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Deep Seafloor Mineral Resources: Environmental Considerations

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Environmental Management

Seafloor Massive Sulphides (SMS)

Manganese Nodules

Cobalt Rich Crusts (CRC)

Understand the Environment → Understand the Impacts → Manage Impacts → Monitor Impacts

Exploration

Mining

Studies to Define the Environment

Physical assessment	Oceanographic assessment	Biological assessment	Existing activities assessment
Air quality	Current regime	Pelagic biodiversity	Fishing
Bathymetry	Hydrodynamic modelling	Benthic biodiversity	Tourism
Sediment characteristics	Water quality	Ecosystem structure	Shipping
Sedimentation rates	Visual characteristics	Ecosystem function	Cultural

Seafloor Massive Sulphides- Biology

Vent-endemic species

- Snails, Mussels, Barnacles, Shrimp, Worms, Crabs, etc
- Symbiotic or mutually beneficial, relationship with chemoautotrophic bacteria
- At least 600 species
- High temperature range tolerance
- Resilient to disturbances

Inactive fauna

- Are a subset of the filter-feeding communities found on other hard substrates in the region

Communities differ regionally as well as at macro and micro scale within a vent site





Manganese Nodules - Biology

Most biodiversity is in soft sediments

- High levels of local biodiversity of tiny animals
- Worms, molluscs, bacteria etc

There is a distinct nodule fauna as well

- Mostly forams, but also small filter-feeding animals: sponges, worms, molluscs,
- Different animals seem to specialize on different nodule surface textures
- In the order of ˜70 species so far

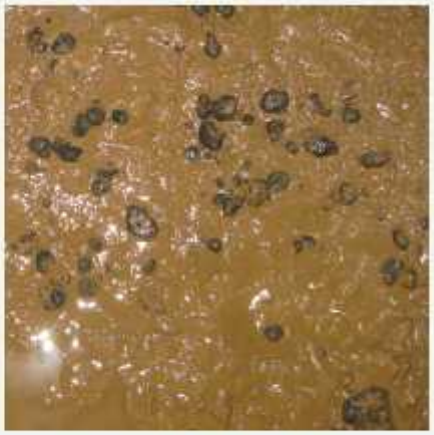
Megafauna: Low density, moderate diversity

- No current evidence for regional scale endemicity

Understand the Environment

Small nodules of high abundance

Large nodules of high abundance



Small nodules of low abundance

Bi-modal nodules of high abundance

Photo: Micheal Wiedicke-Hombach, BGR

Cobalt Rich Crusts - Biology

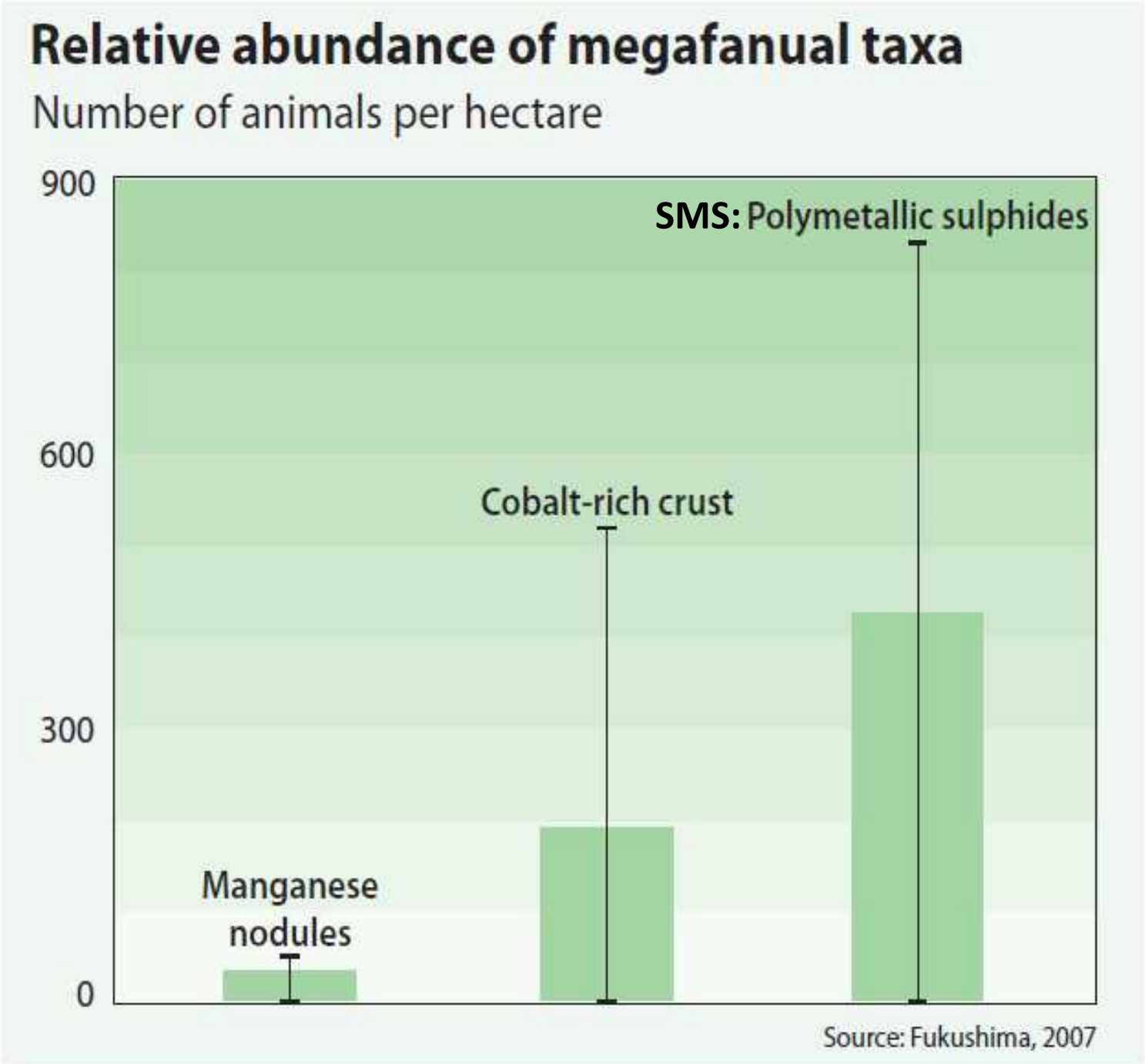
Mostly Sessile Animals

- Require hard surfaces on which to attach
- Sponges, corals, feather stars, and sea squirts

- Sea cucumbers, crabs, and sea stars.

Composition

- Driven by depth
- no significant difference between the faunal composition of ferromanganese- crust and non-ferromanganese-crust features.


Relative abundance of megafanual taxa
Number of animals per hectare
900
600
300
0
SMS: Polymetallic sulphides
Cobalt-rich crust
Manganese nodules
Source: Fukushima, 2007

Potential Impacts

Key components to SMS mining activities:

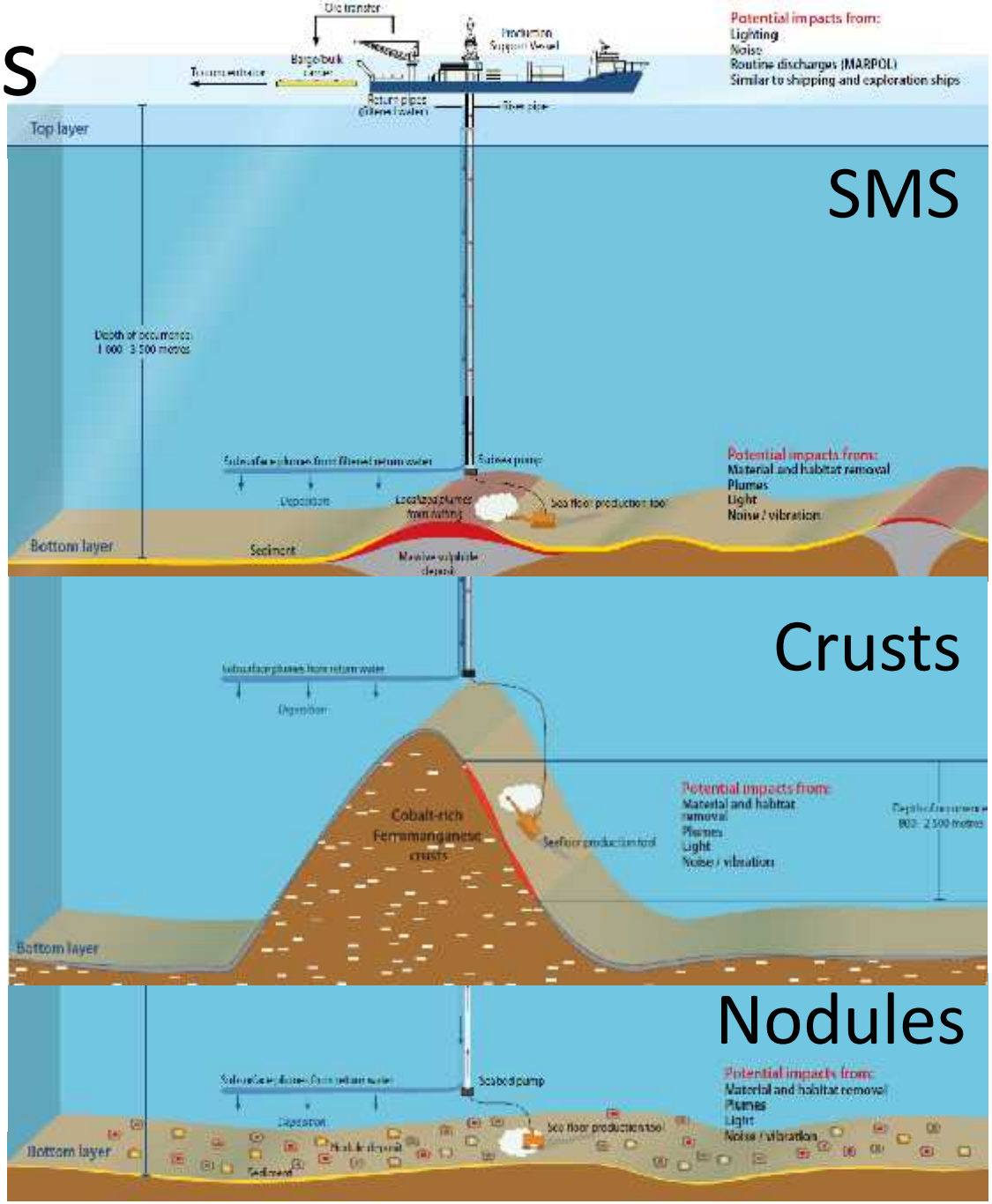
1. breaking up mineralized material (rock) at the sea-floor

2. transporting the material from the sea-floor up to a large boat (mining vessel) at the sea surface

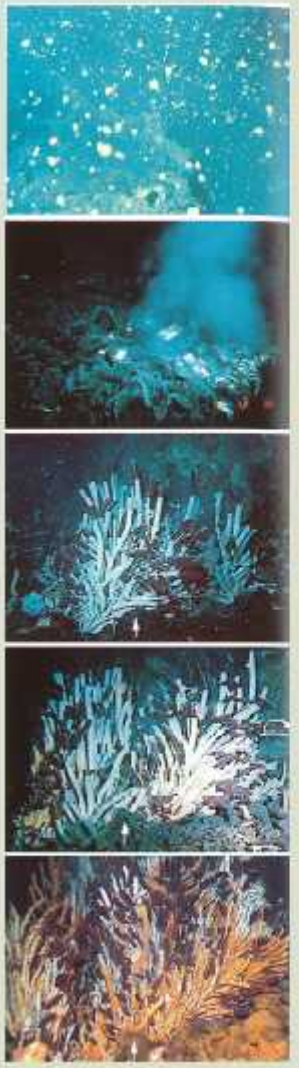
3. dewatering the material (using a filter system on the mining vessel)

4. transporting the material from the mining site to a port, and /or to a processing facility (by boat)

5. disposal of tailings (waste)



SMS: Recovery Potential



T_0 April 1991

$T_{11\ mos}$ March 1992

$T_{20\ mos}$ December 1993

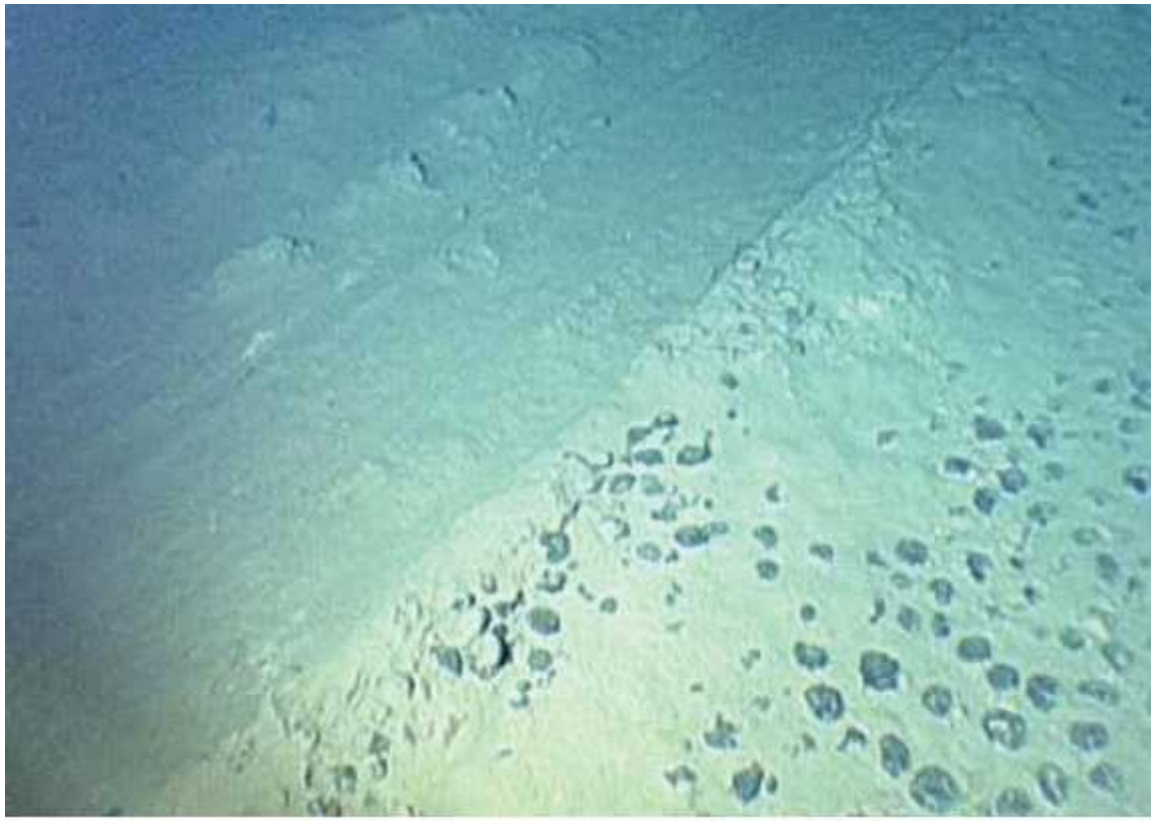
$T_{30\ mos}$ October 1994

$T_{43\ mos}$ November 1995

East Pacific Rise

- Active hydrothermal vent system
- Frequent catastrophic disturbance
- Rapid Recovery (5 years)

Nodules: Recovery Potential



1978 – experimental dredging
4.5 cm deep
1.5 m wide

2004 – site revisited
26 Years

Environmental Management Objectives

Maintain overall biodiversity and ecosystem health and function

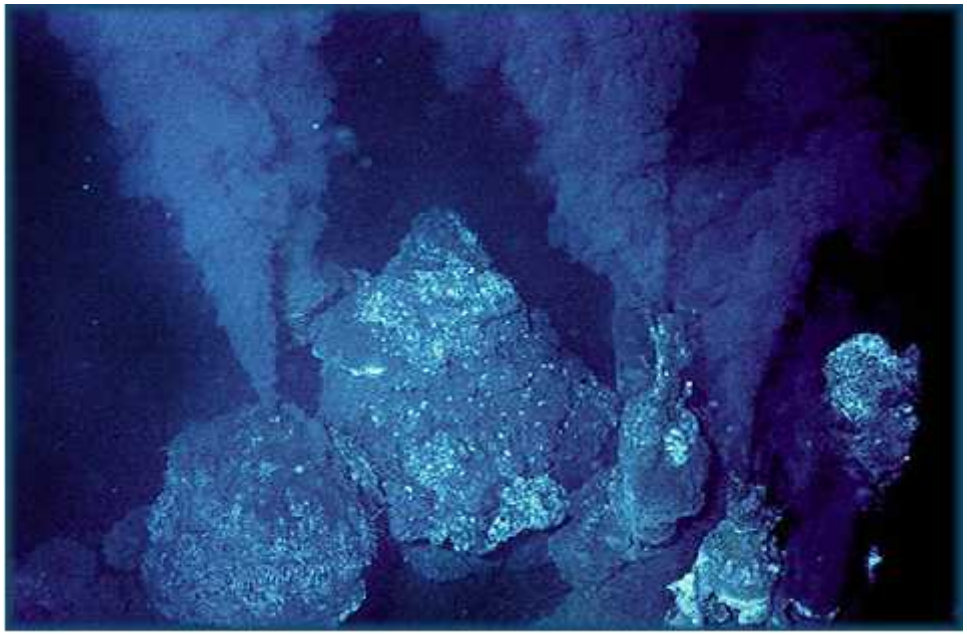
Reduce, mitigate and where possible, prevent adverse effects of mining and pollution to wider habitats and ecosystems

Maintain overall biodiversity and ecosystem health and function

Minimise loss at the mine site (Active SMS)

- Reserve area to provide parent stock for repopulation

- Temporary refuge area(s) within mining area to allow progressive rehabilitation
- Transplantation of fauna within mining area



Maintain overall biodiversity and ecosystem health and function

Establish a Network of Marine Reserves

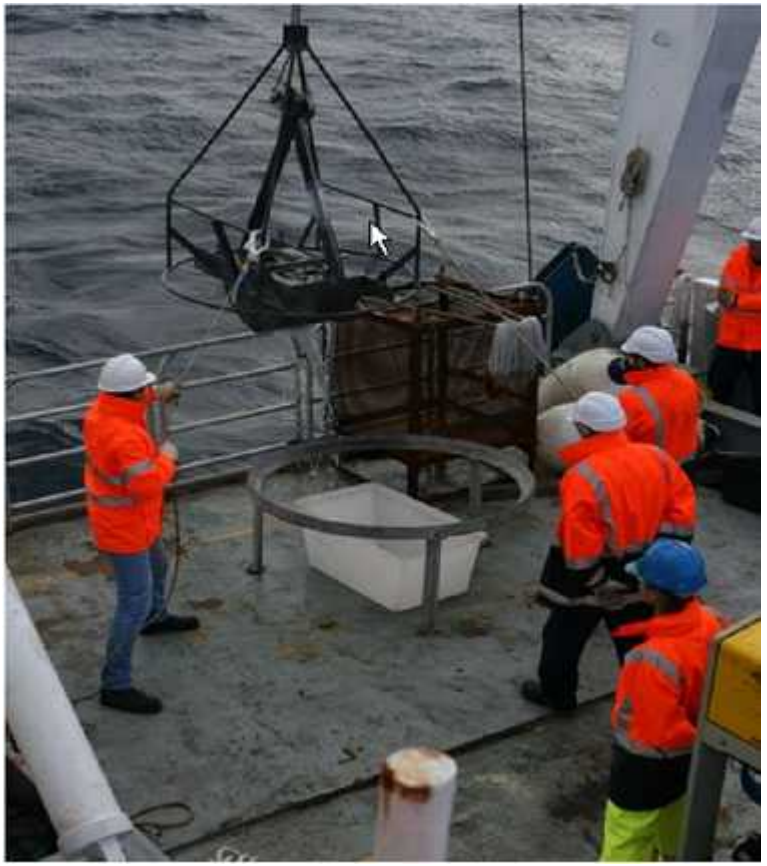
Biodiversity	Ensure maintenance of the ecosystems
Connectivity	Ensure ecological connectivity between sites
Replication	Conserve multiple sites, not just one
Viability	Ensure the size and spacing of reserves is adequate
Representivity	Multiple sites must contain a wide range of species and functions to allow for uncertainty or natural variation in populations
Sustainable use	Include other potential uses in designing the areas (e.g, fishing)

Monitoring

- Before, During and After mining activities
- Control sites

- Direct (effects)
- Indirect (impacts)

- Monitoring compliance

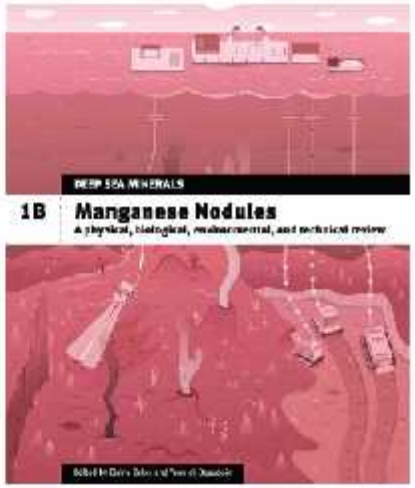


Cumulative Impacts

- Concurrent operations or successive operations
- Far-travelling impacts (e.g. plumes) could move outside of mining licences
- Contractors cannot be expected to monitor outside of their licences
- Regional-scale strategic monitoring role

For More Information:

Volume 1A: SPC (2013). *Deep Sea Minerals: Sea-Floor Massive Sulphides, a physical, biological, environmental, and technical review.* Baker, E., and Beaudoin, Y. (Eds.) Vol. 1A, Secretariat of the Pacific Community.



Volume 1B: SPC (2013). *Deep Sea Minerals: Manganese Nodules, a physical, biological, environmental, and technical review.* Baker, E., and Beaudoin, Y. (Eds.) Vol. 1B, Secretariat of the Pacific Community.

Volume 1C: SPC (2013). *Deep Sea Minerals: Cobalt-rich Ferromanganese Crusts, a physical, biological, environmental, and technical review.* Baker, E. and Beaudoin, Y. (Eds.) Vol. 1C, Secretariat of the Pacific Community.

Volume 2:SPC (2013). *Deep Sea Minerals and the Green Economy.* Baker, E. and Beaudoin, Y. (Eds.), Vol. 2, Secretariat of the Pacific Community.

Take-Home Messages

Understand the Environment

Each site will have different biological, geological and oceanographic characteristics, and as such will require individual assessment and management measures.

Understand the Impacts

Impacts will depend on the mineral type, the site's environment, and the technology used.

Manage Impacts

Assumption that no local recovery will occur, therefore overall regional biodiversity needs to be maintained – through a network of preservation sites

Monitor Impacts

Monitoring is required by the both the operator and the regulator – particularly in the case of cumulative impacts.