Marine reserves, Biodiversity and Marine Spatial Planning

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Outline

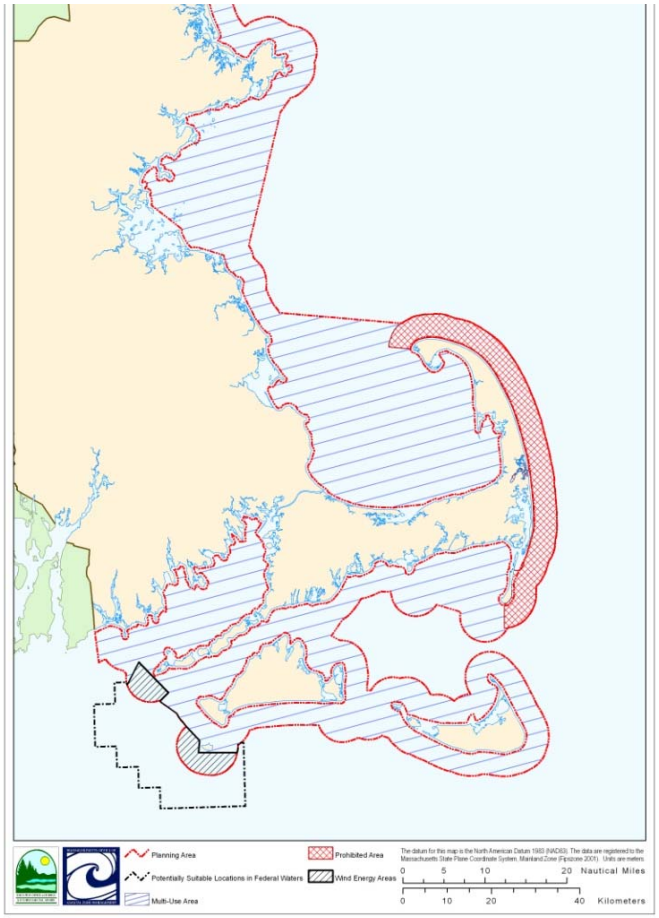
Marine Reserves and Marine Spatial Planning

The role of Marine Reserves in protecting biodiversity

Designing a network of Marine Reserves (briefly)

Marine Reserves and Marine Spatial Planning

- Marine Protected Areas are a key component of Marine Spatial Planning initiatives worldwide
- These can involve a range of different MPA types, but they typically have a core area of no-take Marine Reserves
- NZ Biodiversity Strategy 2000 developed to help stem the loss of biodiversity
  - Aim to protect 10 percent of New Zealand's marine environment in a network of representative protected marine areas



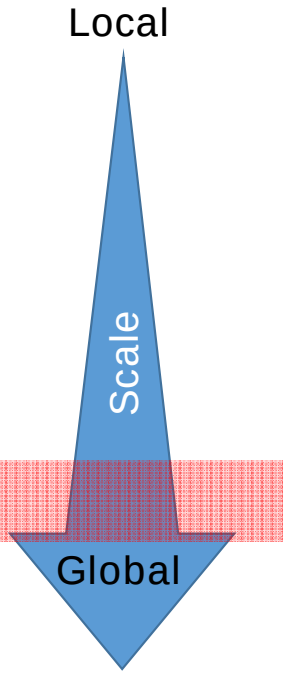
Massachusetts Ocean Plan Management Areas:

- Prohibited-13%
- Renewable Energy-2%
- Multi-use-85%

Many impacts on coastal ecosystems and biodiversity

E.g.,

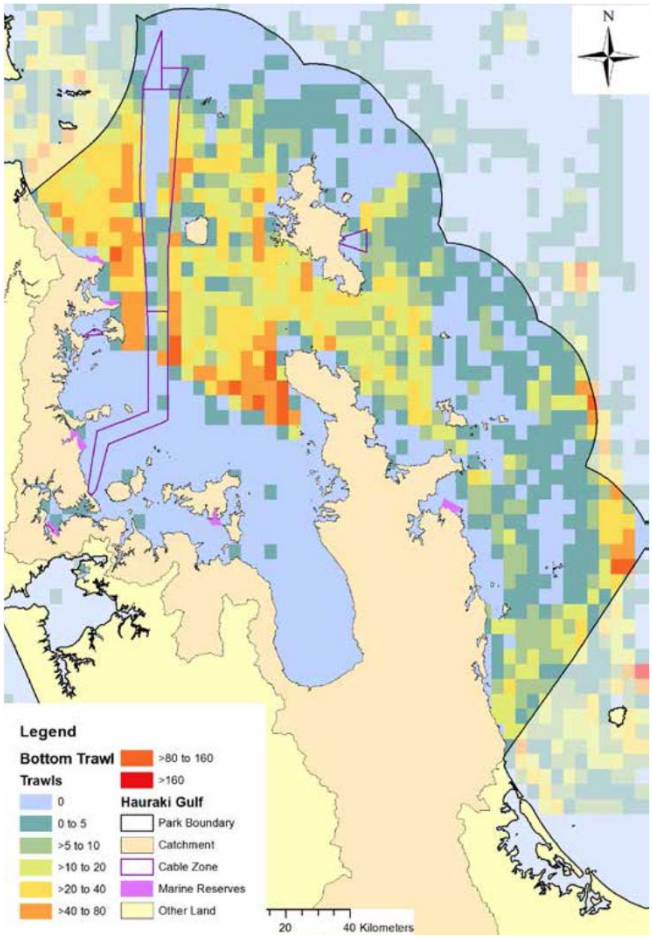
- Contaminants
- Habitat destruction
- Aquaculture
- Sediment and nutrient runoff
- Invasive species
- Fishing
- Climate change

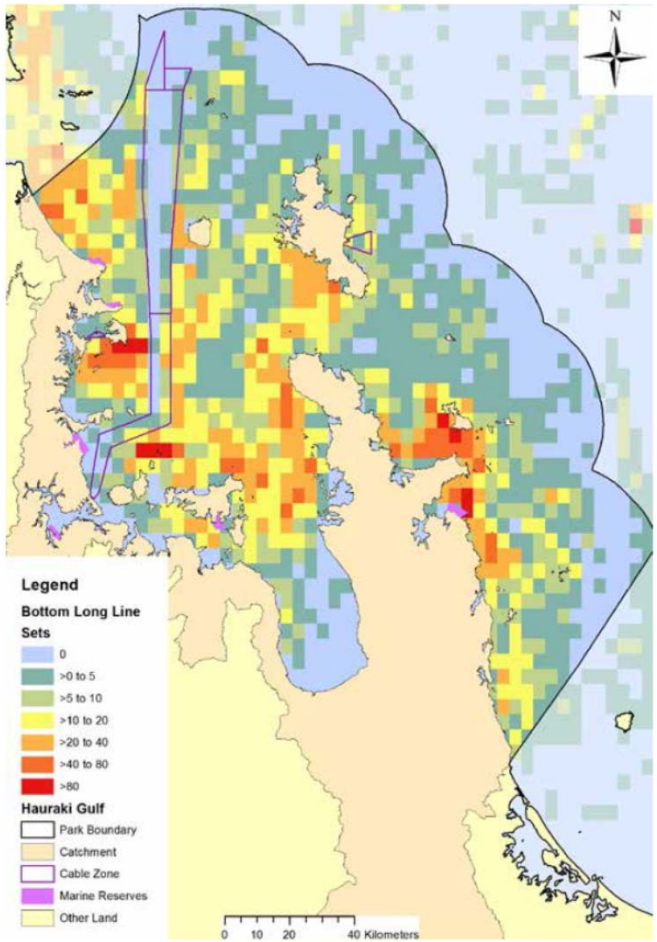


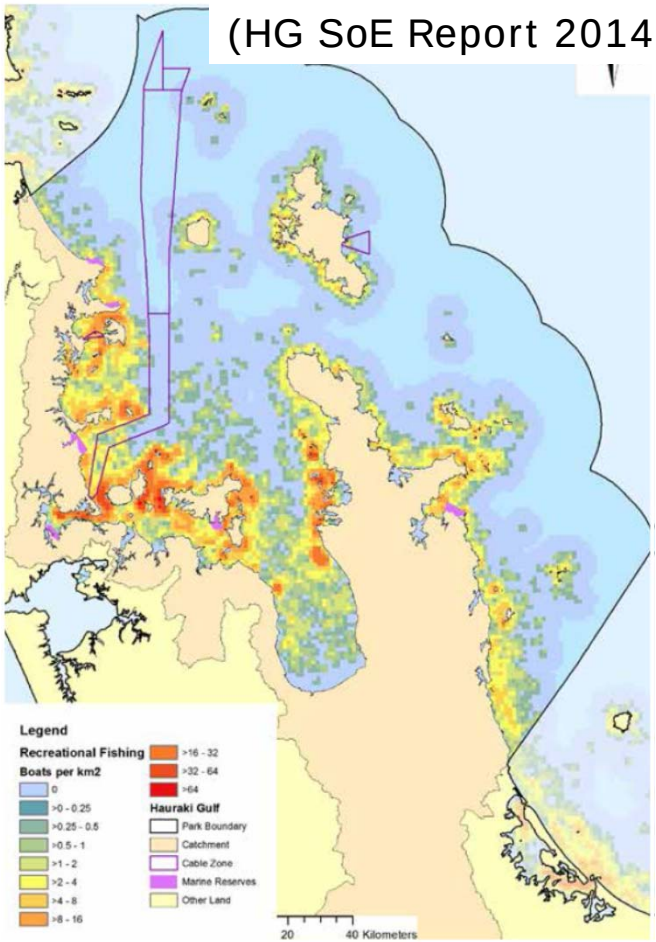
Marine reserve – Very simple management tool that protects an area from all forms of extraction

Fishing in the Hauraki Gulf Marine Park 2011-2013

(HG SoE Report 2014)



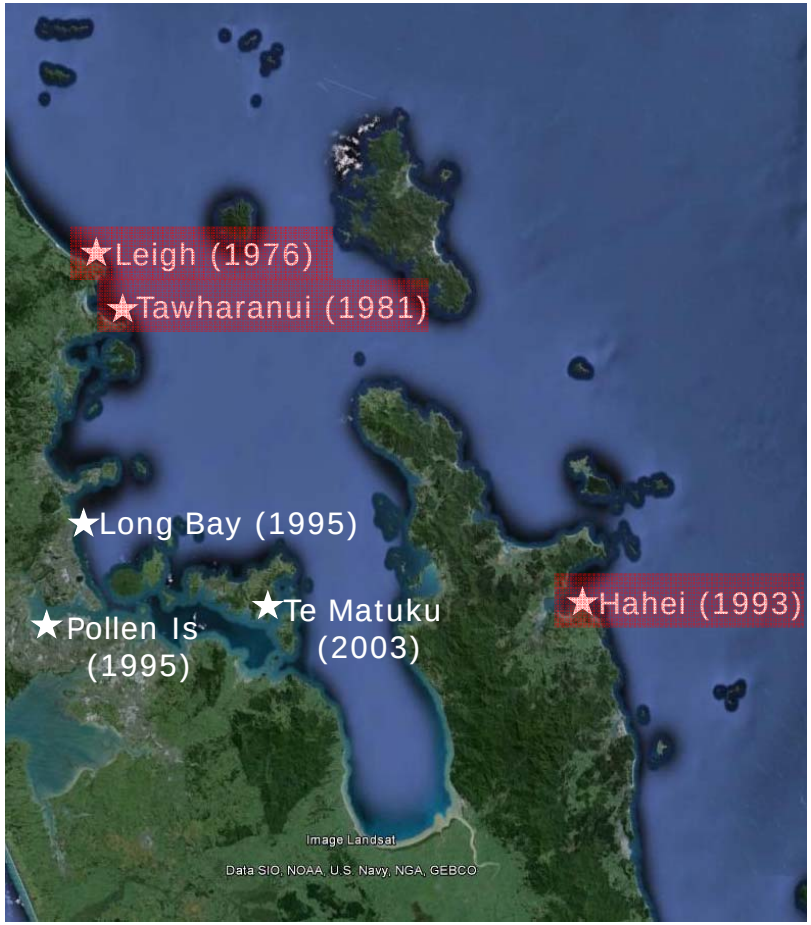




- Very important fishing area: Many species, many methods, many people – all increasing.
- 6 MR's (0.3% of HGMP); fishing also prohibited in cable protection zones (4.9% of the Gulf)

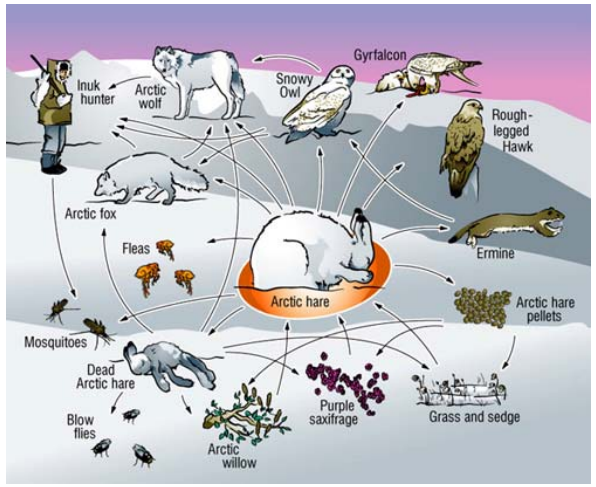
Marine reserves in the HGMP

- Useful research tools for science - experimental framework to investigate impacts of fishing on biodiversity
- Large amount of research carried out in marine reserves in the HGMP
- Developed a strong understanding of how MRs “work” [the effects of fishing]
- MRs controversial and polarising



Marine reserves and biodiversity protection

- Biodiversity is the degree of variation of life (genetic, ecosystem or species)
- Fishing can impact biodiversity directly by removing species, and indirectly via altering ecosystem structure and function
- Marine reserves therefore protect biodiversity by:
  1. Protecting populations of exploited species within their boundaries (direct effects)
  2. Protecting ecosystem structure, function and resilience (indirect effects)

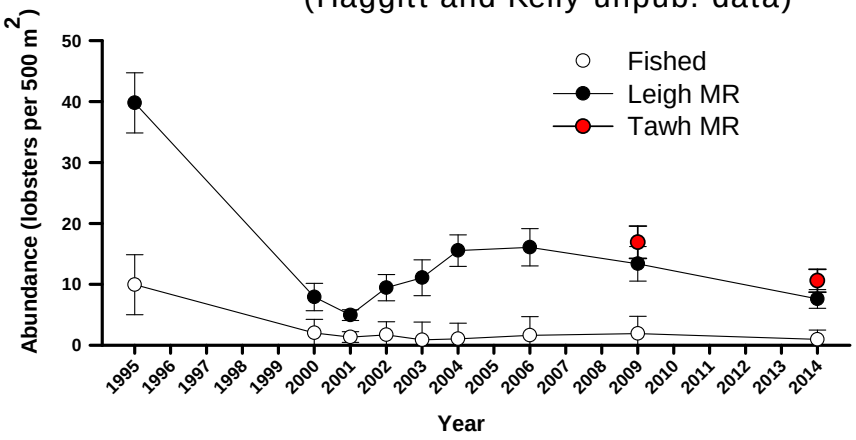


1. Protecting exploited species

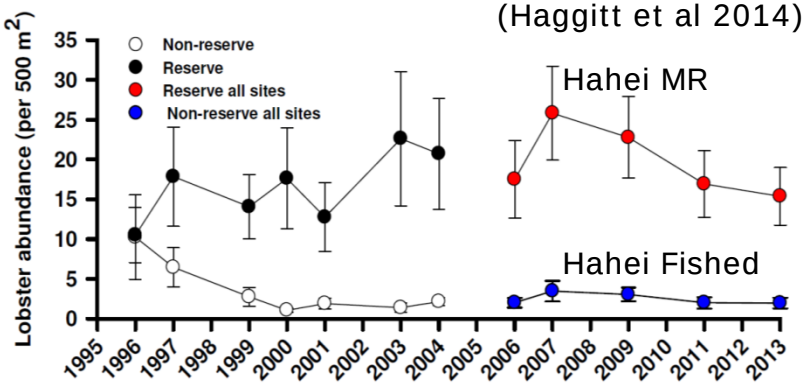
Case study: crayfish *Jasus edwardsii*

- Reserve's provide haven for both juveniles and large individuals
- Populations vulnerable to fishing on boundary (boundary at Leigh and Tawharanui only ~800m offshore)
- Variability driven by recruitment and fishing – reserve densities reflect state of wider fishery

(Haggitt and Kelly unpub. data)



(Haggitt et al 2014)

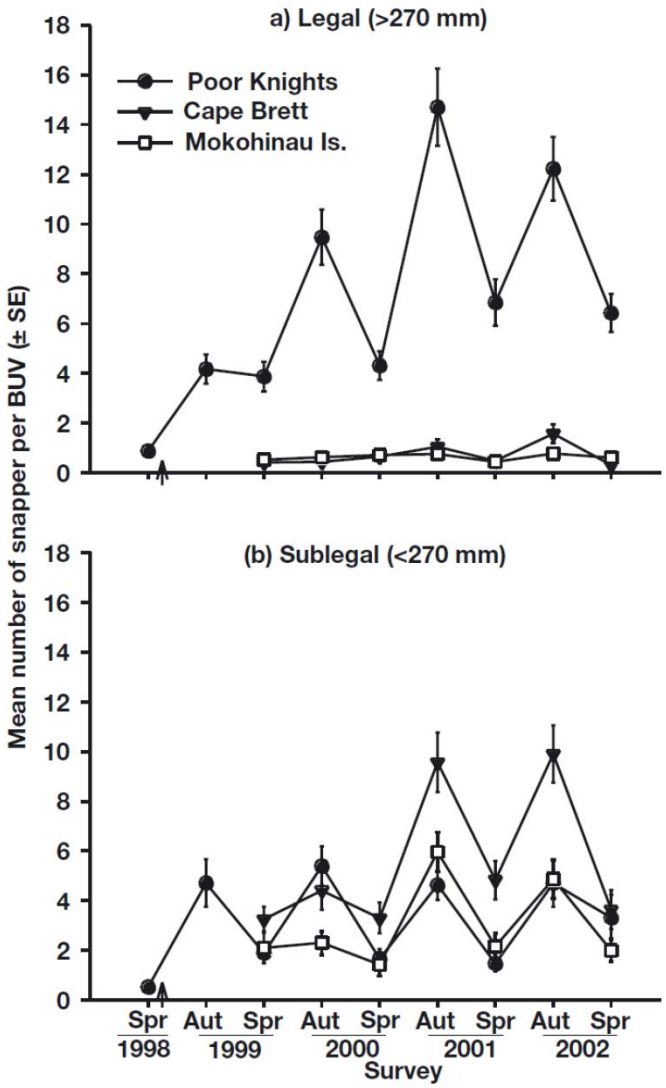


1. Protecting exploited species

Case study:

Snapper *Pagrus auratus*

- Widely shown to recover in neNZ reserves (Willis et al 2003, Denny et al 2004)
- Tagging and modelling studies indicate variation in snapper behaviour and movement beyond boundaries (Babcock et al 2012, Parsons et al. 10)
- Recent evidence from Leigh MR suggests important contribution of larvae to local populations (Le Porte et al. unpubl. data)



(Denny et al. 2004)

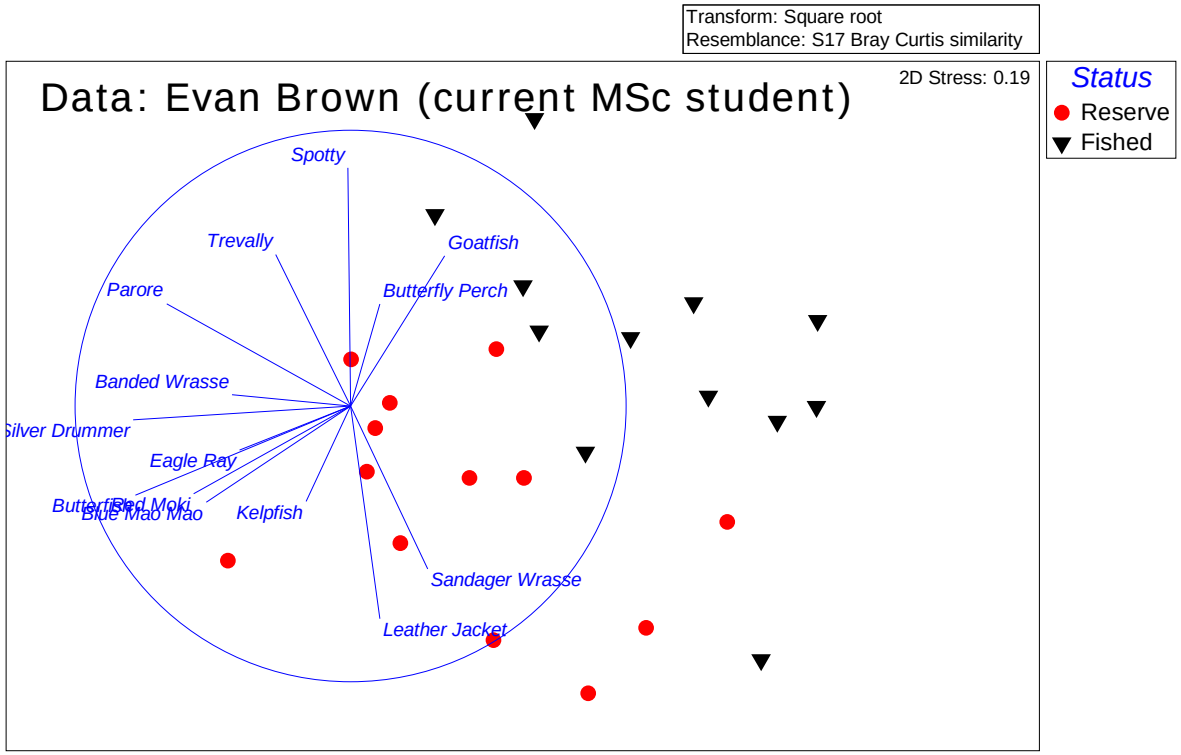
Poor Knights Is before and after no-take protection

1998

2004

1. Protecting exploited species

- What about other reef fish species?
- Numerous species and overall diversity higher in Leigh and Tawh reserve's than outside
- Increasing pressure on previously "non-target" species outside reserve







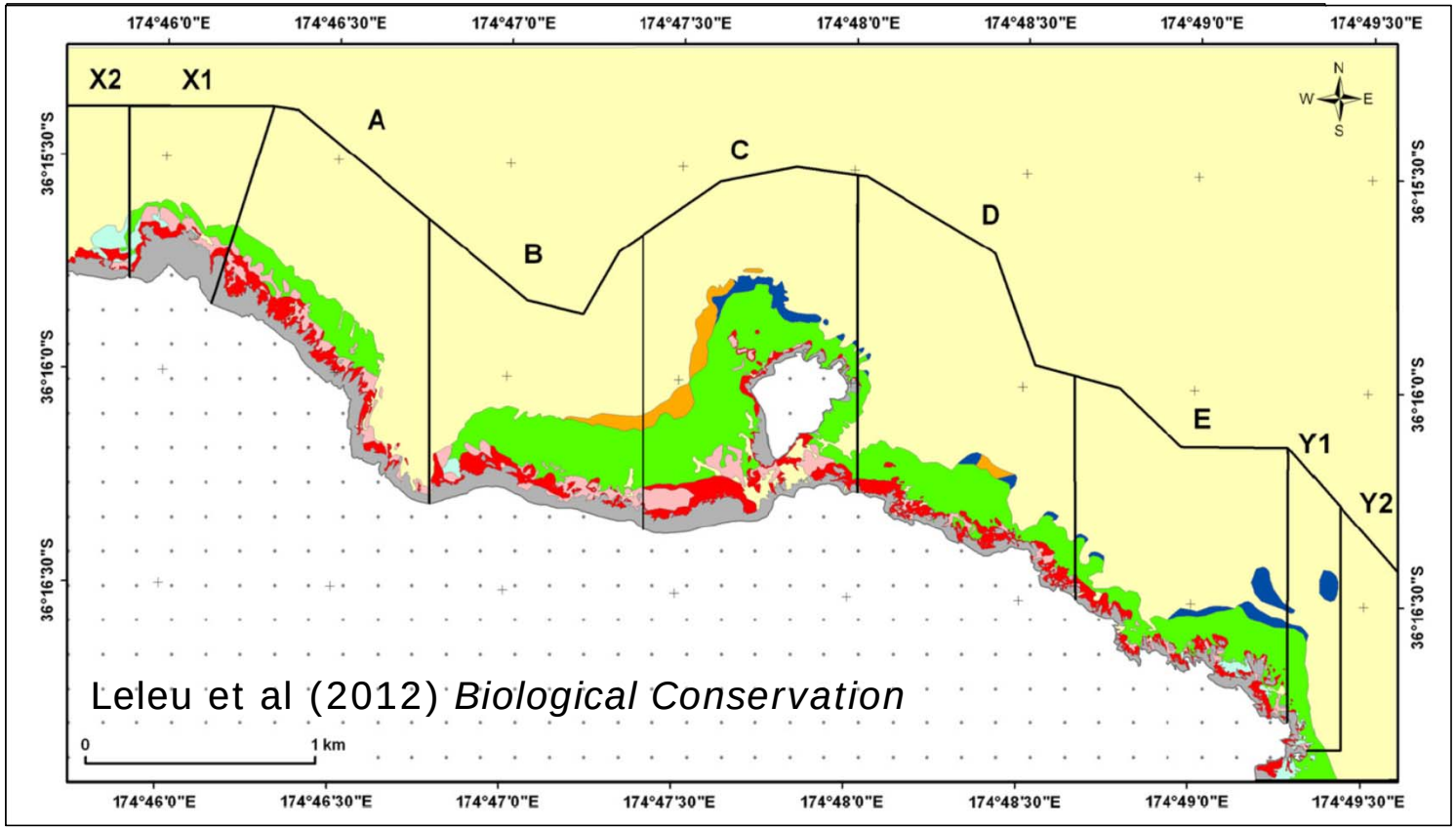
2. Protecting ecosystems

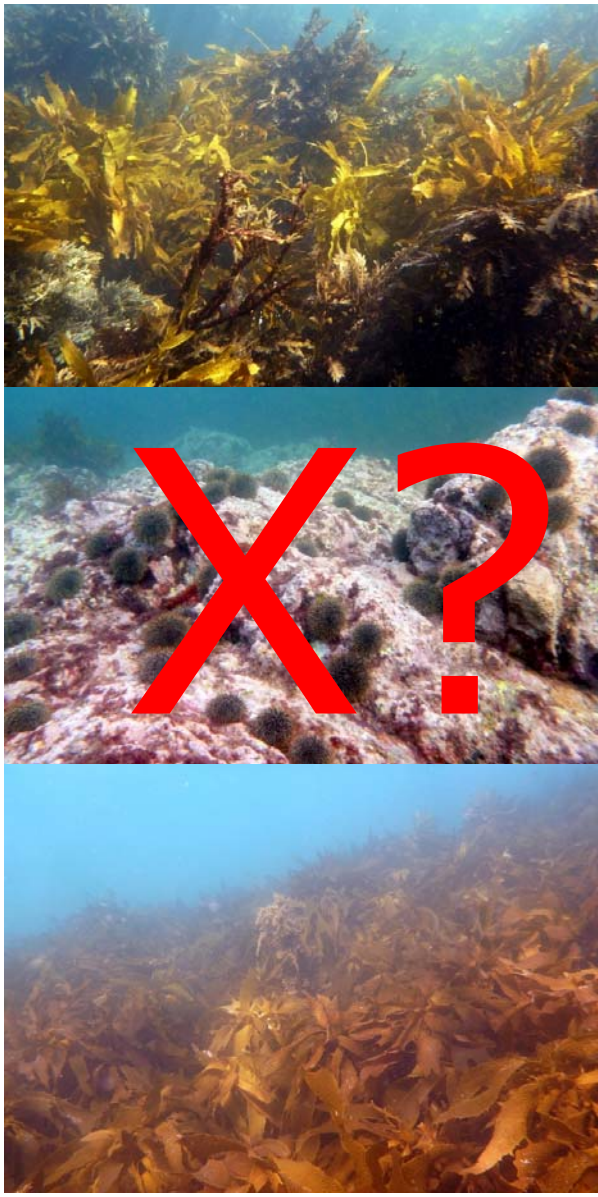
Case study: Kelp forests

What are the effects of removing predators on kelp forest biodiversity?

- Role of predators important ecological question
- Experiments are traditionally difficult
- Marine reserves provide opportunity
- Three reserves in HGMP that are >20yo where predators are abundant: Leigh, Tawharanui and Hahei

Cape Rodney to Okakari Point (Leigh) Marine Reserve

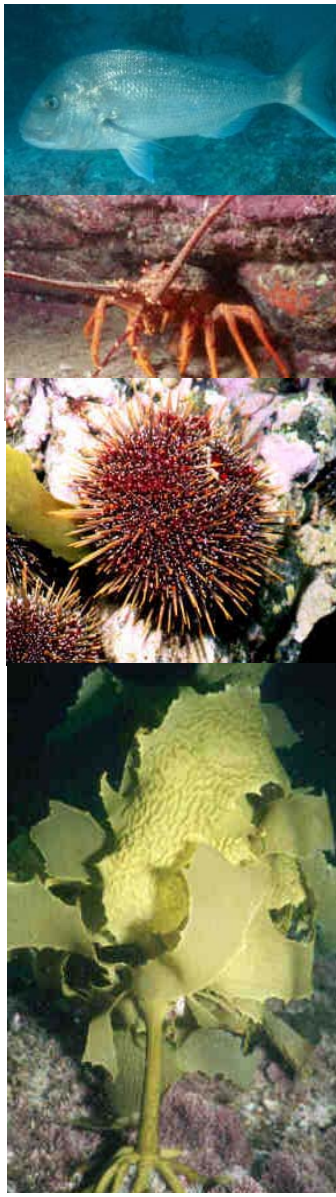




- Long-term declines in urchin barrens in marine reserve
- Babcock et al (1999) found this decline was consistent with an increase in urchin predators (snapper and crayfish), and hypothesised this represented a trophic cascade

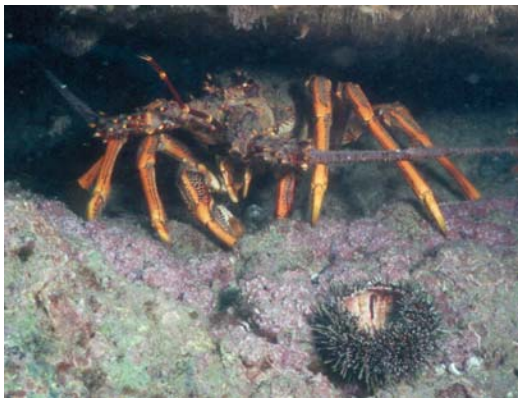
A trophic cascade?

- These changes imply that fishing has led to ecosystem level changes on subtidal reefs
- Initial debate over hypothesised mechanisms - results contrast some earlier work, was there an alternative explanation for these observations?
- Research needed to test and better understand [this is an iterative process]



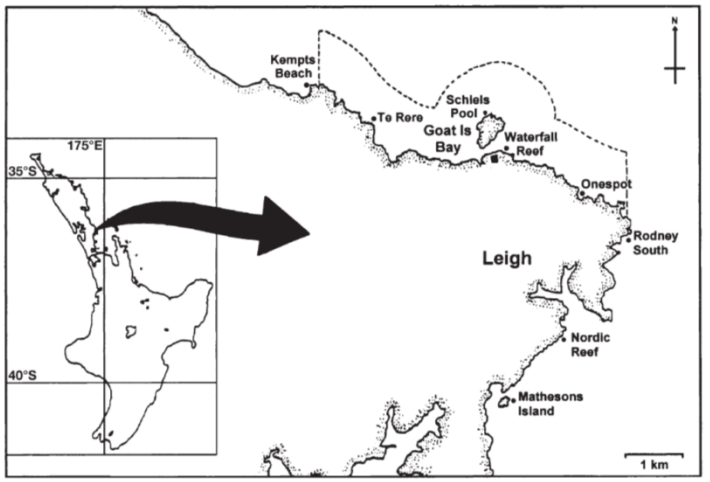
Testing the ecological mechanisms

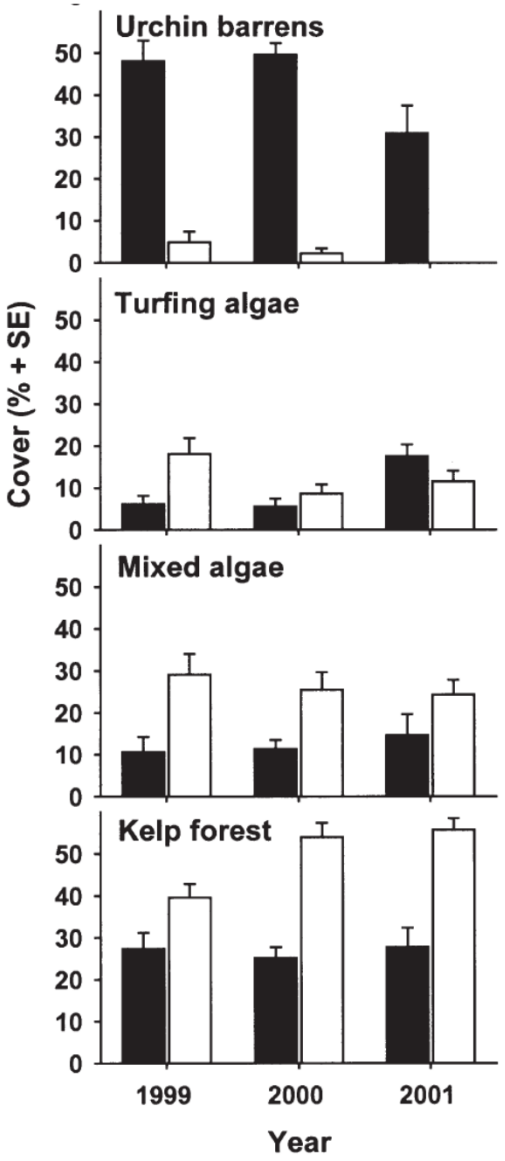
- Numerous field experiments investigating the trophic linkages (Shears and Babcock 2002)
  - Higher predation rates on urchins in marine reserve (due to both Snapper and crayfish)
  - Removing urchins from barrens leads to recovery of kelp and other macroalgae
  - Complex interactions – behaviour and time lags



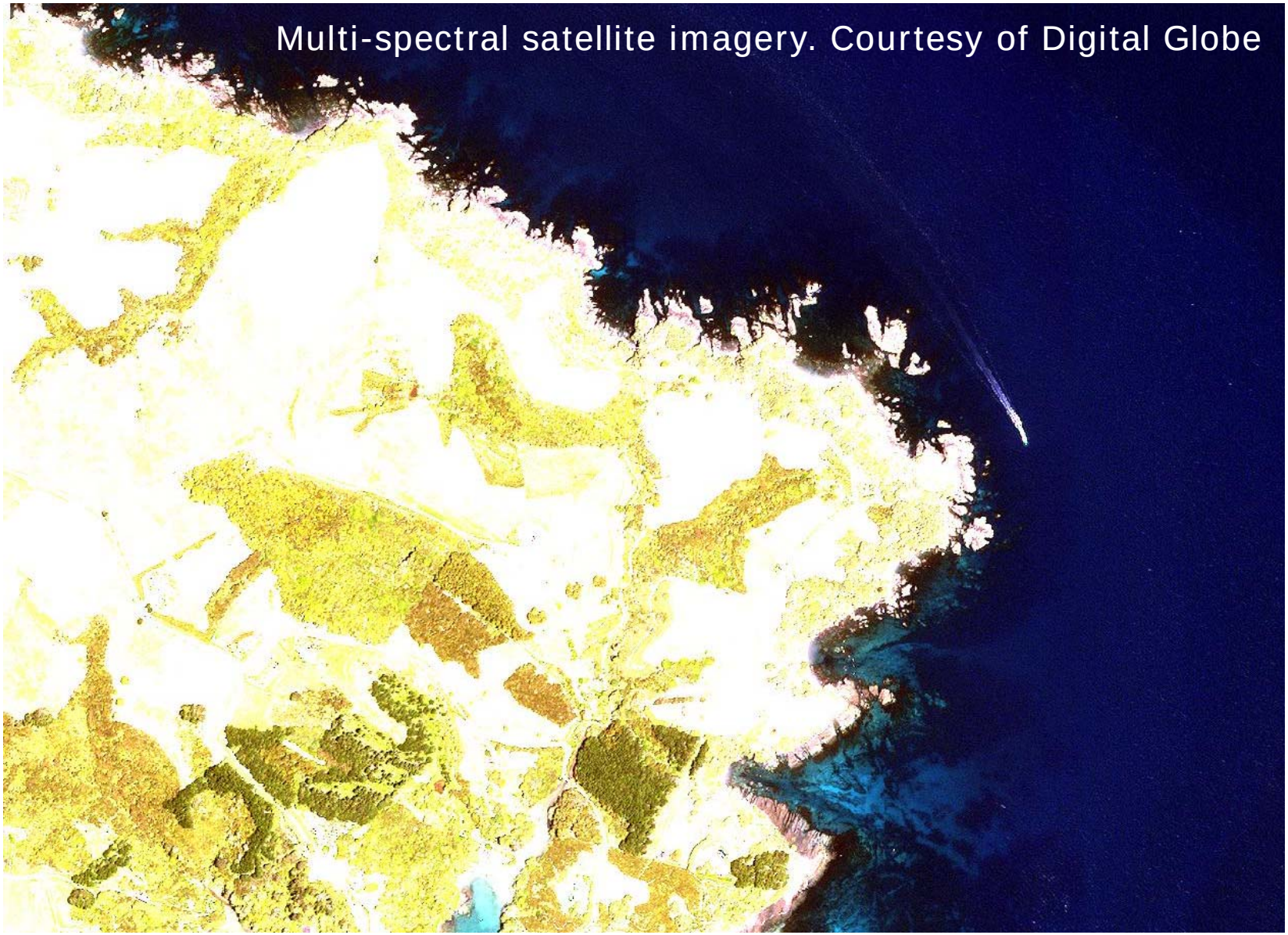
Had similar changes occurred outside the reserve?

- Established monitoring sites in 1999
- Urchin barrens cover 30-50% of reef outside reserve (Shears and Babcock 2003)
- These differences are evident from Space!





12th Jan 2014



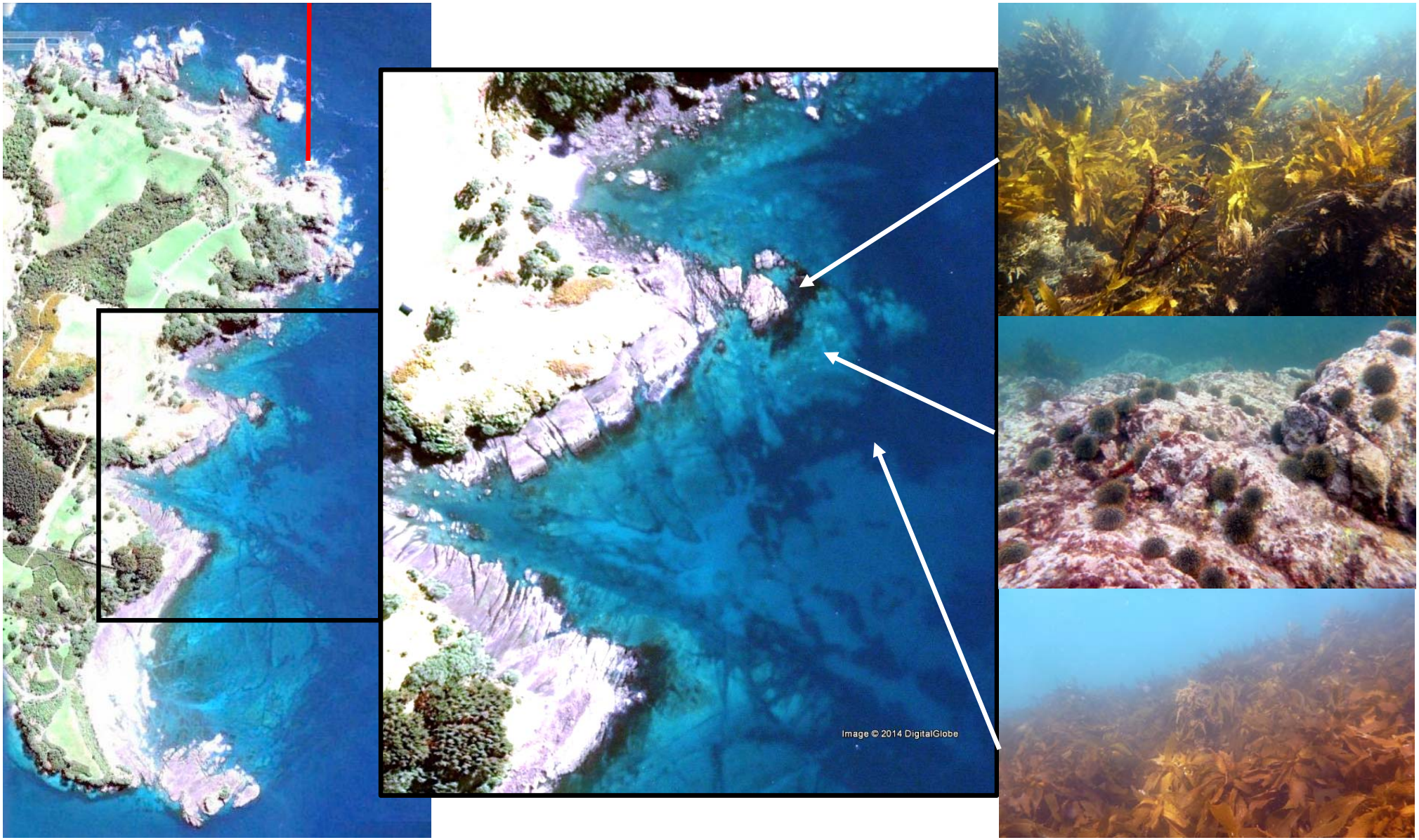
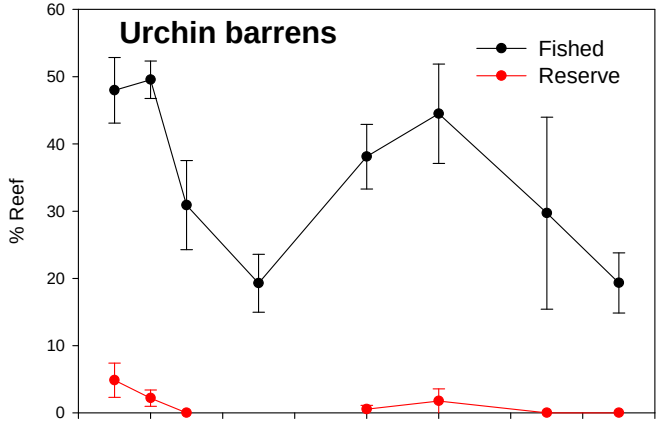
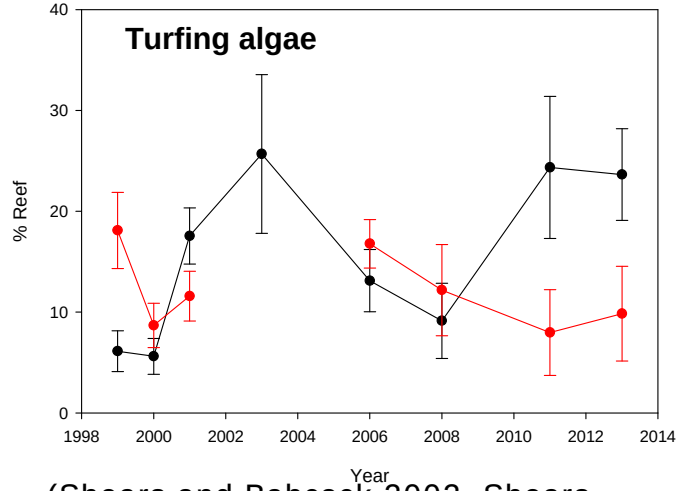


Image © 2014 DigitalGlobe

Are changes consistent over time?

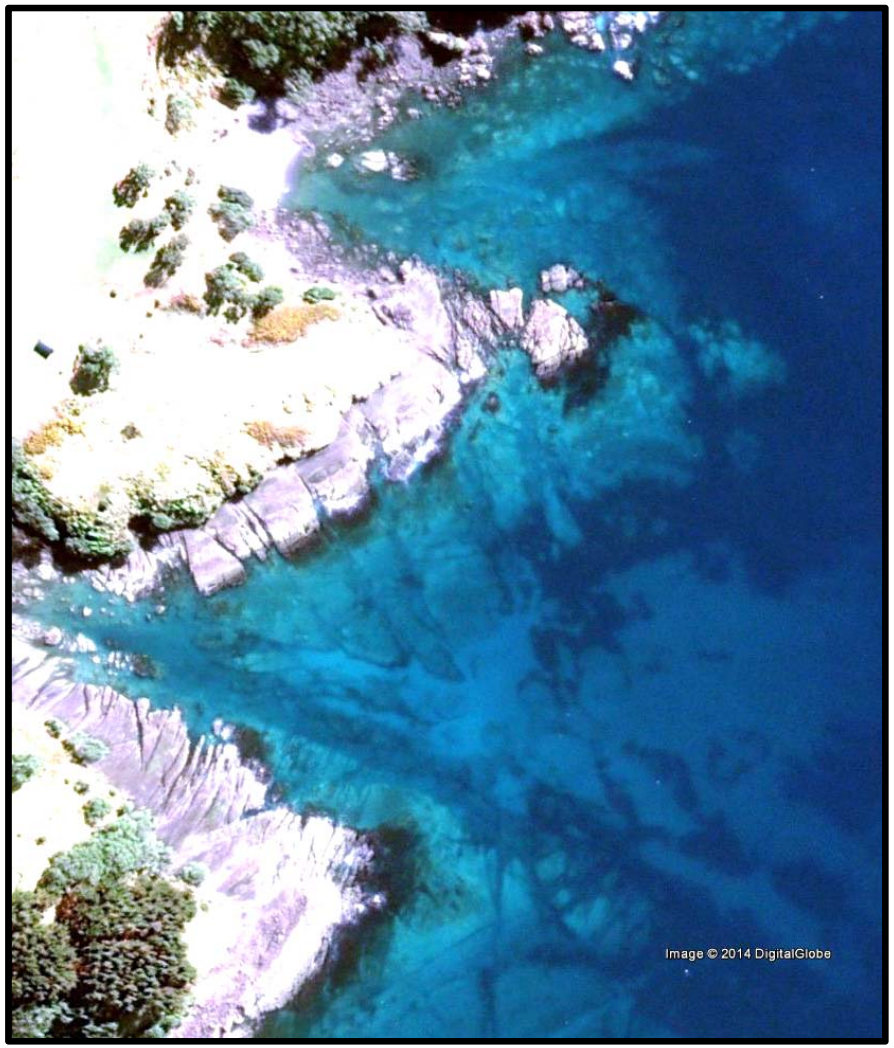
- Monitoring since 1999 inside and outside Leigh Reserve
- Barrens now very rare in reserve (<2%)
- Extent of barrens fluctuate outside reserve – interactions with other stressors



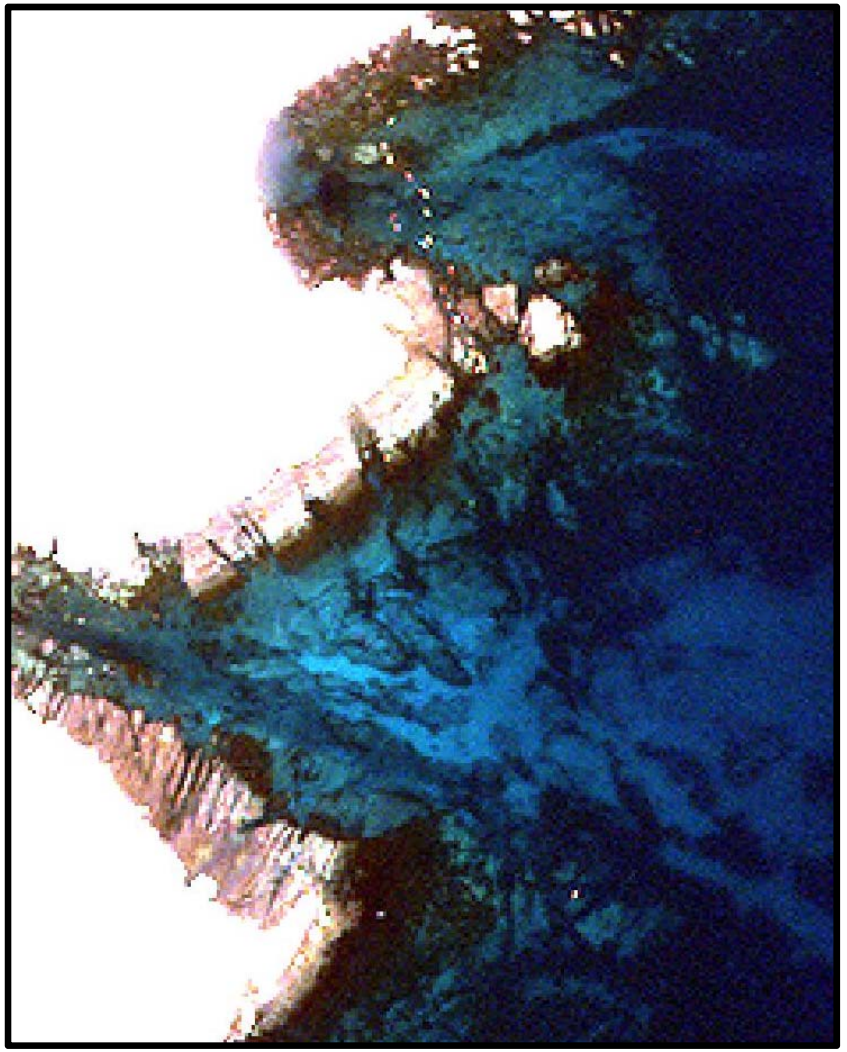


(Shears and Babcock 2002, Shears unpub. data)

2011

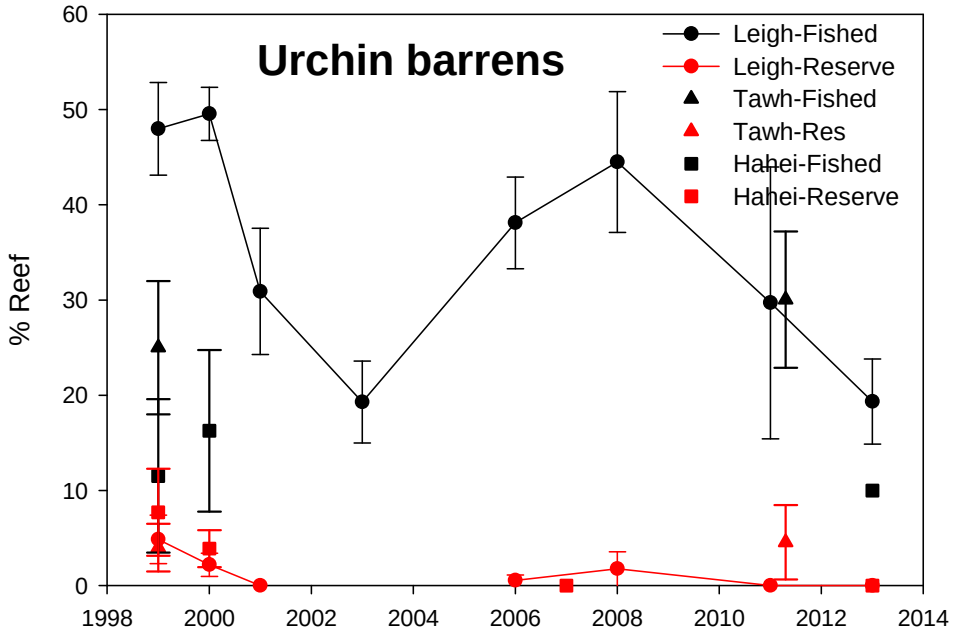


2014



Do trophic cascade effects occur in other reserves?

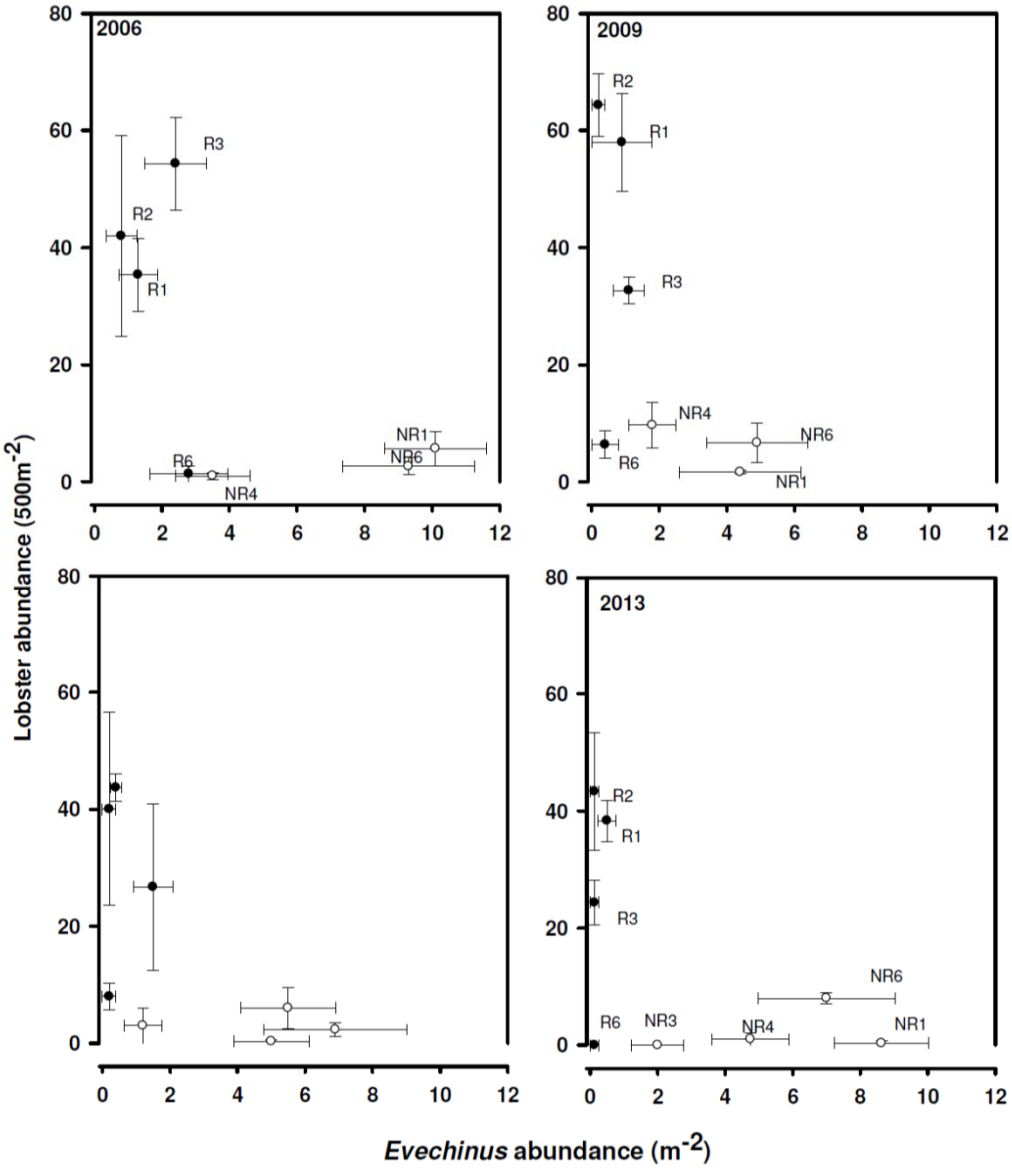
- Yes, long-term decline in urchin barrens at Leigh, Tawharanui and Hahei reserves
- Barrens remain in adjacent fished areas (albeit variable)



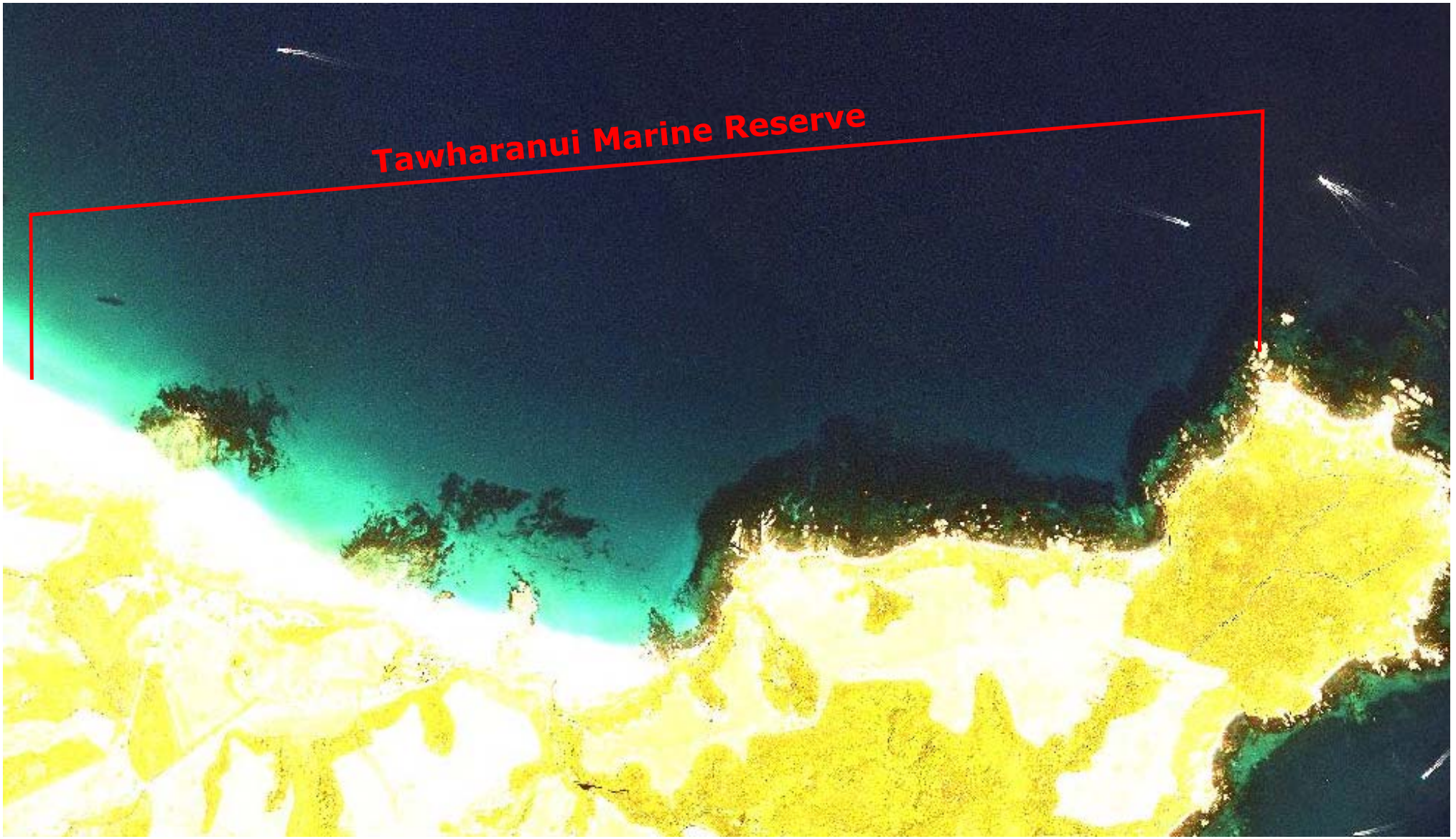
(Shears and Babcock 2003, Shears et al 2008, Shears and Haggitt unpubl. data)

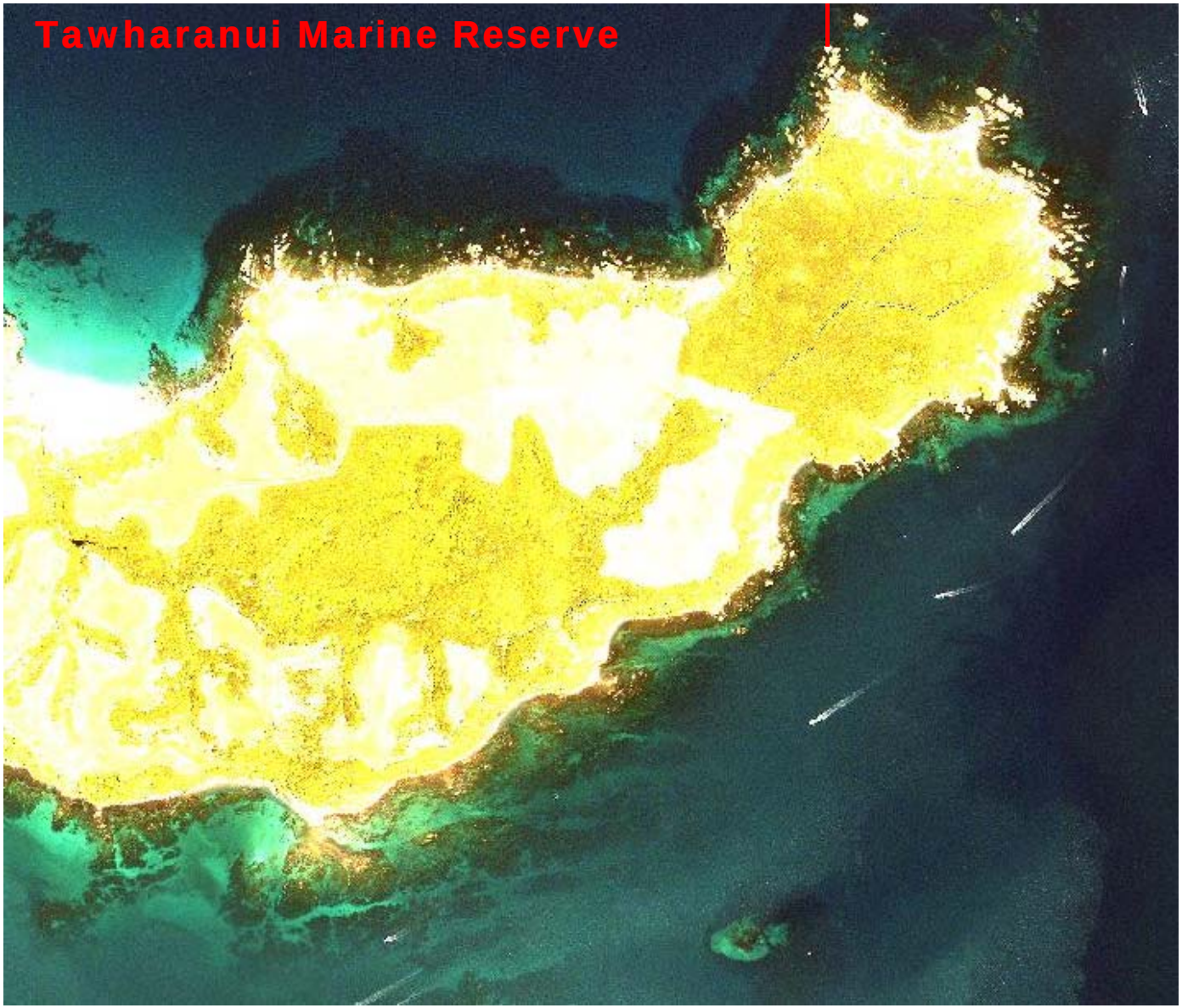
- Hahei Marine Reserve:

- lobster vs urchin abundance
(Haggitt et al 2014)




Tawharanui Marine Reserve


Tawharanui Marine Reserve

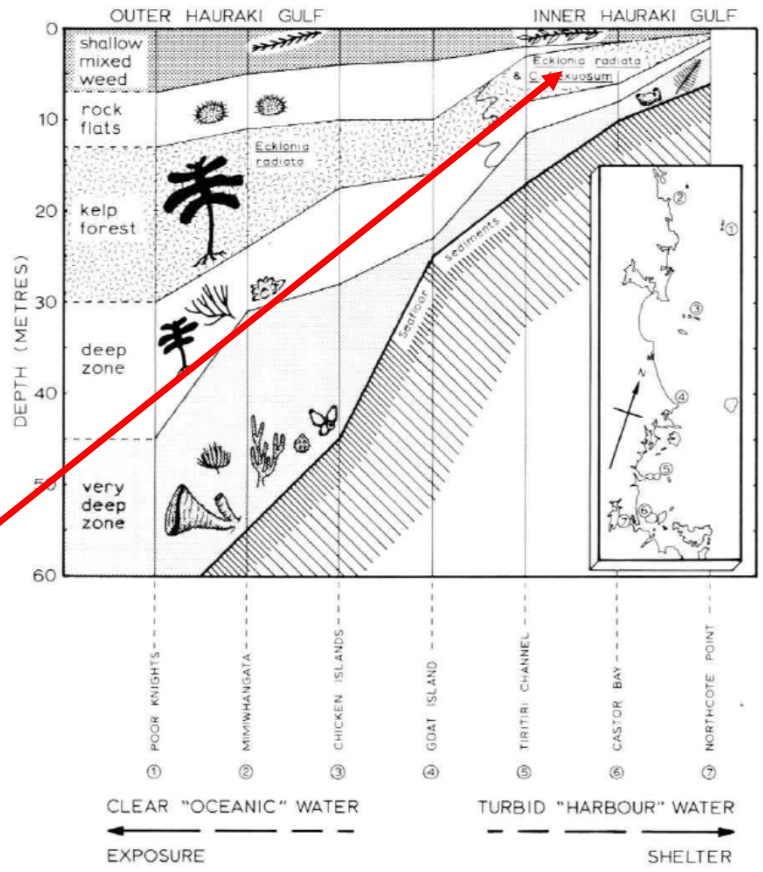


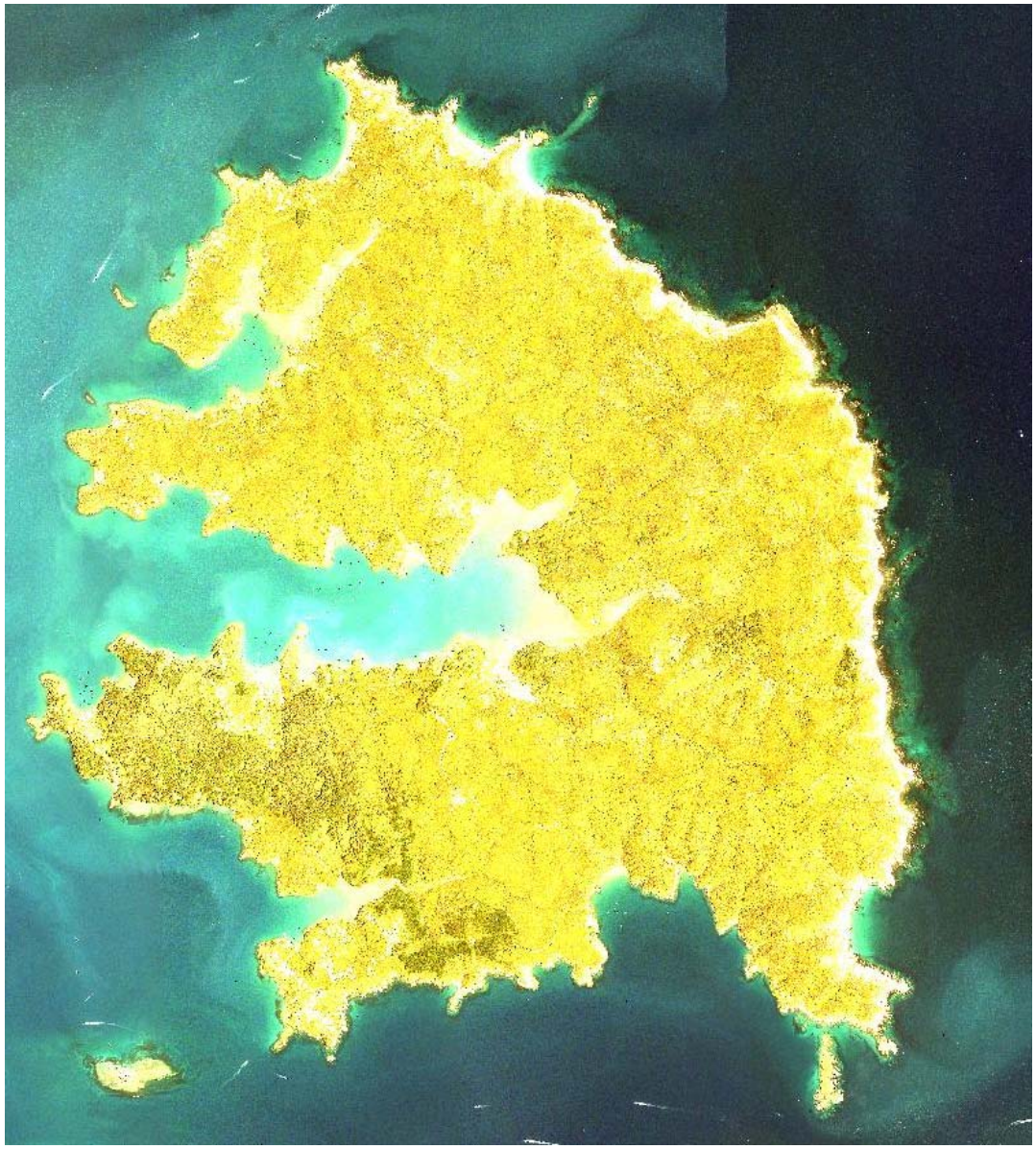
Urchin barrens in 2011:
- Reserve 4.5%
- Fished 30%

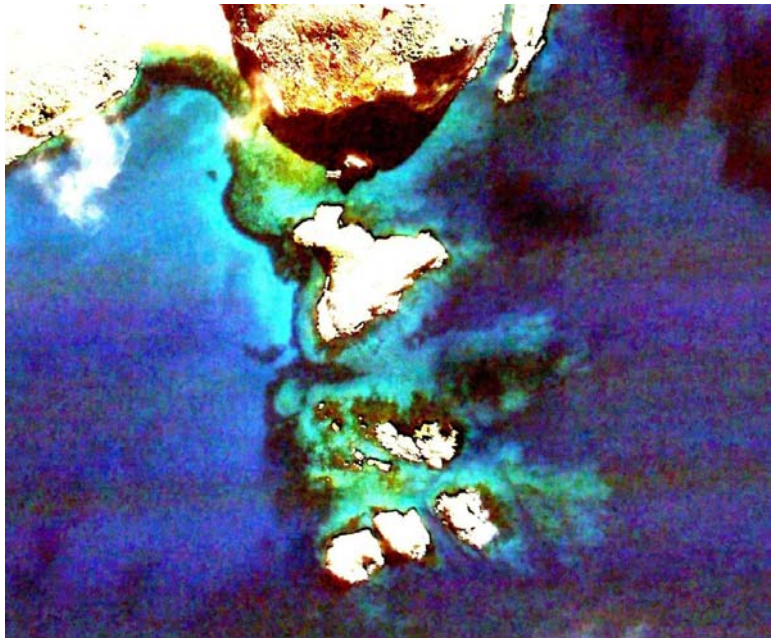
Do trophic cascade effects occur everywhere?

- No, context dependent (Shears et al 2008, Shears 2007)
- For example, urchins don't form barrens on sheltered reefs in HG

Grace (1983)



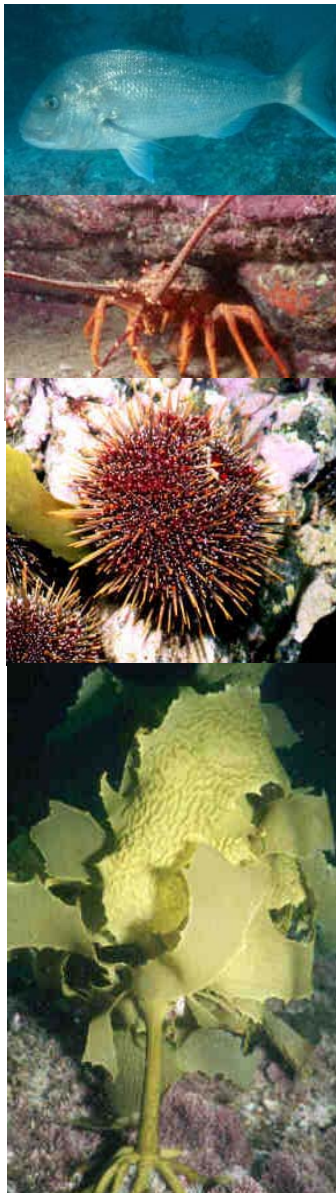




- Barrens are a common feature of exposed reefs (Choat and Schiel 1982)
- Depth extent of barrens varies with wave exposure (Grace 1983, Shears and Babcock 2004)

2. Protecting ecosystems

- Fishing of sea urchin predators has lead to increased prevalence of urchin barrens in the mid-outer Hauraki Gulf
- Effects biodiversity in a number of ways – foodweb simplification, changes in species composition, ecosystem function and primary production
- Research demonstrates these effects are reversed in MRs – widely accepted to occur in neNZ (Schiel 2013)
- This is one obvious and well-studied example – what about effects of protection in other marine habitats and foodwebs?



Designing Marine Reserve Networks

A set of Marine Reserves connected by larval dispersal and juvenile or adult migration

Key considerations:

- Individual reserves need to be large enough to protect populations of exploited species - design to minimise edge-effects (minimum 5 km of coast)

- Reserves need to be spaced in a way that maximises connections among MPAs - necessary for a functioning network (simple spacing guideline <50-100km)

See NZ MPA Policy and Implementation Plan guidelines and Thomas and Shears 2013 for review

California Marine Life Protection Act Initiative

Scientific Guidelines for MPA Design

Summary (based on best available science):

- Represent ‘key’ marine habitats
- Extend from the intertidal zone to deep waters offshore.
- To encompass movement MPAs should have an alongshore extent of at least 5-10 km of coastline, and preferably 10-20 km.
- To facilitate dispersal MPAs should be placed within 50-100 km of each other.
- Replication - at least three to five replicate MPAs should be designed for each habitat type within each biogeographical region.
- To lessen negative impact, while maintaining value, placement of MPAs should take into account local resource use and stakeholder activities
- Placement of MPAs should take into account the adjacent terrestrial environment and associated human activities.
- Other considerations: Keep boundaries simple and aim for low boundary to area ratio

Summary

- Fishing is the most widespread and diverse activity in the HGMP
- Marine reserves are effective at protecting biodiversity from the impacts of fishing within their boundaries (targeted species and ecosystem function)
- Marine reserves are a necessary component of MSP
- Marine reserves need to be designed appropriately to ensure they protect biodiversity [-> value for education, recreation and potentially fisheries]
- Clear scientific guidelines necessary for effective MR and MPA network design

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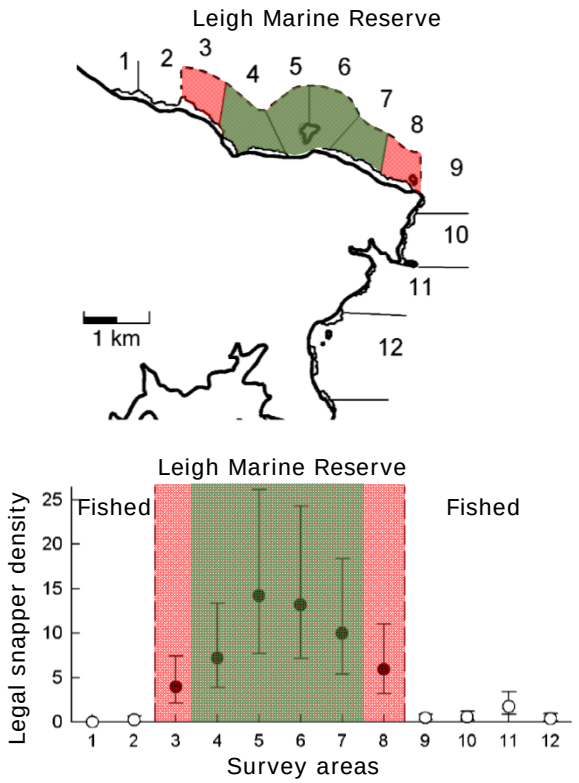
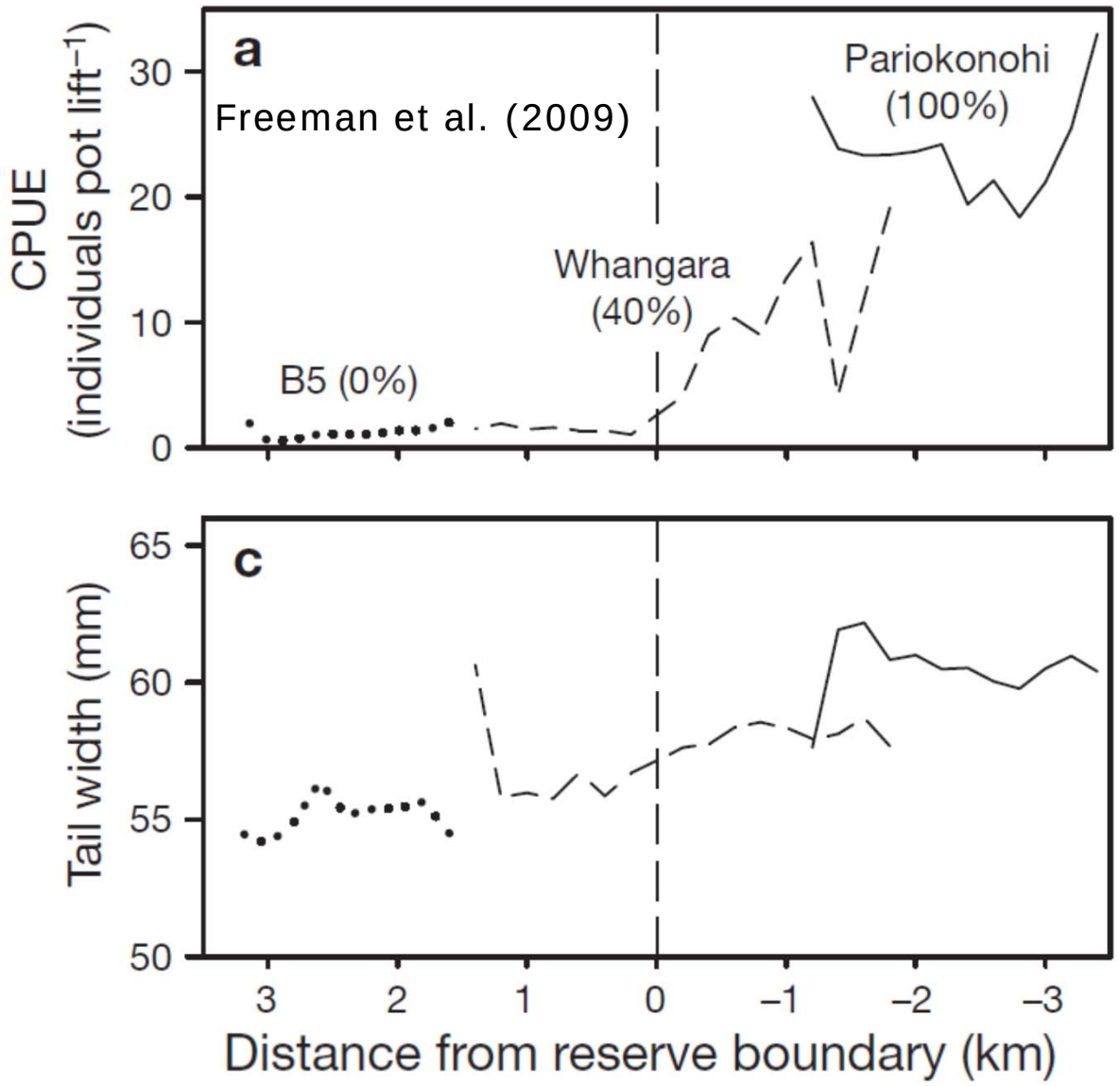
Edge-effects



(Willis et al. 2003)



NZ-wide distribution of urchin barrens (Shears and Babcock 2007)