Ecosystem resilience, recovery, and the rise and demise of inshore abalone populations after the devastating Kaikōura earthquake

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The Team
sponsors & collaborators

- Te Runanga o Kaikoura
- Ministry of primary industries
- MBIE
- Fisheries NZ

The STALWARTS: intertidal surveys, pāua

Shawn Gerrity

Robyn Dunmore & Dan Crossett (subtidal reefs)

Shane Orchard (remote sensing)

Tom Falconer

Prof David Schiel (Programme Leader)

Leigh Tait (algal productivity, monitoring with remote sensing)
Experimental evaluation of commercial-scale enhancement of abalone *Haliotis iris* populations in New Zealand

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**Back to the future**

*Paua: Shallow subtidal, rocky habitat*

(D R Schiel, Fisheries Research - 1980s)

**Density experiments for outplants, 1980s**

- **Paua juvenile: 40-day survival**
- **Paua juvenile: size**

No growth

Identify juvenile habitat

Experiment at many sites
Today’s story (Ki uta ki tai)

- Cataclysm
- Recovery
- Tragedy
- Hope


A large landslip dam in the Waimakariri tributary of the Taieri River near Dunedin. Photo: G.A. Reid.

Dead pilchards washed up near the Waikapi River on the East Coast after Cyclone Haiyán. Photo: Graeme Atkinson.
Cataclysm
(the Kaikoura earthquake)
“The most complex quake ever studied”

Kaikōura Region, 14 November 2016
Monitoring

No uplift: (C- no uplift)
Low uplift: (L - 0.5 to 1m)
Medium uplift: (M – 1.5 to 2.5m)
High uplift: (H – 4.5 to 6.5m)

13 Locations
26 Sites
3 Tidal zones
6 Years
c. 1 million entries in database
Pre-earthquake high tide line

Post-earthquake high tide line

https://www.kaikoura.co.nz/stories/kaikoura-earthquake-story/
HEALTH WARNING
CONTAMINATED WATER

Essential repair work to the earthquake-damaged wastewater network has led to an unavoidable discharge of sewage into this water.

Avoid contact with water. Keep pets away from water.
Do not collect and eat plants, shellfish and fish from this area.
Loss of dominant canopy formers

Hormosira canopy loss on Kaikoura peninsula
Why no/poor recovery?

Hot reefs

Lethal Temp

Maximum daily temperature

15
20
25
30
35
40
45
50

Time
12/2018 01/2019 02/2019 03/2019 04/2019

Why no/poor recovery?
Altered Ecological Infrastructure (spatio-temporal, bio-physical)

**Altered Physical Conditions**
Habitat, Erosion, Temperature, Sedimentation, Light

**Altered Biology**
Loss of key species, diversity, connectivity, demography across life stages

**Ecological losses**
Primary productivity, detrital fall, coastal food webs

Durvillaea: Experimental removal 2008-2016
mostly Coralline Turf
Long ‘recovery’ period after one-off disturbance to Durvillaea canopy
Recovery?

Resilience: an ability to recover from or adjust easily to misfortune or change; toughness, robustness (Merriam-Webster)

"the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" and it includes adaptive capacity:---- CS Holling (1973)

Ten Definitions:
Large brown algae - low zone
Large brown algae:
Recovery still Uplift-dependent

Uplift (m)
-0.2 - 0.2 m
0.4 - 1 m
1.5 - 2.5 m
4.5 - 6.5 m

% cover

0 1 2 3 4 5 6
Fleshy Red Algae inverse relationship with large brown algae

% cover large brown algae

% cover fleshy red algae

Quantiles
- 0.10
- 0.25
- 0.5
- 0.75
- 0.90

2018
Bull kelp (*Durvillaea*) - by site

- **A. Control**
- **B. Low uplift**
- **C. Medium uplift**
- **D. High uplift**

Graphs showing % cover over months post earthquake for different uplift scenarios.
Replacement of large brown algae by smaller browns and reds

New normal?
Bull kelp restoration?
Ongoing stressors

2016

2020
Temperature stress, sediments, human stressors still ongoing (a sorta recovery)

Heat waves affect entire region

Intertidal temperature often lethal

Maximum Daily Temperature (°C)

Gravel inundation & reef erosion

Sediment from storms

Driving on ‘recovering’ coast
Paua recovery
The recreational fishery: ‘Wade-able’ paua
Good recruitment, Full size range
Fished vs Unfished: Legal-Sized Pāua Increase

“Wade-able” pāua

125+ mm paua density through time - fished vs. closed

2021-22 Season

Fished

Un-Fished

Years after earthquake
The Tragedy

Fears Taranaki pāua beds are ‘being stripped bare’ by summer visitors
Catherine Groenestijn ·
05:00, Jan 11 2022

Driver found in Kaikōura with 212 illegal pāua in boot
Morgane Solignac ·
15:41, Oct 28 2021
Fished vs Unfished: Legal-Sized Pāua Increase—then big decline

“Wade-able” pāua

66% decline in abundance at fished sites

Less than we started with 5 years ago
BIOMASS OF FISHED VS NON-FISHED: >125MM PAUA

74% decrease in biomass of accessible pāua
Why is it important?
5 t ‘allocated’, 45 t taken

From this

To this
Going, going, gone (it took only weeks)
So it is ‘fishing’ or is it ‘mining’ a resource?

Best estimate
• 45 tonnes taken recreationally
• 10 t damaged and discarded

• Up to 1000 people fishing per day at some sites ➔ This is unsustainable
• ‘Allocated’ recreational catch was 5t, but it actually was at least 45t. This is the difference between about 15,000 pāua and 120,000 pāua, each at least 7-8 years old ➔ this is unsustainable
the commons, if justifiable at all, is justifiable only under conditions of low-population density. As the human population has increased, the commons has had to be abandoned in one aspect after another.
There are a lot of us; the per-capita pressure is high.
Why is it important?
There is only ONE fishery

To Manage a Modern Fishery

• **Catch limit** (allocation, quota)
• **Size limit**: to allow reproduction and future recruitment
• **Total catch**: ALL sectors
• **Enforcement**: STOP when quota is reached
• Consider the WHOLE life history – connectivity of juvs to adults
• Know the **environment- Haliotistically!**

Commercial Sector  ✔
Customary Sector  ✔

Recreational Sector

• One person fishing for many – so daily limit per fisher is greatly exceeded
• 10t (c 30,000) of undersize paua taken, returned and possibly dead
• No catch reporting, so totals estimated later
• Accumulation limits unenforceable (mostly)
There is still time to fix things

Some difficult-to-dive areas were not harvested heavily
Let’s try some modern tools for modern problems

**Allocation**: an amount of a resource assigned to a particular recipient

**Quota**: a fixed share of something that a person or group is entitled to receive

**Limit**: a point or level beyond which something does not or may not extend or pass
Let’s try some new tools for modern problems

For example:
• App-based reporting of catch, size and where
• Tag issuance to limit total numbers caught
• Something that involves buy-in and help from rec fishers to get things right
• Time-critical so STOP when the allocation/quota/limit is reached
The future and the HOPE

- Manage the ‘manageable stressors’
- Do excellent, relevant and useful science
- Be innovative in solutions, not just in describing ‘what must be done’
- Work with iwi, sector groups and managers to achieve a common purpose

"We must all hang together, or, most assuredly, we shall all hang separately."

*Benjamin Franklin's comment at the time of the signing of the Declaration of Independence*
Survey Results Confirm Pāua A Popular Catch At Kaikōura

Tuesday, 24 May 2022, 5:00 pm
Press Release: Fisheries New Zealand (from the “What Planet are You From Department”)

“The rebuild provided plenty of large pāua in wading depths, making it easy for people to gather a feed of the popular kaimoana. In addition, the excellent weather over the summer meant lots of people were out enjoying the fishery.

“This accessible stock and really good summer weather brought out lots of recreational fishers, both local and visiting fishers who harvested around 35 tonnes of the popular shellfish.”
References


Replacement of bull kelp by other fucoids
Decline of Bull Kelp at many sites recently

Highlight 2
UOC: not to be cited until approved
Small dispersal distances

Combined with fragmented populations and distant sources
Ecological Infrastructure has changed: Temperature, sediments, light, human stressors

Intertidal temperature often lethal

Heat waves affect entire region

Driving on ‘recovering’ coast

Gravel inundation & reef erosion

Sediment from storms
Gravel movement and erosion still affecting invertebrate & algal populations
New land, new uses

Horizontal distance between old and new high-tide marks
Opening Day – 1 December 2021

Photo: Kasey Mollison

Photo: Derek Gerber (MERG)
Seasonal fishing effort / catch model

- Summer holiday period averaged 700 fishers/day
- **Seasonal catch estimate** = 40.5 t assuming 3 pāua/kg and average catch-per-day of 4.5 pāua per-person as recorded in a concurrent catch sampling study

Summer holiday period (23 days) accounted for ~50% of the effort

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7 Holdsworth (2022). *New Zealand Fisheries Assessment Report 2022/40*
Insights from a unique case

Atypical aspects for NZ recreational fisheries
  - Limited open season with defined recreational allowance with the TAC
  - Relatively small management area/ short duration facilitated an evaluative study

Four key findings for sustainable use
  - Daily bag limits (DBLs) unreliable unless fishing effort is known or can be directly controlled (e.g., responsive fishery with real-time monitoring or tag based system for allocating personal catch)
  - Tourism influx can significantly alter fishing pressure trends
  - Equity effects are caused by, and can be addressed by, the choice of management strategy
  - Adaptive management requires the catch to be measured by all sectors

Transferable principles for other recreational fisheries / open-access natural resources
Brown Algal recovery depends on uplift at 4 years.
Durvillaea

Reds

Other fucoids