



A citizen science-based assessment of marine species redistributions in New South Wales

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Range Extension Database and Mapping project

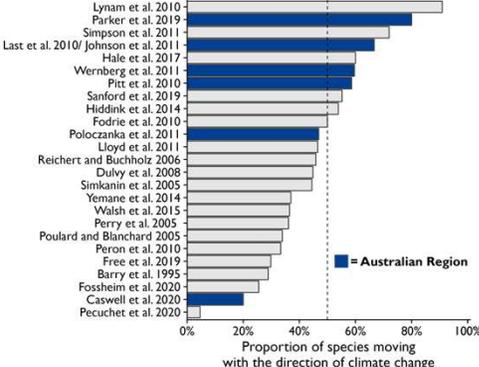


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Global marine species redistributions

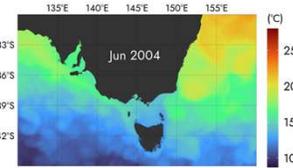
Regional analyses of marine species redistributions



Study	Proportion of species moving with the direction of climate change (%)
Lynam et al. 2010	~85
Parker et al. 2019	~80
Simpson et al. 2011	~75
Last et al. 2010/ Johnson et al. 2011	~70
Hale et al. 2017	~65
Wernberg et al. 2011	~60
Pitt et al. 2010	~55
Sanford et al. 2019	~50
Hiddink et al. 2014	~45
Fodrie et al. 2010	~40
Poloczanka et al. 2011	~35
Lloyd et al. 2011	~30
Reichert and Buchholz 2006	~25
Dulvy et al. 2008	~20
Simkanin et al. 2005	~15
Yemane et al. 2014	~10
Walsh et al. 2015	~5
Perry et al. 2005	~5
Poulard and Blanchard 2005	~5
Peron et al. 2010	~5
Free et al. 2019	~5
Barry et al. 1995	~5
Fossheim et al. 2020	~5
Caswell et al. 2020	~5
Pecuchet et al. 2020	~5

Climate change is driving global species redistributions. In subtropical & temperate oceans, primary responses are 'range extensions' into new, typically poleward areas

In Australia, home to two global ocean warming hotspots, 20–80% of assessed marine species are shifting in the direction consistent with climate change



Rapid ocean warming in SE Australia due to a strengthening East Australia Current extension



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Citizen science and marine species redistributions in Australia

- **198** documented marine species range shifts around Australia, but **critical geographical and taxonomic knowledge gaps** (Gervais, Champion, Pecl 2021)
- **~20%** of studies documenting these shifts used citizen science data
- **Redmap** (Range Extension Database and Mapping Project) was launched in 2009 in TAS to collect unusual species sighted by the public, **expanded nationwide in late 2012**.

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- Sightings w/ photo are logged through the website or smartphone app & are validated by a species expert
- A species list of **204** potentially range-extending species is maintained, each with a historic range boundary & 'where to log'
- Sightings of non-listed species are also collected

80 scientists around the country from 20 institutes verify each photo logged in Redmap

Example species profile page
<https://www.redmap.org.au/species/1/89/>

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Citizen science-based assessment of marine species redistributions

A decision tree framework was developed to assess marine species range extensions in Tasmania with Redmap data

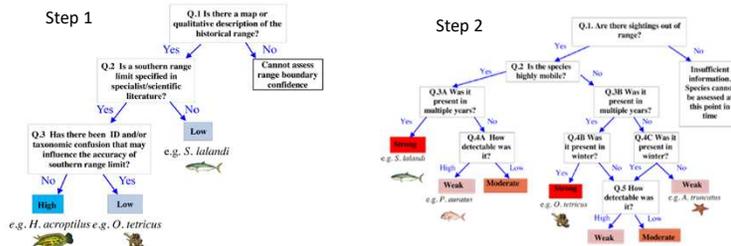
The method combines 1) confidence in species' historical range limits, and 2) strength of evidence provided by citizen science to estimate overall confidence in potential range extension for each species assessed.

Global Environmental Change
Volume 31, March 2015, Pages 28-37

Rapid assessment of an ocean warming hotspot reveals "high" confidence in potential species' range extensions

L.H. Robinson *A.R. Gill *D.G. Gellard *T. van Wassenberg *T. A.J. Middle *S. Priner *N. Barrett *J. Stuart Smith *T.G. Bell *

Methods & results published as a peer reviewed article (Robinson et al. 2015) & disseminated to the community as a "Report Card".



Figures from Robinson et al. 2015

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Redmap Tasmania Report Card (2013)

SPECIES	HOW SEEN BY FISHERIES	REFERENCE POINT CONFIDENCE	DIFFERENCE OF RANGE SHIFT	OVERALL CONFIDENCE
Blotchy octopus (<i>Ectopista</i>)	1	1	1	High
Ormondeband wrasse (<i>Pseudoclinemus</i>)	1	1	1	High
Rock sole (<i>Aphriscirus</i>)	1	1	1	High
Southern Maori wrasse (<i>Dactylopusia</i>)	1	1	1	High
Shearwater (<i>Puffinus</i>)	1	1	1	High
Eastern rock lobster (<i>Scyllarctus</i>)	1	1	1	High
Grey mackerel (<i>Scomber</i>)	1	1	1	High
Frigate mackerel (<i>Chromis</i>)	1	1	1	High
Eastern blue sparger (<i>Chromis</i>)	1	1	1	High
Dusky snapper (<i>Epinephelus</i>)	1	1	1	High

Four-page print and online versions designed to:

1. Inform the public on how their data are used & what it is telling us about potential range shifts.
2. Acknowledge the importance of volunteer contributions to the scientific community through high quality research output.

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A decade of Redmap out-of-range species sightings

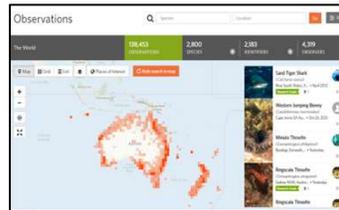
Since 2012:

- Redmap has collected nationwide sightings of at least **82 species** “out-of-range”
- Other citizen science programs that complement Redmap data have developed

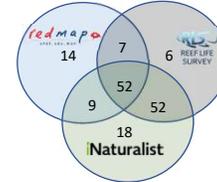
Reef Life Survey: species observations collected by trained divers with standardised methodology



iNaturalist (esp. Australasian fishes project) 2016- species observations submitted w/ photo



Out-of-range species represented:



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A citizen science-based assessment of marine species redistributions in New South Wales

Current project: expand the “Report Card” assessment nationwide, incorporating iNaturalist and Reef Life Survey data, leading with NSW

Series of workshops beginning in November 2021 to:

- Consider updates to original Robinson et al. 2015 methods based on advances in species distribution research
- How to incorporate other citizen science data sources rigorously
- Representatives from Unis, state managers, museums, all three citizen science programs

Results: 94 species assessed in New South Wales, 23 with evidence of potential range extension, 11 with high confidence



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New South Wales Report Card

Four-pages designed to work as a printed A3 folded leaflet as well as on-screen

After internal review & revisions, we shared draft report cards with:

- Citizen scientist (~12 each) users of iNaturalist & Redmap that contributed data to the report cards
- Variety of stakeholders including dive clubs, state managers

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redmap

SPOT. LOG. MAP.

NEW SOUTH WALES REPORT CARD

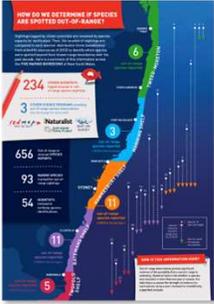
Over the past decade, Redmap (Range Extension Database & Mapping Project) has recorded out-of-range marine species with the help of observant citizen scientists across the state.

Marine species are moving further south

The East Australian Current or EAC, which transports warm, tropical water south along the coast of New South Wales, has strengthened over the past several decades. As a result, south-eastern Australia is one of the fastest warming regions of the world's oceans. In response to warming waters, some marine species are extending their ranges south. In recent years, the New South Wales community has spotted many species south of their usual ranges, for example:

- 1 In 2013 SCUBA divers first spotted a bed of the tropical branching coral (*Pocillopora alicalae*) near Sydney, which has been multiplying since. Several tropical fishes have been spotted in the coral bed, including Dick's Damselfish (*Plectroplitodon dickii*).
- 2

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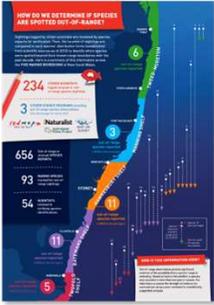
- 1 In 2013 SCUBA divers first spotted a bed of the tropical branching coral (*Pocillopora aliciae*) near Sydney, which has been multiplying since. Several tropical fishes have been spotted in the coral bed, including Dick's Damselfish (*Plectrogliphodon dicki*).
- 2 Dogtooth Tuna (*Gymnosarda unicolor*) usually live in tropical waters north of the Queensland border, but this highly prized fish has been surprising anglers and spearfishers with several catches along the New South Wales coast since 2015.
- 3 Each spring, tropical juvenile fishes carried by the EAC appear along the New South Wales coast. Now, these tropical recruits are being spotted much further south than previously reported, for example the Bluespine Unicornfish (*Naso unicornis*) near Narooma, about 340 km south of its recognised range limit.

Image credits: (1) J. Sear; (2) D. Cruz; (3) A. Green

CITIZEN SCIENCE HELPS DETECT SPECIES RANGE SHIFTS

Thank you to New South Wales' citizen scientists (bachcombers, boosters, divers, and fishers), who since 2012 have been logging "out-of-range" species sightings like those above with Redmap. These observations can provide an early indication of how species distributions are changing, improving our ability to predict and prepare for the challenges and opportunities range extending species may deliver. By contributing to citizen science programs like Redmap, anyone with a camera can become an "ecological detective", helping to uncover which species are on the move and how their local region may be changing in response to ocean warming.

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WHAT SPECIES ARE ON THE MOVE IN NEW SOUTH WALES?

How confident are we that a species' range is shifting?

HIGH 🔴 Confidence that a species' range is shifting was assessed as 'High', 'Medium' or 'Low' by combining the strength of evidence provided by citizen scientists' observations with our confidence in each species' known southern range limit.

MEDIUM 🟡

LOW 🟠

Number of sightings by:

SNORKELERS/DIVERS 👤 FISHERS 🎣 BEACH-COMBERS 🏖️ SPEAR-FISHERS 🔪

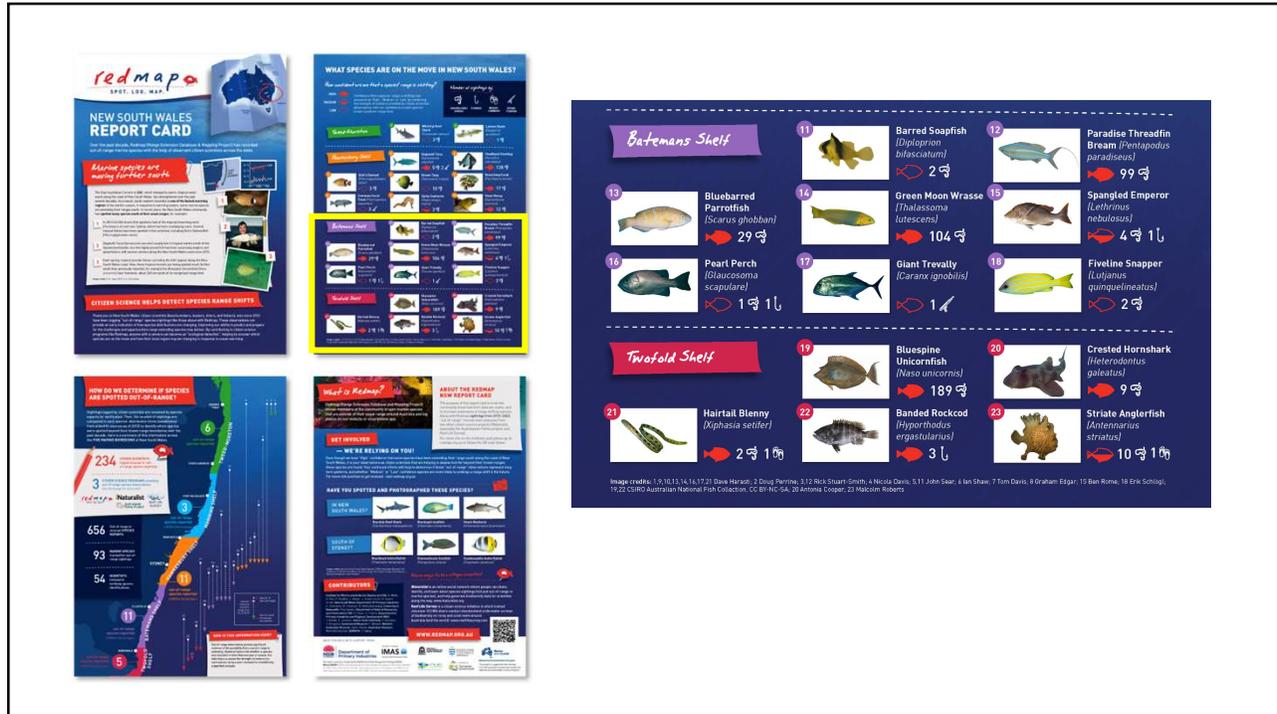
Tweed-Morerton

1 Whitetip Reef Shark (<i>Triaenodon obesus</i>) 🔴 3 🗨️	2 Lemon Shark (<i>Negaprion aculeatus</i>) 🔴 1 🗨️
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Hawkesbury Shoals

3 Dogtooth Tuna (<i>Gymnosarda unicolor</i>) 🔴 5 🗨️ 2 🎣	4 Headband Humbug (<i>Dascyllus reticulatus</i>) 🔴 138 🗨️
5 Dick's Damselfish (<i>Plectrogliphodon dicki</i>) 🔴 3 🗨️	6 Brown Tang (<i>Zebbrasoma scopas</i>) 🔴 10 🗨️
7 Common Coral Trout (<i>Plectropomus leopardus</i>) 🔴 3 🗨️	8 Branching Coral (<i>Pocillopora aliciae</i>) 🔴 17 🗨️
9 Spiny Seahorse (<i>Hippocampus histrix</i>) 🔴 3 🗨️	10 Stout Moray (<i>Gymnothorax eurostus</i>) 🔴 12 🗨️

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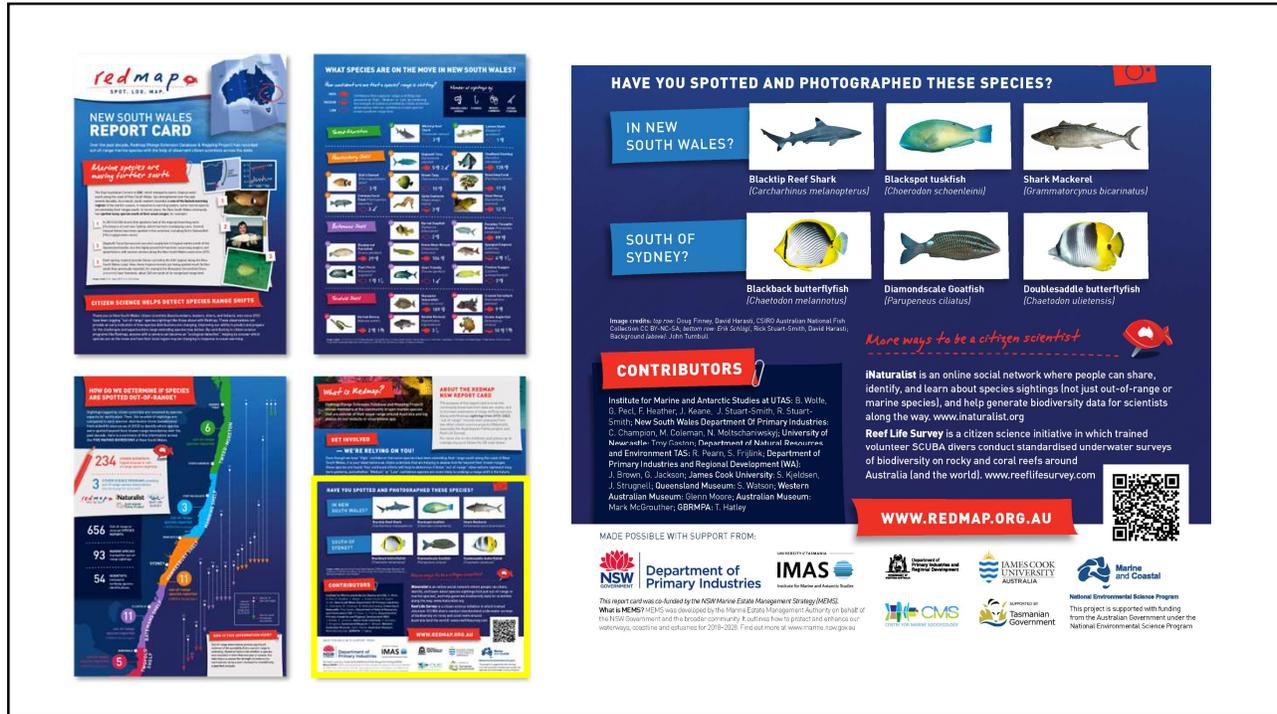
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Dissemination and Engagement

- Facebook, Twitter, Insta, Redmap website

Please get in touch if you are interested in:

- Hard copies of the report card
- Signage —
Redmap signage along the NSW coast rolling out in 2022

World Science Festival Event, Townville, 2021

Sign posted at Townsville Port

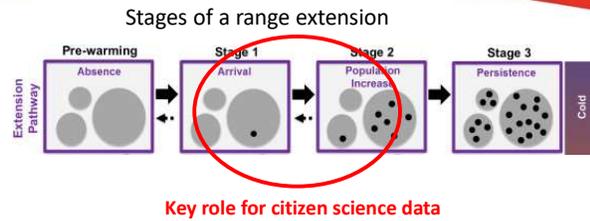
Sign at Orpheus Island Research station

97% of people surveyed say they trust the information they get from Redmap

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Conclusions and next steps

- Citizen science can support early detection of species range extensions
- **Also facilitates two-way engagement on climate change**
- We used a 'pre-registered' list of ~200 species (AUS has over 4k spp of fishes alone) - definitely many more range extensions occurring!
- Next steps - WA, TAS, and Nationwide Report Cards – nationwide planned as an A0 poster



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