The environmental effects of seabed mining: aspects of the New Zealand experience

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NIWA, Wellington, New Zealand

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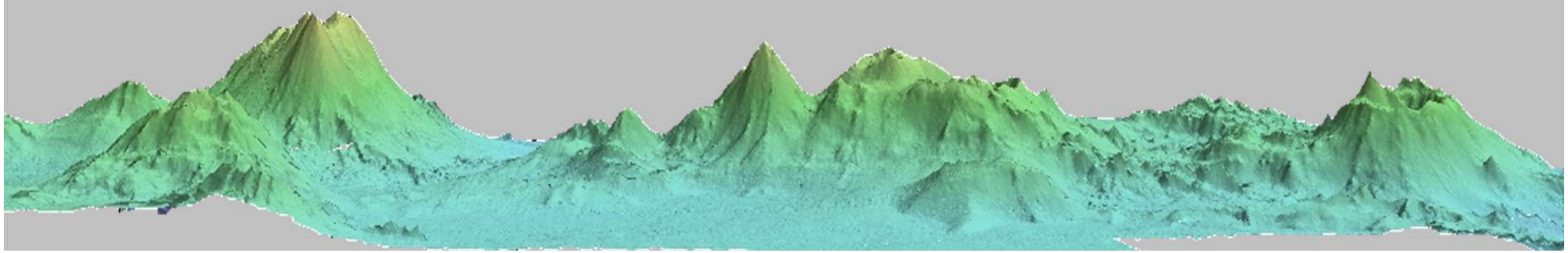
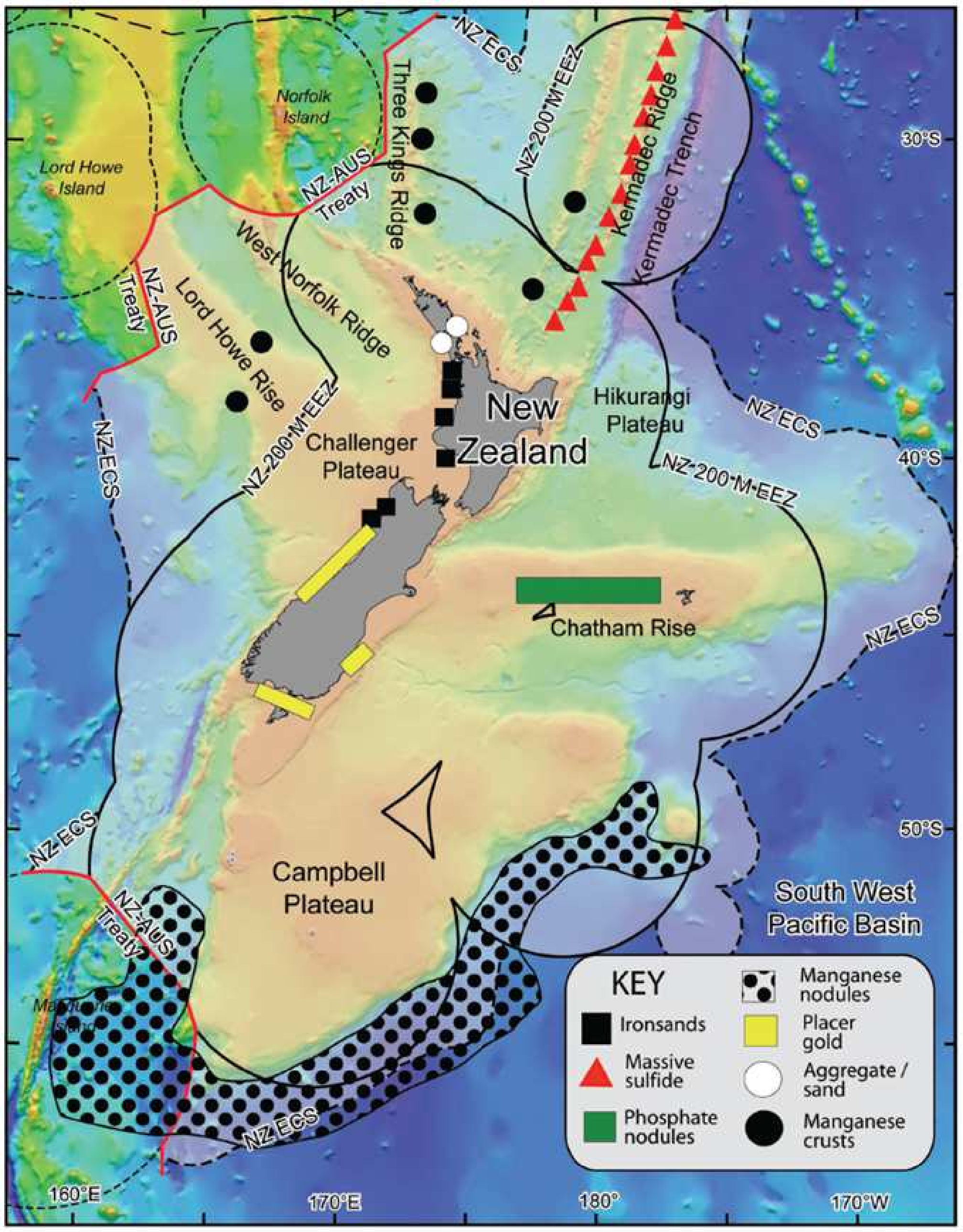
Presentation Outline

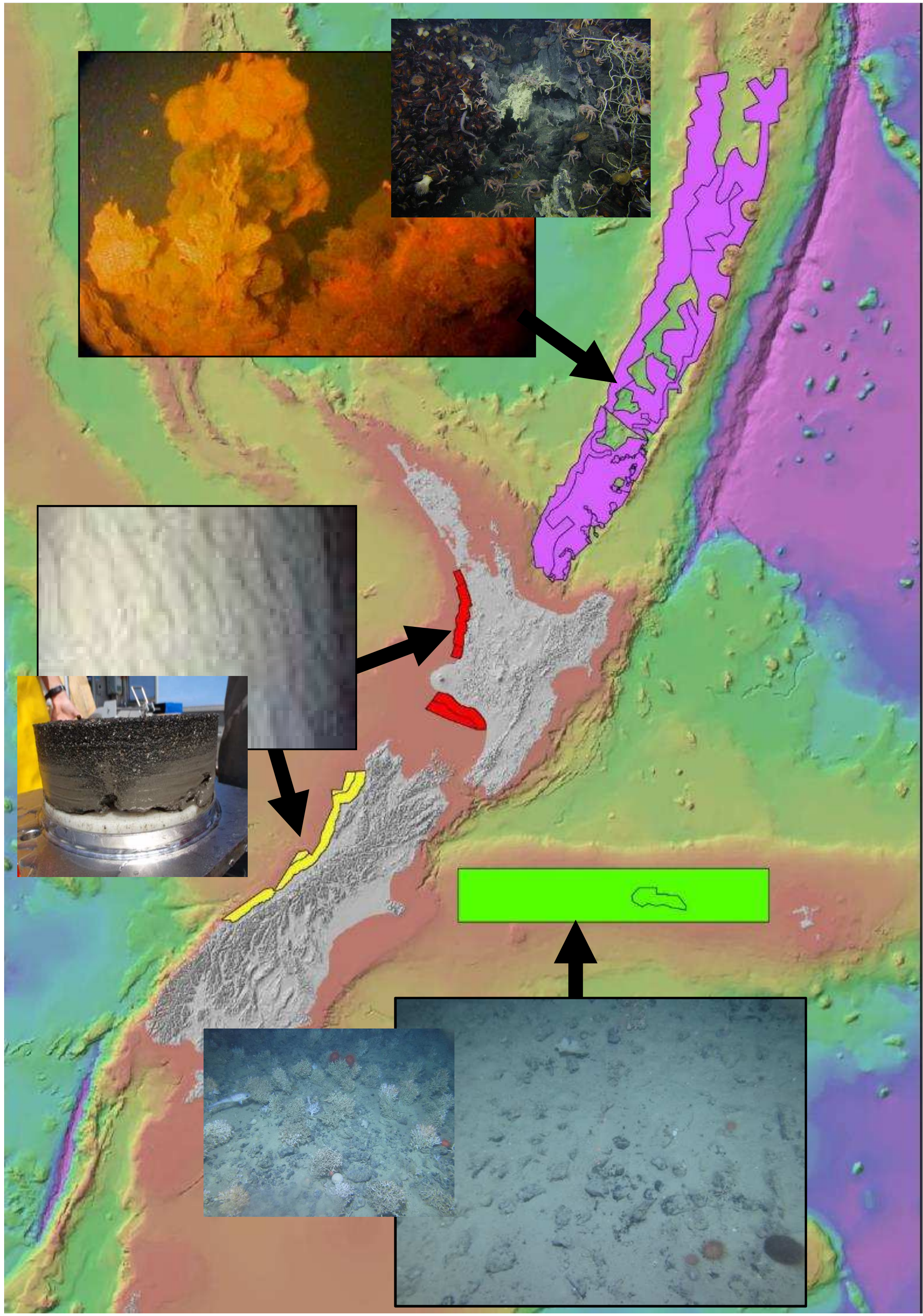
- Background
  - resource context in New Zealand
- Science requirements
  - General needs to support exploration phases
- Current minerals research
  - Developing risk assessment
  - Developing impact assessment
- Environmental management issues
  - Lessons learnt from DSM applications



Offshore Resources



- Conventional & non-conventional hydrocarbon
  - Oil and gas
  - Gas hydrates
- Minerals, placer deposits and nodules
  - Ironsands
  - Massive sulphides
  - Phosphate nodules
  - Cobalt-rich crust
  - Manganese nodules



Deep-sea Minerals

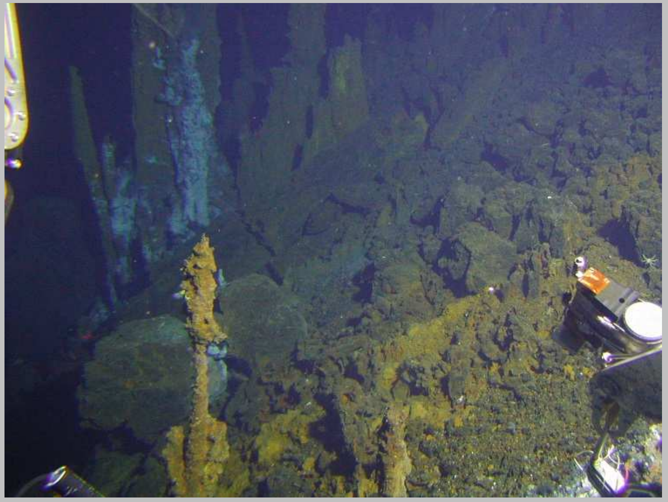
- ***Seafloor Massive Sulfides***
Kermadec & Colville Ridges
1000-2000 m
Gold, copper, lead, zinc and silver
Vent fauna, corals, sponges

- ***Ironsands & other placer deposits***
West Coast – 30,000 km^2
100-150 m
Fe for steel production
Resource estimate > 850 million t.
Bryozoa, infauna soft sediment

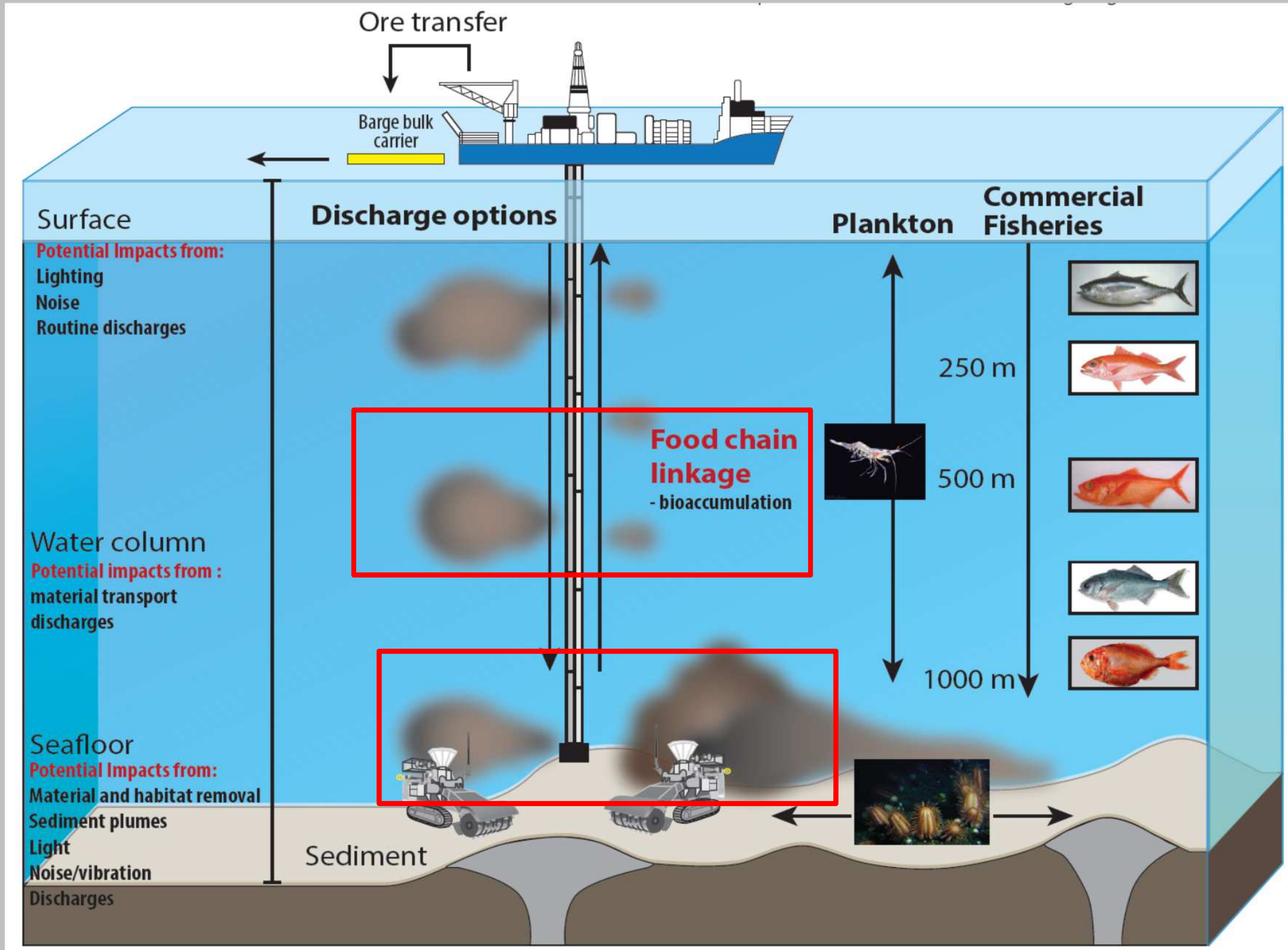
- ***Phosphorite nodules***
Chatham Rise, 4500 km^2 licensed area
300-400 m
Phosphate for fertiliser
Resource estimate > 100 million t
Corals, sponges on nodules

Environmental considerations

- Fauna of each resource type can be very different
  - Vent fauna (SMS), bryozoan beds & infaunal nematodes (FeS), nodule corals and sponges (PN)
- Hence need to consider impacts on the different habitats separately
  - Different depths meaning different faunal communities
  - Different technology and hence disturbance characteristics
  - Different vulnerabilities of fauna

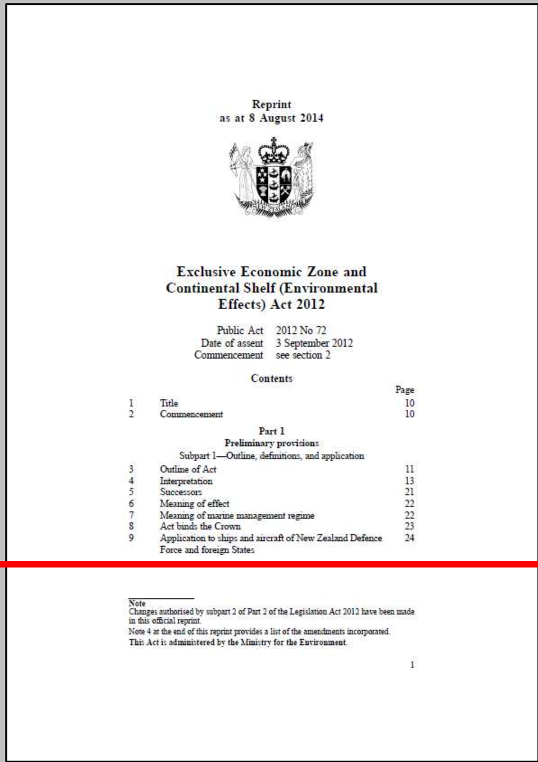


Deep-sea mining impacts



The EEZ Act (2012)

- Purpose of the act is "*to promote the sustainable management of the natural resources of the exclusive economic zone and continental shelf*." (But not fisheries…)
- The importance of protecting the **biological diversity and integrity** of marine species, ecosystems, and processes
- The importance of protecting **rare and vulnerable ecosystems** and the habitats of threatened species



Reprint
as at 8 August 2014

Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

Public Act 2012 No 72
Date of assent 3 September 2012
Commencement see section 2

Contents

Note
Changes authorised by subpart 2 of Part 2 of the Legislation Act 2012 have been made in this official reprint.
Note 4 at the end of this reprint provides a list of the amendments incorporated.
This Act is administered by the Ministry for the Environment.

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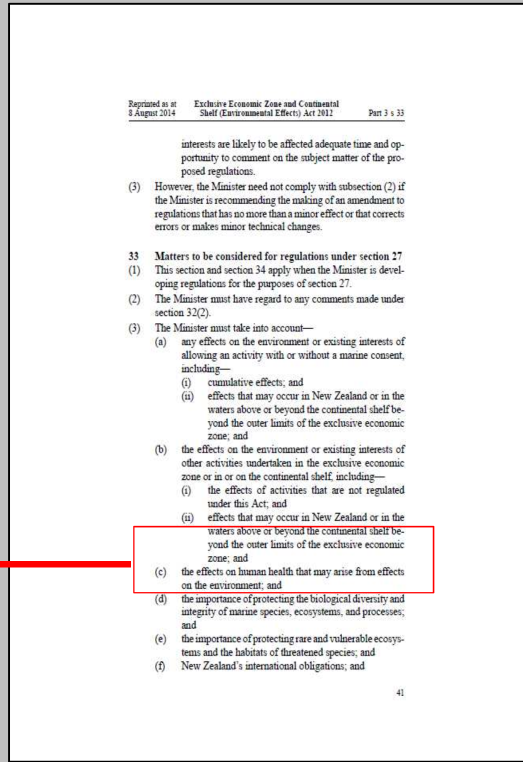

Reprinted as at 8 August 2014 — Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 — Part 3 s 33

interests are likely to be affected adequate time and opportunity to comment on the subject matter of the proposed regulations.

(3) However, the Minister need not comply with subsection (2) if the Minister is recommending the making of an amendment to regulations that has no more than a minor effect or that corrects errors or makes minor technical changes.

33 Matters to be considered for regulations under section 27

(1) This section and section 34 apply when the Minister is developing regulations for the purposes of section 27.

(2) The Minister must have regard to any comments made under section 32(2).

(3) The Minister must take into account—
(a) any effects on the environment or existing interests of allowing an activity with or without a marine consent, including—
(i) cumulative effects; and
(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and
(b) the effects on the environment or existing interests of other activities undertaken in the exclusive economic zone or in or on the continental shelf, including—
(i) the effects of activities that are not regulated under this Act; and
(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and
(c) the effects on human health that may arise from effects on the environment; and
(d) the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes; and
(e) the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species; and
(f) New Zealand's international obligations; and

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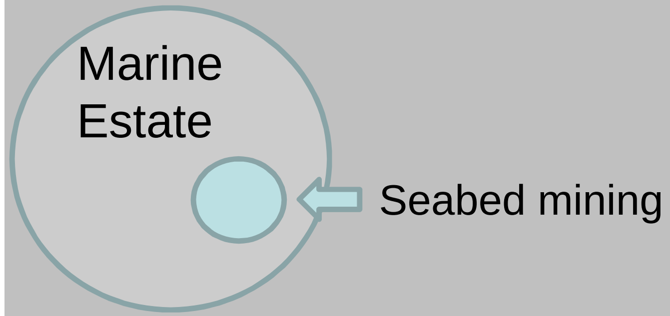
- Underlying concept is sound environmental management, with a strong scientific basis

Science in DSM management process



Integration across the multiple environmental components of DSM mining

New Zealand EEZ Act Impact Assessment

ERA
(Ecological Risk Assessment)

- Risk scoping (level I)
- Advanced ERA (level II)
- **Identify threats**
- **Ask the right questions**!

EIA
(Environmental Impact Assessment/Statement)

- **Focus on main risks**
- Ecosystem approach
- Cumulative impacts
- Other activities
- Spatial scale variability
- Traditional knowledge

EMP
(Environmental Management Plan)

- **Monitoring programmes**
- **Adaptive management** options
- Appropriate spatial and temporal scale

Ecological Risk Assessment

- Initial scoping
  - Prior to prospecting/exploration
  - Expert panel (Level 1, qualitative)
    - Likelihood-consequence approach common, rank scores

Table 4-8: Expert Panel Assessment: Polymetalic crust mining. Levels of consequence, likelihood, risk and confidence associated with this activity in the EEZ and ECS. Activities are listed (a, b, c, etc) after each threat to which they contribute. The maximum possible level of environmental risk is 30. Extreme environmental risks are highlighted in red, high in yellow, and moderate in green. Low risk activities are not highlighted. *Threats managed under the Maritime Transport Act (1994). NA = not applicable as species assessed are all protected.

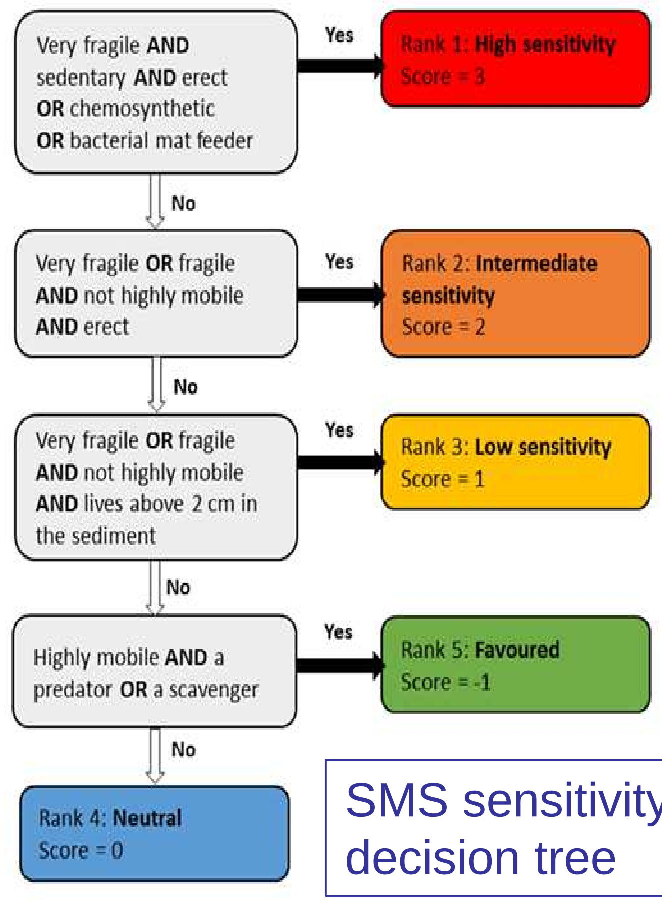
Expert Panel Assessment: Polymetalic crusts		Recovery period				Key species				Protected species				Ecosystem functional impact				Proportion of habitat affected			
Activity	Threat	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence	Consequence	Likelihood	Risk	Confidence
Prospecting a) Surface flood lights and noise b) ROV and other imaging surveys c) Acoustic swath mapping d) Sub-bottom profiling using CHIRPS, boomers and sparkers e) Spot sampling using ROV, submersible, or rock dredge f) Survey vessel activities	*Seabird attraction, disturbance, collision (a)	1	6	6	2b	NA	NA	NA	NA	3	5	15	2b	0	6	0	2b	3	6	18	2b
	Acoustic impact from multi-beam echo sounders on marine mammals, reptiles, fish and invertebrates (c)	0	5	0	2a	0	6	0	2a	1	5	0	2a	0	6	0	2a	0	6	0	2a
	Acoustic impact of high resolution seismics on marine mammals, reptiles, fish and invertebrates (d)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	*Ship strikes on marine mammals, fish, and reptiles (f)	3	6	18	2b	2	2	4	2b	2	2	4	1c	0	6	0	2b	0	6	0	2b
	Impact on benthos (b, e)	4	3	12	1c	1	4	4	2a	1	4	4	2a	2	5	10	1c	1	6	6	2a
Exploration g) Surface flood lights and noise h) Test extraction methods i) Bulk sampling j) Sediment plume k) Underwater noise l) Sub-bottom profiling using CHIRPS,	*Seabird attraction, disturbance, collision (g)	0	6	0	2b	NA	NA	NA	NA	2	5	10	2b	0	6	0	2b	0	6	0	2b
	Impact on benthos (h, i)	4	6	24	1c	2	4	8	2a	1	4	4	2a	2	5	10	2a	1	4	4	2b
	Acoustic impact on marine mammals, reptiles, fish and invertebrates (l, m)	1	6	6	2a	2	6	12	1c	2	6	12	2a	0	6	0	2b	2	6	12	2b
	Entanglement of megafauna (h, i)	3	5	15	2b	1	3	3	2b	1	3	3	2b	0	6	0	2b	0	6	0	2b

Ecological Risk Assessment

- Initial scoping
  - Prior to prospecting/exploration
  - Expert panel (Level 1, qualitative)
    - Likelihood-consequence approach common, rank scores
- Advanced
  - Typically Level 2 (semi-quantitative)
  - Uses information from exploration
  - Contributes to EIA
  - Ecological traits approach developed
    - addresses FUNCTION rather than species composition
    - estimates COMMUNITY-level risk rather than species
  - Two stages:
    - evaluate sensitivity to disturbance (vulnerability)
    - evaluate recovery from disturbance (productivity)

Ecological traits

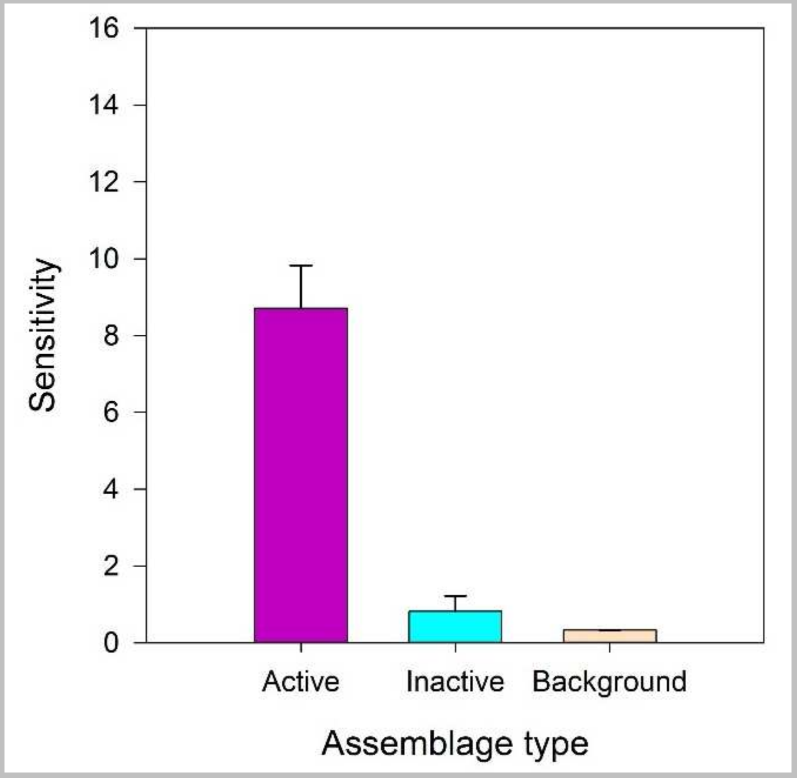
- Focus is on the **ecological role** of a taxon
- 365 taxa (from Family to species)
- Sensitivity
  - Adult size (5 categories)
  - Environmental position (6 categories)
  - Living habitat (10 categories)
  - Feeding habit (10 categories)
  - Mobility (3 categories)
  - Structural fragility (3 categories)
- Recoverability
  - Longevity (5 categories)
  - Reproductive frequency (3 categories)
  - Development type (4 categories)
  - Mobility (adult, juvenile) (10 categories)
  - Adult-juvenile interactions (3 categories)

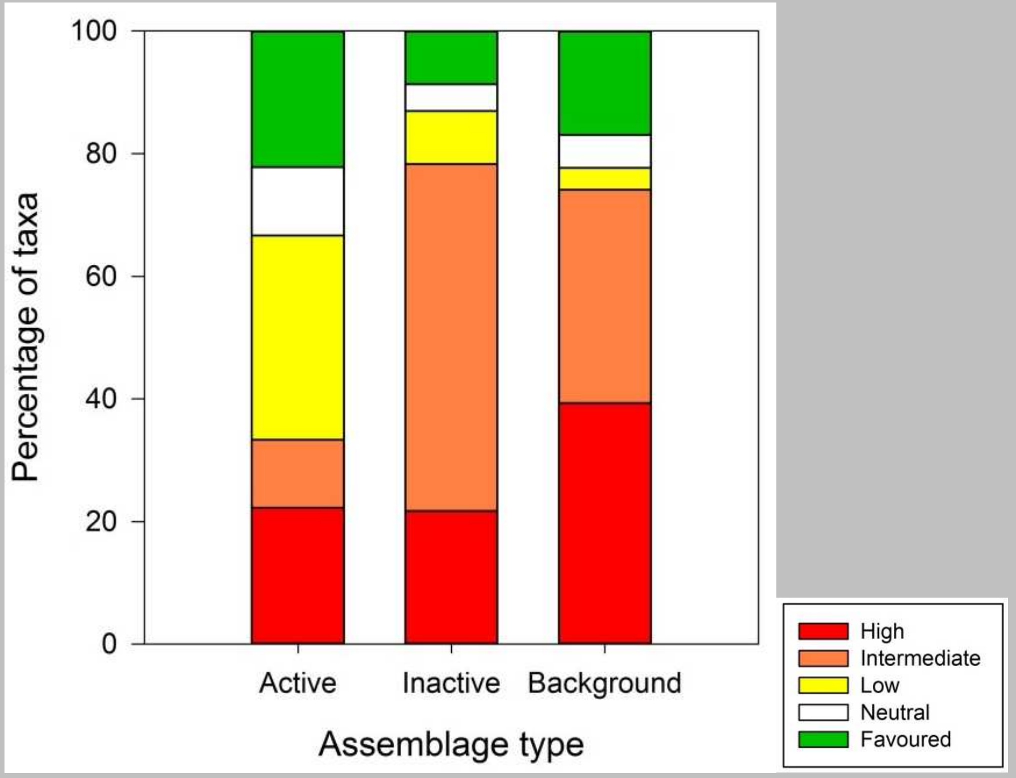


SMS sensitivity decision tree

Sensitivity differences

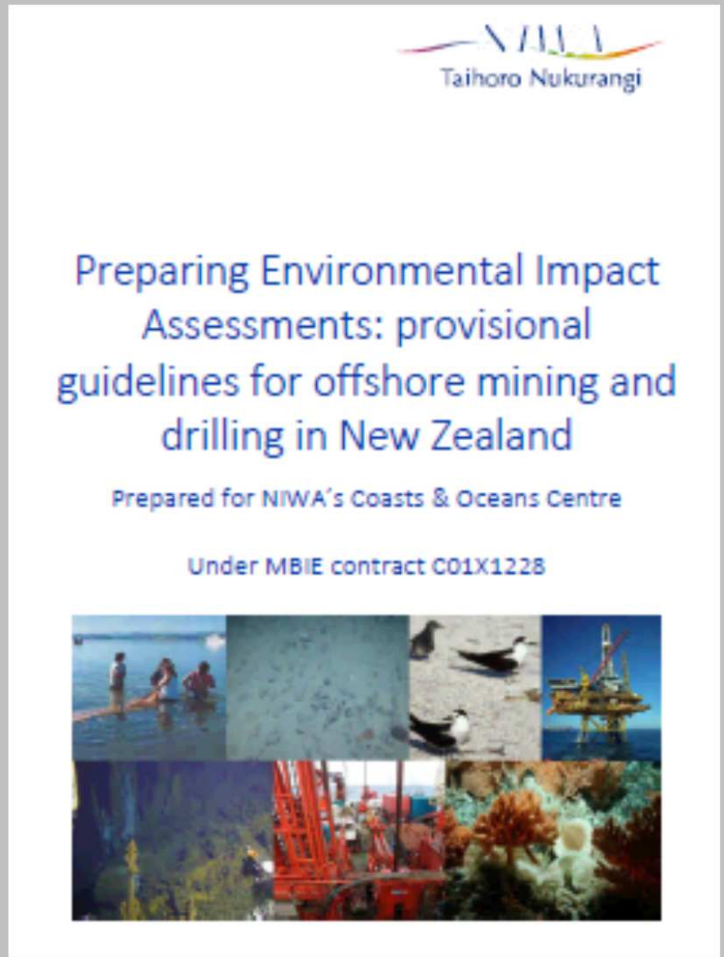
- Faunal communities at active hydrothermal sites (SMS) more sensitive than at inactive or background sites (left panel)
- Depends on the mix of species, and abundance of sensitive taxa (right panel)
- Work in progress…



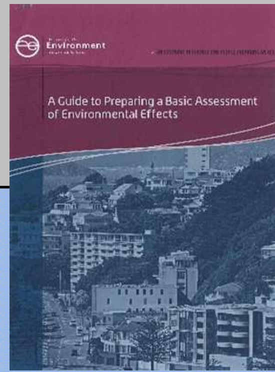


DSM-EIA science guidelines

- Existing standards and guides
  - Literature review of environmental management frameworks (O&G, coastal, ISA)
- Environmental Impact Assessment
  - Template and guidelines



The EIA template and guidelines



- Intended to apply
  - **To IAs in New Zealand**
  - **EIAs internationally** (especially SW Pacific)
- Align with ISA EIS framework (2012)
- Not prescriptive, but generic guide
  - Aid in consistency of format and information
- Each template heading is expanded
- Living document
  - Discussion govt agencies
  - Current revision

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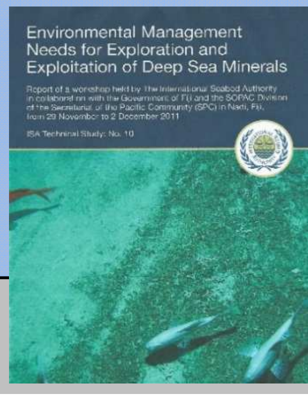


Expansion of template

4. Description of existing physic-chemical environment

4.1 Key messages
4.2 Regional Overview
4.3 Meteorology and Air Quality
4.4 Geological setting
4.5 Physical oceanographic setting
4.6 Water quality
4.7 Seabed sediment characteristics
4.8 Natural hazards
4.9 Noise
4.10 Greenhouse gas emissions/climate change issues
4.11 Summary of existing physical environment

http://www.niwa.co.nz/coasts-and-oceans/research-projects/enabling-management-of-offshore-mining

Baseline scientific requirements for DSM

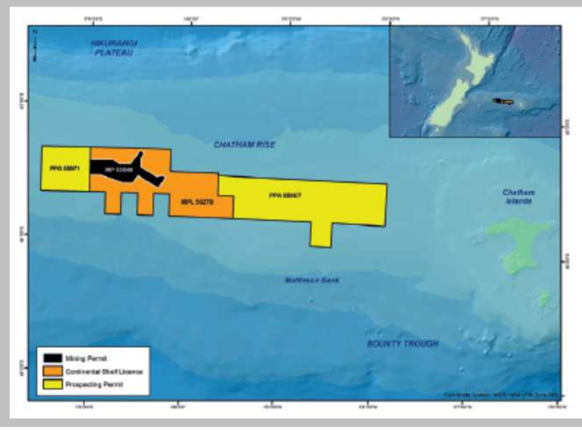
- Science guidelines
  - Commercial operators
  - Research agencies
- Collaborative with EU/SPC (Fiji) and NIWA (NZ)
- Define a Marine Scientific Research Plan for minerals exploratory phase
  - Baseline survey
  - Monitoring activities
- So EIA adequately informed
- Describes current “best practise” science

Science Plan details

	Aspect	Reason	Main Parameters	Sampling
Geology	Topography	Seabed characteristics, identification of habitats for assessment, survey stratification, selection of test and control areas	Bathymetry, morphometry, seafloor type	Multibeam echosounder, dredges, box-corer, drilling equipment
	Backscatter	Seabed characteristics, identification of habitats for assessment, survey stratification, selection of test and control areas	Acoustic reflectivity	Multibeam echosounder
	Sub-seafloor	Petrology, geochemistry, and mineralogy for resource characterisation	Penetration layers, rock properties, mineral and chemical composition,	Seismic, drilling, rock sampling (dredges, coring)
Sediment characteristics	Sediment properties	Sediment plume dynamics	Sediment and pore water measurements: Water content, grain size, specific gravity, porosity, depth oxic layer, carbon content, chemical composition (trace and heavy metals)	Box corer or mulitcorer
	Bioturbation rates	Natural mixing of sediments	Bioturbation depth, faunal zonation, Pb210 activity	Corer samples
	Sedimentation rates	Distribution and concentration of natural suspension, settlement rates	Particle flux, suspended particle concentrations, settlement rates	Moorings and sediment traps
Seafloor community	Megafauna	Impacts on benthic communities	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Photographic surveys from ROV/towed camera; direct sampling dredge/sled/trawl
	Macrofauna	Impacts on benthic communities	Species composition, distribution, abundance. Biological characteristics (sensitivity, recoverability parameters)	Box corer or muliticorer, epibenthic sled
	Scavenger/demersal fish	Impacts on benthic communities	Species composition, distribution, abundance	Baited lander, fish trawls, traps, ROV observations

Is the science good enough?

- TTR and Chatham Rock Phosphate applied for mining licences in 2014, spending something like 80 and 25 million euros on expl ... ork
- First applicati ... legislation



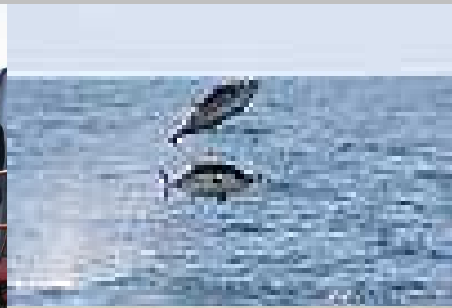
The NZ EPA decisions and lessons

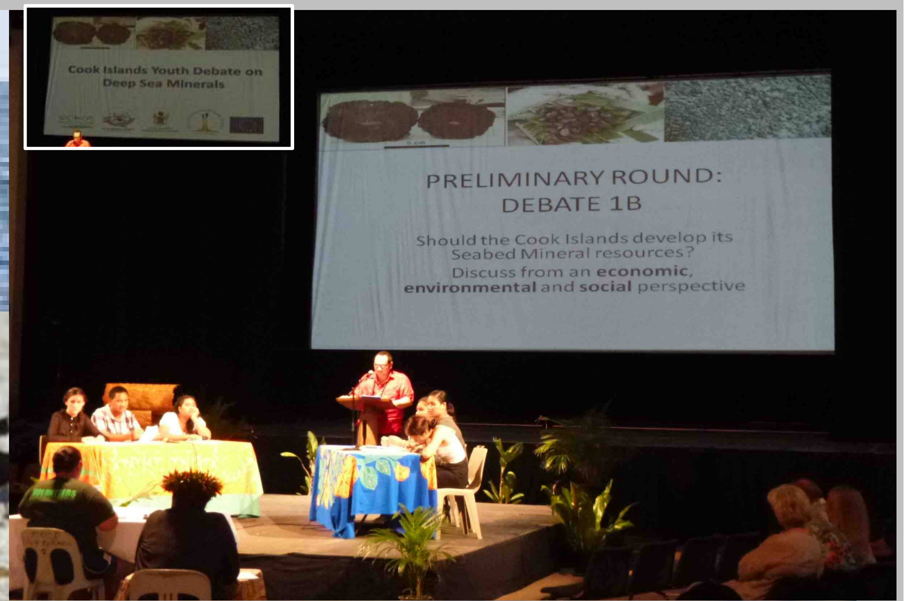
- A complex of environmental, social, economic and cultural issues involved in DMC decisions
  - Focus on EIA, lack of SEA, consultation issues etc
- Key scientific issues arose
  - Inadequate description and treatment of **scientific uncertainty** (how uncertain, what to do about it)
  - Limited characterisation of **ecosystem** structure and function – moving beyond partial community descriptions
  - Inadequate **assessment of impacts** (especially indirect effects such as footprint and intensity of sediment plumes-modelling but no ground-truthing)
  - Insufficient detail in some aspects of **monitoring plans** and **adaptive management** regime not sufficiently robust

Conclusions

- Each deep-sea mineral resource has its own faunal characteristics, every situation is different
- Complex array of impacts, direct and indirect, that require extensive multidisciplinary research and assessment
- Nothing new, same issues as terrestrial/inshore situations
- But, the deep sea will always be data-limited, difficult research
- Effective EIA needs strong ERA component
- Open 4 dimensional system, clear need for ecosystem approach, that integrates benthic and midwater components across physical, oceanographic and biological elements
- Functional/Community level approaches rather than species
- Precaution will require managing high uncertainty
- Spatial management at early stage, coupled with adaptive management and strong monitoring systems

A challenging and daunting task…

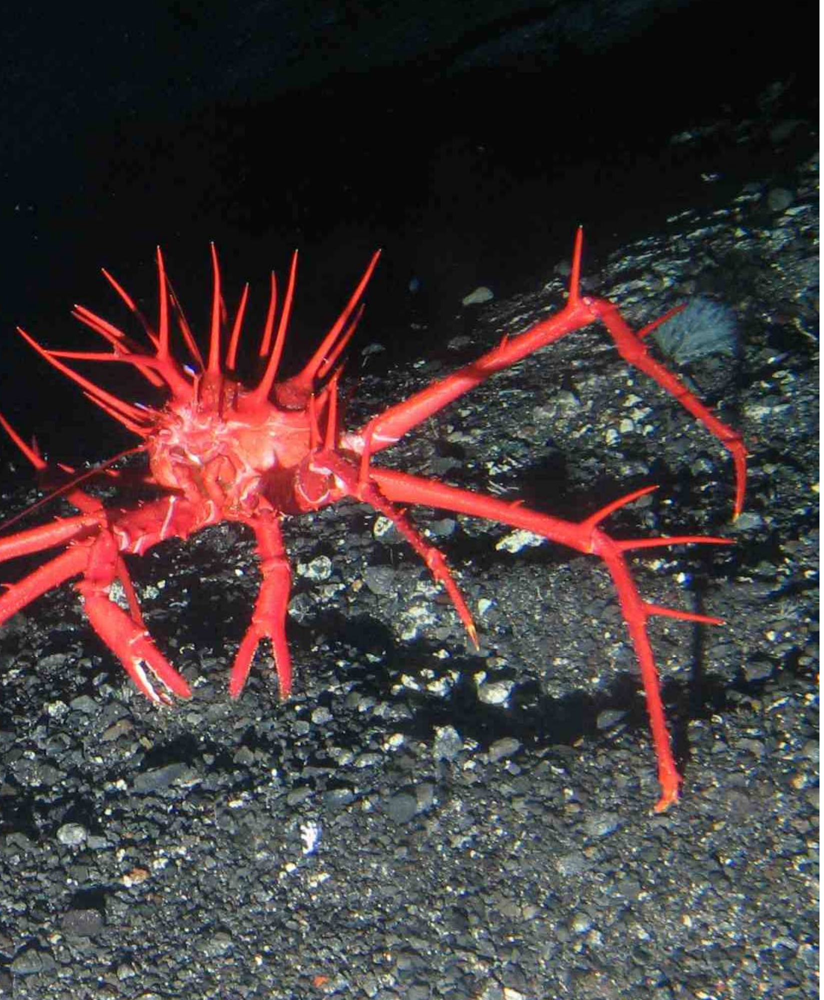




Arigato gozaimasu

NIWA
Taihoro Nukurangi

- This presentation has used material from NIWA research projects funded by the New Zealand Ministry of Business, Innovation and Employment: in particular NIWAs Vulnerable Deep-Sea Communities (DSCA), Kermadec Minerals (COPR) and Enabling Management of Offshore Mining (EMOM) projects.
- The EMOM project is collaborative between NIWA, Cawthron, Victoria University of Wellington, and Focus Group.
- SOPAC-EU DSM project has strong collaborative links also
- A large amount of research has been funded and carried out in collaboration with Trans Tasman Resources, Chatham Rock Phosphate, and Neptune Minerals.
- My appreciation to the organisers of this DSM session for the invitation to participate in the workshop, and JAMSTEC for travel funding.



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