Significant, Serious and Sobering: Defining Serious Harm and Harmful Effects from Seabed Mining

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DEEP OCEAN OBSERVING STRATEGY

Acknowledgements

Two DOSI Workshops

1. March 2014. Scripps. ***Defining 'Significance' in Environmental Impact Assessment for Deep-sea mining.***

1. Feb. 2017. Scripps. **Review of the *ISA Discussion Paper on the development and drafting of Regulations on Exploitation for Mineral Resources in the Area (Environmental Matters)*** *(EREGS)*

36 Total Participants: *Those in bold attended both*

Jeff Ardron, Claire Armstrong, Maria Baker, Dave Billett, Rachel Boschen, Joseph Brider, Malcolm Clark, Amber Cobley, Bronwen Currie, Elizabeth DeBlois, Elva Escobar, Natalya Gallo, Andrey Gebruk, Matt Gianni, ***Kristina Gjerde****, Aline Jaeckel,* Megan Jungwiwattanaporn, *Jennifer Le,* ***Lisa Levin****, Hannah Lilly, Prideel Majeidt, Kathryn Mengerink, Anna Metaxas, Sandor Mulsow, Barry Obiol, Raewyn Peart,* ***Eva Ramirez,*** *Ashley Rowden, Dale Squires,* ***Craig Smith,*** *Alison Swadling, Andrew Sweetman, Verena Tunnicliffe,* ***Cindy Van Dover,*** *Ray Wood.*

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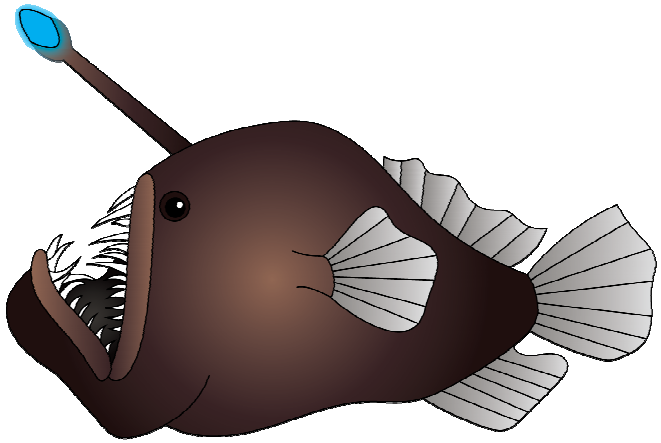
Let's get *Serious*

(about serious harm)



I. What's all the fuss?

The legal and scientific imperative for thresholds

II. What's the problem?

Challenges to operationalizing the concepts

III. Harm to what?

The need for environmental objectives

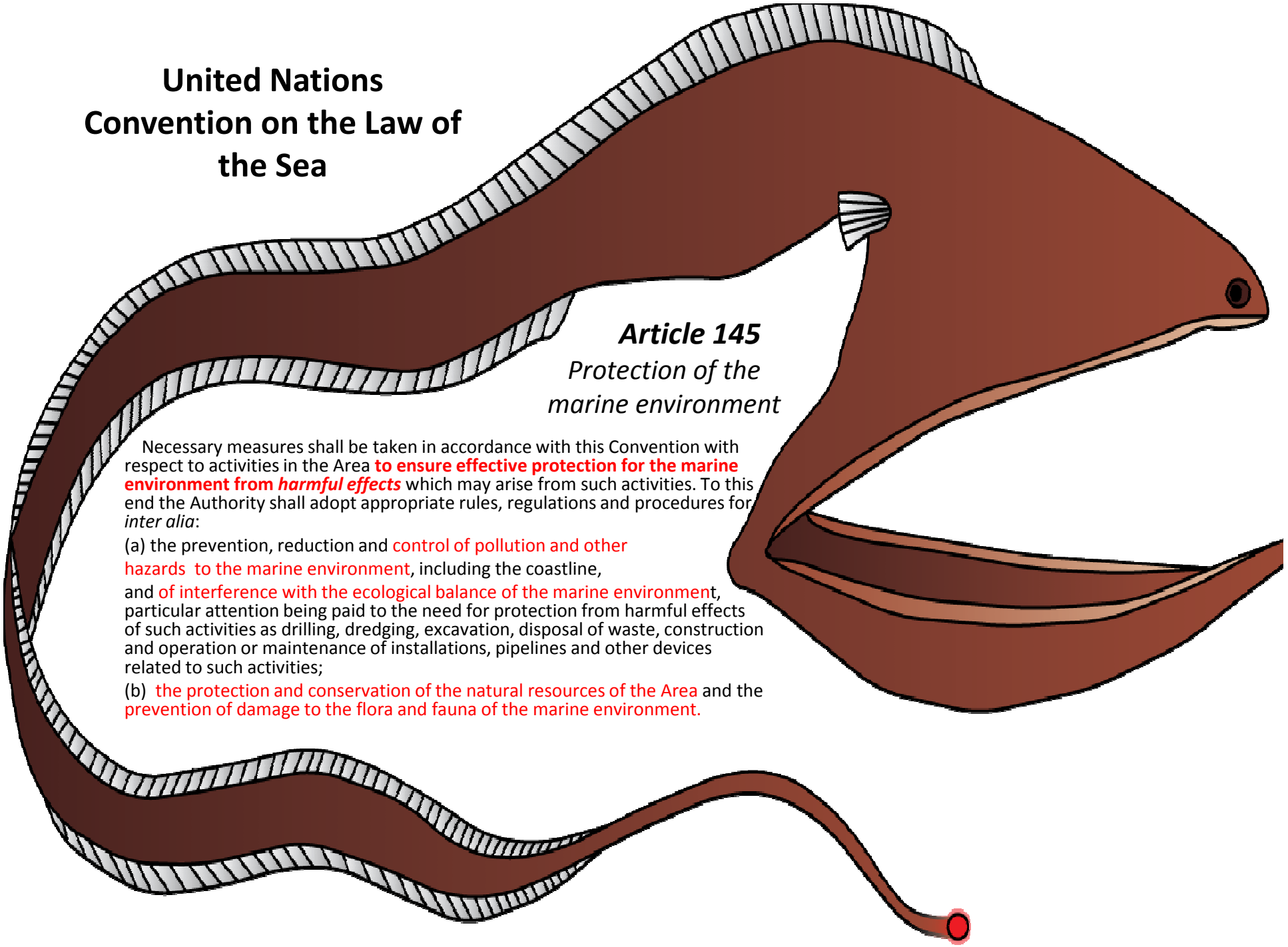
IV. What's at stake?

What is there, what are the impacts and what will be lost?

V. Operationalizing Serious Harm

Two thresholds? Space, Time and Cumulative Impacts

United Nations Convention on the Law of the Sea



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*:

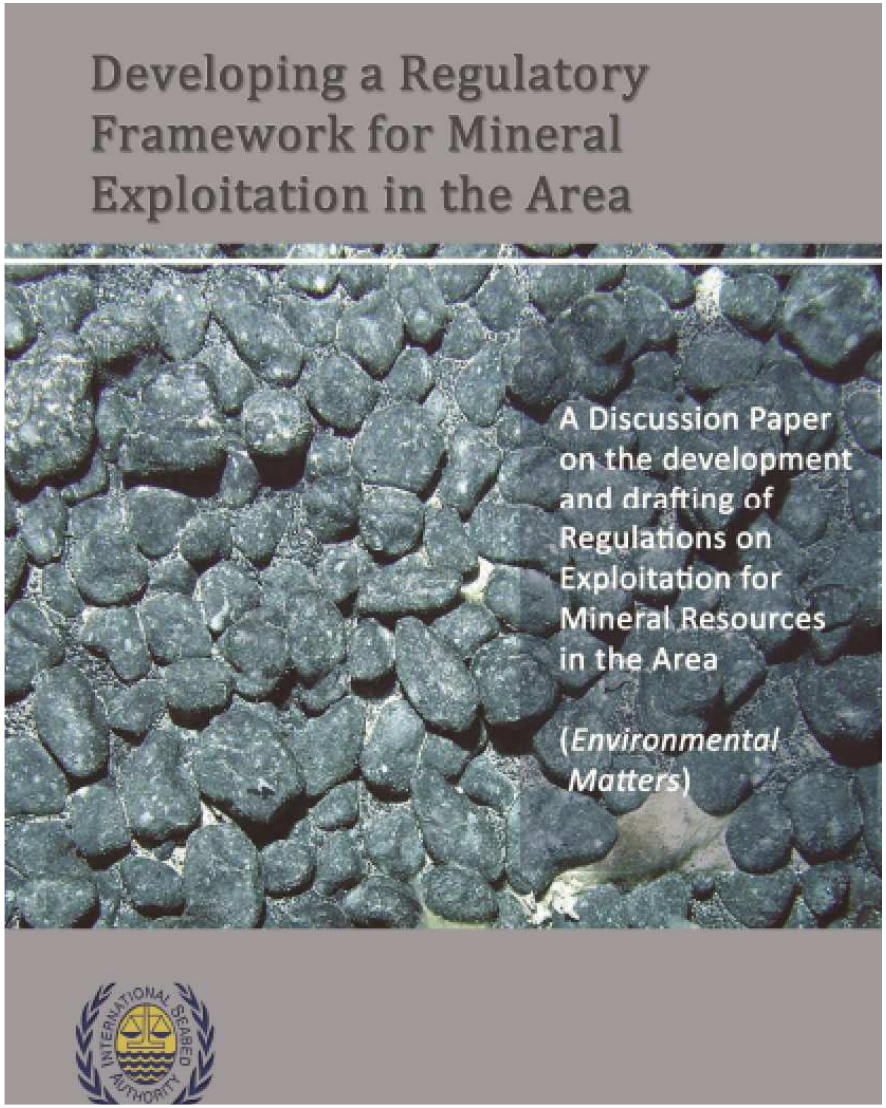
(a) the prevention, reduction and control of pollution and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities;

(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.

According to UNCLOS
The risk of *serious harm* should:

- Induce the Council to disapprove areas for exploitation - ie deny application for a new contract [art 162 (x), 165 (l)]
- Cause areas to be set aside for no mining
- Induce emergency orders to suspend, adjust or terminate mining [art 162(w)' 165 (k)]
- Hold the contractor and its sponsoring state liable for any environmental harm

There may be no more ubiquitous concept in the ISA (Regulatory Framework) Discussion paper on Environmental Matters



Serious harm appears in the discussions of:

- The precautionary approach
- Emergency dumping and discharges
- Environmental Risk Assessment
- Environmental Impact Statement
- Financial Guarantee/Security
- VMEs
- Monitoring
- Best Available Scientific Evidence
- Unforeseen incidents
- Emergency orders
- Environmental protection measures

Definition of Serious Harm

ISA DRAFT (Regulatory Framework) Discussion Paper on Environmental Matters

"Serious Harm to the marine environment" means any effect from activities in the Area on the Marine Environment which represents a *Significant Adverse Change* in the Marine Environment determined according to the rules, regulations and procedures adopted by the Authority, on the basis of Internationally Recognized Standards and Practices. *

*The operationalization of "serious harm" is a Priority Deliverable.

What is the *marine environment*?

- **"Marine Environment"** includes the physical, chemical, geological and biological and genetic components, conditions and factors which interact and determine the productivity, state, condition and quality and connectivity of the marine ecosystem*(s)*, the waters of the seas and oceans and the airspace above those waters, as well as the seabed and ocean floor and subsoil thereof.

Working Draft Regulations and Standard Contract Terms on Exploitation for Mineral Resources in the Area July 2016

What’s the problem?

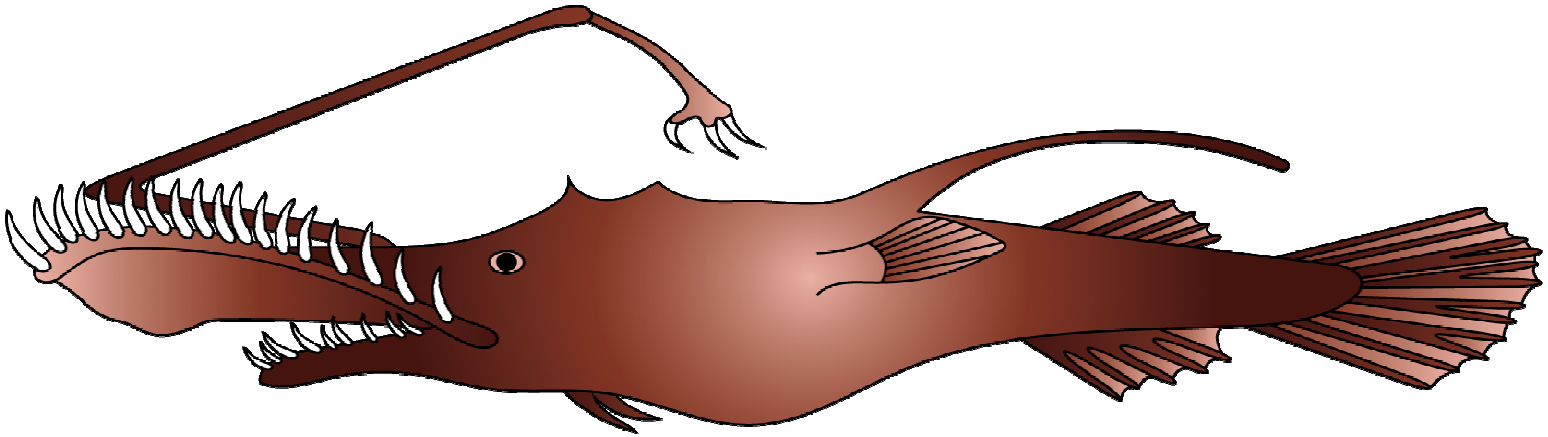
Mining causes *Serious Harm*

So how can we operationalize this term in the context of seabed mining operations?

- Authorize a fixed amount of harm?

  How much is acceptable??

- Identify thresholds and triggers
- Recognize context dependence
- Incorporate cumulative impacts.



Is there a second (lower) threshold - for harmful effects?

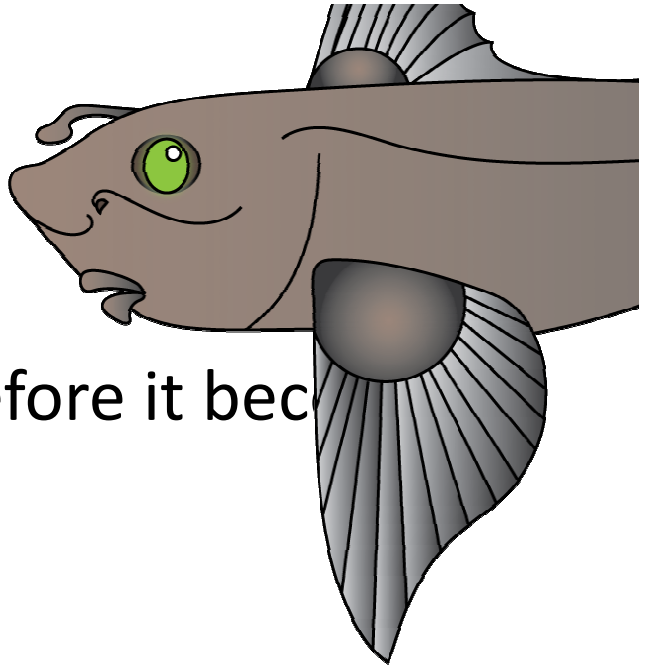
Two thresholds could pertain.
A threshold for granting a mining contract (prevention of harmful effects)
AND
A threshold for altering/halting/stopping operations and triggering liability (serious harm).

One threshold could be sufficient.
A contract could be granted if the applicant has taken all reasonable steps to prevent serious harm and that serious harm is unlikely to result from the operations. If, once operations have commenced, serious harm does occur, the operations can be halted and the contractor may have to pay compensation.

Also, consider **precautionary thresholds/signs** (triggering change actions) and **absolute limit thresholds/effects** (stop actions)

(Thank you Aline & Kristina)

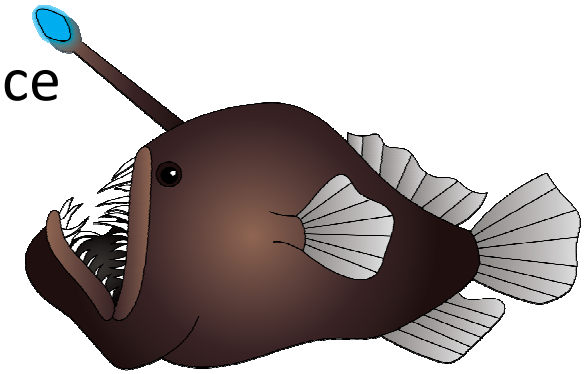
Further Challenges



- How much harm/loss is tolerated before it bec serious?
- Can the definition of serious harm be adaptive as knowledge accumulates?
- How can scientists have input?
- Dealing with uncertainty in identifying serious harm: the ideal vs what we can know.

Harm to What?

Identification of *Serious Harm* requires the existence of Environmental Goals and Objectives
(ie what is necessary to sustain or protect)



Other motivations for adoption of Environmental Objectives

- Standard Best Practice
- Necessary for policy development and monitoring
- Scaling up – goals will transcend contractor license areas
- Level playing field
- Common Heritage of (hu)mankind – future generations
- Contributions to SDG 14

Griffiths Report: The **operationalization of serious harm requires explicit conservation objectives** as well as indicators, thresholds and trigger levels to enable management decisions….

EREGS Suggested Environmental Goals and Objectives

GOAL 1: Preserve the **Common Heritage of Mankind** for future generations including biological, geological and cultural resources and services.

GOAL 2: Ensure that the development of deep-seabed mining is done in the context of **sustainable development** as reflected in SDG 14 and other relevant instruments.

GOAL 3: Protect and preserve the marine environment (UNCLOS Art. 192 – Gen.Obl.) through the **application of precautionary measures.**

GOAL 4 : **Sustain marine (benthic and pelagic) ecosystem integrity** including the physical, chemical, geological and biological environment.

GOAL 5: Generate and **share the best scientific information a**vailable for decision-making and improve techniques for dealing with risk and uncertainty

GOAL 6: Ensure ecosystem integrity on regional scales by **integrating strategic and contractor environmental management plans**.

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GOAL 6: Ensure ecosystem integrity on regional scales by **integrating strategic and contractor environmental management plans**.

GOAL 4 Sustain marine (benthic and pelagic) ecosystem integrity including the physical, chemical, geological and biological environment.

Objectives are:

(i) **Protect ecosystems from contamination** by pollutants generated during any phase of the mining process.

(ii) **Maintain the ability of populations to replace themselves** and retain functionality, including through ensuring genetic connectivity, and suitable habitat.

(iii) **Maintain ecosystem functions** (e.g., long-term natural productivity of habitats; elemental cycling, trophic relationships)

(iv) **Maintain genetic diversity, species richness, habitat or community type, and structural complexity**.

(v) **Sustain ecosystem services** including those not yet discovered (e.g., carbon sequestration)

(vi) **Maintain resilience** to promote recovery from mining impacts, including cumulative impacts (consider corridors, source populations, connectivity, habitat suitability, life history, species distributions in space and time including larval stages, tipping points).

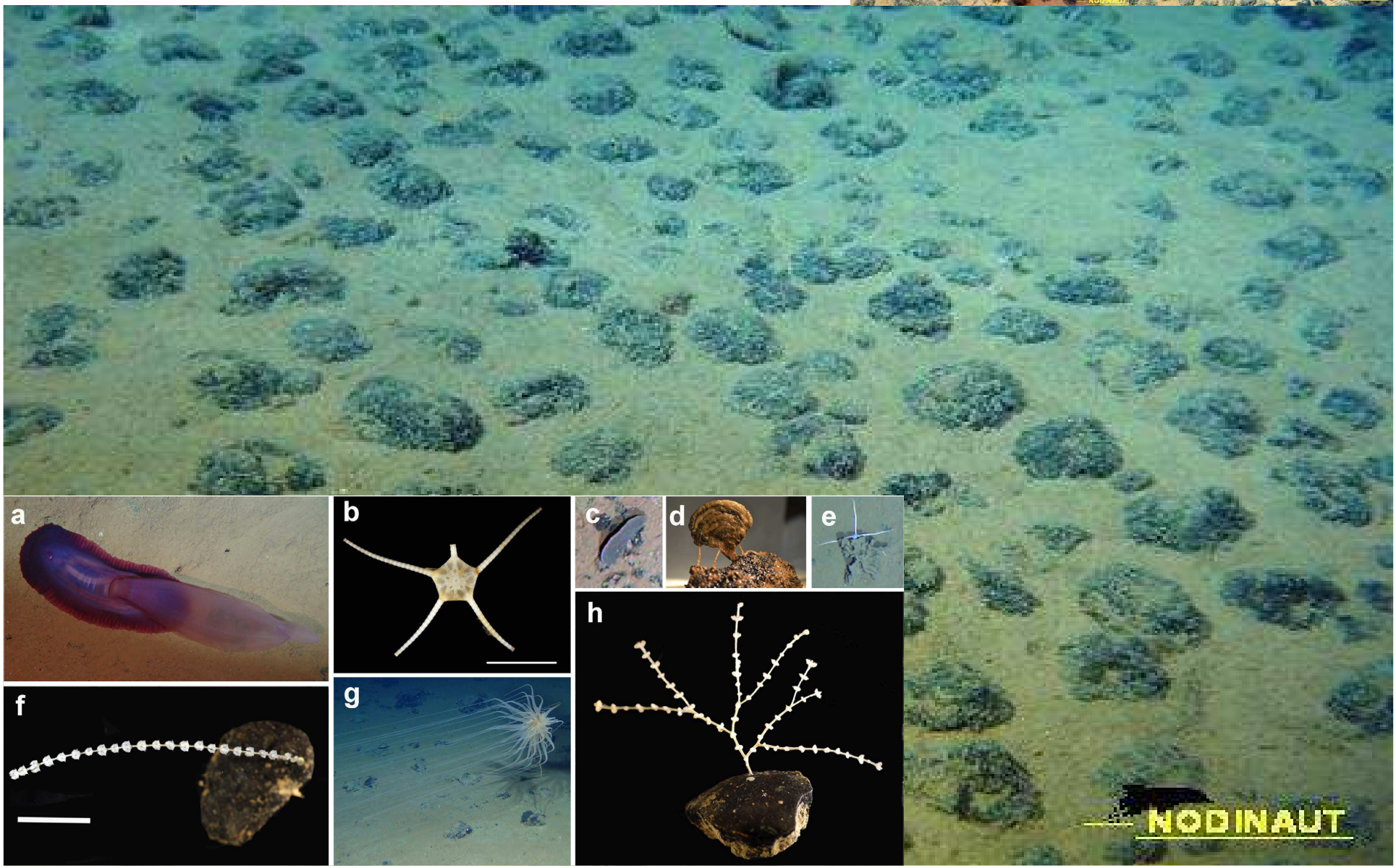
(vii) **Incorporate uncertainty** into risk assessment

(viii) Carry out **context-specific environmental management** (substrate, climate, space and time scale, cumulative impacts, carrying capacity, other uses, functions etc. etc.)

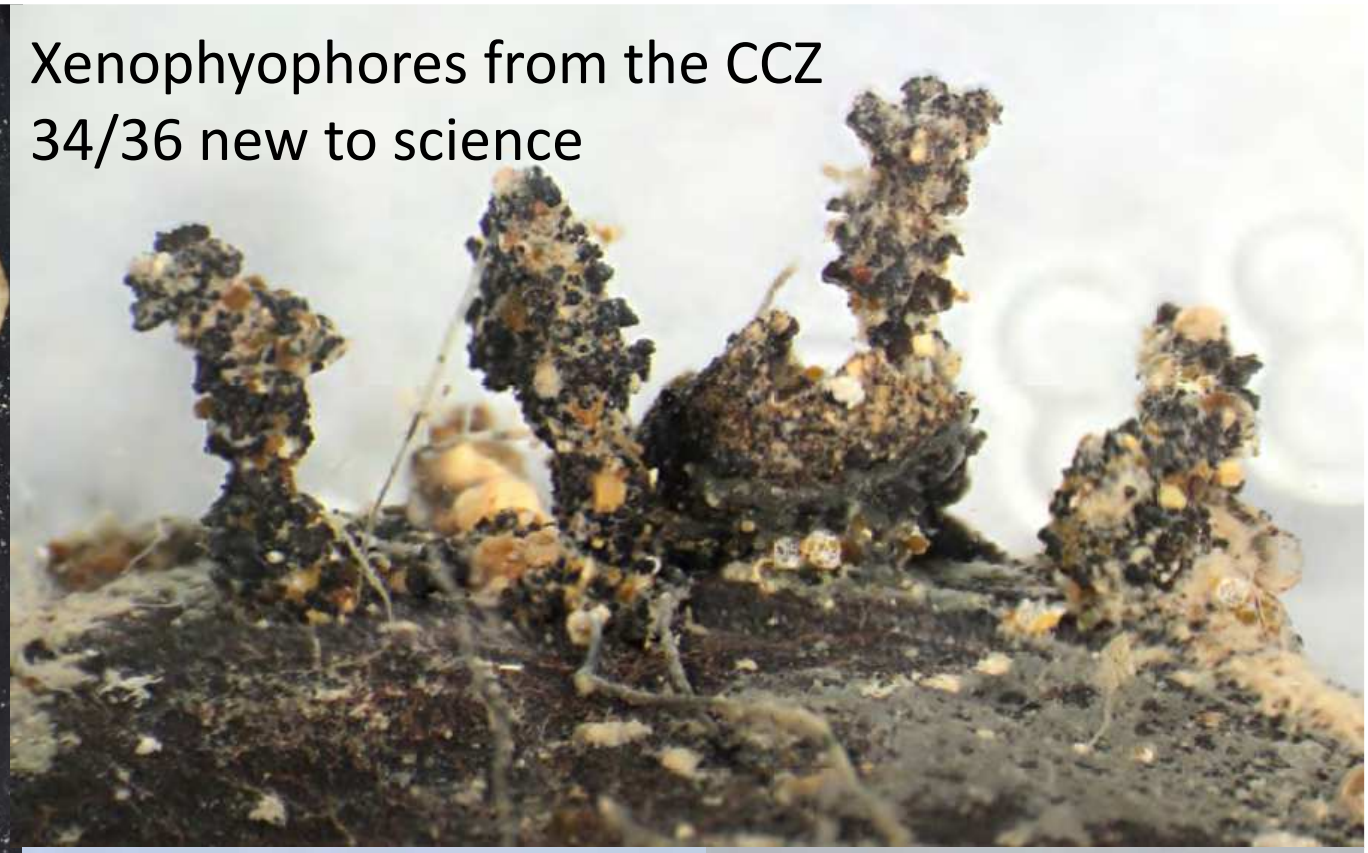
What’s At Stake?

The Settings

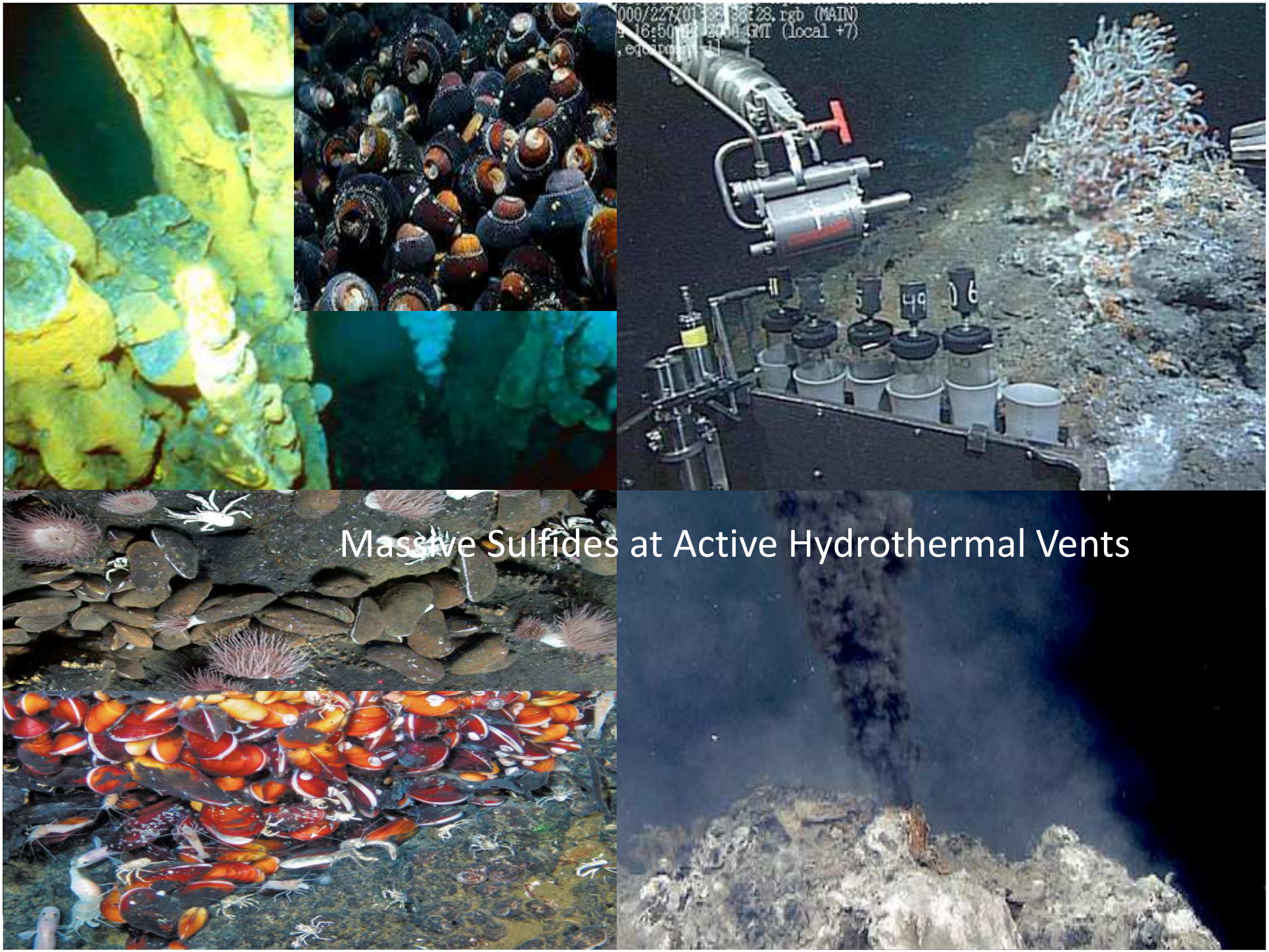
Nodule Province



Xenophyophores from the CCZ
34/36 new to science



Gooday et al. 2017


Massive Sulfides at Active Hydrothermal Vents

Active Hydrothermal Vent Taxa

- Siboglinid Tubeworms
- Vesicomyid clams
- Bathymodiolin mussels
- Galatheid crabs
- Kiwaidae crabs
- Alvinocarid shrimp
- Lepetodrilid limpets
- Alvinoconchid Snails
- Foliculinid ciliates





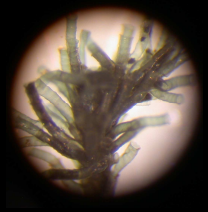
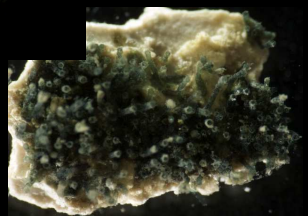




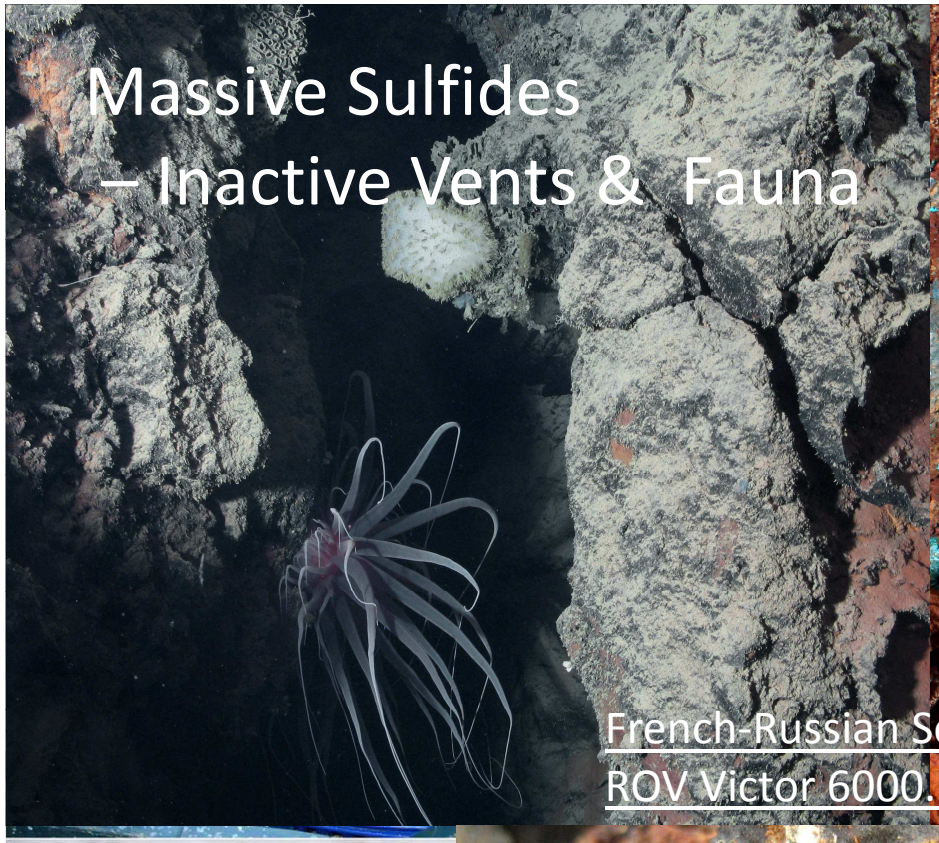






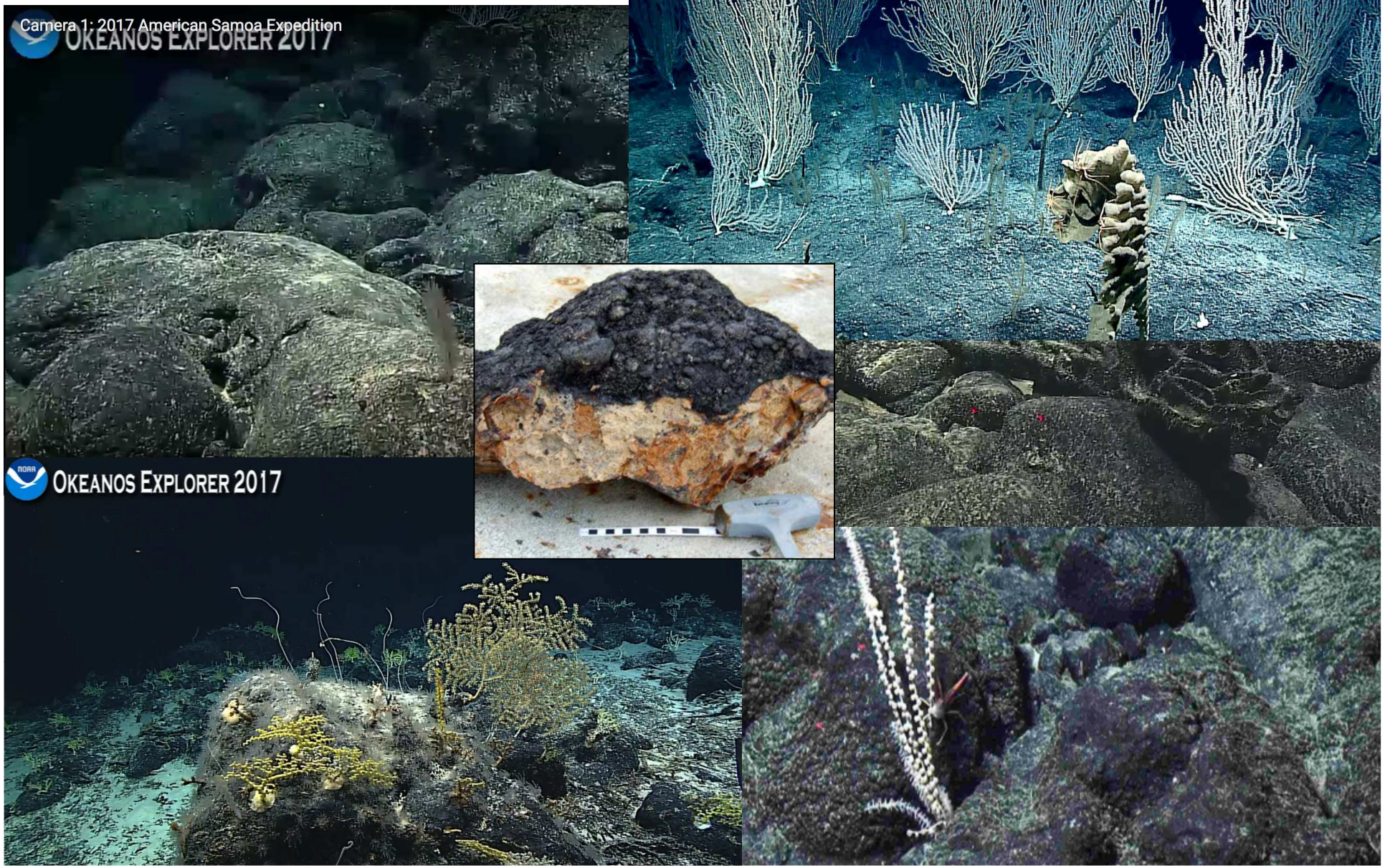
Massive Sulfides – Inactive Vents & Fauna



French-Russian Serpentine Cruise Pourquoi Pas? 2007
ROV Victor 6000. PI Yves Fouquet (A. Gebruk)

Molodstova
2016

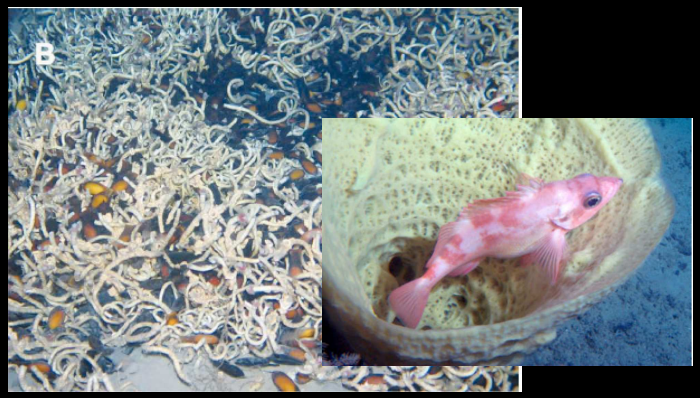
Ferromanganese Crusts on Seamounts (800-2500 m)



Valuable Functions & Services

Provisioning Services: fish, shellfish, (oil, gas) pharmaceuticals, industrial agents, biomaterials

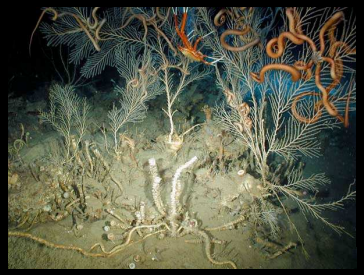
Support Functions: habitat, trophic support, refugia, nursery grounds

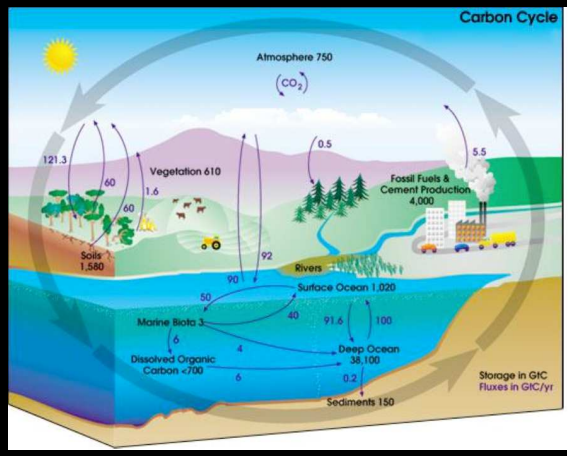


Regulating Services: Climate mitigation:
carbon sequestration, nutrient cycling

Biodiversity: genetic resources, biomaterials, adaptation to change

Scientific Research
Communications
Artistic Inspiration
Education





Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Defining "serious harm" to the marine environment in the context of deep-seabed mining

…. "seabed mining actions that may cause harmful effects or serious harm across all targeted resources include:

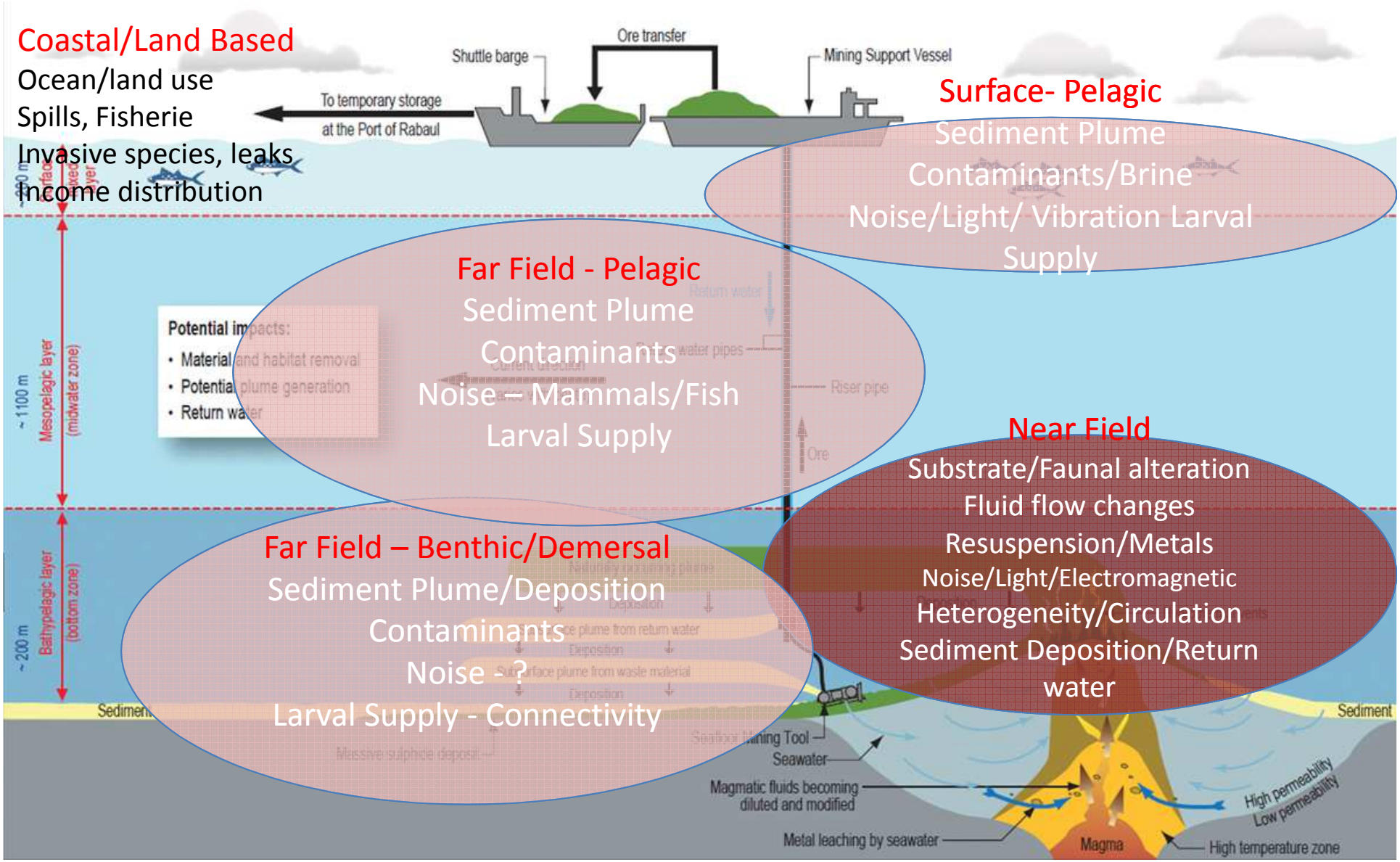
- direct removal and destruction of seafloor habitat and organisms;
- alteration of the substrate and its geochemistry;
- modification of sedimentation rates and food webs;
- changes in substrate availability, heterogeneity and flow regimes;
- suspended sediment plumes
- released toxins
- contamination associated with noise, light or chemical leakage

- Extent
- Duration and frequency
- Intensity or magnitude

- Probability
- Sensitivity/vulnerability
- Cumulative effects

Levin et al. 2016

SEABED MINING IMPACTS

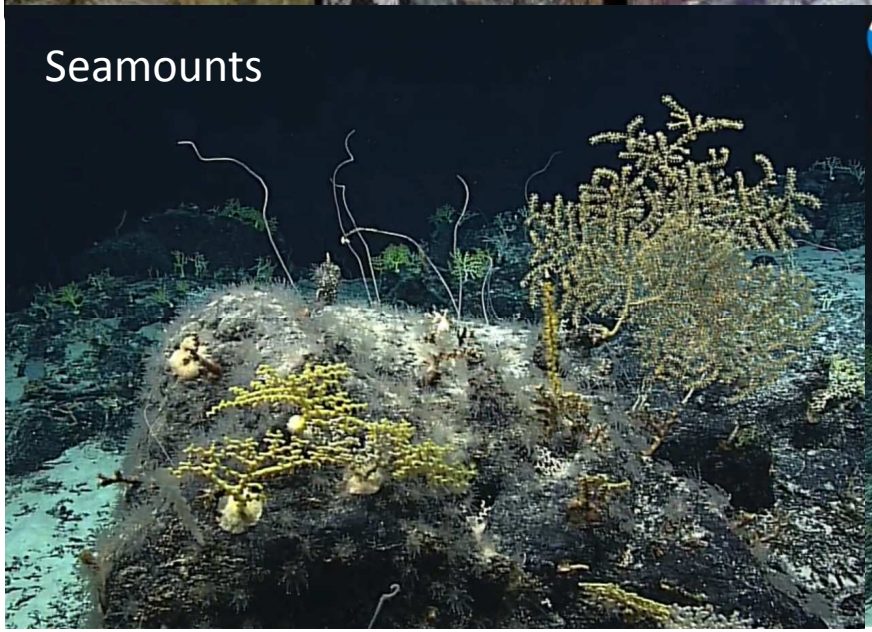


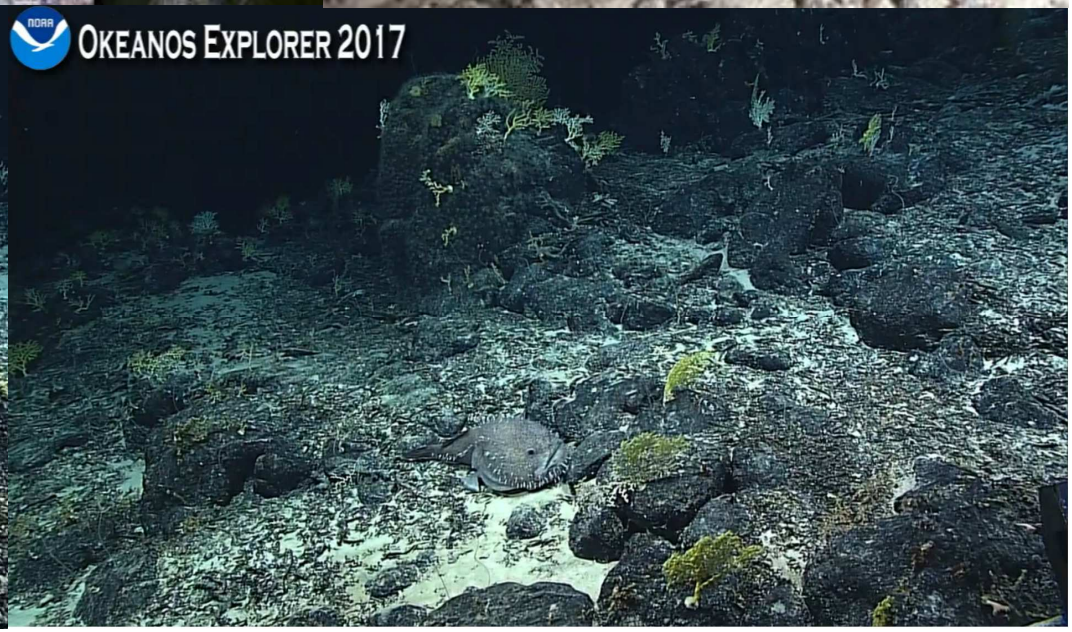
Harmful Effects

These are what should be avoided to protect the marine environment
in all phases of environmental management:
SEA, REMP, EIA, monitoring, risk assessment etc.

Harmful Effects

Altered Substrate: Removal, loss of vertical topography and heterogeneity, & altered texture may cause loss of genetic, species, functional and habitat diversity.





Harmful Effects

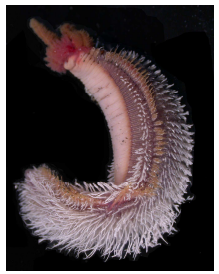
Mining Can alter **Geochemical Underpinnings**

Diverse bacteria as the foundation of food webs

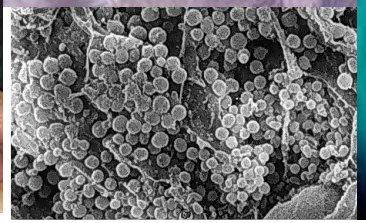
Reduced Compounds (electron donors) H_2S, CH_4, H_2, Fe

Availability of Oxygen and H_2S in sediments

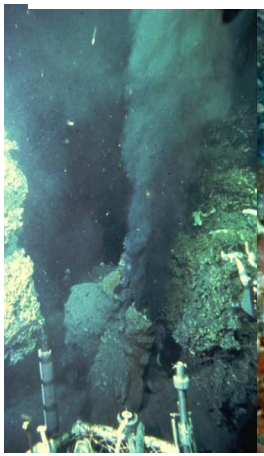
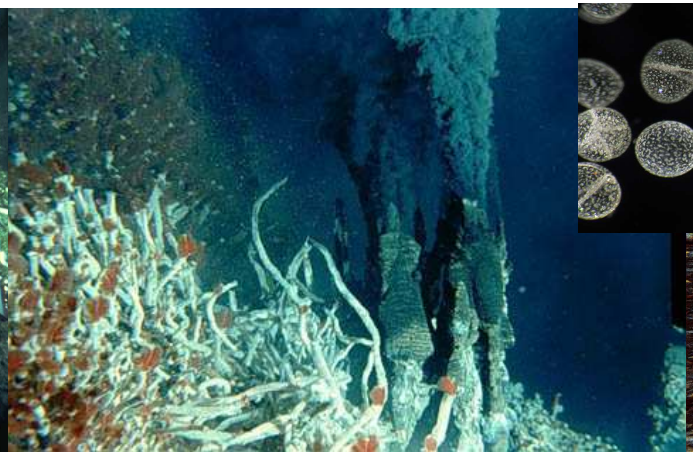


Scaly foot snail

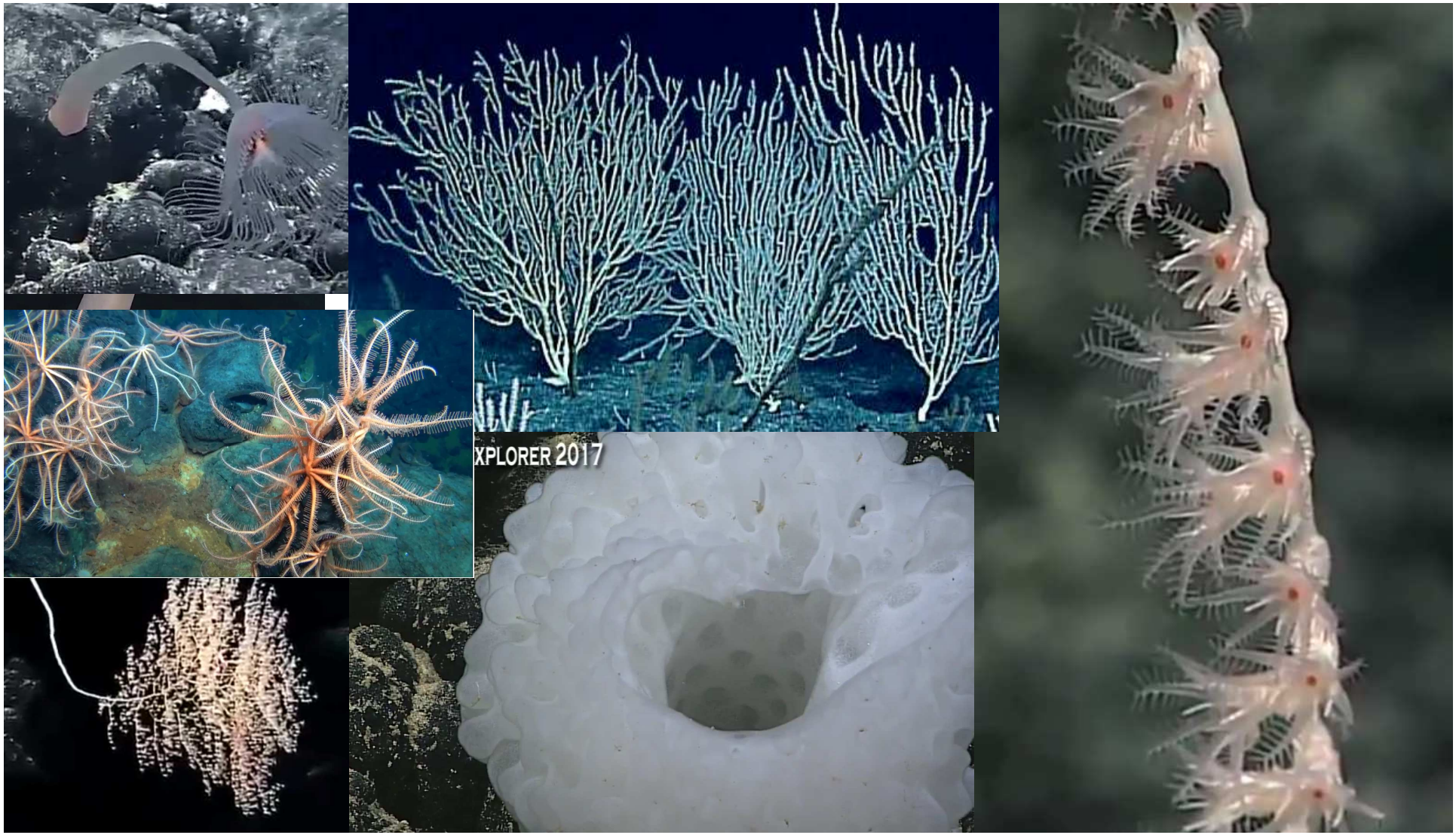

Stewardship of geochemical source diversity required to support free-living microbes, symbionts, and animals that feed on them.


Harmful Effects

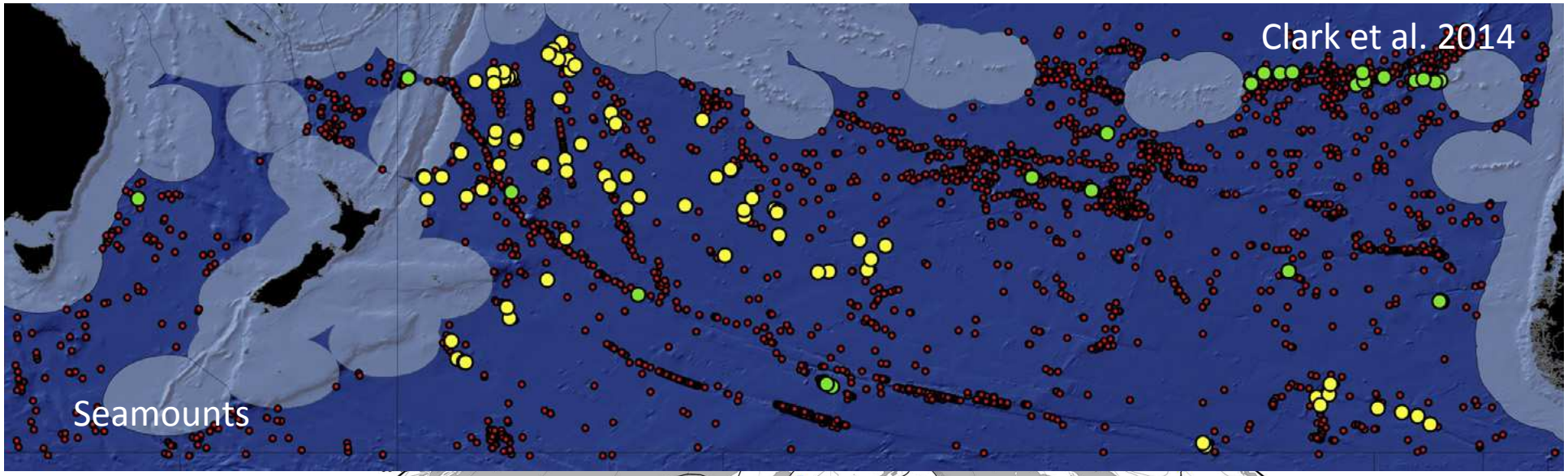
Plume Interference: **turbidity** (suspended sediment) with effects on feeding,vision; **metal contaminants** affect development & bioaccumulation

Filter Feeding Apparatus is easily clogged by suspended sediment

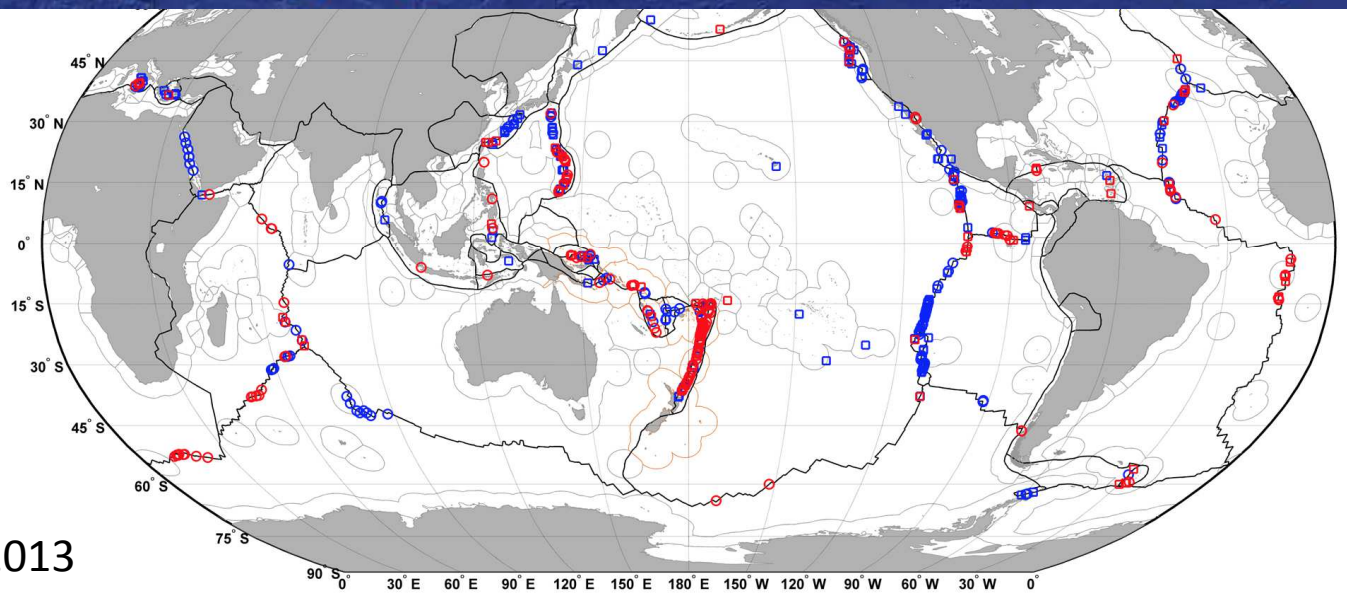


Harmful Effects

Limited Spatial Extent and patchy, isolated habitat (vents & seamounts) yield high endemism. Mining may cause **breaks in connectivity and risk of local extinction,** especially from cumulative impacts



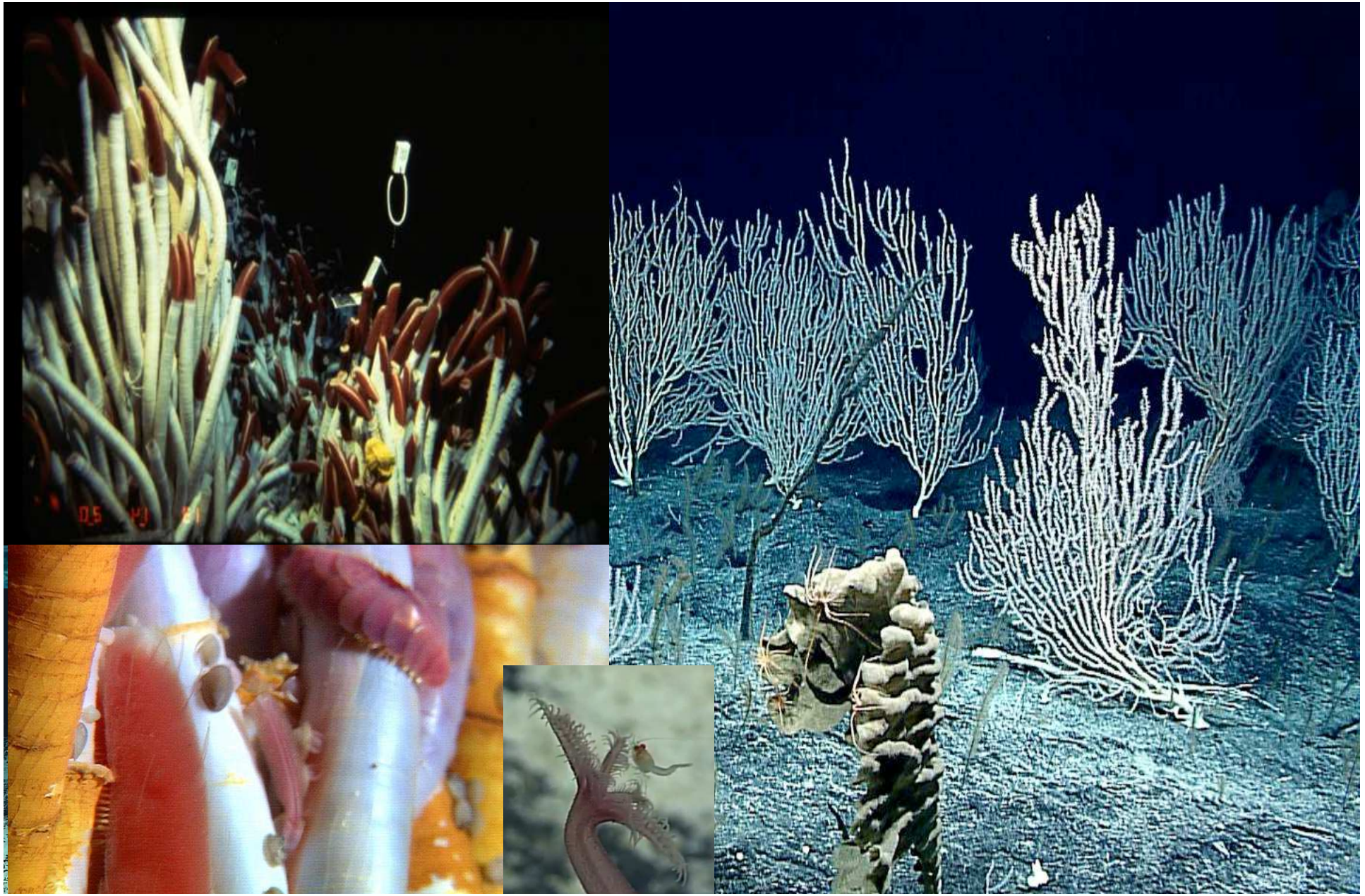
Vents:



Beaulieu et al. 2013

Harmful Effects

Loss of Biogenic Habitat: Complex, often fragile. Loss will reduce diversity of associated organisms.



Harmful Effects

Great Longevity, Slow Growth, Late Maturity reduce resilience and recovery from disturbance.

Disturbance may persist for centuries or indefinitely.

These attributes engender Vulnerable Marine Ecosystems

Options for Operationalizing Serious Harm

Serious harm:

- That which is not acceptable or allowed under the terms of the contract.
  (NZ Comment)
- Violates the environmental objectives.
- Should be defined with time scales for ecological and regulatory relevance.
- Is operationalized within a hierarchy of space scales of impact.
- Develop **criteria for adverse change** which when **applied across multiple dimensions** could "add up" to serious harm. Possibly formulate a **'deep- ocean health index' (**based on an overarching environmental objectives to maintain ecosystem integrity, including structures, functions and services).
- Craft rules and procedures with built-in flexibility to **account for forms of serious harm that are as yet unknown**

Harmful Effects alone or in aggregate may reach the threshold of *Serious Harm*

Species-level significance:

- Extinction
- Decline in foundation species
- Reduction below critical population density
- Loss of source populations
- Loss of stepping-stone populations

Community-level significance:

- Alteration of key trophic linkages
- Diversity loss below natural levels of variability
- Regional declines in habitat heterogeneity (e.g. loss of habitat types)

Ecosystem–level significance:

Loss of key functions (e.g. production, C burial) leading to loss of major services such as C sequestration, genetic resources, fisheries production.

Multiple Indicators of ***Serious Harm****

(Reg. 7.7: *No one single component will define serious harm or significant adverse change.)*

- **Loss of biodiversity (at different levels and rates)**

  Species richness, Species extinction, Evenness, Phylogenetic distinctness, Rarity (species area curve, rarefaction), Endemicity, Abundance
- **Community structure: species composition (indicator)**
- **Significant ecosystem components, including ecosystem engineers.**
- **Habitat (physical and biogenic communities, habitat diversity)**
- **Endangered species (migration, entanglement, live stage impairment, extinction threats)**
- **Productivity**

  Biomass, Primary productivity, Autotroph/heterotroph ratios
- **Heterogeneity**
- **Connectivity**
- **Respiration (oxygen consumption)**
- **Nutrient cycling**
- **Trophic structure (trophic index, SIA, molecular gut contents)**
- **Demographic structure**

  Age structure, Size structure
- **Recovery**
- **Resilience**

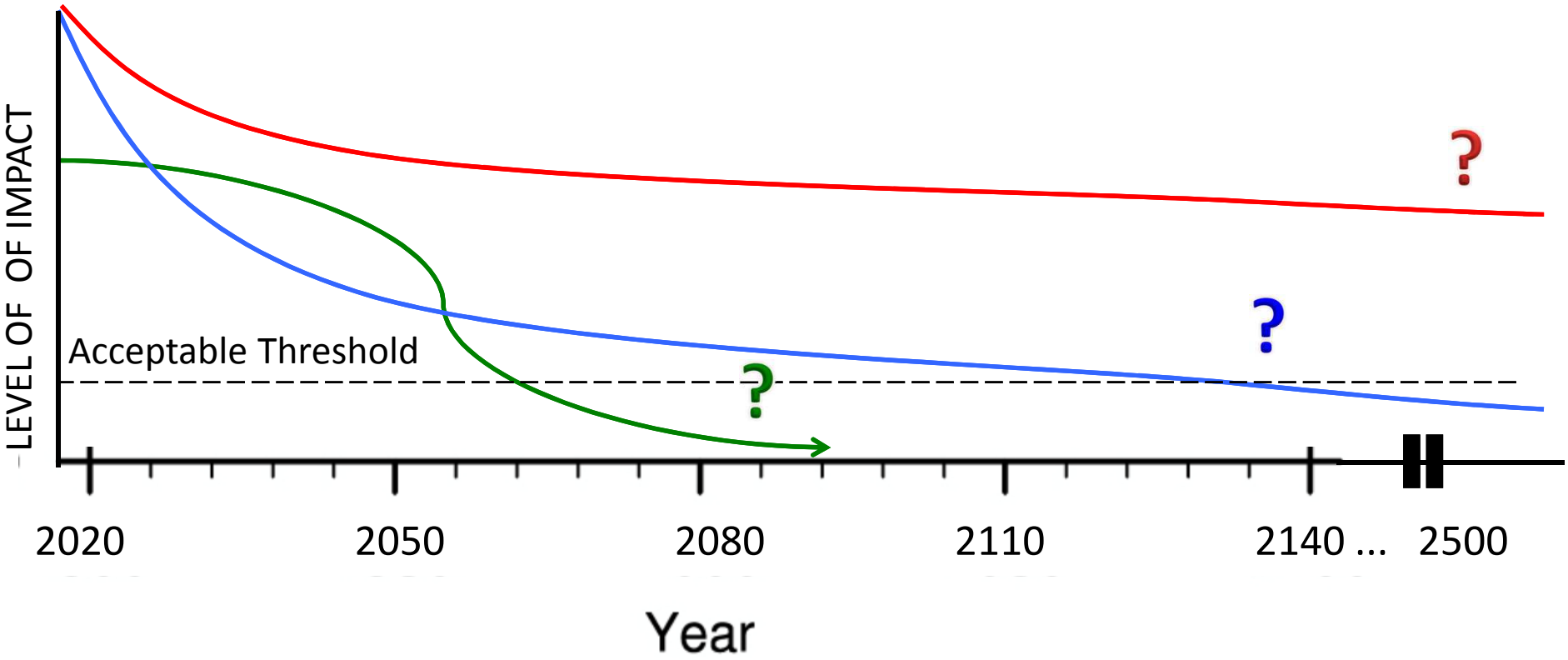
*Not all are 'instrument ready' but may be the focus of further research

Together these could comprise a health index

Temporal Scale

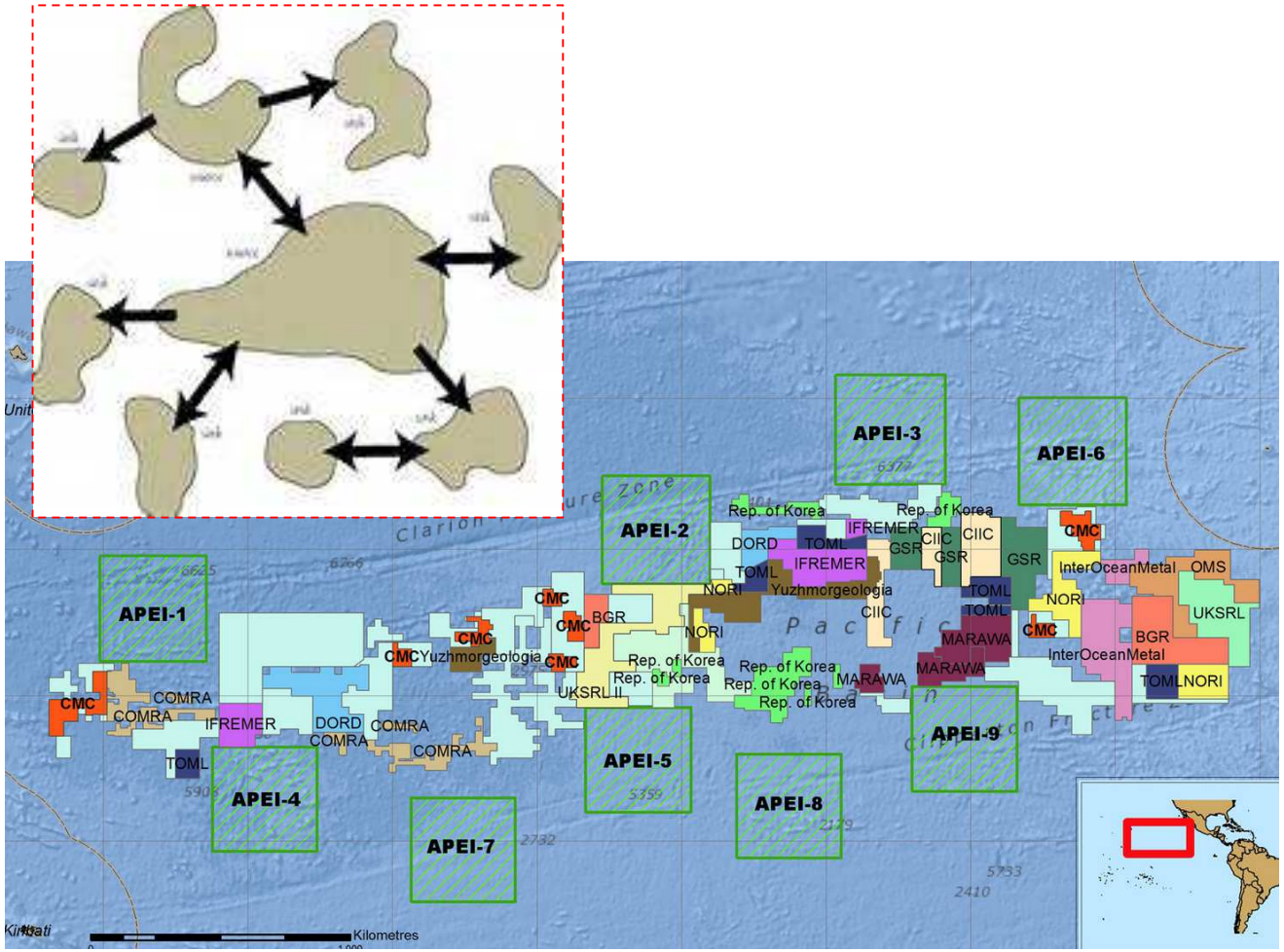
Serious harm must be defined as a function of time

Must effects cross faunal generations to be ‘serious’ ?
Adverse effects that persist indefinitely (on human time scales) are serious.



Serious Harm

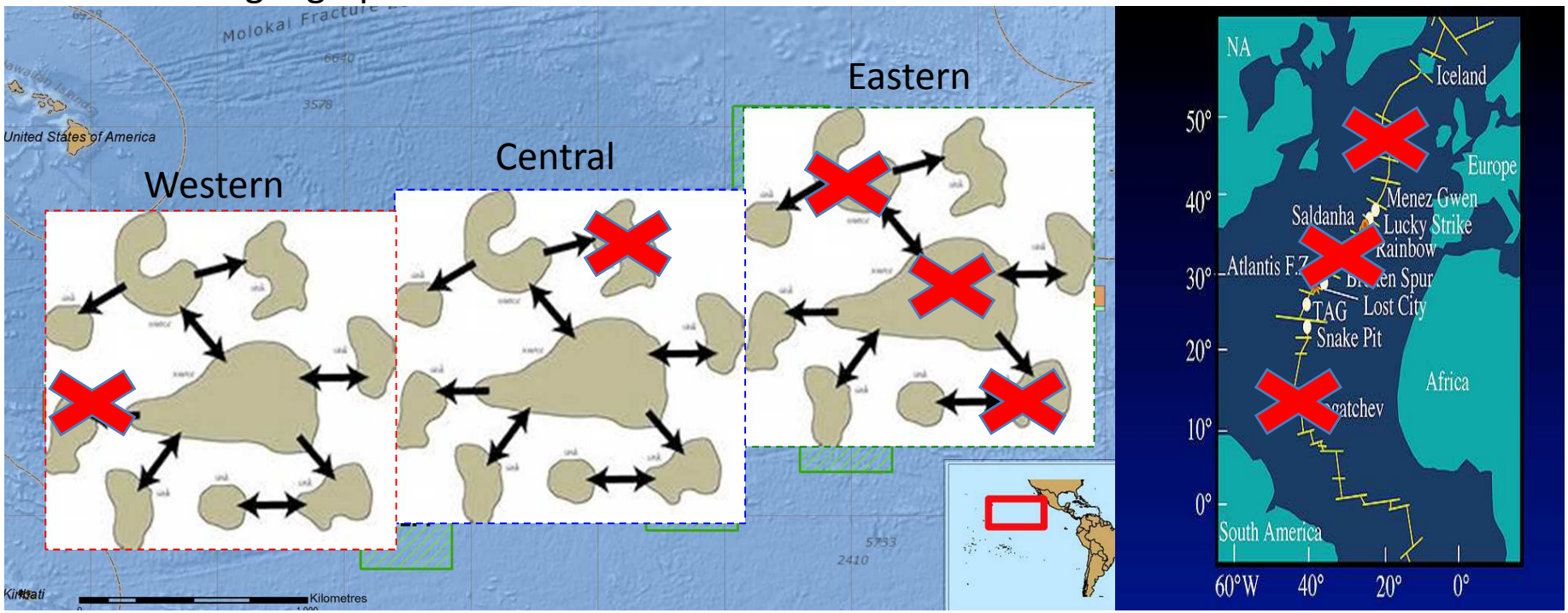
may be defined within biogeographic provinces where connectivity controls assemblages.



Cumulative Impacts at multiple mining sites may lead to

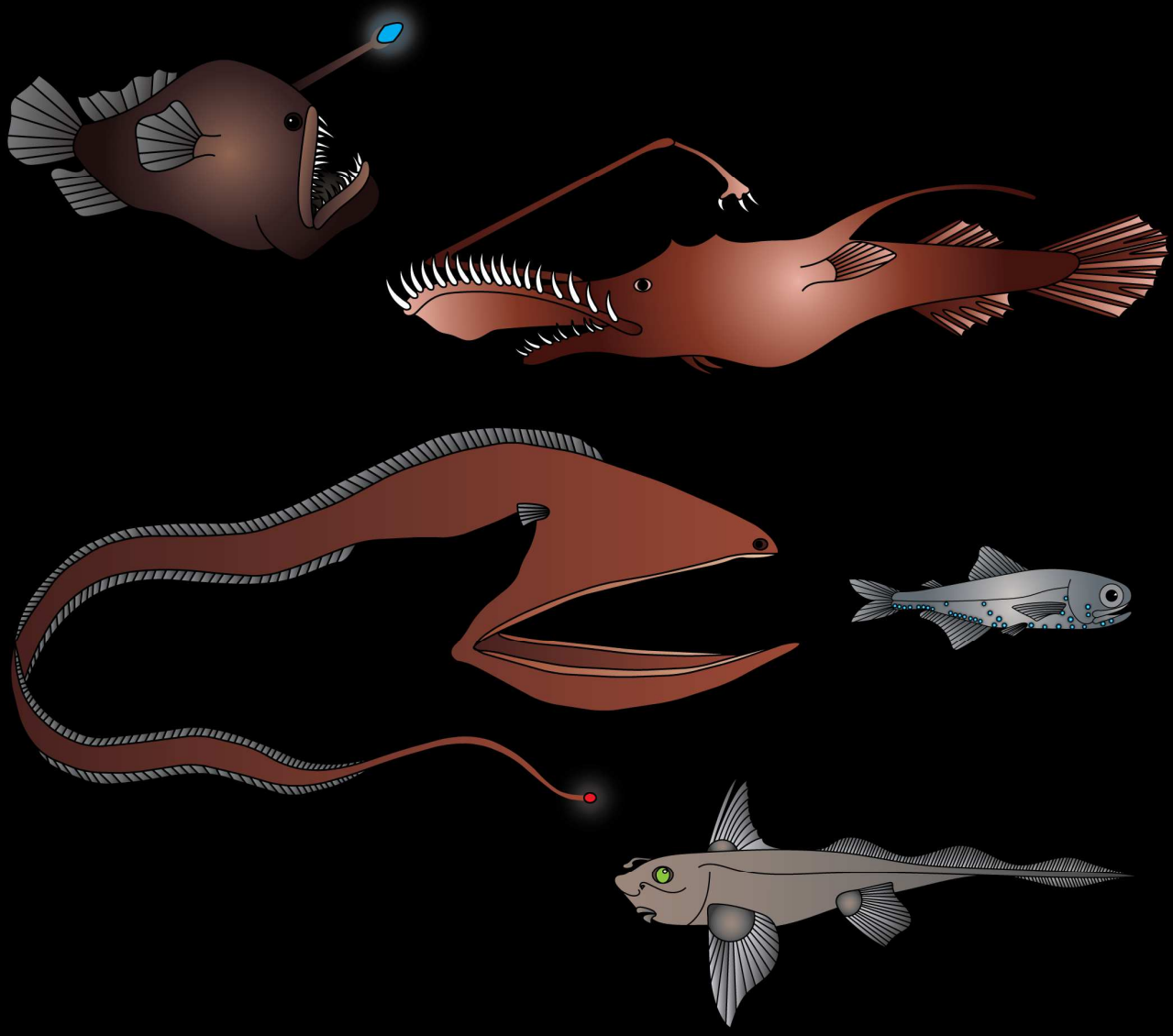
Serious Harm

Three Biogeographic Zones



Loss of diversity, species, functions

We have not yet considered what is happening in the water column or near the surface!



Artwork by Adi Khen

Scientific Knowledge Needs to Operationalize Serious Harm

- Regional distribution of habitats (active and inactive vents, seamounts, other features)
- Natural variability, connectivity, succession endemicity of taxa
- Ecotoxicology of plumes
- Interactions with fish and fisheries (seamounts)
- Faunal sensitivity to changes in substrate & chemistry
- Impacts within the water column & at the surface

Some Additional EREGS Recommendations

(a) Ensure that a **strategic environmental assessment is completed** and protected no-mining areas are put in **place *prior to* awarding any additional contracts**;

(b) Ensure scientifically and statistically sound design of the **network of Preservation Reference Zones and Impact Reference Zones**, as these will determine the contractor's ability to detect serious harm.

(c) Additionally, **broader regional sampling** will be required because affected habitats and species populations are not likely to be limited to contractors' mining claim areas.

(d) Should require **the burden of proof on the proponent and the ISA to demonstrate a reasonable trade-off** in terms of benefits of mining to humankind versus the costs, including non-economic, in the face of high uncertainty, high risk and the long-term nature of the harm

Conclusions and Recommendations

- Thresholds and tipping points that define serious harm are a challenge to identify – even in well studied systems.
- Multi-dimensional, scientific approach needed
- Assemble expert panel to determine what constitutes and how to identify 'serious harm' and to prepare guidelines for provision of information
- Link serious harm to the **precautionary principle** and (im)possibility of restoration
- Develop proper advisory infrastructure at ISA to address harmful effects and serious harm at all appropriate phases of environmental management.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