National SCIENCE Challenges

Webinar starts: 1:05pm, Thursday 27 August

SUSTAINABLE SEAS

Ko ngā moana whakauka

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

Malcolm Clark[1] & Vonda Cummings[1]

On behalf of the Project Team

Jenny Beaumont[1], Valeria Mobilia[2], James Bell[2], Neill Barr[1], Di Tracey[1], Emily McGrath[2]

1, NIWA; 2, Victoria University

THE UNIVERSITY OF AUCKLAND Te Whare Wānanga o Tāmaki Makaurau NEW ZEALAND

THE UNIVERSITY OF WAIKATO Te Whare Wānanga o Waikato

VICTORIA UNIVERSITY OF WELLINGTON TE HERENGA WAKA

NIWA Taihoro Nukurangi

UNIVERSITY of OTAGO Te Whare Wānanga o Otāgo NEW ZEALAND

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha CHRISTCHURCH NEW ZEALAND

GNS SCIENCE TE PŪ AO

CAWTHRON The power of science®

AUT

National SCIENCE Challenges

SUSTAINABLE SEAS

Ko ngā moana whakauka

Presentation outline

Project background

- Aims

Our work

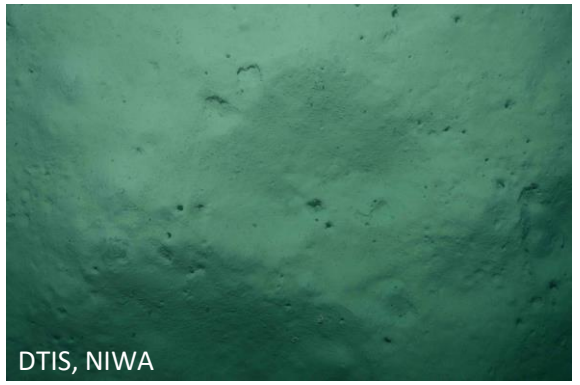
- Experimental system development
- Results

Project conclusions and future application

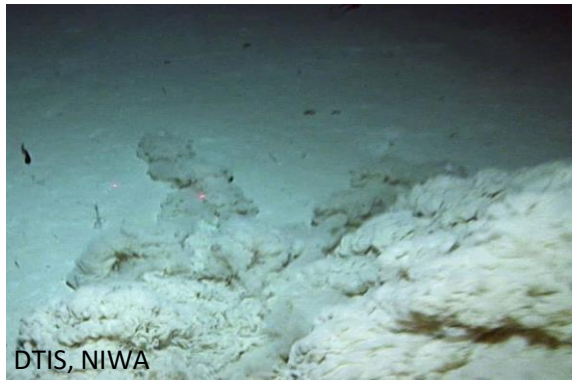
Q & A

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


DTIS, NIWA

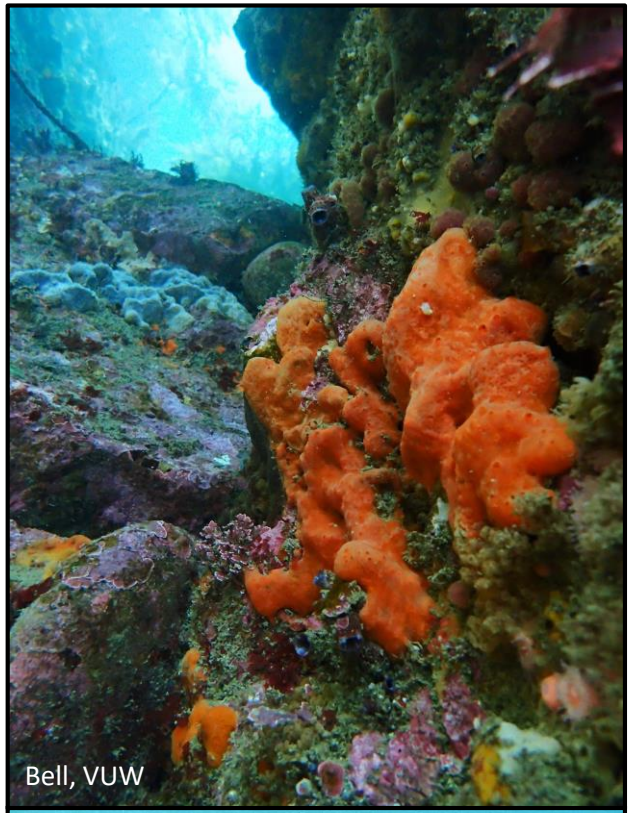

Lohrer, NIWA


DTIS, NIWA

National Science Challenges SUSTAINABLE SEAS Ko ngā moana whakauka

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


Bell, VUW


Budd, NIWA

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 NZs 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

Innovation Fund

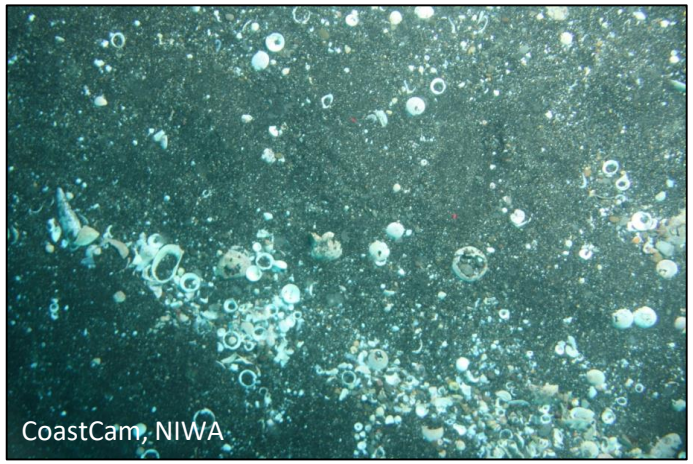
National Science Challenges | SUSTAINABLE SEAS | Ko ngā moana whakauka

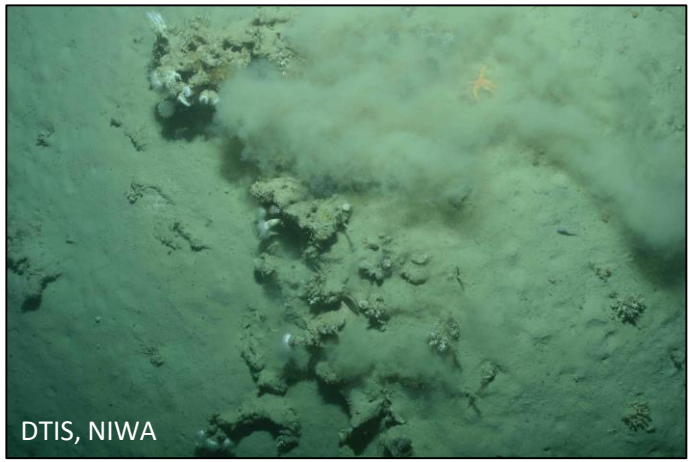
Aims

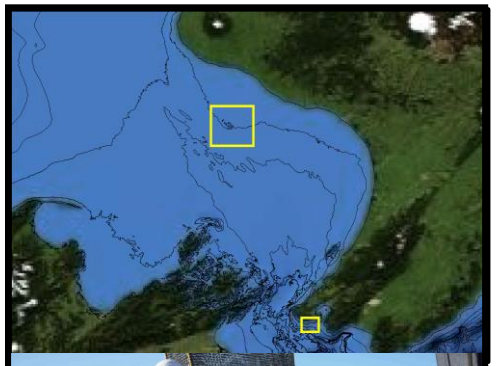
- to help establish threshold levels of suspended sediments where impacts might become “ecologically significant”

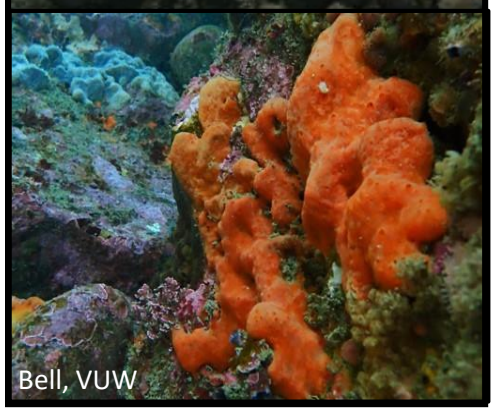
- provide information to mitigate or manage impacts of suspended sediments


Stevens NIWA


CoastCam, NIWA


DTIS, NIWA





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)

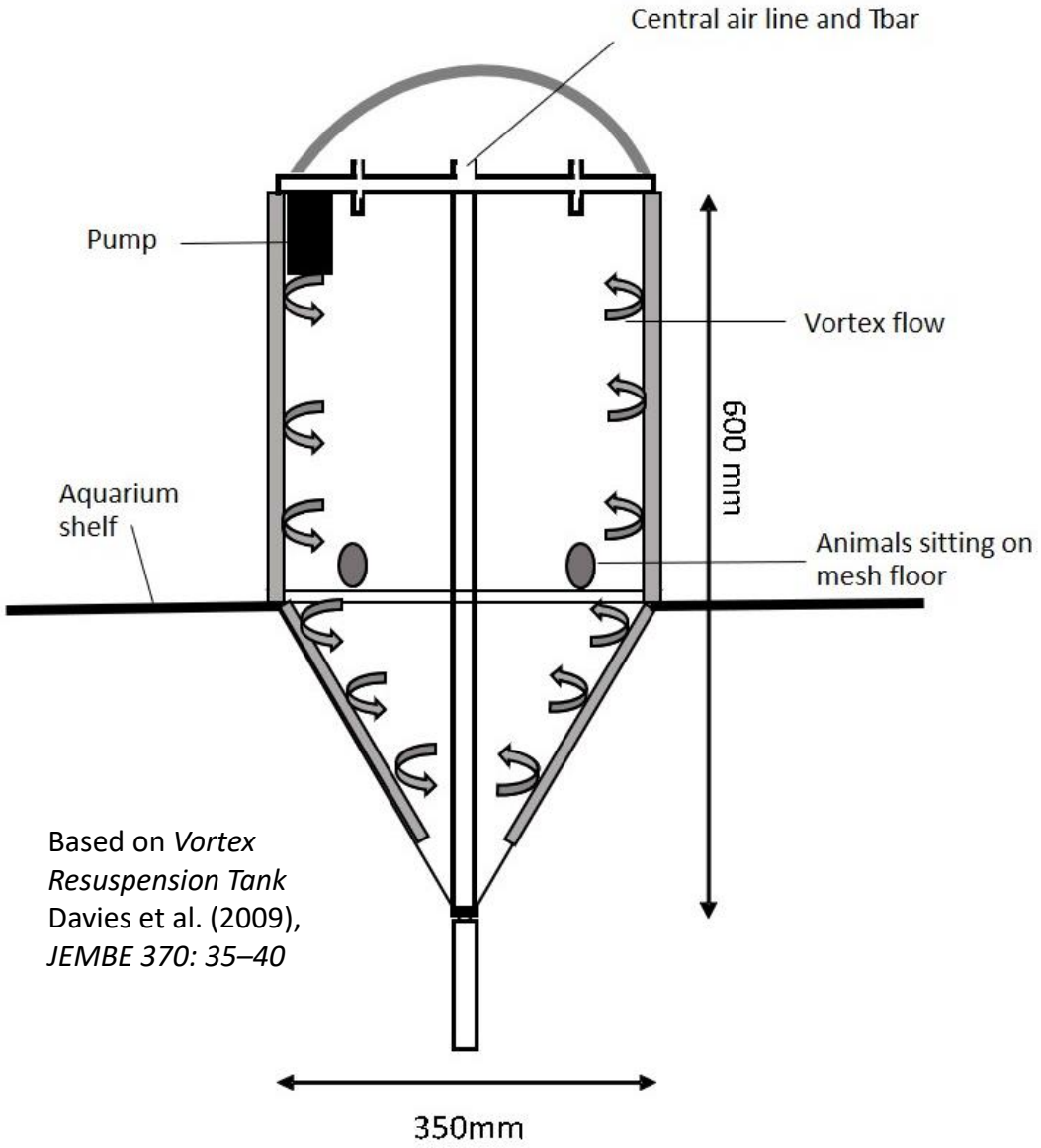
What?

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

How?

- Laboratory experiments
- Suspended sediment system

Chamber system development

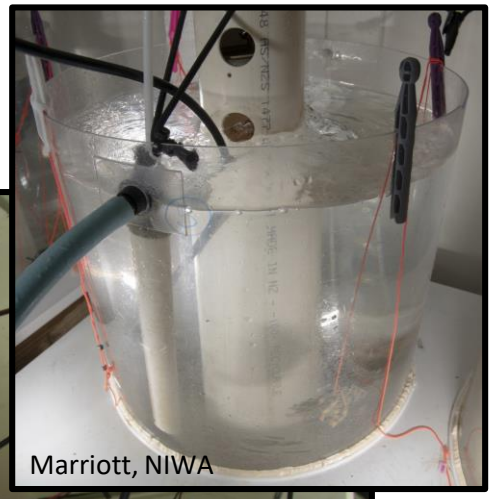


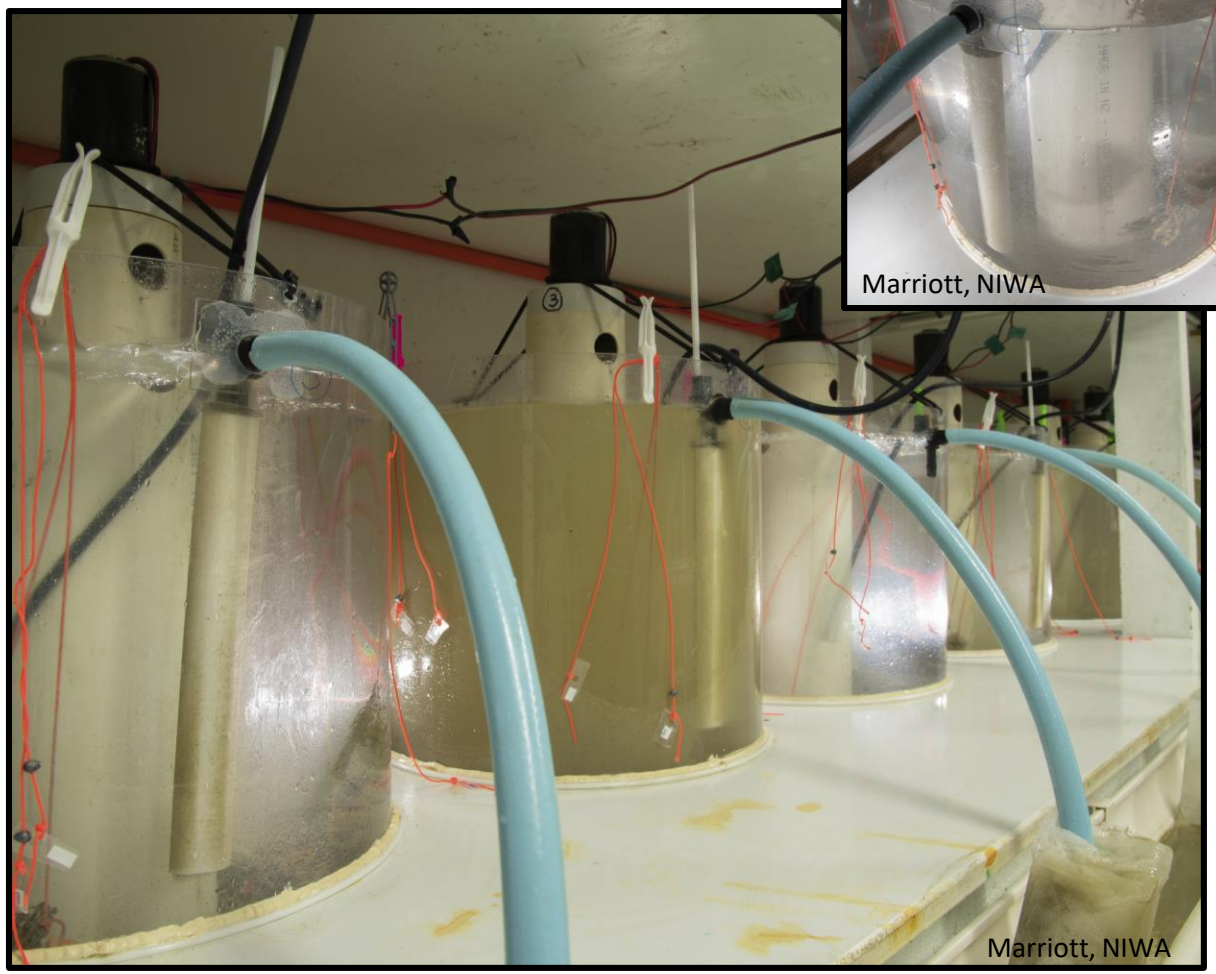
Based on *Vortex Resuspension Tank* Davies et al. (2009), *JEMBE 370: 35–40*

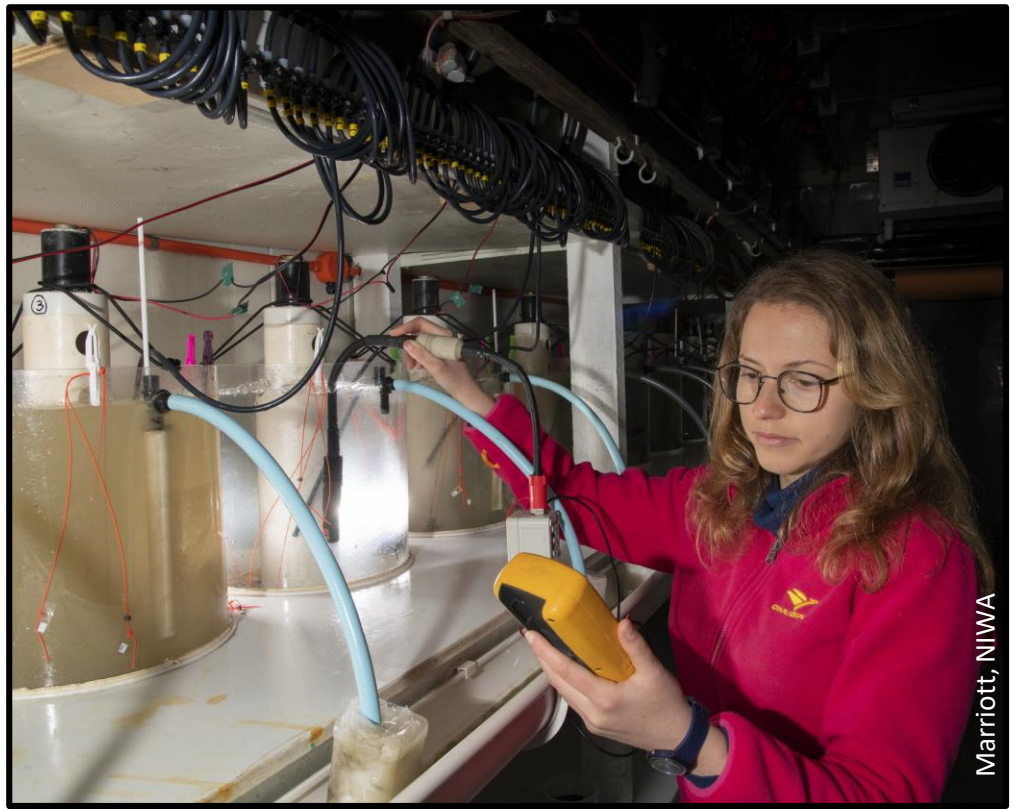
Suspend sediments, control loading
16 chambers, ~37 litres, flow through

Chamber system development

Chambers Version 3



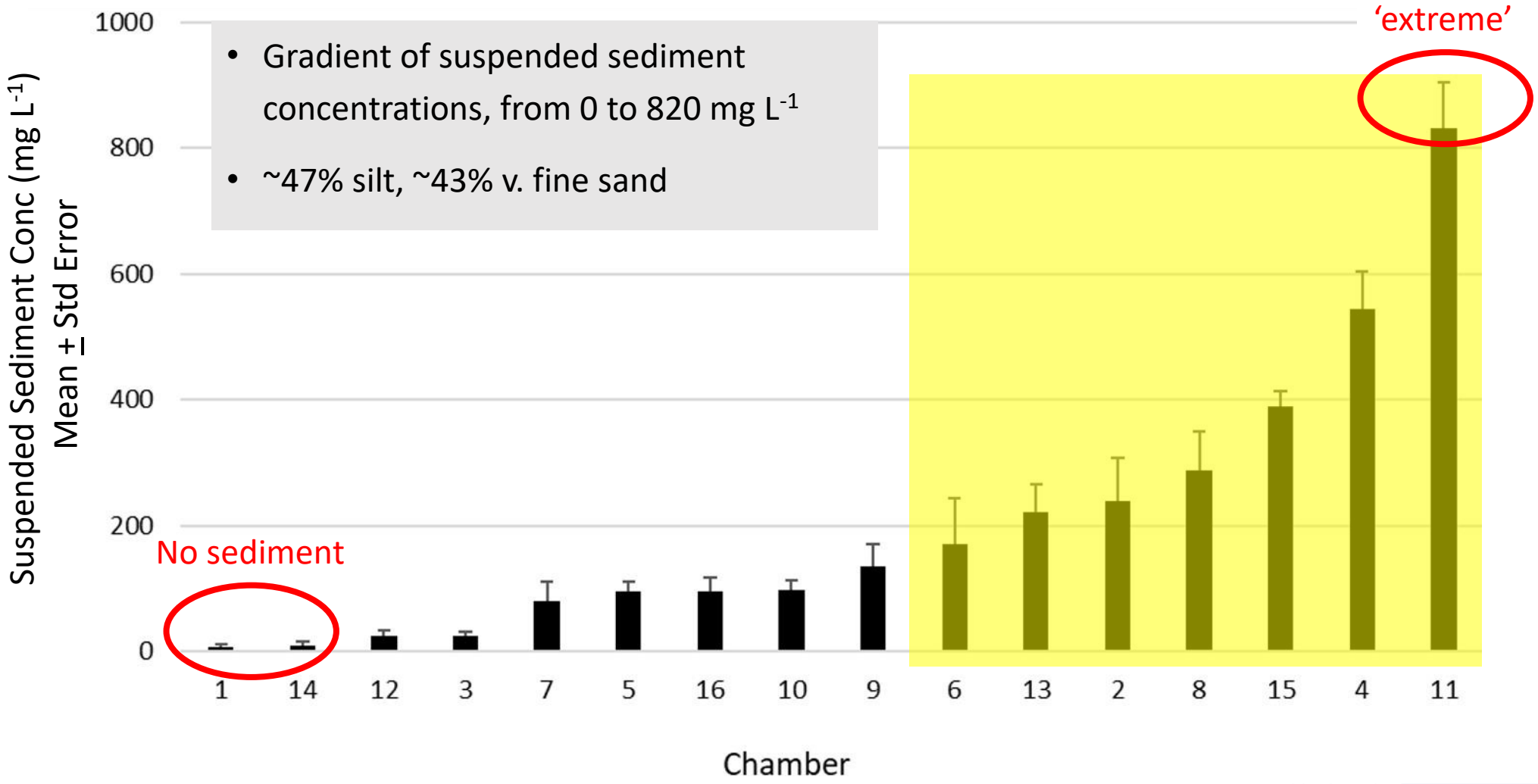




Manual checks (optical turbidity meter)

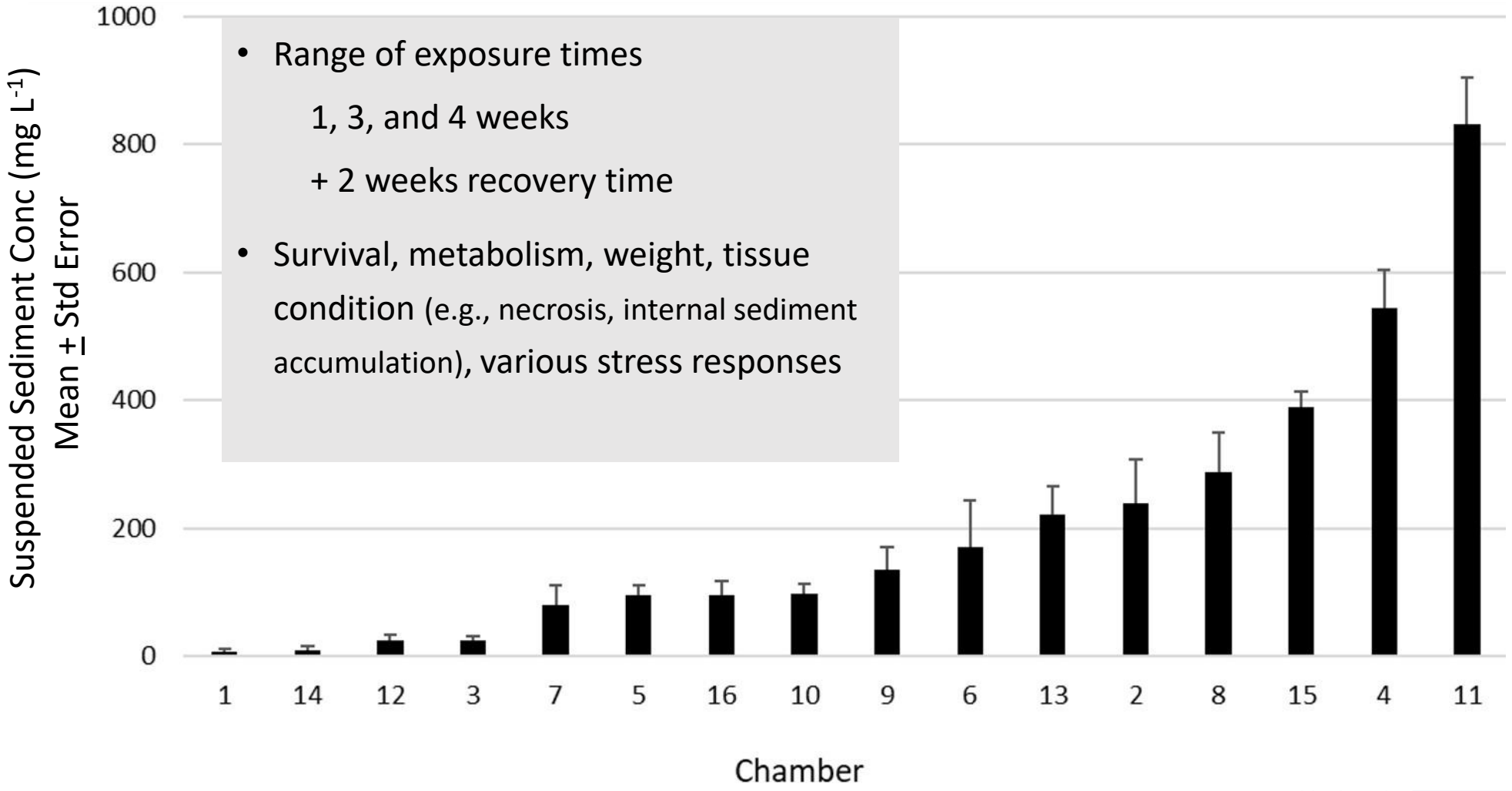
Experimental design

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



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



Collection

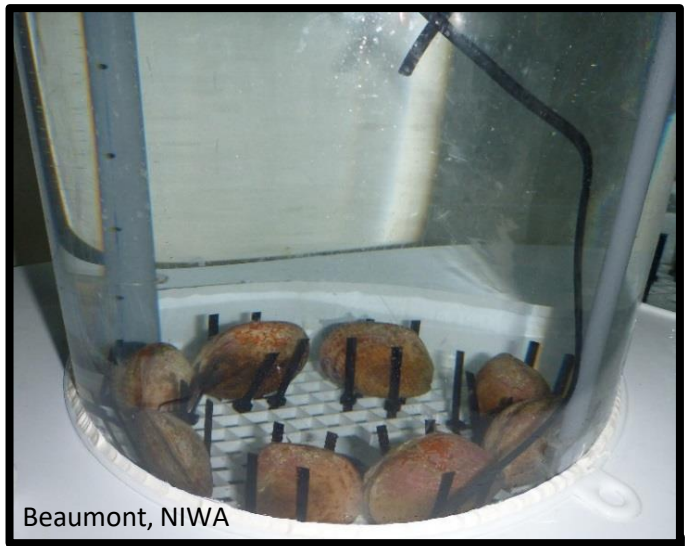
Tucetona laticostata (dog cockle)

RV Kaharoa

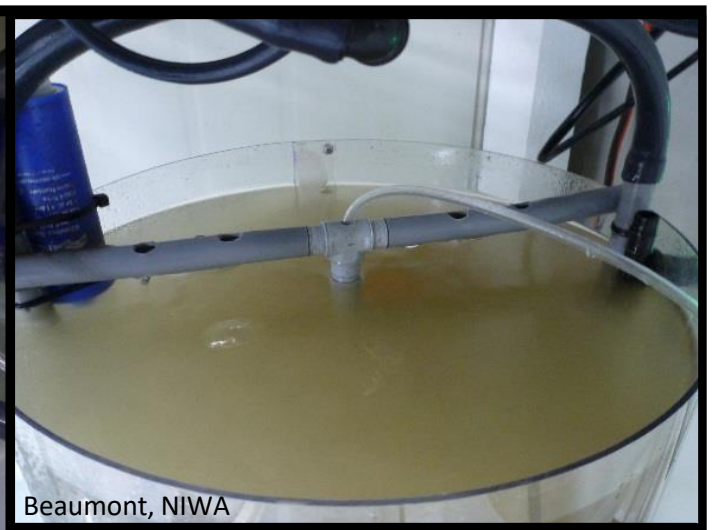
Victoria University of Wellington, divers

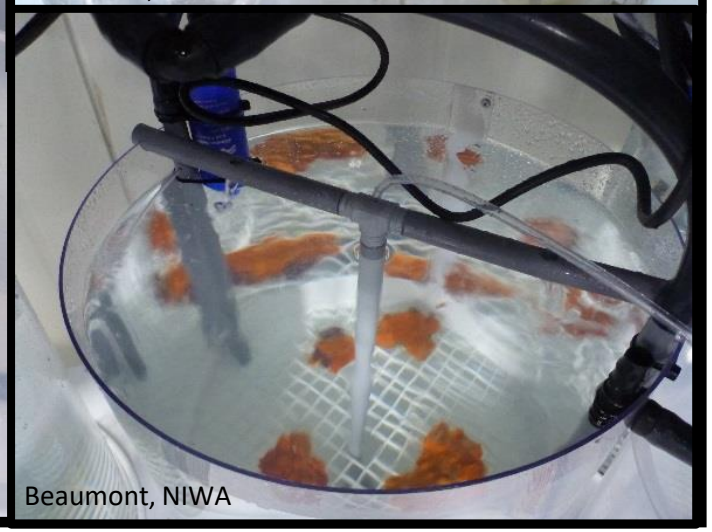
Crella incrustans (sponge)

Cockles



Sponges

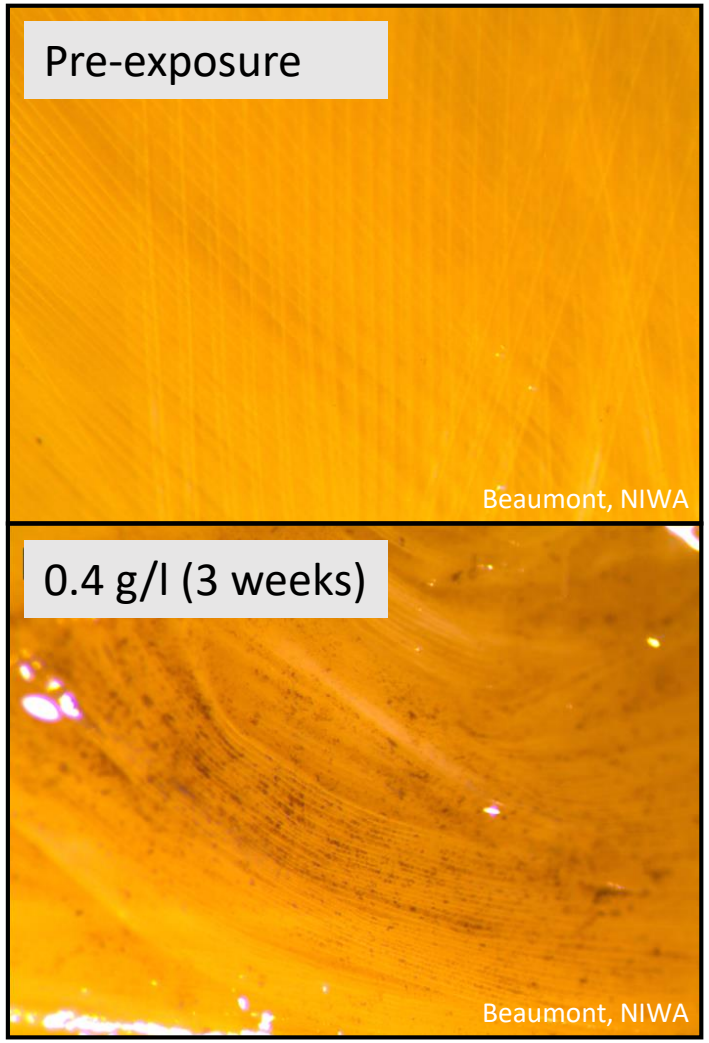




National SCIENCE Challenges | SUSTAINABLE SEAS | Ko ngā moana whakauka

Tucetona laticostata

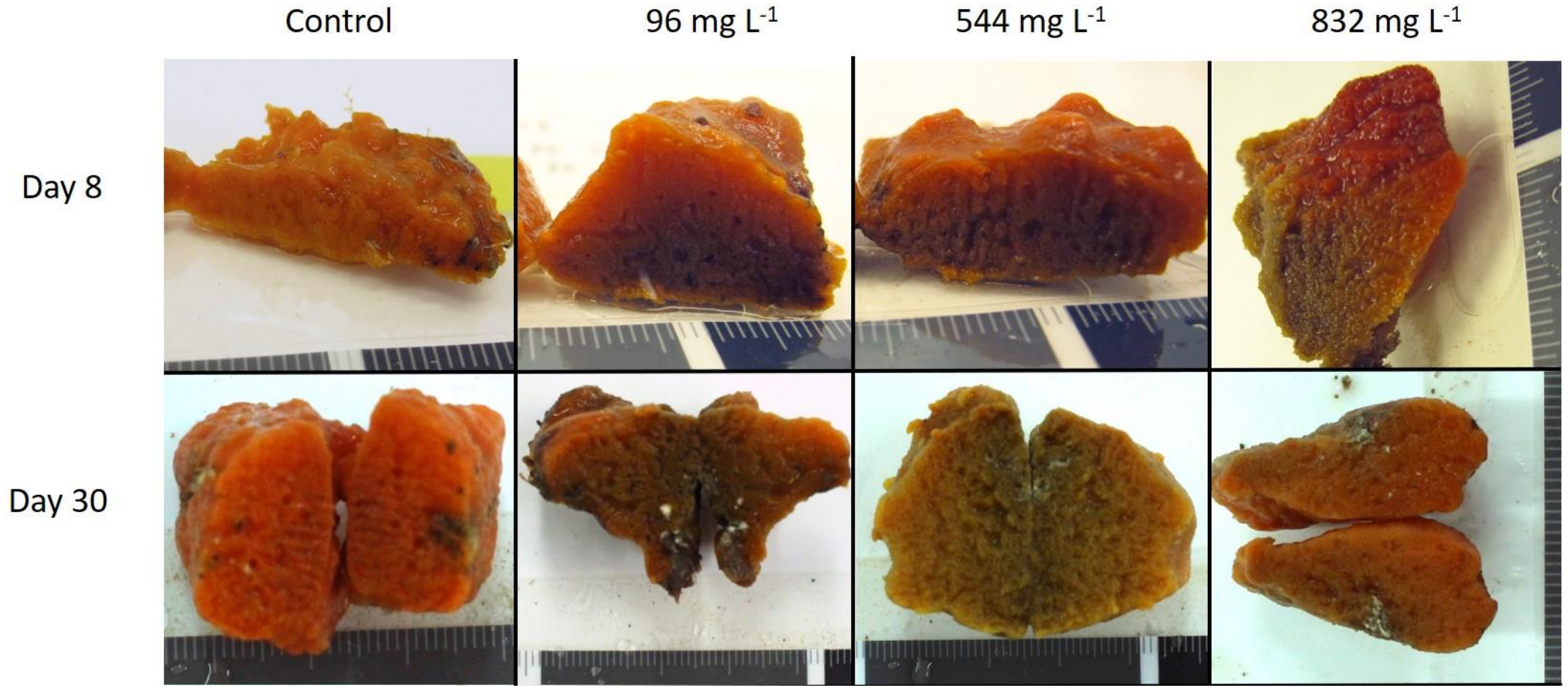
Cockle gills



National SCIENCE Challenges
SUSTAINABLE SEAS
Ko ngā moana whakauka

Crella incrustans

High survival
Sediments accumulated internally



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?

Beaumont, NIWA

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


Bell, VUW


Allen, NIWA


Beaumont, NIWA

Conclusions and follow-up research

Results and methodologies have informed other sedimentation research projects

- Juvenile scallops (NIWA)

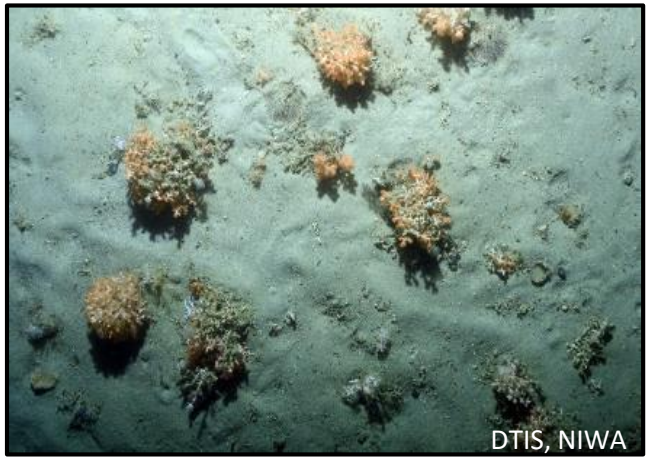
  Tolerance of juvenile scallops to suspended sediments, to inform ecosystem modelling (2020)

- 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)


DTIS, NIWA


Mobilia, NIWA

National Science Challenges | SUSTAINABLE SEAS | Ko ngā moana whakauka

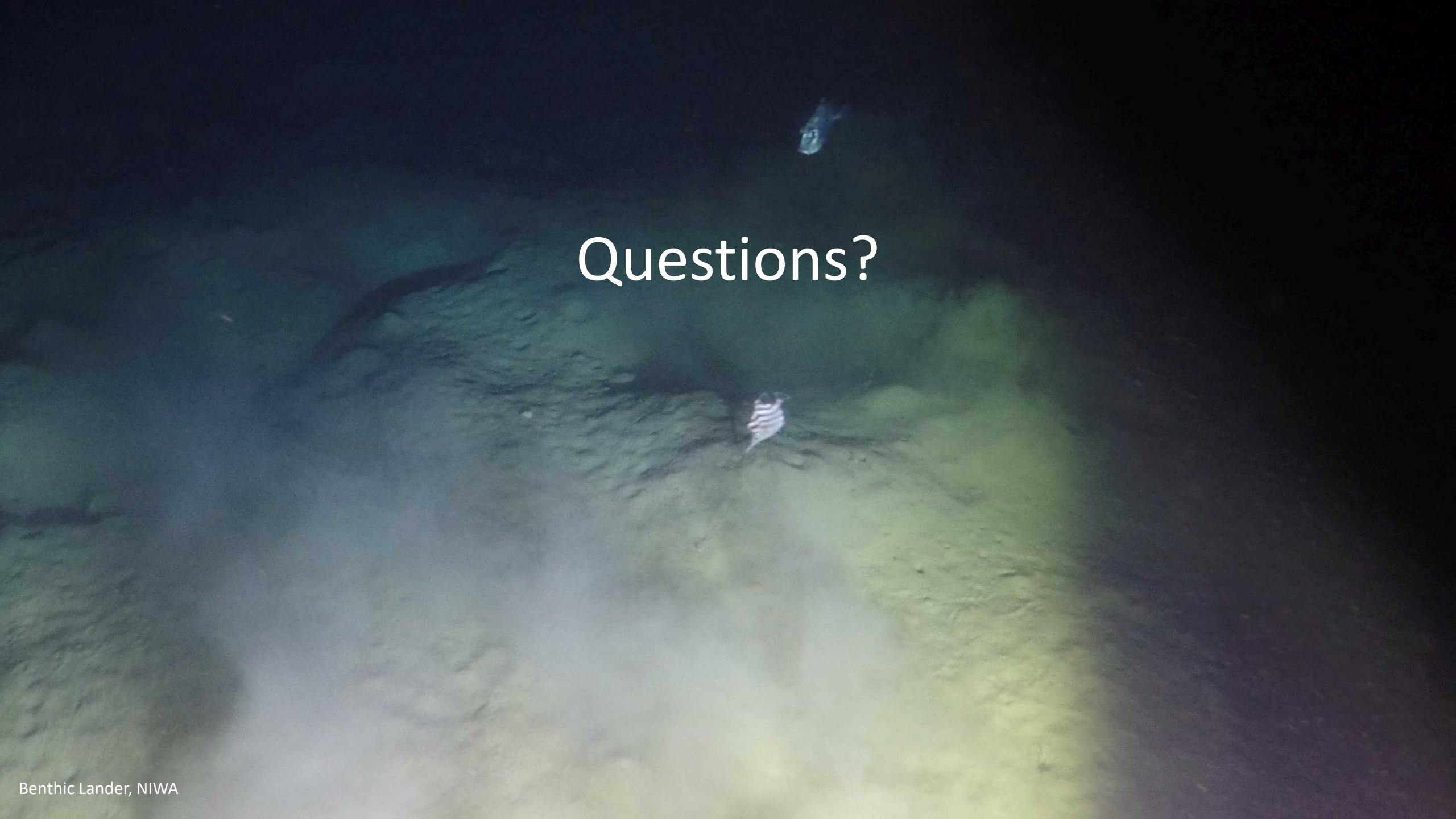
Acknowledgements

- Ko ngā moana whakauka / Sustainable Seas National Science Challenge for funding.
- *RV Kaharoa* crew and NIWA staff for dog cockle collection.
- 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

National SCIENCE Challenges | SUSTAINABLE SEAS | Ko ngā moana whakauka



Benthic Lander, NIWA