Ecological aspects of Deep-sea Mining: Impacts & risks

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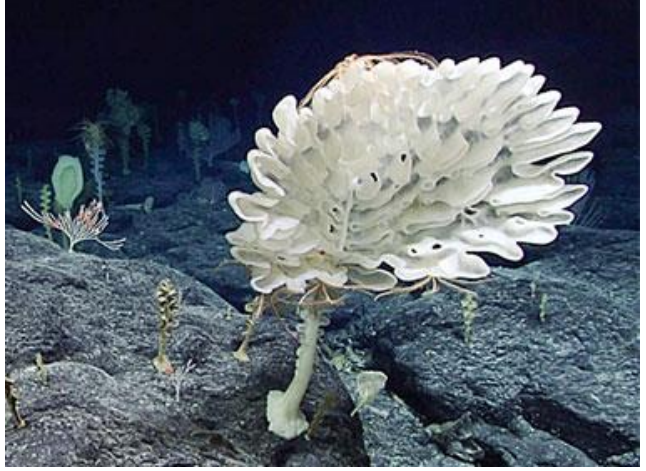
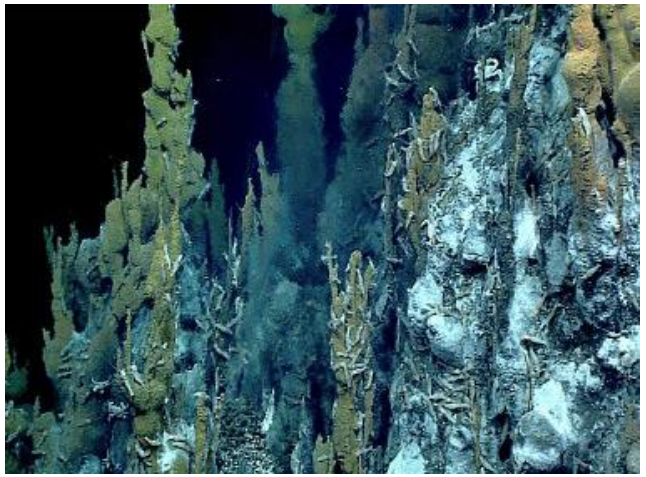




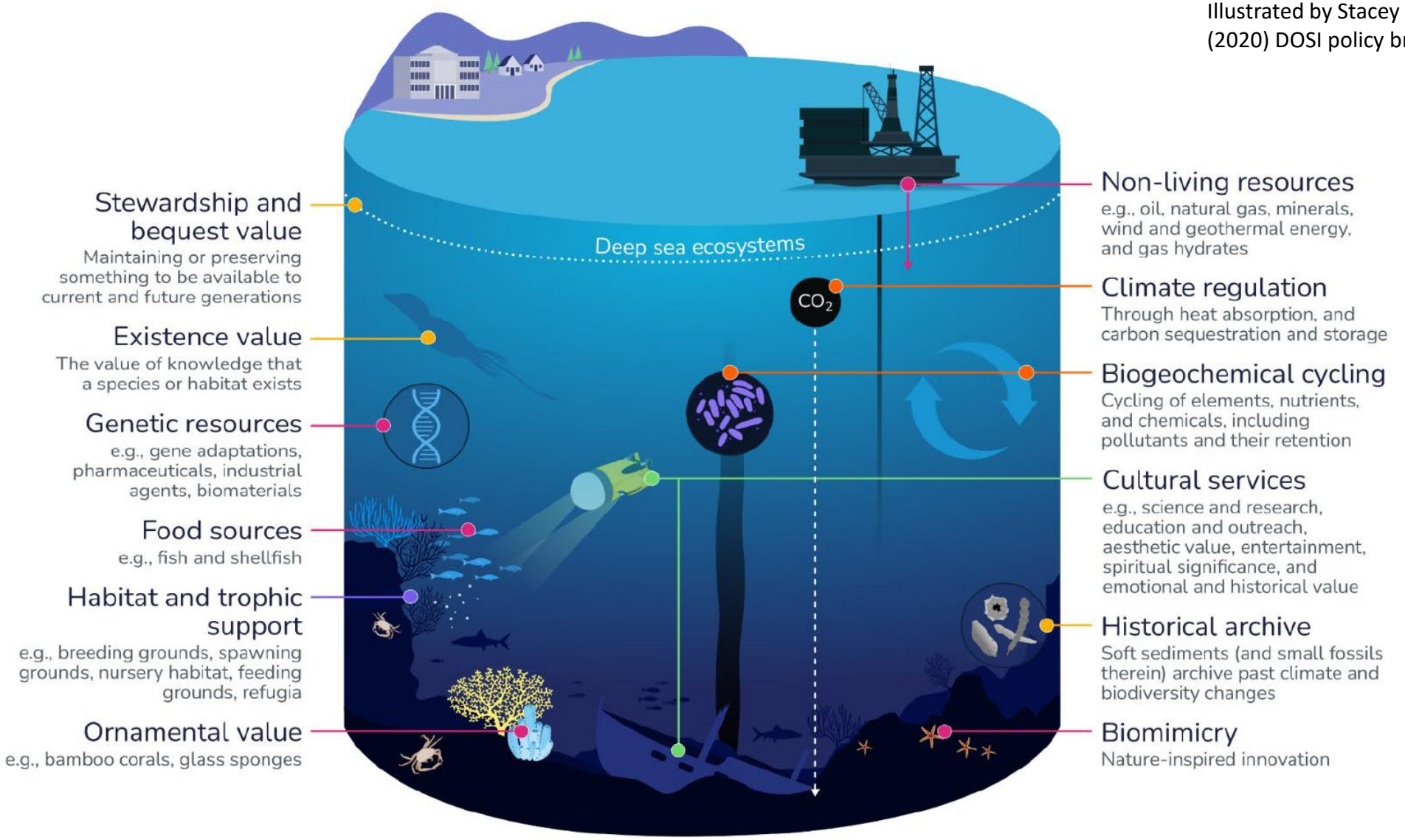
Deep-Sea Ecosystems

- >200 m depth
- 96% of habitable space on earth
- Extraordinary variety of habitats & extremely high biodiversity (250K described, estimated >2M spp)
- Largely understudied in terms of biodiversity and ecosystem functions
- Extreme conditions:
  - Temperature
  - Pressure
  - Light
  - Chemistry
  - Nutrients

  =>Adaptations, biological process…
- What we know from land/coastal ecosystems (conservation, restoration) is not applicable to the deep sea.

Photo credit: NOAA

Illustrated by Stacey McCormack.. In Le et al. (2020) DOSI policy brief



KEY

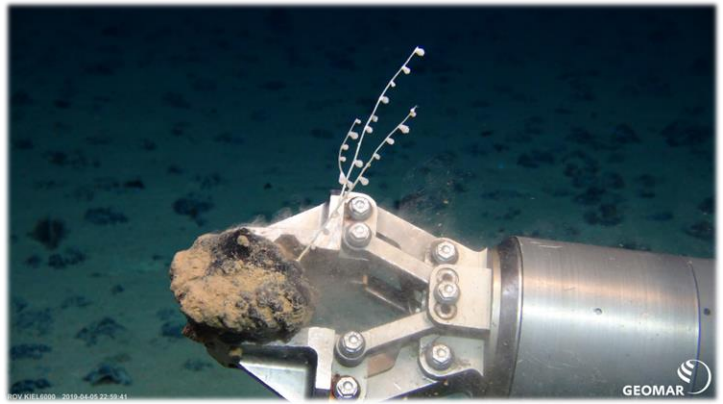
- **Provisioning services**: result in tangible goods and/or products
- **Regulating services**: contribute to the natural production and resilience of habitats and ecosystem processes
- **Supporting services**: underlying ecosystem functions that are essential to produce other services
- **Cultural services**: non-material benefits deriving from nature
- **Biodiversity values**: biodiversity has intrinsic value, but is also the source of most ecosystem services

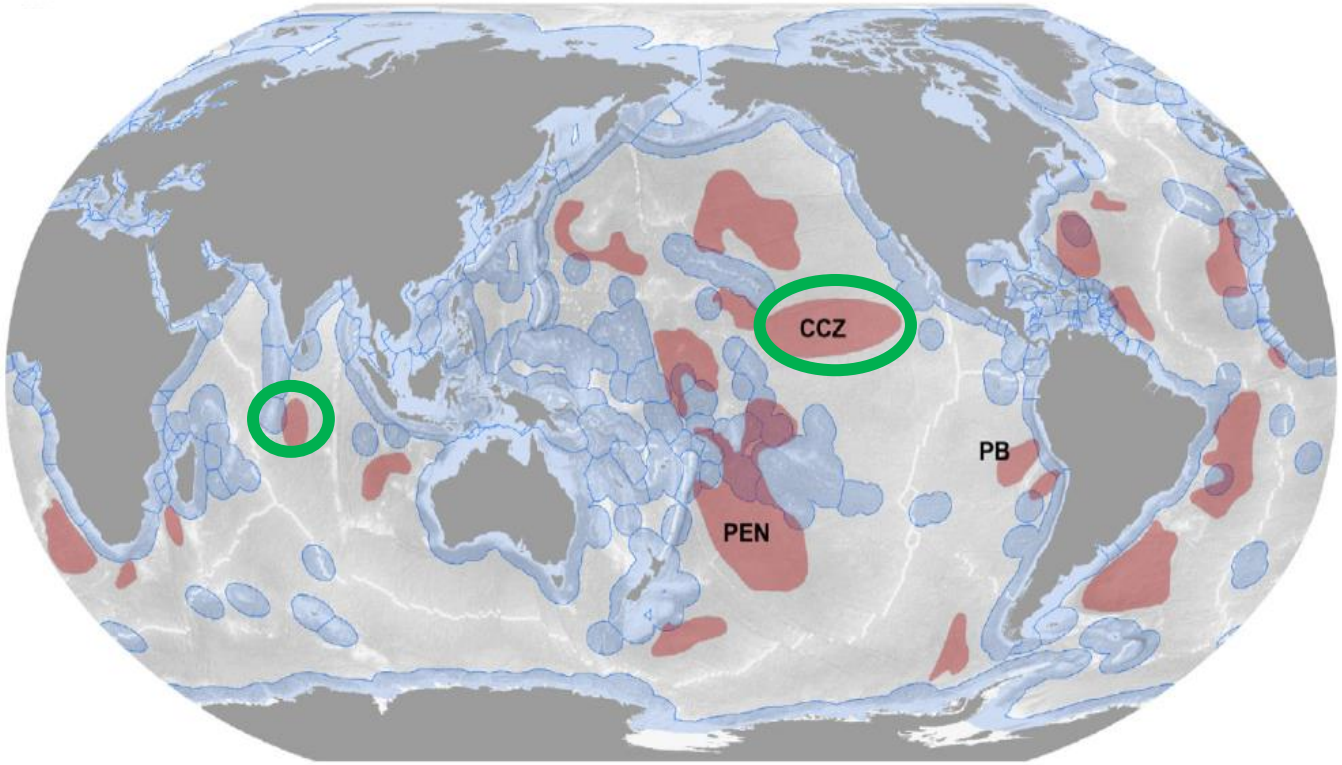
Polymetallic Nodules

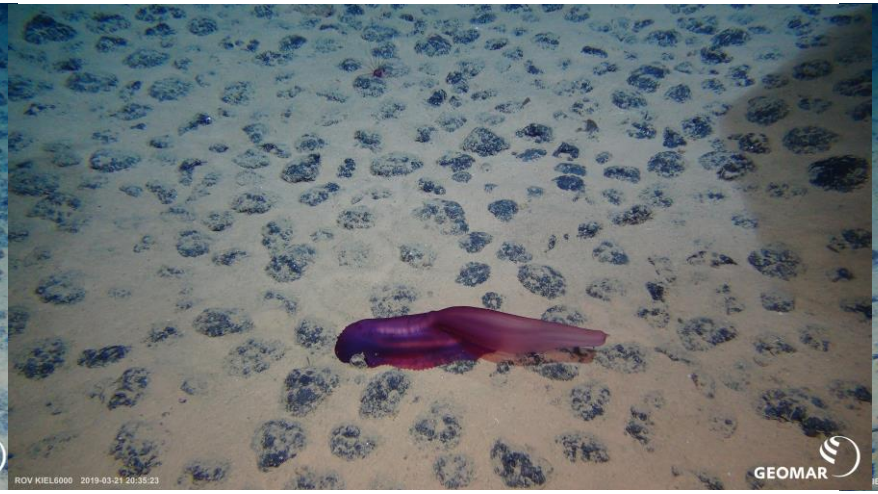
Abyssal Plains (3000-6000 m)

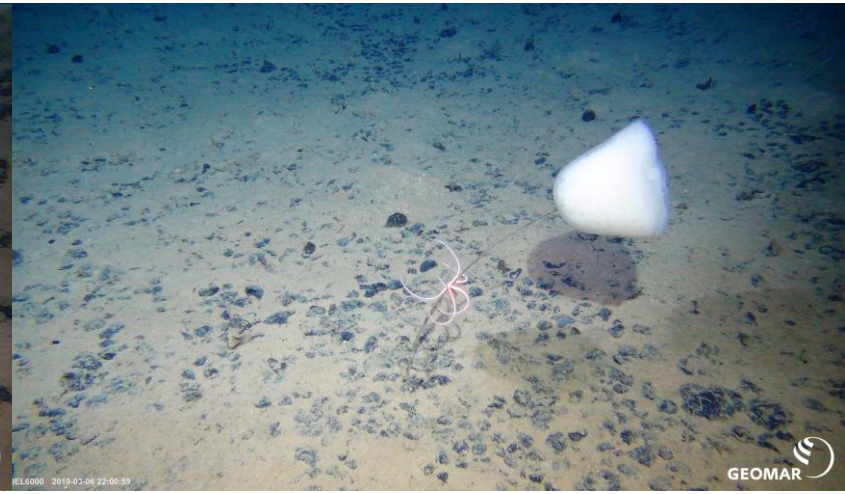
Ni, Co, Cu, Mn, Li, Mo, Ti, REE

CCZ: 21,100 Mio t = US$ 15-20 trillion



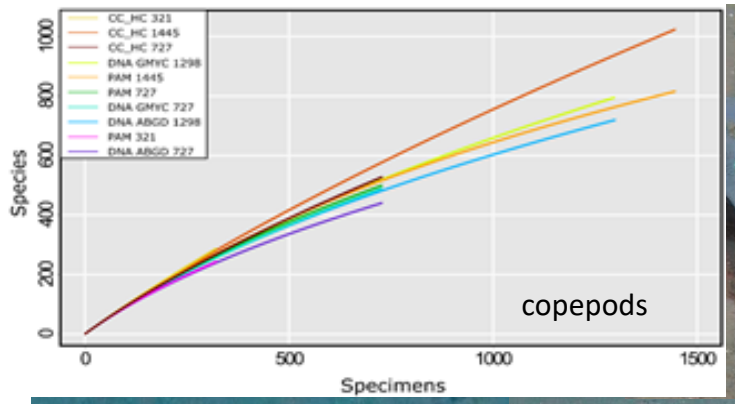


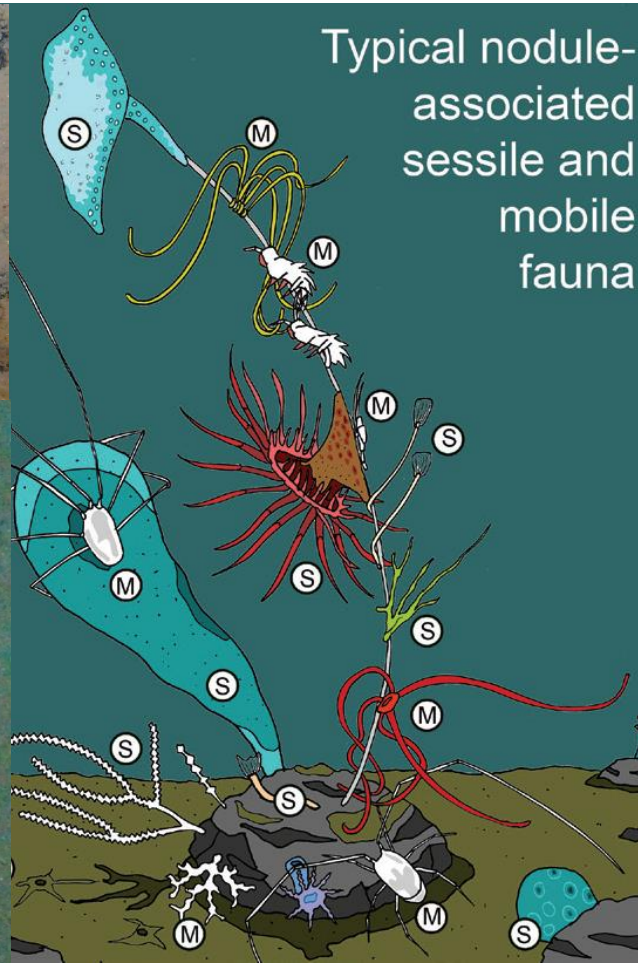


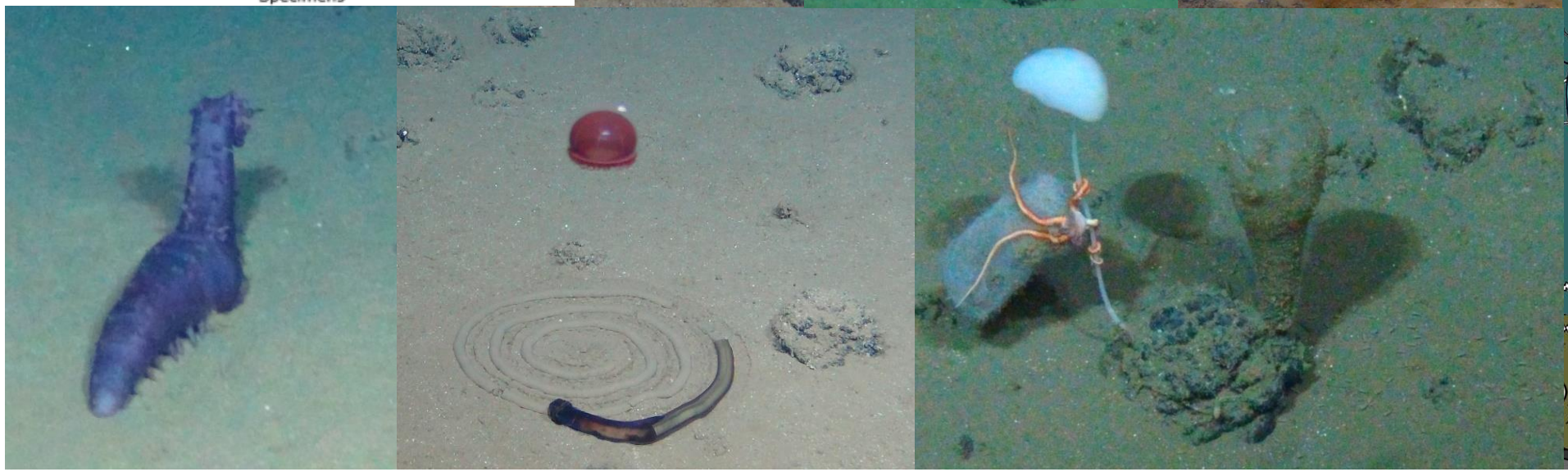


Benthic ecosystem in the deep Pacific Ocean

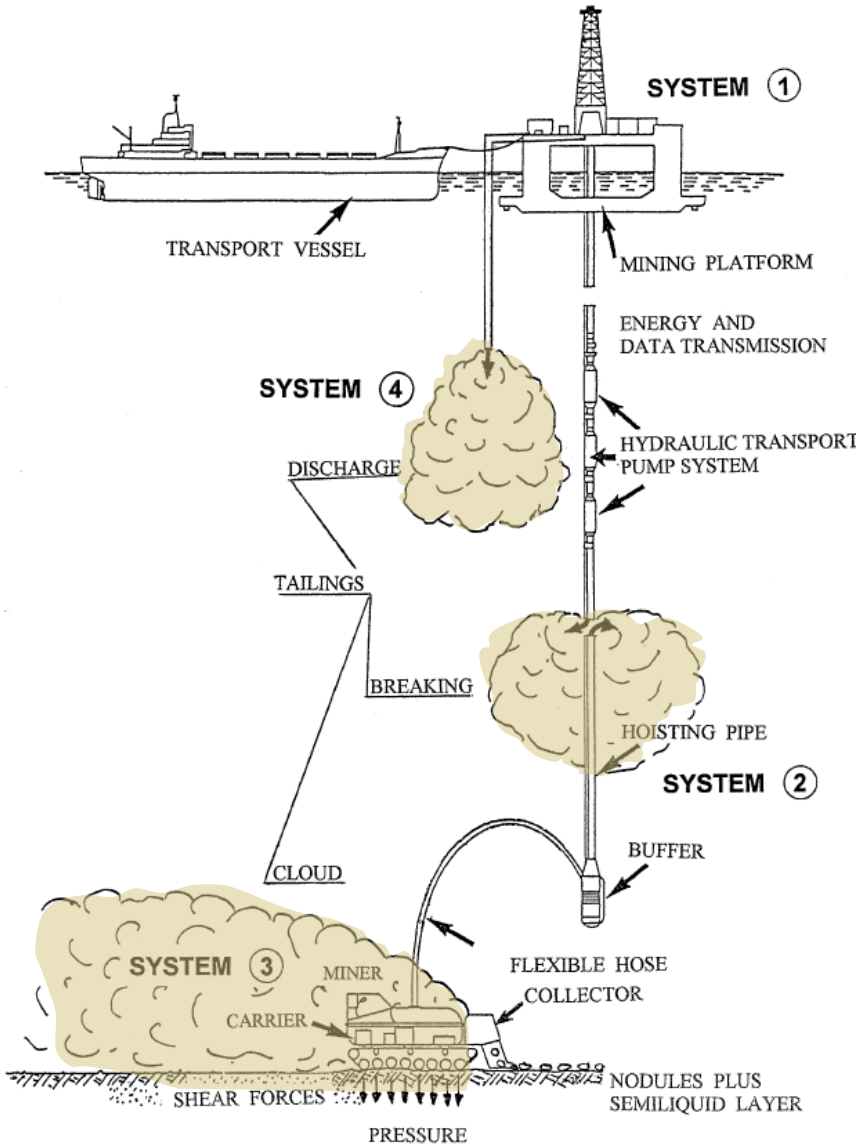
- Nodule ecosystems support a highly diverse fauna of sessile and mobile species
- Faunal communities & environmental parameters show high variability on local spatial scale





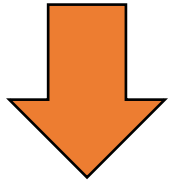


Impacts of polymetallic nodule mining



Oebius et al. (2001) DSR II 48

- Removal of nodules + bioactive layer (200-300 km²/a per operation)
- Suspension of sediment plume and redeposition the seafloor
  => impact area >> mining area
- Discharge of sediment waste from surface platform riser pipe
- Noise & light



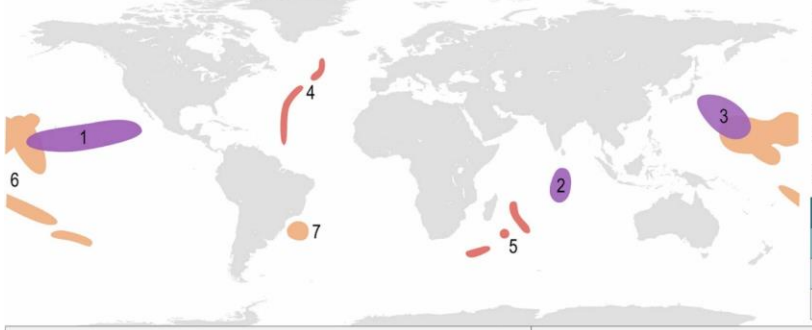
- Loss of habitat
- Loss of species & genetic diversity
- Loss of ecosystem structure & functions => services
- Change of seabed characteristics & processes => recovery?

Boetius & Haeckel (2018) Science 359

Protection & management tools:
- Spatial planning: MPAs REMPs
- EIA
- Monitoring

Knowledge gaps:

- Parameters:
  - Environmental conditions
  - Biodiversity
  - Natural variability (space, time)
- Processes:
  - Connectivity
  - Life histories
  - Trophic relationships
- Ecosystem functions & services
- Resilience to:
  - Removal of resources
  - Plumes
  - Noise, light
  - Long-term
  - Cumulative impacts (e.g. climate change)

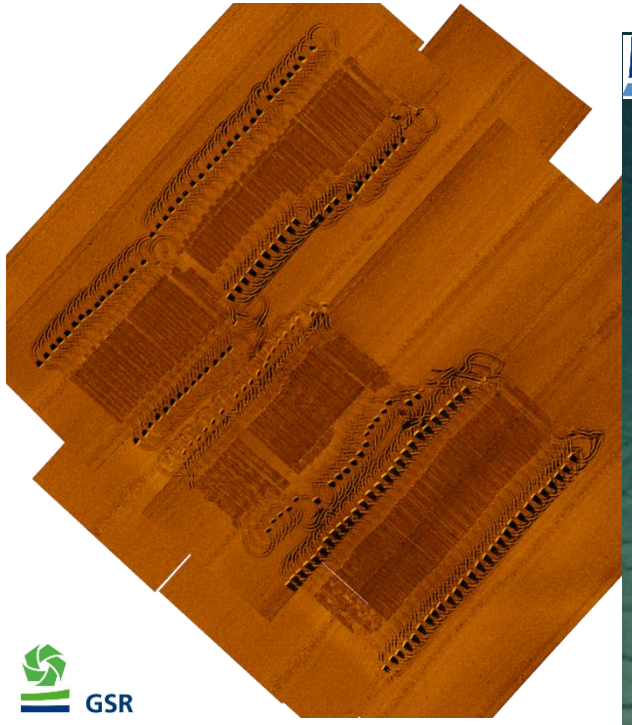


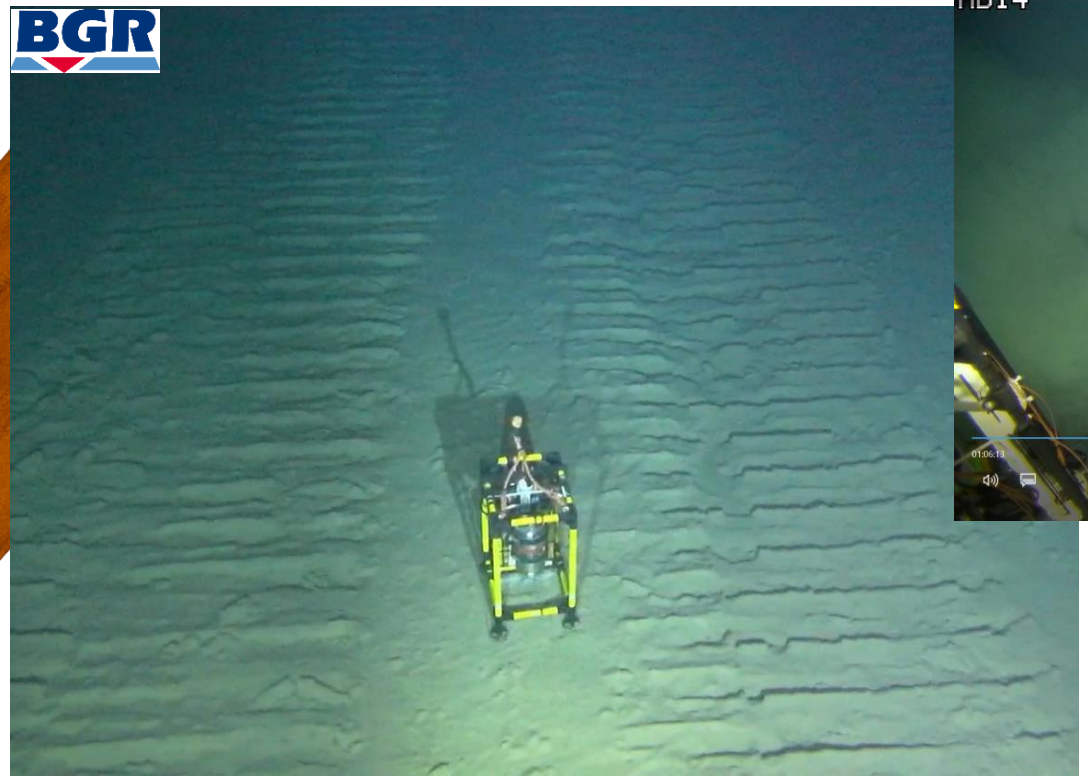
Location
1. Clarion-Clipperton Zone
2. Central Indian Ocean Basin
3. West Pacific
4. Mid-Atlantic Ridge
5. Indian Ocean Ridges
6. West Pacific Prime Crust Zone
7. South Atlantic Rio Grande Rise

Knowledge
- Scientific knowledge enables evidence-based management
- Few gaps in scientific knowledge for evidence-based management remain
- Scientific knowledge gaps for evidence-based management dominate
- There is no or next to no scientific knowledge to enable evidence-based management

Key Scientific Gaps			Habitat								
			Nodules			Active Sulfides		Inactive Sulfides		Cobalt-rich Ferromanganese Crusts	
Theme	Topic	Sub-Topic	1	2	3	4	5	4	5	6	7
Environmental Baselines	Abiotic	High-resolution bathymetry									
		Oceanographic setting (e.g., currents, oxygen minimum zones, temperature, turbulence levels, sound, suspended particles)									
		Seabed properties (e.g., sediment characteristics, oxygen penetration, redox zonation, metal reactivity)									
		Natural disturbance regimes									
	Biotic*	Species taxonomy									
		Trophic relationships									
		Life histories (e.g., age of maturity, longevity, reproduction, fecundity)									
		Spatial variability									
		Temporal variability									
		Connectivity (e.g., dispersal mechanisms, species ranges, source/sink populations)									
		Ecosystem functions and services									
Deep-Seabed Mining	Impacts	Removal of resources									
		Plumes									
		Contaminant release and toxicity									
		Noise, vibration and light									
		Cumulative impacts									
	Resilience										
	Management	Environmental goals and objectives									
		Survey and monitoring criteria									
		Effectiveness of mitigation strategies									

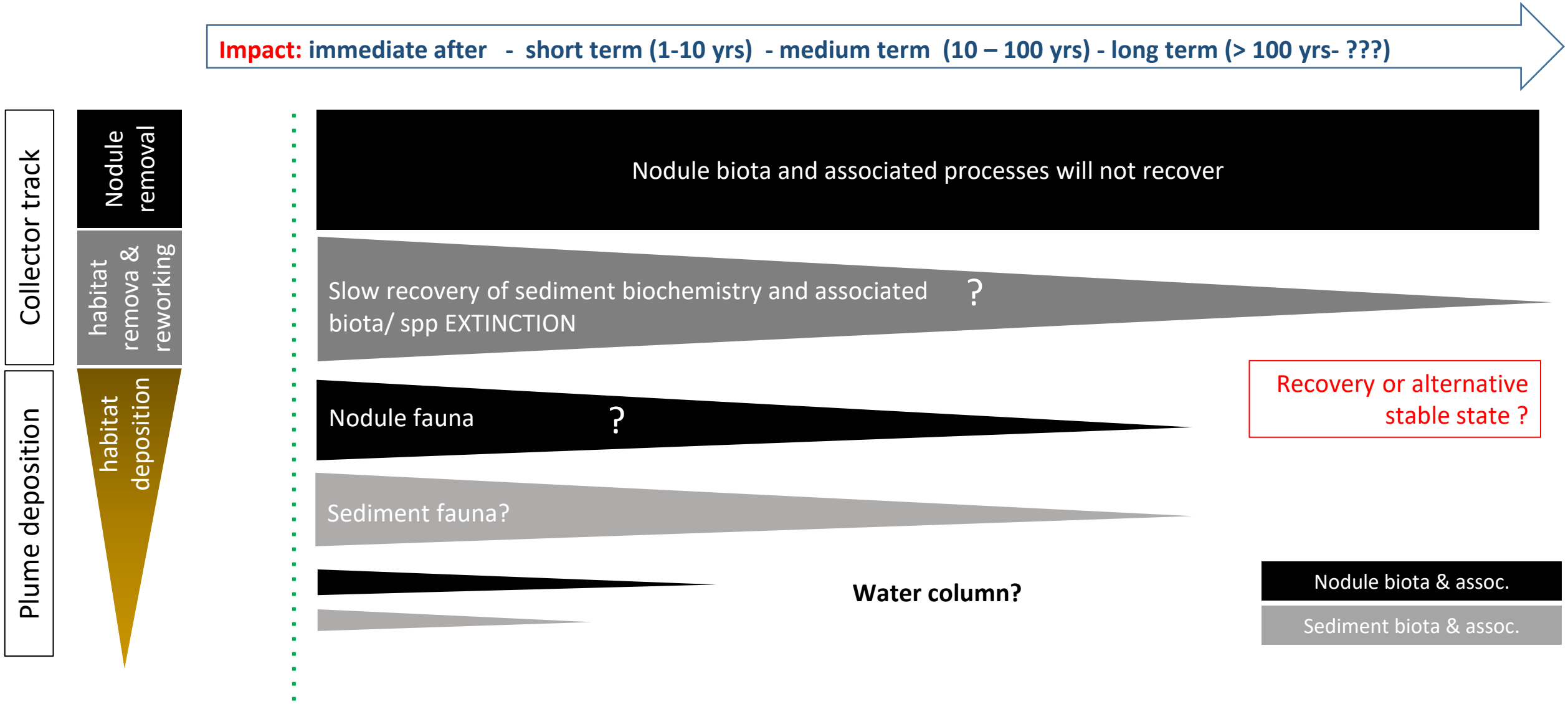
Amon et al 2022, Marine Policy

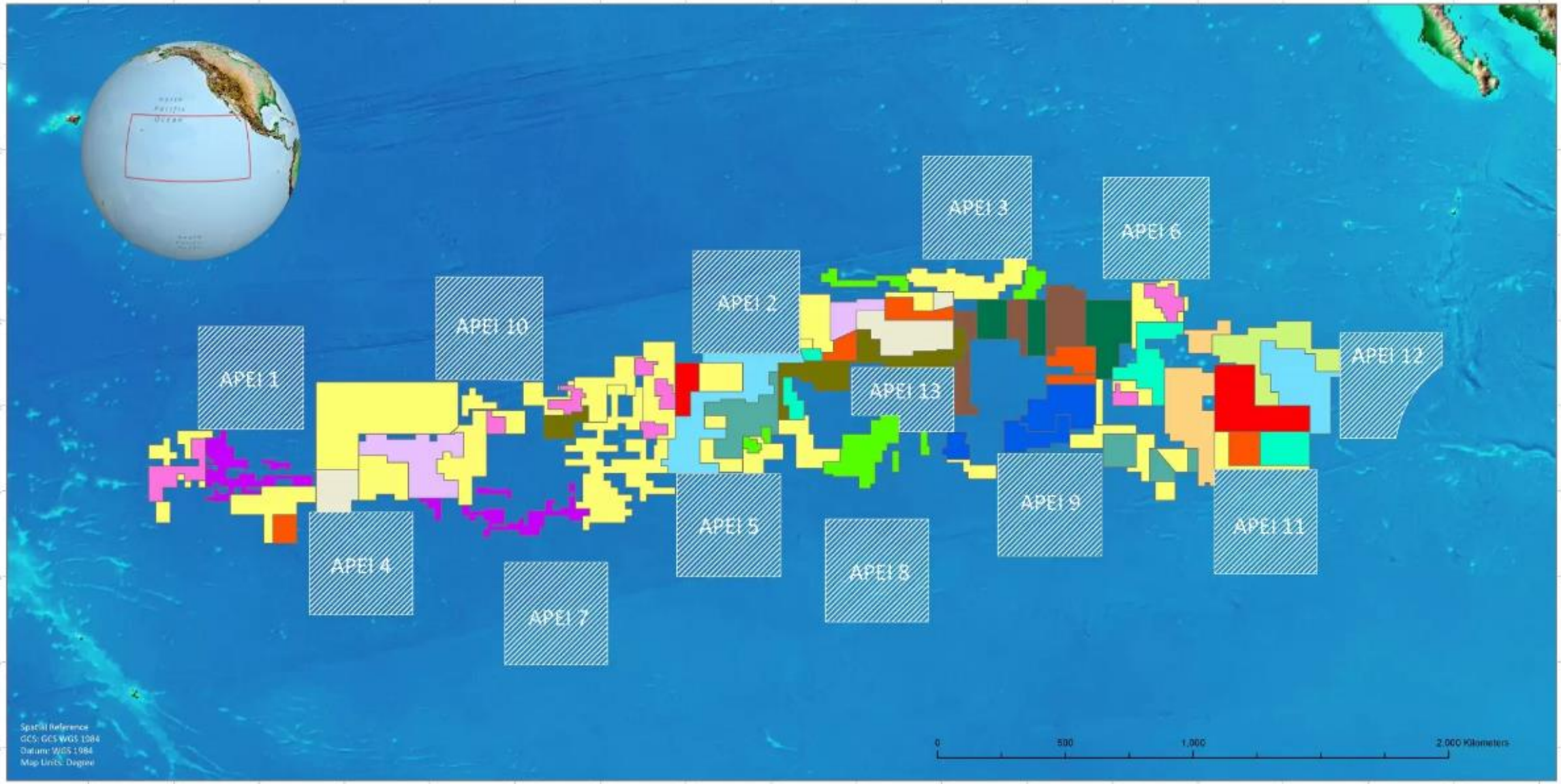




- Removal of 4-8 cm of surface sediment => redeposition of 2-3 cm inside+vicinity
- Sediment plume 5-10 m from seafloor
- Far-field transport (4 km in 24 h) in low concentrations with bottom currents
- Toxicity

Implications for conservation

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APEI 10
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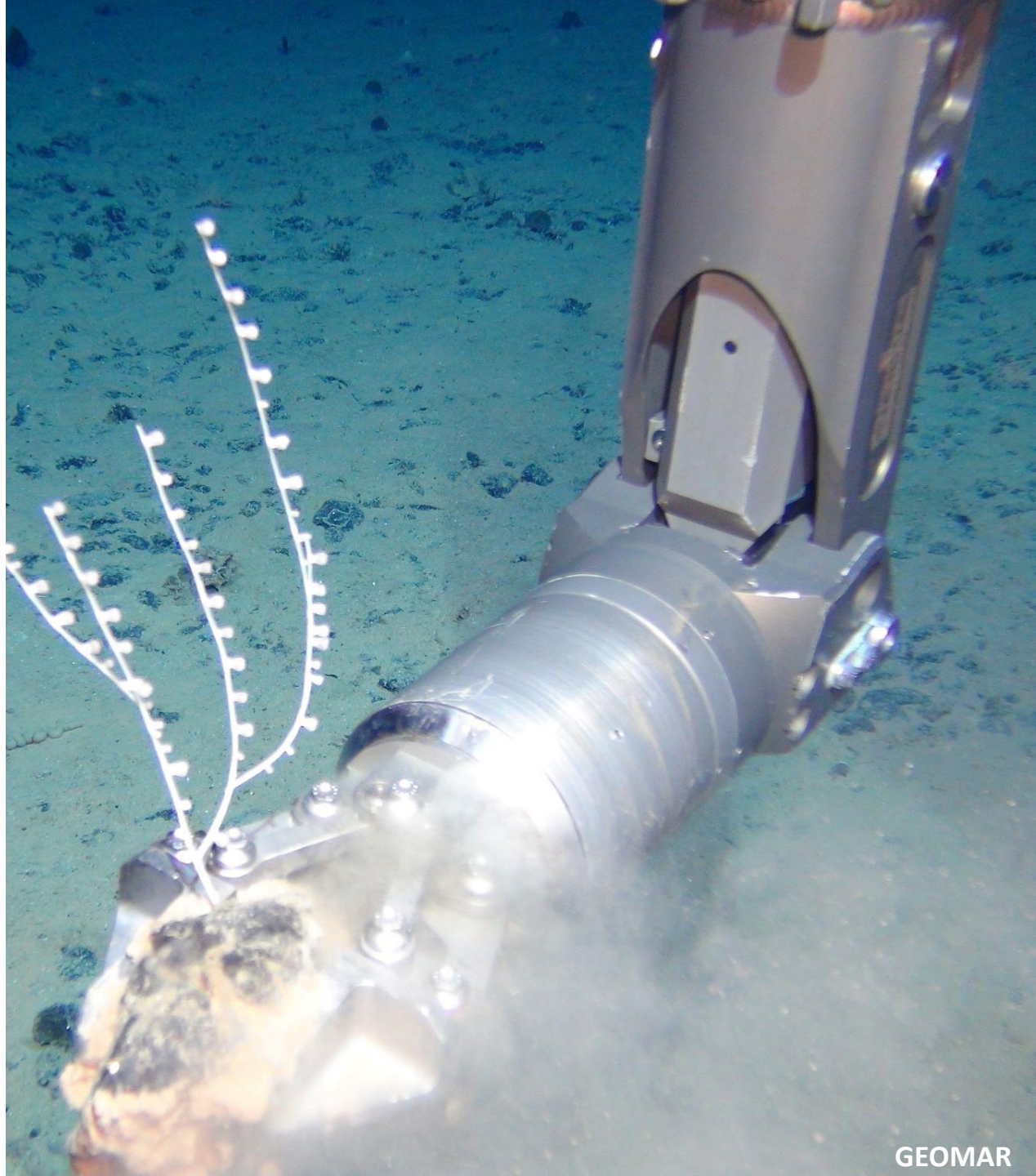
APEI 9
APEI 11
Spatial Reference
GCS: GCS WGS 1984
Datum: WGS 1984
Map Units: Degree
0
500
1,000
2,000 Kilometers

Summary

- Nodule fields **are hyperdiverse ecosystems**, with high variability at local spatial scale
- Provide a number of **ecosystem services**
- Many species **depend directly or indirectly on the nodules**
- The biodiversity, functioning, resilience and variability are **far form being fully understood**.

- **The effects** of mining activities are expected to be **long lasting**, ranging from decades to centuries. **Some will be permanent**

- **The current knowledge does not permit a responsible management** of the industriy that ensures protection



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IMPACTS AND RISKS OF DEEP SEA MINING
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