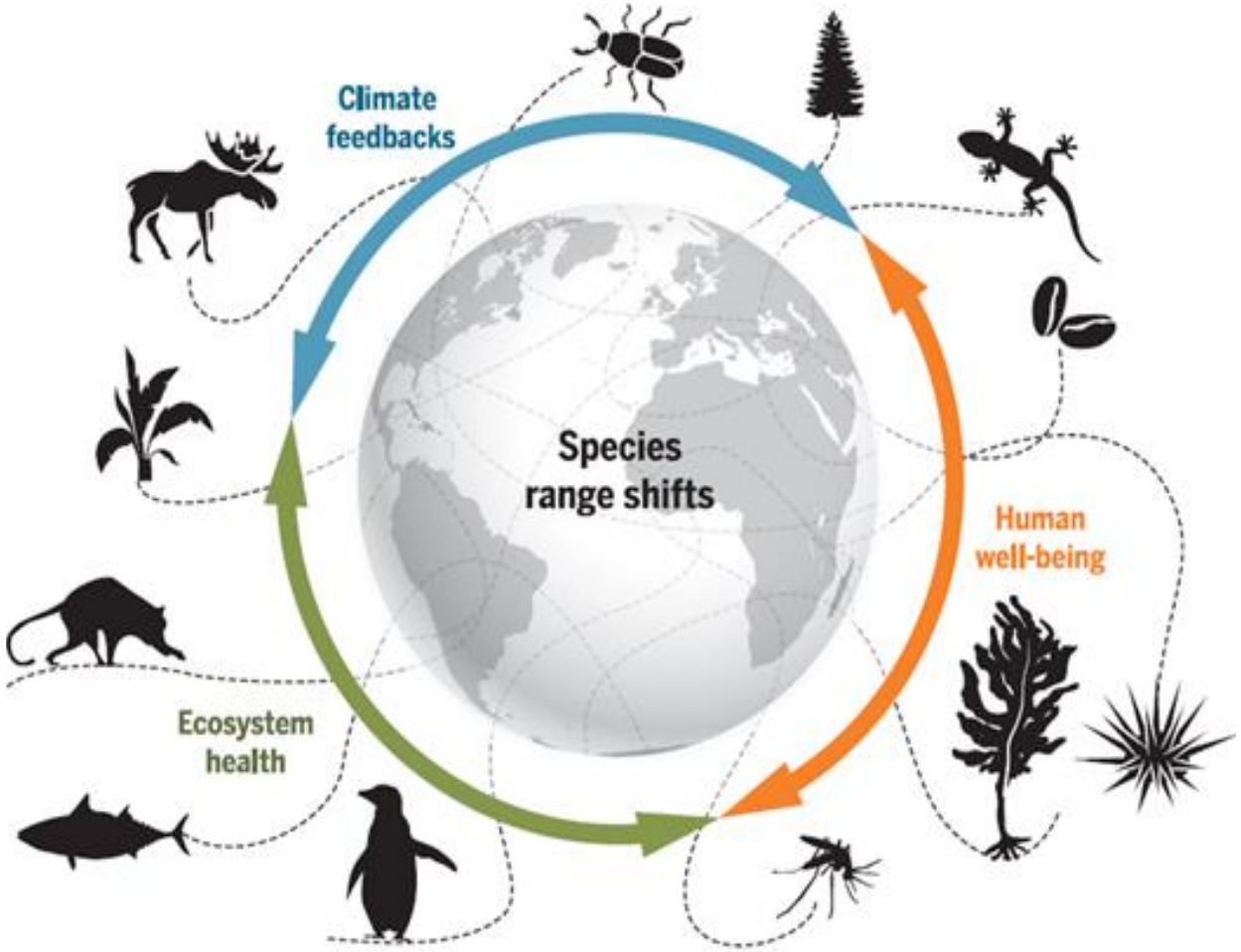
Fish body sizes change with temperature but not all species shrink with warming

Asta Audzijonyte[1,2]✉, Shane A. Richards[3], Rick D. Stuart-Smith[1], Gretta Pecl[1,2], Graham J. Edgar[1], Neville S. Barrett[1], Nicholas Payne[4] and Julia L. Blanchard[1,2]



- 55% of species were smaller in warmer waters (especially among small-bodied species)
- ~40% change in body size per 1 °C change
- Rapid and variable responses of fish size to warming - unexpected impacts on ecosystem restructuring, with potentially greater consequences than if all species were shrinking.

Major effects of climate change = changes in distribution (species range shifts)



Pecl et al 2017, Science

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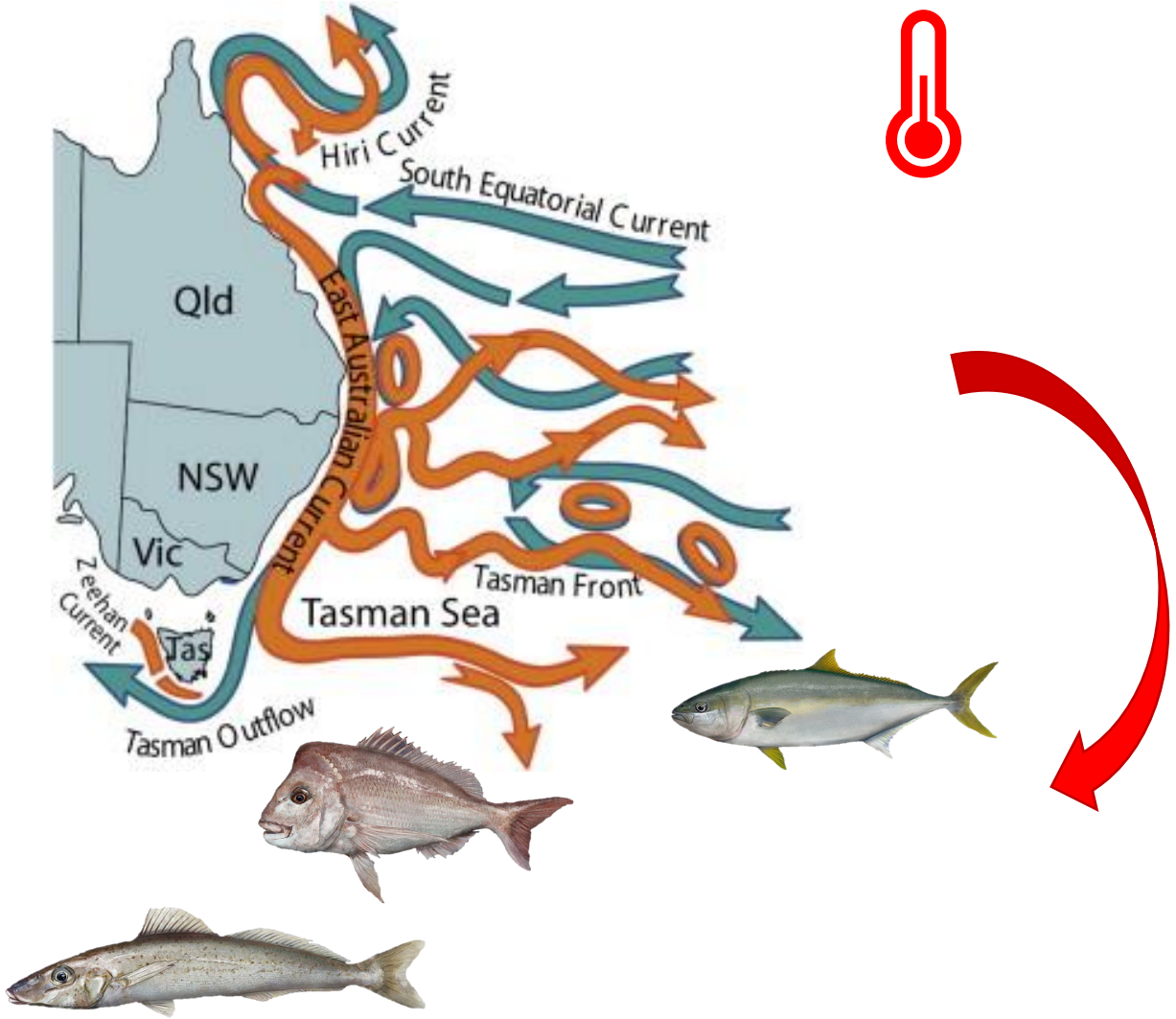

Tasmania = more records of range shifting species than any other region of Australia's surrounding ocean
(Gervais et al. 2021)

Fisheries impacts of ‘Species on the Move’

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- *Centrostephanus* first detected in Tasmania in 1978, by 2017 - 20 million individuals & barrens cover of ~15% of rocky reefs (Ling and Keane 2018)
- Negative impact on abalone and rock lobster
- Catch of urchins almost 600 tonnes (1.8 million urchins) in 2019 alone

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Opportunities and impacts of range extending scalefish species

Understanding population dynamics, ecosystem impacts and management needs

Alexia Graba-Landry, Curtis Champion, James Haddy, Jeremy Lyle, David Mossop, Rod Pearn, Gretta Pecl, Heidi Pethybridge, Barrett Wolfe and Sean Tracey

May 2022

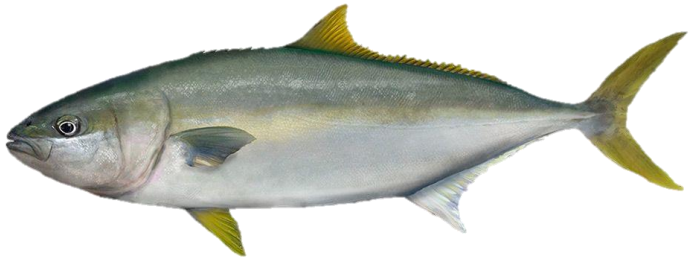
FRDC Project No. 2018/070

AIM

Understand the **life history, biology, distribution and potential shifts** of

Yellowtail Kingfish, Snapper & King George Whiting

& their ecological impacts to inform management of these potential emerging fisheries in Tasmania



Range-Extending Species

ABC RURAL

Fish species opting for a sea change are making Tasmanian fishers happy

ABC Rural / By Fiona Breen

Posted Sat 13 Aug 2022 at 11:38am

Gloomy octopuses 'happy, healthy' in warming Tasmanian waters, marine science study finds

By Emily Bryan

Posted Thu 28 Jun 2018 at 5:29pm, updated Fri 29 Jun 2018 at 10:22am

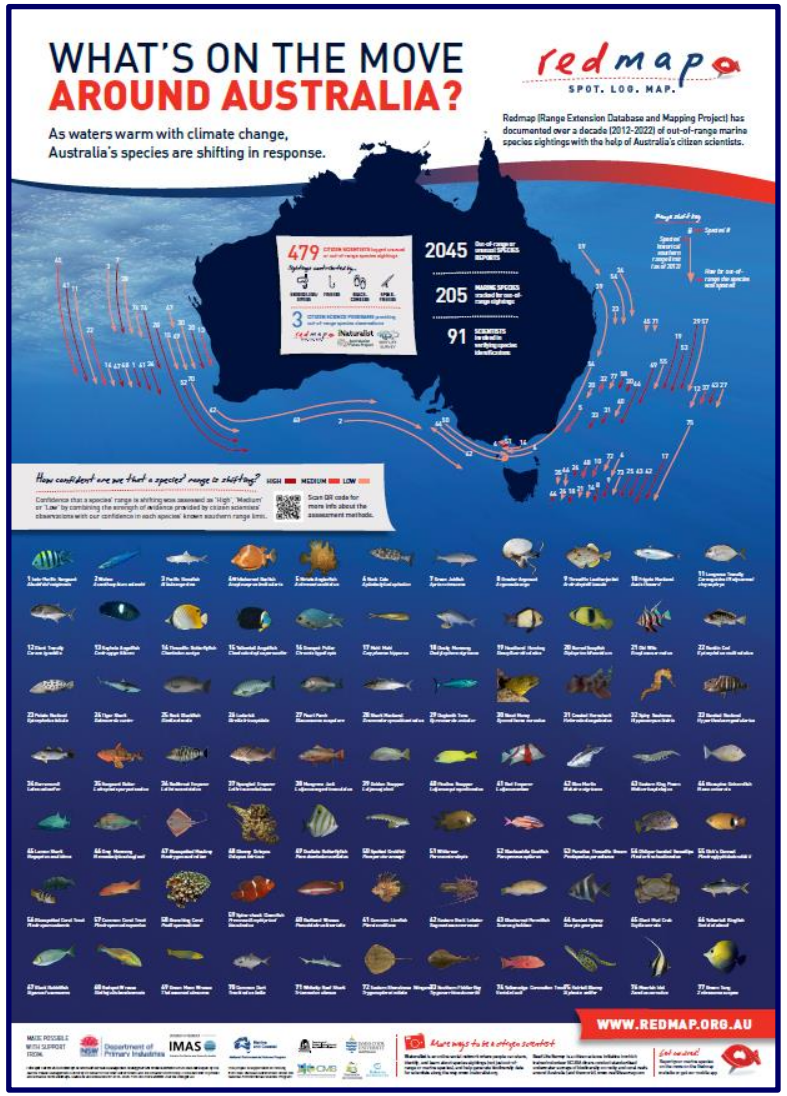
ABC NEWS

https://www.abc.net.au/news/2018-06-28/gloomy-octopus-migrating-to-tasmania-due-to-climate-warming/9919122

https://www.abc.net.au/news/rural/2022-08-13/fish-species-move-tasmania-snapper-kingfish/101327780

Marine citizen science

Contributions from Australian fishers, divers, and scientists



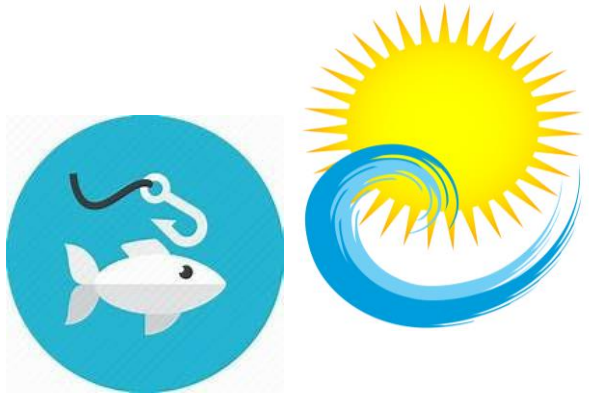
Key points

- Small changes in physical environment = large biological changes
- Whether that effect is ‘negative’ or ‘positive’ depends on the species & its range
- Exposure and sensitivity to physical changes will vary across life stages




Summary

MARINE HEATWAVES + climate change



- MHWs/CC can lead to **unpredictable fluctuations** in fish populations
- MHWs/CC can **severely disrupt fisheries**, affecting fish populations, ecosystem dynamics, & economic well-being of communities dependent on fishing industries
- MHWs/CC pose **challenges for fisheries management** - fisheries management authorities may need to adapt regulations/policies to account for rapid environmental changes
- Addressing impacts of MHWs/CC on fisheries **requires proactive measures**
  - adaptive management strategies, conservation efforts
  - global initiatives to mitigate climate change & reduce ocean warming

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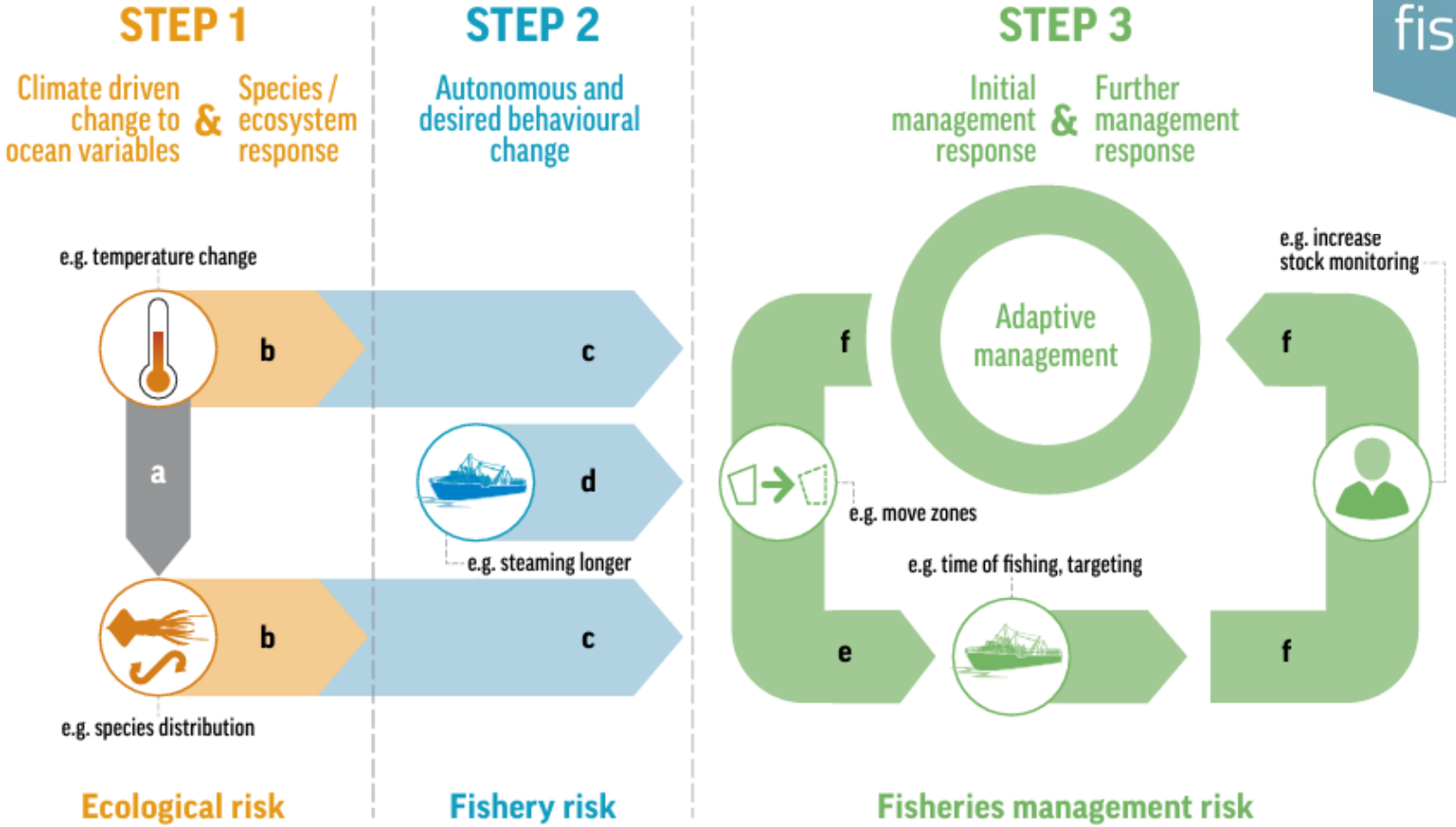
FIGURE 2-1 Schematic representation of why a risk assessment needs to be undertaken – showing the relationship between climate change, autonomous fleet adaptation and response and any management responses.



https://research.csiro.au/cor/research-domains/climate-impacts-adaptation/climate-adaptation-handbook/

CITATION

Fulton EA, van Putten EI, Dutra LXC, Melbourne-Thomas J, Ogier E, Thomas L, Murphy RP, Butler I, Ghebrezgabhier D, Hobday AJ, Rayns N (2020) Adaptation of fisheries management to climate change Handbook, CSIRO, Australia.

Australian Government
Australian Fisheries Management Authority

CSIRO

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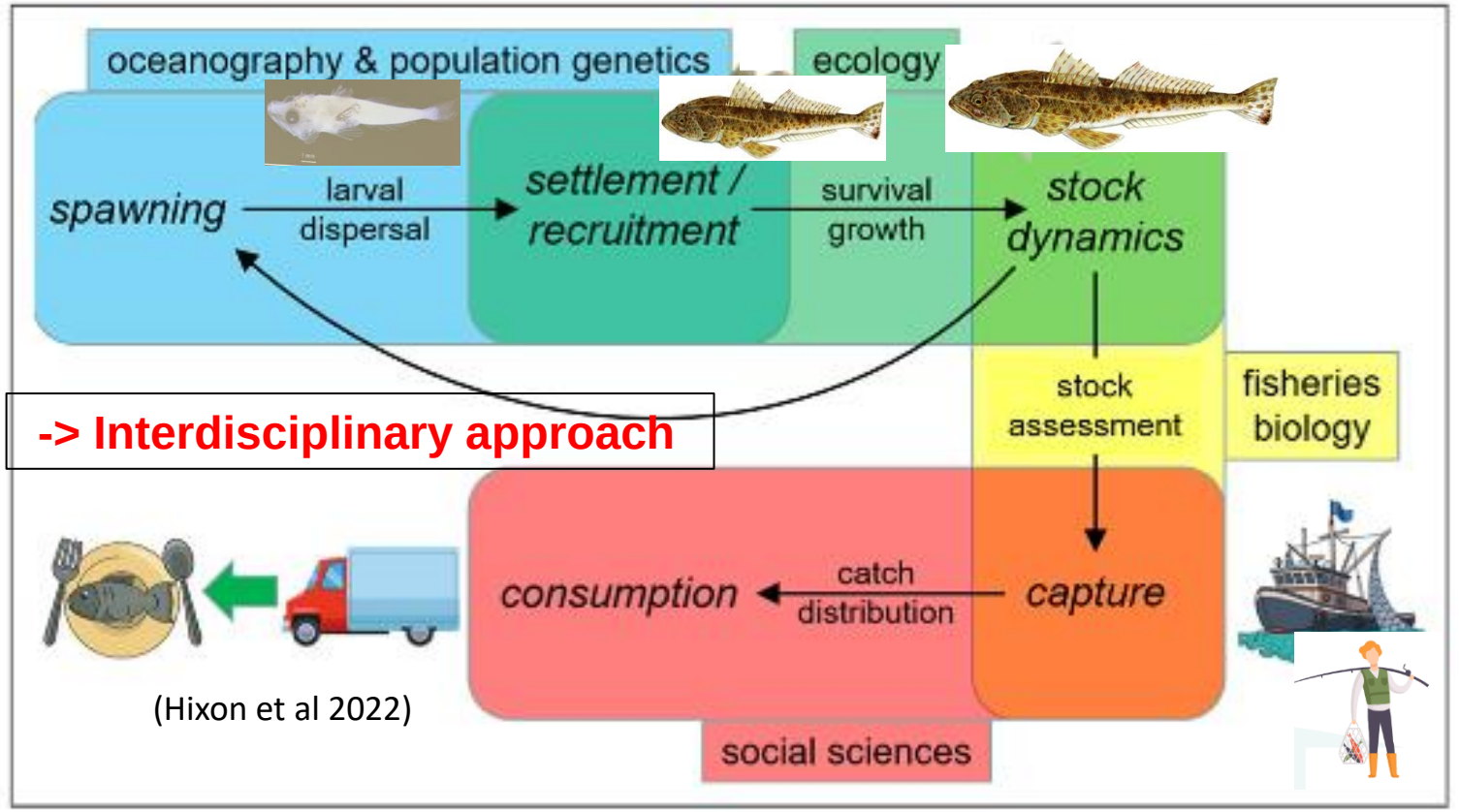
Tasmanian Aboriginal Centre

CSIRO

"Managing fisheries is hard: it's like managing a forest, in which the trees are invisible and keep moving around"
John Shepherd (unpublished lecture at Princeton University, 1978)



(Hixon et al 2022)

Flathead for the future

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TARFISH Tasmanian Association for Recreational Fishing

UNIVERSITY of TASMANIA — Tasmanian Behavioural Lab

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https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/publications-and-resources

Thank you

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Species redistribution - challenges & opportunities for marine species & human communities

- Species shifts are fundamentally changing natural & managed systems
- Species on the move – 'status quo' for the foreseeable future
- Almost everything is changing all at once
- We need mechanistic process-based understanding in order to project future changes
- Human systems are already having major challenges
- Adaptation (within limits) is possible BUT needs strategic planning

(Melbourne-Thomas et al Pecl 2021, Reviews in Fish Biology & Fisheries)

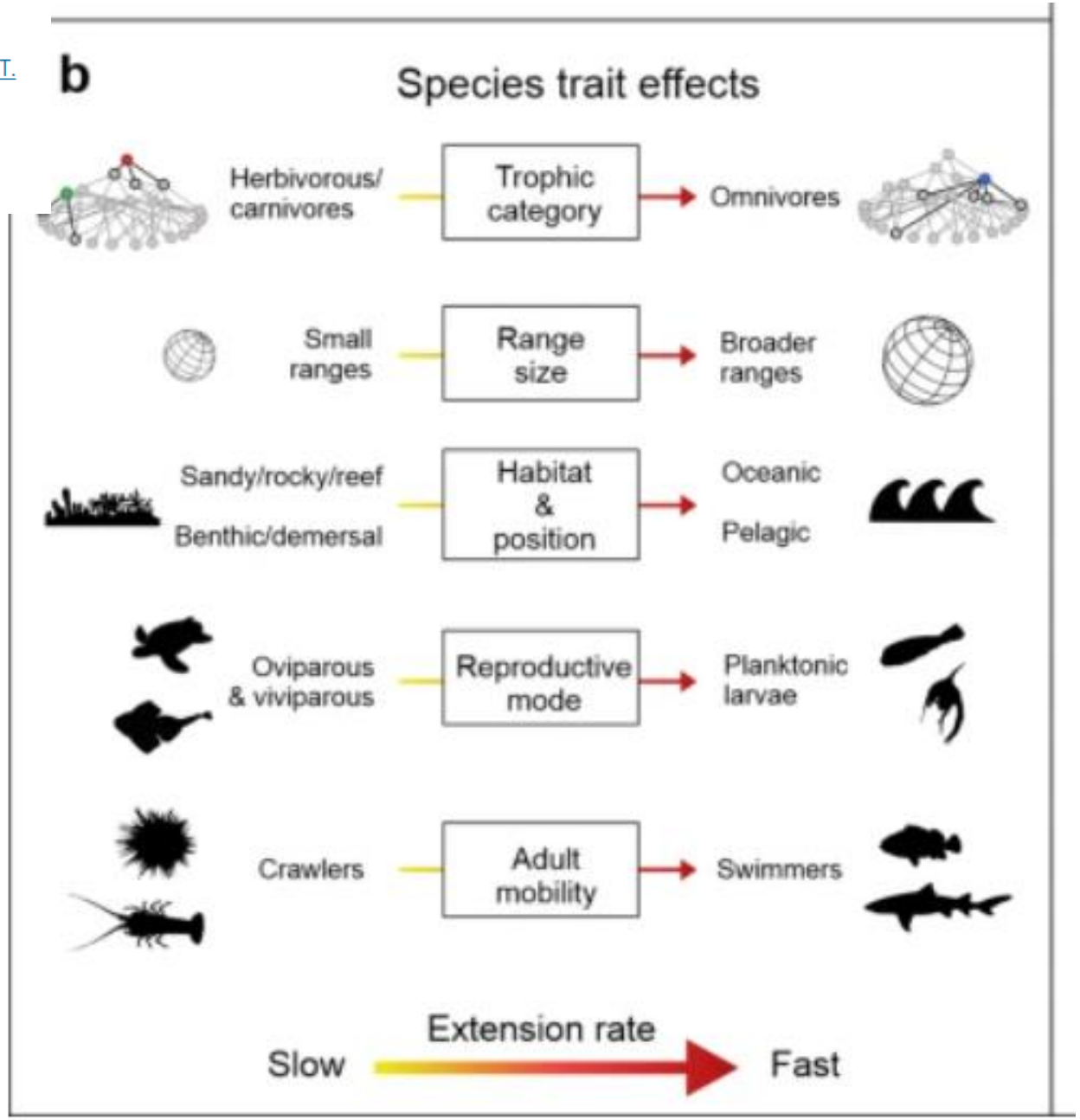
Climate, currents and species traits contribute to early stages of marine species redistribution

Jorge García Molinos, Heather L. Hunt, Madeline E. Green, Curtis Champion, Jason R. Hartog & Gretta T. Pecl

Communications Biology **5**, Article number: 1329 (2022) | Cite this article

Species biological identity

- influences responses to warming
- based on traits related to
    - adults/larvae dispersal
    - dependency on specific habitats
    - trophic category
    - historical range size



https://www.nature.com/articles/s42003-022-04273-0