Professor Gretta Pecl
Climate-driven species re-distribution in marine coastal systems
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Climate-driven global re-distribution of species

Poleward movement
17 km dec$^{-1}$ on land
72 km dec$^{-1}$ in ocean
(Poloczanska et al. 2013)

Higher elevations

Deeper in ocean
(Dulvy et al. 2008)

Shifts greatest where climate has warmed the most
Between 25-85% of species are already shifting
Variation in timing & pace of species shifts

- Confounding factors, influences other than climate
- Detectability
- Not all species can/will shift – adapt, move or die
- Species shift at different rates
Variation in rate and magnitude of shifts

- Ecological interactions
- Habitat availability
- Stage of shift being measured?
Variation in rate and magnitude of shifts

Measuring different stages of range extension?
(Bates, Pecl et al. 2014)
Currently very species focussed

“Shiftiness” of species

• Local climate velocity
• Life history traits
• Physiological responses
• Direct interactions

“Receptiveness” of receiving community?

• Dependent on resident ecological network
• Opportunity niche in trait space?
• Network instability?
• Emerging properties of system?
Range shift = ‘shiftiness’ + ‘receptiveness’
Parallels with other processes & research fields

- **Range shift**
- **Invasion**
- **Disease**
Ecological consequences of ‘shifters’

- Impacts *can* be equivalent to invasive species (Ling 2008)

- Current focus on individual species rather than collective impacts of multiple shifters (Bonebrake et al Pecl 2017)

25-85% species shifting....

(Marzloff, van Putten, Pecl et al 2016)
Why do these shifts in distribution matter?

- Ecosystem structure & function
- Food security
- Human health
- Livelihoods
- Feedbacks to the climate system
- Culture
Adaptation & ‘Species on the Move’?

Adaptation targets
- Sustainable development
- Security
- Trophodynamics
- Variability
- Fitness

Adaptation responses
- Global
  - Country/Federal Government
  - High Seas (Sumby, Pecl – poster!)
  - Regional fisheries
- Local community
  - Conservation approaches (Bonebrake et al., Pecl 2017)

Organization scale

(re-drawn from Miller et al., 2017)
Global biodiversity redistribution:
Impacts on ecosystems, human well-being, governance and climate feedbacks

Pecl et al Science 2017
Access to natural resources change
Change in distribution of pathogens, parasites
Wetlands, coastal areas particularly important for vulnerable people in rural areas

- Skipjack tuna (9)
- Atlantic salmon (14)
- Tropical fish (21)
- Oil sardine (25)

‘Species on the move’ interact with almost EVERY SDG

*but* not explicitly considered in any SDG
3,500 leaders - SDG14 is the least important goal

Source: Listening to Leaders 2018: Is development cooperation tuned-in or tone-deaf?
Local level – climate change & adaptation in Tasmania

- High rate (29.3%) recreational fishing
- Highest value of seafood nationally
- Seafood 1/3 value of agricultural production
- Diverse communities of temperate marine life
- Warming almost 4x global average (Hobday & Pecl 2014)
Local changes associated with temperature increase

- Poleward expansion of sea urchins - loss of kelp forests (Ling et al., 2009)
- ‘New’ octopus species (Ramos et al., 2014a & b, 2018)
- 50% intertidal species moved poleward over last 50 years (Pitt et al., 2010)
- Dozens fish species - major distributional changes (Last et al., 2011, Sunday et al., 2015, Robinson et al., 2015 - www.redmap.org.au)
- 85% of seaweeds found further poleward on east coast from 1940 (Wernberg et al., 2011)
Significant changes linked to warming on the east coast of Tasmania

Pecl et al in review
What has been the response to these changes?

- Limited Government action on fisheries globally (Miller et al., 2017)
- Started collating the autonomous adaptation actions of marine sectors (Pecl et al., in review)

And charter operators, salmonid aquaculture & shellfish aquaculture
Many ‘autonomous’ or ‘bottom-up’ adaptation actions

- Charter operators advertising trips for ‘new’ species
- Changes to product handling & landing practices
- Changing farming practices
- Using seasonal forecasting for farm management

Individuals, organisations and communities may adjust their behaviour more readily?

Pecl et al in review
Half the autonomous adaptations were potentially countervailing to planned government-led adaptations.
Research to assist stakeholder planning to temporal changes in species redistributions

Habitat suitability modelling under near-future climate conditions to inform adaptation

1996 = 11 months suitable per year
2018 = 10 months suitable per year
2040 = 9 months suitable per year

1996 = 1 month suitable per year
2018 = 2.5 months suitable per year
2040 = 3.5 months suitable per year

* denotes significant regional shifts

In press: Curtis Champion, Hobday, Pecl et al. 2018 Mar Freshw Res
Adaptation to climate change is complicated & messy

- Limited gov level planned adaptation action
- Low awareness of non-gov adaptations
- Multi-sector, multi-stakeholder, competing values & interests
- Winners and losers, trade-offs, value-based decisions..... who makes the decisions?
- Interdisciplinary, participatory & integrated approaches essential
Some implications of climate-driven biodiversity changes cannot be adapted to

“When kelp and weed beds are dying and the rainbow kelp shells are depleted in rapid numbers, then women feel the cultural loss of governance and connections to sea country”

(tebrakunna country and Lee 2017).

In Pecl et al (in review) & used with permission from Dr Emma Lee, trawlwlwuy woman of tebrakunna country and Research Fellow at CMS UTAS
Adapting to global species redistribution requires ‘all hands on deck’

Catalyst for respect, collaboration, exchange & integration of Indigenous, Industry, Community-based and formal/academic science

‘Species on the move’ – visual – opportunity for engagement, communication & collaboration on climate change

‘Two-Eyed Seeing’ (Mi’kmaw Elder Albert Marshall, 2004)

eg citizen science project www.redmap.org.au
An invitation

Please join us for the second interdisciplinary international *Species on the Move* conference in July 2019 at Kruger National Park in South Africa

www.speciesonthemove.com

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Major challenges & major opportunities

• Fascinating & unprecedented learning opportunity for ecology & evolution

• We can learn more from marine species than terrestrial
What are we doing about ‘Species on the Move’?

- Global Strategies (Pecl et al., 2017)
- Country/Federal Gov level (Pecl et al., in prep)
  - High Seas (Sumby, Pecl – poster!)
  - Regional fisheries adaptation (Pecl et al. 2014)
- Human local community level adaptation (Pecl et al., in review)
  - Conservation approaches (Bonebrake et al., Pecl 2017)

(re-drawn from Miller et al., 2017)
Warming almost 4 x global average

One of the fastest warming regions globally and will likely remain so in the future

Animation courtesy of CSIRO
Government level adaptation planning:
in countries with fastest-warming seas

Areas of rapid ocean warming (top 10% change in SST, Hobday & Pecl 2014)
Government level adaptation planning in countries with fastest-warming seas

- **HIGH**
  - Specific sectoral plan for marine biodiversity/fisheries
  - Actions: Recommended – Planned – Undertaken

- **LOW**
  - ’National adaptation plan’ for all sectors combined
    - Mentioned fisheries/marine biodiversity
    - Some detail of specific marine/fisheries actions
  - Brief/cursory mention of adaptation for fisheries/marine biodiversity
  - No mention of adaptation for fisheries/marine biodiversity

42 countries
Pecl et al in prep
Climate change impacts through-out food web

Frusher et al 2014
Rapidly growing research field......

• Fascinating & unprecedented learning opportunity for ecology & evolution
• Need to understand (explanatory ecology) & predict (anticipatory ecology)
Climate change will bring opportunities as well as negative implications

• Some increases in abundance & changes in distribution will be favourable

• HOWEVER, even opportunities may require management and/or planning to ensure maximising these

Citizen science observation sent in to www.redmap.org.au