

What does climate change mean for braided rivers?

Sonny Whitelaw

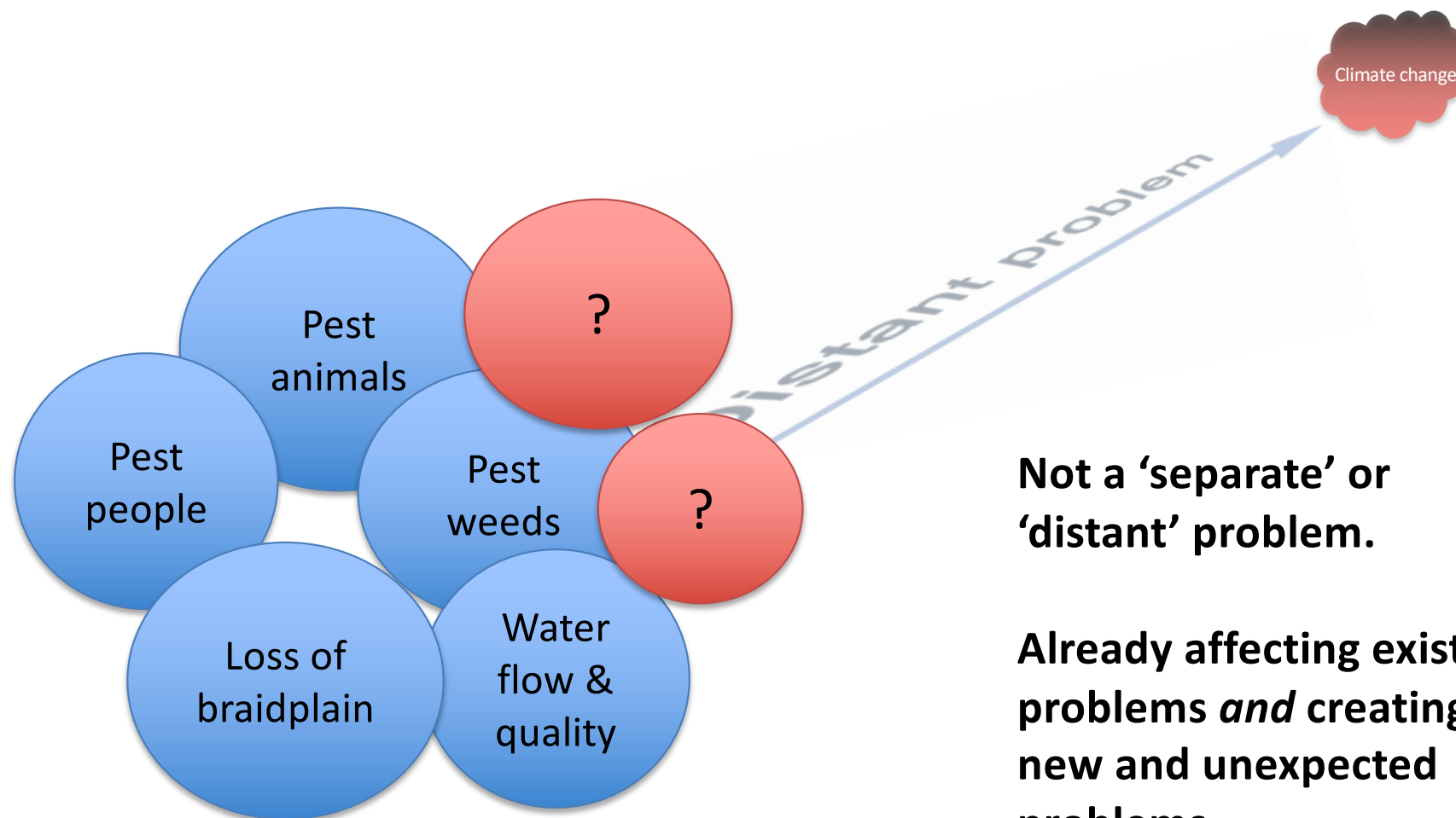


Risk Perception

“Science has already prompted political action, and science is the pathway to solutions.”

- John Morgan Chief Executive, NIWA, June 2019 *Water & Atmosphere* pp4.

Problems



Problems

- Climate change often referred to as a 'super wicked problem'
- Best regarded as a 'risk multiplier'



Risk Perception



Risk Analysis

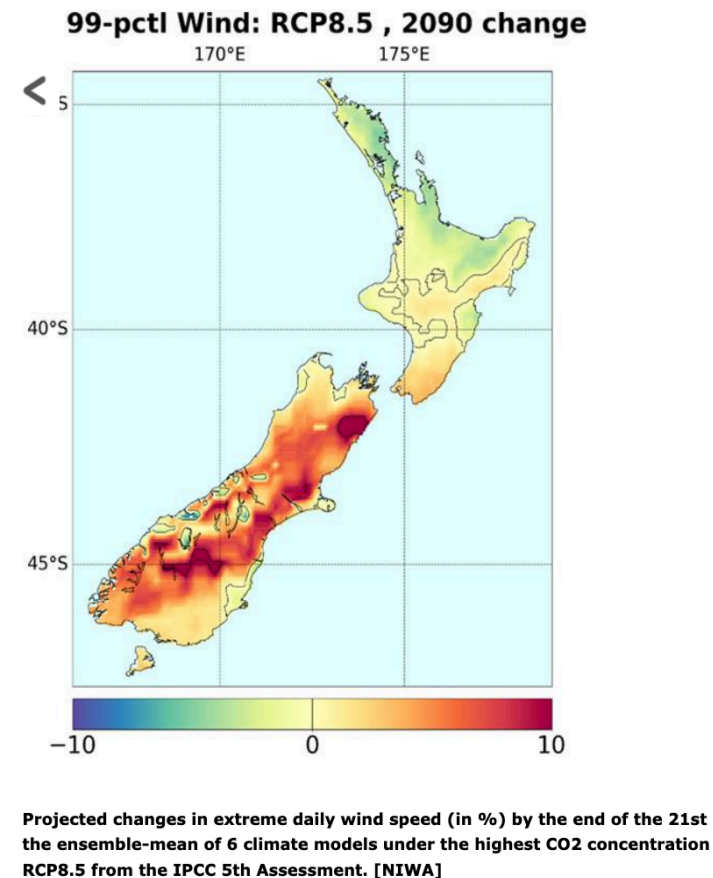
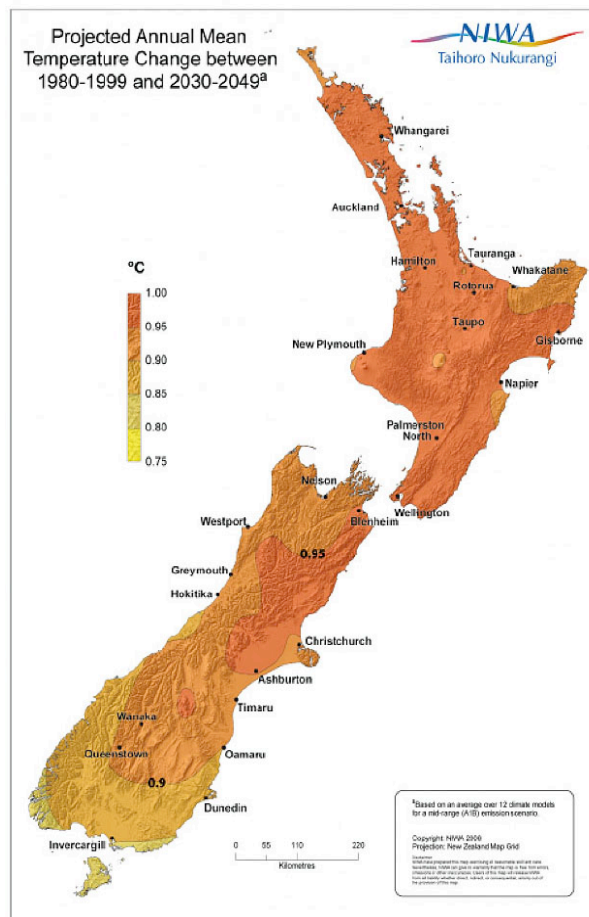
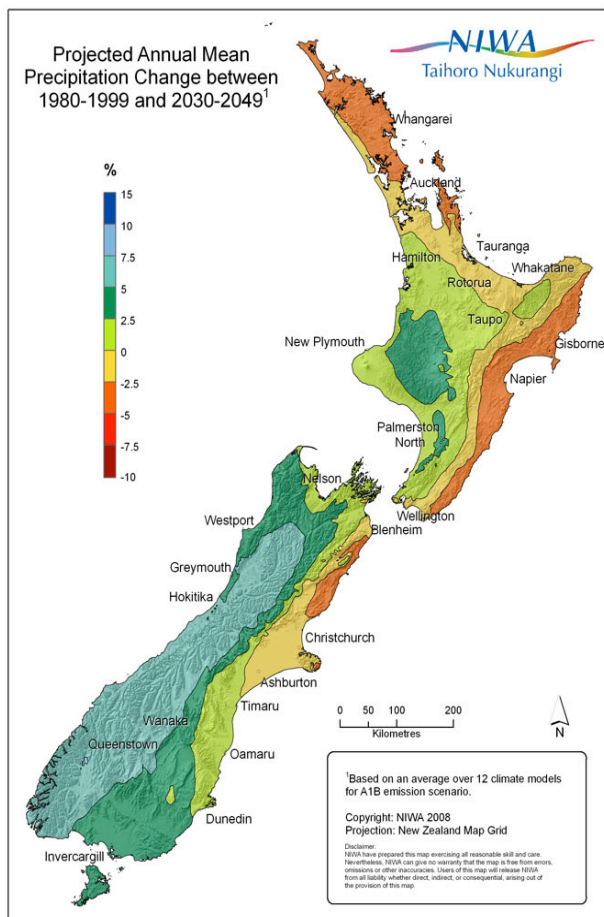
Problems

Risk multiplier: altered weather patterns

> Precipitation (alps)
< Rain (foothills)

Higher
temperatures

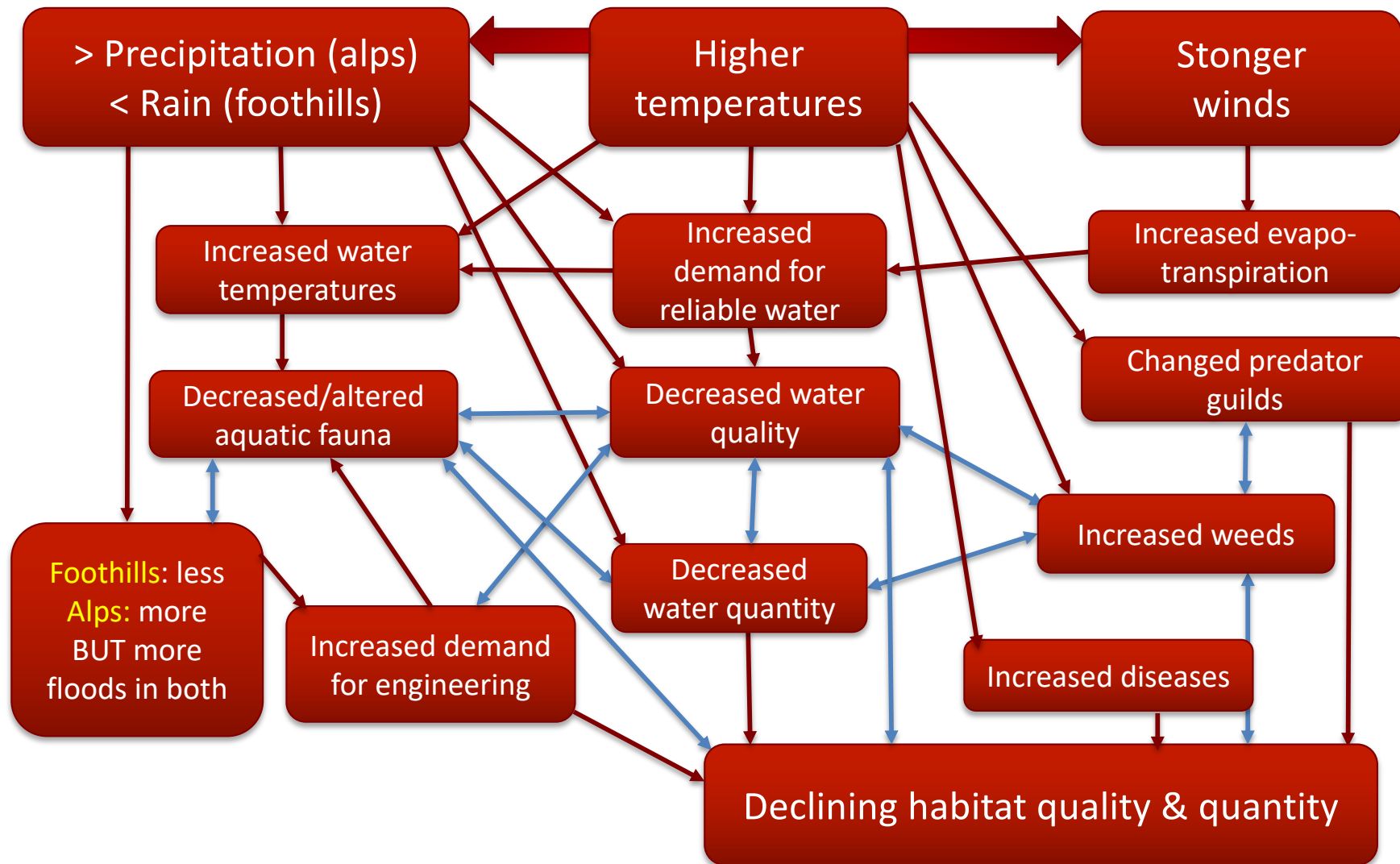
Stronger
winds



What does climate change mean for braided rivers?

Problems

Risk multiplier: altered weather patterns



Problems for foothill-fed braided rivers

Risk multiplier: altered weather patterns

Ashley Rakahuri



What does climate change mean for braided rivers?

Problems for alpine-fed braided rivers

Risk multiplier: altered weather patterns



Franz Josef Christmas 2005

What does climate change mean for braided rivers?

Problems for alpine-fed braided rivers

Risk multiplier: altered weather patterns



Franz Josef Christmas 2015

What does climate change mean for braided rivers?

Problems for alpine-fed braided rivers

Risk multiplier: altered weather patterns

Reduced winter snowpack/increased glacial melt

Ice volume in the Southern Alps

1890s : 170.00³ kms (estimated World Glacier Monitoring Service)

1978 : 54.50³ kms (NIWA)

2015 : 36.10³ kms (NIWA)

2018 : *“...two record-breaking summers in a row show more glaciers have completely disappeared and others have retreated further... Many appear out of balance and do not have enough ice left to suggest they will survive.”*

- Dr Andrew Lorrey, NIWA, 23 May 2019

Problems

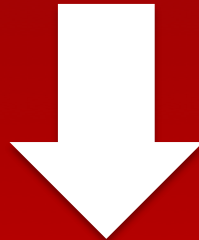
Risk multiplier: altered weather patterns

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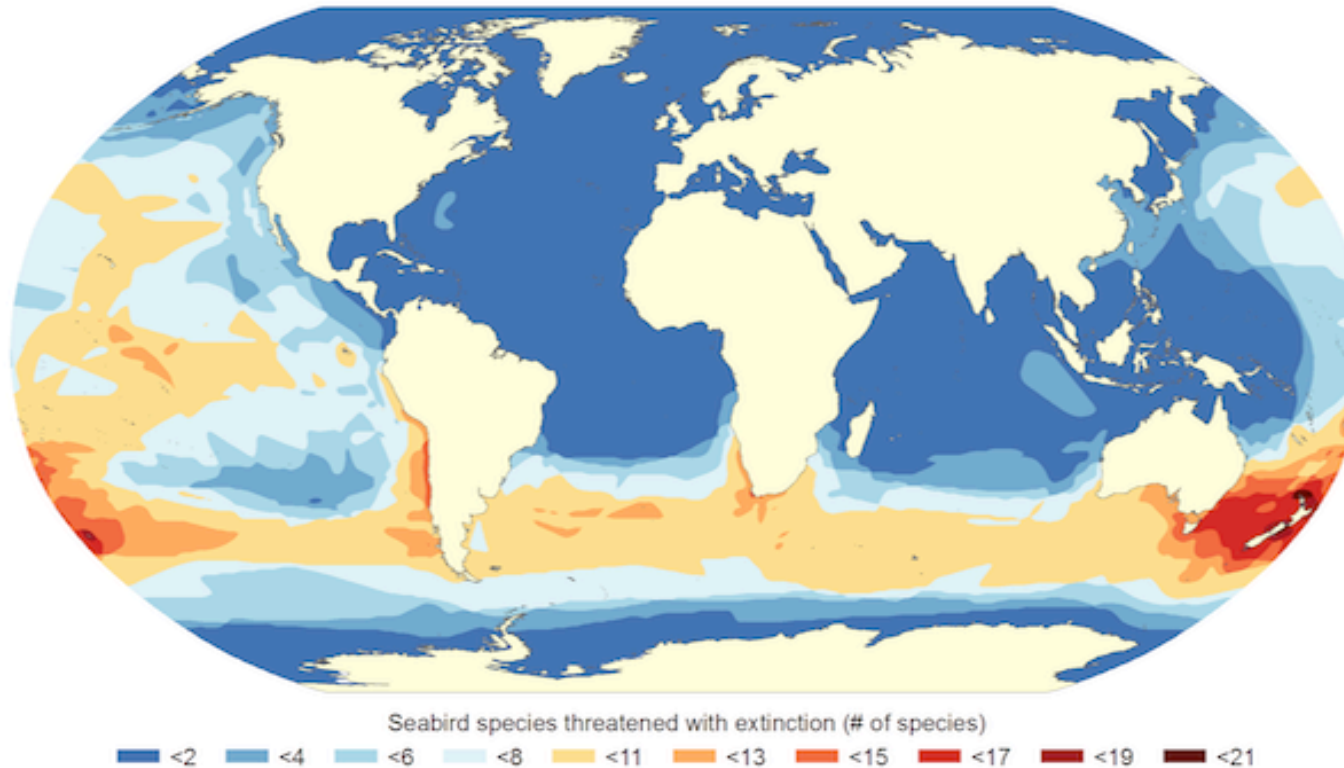
Change in braidplain structure & function
Decline or loss of species and habitats



Loss of braided river ecosystems

Problems for braided river birds

Changes in the ocean ?



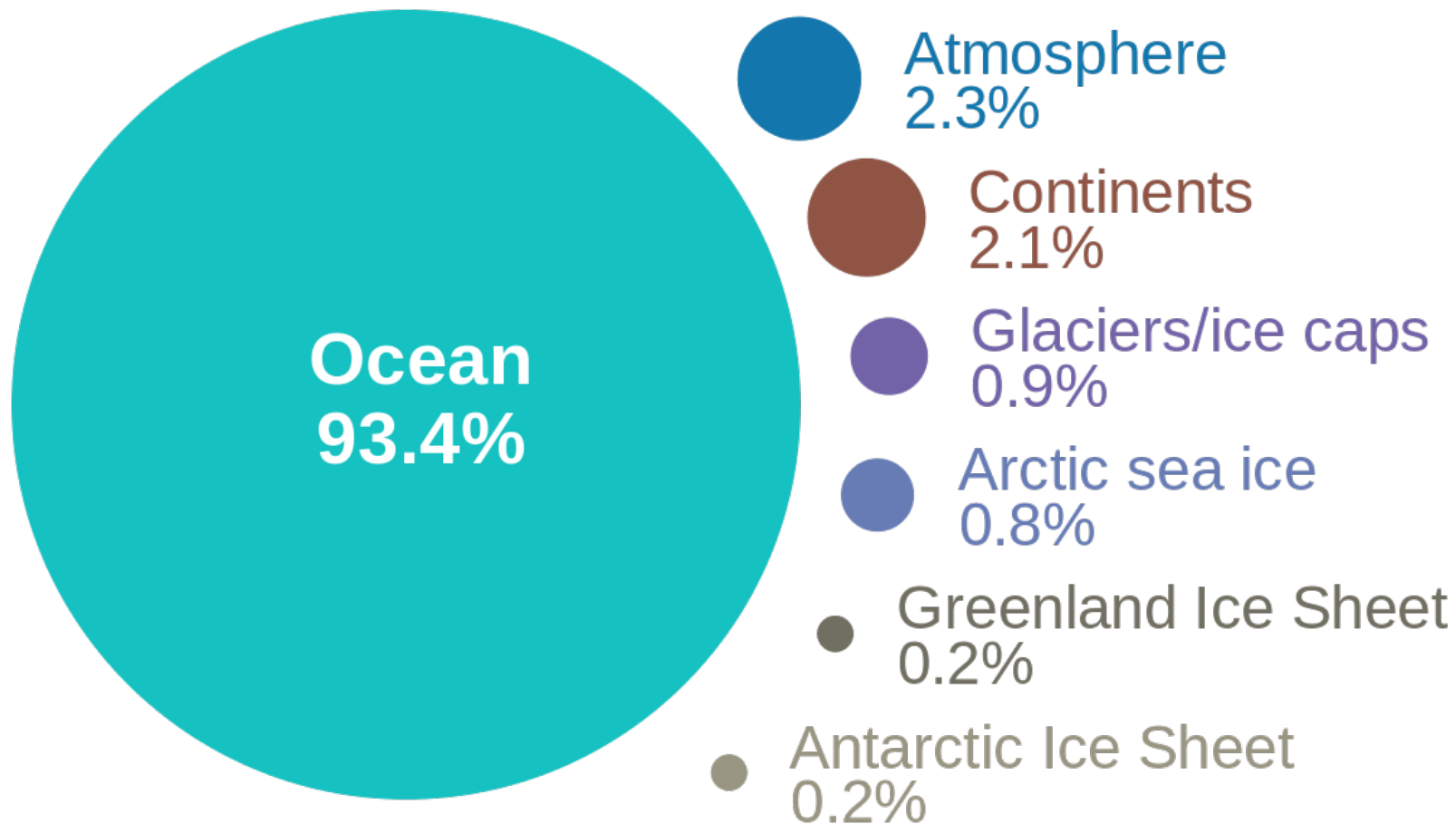
- Paleczny et al (2015) Population Trend of the World's Monitored Seabirds 1950-2010, *Plos One* doi.org/10.1371/journal.pone.0129342

“Changes in seabird numbers are probably the best way to monitor the quality of the marine environment...**In the past 50 years, the world population of marine birds has more than halved. What's worse is that few people have noticed.**” - Tim Birkhead, Emeritus Professor of Zoology, University of Sheffield May 30, 2019

Problems for braided river birds

Changes in the ocean: increasing temperatures

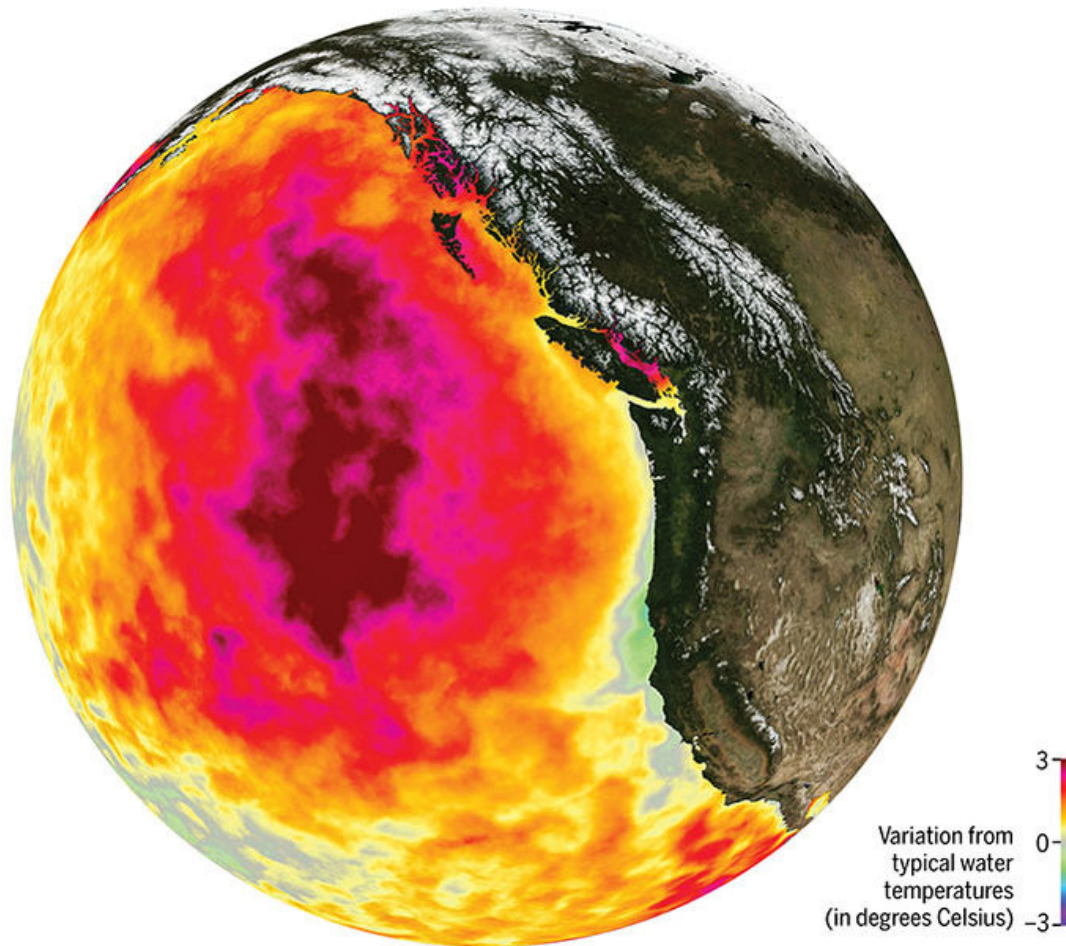
Where is global warming going?



Problems for braided river birds

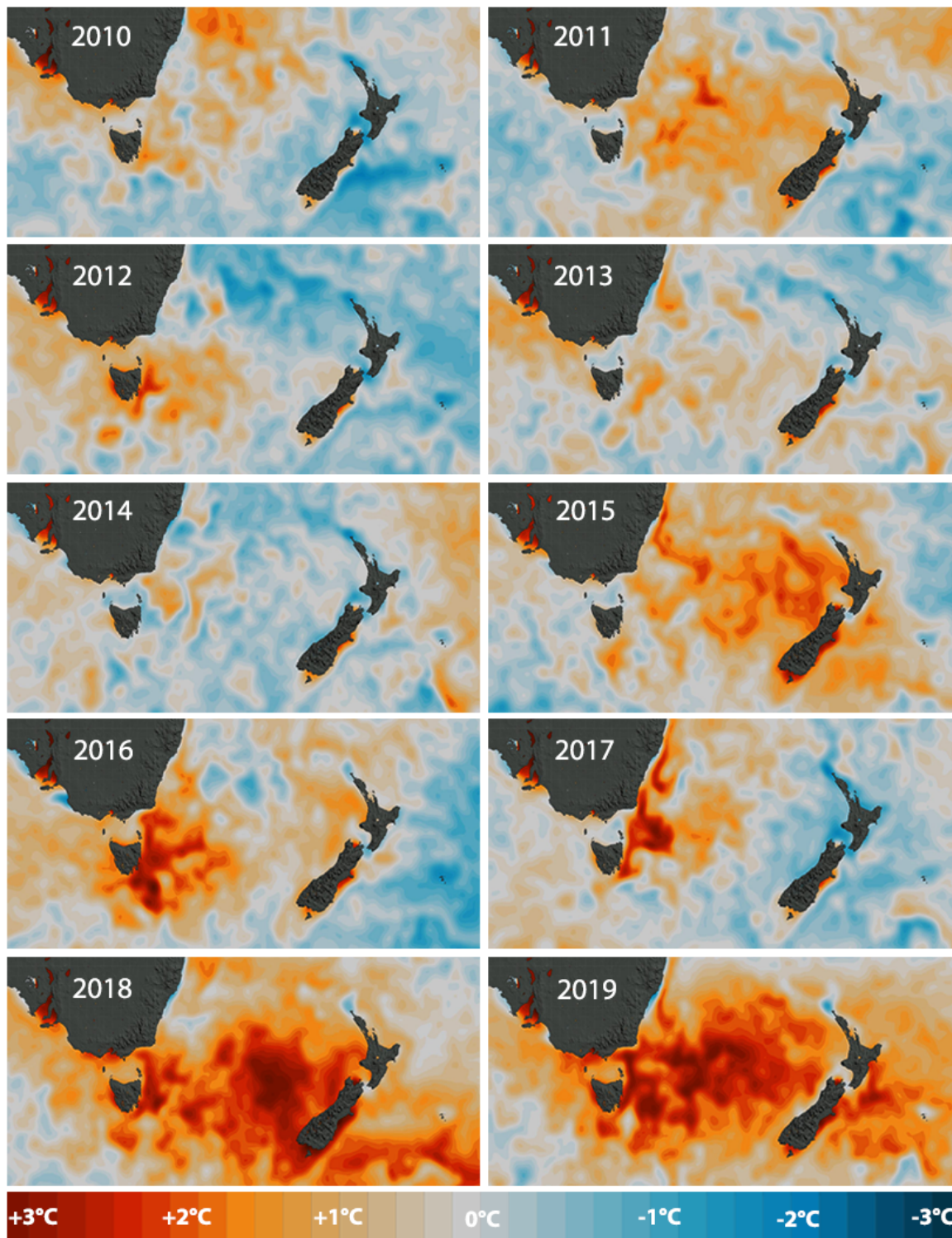
Changes in the ocean: increasing temperatures

Where is global warming going?



“By early 2015, the unusually warm water known as ‘The Blob’ covered a vast swath of the Pacific Ocean.” – *Gentemann et al (2017)*
Geophysical Research Letter 44.1, 312

“...up to 9,000 puffins and other seabirds died over the course of a few months...
when the fish they eat migrated north with rising sea temperatures. This was far from being a trivial event.” – *Jones et al (2019)*
Unusual mortality of Tufted puffins (*Fratercula cirrhata*) in the eastern Bering Sea. Plos one May 29, 2019
doi.org/10.1371/journal.pone.0216532



“During austral summer 2017/18, the New Zealand region experienced an unprecedented coupled **ocean-atmosphere heatwave**, covering an area of 4 million km². Regional average air temperature anomalies over **land were +2.2 °C**, and **sea surface temperature** anomalies reached **+3.7 °C** in the eastern Tasman Sea.”

- Salinger et al (2019) The unprecedented coupled ocean-atmosphere summer heatwave in the New Zealand region 2017/18: drivers, mechanisms and impacts, *Environ. Res. Lett.* 14 044023

<https://iopscience.iop.org/article/10.1088/1748-9326/ab012a/meta>

“Two GCM ensembles indicate that the record sea surface temperatures during the **2017/18 Tasman Sea marine heatwave** were virtually impossible without **anthropogenic influence**.”

- Perkins-Kirkpatrick et al (2018) *Bull. Amer. Meteor. Soc.*
doi: [10.1175/BAMS-D-18-0116.1](https://doi.org/10.1175/BAMS-D-18-0116.1)

Image: www.niwa.co.nz/news/our-changing-oceans

13 June 2019

Problems for braided river birds

Changes in the ocean: increasing temperatures

“Antarctic offshore polynyas linked to **Southern Hemisphere climate anomalies**” -

Campbell et al (2019) *Nature* 10 June 2019 <https://doi.org/10.1038/s41586-019-1294-0>

“Large and globally consistent shifts have been detected in species **phenology, range extension and community composition in marine ecosystems... Climate change is driving plankton towards the poles.**” - Jonkers et al (2019) Global change drives modern plankton communities away from the pre-industrial state... *Nature Geoscience* 22 May 2019 <https://doi.org/10.1038/s41586-019-1230-3>

“...up to 9,000 puffins and other seabirds died over the course of a few months... it seems to be part of **massive shift in the marine environment.**” – Jones et al (2019) Unusual mortality of Tufted puffins (*Fratercula cirrhata*) in the eastern Bering Sea. *Plos one* May 29, 2019 doi.org/10.1371/journal.pone.0216532



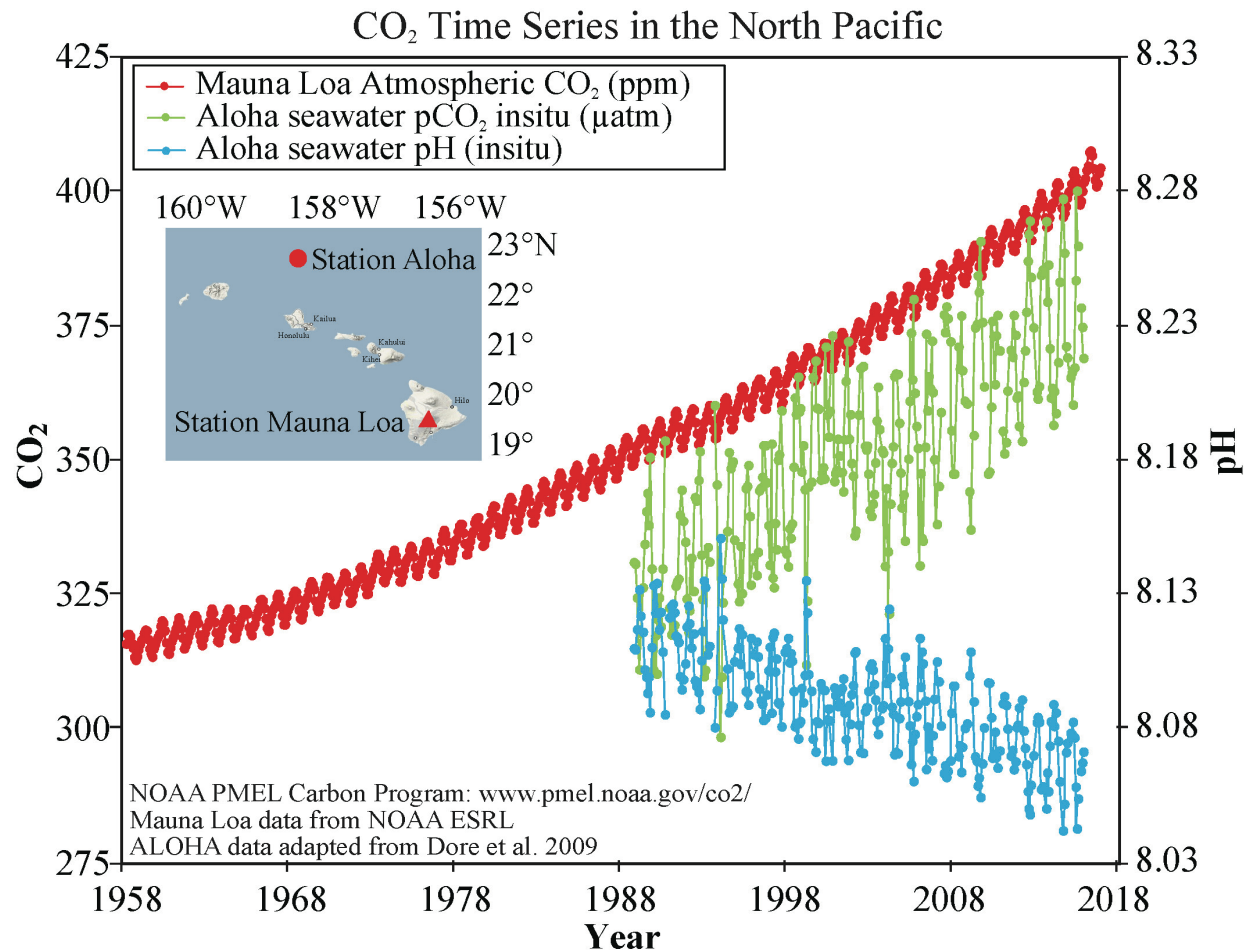
Decline / loss of some river bird winter food

Problems for braided river birds

Changes in the ocean: acidification

“Toxic algal bloom induced by **ocean acidification** disrupts the pelagic food web.”

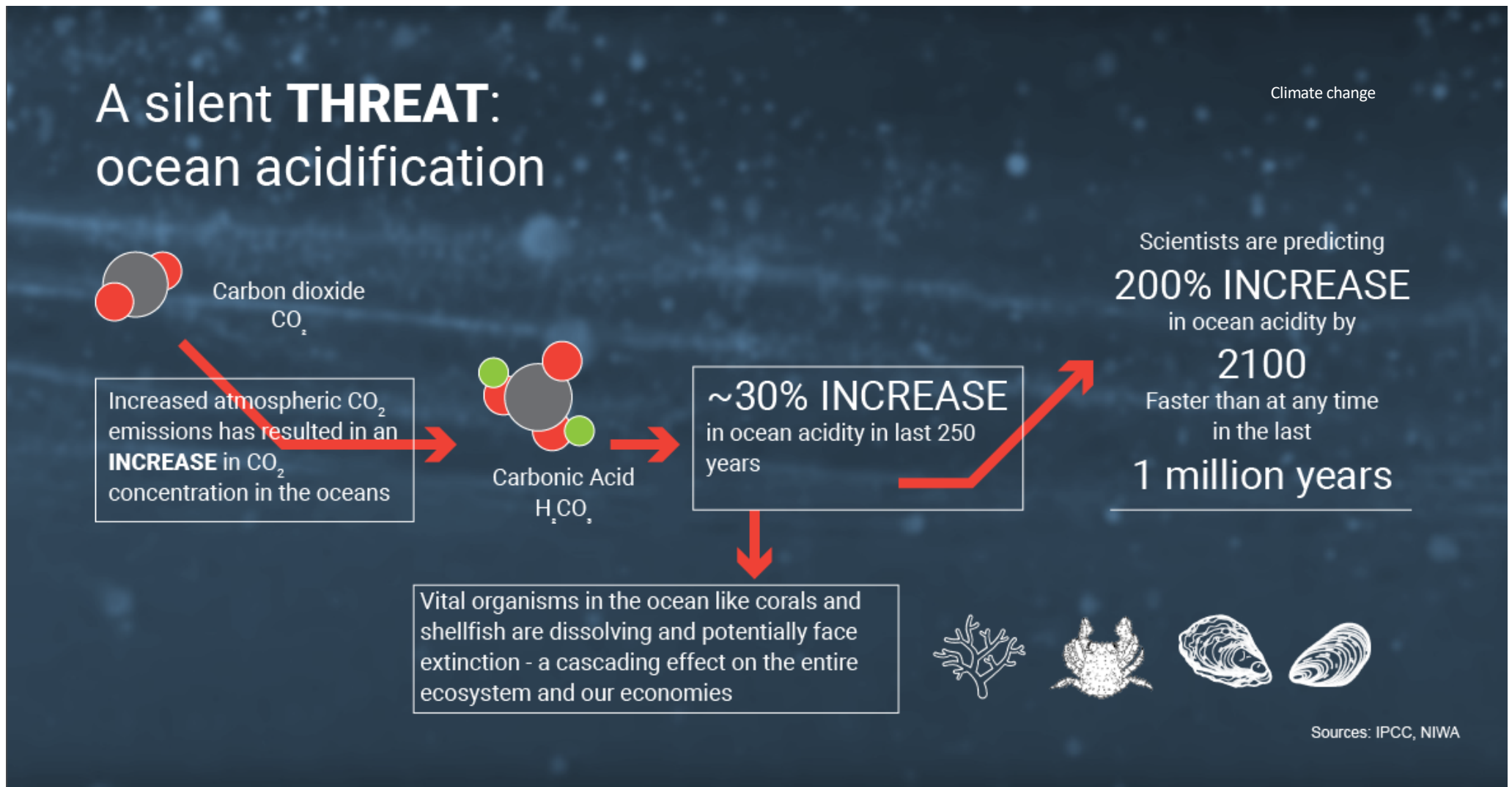
- Riebesell, U. et al. (2018) *Nature Climate Change* <https://doi:10.1038/s41558-018-0344-1>



Data: Mauna Loa (ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_mm_mlo.txt) ALOHA (http://hahana.soest.hawaii.edu/hot/products/HOT_surface_CO2.txt)
Ref: J.E. Dore et al, 2009. Physical and biogeochemical modulation of ocean acidification in the central North Pacific. *Proc Natl Acad Sci USA* **106**:12235-12240.

Problems for braided river birds

Changes in the ocean: acidification



“The speed of change makes it unlikely that marine organisms will be able to adapt before becoming extinct.”

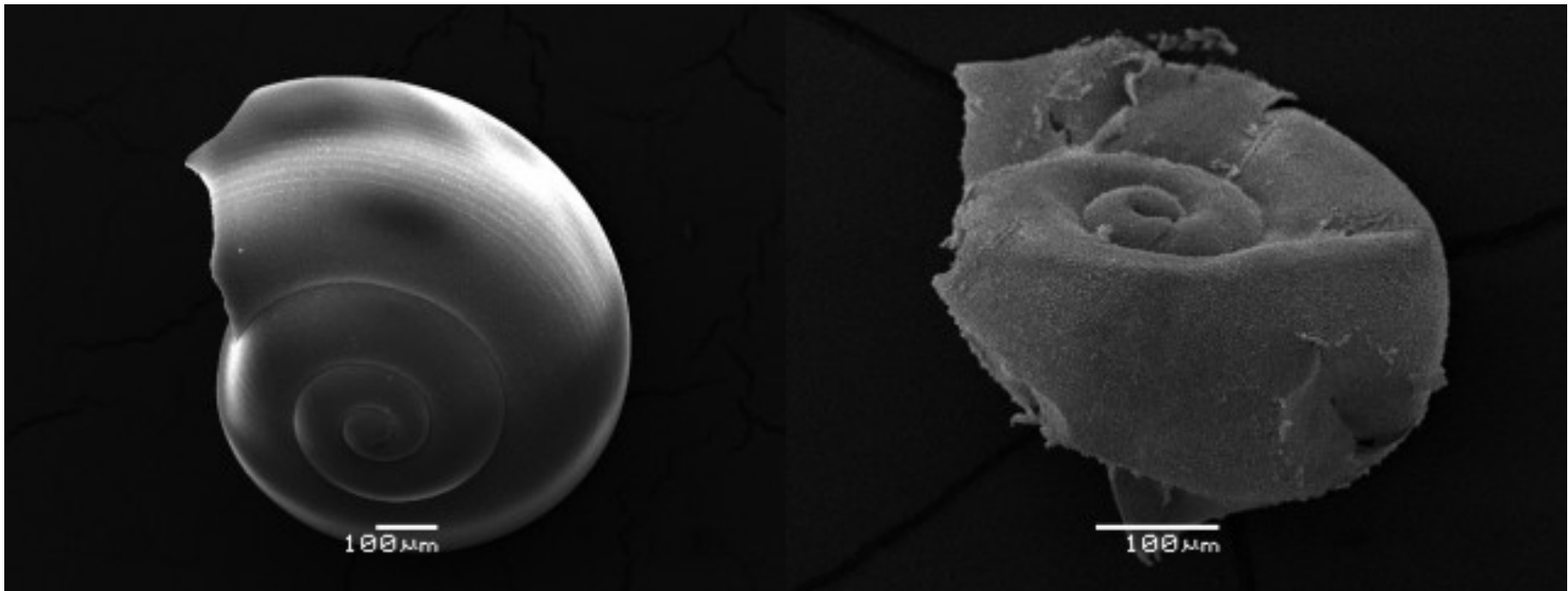
Comeau et al (2019) Resistance to ocean acidification in coral reef taxa is not gained by acclimatization. *Nature Climate Change* 9, 477–483, 27 May.

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Problems for braided river birds

Changes in the ocean: acidification

Sea butterflies collected in Antarctic waters 2011:



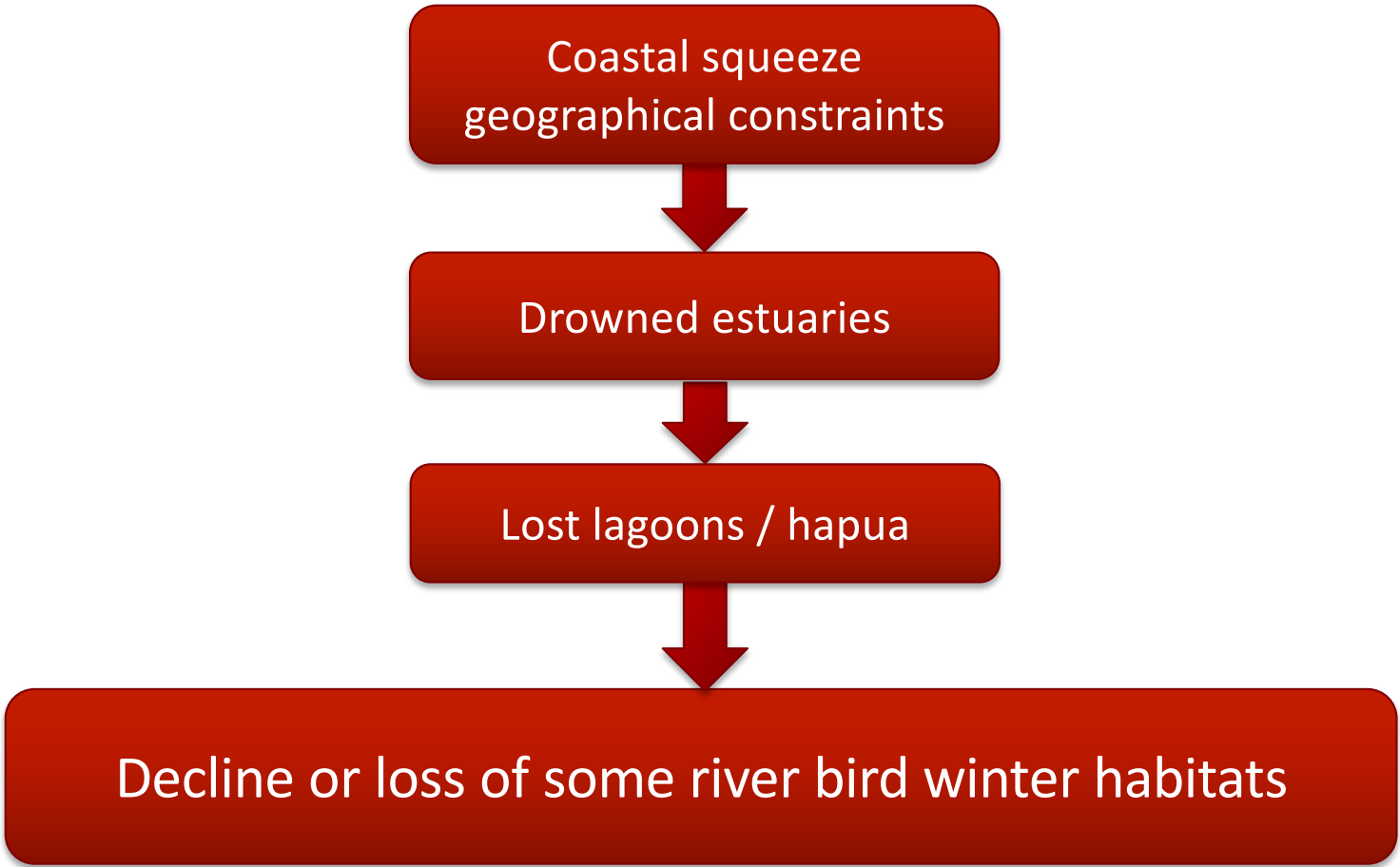
- Bednarsek et al (2012) Extensive dissolution of live pteropods in the Southern Ocean *Nature Geoscience* **volume 5**, pages 881–885



Decline / loss of some river bird winter food

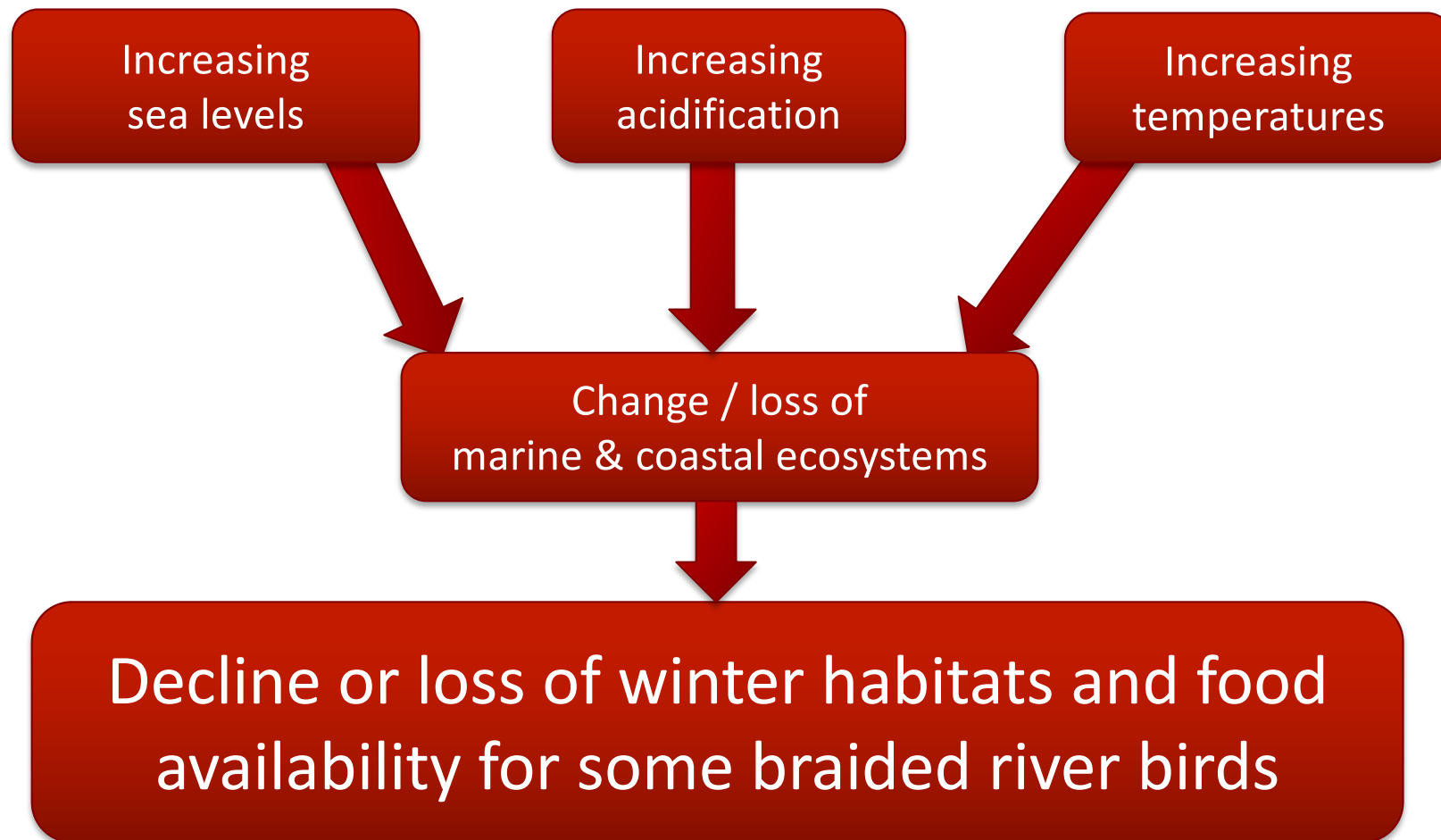
Problems for braided river birds

Changes in the ocean: rising sea levels



Problems for braided river birds

Changes in the ocean



What does a 'Climate Emergency' mean for braided rivers?



Risk Perception



Risk Analysis



Risk Management

Good news!

Braided river ecosystems evolved to **thrive in response to rapid and dynamic change**. If we protect them 'from the mountains to the sea' then of all the ecosystems in NZ, **they are the most inherently capable of surviving climate change**.

“Science has already prompted political action, and science is the pathway to solutions.”

- John Morgan Chief Executive, NIWA, June 2019 *Water & Atmosphere* pp4.

What does climate change mean for those responsible for managing braided rivers?

What should river managers do? They cannot look to tools of old: conventional management techniques that aim to restore ecosystems to their original state. Ongoing human development and **climate change mean that this is no longer possible**. And models based on past correlations do a poor job of predicting how species might respond to unprecedented changes in future. A different approach is called for.

Four steps

1. **Collect data on mechanisms**
2. **Describe key processes in models**
3. **Focus management on bottlenecks**
4. **Pinpoint uncertainty**

- Tonkin et al. (2019) Prepare river ecosystems for an uncertain future, *Nature* 570, 301-303 (2019)
www.nature.com/articles/d41586-019-01877-1

Take home message

- Climate change is Integral to and exacerbating existing problems
- Climate change is creating new problems, some 'outside' braided river ecosystems, ie coastal/oceanic and policy/planning
- Braided river ecosystems evolved inherently capable of adapting **IF** we protect them through adaptive rather than conventional management strategies

