Restoring the lost kelp forests of Port Phillip Bay

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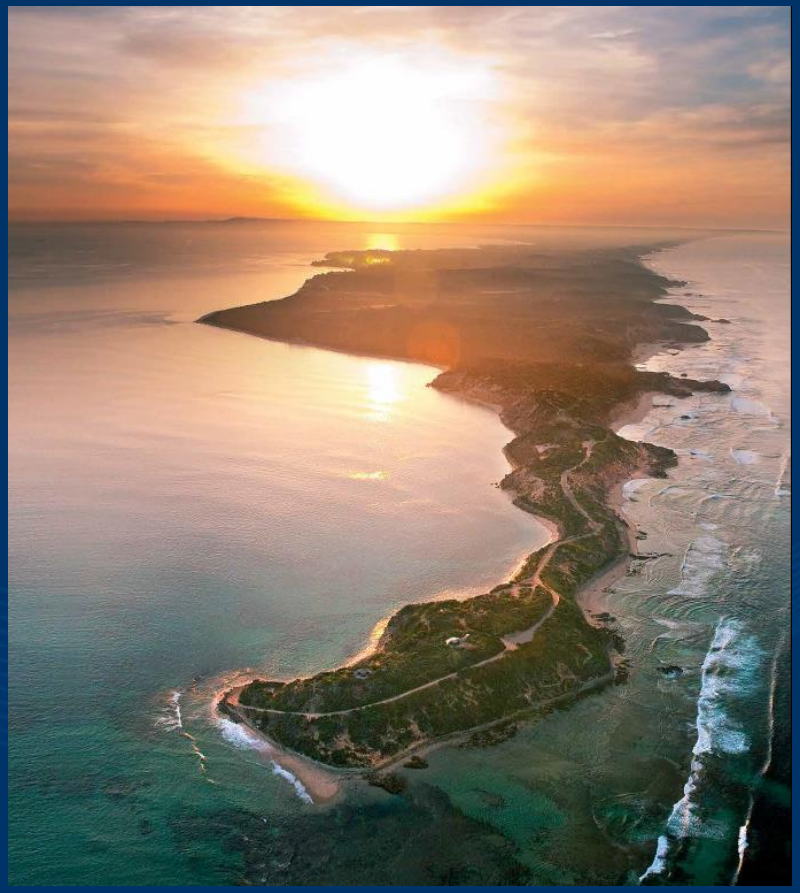
NCCC
National Centre for Coasts and Climate

Steve Swearer



Outline

- National Centre for Coasts and Climate
- The Reef Ecosystem Evaluation Framework (REEF)
- Roadmap for restoring kelp forests in PPB

Earth Systems and Climate Change Hub

National Environmental Science Programme

Point Nepean Quarantine Station

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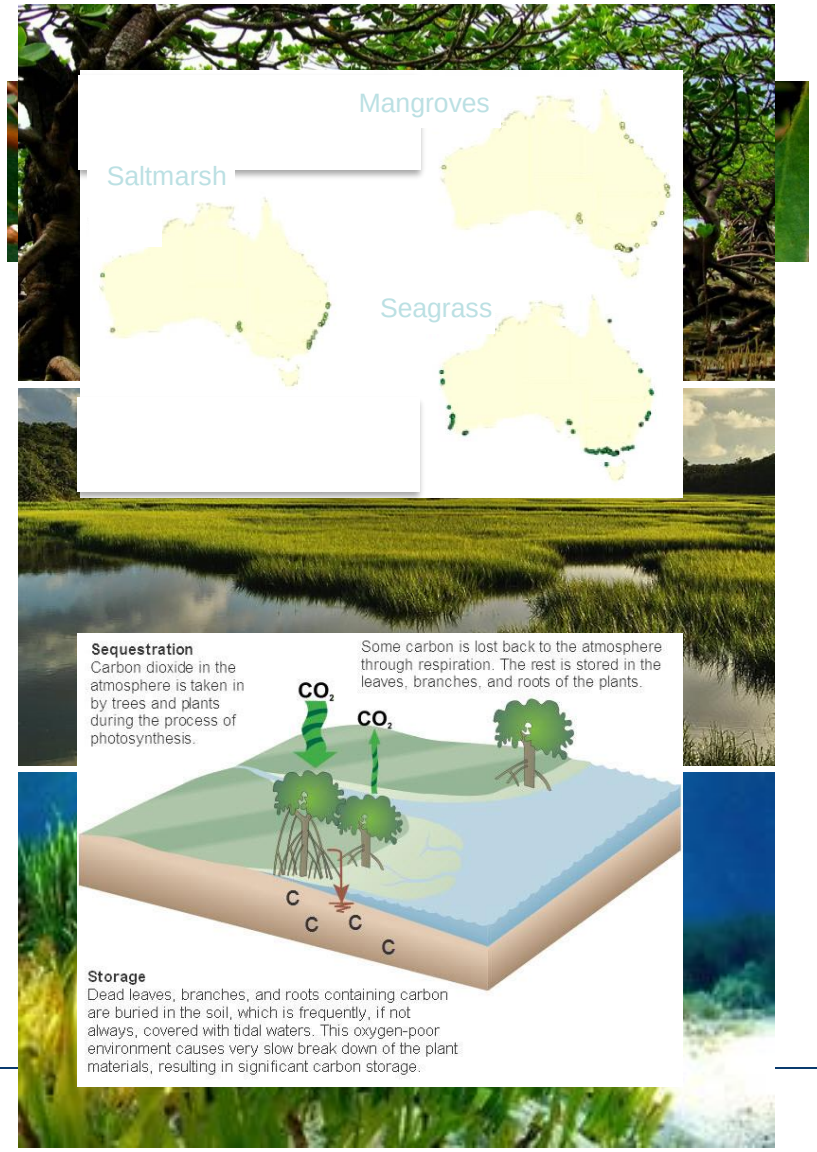
National Centre for Coasts and Climate

To undertake solutions-focused research that advances understanding of risks and opportunities in the coastal zone, and informs new approaches to environmental management and coastal governance.

NCCC

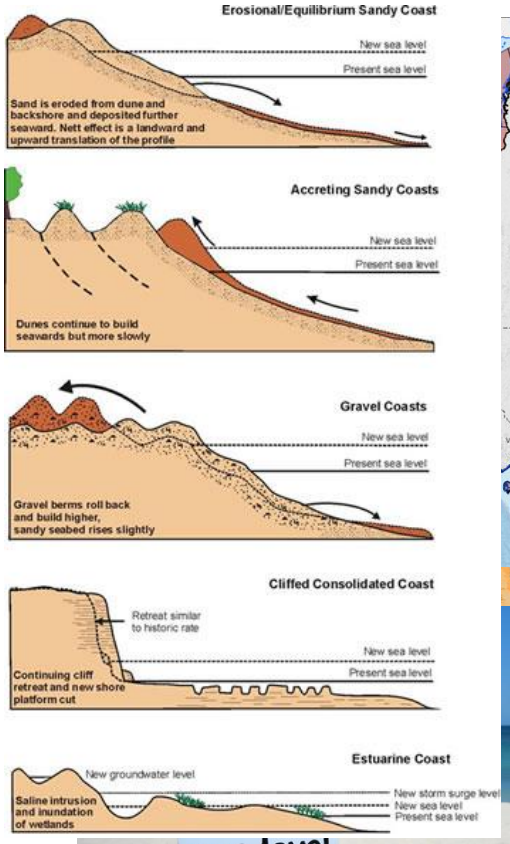
National Centre for Coasts and Climate

Carbon sequestration potential of coastal vegetated ecosystems



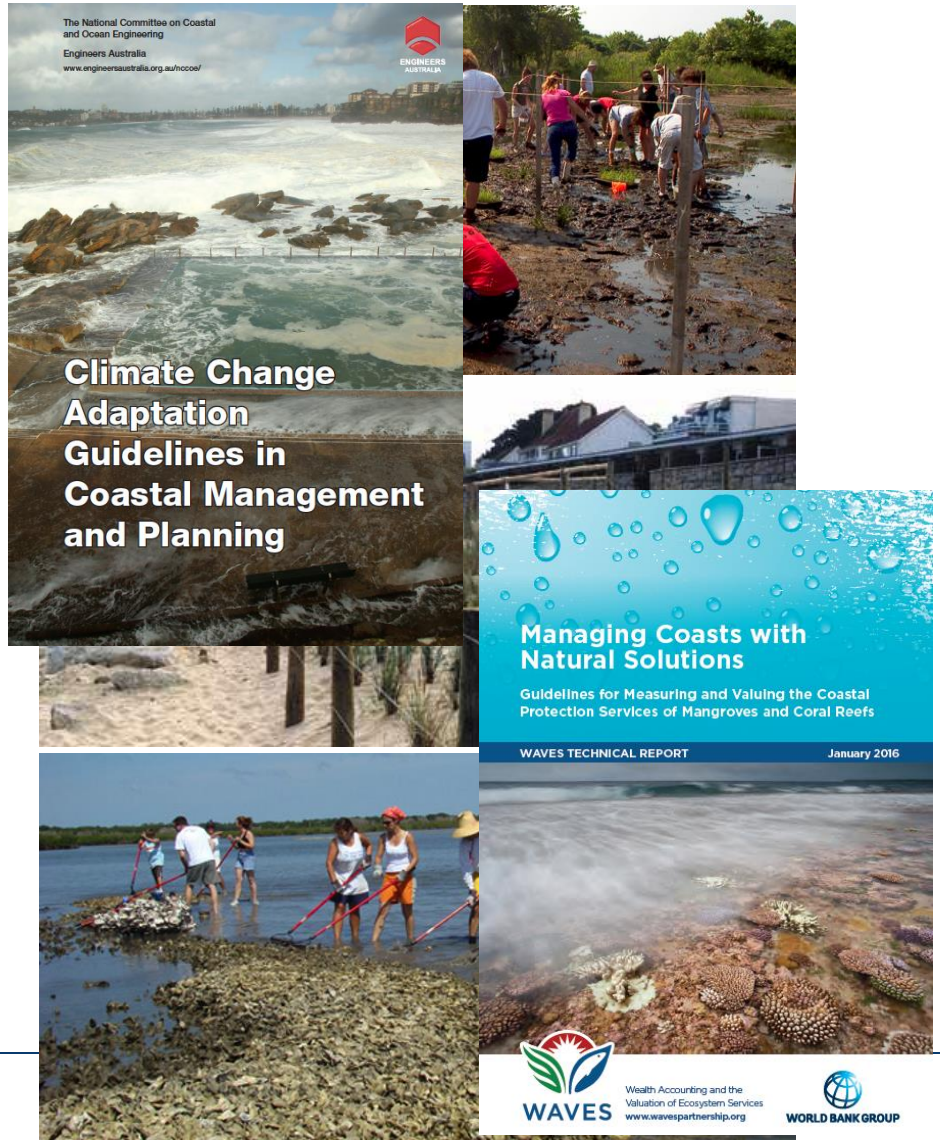
- Problem
  - Blue Carbon under threat
  - Climate mitigation potential uncertain
- Research Needs
  - Filling regional data gaps
  - C cycling & storage potential
- Outcomes & Impacts
  - Emissions Reduction Fund
  - National Inventory

Predicting coastal erosion



- Problem
  - 85% within 50km of the coast
  - Risks to natural and built assets
- Research Needs
  - Looking to the recent past to predict the future
  - Linking coastal erosion and hazards through modelling
- Outcomes & Impacts
  - Improved understanding of drivers of erosion under climate change
  - More accurate identification of erosion hotspots

Ecologically engineering more resilient coasts



- Problem
  - Multiple stressors reduce capacity for mitigation and adaptation
  - Hard engineering solutions are expensive, static, and short-term
- Research Needs
  - Methods for Blue Carbon ecosystem restoration
  - Methods for nature-based solutions for coastal protection
- Outcomes & Impacts
  - Case study demonstrations
  - National guidelines for design & implementation

Carbon Storage Potential of Coastal Vegetated Ecosystems

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MONASH University

Improving Understanding of Coastal Erosion

NCCC – Research Capability

Nature-Based Solutions to Climate Change



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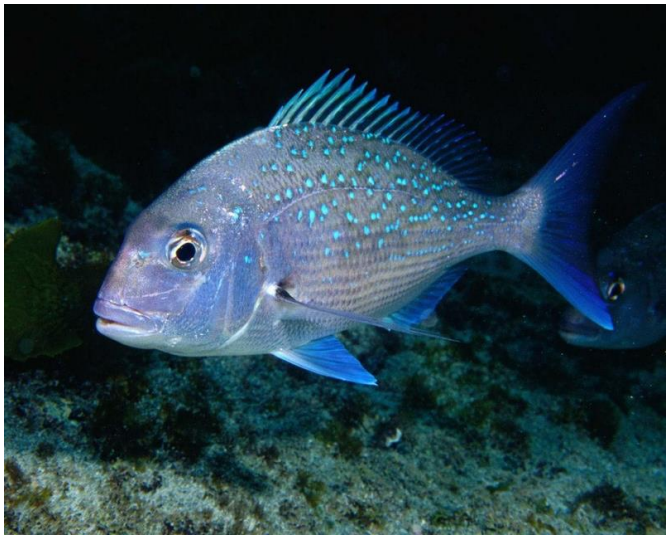
The Nature Conservancy Australia

CITY OF GREATER GEELONG

Optimising nutrients for coastal fisheries productivity



NCCC –Research Capability

Culturing macroalgae to reduce nitrogen in wastewater

macro
Centre for Macroalgal Resources & Biotechnology

Melbourne Water

NCCC –Research Capability

Environmental benefits of sea farming in coastal oceans

AQUATROPHIC
Aquatic Biotechnology

RURAL INDUSTRIES
Research & Development Corporation

DEAKIN UNIVERSITY AUSTRALIA

National Marine Science Centre

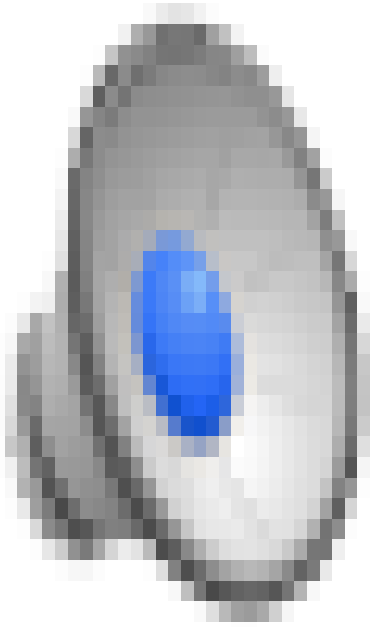
Reef Ecosystem Evaluation Framework (REEF) Project

The REEF project examined:

- The effect of sea urchins and anthropogenic stressors (sediment and nutrients) on the ecology of rocky reefs in Port Phillip Bay (PPB).

- Implications for management of resilience of PPB reefs.

Melbourne's Hidden Plague



Regions (Bay-wide survey across 35 sites)

West

- no kelp
- lowest algal richness
- highest urchin density
- ↑ urchin barrens
- ↑ turf-sediment matrix
- some *Undaria*

North

- remnant kelp
- ↑ urchin density
- ↑ urchin barrens
- ↑ turf-sediment matrix
- highest cover *Undaria*

Southwest

- ↑ kelp
- ↑ algal canopy cover
- ↑ algal richness
- no *Undaria*
- ↓ urchins

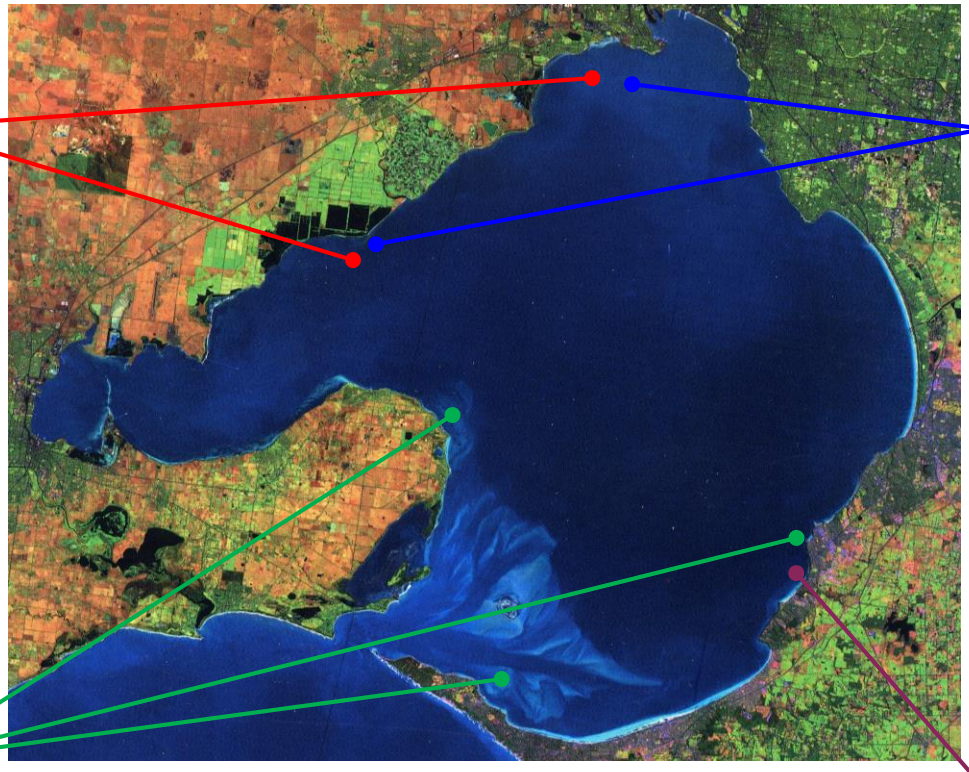
Southeast

- ↑ kelp in many areas
- ↑ fucoids
- ↑ algal canopy cover
- ↑ algal richness
- no *Undaria*
- ↓ turf-sediment matrix
- urchin barrens appearing

Different Reef Conditions Throughout the Bay

urchin barrens

turf-sediment matrix



kelp bed

mixed canopy

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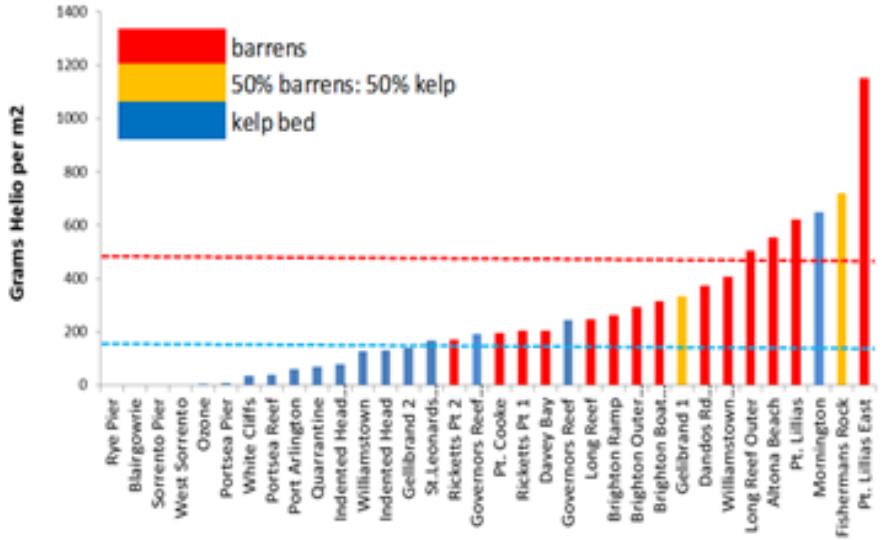
Sea urchins

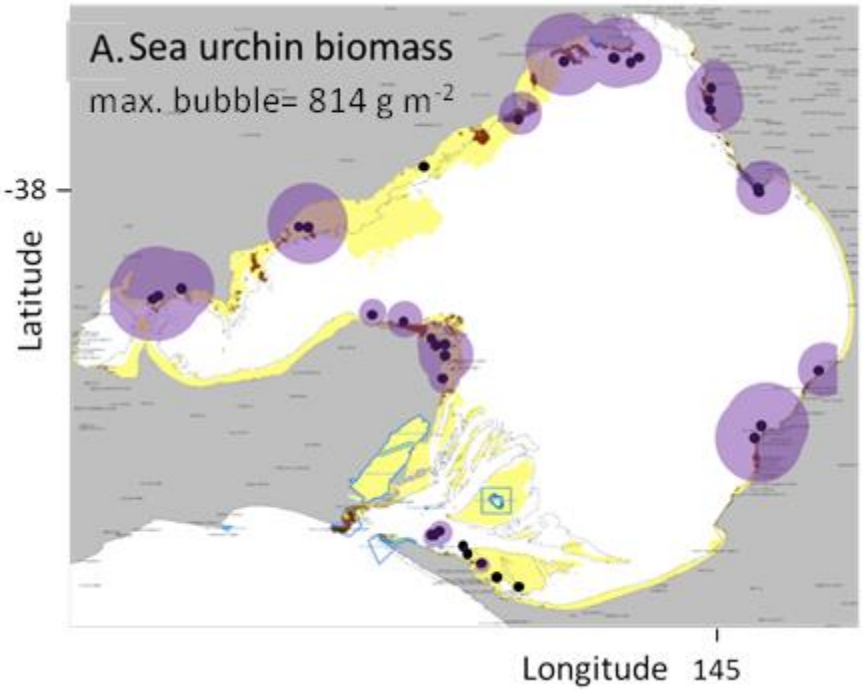
- Attracted to and consume kelp (*Ecklonia radiata*)
- Kelp grown in elevated nutrients appears more attractive to urchins
- Urchin densities ≥ 8 m^{-2} will overgraze kelp and maintain urchin barrens
- Kelp survives / grows at urchin densities ≤ 4 m^{-2}
- At current densities in many parts of PPB, grazing by urchins overrides any stimulating effect on kelp growth of elevated nutrients
- Urchins will feed on drift kelp if it is available and largely avoid attached kelp
- If drift kelp is not available urchins will consume attached kelps

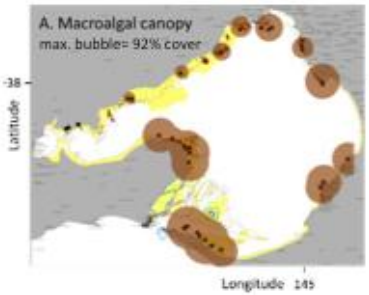
Sea urchins

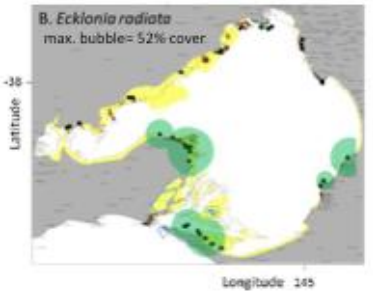
8 km^2 of reef habitat

~6000 tons of urchins
50-100 million urchins









Management implications

- The single largest threat to the integrity of kelp beds (*Ecklonia radiata* and fucoids) in PPB is elevated sea urchin densities
- Overgrazing by sea urchins has greatly reduced kelps beds in the northern and western regions to create extensive sea urchin barrens
- The abundance of *Ecklonia radiata* in the SE is currently threatened by sea urchin grazing
- Current levels of anthropogenic nutrient and sediment input into PPB appear to have no *direct* detrimental impact on kelp beds
- Elevated nutrients have an *indirect* impact on kelps by:
  - stimulating growth of algal turfs (which inhibit kelp recruitment)
  - making attached kelps more attractive and/or palatable to sea urchins (which aggregate on and graze kelps)

Roadmap for Reef Rehabilitation

- Rehabilitation of kelp beds on existing barrens will require both:
  - reduction of sea urchin densities and …
  - ‘seed patches’ of adult kelps (as remnant or transplanted patches) to provide spores and sweep the substratum to prevent turf development
- Important source populations for reef organisms with dispersive larvae (many inverts and fish) are located in the southern region of the bay, which are part of the network of marine sanctuaries and parks with PPB
- Rehabilitation of kelp beds will have important flow-on benefits to other reef organisms, including fishes

Why are there so many urchins?

- Low mortality
- Limited dispersal
- Living dead…
- Nutrient inputs from WTP and Yarra/Maribyrnong? Through turf and/or drift?

Persistent Drift Algal Mats

Standing Crop and Nutrient Content of Macrophytes in Port Phillip Bay

S.S. Chidgey and M.J. Edmunds
Consulting Environmental Engineers
90 Bridge Rd, Richmond, 3121, Australia

Technical Report No.32

Port Phillip Bay Environmental Study
CSIRO Environmental Projects Office
GPO Box 1666
Canberra, ACT 2601, Australia

December 1997

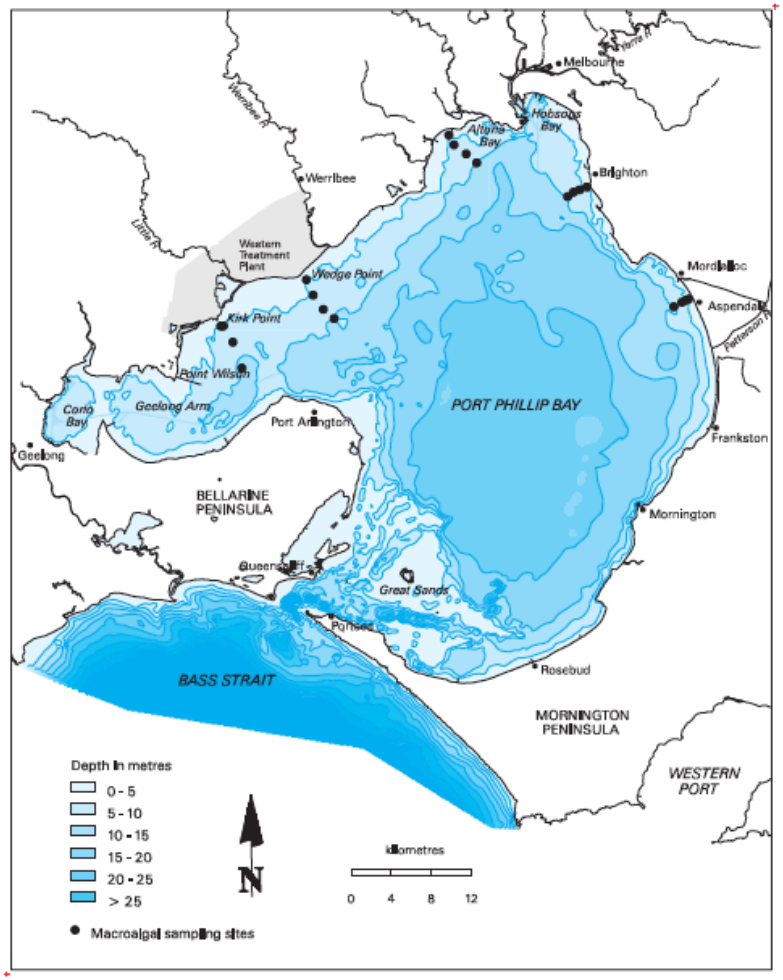


Figure 1: Port Phillip Bay locations and macroalgal sampling sites

Persistent Drift Algal Mats

- Standing stock varied from 110,000 – 240,000 tons (210 – 1,000 tons N)
- Potential for impairment of denitrification in the sediments

Questions

- Are mats a product of WTP and/or Catchment N inputs?
- Are mats an important trophic subsidy supporting high urchin biomass?

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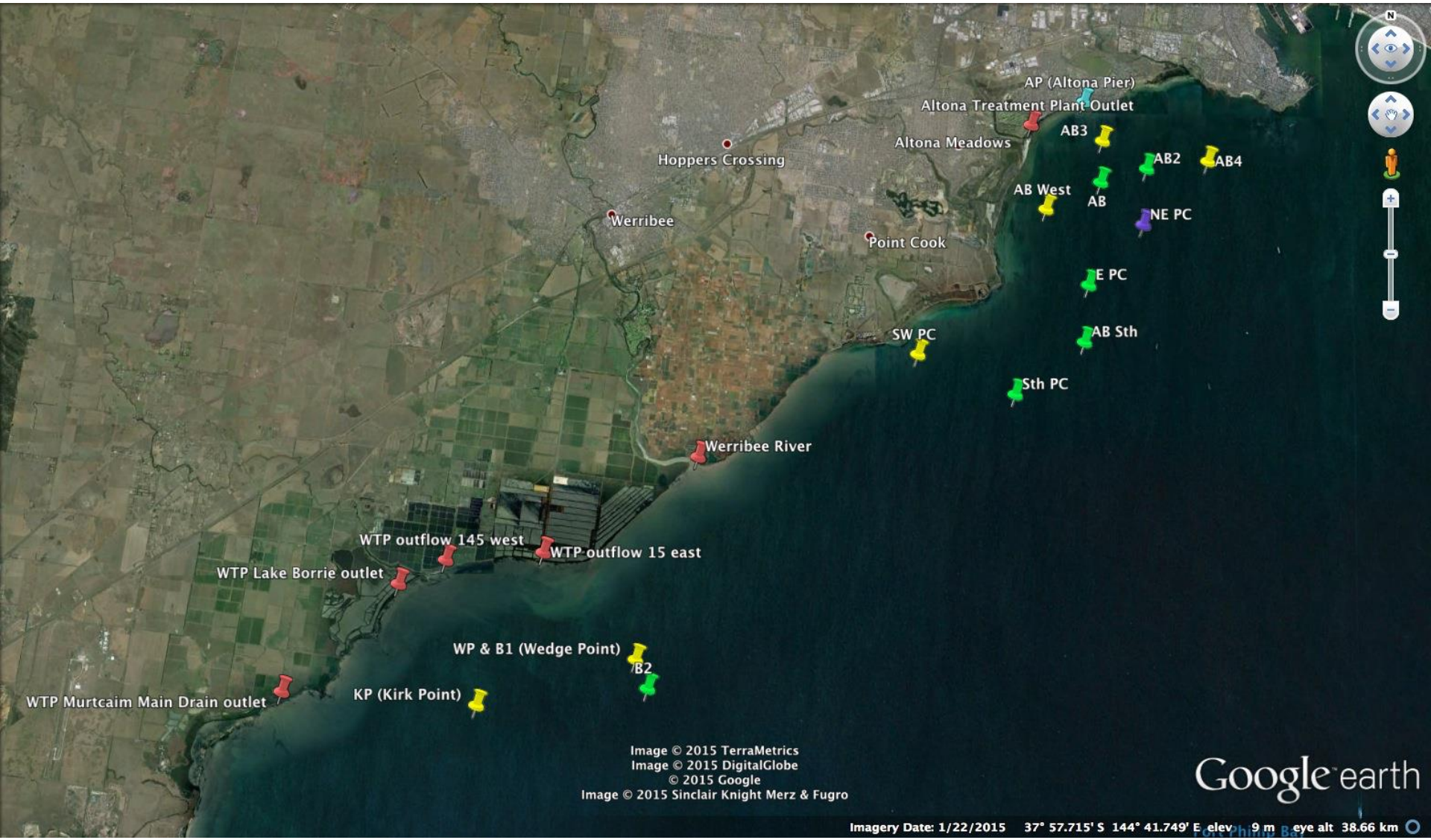
Persistent Drift Algal Mats



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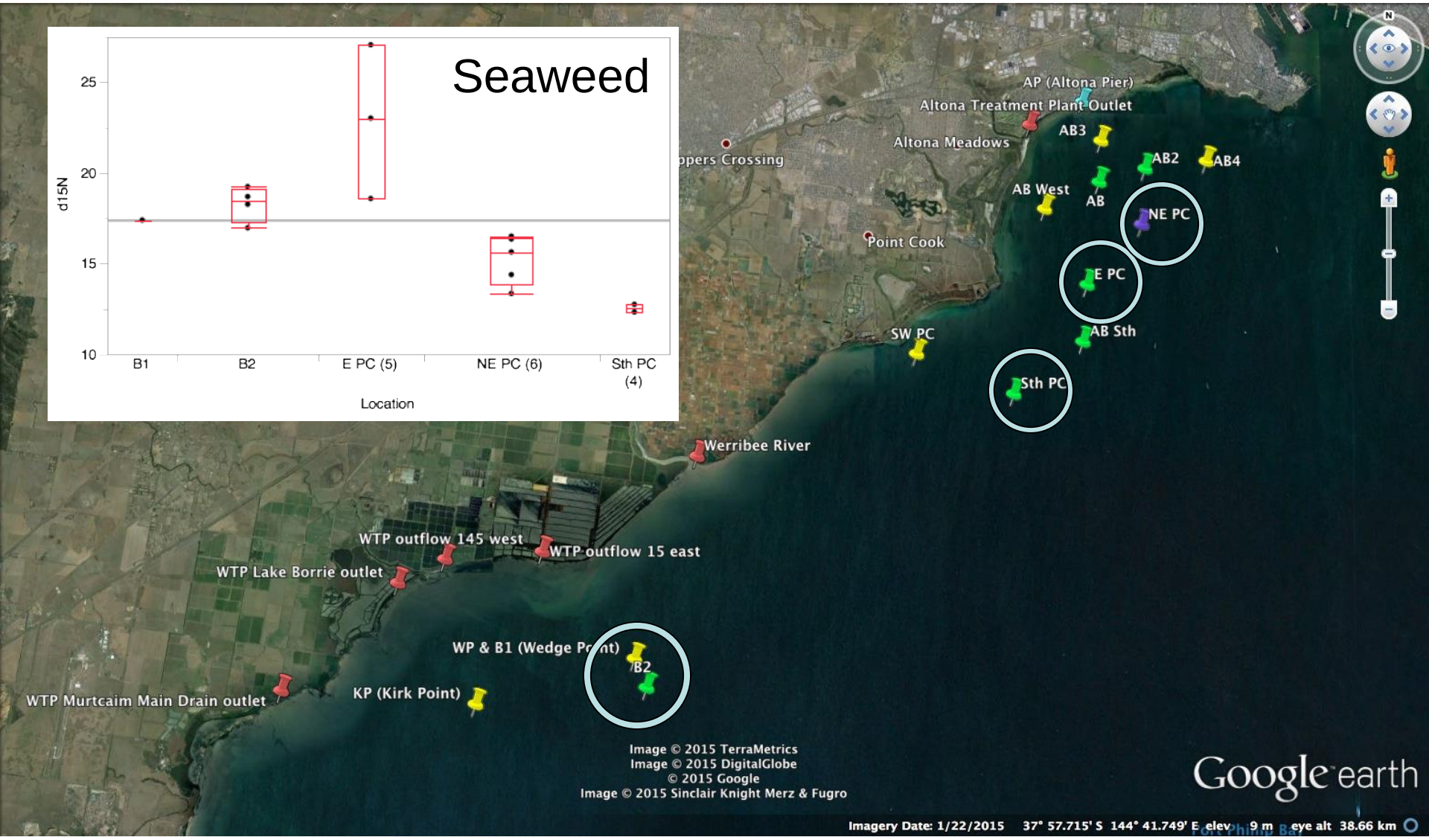
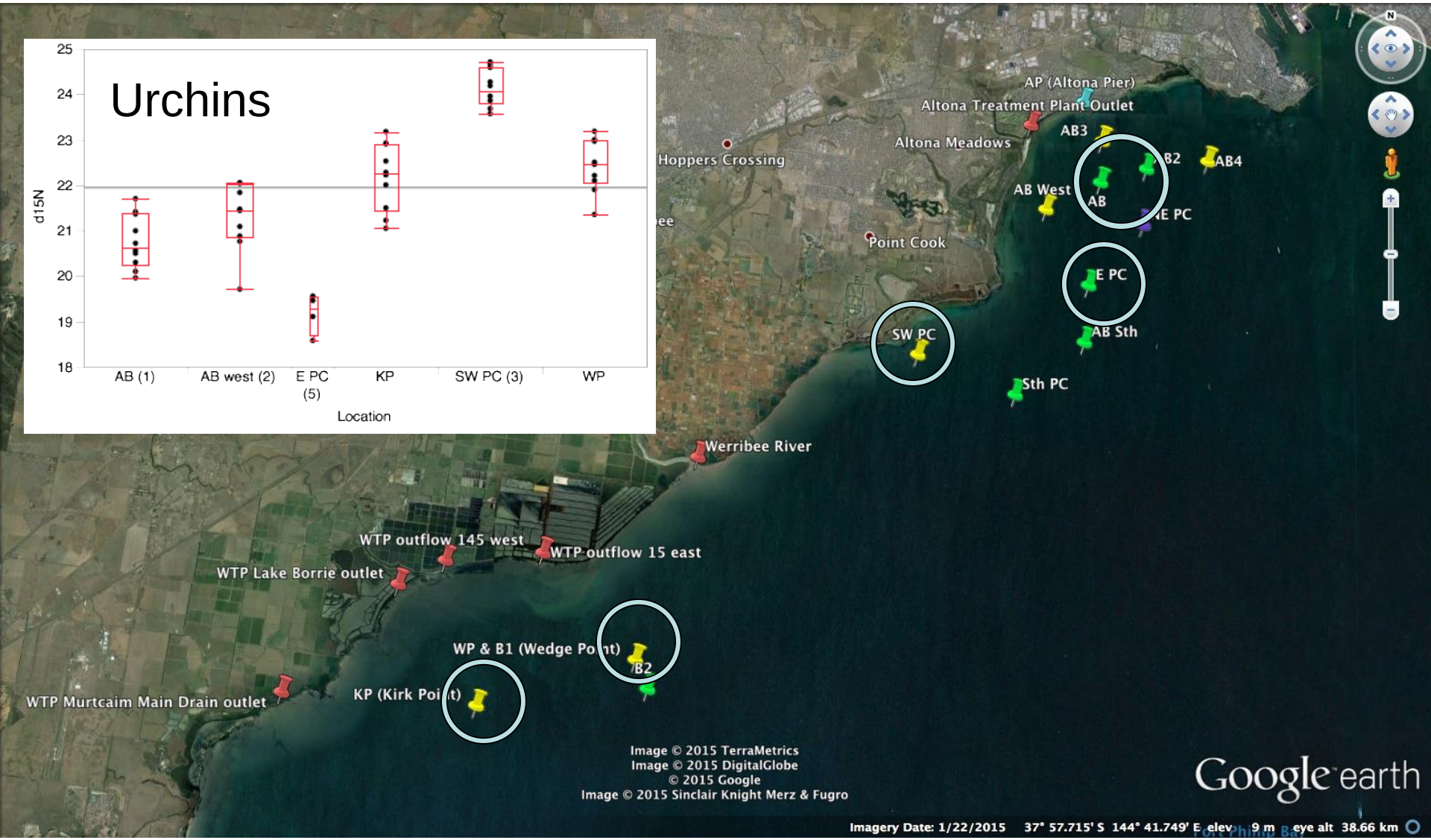
Persistent Drift Algal Mats

Persistent Drift Algal Mats



Food Source for Urchins?



New Research Findings

- Algal drift mat is still present and extensive
- Growth of algal drift is being fuelled by the WTP
- High urchin biomass is being supported by the nutrient enrichment from the WTP

Harvesting of Drift Algae

Potential benefits

- Nitrogen removal from PPB (N offset/trading scheme)
- Increased denitrification efficiencies in sediments
- Reduced food for urchins

Outstanding research questions

- How extensive are the beds? Do they occur in Hobson's?
- What impacts would harvesting have?
- How quickly does the drift recover?
- What impact does removal have to denitrification rates?

Harvesting of Sea Urchins

How do you remove 50 million urchins from 8km^2 of reef?

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Harvesting of Sea Urchins

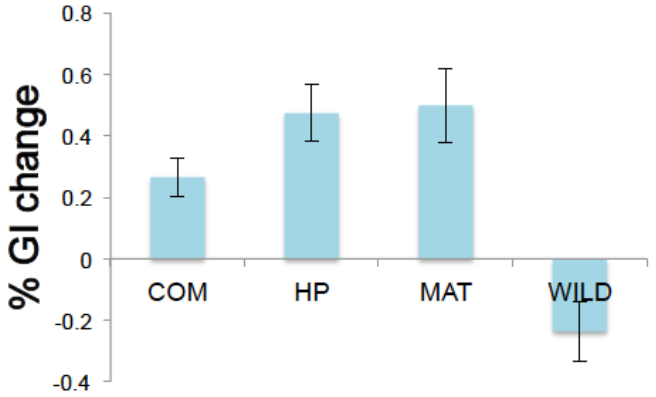
Potential benefits

- Necessary for recovery of macroalgal beds
- Potential for community engagement
- Potential to develop a new industry

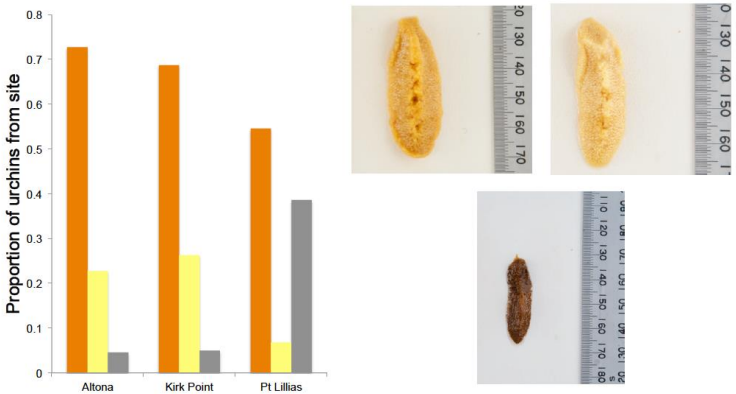
Outstanding research questions

- Can urchins from barrens be reconditioned to a commercially viable product?
- What feed biochemistry maximizes product quality?
- Can they be reconditioned in the field?

Reconditioning Poor-quality Urchins from Barrens



Final results - Colour



Barrens of gold



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