

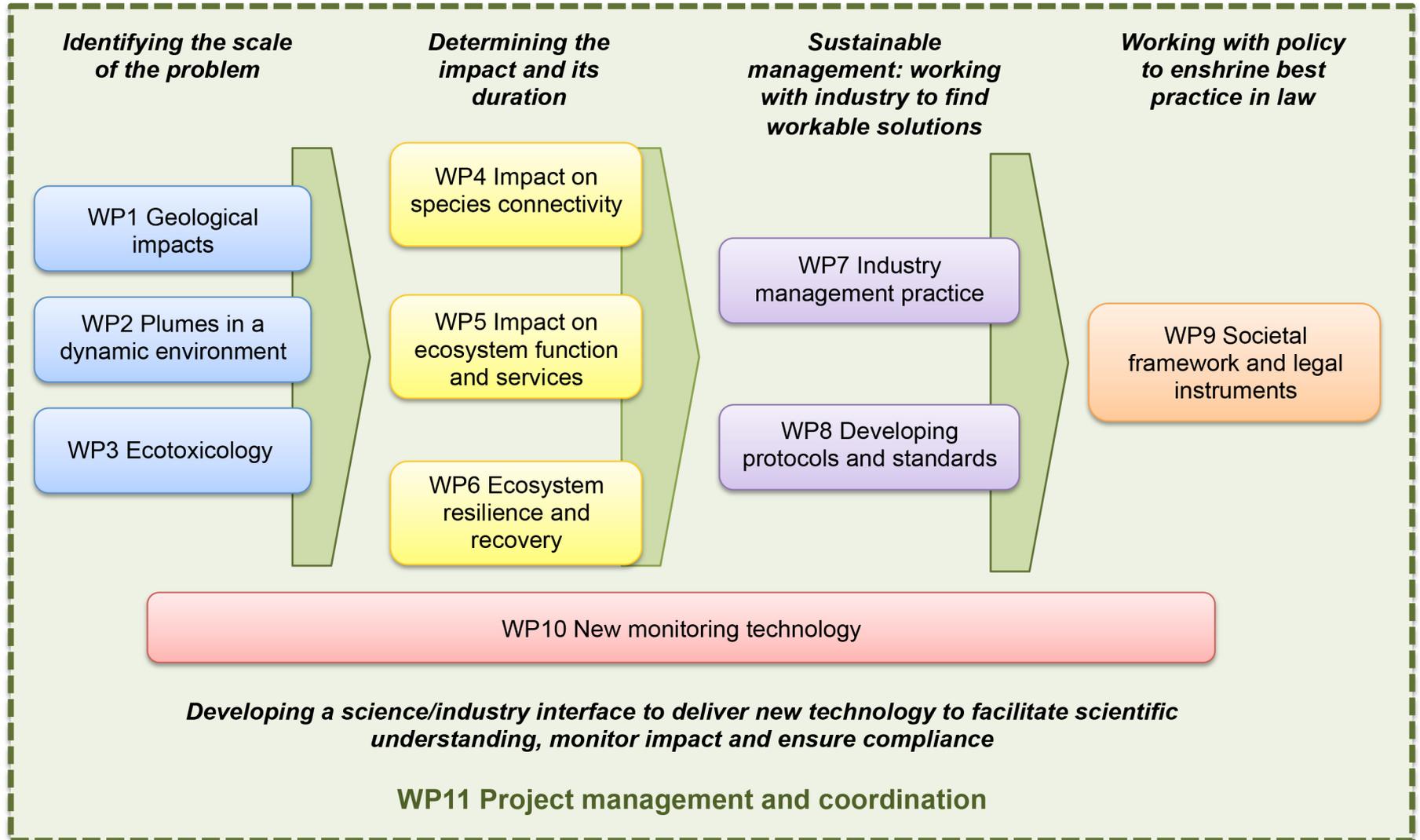
# **Environmental Impacts of Deep Sea Mining – Final Results & Recommendations of the MIDAS Project**

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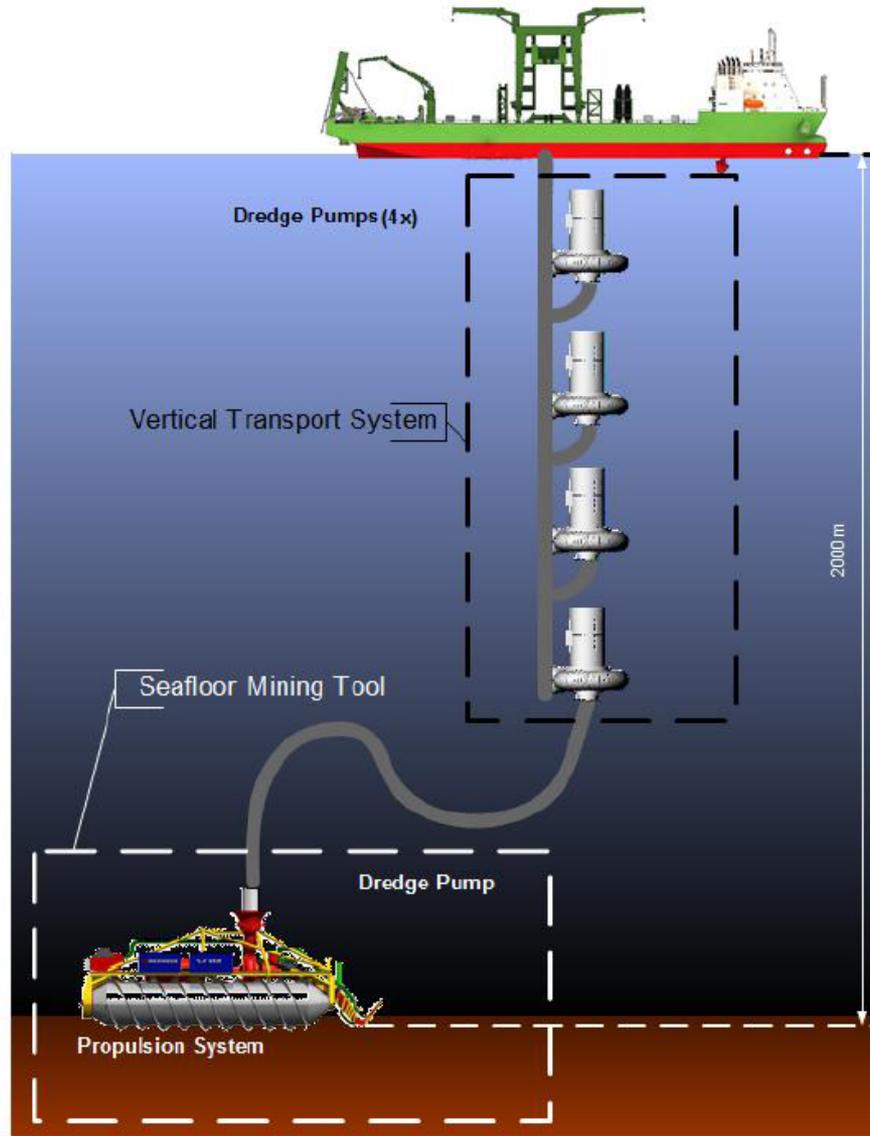


Offshore & Deep Sea Mining Conference, London 28 and 29 November, 2016

# MIDAS Work Programme



# Environmental impacts of Deep-sea Manganese Nodule Mining



Emissions, waste from ore processing

Light, pollution from ship

Trans-shipment plume

Returned water plume

Noise, vibration

**Large area impacted  
(connectivity, ecosystem  
function, recovery etc)**

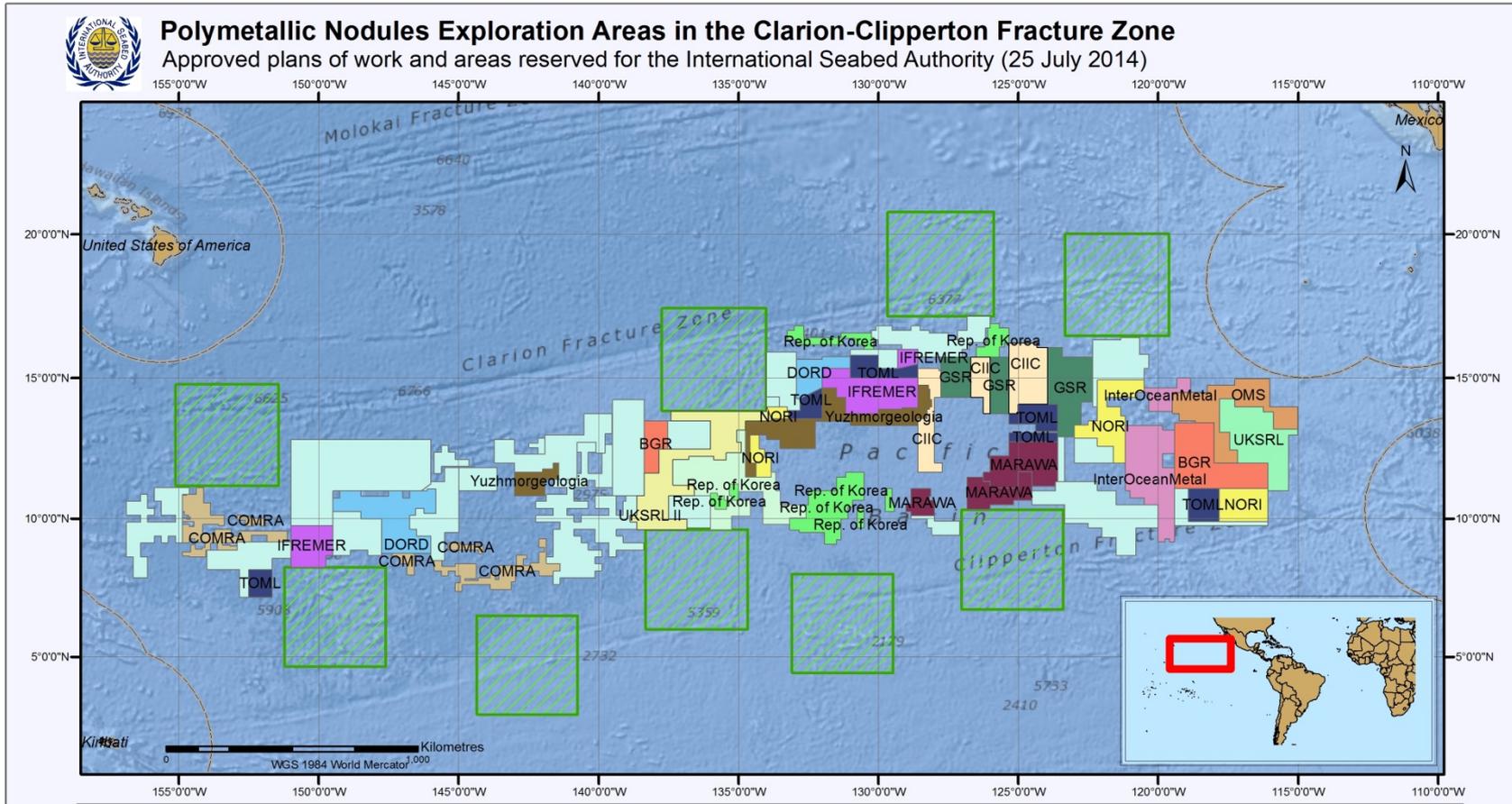
**Generation of benthic plume**

**Substrate removal (nodules)**

**Re-deposition of surficial sediment  
layer**

**Sediment compaction**

# Licence blocks and APEIs in the Clarion Clipperton Zone

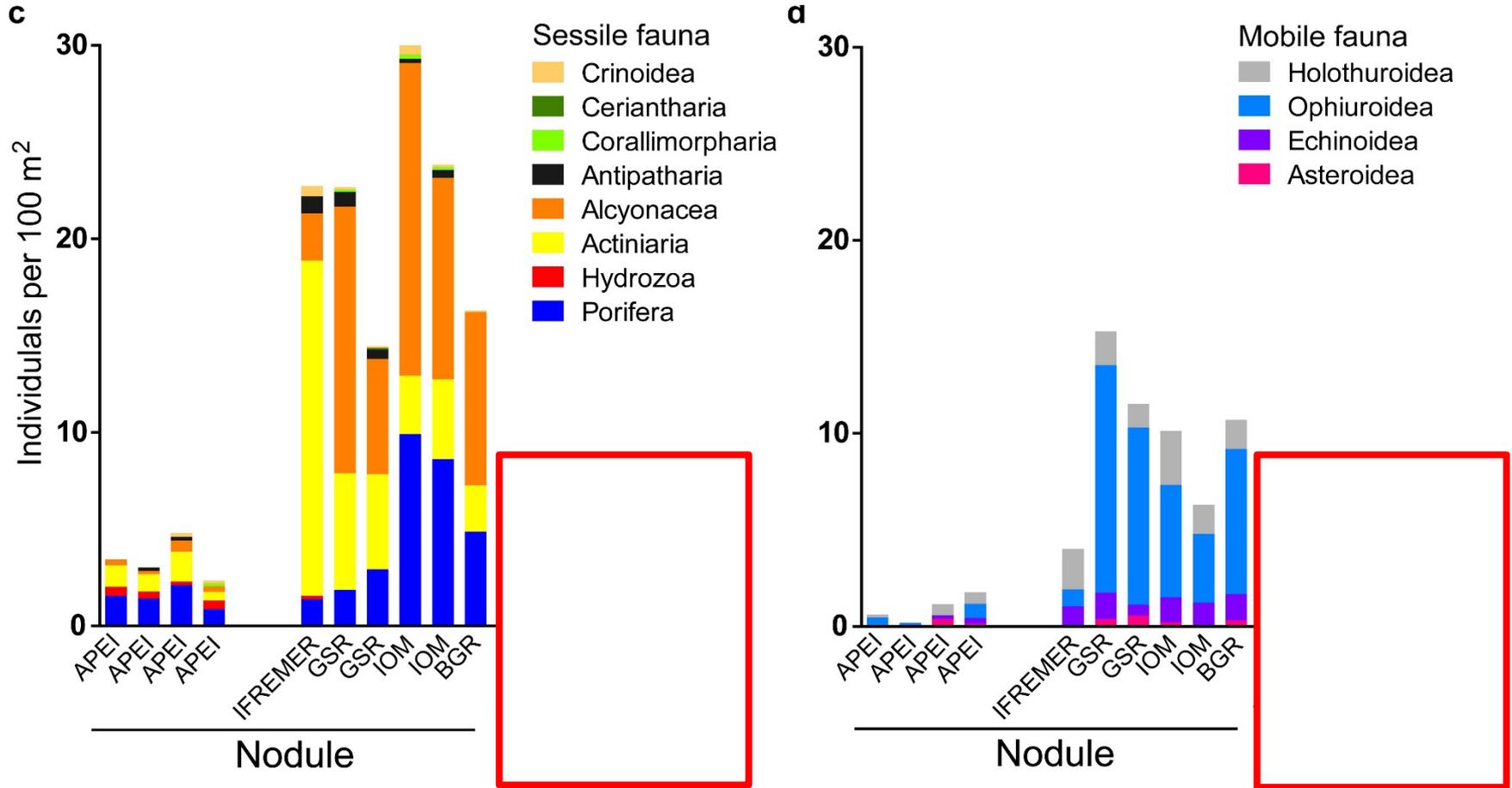


16 signed contracts (1 waiting signature)  
Total area for exploration 1.2 million km<sup>2</sup>

# Summary of comparison of land based and deep-sea mining footprints per million tons of ore

<b>Deep sea mining activity</b>	<b>Deep-sea area required per million tons mined ore</b>	<b>Area required to produce same products on land</b>
Nodule mining	83 km <sup>2</sup>	0.52 km <sup>2</sup>
Cobalt crust mining	12.8 - 38 km <sup>2</sup>	0.66 km <sup>2</sup>
SMS mining	0.054 km <sup>2</sup>	0.12 km <sup>2</sup>

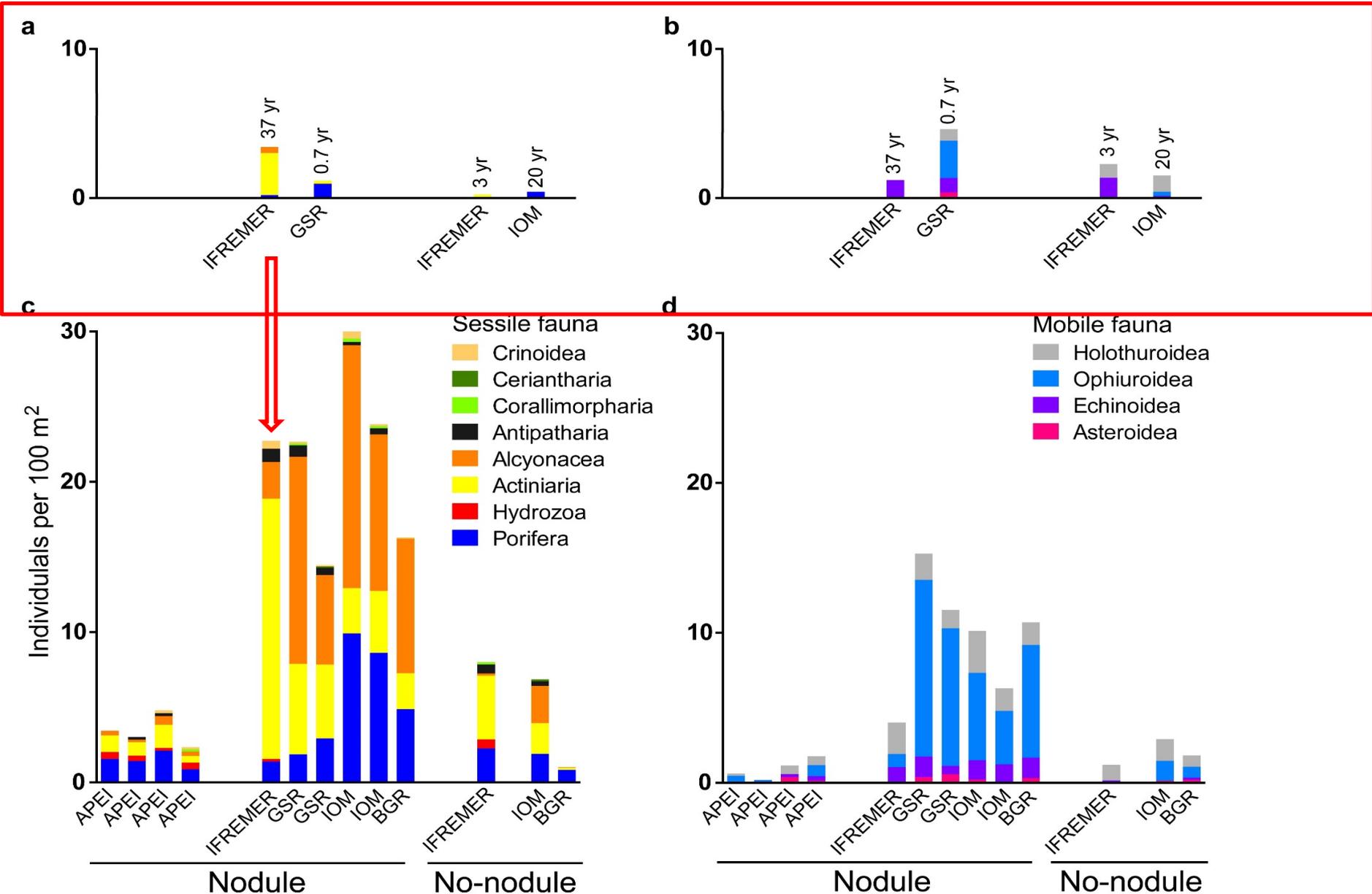
# Nodule rich areas vs nodule poor areas

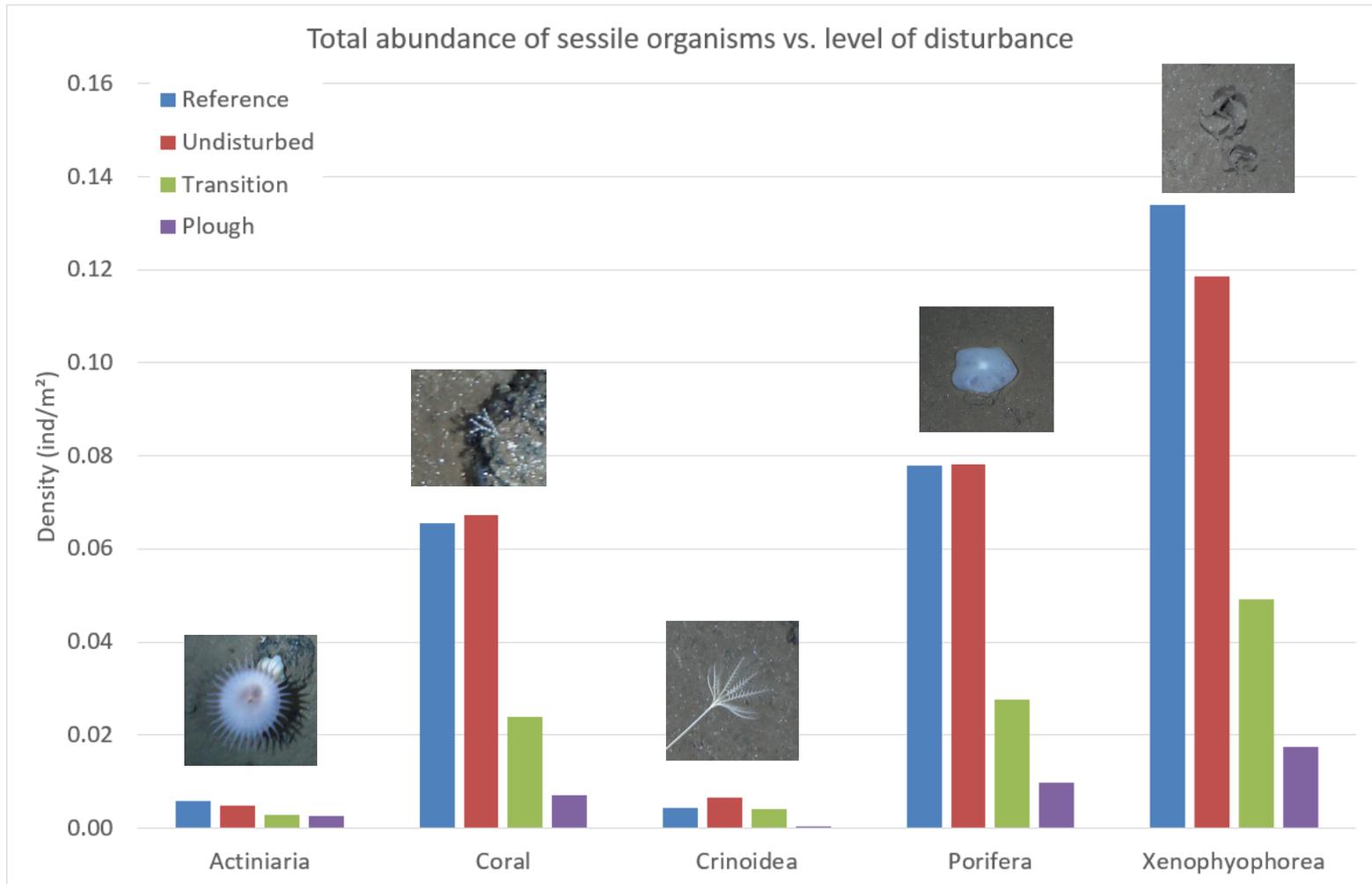


**Low densities megafauna in APEI**

**Low densities megafauna in nodule poor areas**

# Reduced densities in experimental tracks





## Sessile megafauna:

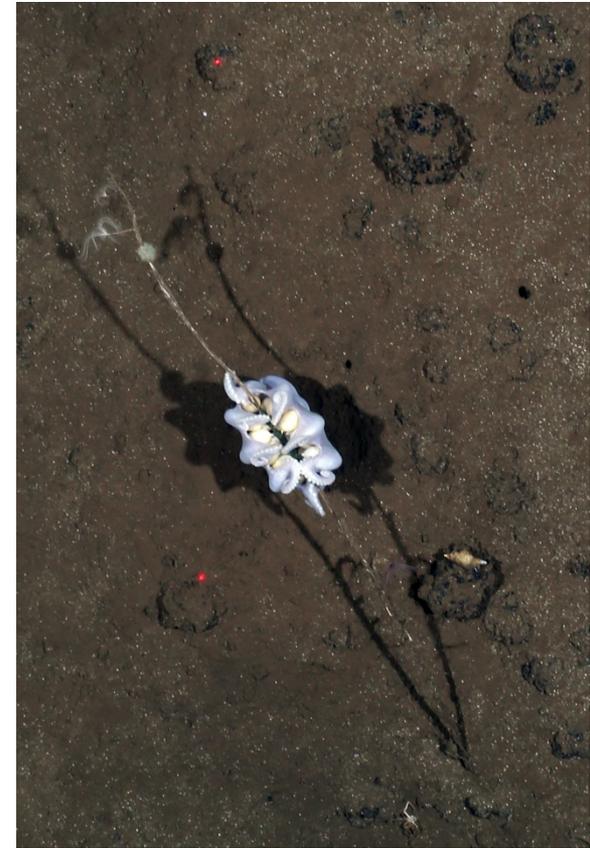
- > Sessile megafauna strongly affected by disturbance (even after 26 years)
- > Recovery likely hindered by the lack of hard substrate (nodules)



Sponges colonising dead sponge stalk, along with amphipods, isopods, barnacle.



*Graneledone* sp. deep sea octopi brooding eggs on dead sponge stalks.

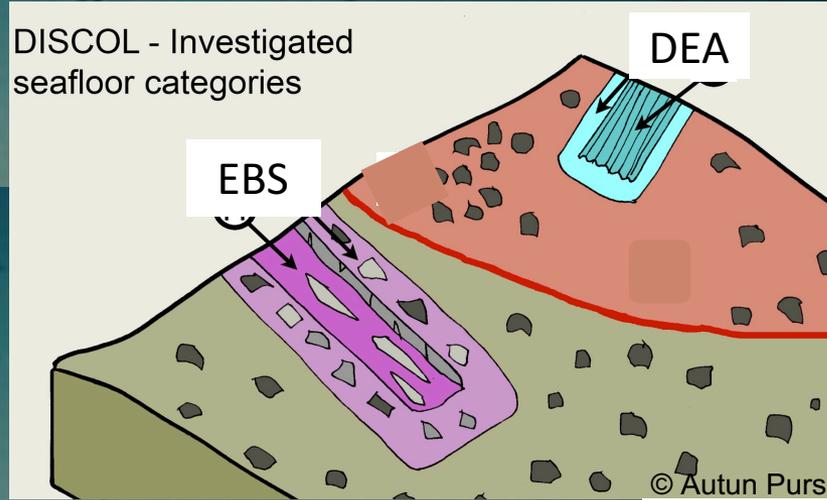


-> Stalks and the nodules they attach to are a required niche for species (protection, exposure to oxygenated water?)

-> Almost no stalks in ploughed areas

# Sampled microhabitats

5 weeks  
before  
sampling



26 years  
before  
sampling



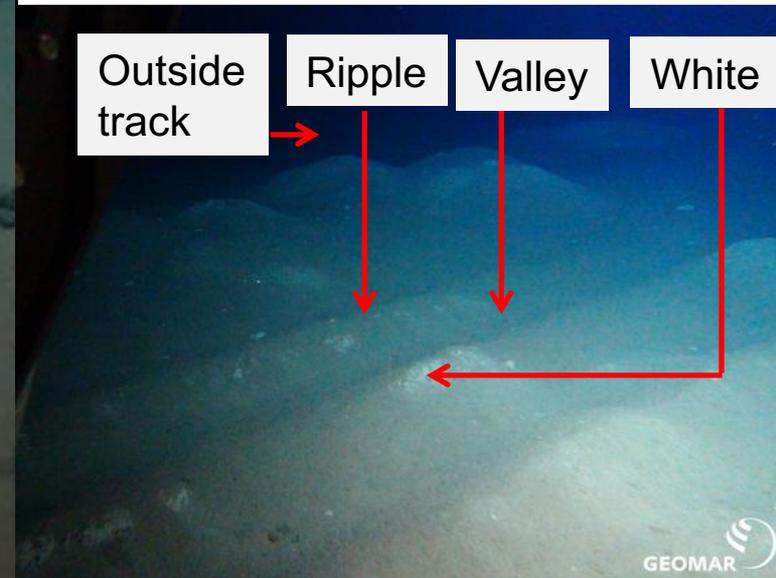
Reference



EBS



DEA: plough harrow

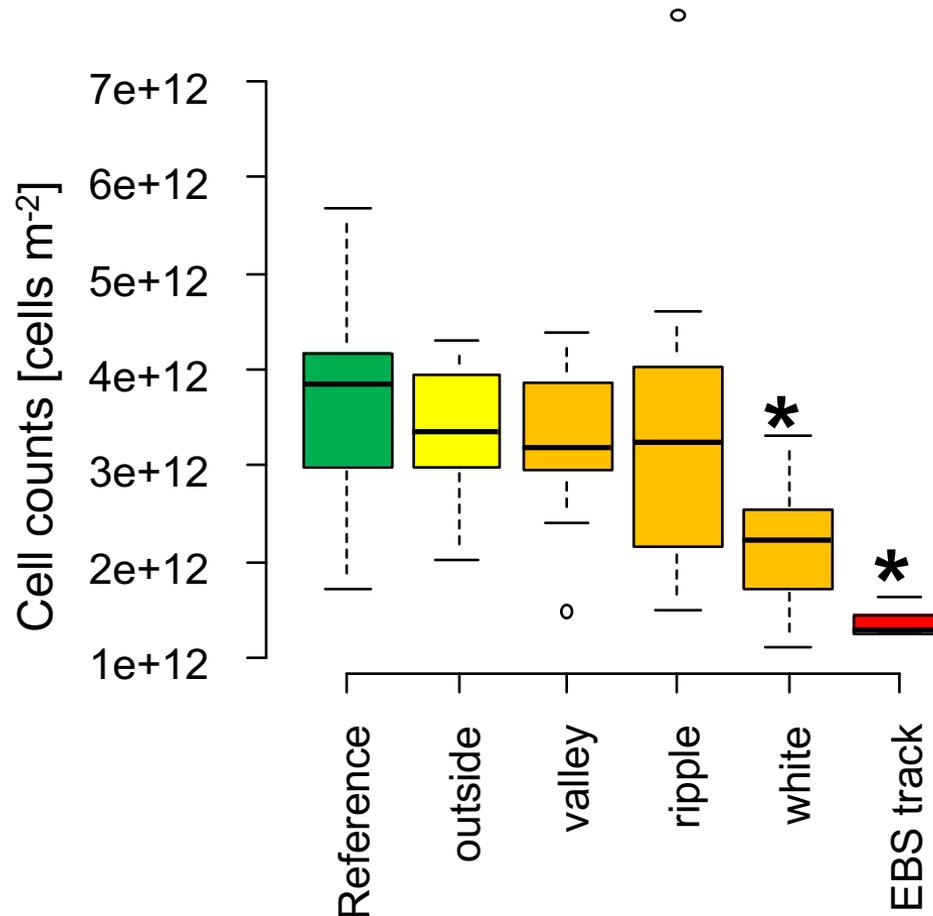


# Microorganismsim abundance (total cell counts)

Cell numbers decreased by a factor of 2-4, where surface sediment is removed

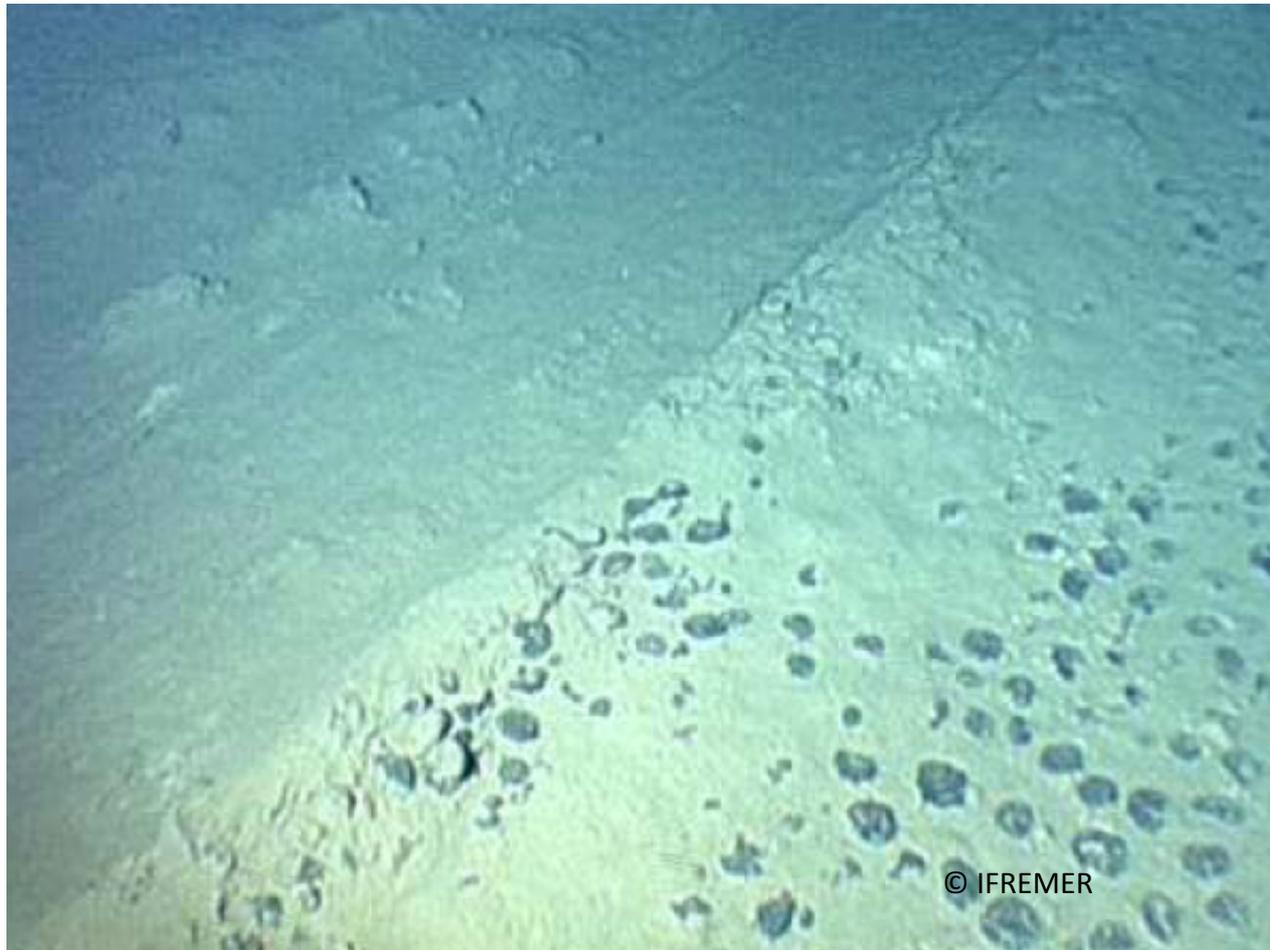
No full recovery after 26 years

Cells removed by removal of the surface sediment layer



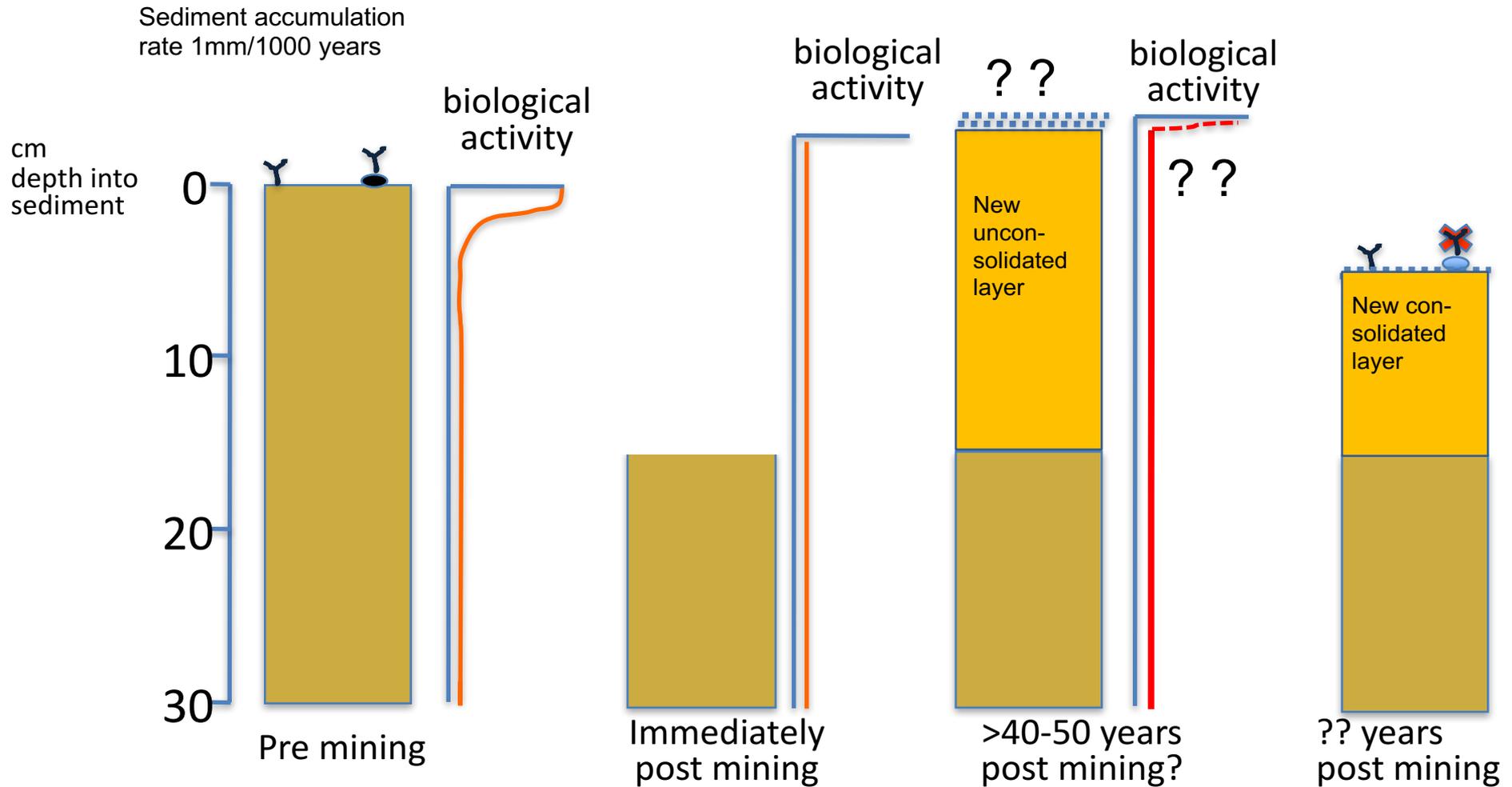
# Extremely slow recovery of ecosystems

This area in the French claim in the Clarion Clipperton Zone was dredged 26 years before this photograph was taken.



© IFREMER

# Biological recovery in areas of manganese nodules subsequent to mining



Vertical section through upper few centimetres of seabed

# Why is this loss of habitat and poor recovery important?

## UNCLOS Article 145

### **Protection of the marine environment**

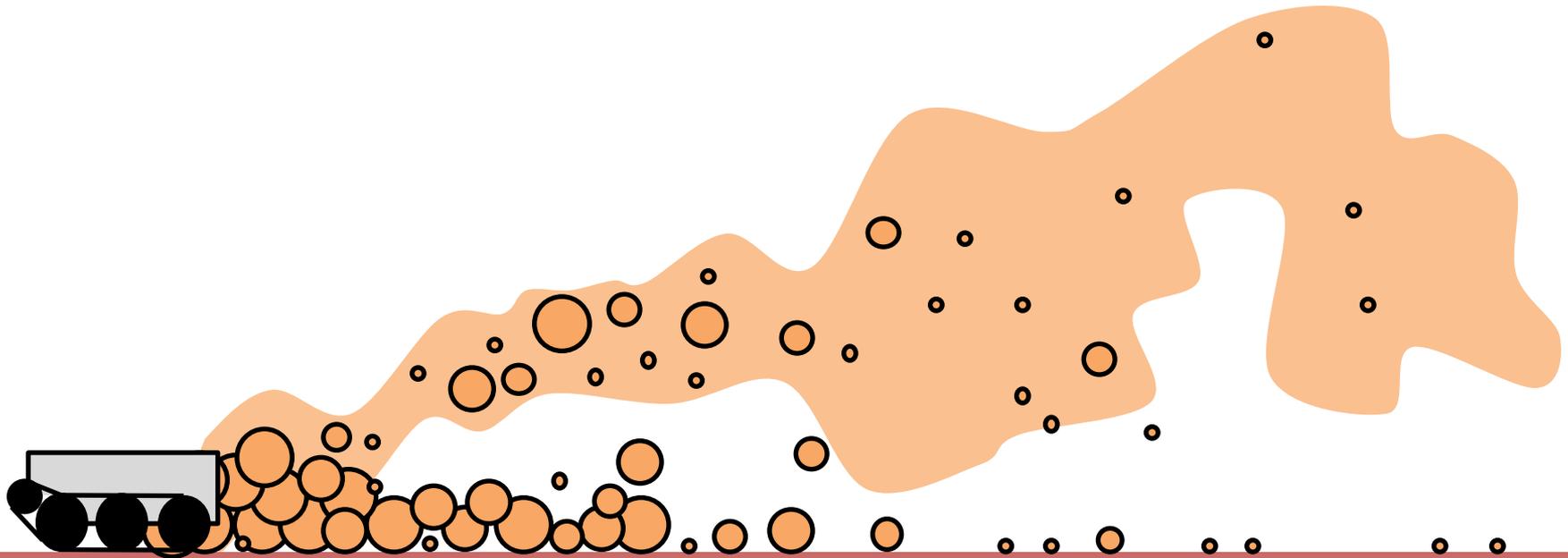
Necessary measures shall be taken in accordance with this Convention with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities.

To this end the Authority shall adopt appropriate rules, regulations and procedures for inter alia :.....

.....(b) the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment.

# Impact of Plumes

- Clouds of sediment laden water generated by the collector vehicle
- Dewatering of ores on the ship will also generate a plume that will be added to the ocean
- Will contain particulates and may contain toxic chemicals

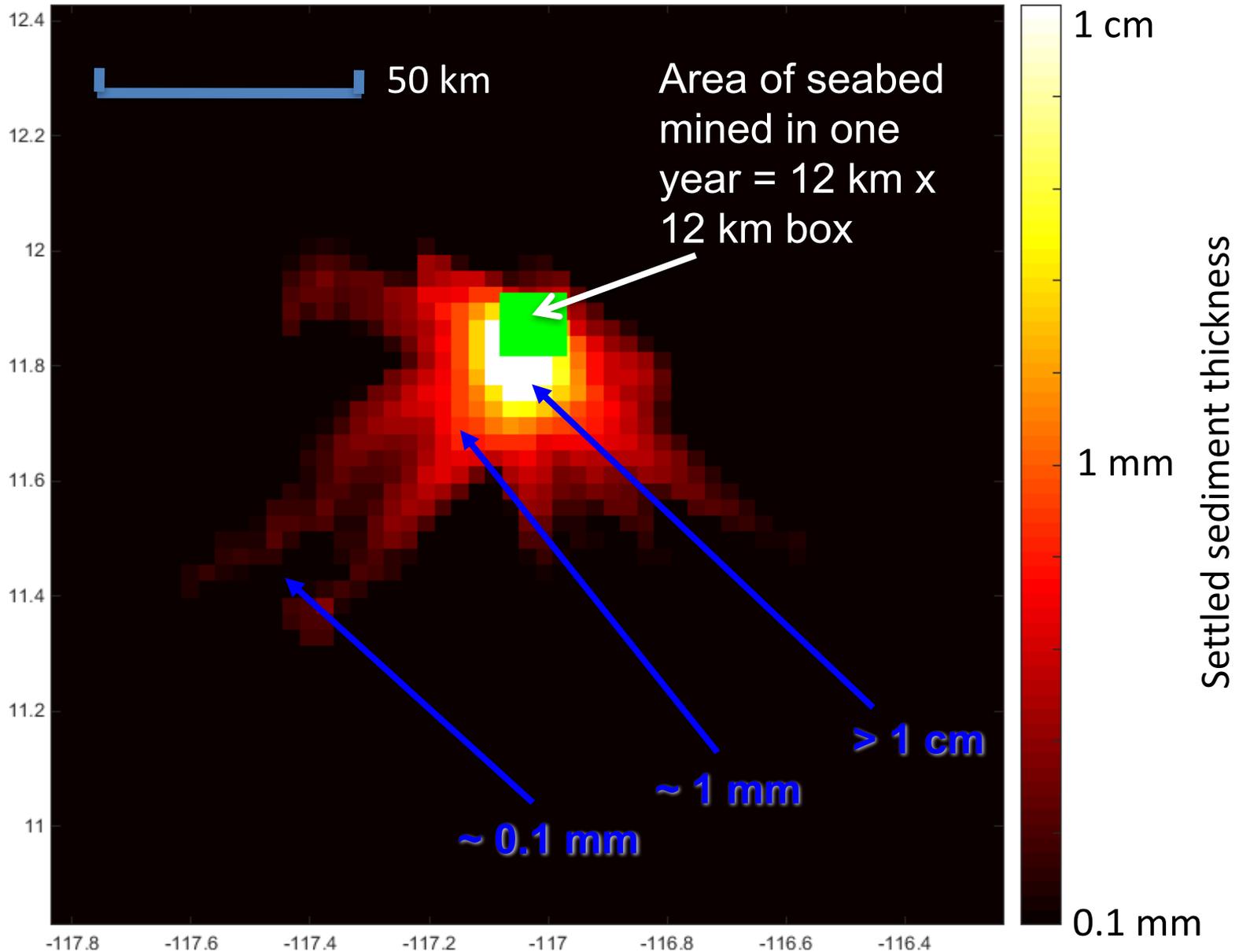


323 days

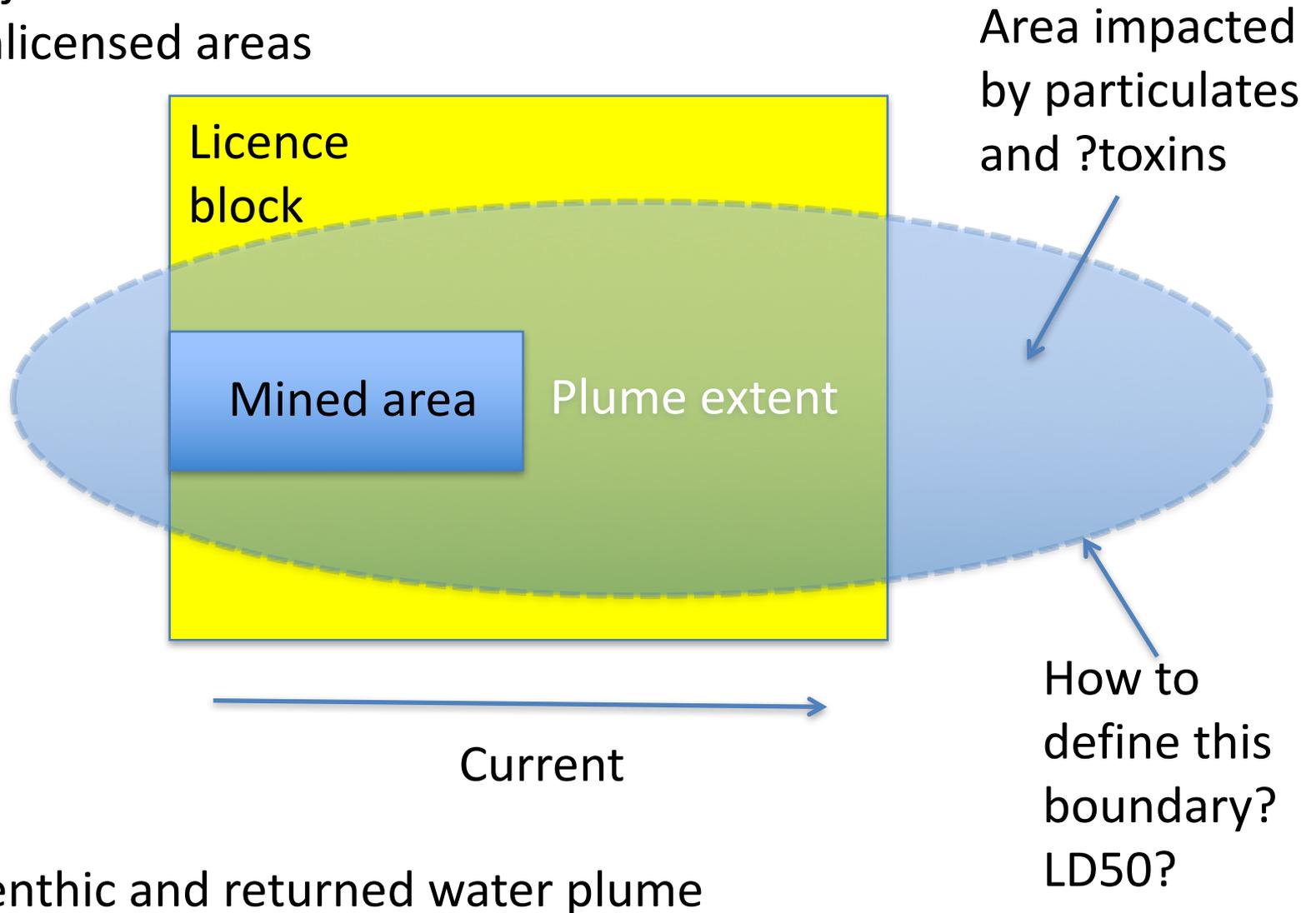
$$k_x = 0.1 \text{ m}^2 \text{ s}^{-1}$$

$$k_z = 10^{-4} \text{ m}^2 \text{ s}^{-1}$$

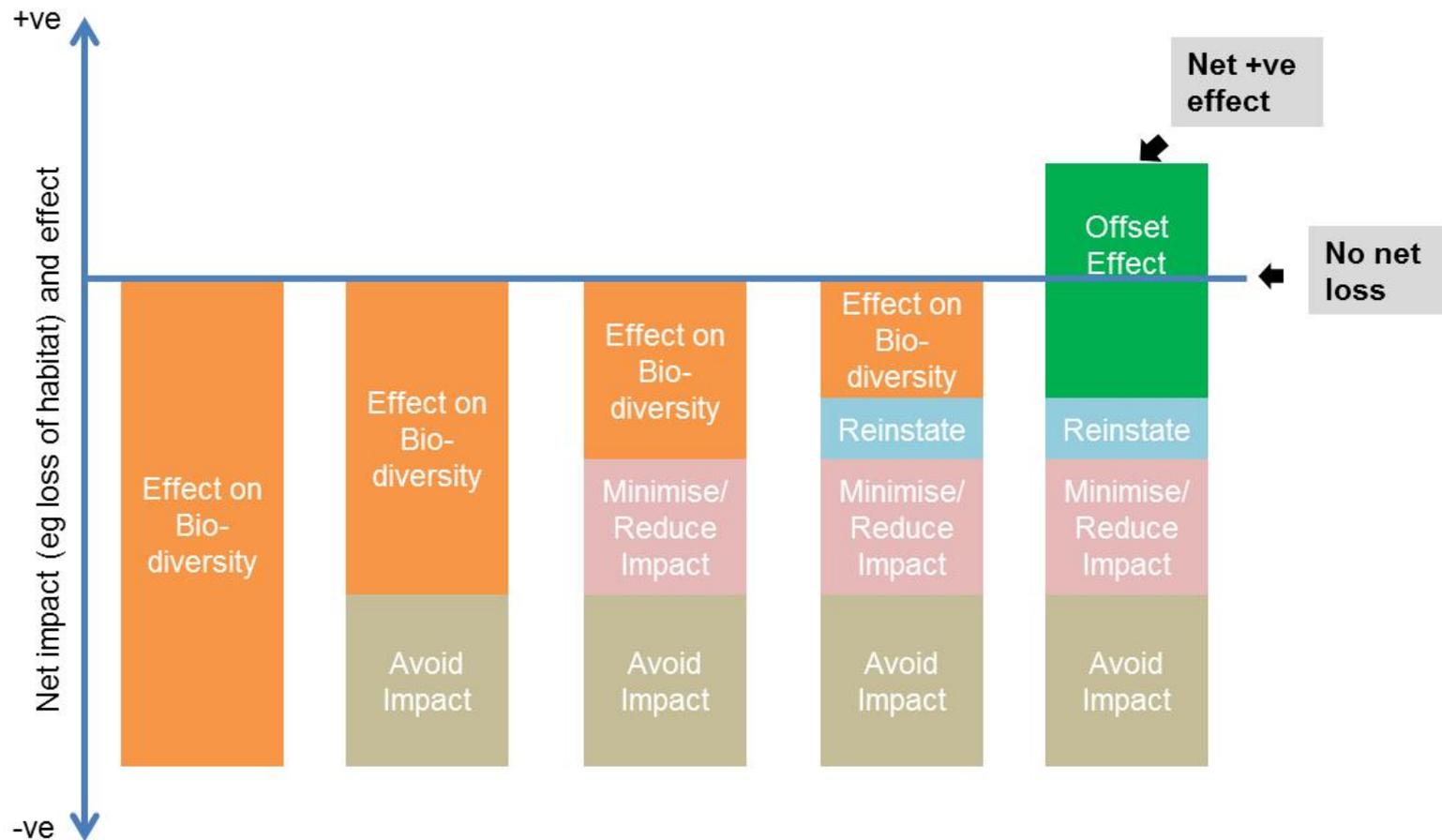
Area of seabed that could be affected by a plume resulting from a single year of mining



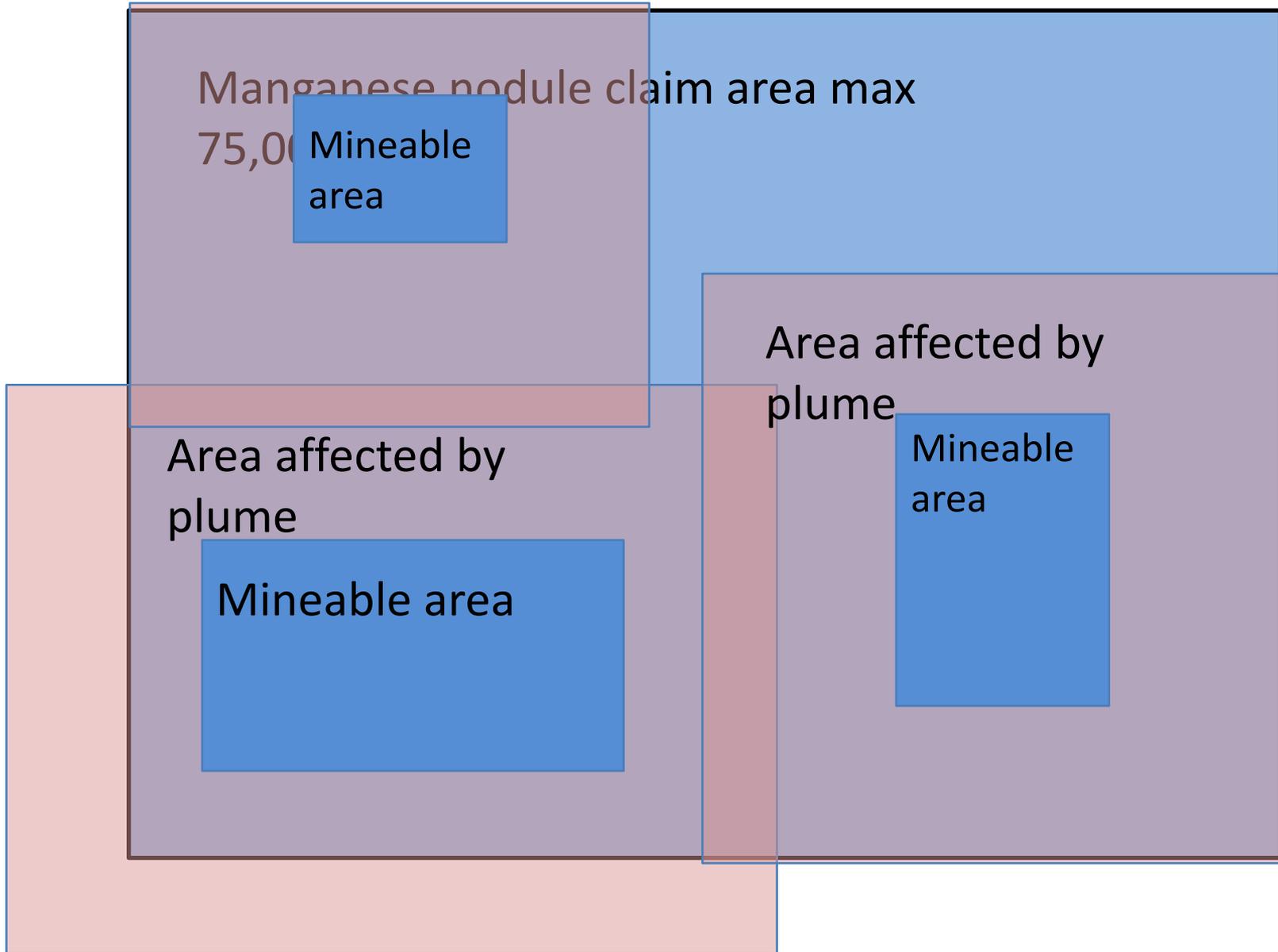
Who will be responsible for measurements  
In the licence block  
In adjacent licence blocks  
In unlicensed areas



# The 'Classic' EIA Mitigation Hierarchy



# Potential aerial impact of plumes on the seabed

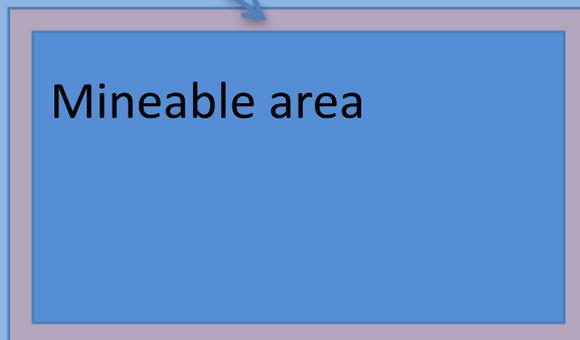


# Potential aerial impact of plumes on the seabed

Manganese nodule claim area max  
75,000 km<sup>2</sup>

Could the uneconomic parts of  
the claim be identified for all  
contractors and included in the  
strategic environmental  
management plan for the CCZ?

Area affected by  
plume



Area affected by  
plume



# Areas of Particular Environmental Interest (APEIs)

In 2012, the ISA Council approved an environmental management plan for the Clarion Clipperton Zone (CCZ), including a network of nine APEIs, in total covering an area of 1.5 Million km<sup>2</sup>, noting the need for a 'comprehensive environmental management plan at the regional level'.



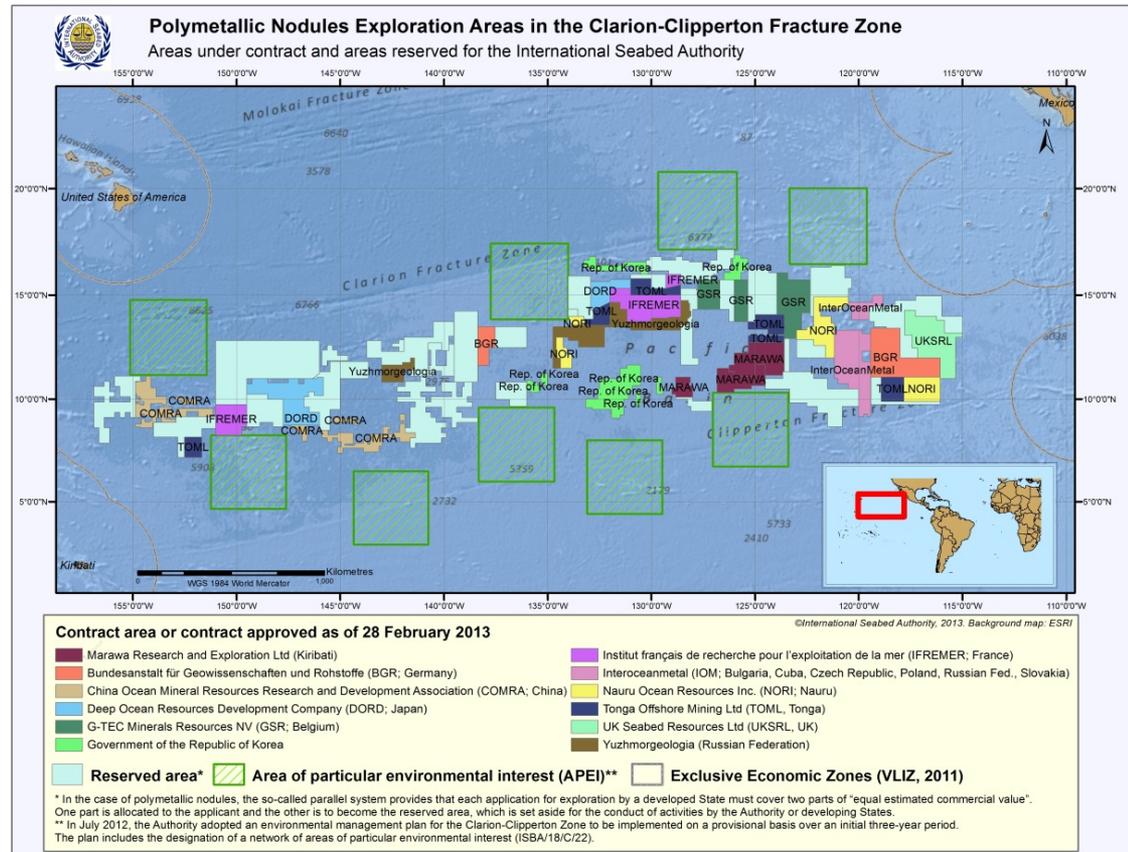
*Psychropotes longicauda* (source Ifremer)



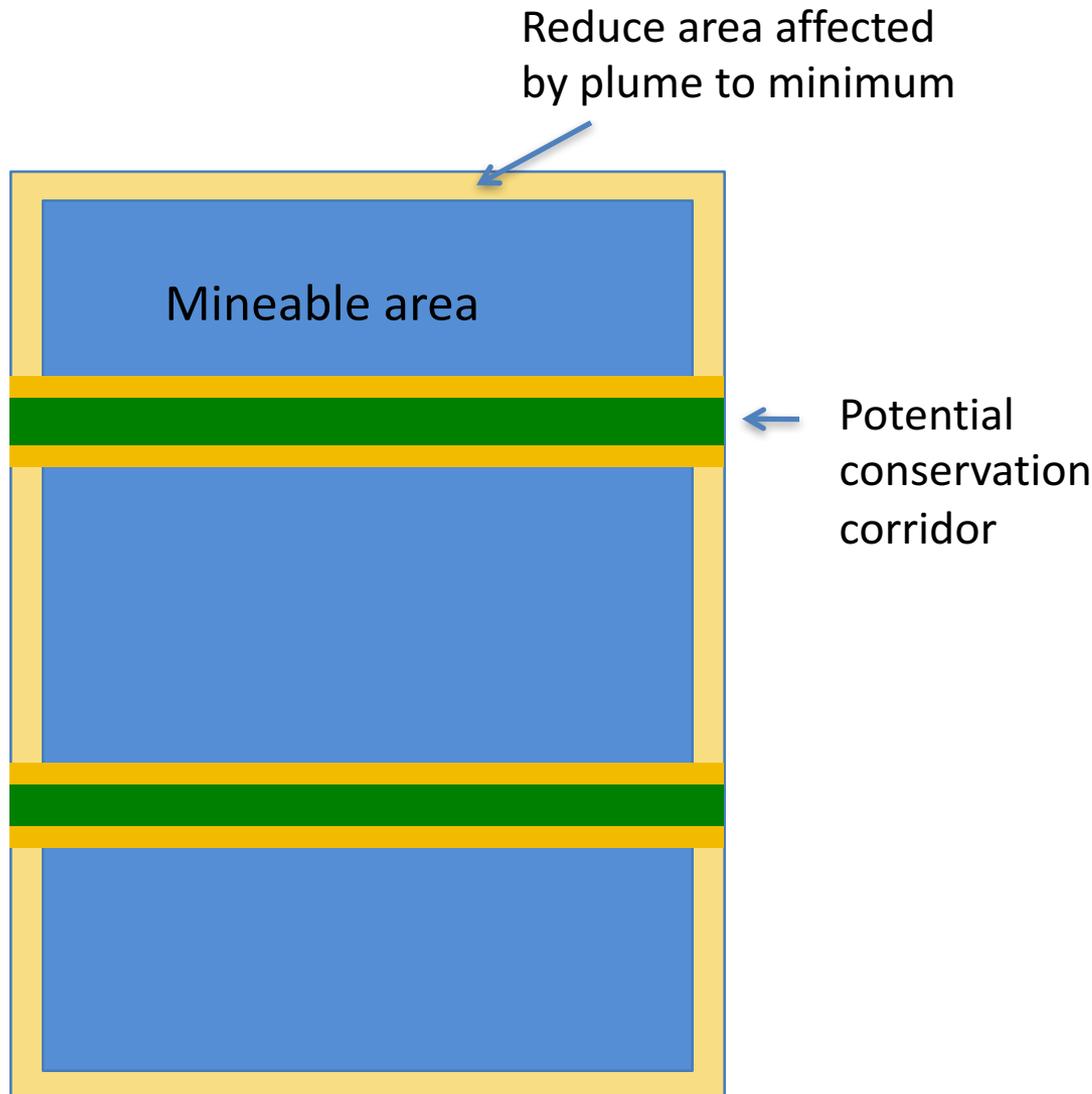
©Ifremer



©DZMB



# Potential actions that may reduce impact to benthic ecosystems and/or speed recovery in nodule areas

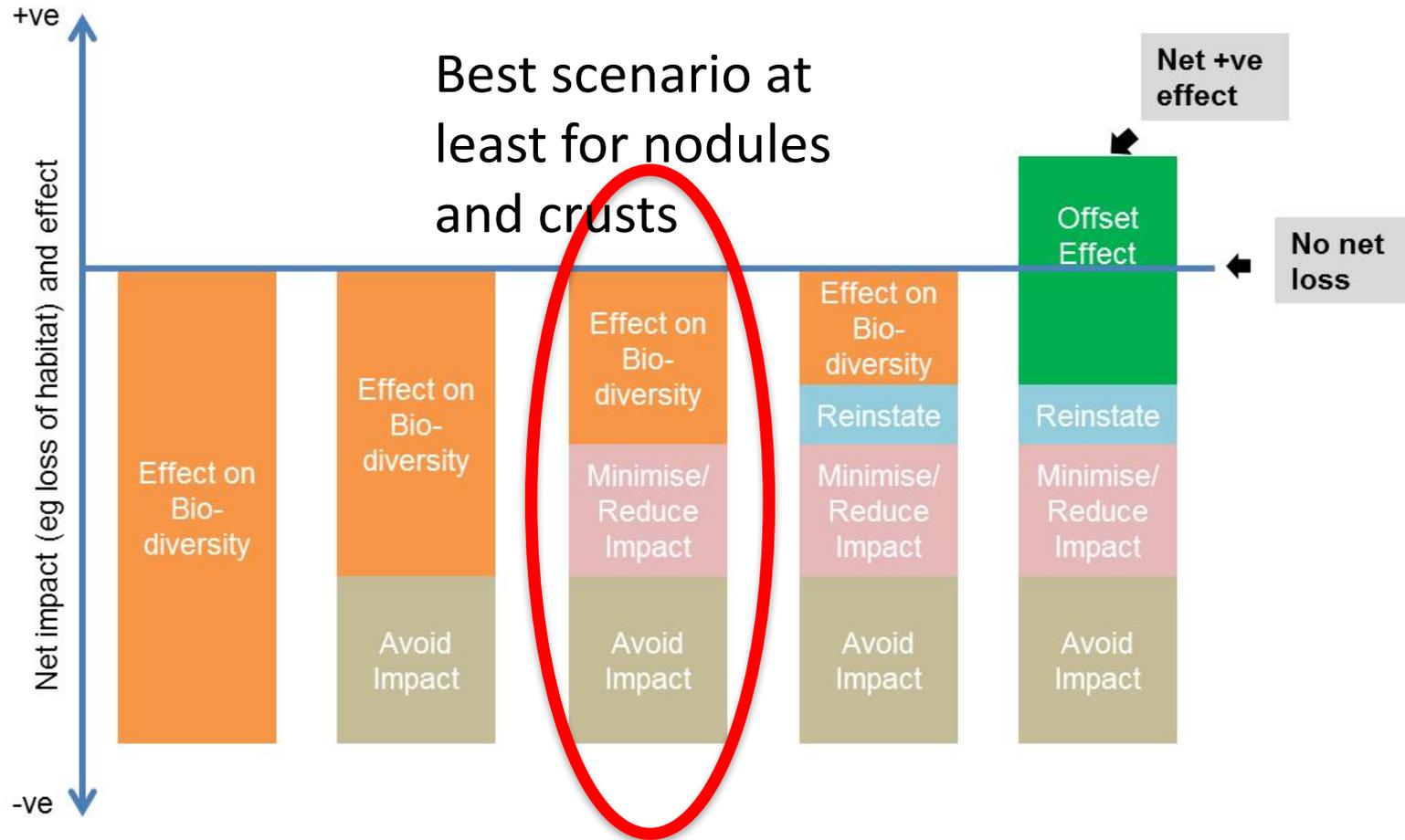


## Other potential actions

- De-compact sediment behind the collector (??)
- Compact the returned sediment?
- Leave some nodules behind on the seabed (the largest and/or smallest?)
- Add fabricated nodules e.g. using waste manganese
- Experiment with adding small amounts of organic material to kick start the recovery

All the above need research to determine their effectiveness.

# The 'Classic' EIA Mitigation Hierarchy



## Conclusions

1. The areal impact of mining nodules and crusts will be large in comparison to mines on land or to polymetallic sulphide mining
2. The impacted areas could become very large if plumes are not reduced to a minimum through smart engineering design
3. Recovery of ecosystems at nodule and crust mining sites is likely to be very slow (several tens to hundreds of years or even more)
4. Some mitigation measures may be possible but much more research is needed to understand whether these would be effective