The Chatham Rise Phosphorite Project Science, Uncertainty and the Way Forward

Ray Wood
2016

Chatham Rock Phosphate Ltd

Development, Uncertainty and Science

- Every component of a 21st century lifestyle has an environmental impact
- It is morally indefensible to export all of the impacts of our lifestyle to other countries
- Society must accept some development, but endeavour to minimize its environmental impacts
- Science's role is to help society deal with uncertainty and decide on acceptable impacts
- Decisions are values-based and science is not sufficient to address all concerns

Acknowledgement

Sir Peter Gluckman's Salmon Lecture in September 2015 provides an insightful discussion of how science and society perceive uncertainty, and how tools such as the precautionary principle can be used to manage it.

His thoughts have helped clarify my view on CRP's experiences so far and how we might proceed.

Outline of Talk

Science has been fundamental to the project

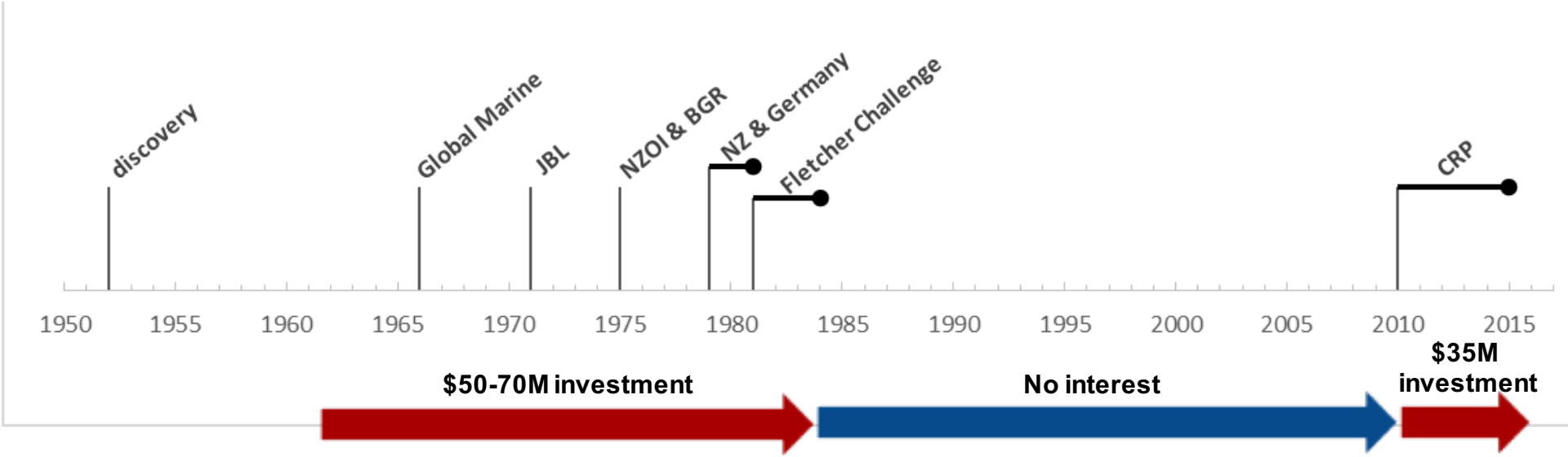
- mapping the resource
- mapping the environment
- engineering design of mining system and mining plan
- predicting mining effects
- agricultural application

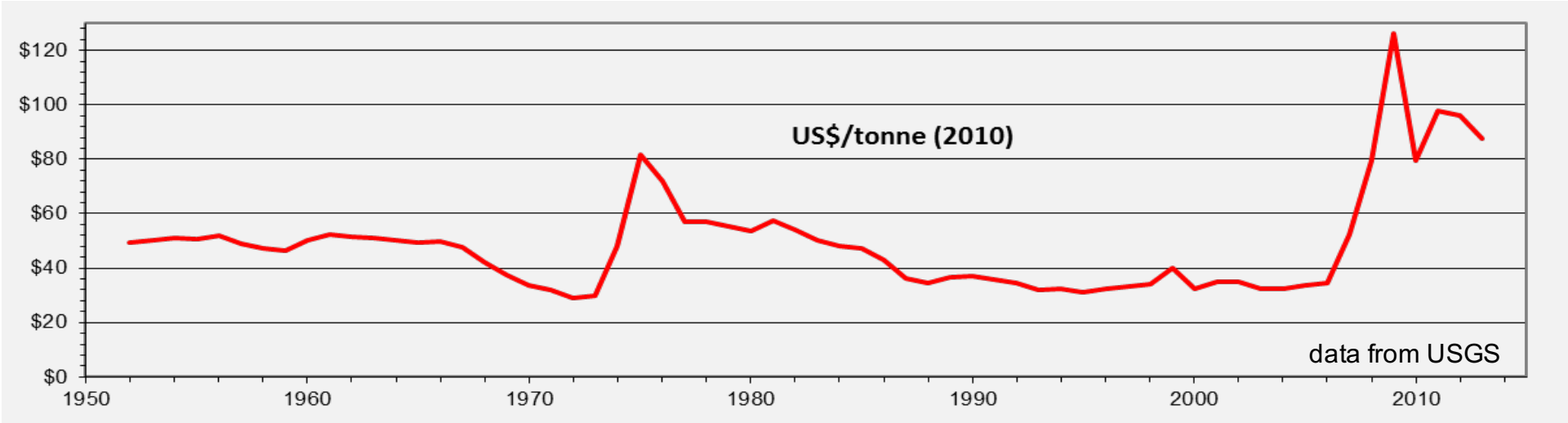
Science has not been enough

- CRP has a mining licence but not an environmental consent
- why - role of science, society and uncertainty

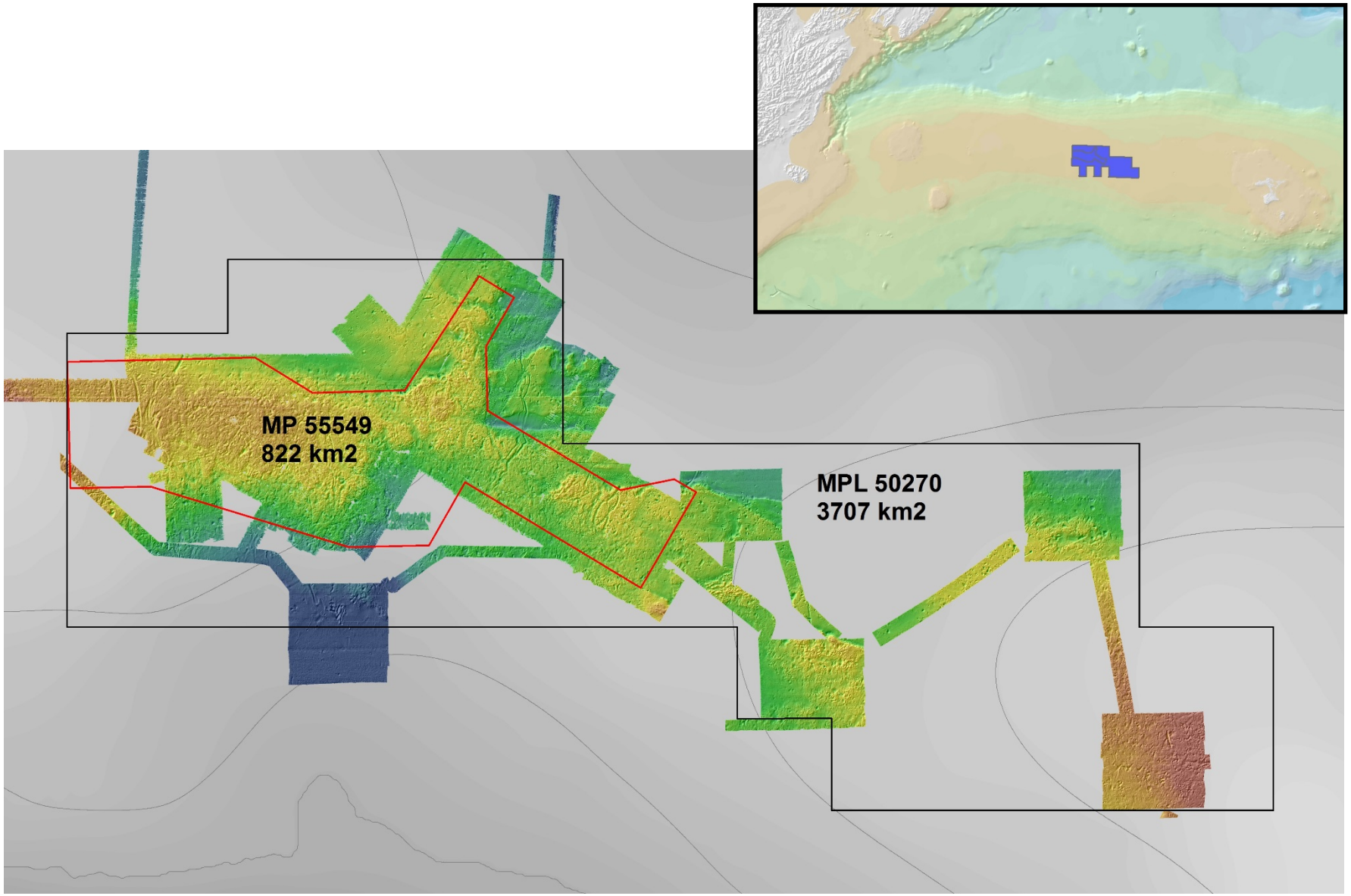
Next steps

Chatham Rise Phosphate Timeline

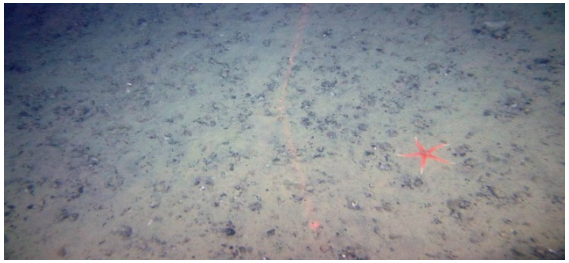




CRP Licences

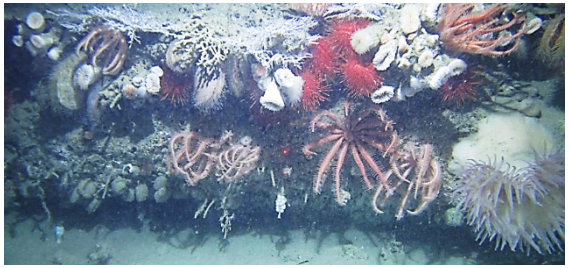


Review of What Is Known

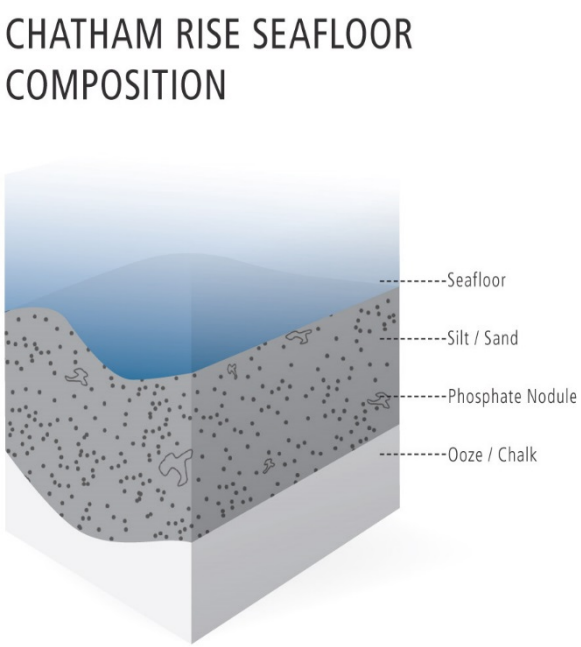


What do we know about

- the resource
- the environment
- the mining system
- agricultural applications

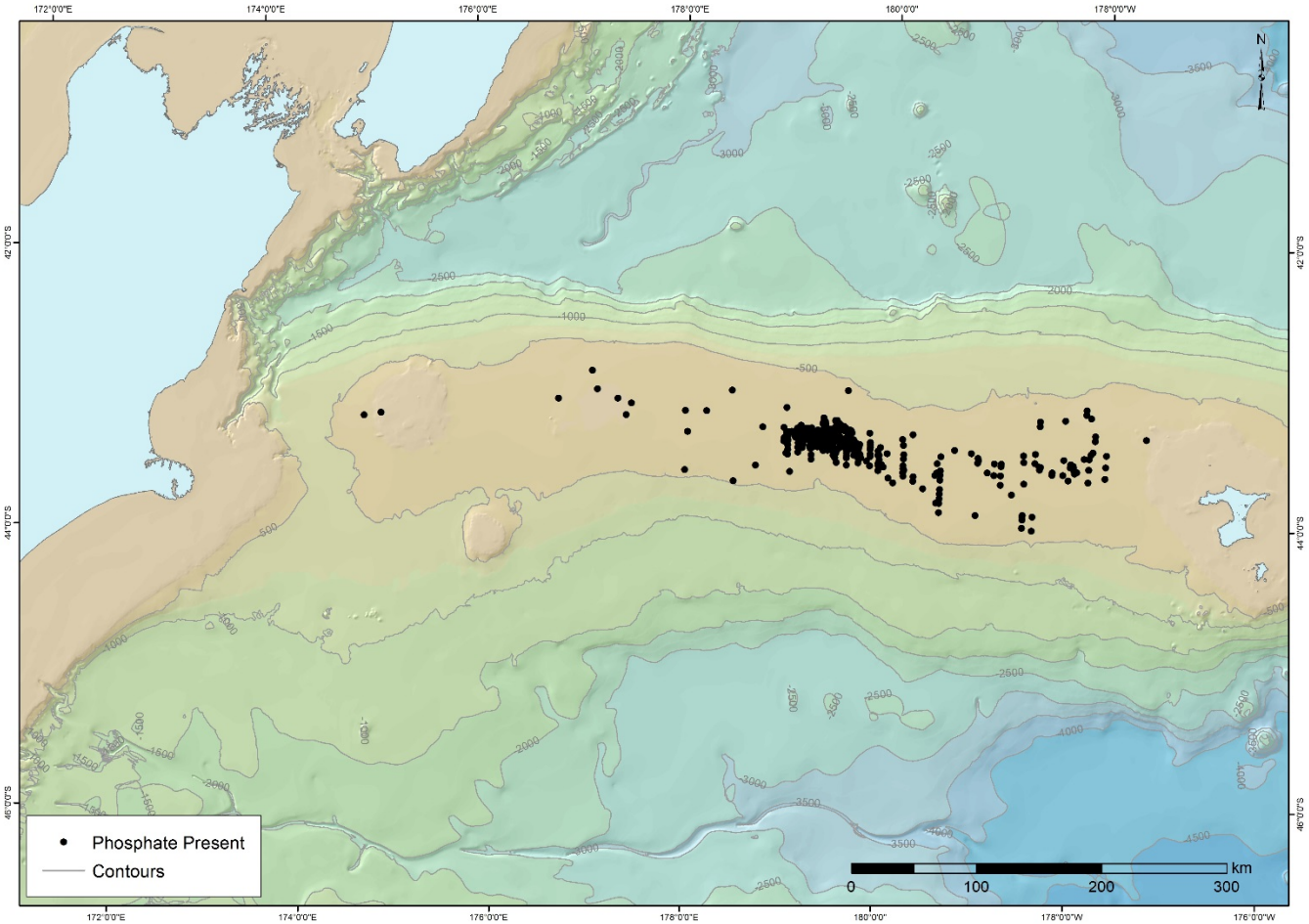


The Deposit

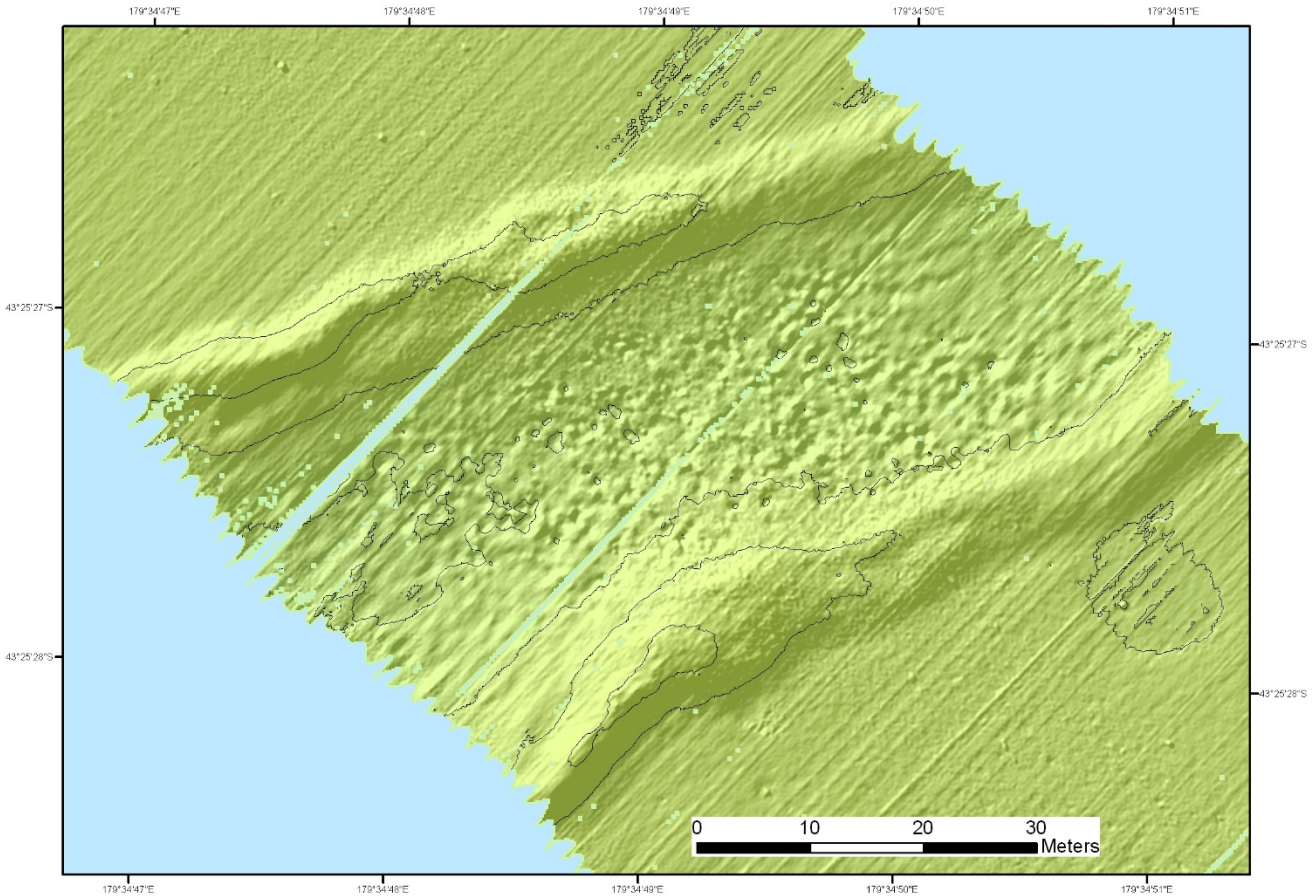


- Depth 400 m
- Formed 5-10 million years ago by current action on limestone seabed
- Nodules 1-150 mm in top 30-40 cm of sandy silt
- 15% of seabed layer by volume

Phosphorite Samples on the Chatham Rise

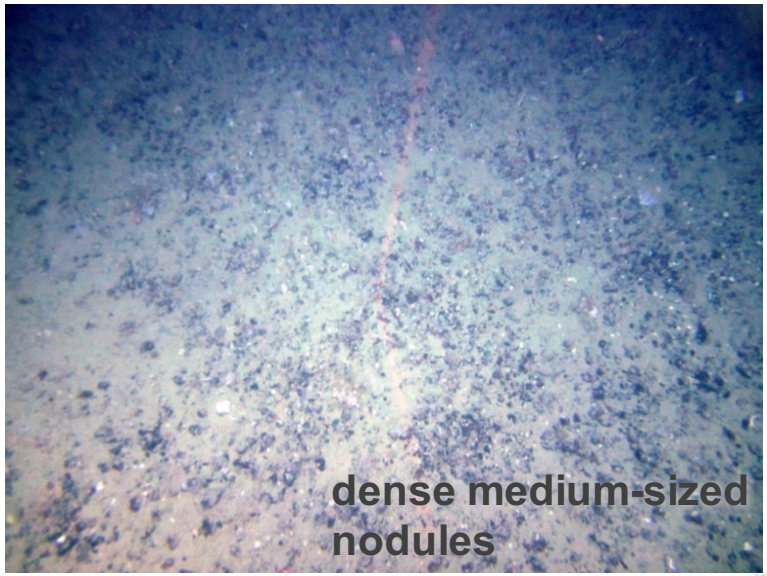


Small-scale Variability

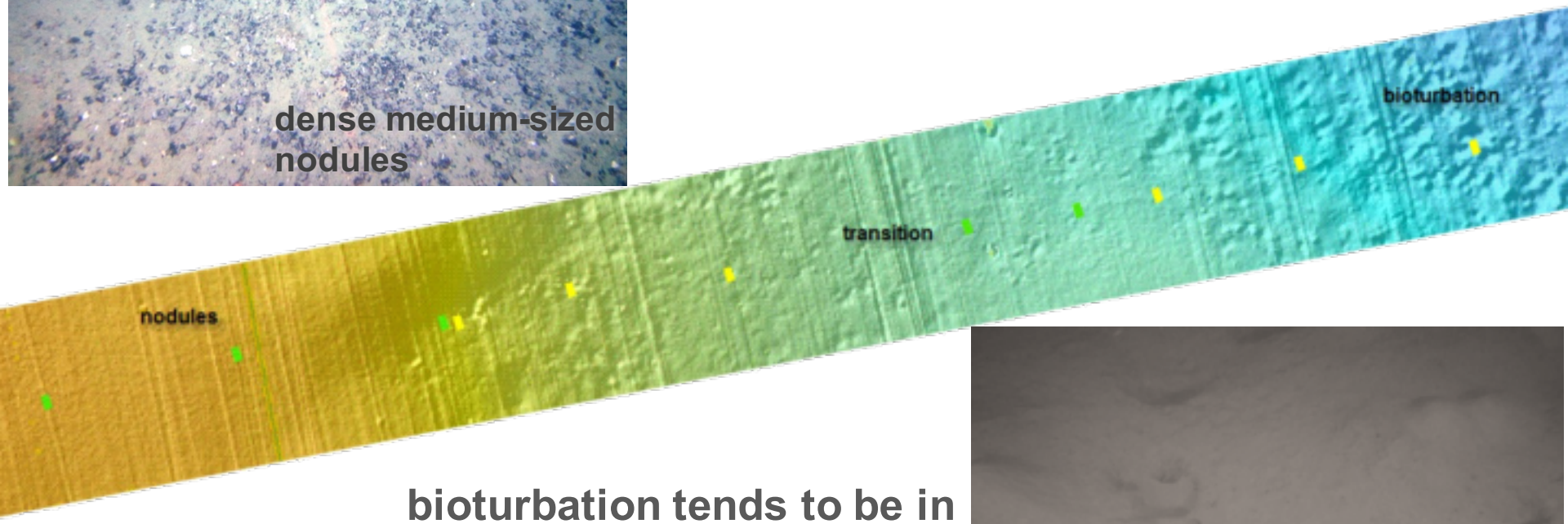


ice berg scours have disrupted the resource, making concentrations highly variable on scales of tens of metres

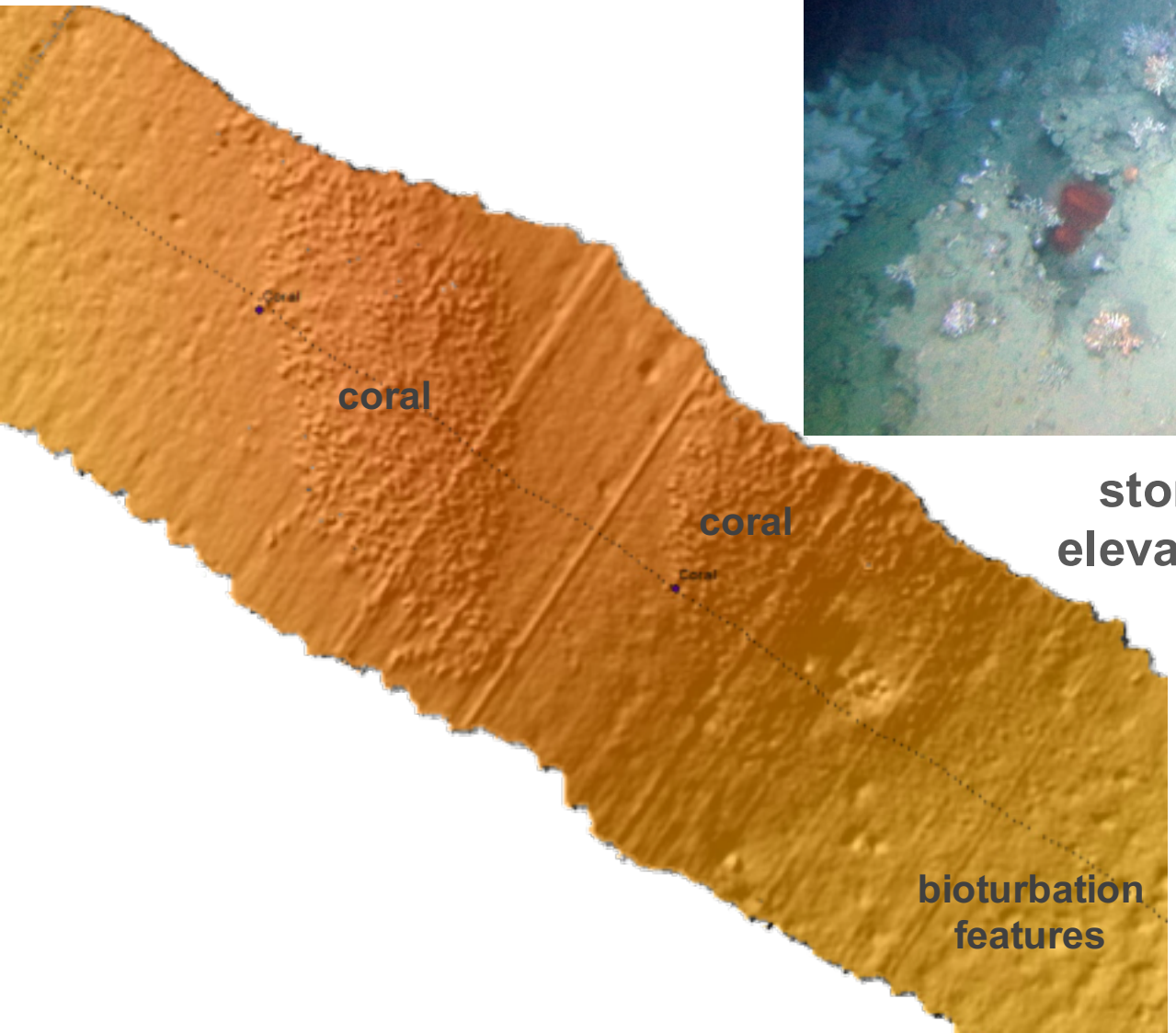
The Environment

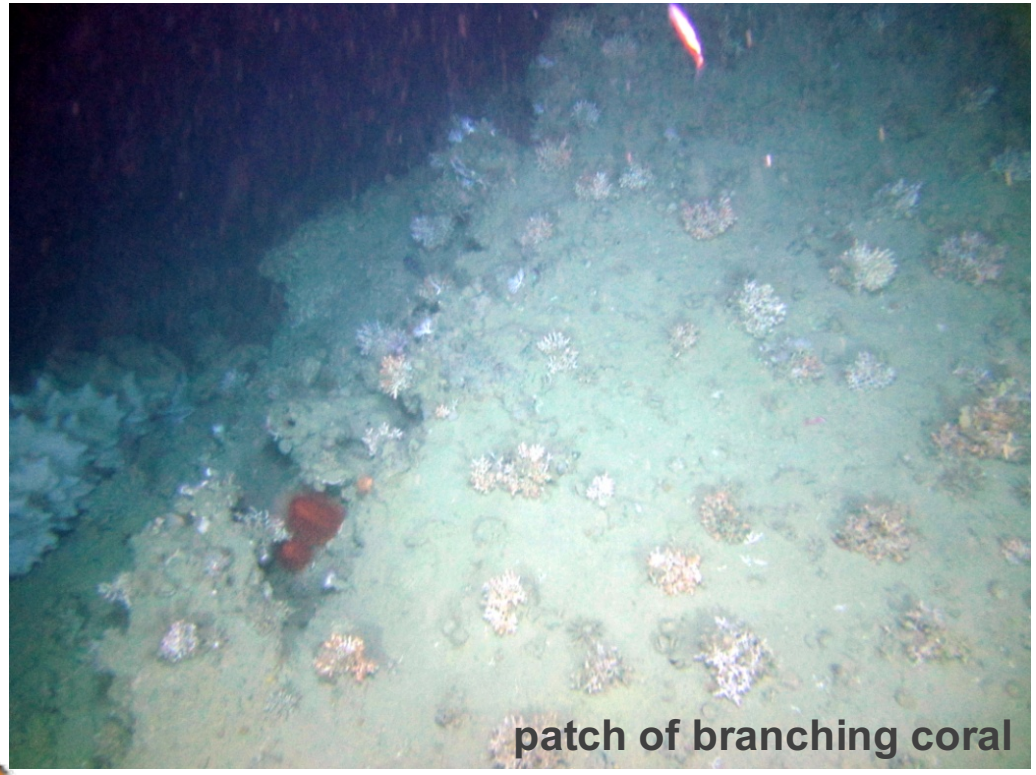


nodules at surface tend to be on elevations (iceberg ridges)



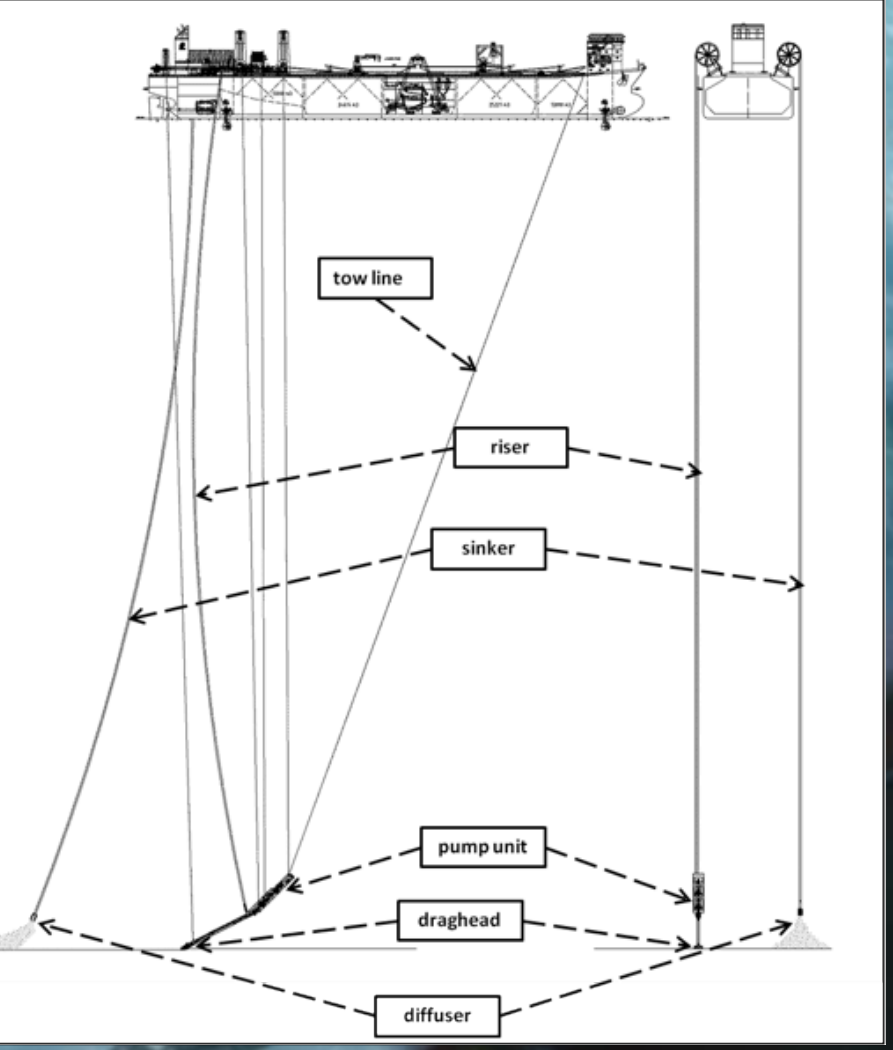
bioturbation tends to be in depressions (iceberg furrows)





stony coral tend to be on elevations (iceberg ridges)

Mining Method



Boskalis is CRP's technology partner

Mining system based on conventional trailing suction dredging technology

Agricultural Applications

Direct application fertiliser supports a change to more sustainable, resilient farming practices in New Zealand

Field trials have shown Chatham Rise phosphorite is suitable for direct application

- Most phosphorus is currently applied as superphosphate
- Direct application can improve soil qualities, reduce phosphate runoff in waterways and reduce total fertilizer application over time

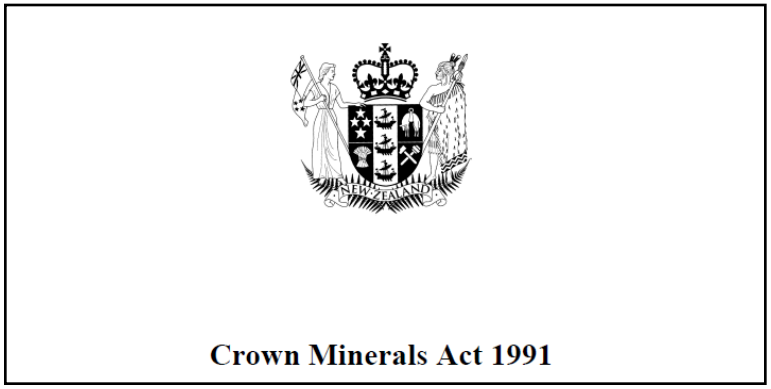
Chemical analyses show it is exceptionally low in cadmium

- All phosphates have some cadmium
- Low cadmium levels reduce health risk from concentration of cadmium in crops

Review of CRP's Environmental Consent Process

- Relevant legislation
- Environmental concerns and predicted impacts
- Reasons for decline
- Science and uncertainty

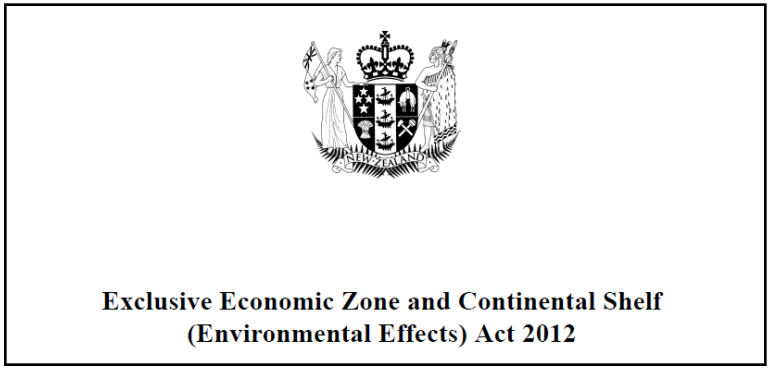
Regulatory Regime



Crown Minerals Act

- The purpose of the Crown Minerals Act regime is ***to promote development of Crown owned minerals for the benefit of New Zealand***
- Permits are required to prospect, explore and mine minerals
- Quality and extent of work programme is a primary condition on licences
- Crown receives annual permit and royalty fees

Regulatory Regime



EEZ Act

- The purpose of this Act is ***to promote the sustainable management of the natural resources*** of the exclusive economic zone and the continental shelf
- Marine environmental consent is decided by a 6 month process, run by a Decision Making Committee appointed by the EPA

CRP's consent process

Environmental Protection Authority
Te Mana Rauhī Taiao

Major public concerns

- Removal of seabed and associated biota (e.g., corals)
- Impacts of the sediment plume on the adjacent environment and deepwater fisheries
- Interactions with marine mammals and seabirds
- Trophic impacts
- Mining inside a Benthic Protection Area (bottom trawling prohibited)

Predicted impacts

Experts agreed

- Marine mammals unlikely to be affected
- Sea birds unlikely to be affected
- Major fish stocks unlikely to be affected
- Primary productivity unlikely to be affected
- Toxicology effects in water column will be very low
- Uranium not an issue

Reasons why consent was declined

DMC's decision summary

Significant and permanent damage to the benthic environment

Modest economic benefits compared to environmental effects

Significant effect on Benthic Protection Area

Proposed adaptive management measures would not address fundamental concerns

Requirement to favour caution and environmental protection

Effect of Uncertainty

All agree: unavoidable benthic impacts in mined areas

CRP's interpretation of evidence

- No significant environmental impacts outside mining areas
- Area mined each year is relatively small
- Most environmentally significant areas not mined
- BPA conservation values preserved in other areas

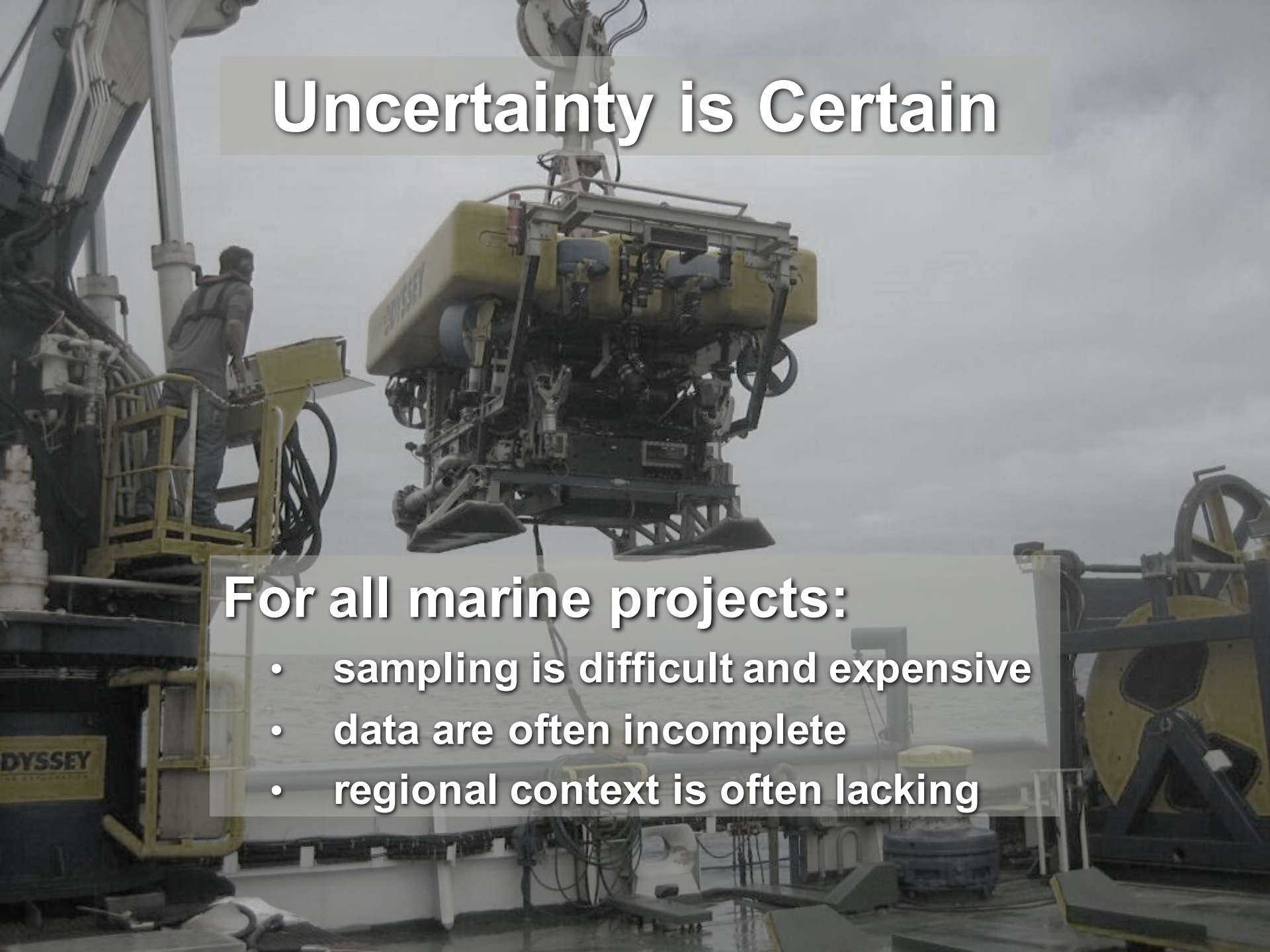
DMC's interpretation of evidence

- Distrust of numerical modelling (uncertainty)

⇒ Most environmentally significant areas will be destroyed

⇒ Proposed monitoring and management conditions inadequate

⇒ Compromise of BPA conservation values unacceptable



Uncertainty is Certain

For all marine projects:

- sampling is difficult and expensive
- data are often incomplete
- regional context is often lacking

Science and Uncertainty

Science assumes that the world is governed by natural laws

Resource distribution

- phosphatization associated with upwelling
- function of sea floor morphology and oceanographic conditions
- modified by icebergs in glacial periods

Distribution of marine environments and communities

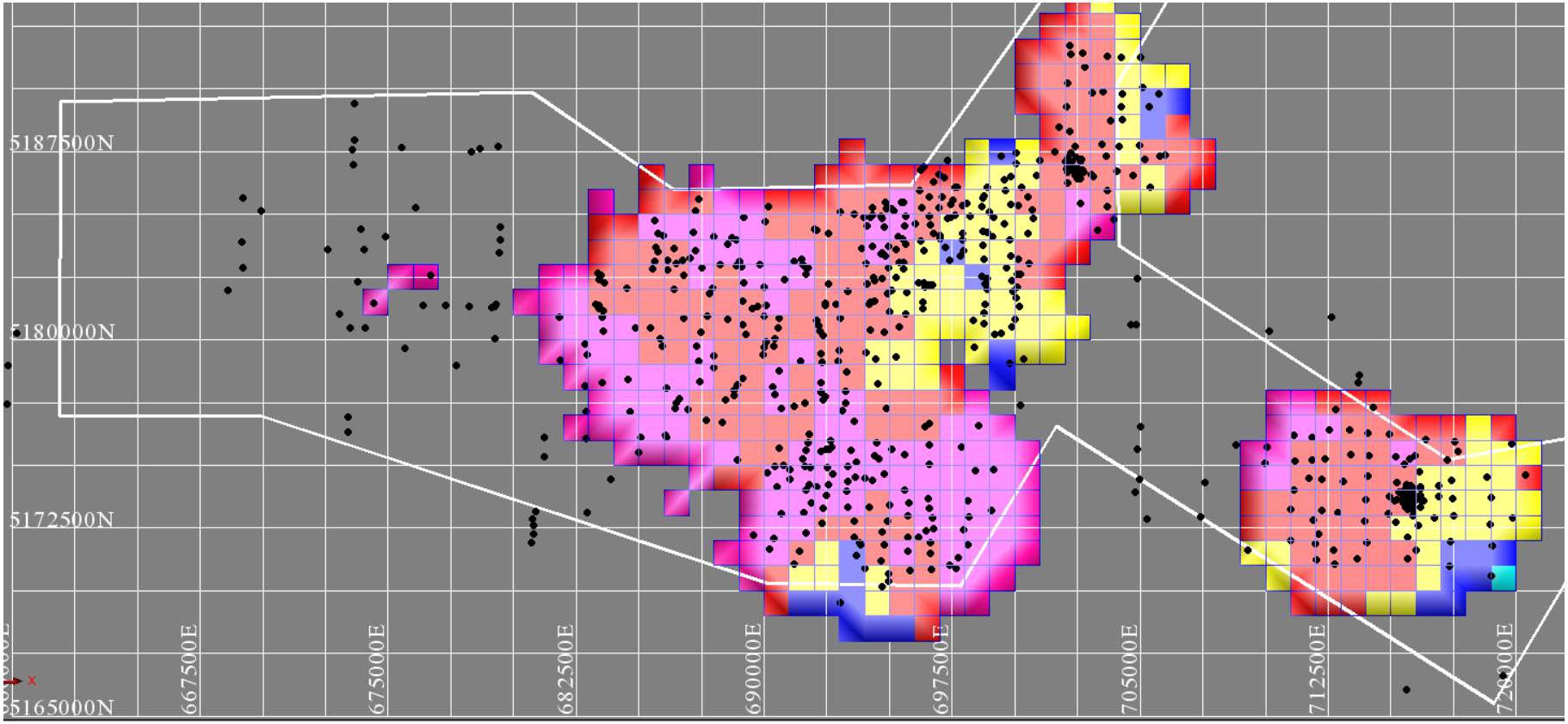
- organisms need suitable habitat and sources of energy
- function of sea floor morphology, oceanographic conditions, evolution

These are governed by laws of physics, chemistry and biology

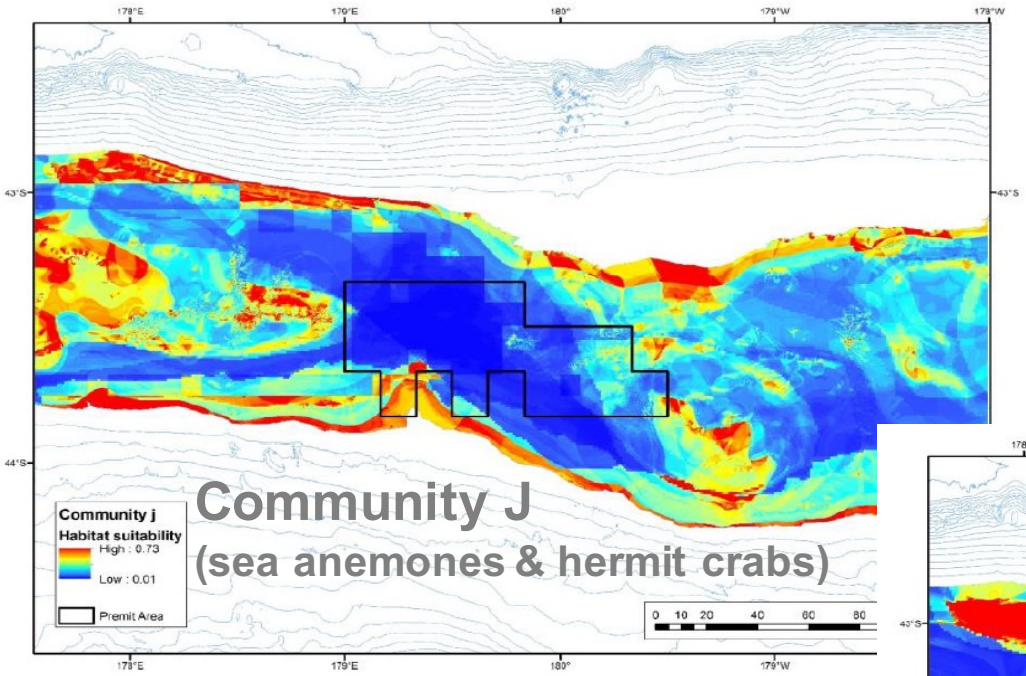
If the sampling is adequate and the natural laws are understood then the distributions can be predicted

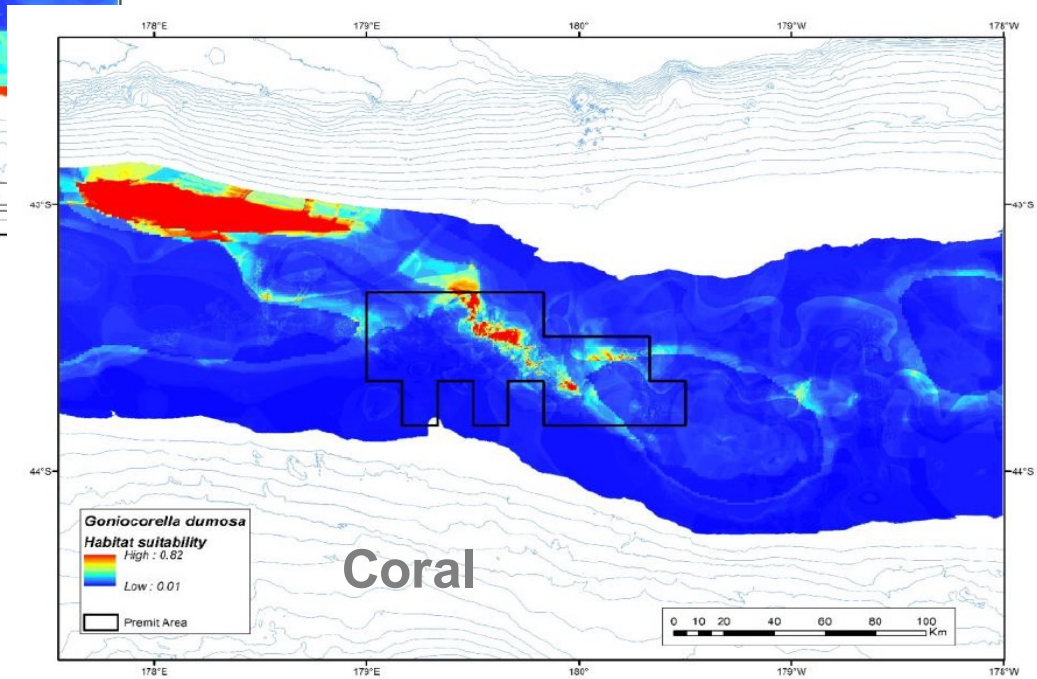
The Resource

Inferred resource of 23.4 Mt, 100 kg/m^3 cutoff (JORC compliant, RSC MME Ltd)
Exploration potential additional 8-12 Mt



Predicted Community Habitats





Multivariate analysis of environmental and other data predicted 13 epifaunal communities on the central Chatham Rise

Science and Uncertainty

Science assumes that if the sampling is adequate and the natural laws are understood then the results of perturbations of the system are also predictable

The extents of the plume and sediment footprint are predictable

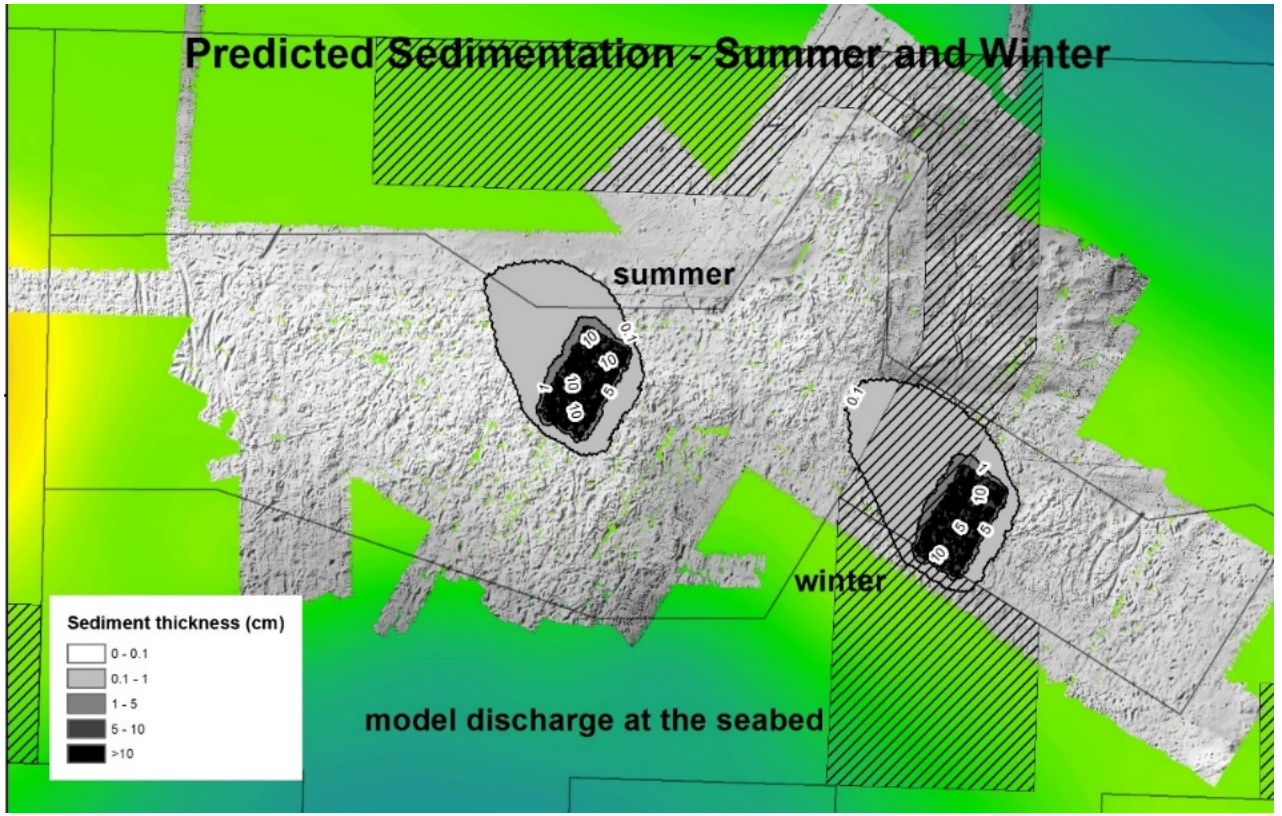
- the rate of particle fall is governed by physical laws
- the tides and currents can be measured or estimated
- the particle size distribution is measureable

The extent of effects on the environment is predictable

- organism distributions are governed by the physical environment
- the community structure can be estimated
- the sensitivity of organisms can be measured or estimated

From these the extent of effects on communities can be predicted

Sea floor effects



- Scientists estimate 5 cm of sediments are likely to seriously impact seafloor biota, and deposits as thin as 1 mm could affect smaller organisms
- Models predict 5 cm sediment will be restricted to immediate mining area, 1 mm of silt and clay sediment could extend 8 km
- Conclusions: serious effects limited to mining area, observable effects may extend up to 8 km

Society and Uncertainty

In our experience Regulators want to minimise uncertainty

Mining permit

- certainty that the resource is adequately defined
- certainty that the maximum value of the resource will be realised
- certainty that CRP has the capacity to develop the resource

Environmental consent

- certainty that the nature and extent of the environmental effects are known
- certainty of the economic value of the project

Tools for Managing Uncertainty

The precautionary principle and adaptive management

✗should not result in ‘paralysis by analysis’

✓allows approval if risk thresholds are agreed

✓requires regular monitoring and checking against those thresholds

✓requires operations to stop if thresholds exceeded

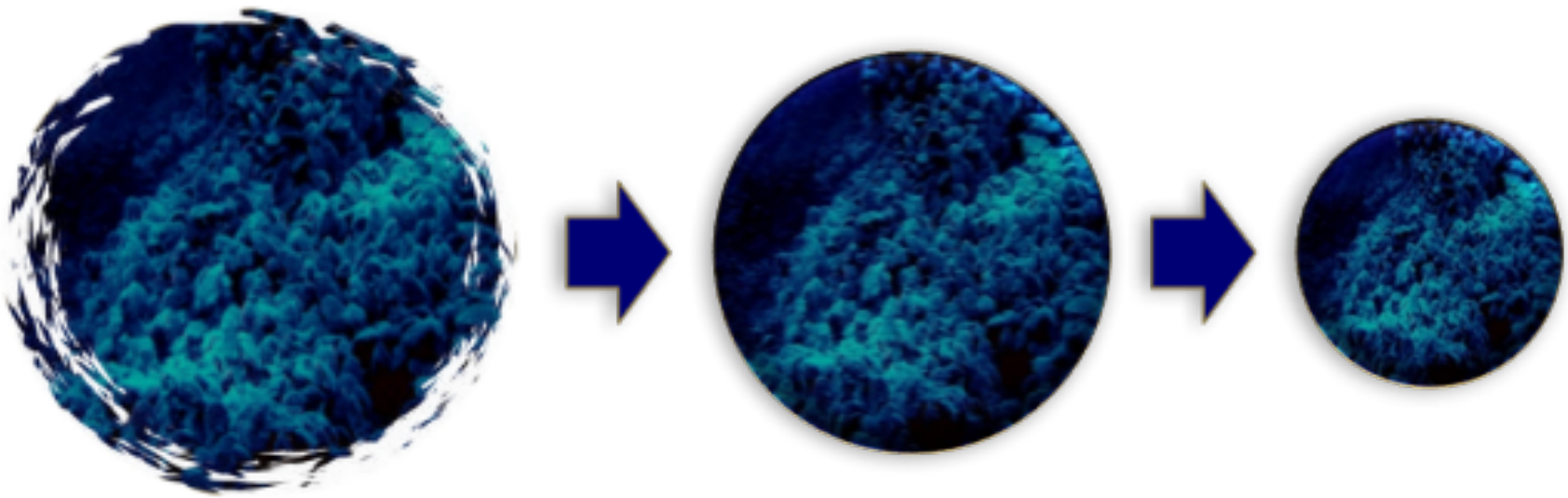
✓requires confidence in the predicted nature and extent of effects, and the capability of monitoring to identify variations from predicted effects

Agreed Risk Thresholds and Uncertainty

defined range of expected economic, environmental and social effects

defined range of expected economic, environmental and social benefits

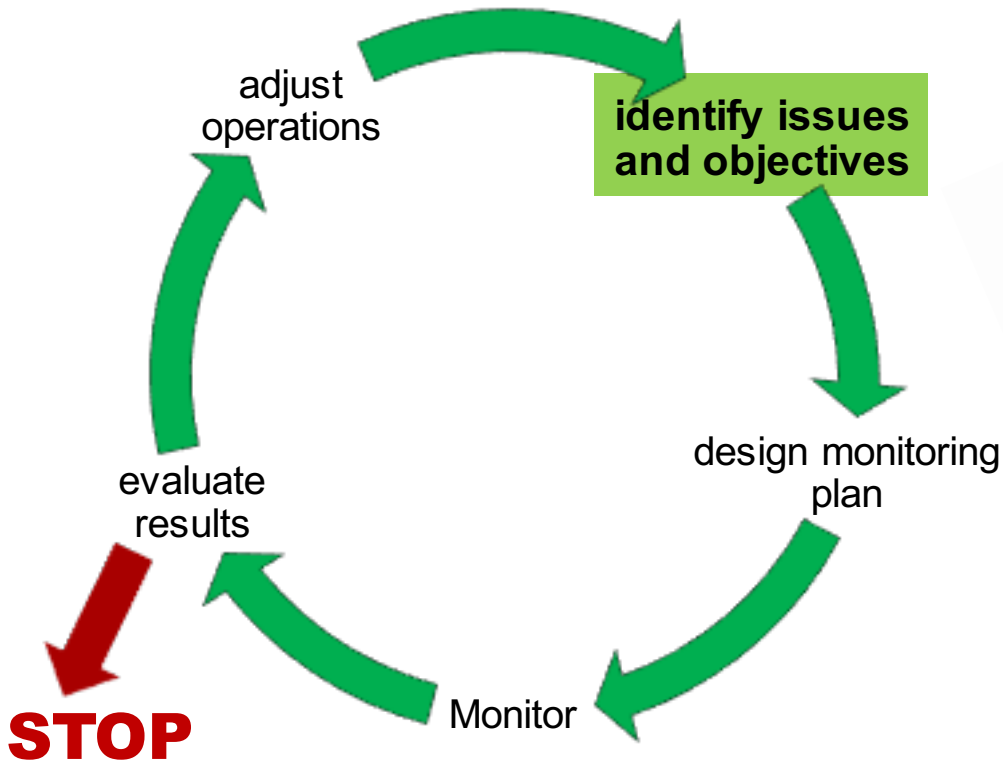
Role of Science

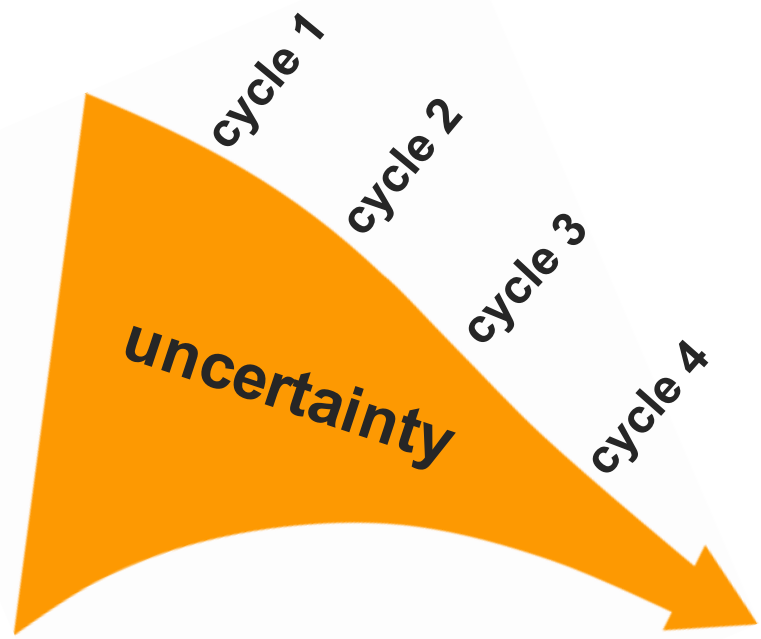


Reduce the scale of the uncertainties

- improve knowledge of the nature and significance of risks and uncertainties
- improve knowledge of the predicted effects

Uncertainty and Adaptive Management





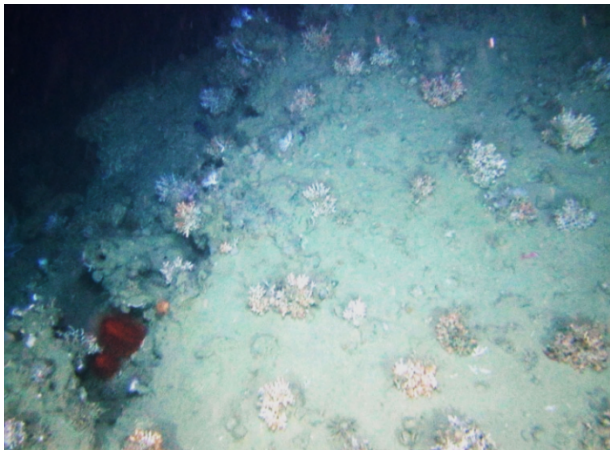
Adaptive management is a systematic approach for improving outcomes by reducing uncertainties through learning from management outcomes

Perceptions of Uncertainty and Adaptive Management

Proposed adaptive management conditions were not accepted by the DMC

- reflected different views on the uncertainties and the ability to manage them

uncertainties about nature and scale of effects and benefits, and ability to monitor and manage those effects



DMC unwilling to risk any environmental impact

uncertainties about impact of effects on operations and profitability of project

CRP willing to spend $200 million on environmental data and risk a $500 million investment

The Way Forward

CRP

•Consult with stakeholders (e.g., Government, industry, iwi/imi, NGO's)
•Review entire project, revise if necessary
•Complete scientific research on essential issues
•Write EIA
- clarify uncertainties, risks, effects, benefits
- clarify conditions and role of adaptive management

•Reapply for an environmental consent

NZ

•Decide on social, economic and environmental goals
•Initiate spatial planning
•Look for solutions not problems