Sea-floor species health and survival to underwater 'sediment clouds'

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On behalf of the Project Team

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Presentation outline

Project background
  • Aims

Our work
  • Experimental system development
  • Results

Project conclusions and future application

Q & A
Background

- A large proportion of the seafloor in New Zealand waters is soft sediment

- Sediments can be disturbed by storms and/or by human activities
  - e.g. seabed dredging, mining, fishing, land-based activities

- Create clouds or plumes of suspended sediments
  - potentially extend over a wide area

- Limited data and understanding of biological responses to exposure to elevated suspended sediments (cf. direct seabed disturbances)
  - especially deeper shelf and continental slope fauna
Biological responses

• Suspended sediment can affect the abundance, diversity and structure of benthic communities
• May influence factors such as survival, larval recruitment, feeding rates and efficiency, growth
• Species, and life history stages, vary in their vulnerabilities
• Some have specific strategies to reduce sediment intake
  • cessation or reduction of respiration or pumping
  • mucous production to remove sediment
  • particle expulsion
Background (the Sustainable Seas “fit”)

- The “Sediment tolerance and mortality thresholds of benthic habitats” project began in 2016
- Funded through the Challenge’s Innovation Fund and part of the Dynamic Seas Programme from Phase I
- Aligned to the Sustainable Seas Challenge objective:
  “to enhance the value of NZ’s marine resources while providing a healthy marine environment”
- Improved knowledge of impacts, support for ecological risk assessments and ecosystem based models
- Extend Sustainable Seas research to deeper shelf waters
Aims

• to help establish threshold levels of suspended sediments where impacts might become “ecologically significant”

• provide information to mitigate or manage impacts of suspended sediments
Study focus

Where?
- South Taranaki Bight and Wellington
- Consistent with West Coast Stage 1 Challenge study area
- Relevance to interest at the time in offshore impacts and sediment clouds (e.g. ironsands mining)

What?
- Common species
- Dog cockle (*Tucetona laticostata*)
- Sponge (*Crella incrustans*)

How?
- Laboratory experiments
- Suspended sediment system
Chamber system development

Based on Vortex Resuspension Tank
Davies et al. (2009),
JEMBE 370: 35–40

Suspend sediments, control loading
16 chambers, ~37 litres, flow through
Chamber system development

Chambers Version 3

Manual checks (optical turbidity meter)
Experimental design

- Gradient of suspended sediment concentrations, from 0 to 820 mg L\(^{-1}\)
- ~47% silt, ~43% v. fine sand

![Bar chart showing suspended sediment concentrations in different chambers with error bars representing mean ± std error.](chart.png)
Suspended Sediment Conc (mg L$^{-1}$) Mean ± Std Error

- **Experimental design**
  - Range of exposure times
    - 1, 3, and 4 weeks
    - + 2 weeks recovery time
  - Survival, metabolism, weight, tissue condition (e.g., necrosis, internal sediment accumulation), various stress responses

![Graph showing suspended sediment concentration across different chambers](image-url)
Collection

*Tucetona laticostata*  
(dog cockle)

*Crella incrustans*  
(sponge)

RV Kaharoa  
Beaumont, NIWA

Victoria University of Wellington, divers  
Bell, VUW
**Tucetona laticostata**

Pre-exposure

0.4 g/l (3 weeks)
**Crella incrustans**

- **High survival**
- **Sediments accumulated internally**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>96 mg L$^{-1}$</th>
<th>544 mg L$^{-1}$</th>
<th>832 mg L$^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 8</td>
<td><img src="image1.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
<td><img src="image3.jpg" alt="Image" /></td>
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- **Respiration rates not significantly affected**
**Crella incrustans**

- Morphological changes
- Greater number of ‘apical fistules’ at higher suspended sediment concentrations (SSC)
- *Crella* tolerance to temporary (thin) sediment deposition?
Conclusions

- Lack of strong negative effects on either *Tucetona* or *Crella*
- Both species had mechanisms to clear the sediments
- May be predisposed to ‘coping’, at least over the time frames and conditions investigated
- BUT, more sensitive measures, mechanisms of sediment processing, different life stages, will all enhance understanding of species responses
Conclusions and follow-up research

• Multiple insights into the resilience of two species
• Established effective laboratory system for maintaining sediment in suspension - not an easy task
• Developed approaches and methodology to undertake experimental work, to complement *in situ* observations and disturbance research
Conclusions and follow-up research

Results and methodologies have informed other sedimentation research projects

• Juvenile scallops (NIWA)
  Tolerance of juvenile scallops to suspended sediments, to inform ecosystem modelling (2020)

• Deep sea corals and sponges (NIWA, VUW)
  ROBES (Resilience Of deep-sea Benthos to the Effects of Sedimentation) (2016-2021)
  Chatham Rise corals (*Goniocorella dumosa*) and sponges (*Ecionemia novaezelandiae*) (2019)
  Follow up deep-sea coral experiments, expanding response variable scope to include genetic microbiome and histology studies (2020)
Acknowledgements

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• Victoria University of Wellington’s dive team for sponge collection.
• NIWA and VUW staff and students for their help with aspects of the experimental work.
• Images and photos provided by a number of NIWA and VUW staff and students

Results related to *Crella incrustans* have been published:

Cummings et al. (2020): Responses of a common New Zealand coastal sponge to elevated suspended sediments: indications of resilience. *Marine Environmental Research* 155
doi.org/10.1016/j.marenvres.2020.104886
Questions?