Tracking long-term biogenic changes in response to an earthquake and a modified physical environment

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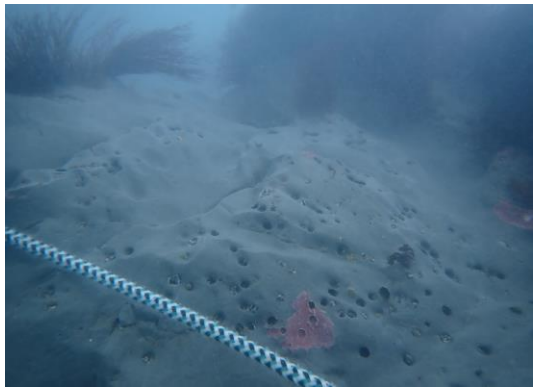
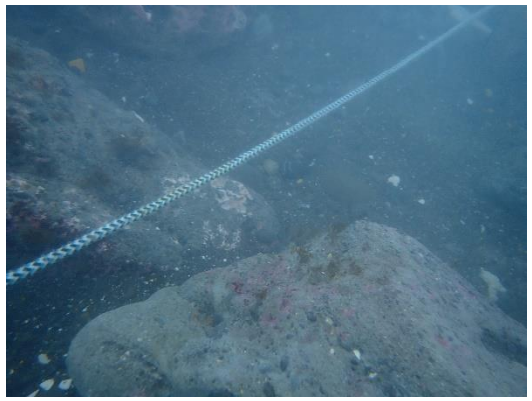
global **environmental** and **advisory** solutions

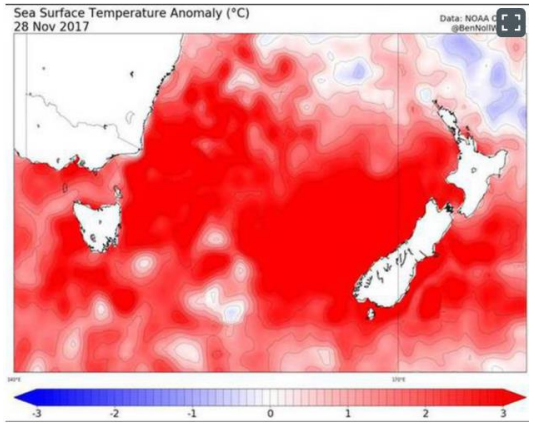
2016 Kaikōura earthquake

7.8 Mw, Uplift up to 6 m

- Subtidal became intertidal or terrestrial
- Subtidal emergent rock pushed up through gravel and sand
- Exposed to altered wave environments







New Zealand's most severe marine heatwave as observed in late November, 2017. Image / Ben Noll, Niwa

Uplift

Subtidal emergent bare rock
Different wave environment

Turbidity

Runoff and erosion

Movement of gravel and sand

Scour and burial

Marine heat wave

2017/2018

Sites: across a degree of uplift, From Cape Campbell to Oaro

Sites allocated Uplift levels according to values determined by GNS Science

C = control L = low M = medium H = high

0m ~1m 2-3m 5-6m

10 locations surveyed up to 7 times

2017

2018

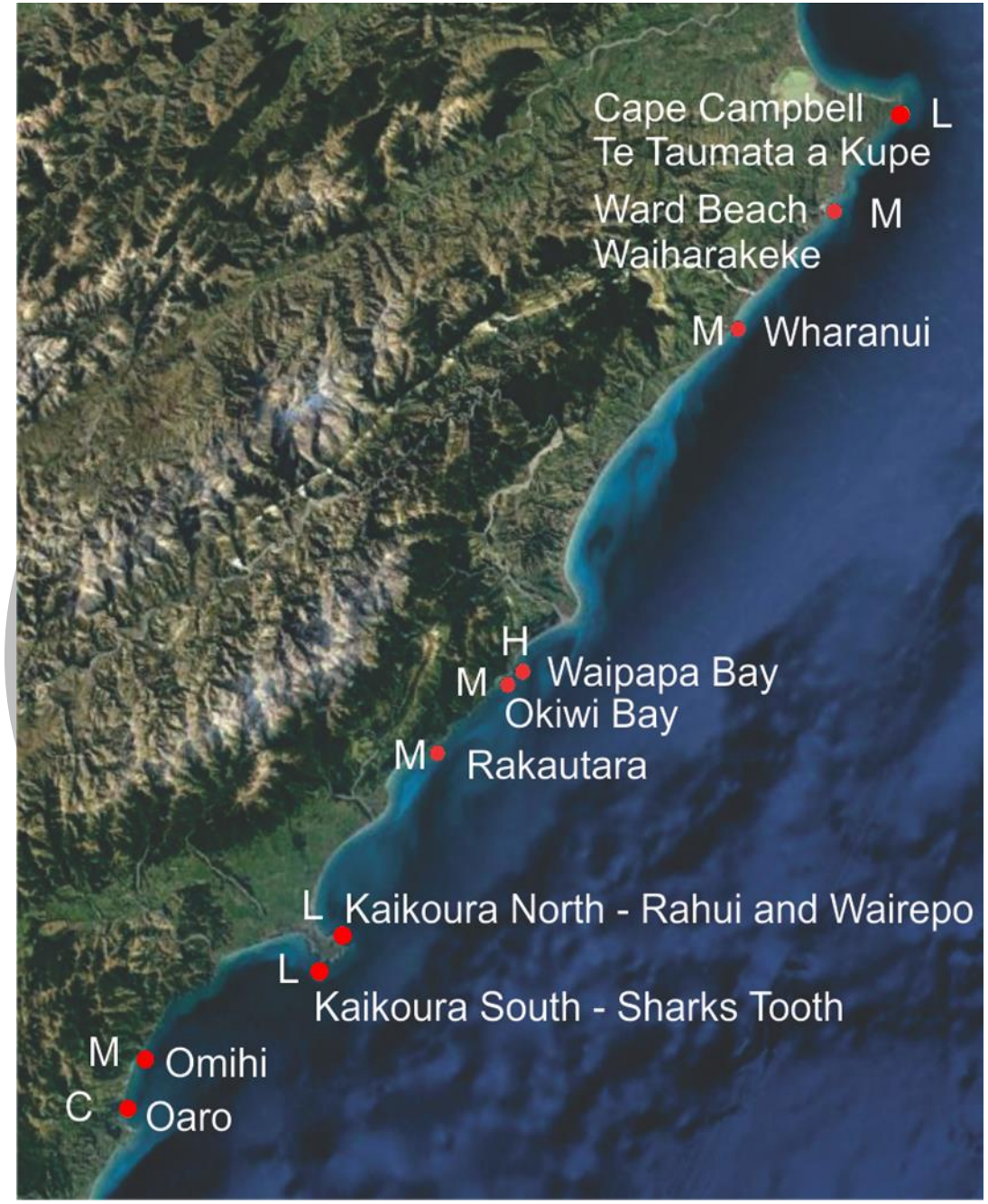
2019

2019/20

2020

2021

2022



Survey design

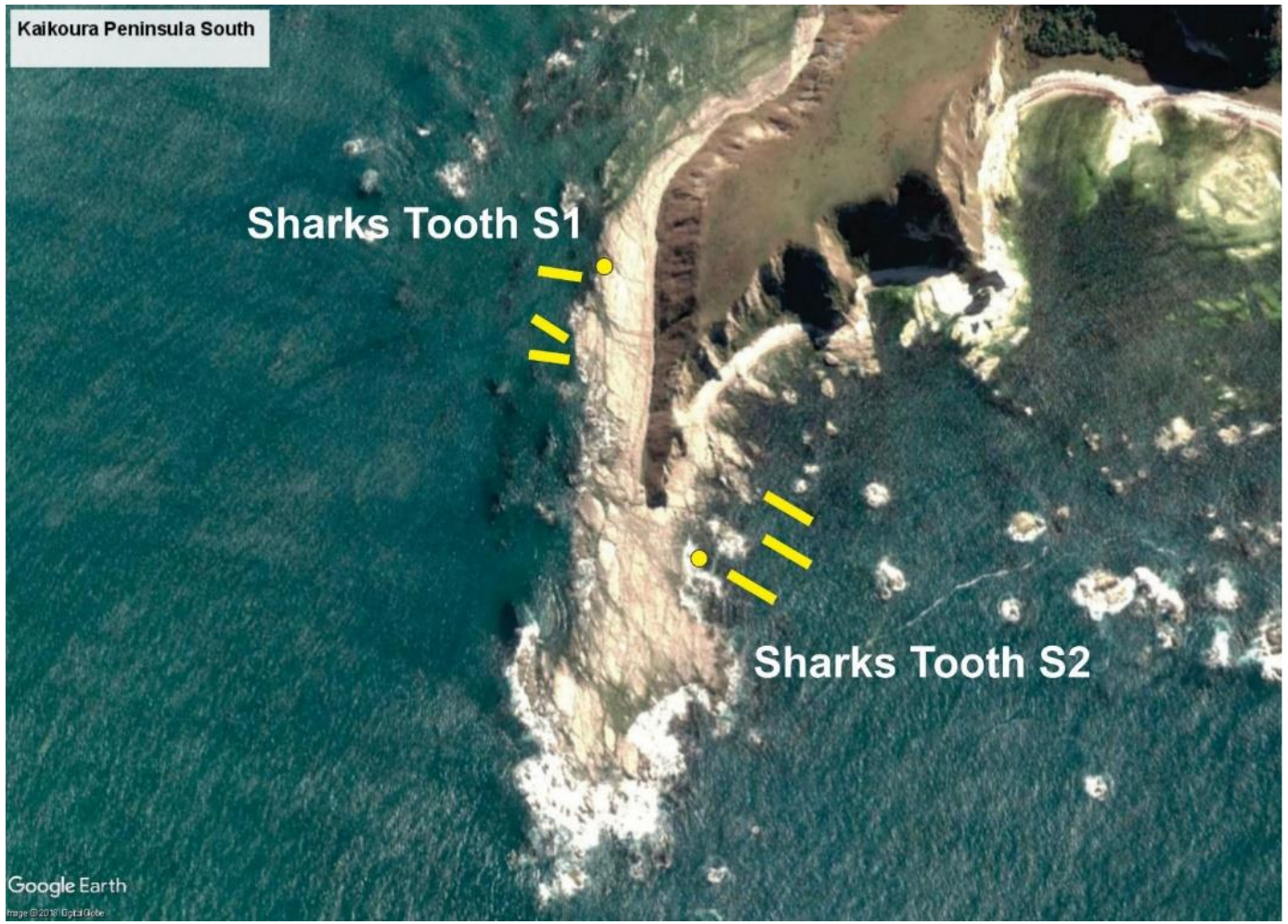
At each location: 2 sites

At each site: 3 transects

50 m transects perpendicular to the shore, from the low tidal zone to depths of <10 m

2.5m x 2 m quadrats

- substrate type
- seaweed and sessile invertebrate percentage covers
- numbers of mobile invertebrates surveyed
- fish counts,
- pāua depths and sizes recorded
- video



Summary of initial surveys (2017)

Location	Uplift	Effects
Oaro	C	No obvious
Cape Campbell	L	No obvious
Kaikoura North	L	No obvious
Kaikoura South	L	No obvious
Omihi	M	Minor
Rakautara	M	Minor
Ward	M	Minor-medium
Wharanui	M	Minor-medium
Okiwi Bay	M	Minor-medium
Waipapa Bay	H	Major

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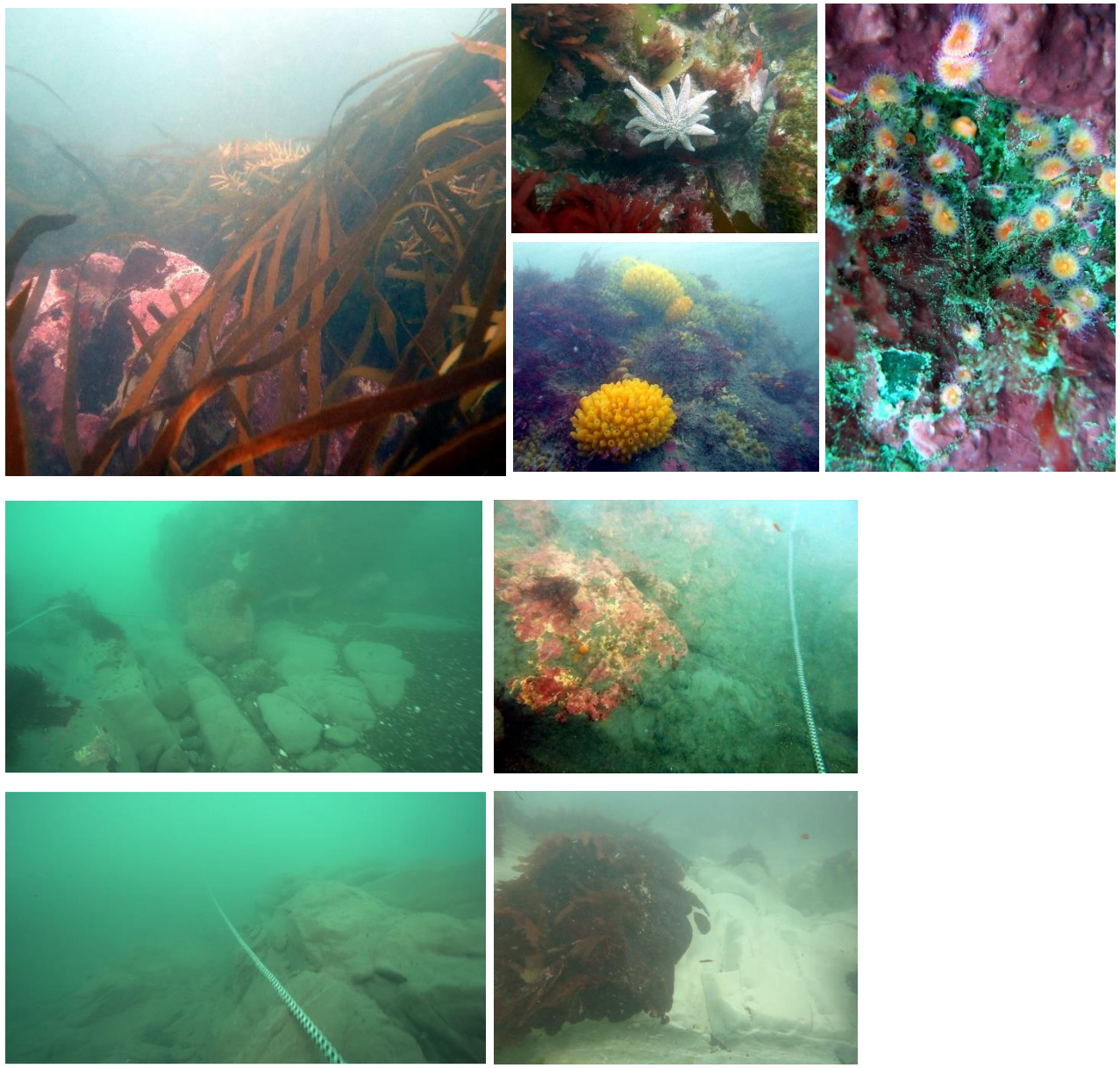
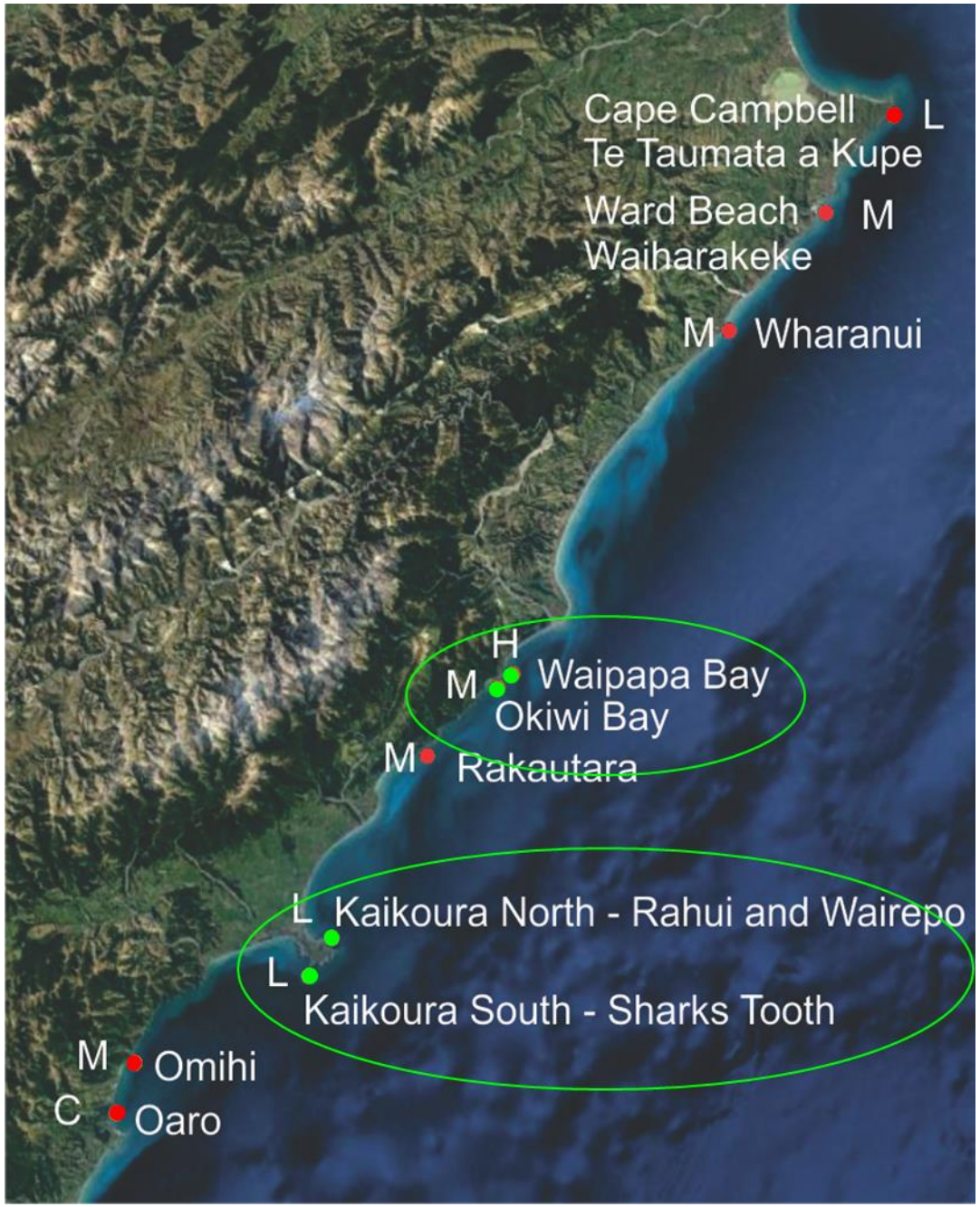
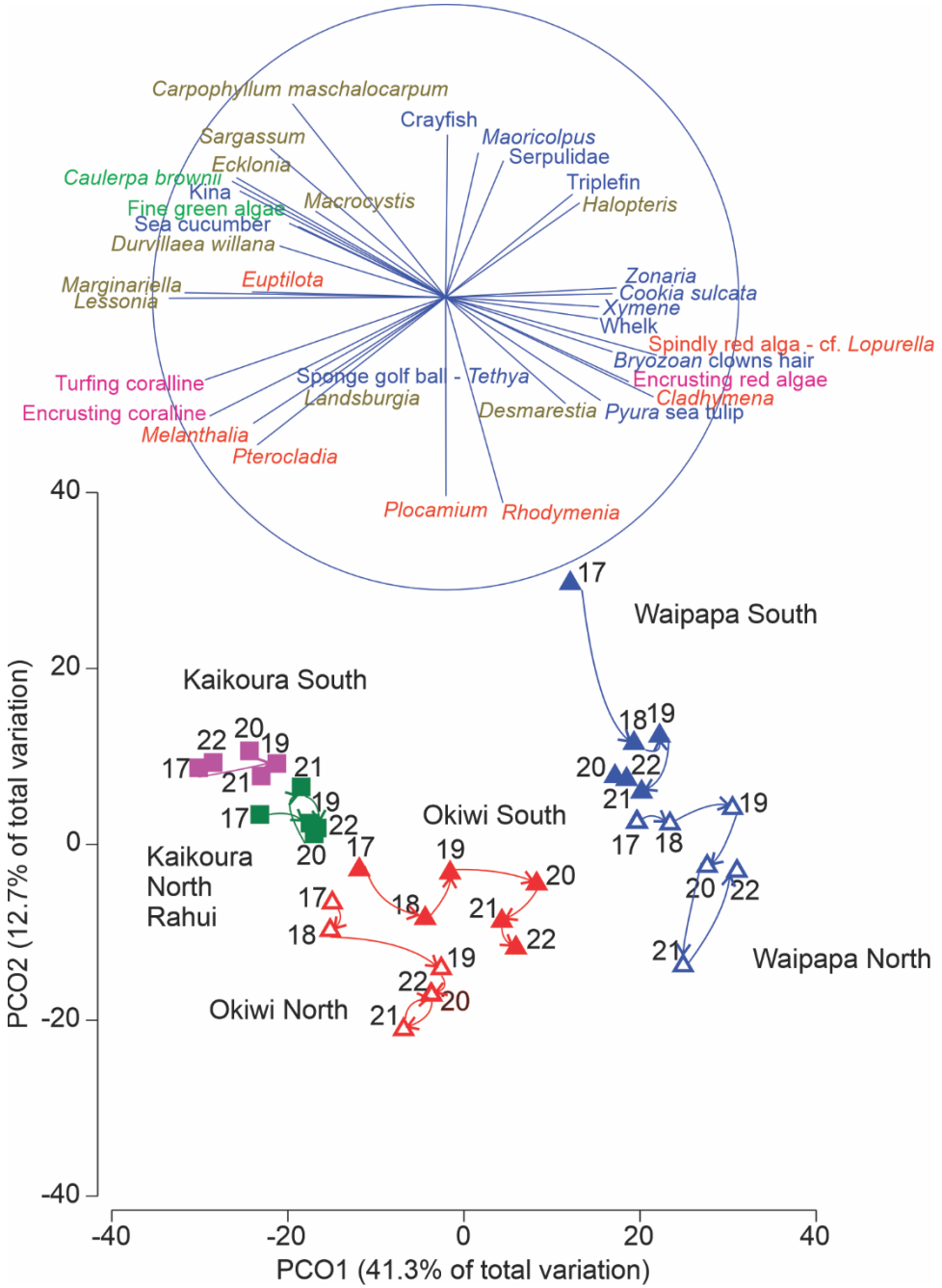



Cape Campbell
Te Taumata a Kupe
L
Ward Beach
Waiharakeke
M
M
Wharanui
H
M
Waipapa Bay
Okiwi Bay
M
Rakautara
L
Kaikoura North - Rahui and Wairepo
L
Kaikoura South - Sharks Tooth
M
Omihi
C
Oaro

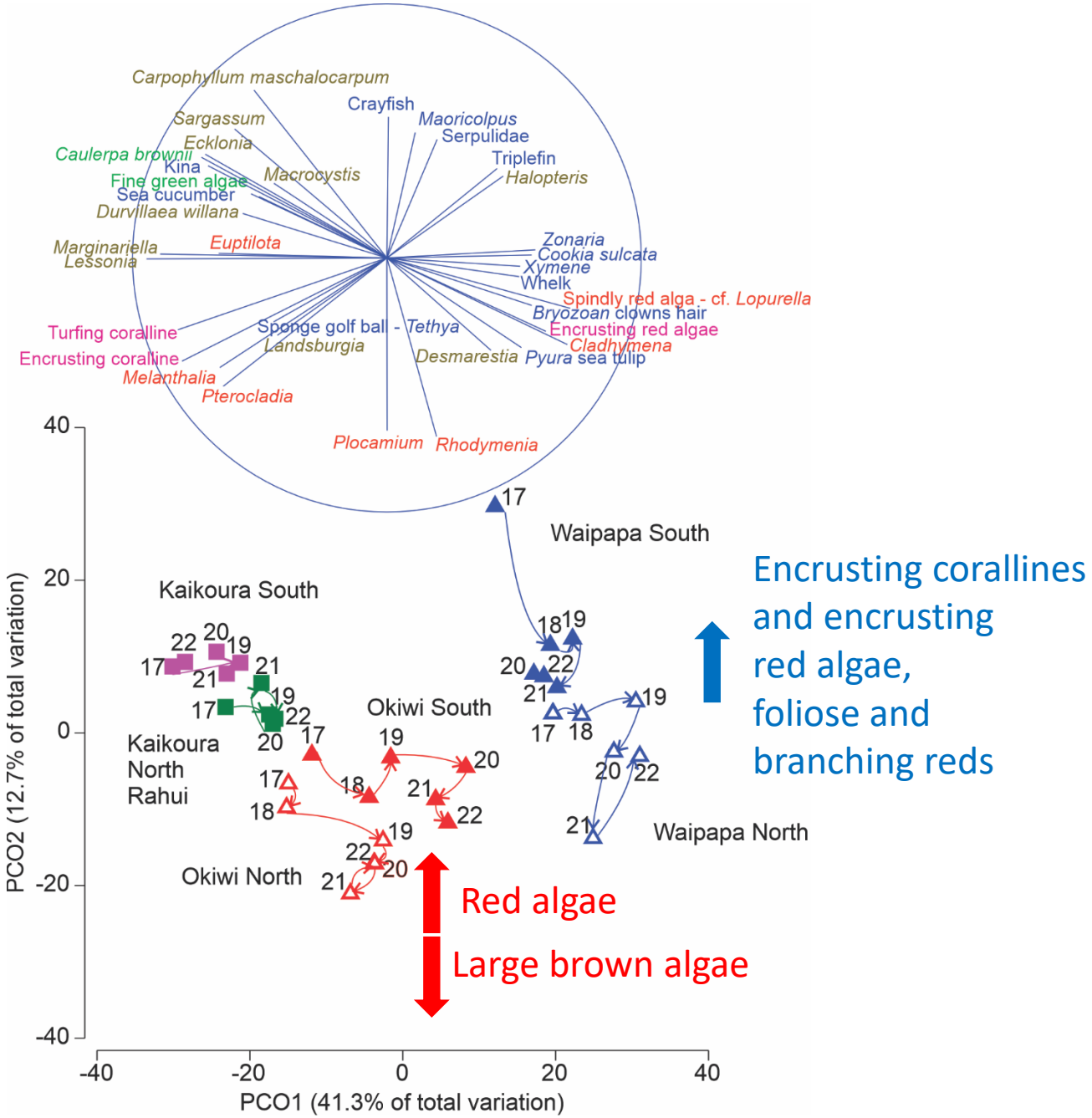
PCO of entire community data

- Seaweeds and invertebrates



PCO of entire community data - Seaweeds and invertebrates

Initial decline in large brown algae in 2019, then increase 2020-22



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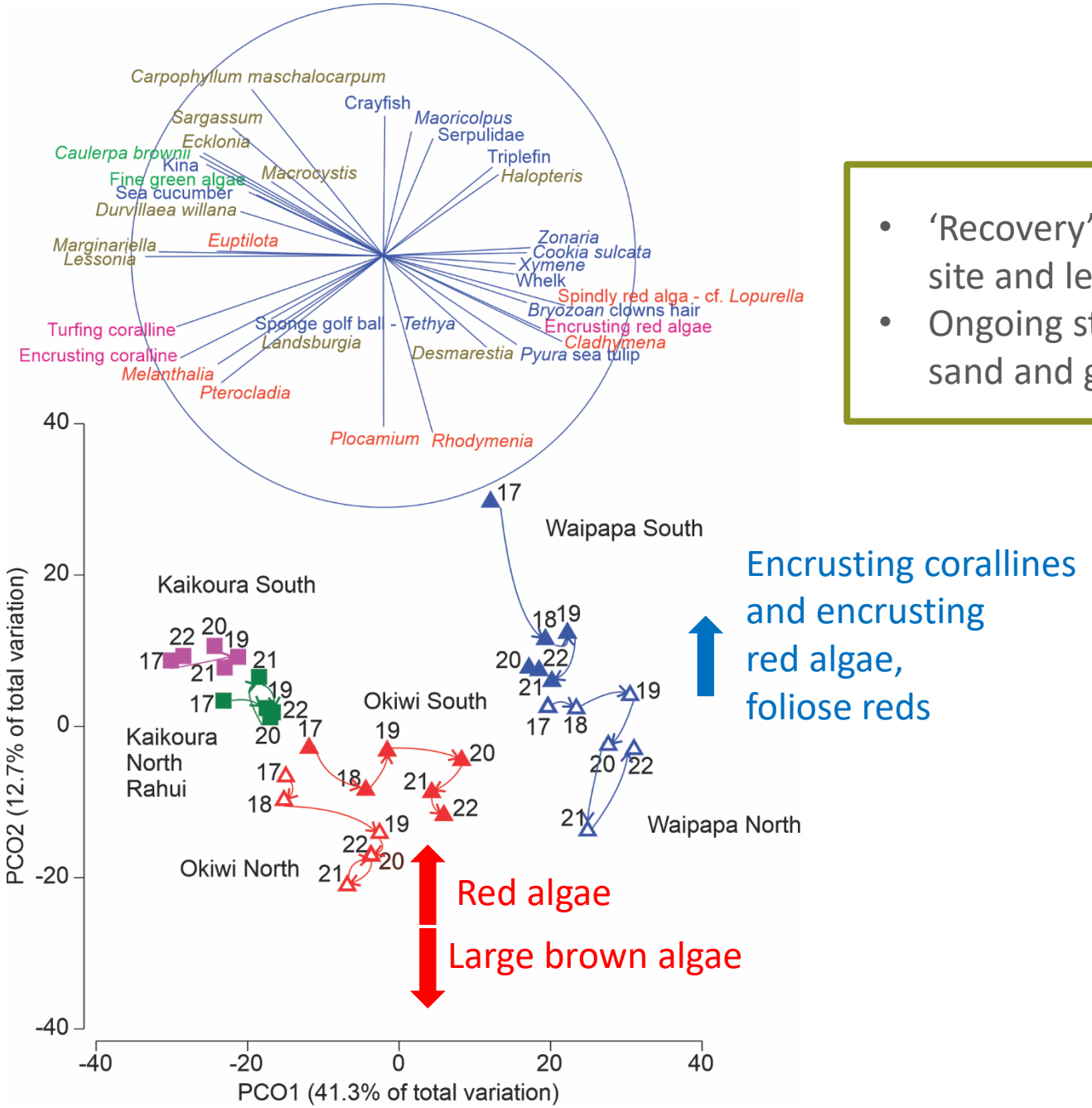
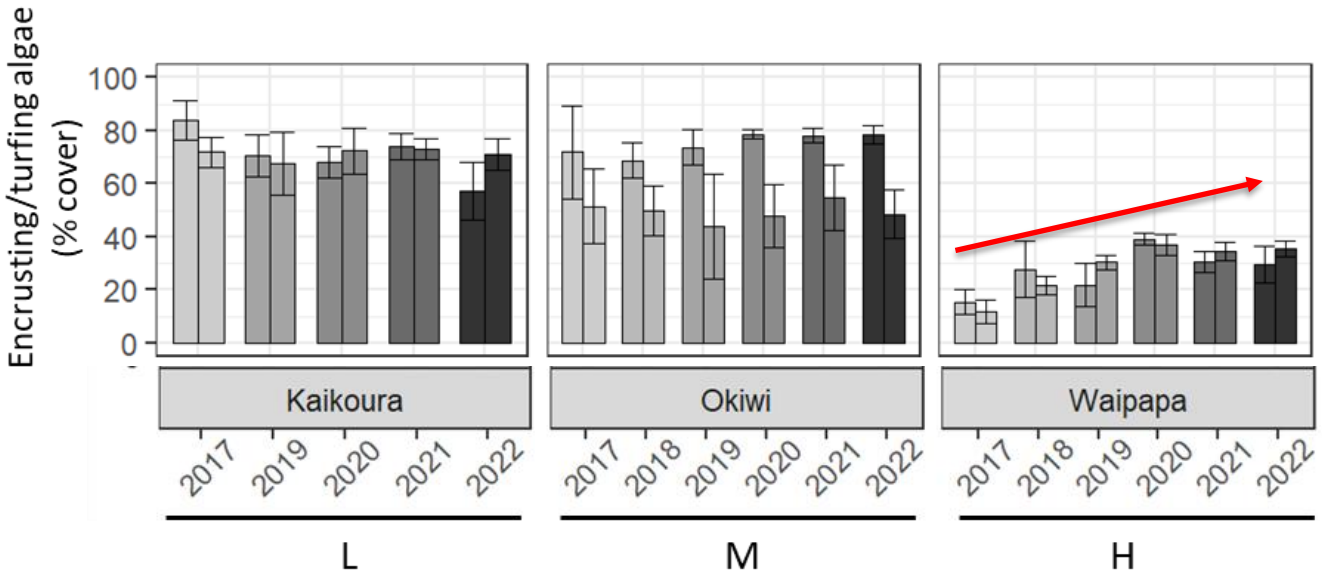


- ‘Recovery’ different for each site and level of uplift.
- Ongoing stressors such as sand and gravel movement

Seaweed abundances through time



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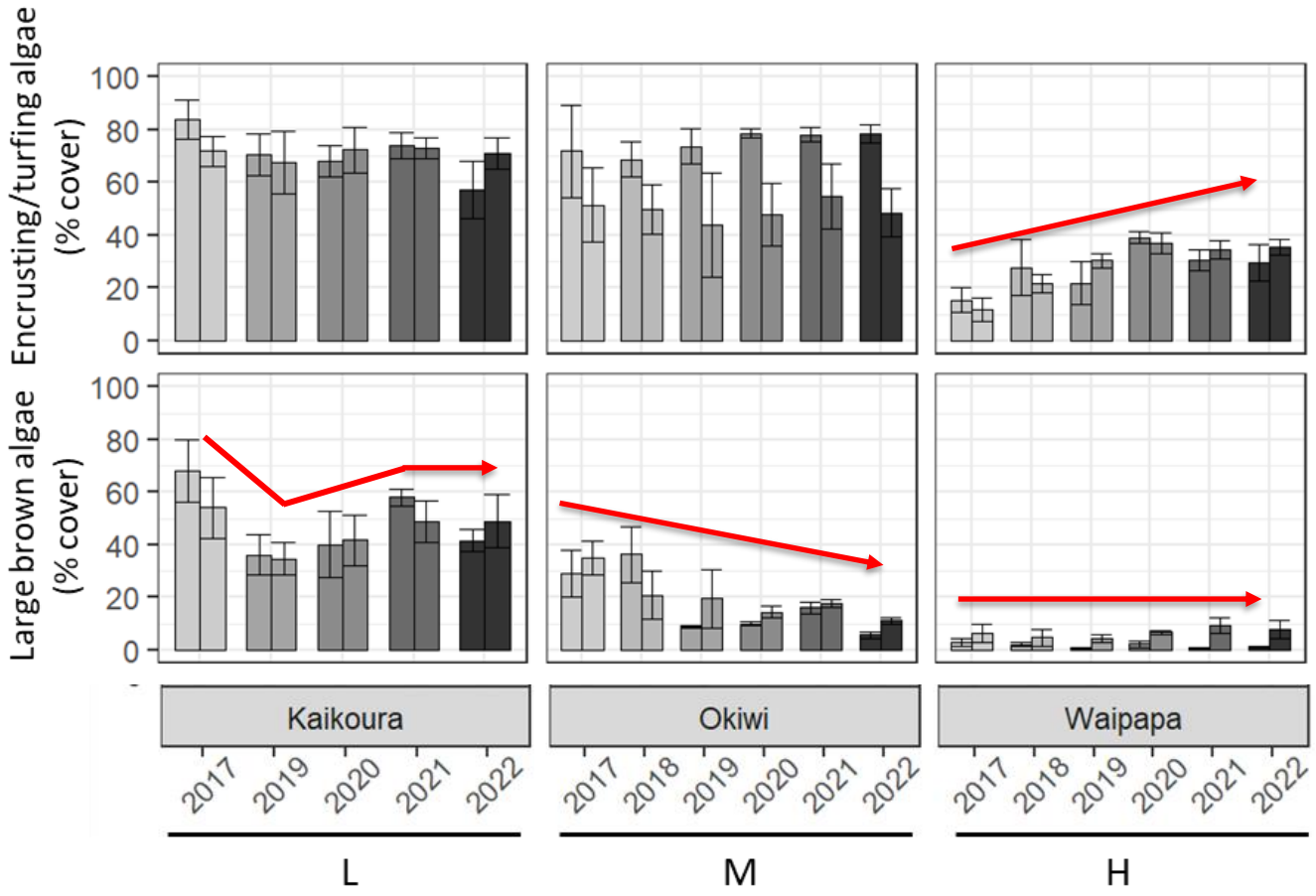

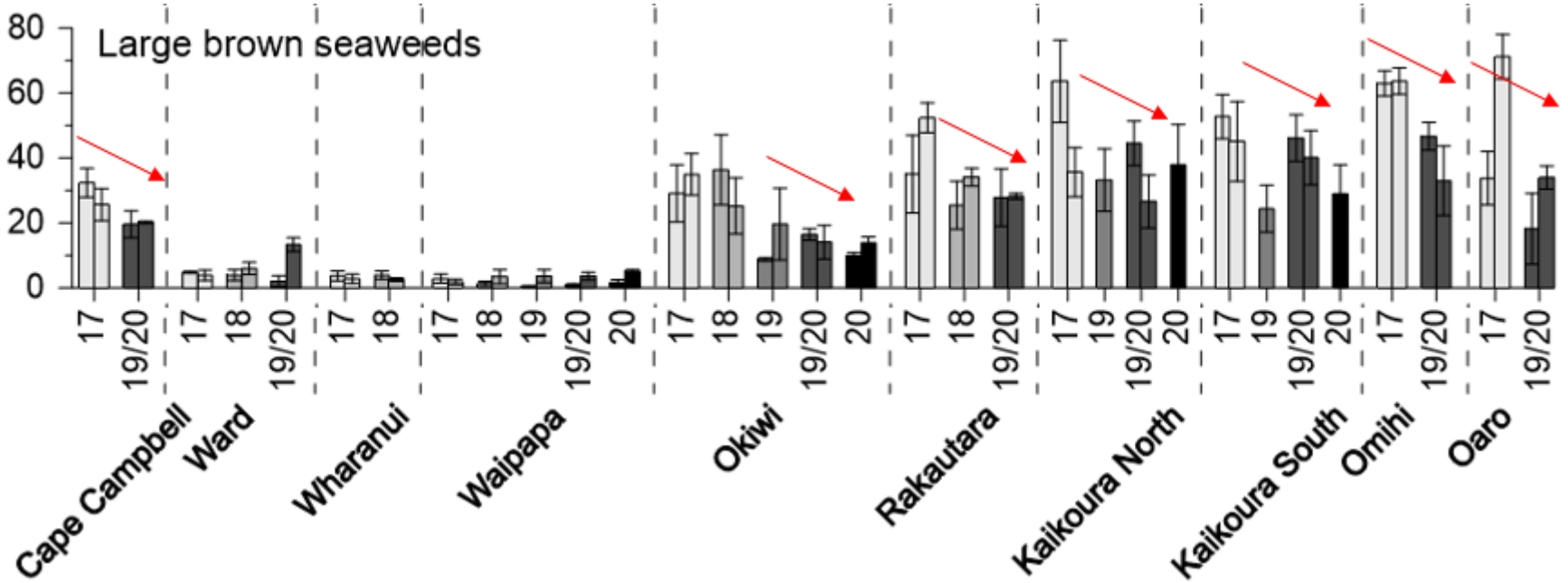
Large brown seaweeds
80
60
40
20
0
17
19/20
17
18
19/20
17
18
17
18
19
19/20
20
17
18
19
19/20
20
17
18
19/20
17
19
19/20
20
17
19
19/20
20
17
19/20
17
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Cape Campbell
Ward
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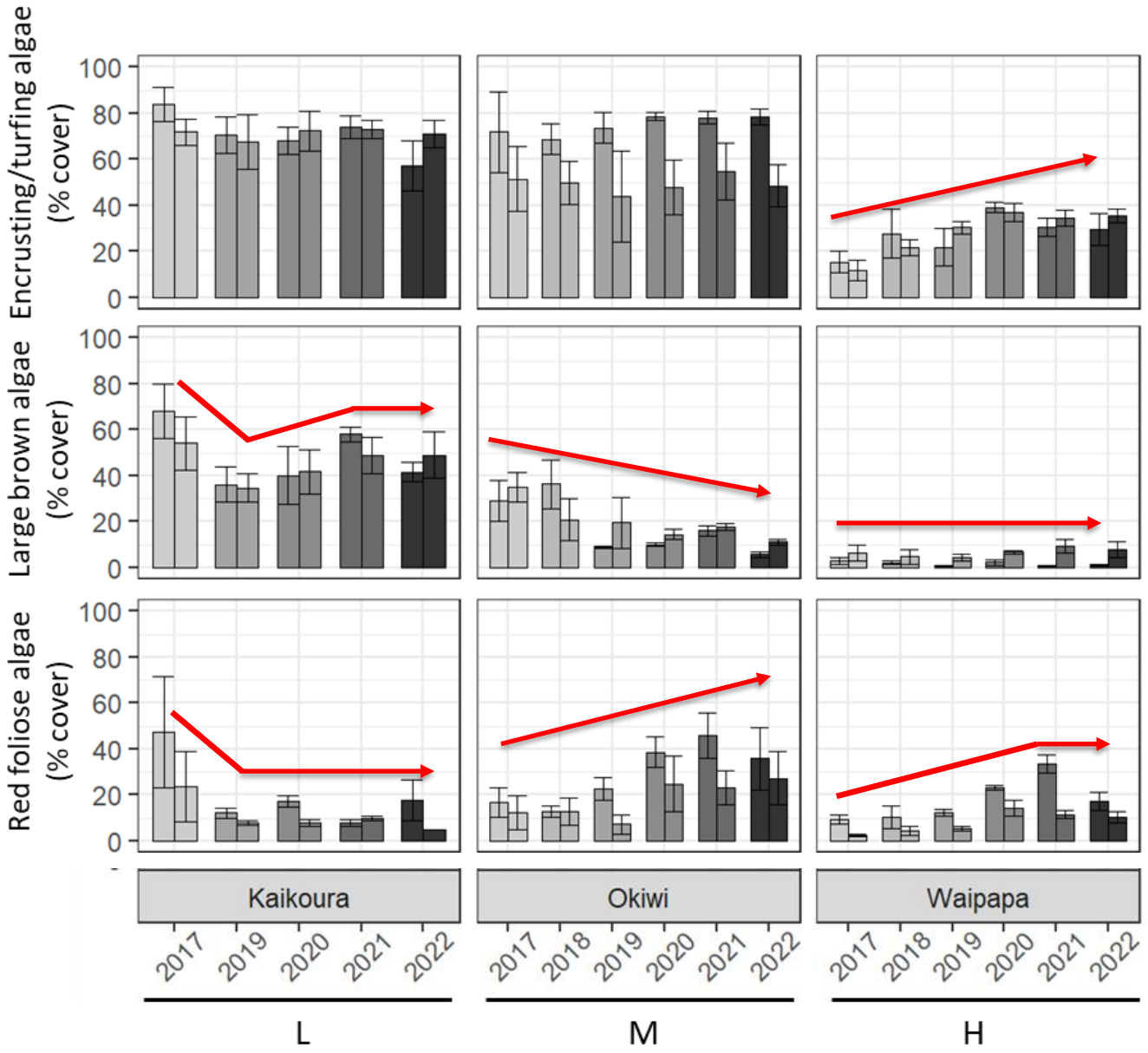
Okiwi
Rakautara
Kaikoura North
Kaikoura South
Omihi
Oaro

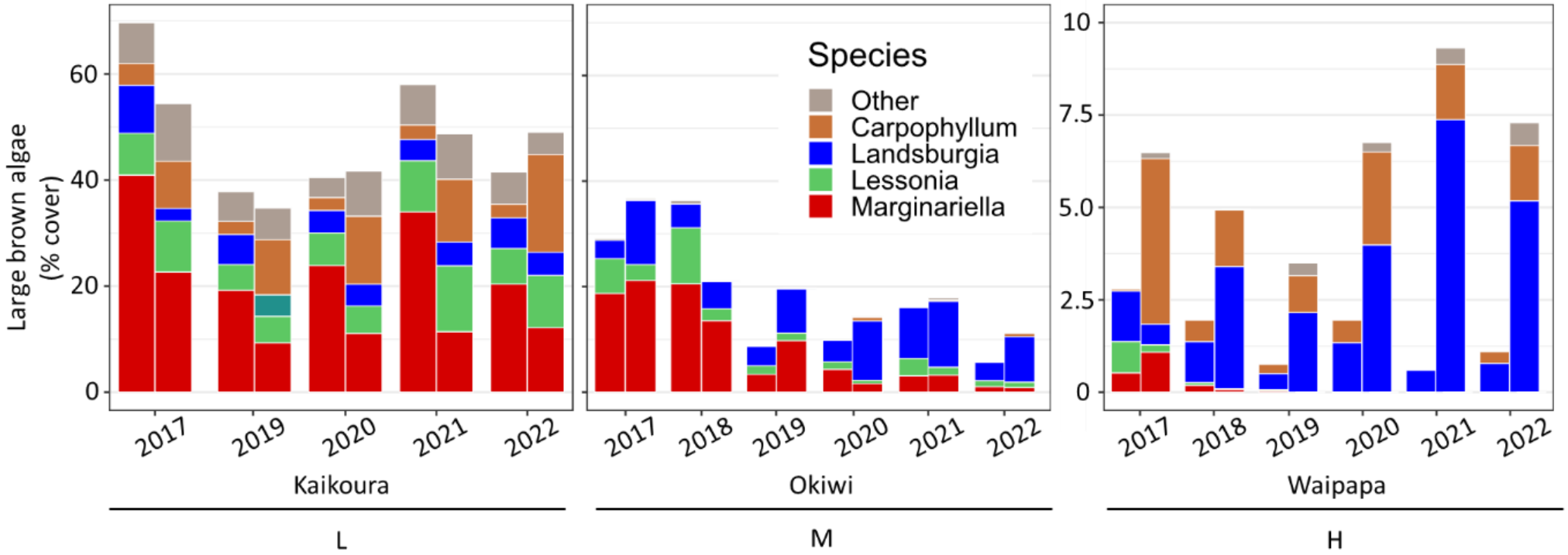
L M M H M M L L L C

Seaweed abundances through time



Large brown algal species



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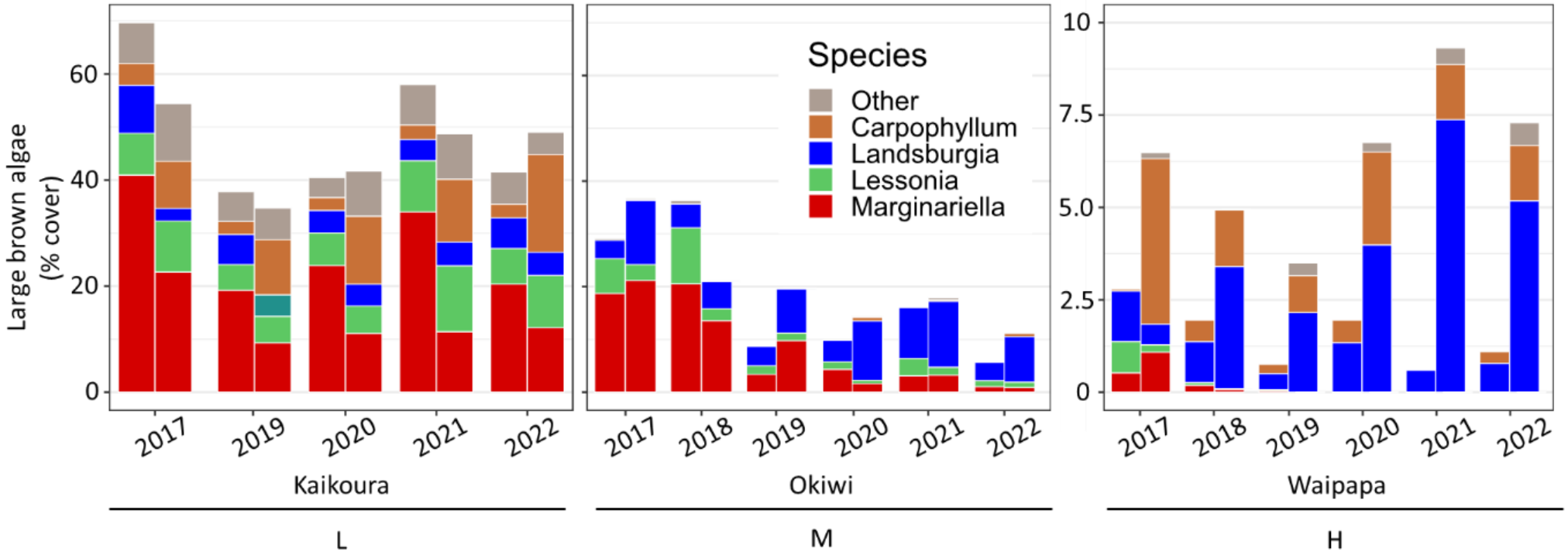
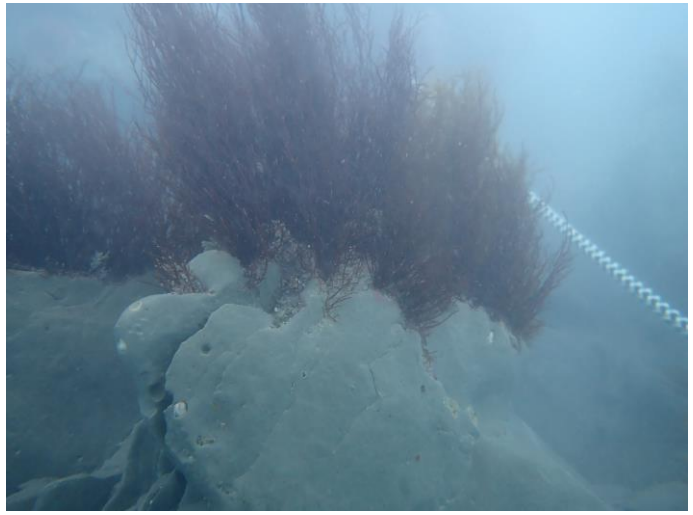
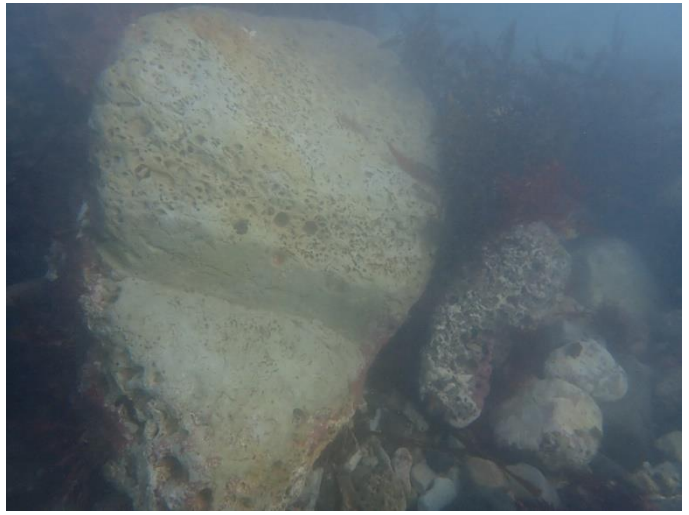


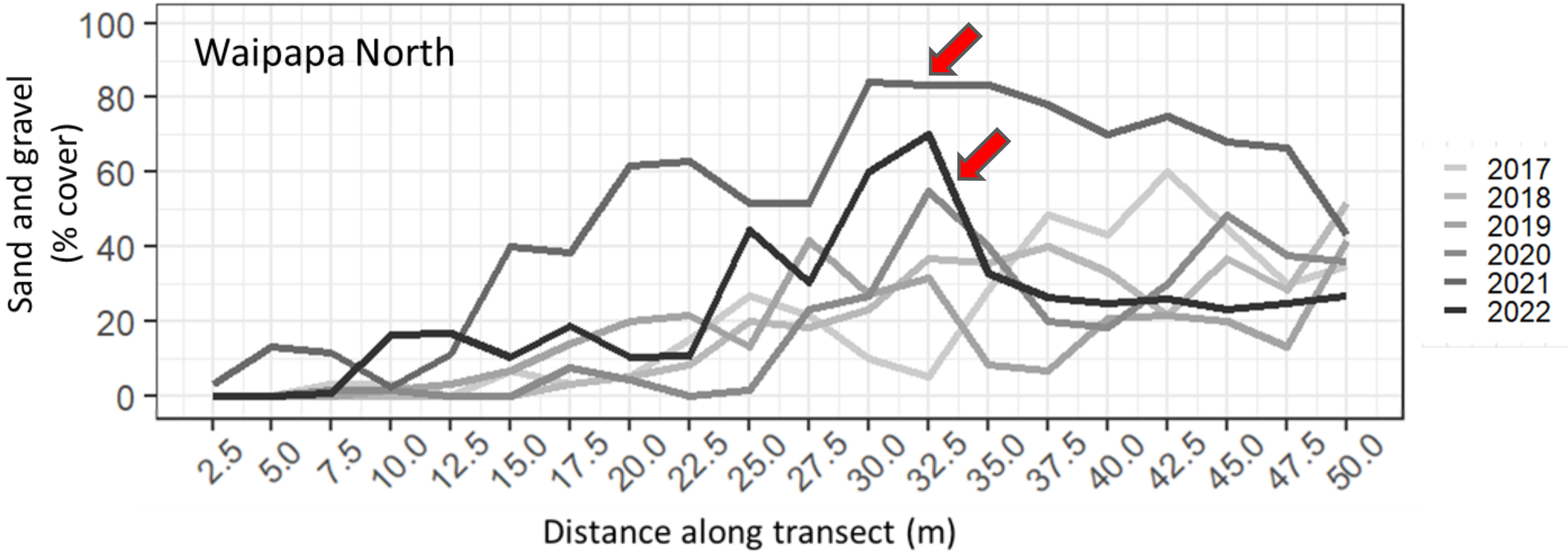
Fucoids are cool too! ☺

Recovery – affected by scour and burial

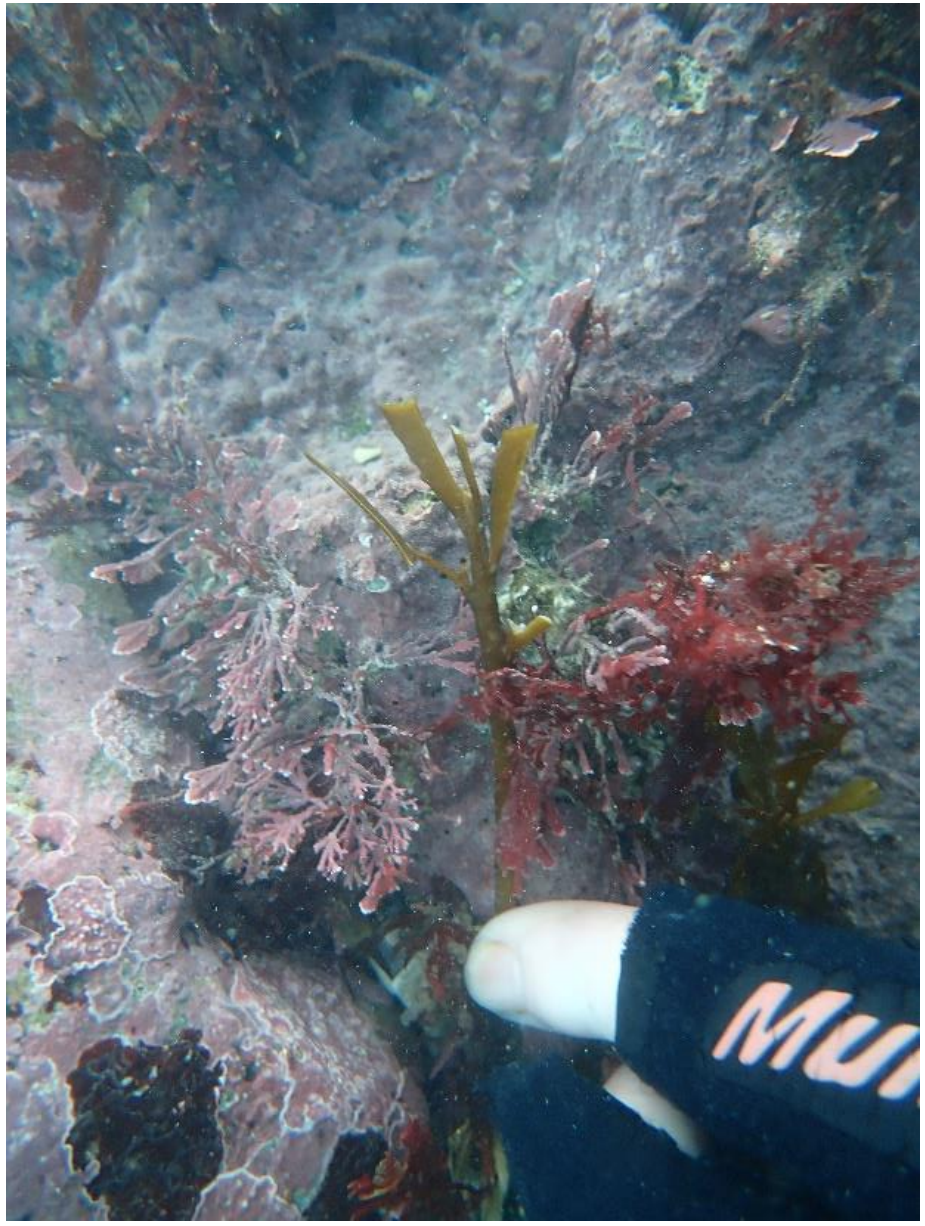




Sand/gravel movement



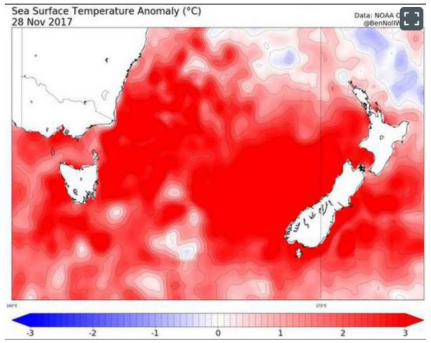
Recovery – affected by fish grazing



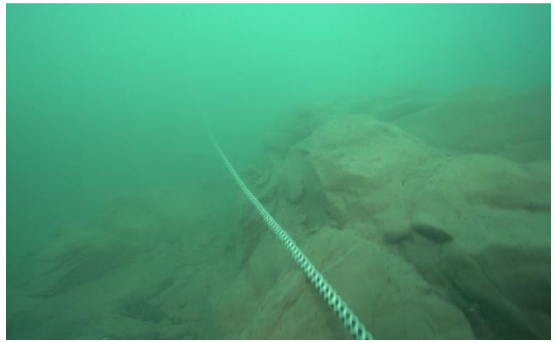
Fish grazing

Recovery

- Turbidity levels – increased runoff, erosion
- Marine heat waves
- Contend with gravel/sand movement
- Different wave climate
- Fish grazing
- Lack of adult supply



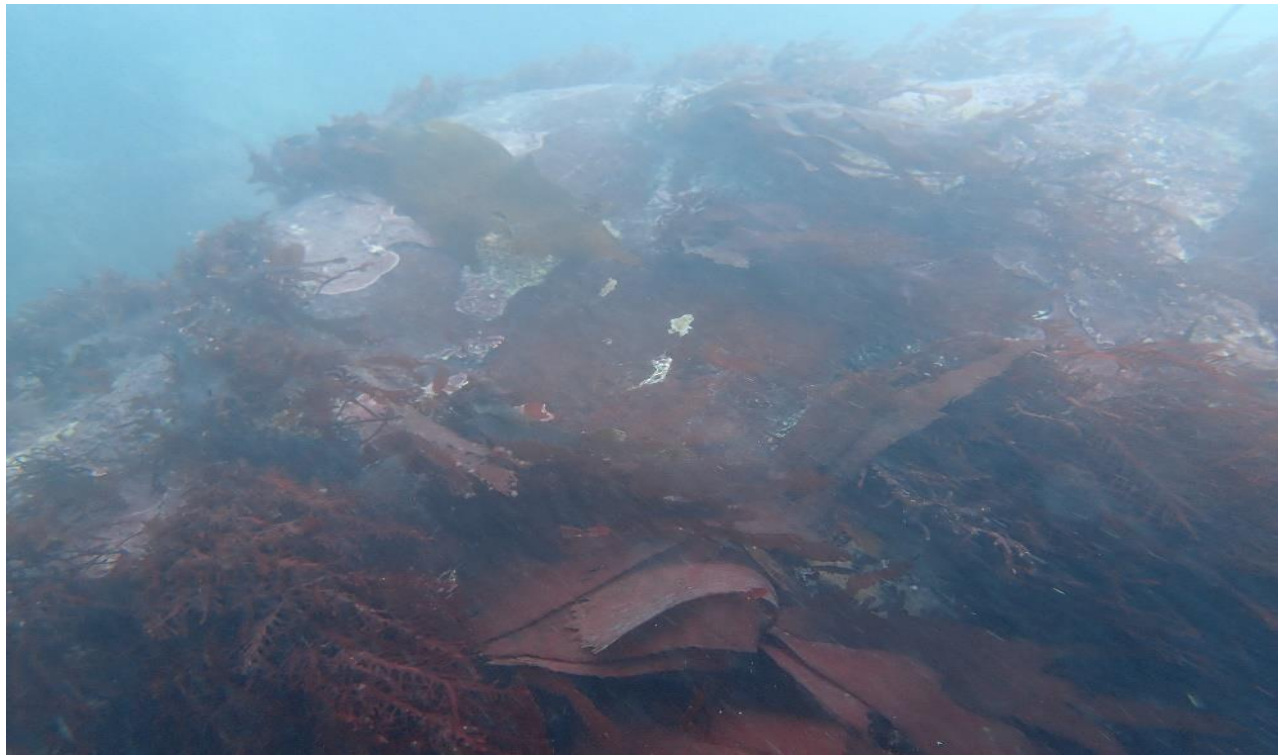
New Zealand's most severe marine heatwave as observed in late November, 2017. Image / Ben Noll, Niwa



Still many changes in this dynamic subtidal environment, 'recovery' far from complete

Okiwi 2017

Okiwi 2022



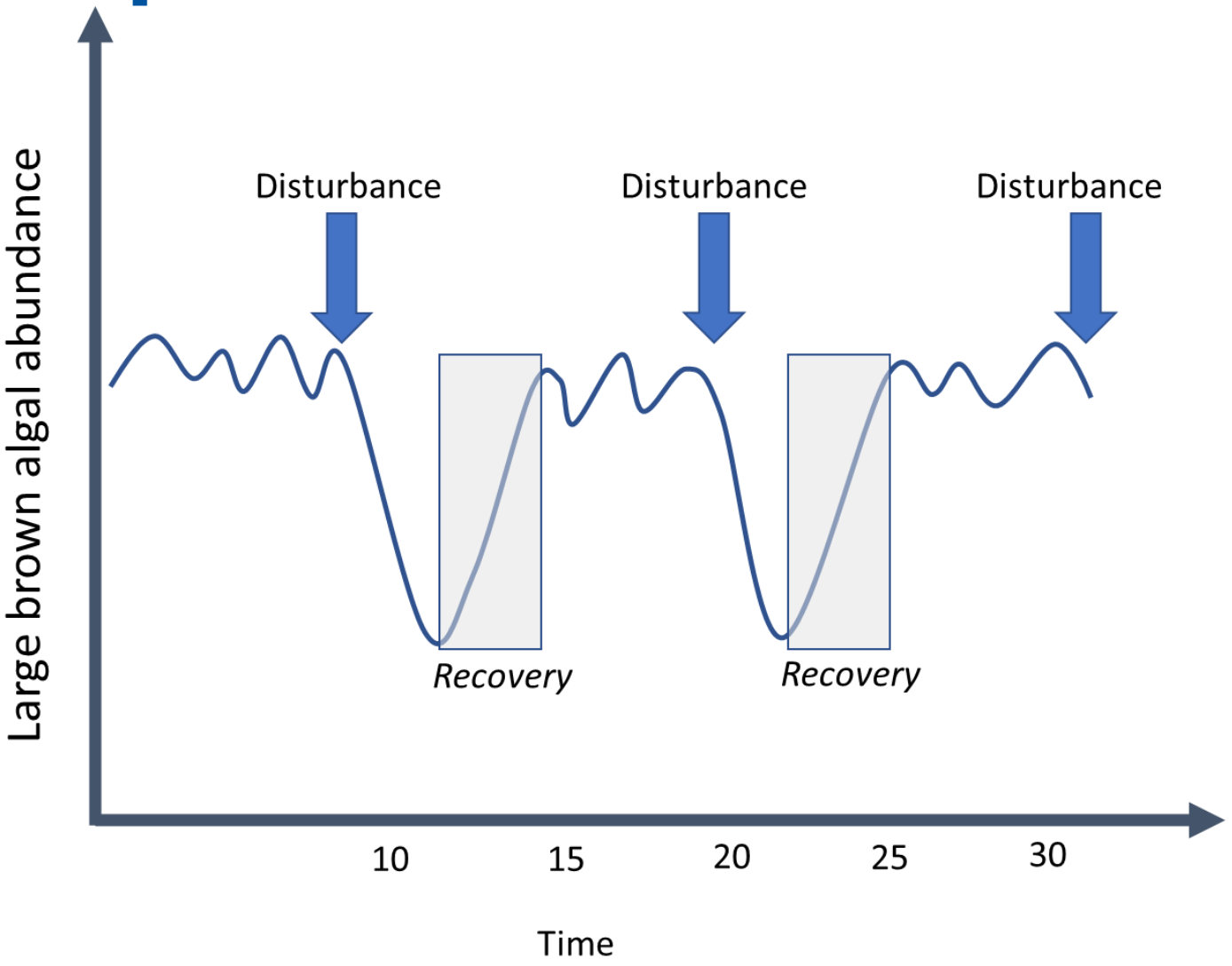
2017

2018

2021

Photos: The New Zealand King Salmon Co. Limited

Potential phase shift?



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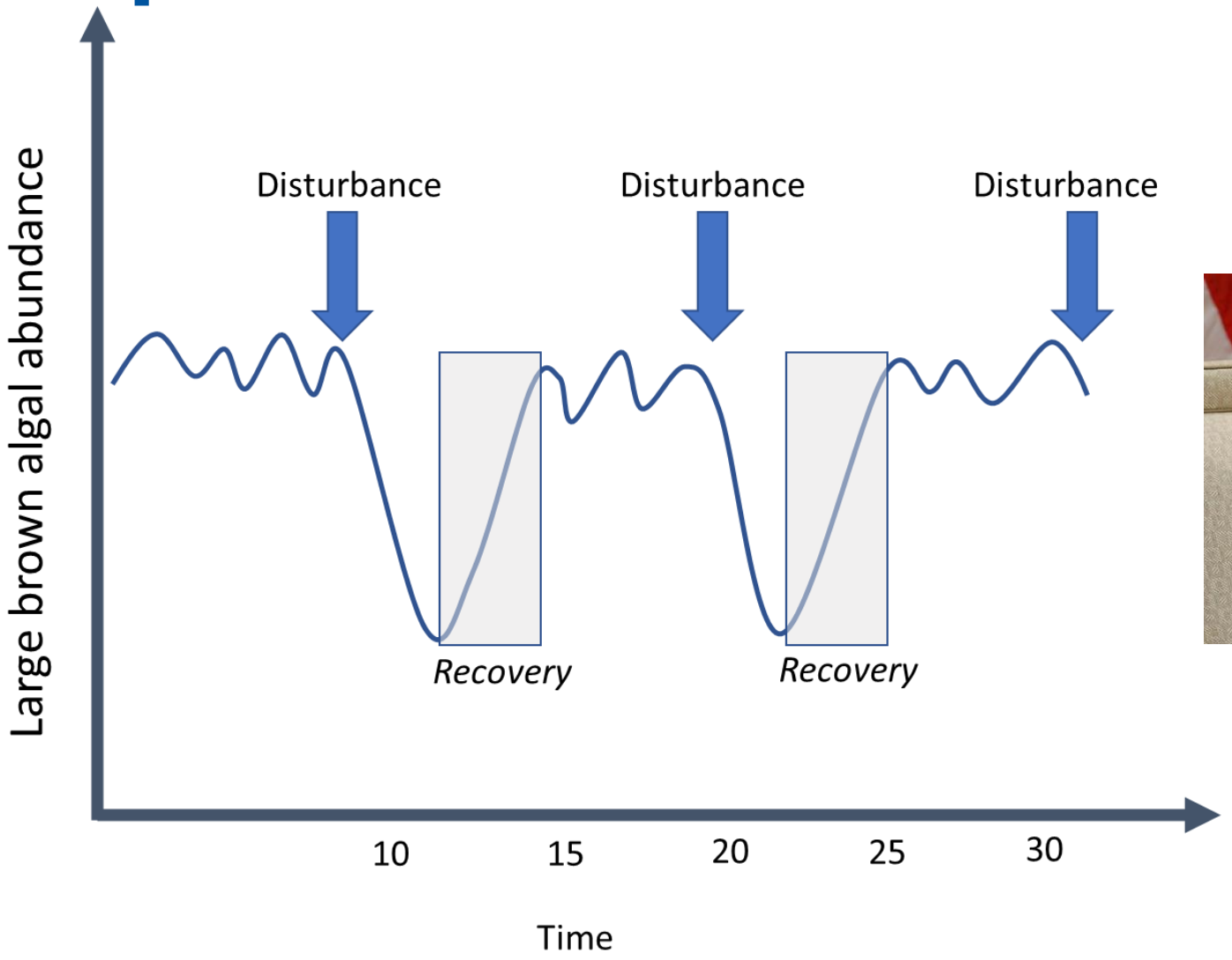

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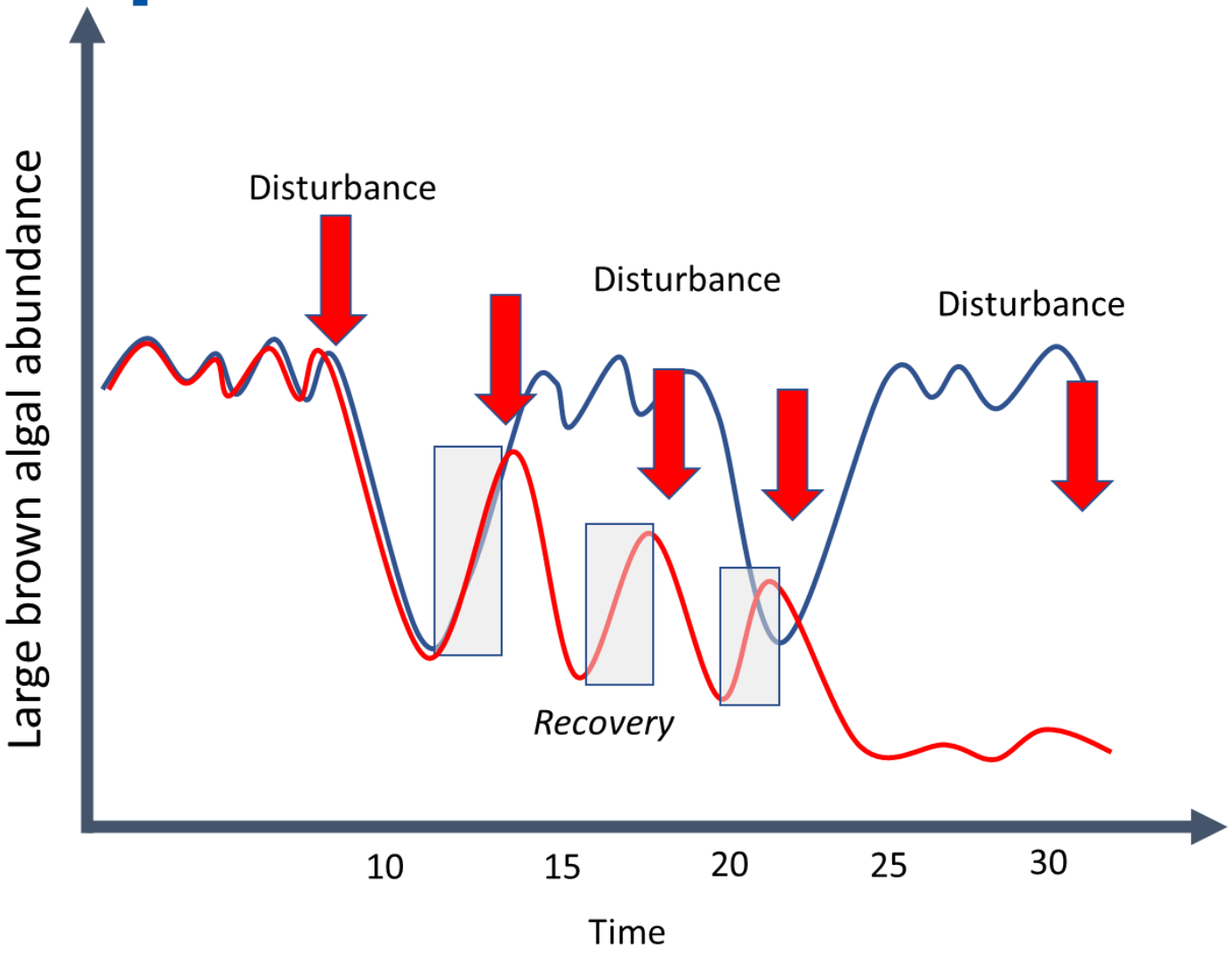

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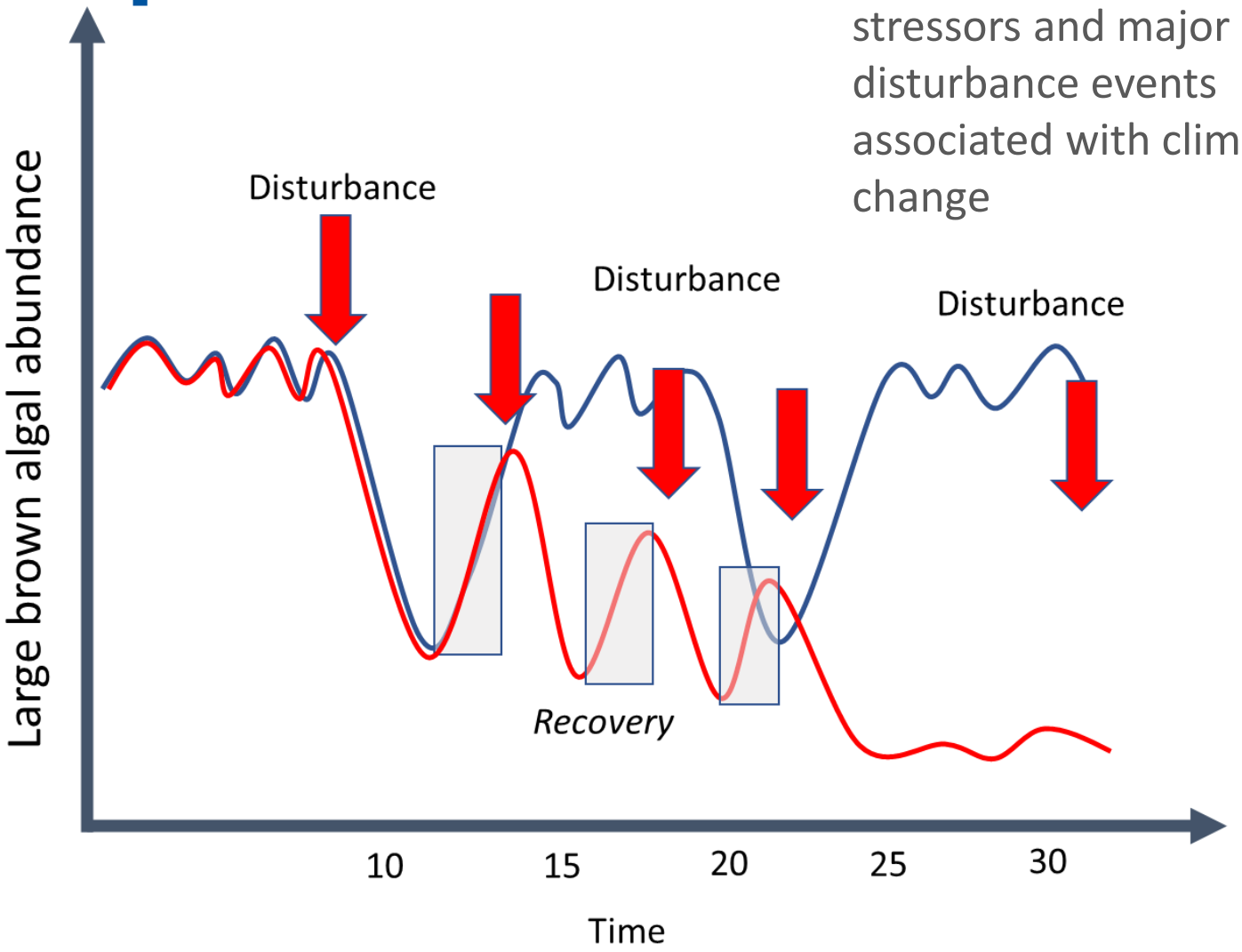
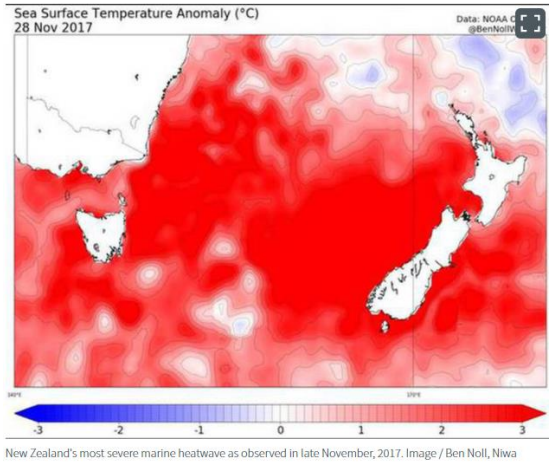


Cumulative impacts of earthquake plus ongoing stressors and major disturbance events associated with climate change



New Zealand's most severe marine heatwave as observed in late November, 2017. Image / Ben Noll, Niwa

ACKNOWLEDGEMENTS

Divers: Cawthron (Ross Sneddon, Dave Taylor, Dana Clark, Javier Atalah and Matt Cameron), Marlborough Commercial Diving Services (James Brodie, Luke Ogilvy, Mark Hodren, Lee McFetrish, Craig Honeybone, Craig Greenwood) and Diving Services New Zealand (Sam Hodgson).

Site knowledge, access and boat launching: Reader Fishing Ltd. - Tonya Patchett, Ash, Jak and John Reader, North Canterbury Transport Infrastructure Recovery (NCTIR), Cape Campbell Farm - The Peters family, Dean and Lester Gregg, Burkhart fisheries - Jeremy Phipps, Geoff Lawrence, Sim Bell, Johnny Clark, Ted Howard, Nigel Scott, Pāua Industry Council - Tom McCowan, Jason Ruawai.

Dive tank fills: BP Kaikōura - Richard Priddle, Hunting and Fishing Kaikoura and the Blenheim Dive Centre

Accommodation: Tonya Patchett and John Reader, Sue, Chid and Hamish Murray, Donna Worthington, Graham family, Awatea - Alison Taylor.

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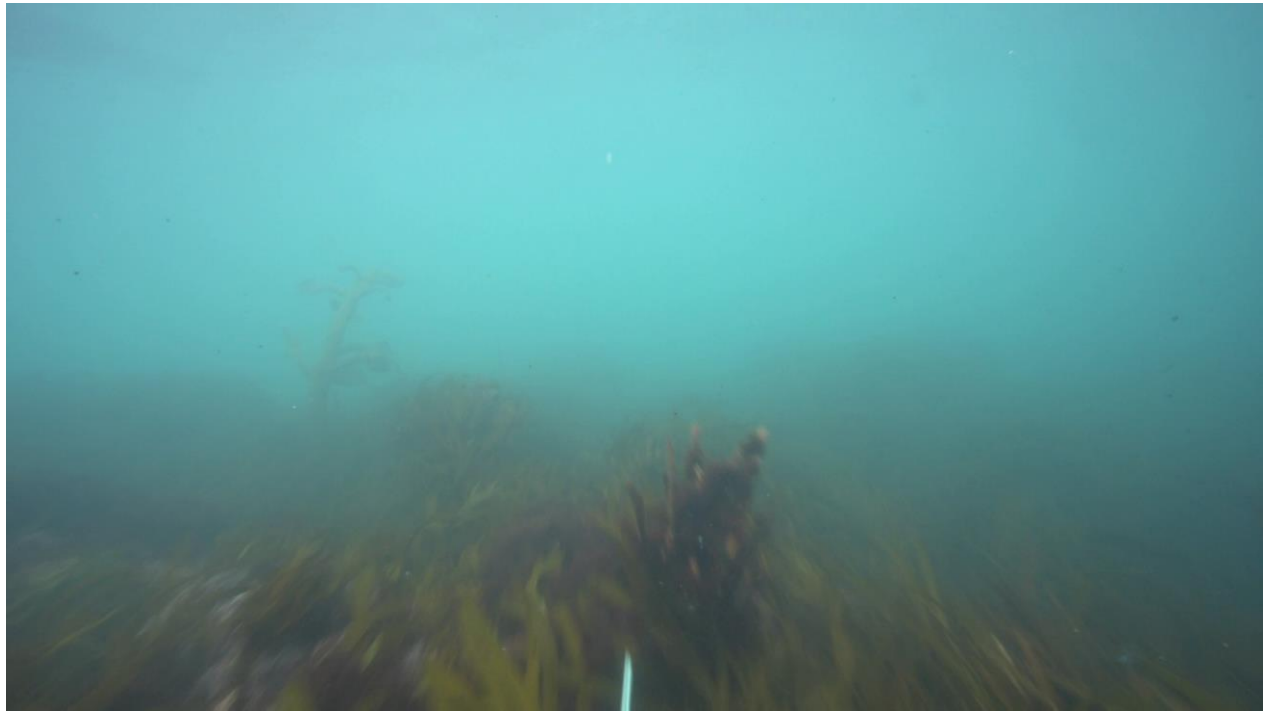
Okiwi North T3

2017



2022

Sessile invertebrate abundances

Waipapa North: Increases in % cover of sponges and ascidians 2017-2020, then decline