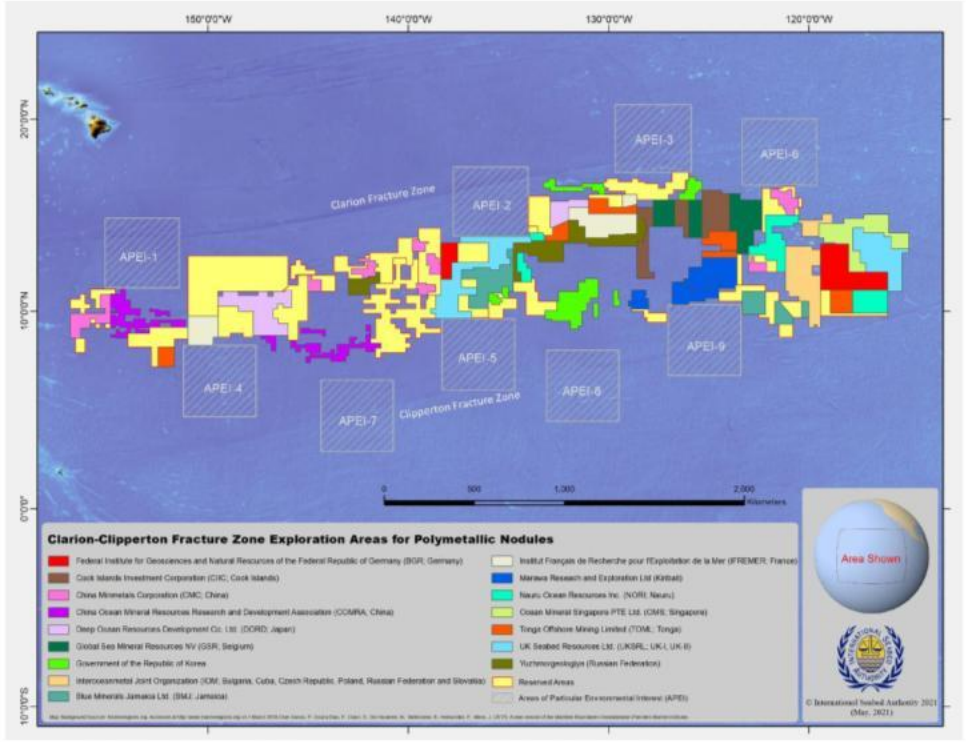
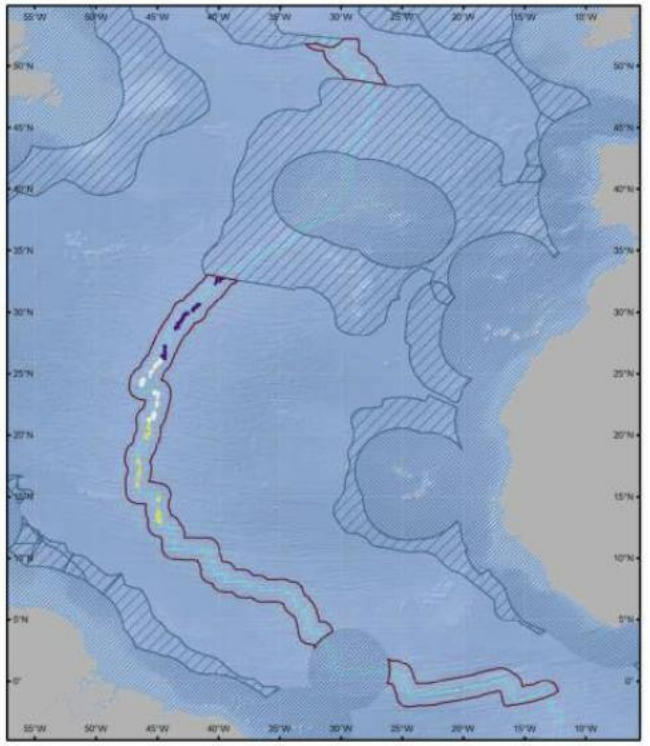
Scientific data for effective REMPs

The work on REMPs and APEIs in the framework of the ISA, with a focus on the work on the Clarion-Clipperton Zone and Mid-Atlantic Ridge from a comparative perspective





Sabine Gollner
Senior Scientist
Royal Netherlands Institute for Sea Research (NIOZ)
The Netherlands, Sabine.Gollner@nioz.nl

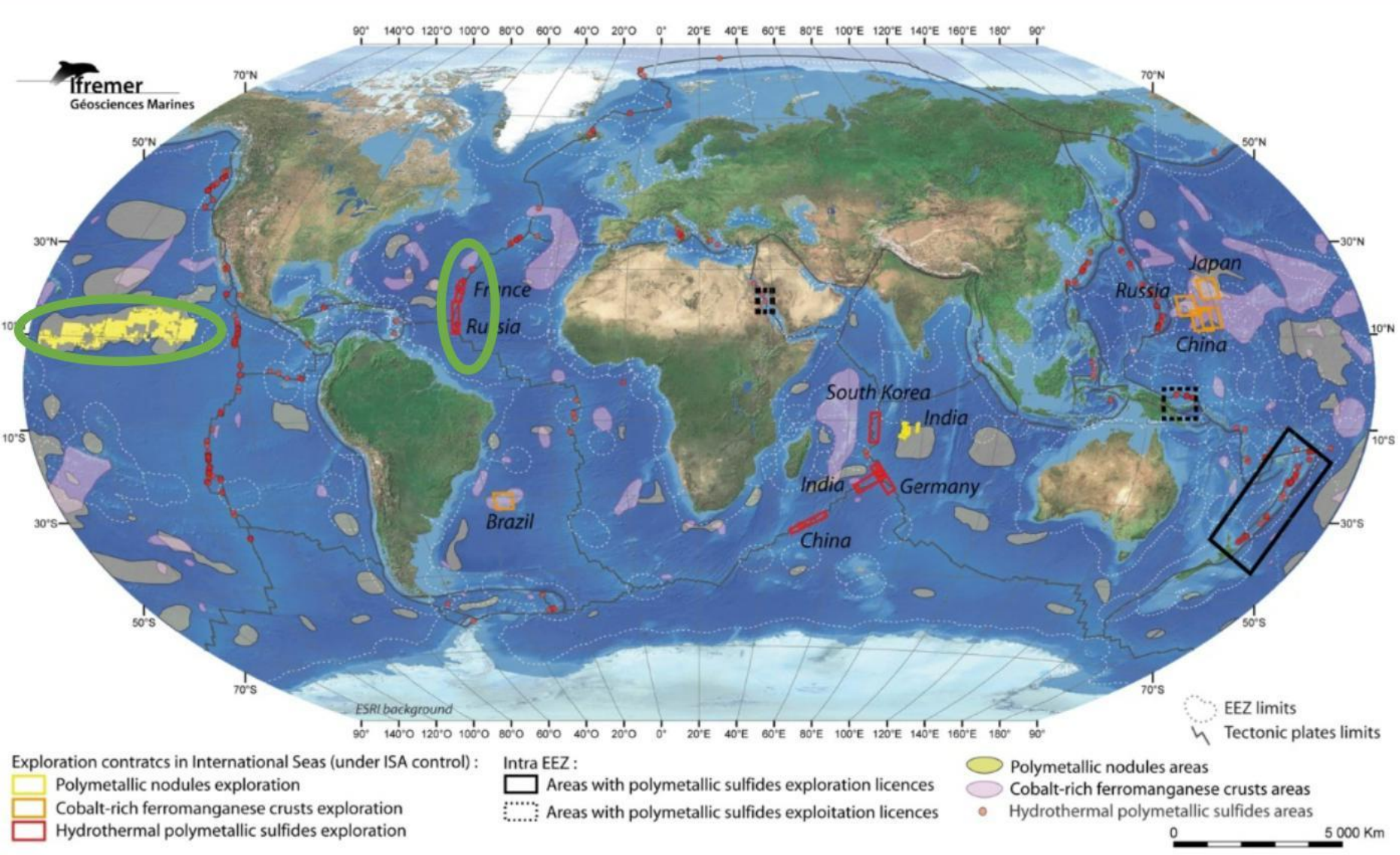
Presentation for Workshop:

Protecting deep seabed ecosystems under the future Agreement on the Conservation and Sustainable Use of BBNJ and by the ISA – Perspectives of Government, Civil Society, Stakeholders, and Law and Science
Workshop, Utrecht 13 and 14 December 2021

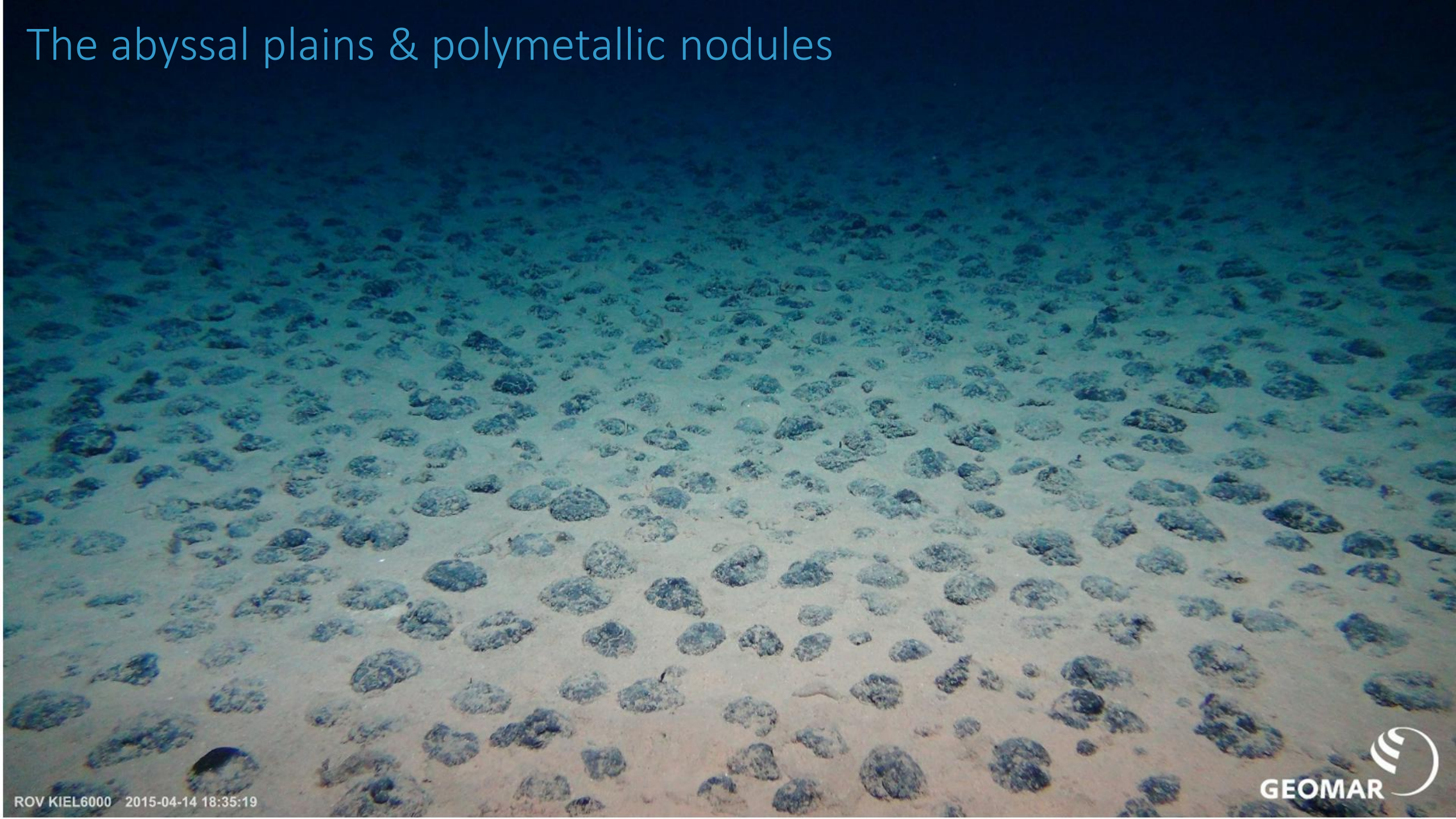
Organized by the Netherlands Institute for the Law of the Sea (NILOS), the Utrecht Centre for Water, Oceans and Sustainability Law (UCWOSL) of Utrecht University, and the Netherlands Ministry of Foreign Affairs, in collaboration with The Royal Netherlands Institute for Sea Research (NIOZ)

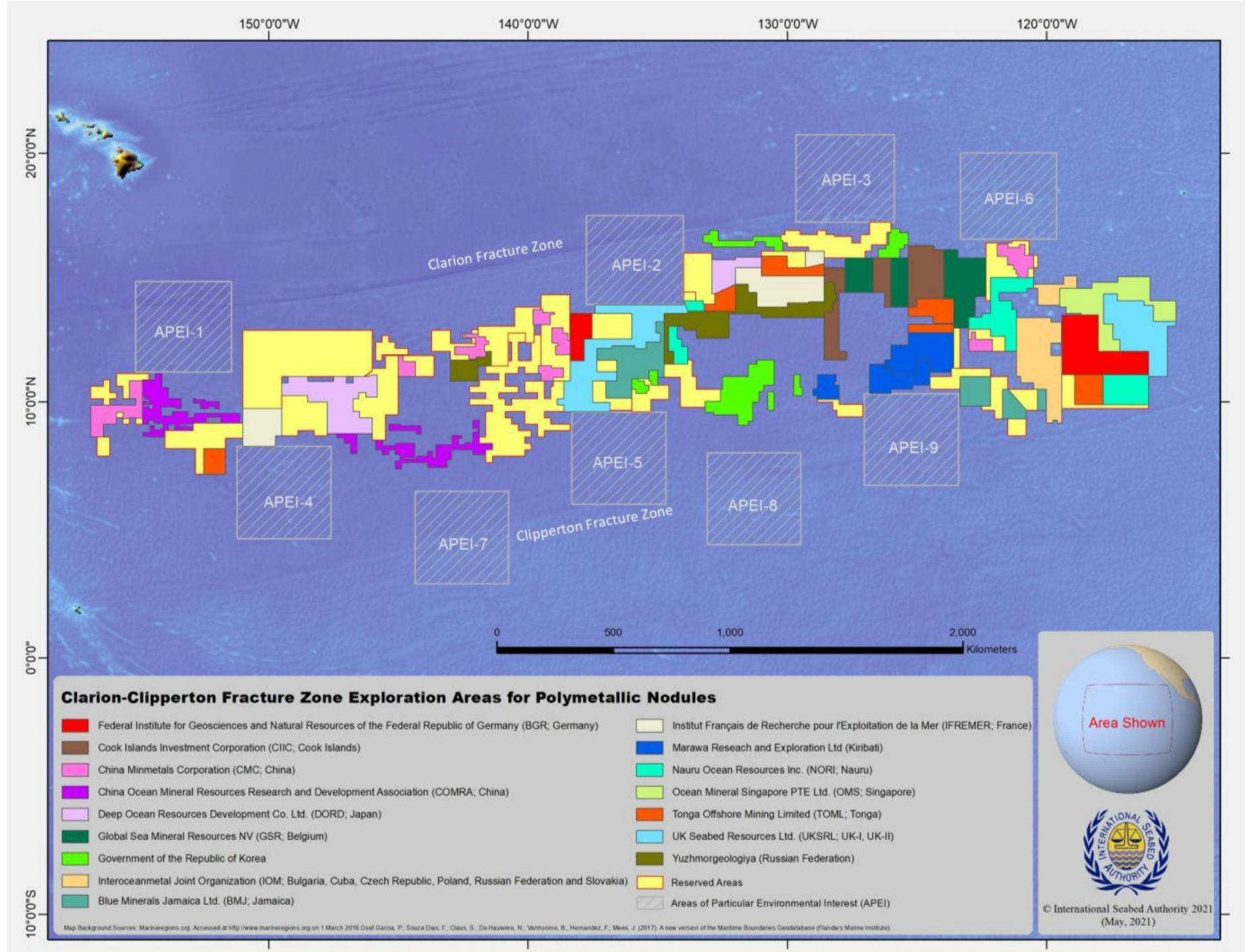
Deep-sea mineral resources

polymetallic nodules/abyssal plains, polymetallic sulfides/hydrothermal vents, cobalt-rich crusts/seamounts

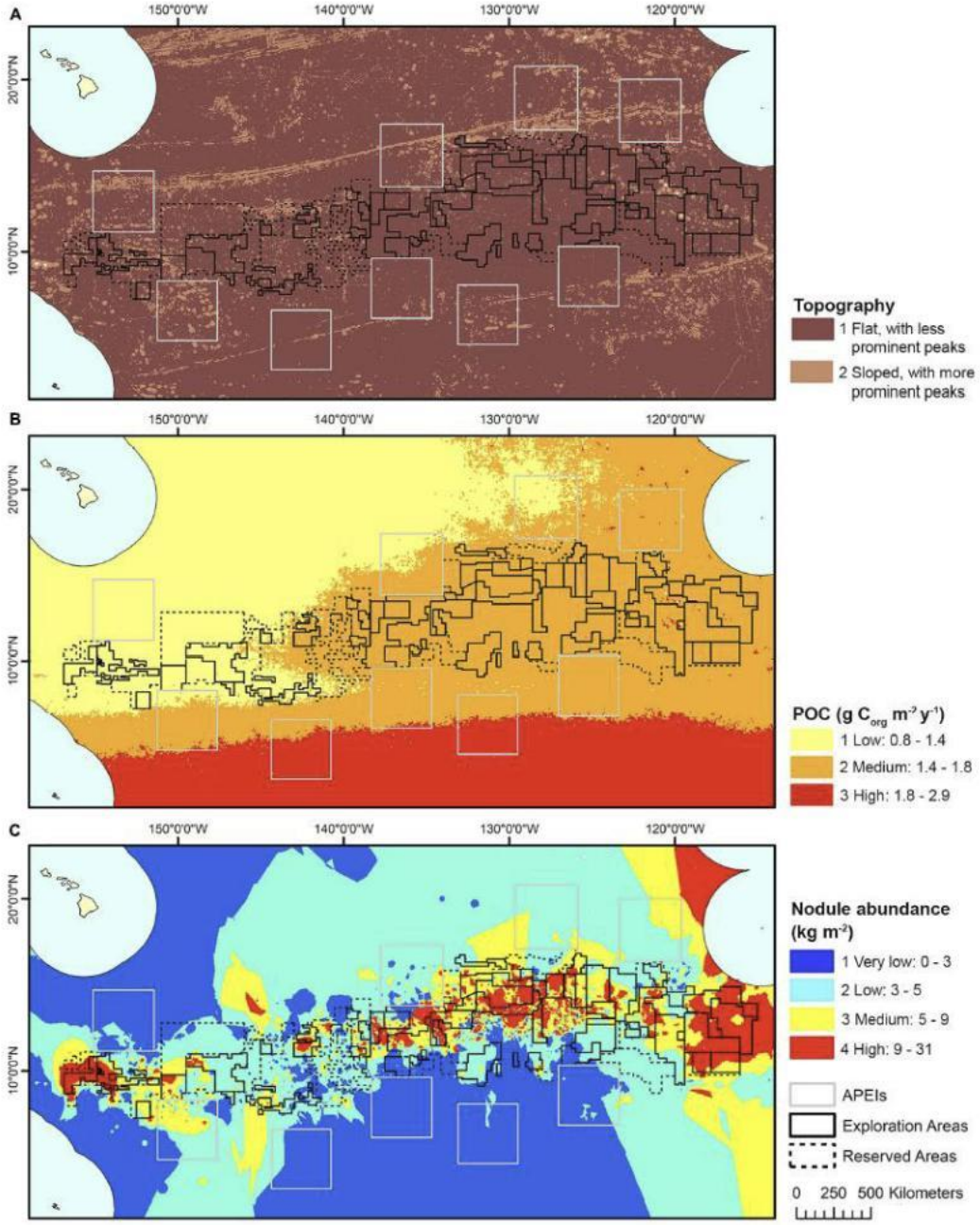


The abyssal plains & polymetallic nodules




150°0'0"W
140°0'0"W
130°0'0"W
120°0'0"W
20°0'0"N
10°0'0"N
0°0'0"
10°0'0"S
APEI-1
APEI-2
APEI-3
APEI-4
APEI-5
APEI-6
APEI-7
APEI-8
APEI-9
Clarion Fracture Zone
Clipperton Fracture Zone
0
500
1,000
2,000
Kilometers
Clarion-Clipperton Fracture Zone Exploration Areas for Polymetallic Nodules
Federal Institute for Geosciences and Natural Resources of the Federal Republic of Germany (BGR; Germany)
Cook Islands Investment Corporation (CIIC; Cook Islands)
China Minmetals Corporation (CMC; China)
China Ocean Mineral Resources Research and Development Association (COMRA; China)
Deep Ocean Resources Development Co. Ltd. (DORD; Japan)
Global Sea Mineral Resources NV (GSR; Belgium)
Government of the Republic of Korea
Interoceanmetal Joint Organization (IOM; Bulgaria, Cuba, Czech Republic, Poland, Russian Federation and Slovakia)
Blue Minerals Jamaica Ltd. (BMJ; Jamaica)
Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER; France)
Marawa Reseach and Exploration Ltd (Kiribati)
Nauru Ocean Resources Inc. (NORI; Nauru)
Ocean Mineral Singapore PTE Ltd. (OMS; Singapore)
Tonga Offshore Mining Limited (TOML; Tonga)
UK Seabed Resources Ltd. (UKSRL; UK-I, UK-II)
Yuzhmorgeologiya (Russian Federation)
Reserved Areas
Areas of Particular Environmental Interest (APEI)
Map Background Sources: Marineregions.org. Accessed at http://www.marineregions.org on 1 March 2018.Osel Garcia, P; Souza Dias, F.; Claus, S.; De Hauwere, N.; Vanhoorne, B.; Hernandez, F.; Mees, J. (2017). A new version of the Maritime Boundaries Geodatabase (Flanders Marine Institute)
Area Shown
INTERNATIONAL SEABED AUTHORITY
© International Seabed Authority 2021
(May, 2021)

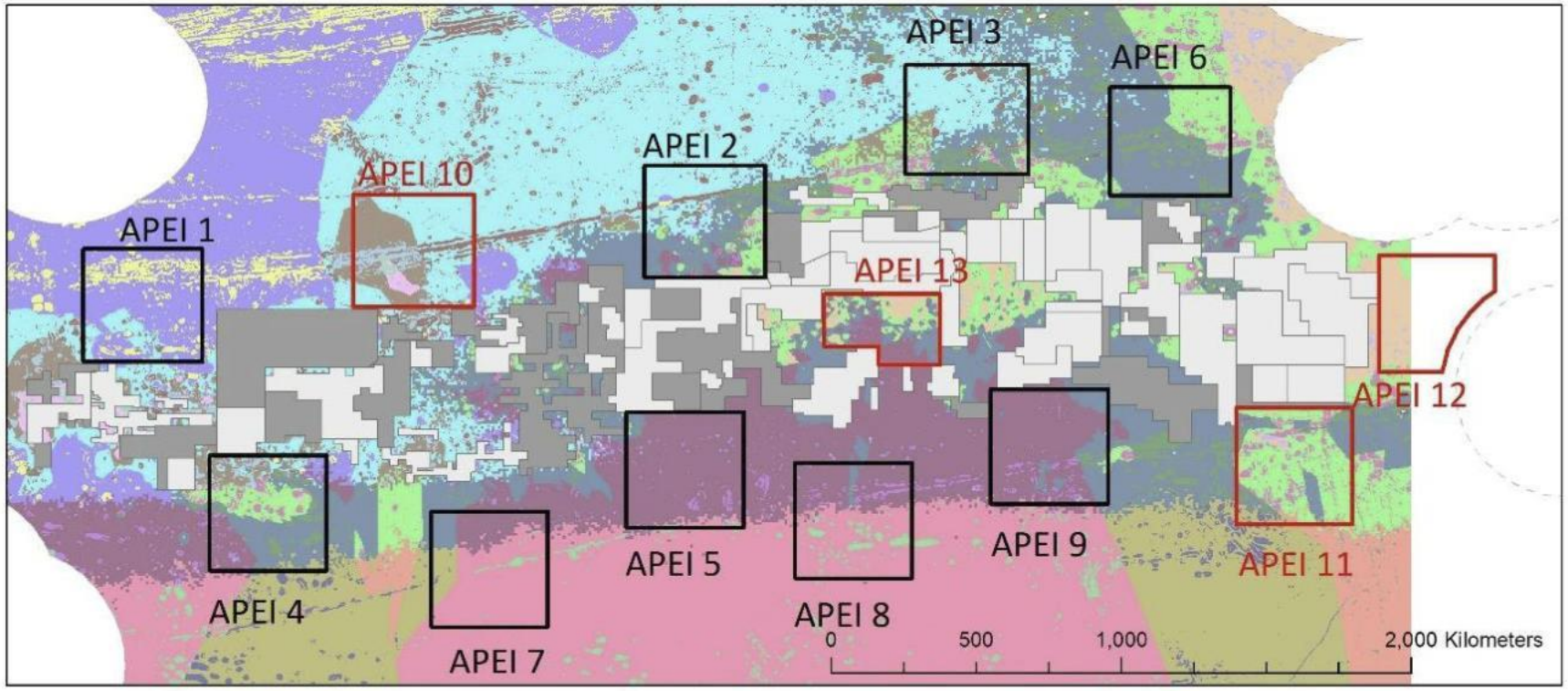
ISBA/26/C/43: Review of the implementation of the Environmental Management Plan for the CCZ



APEIs (Areas of Particular Environmental Interest) based on topography, POC flux, nodule abundance

APEI criteria

- Large areas
- Self-sustaining populations (rule of thumb 200 km)
- Broad range of habitat variability
- No direct and indirect mining effects
- unknown impacts



- 4 new APEIs suggested (but connectivity buffer zone violated for APEI 13)
- High nodule density habitat still underrepresented:

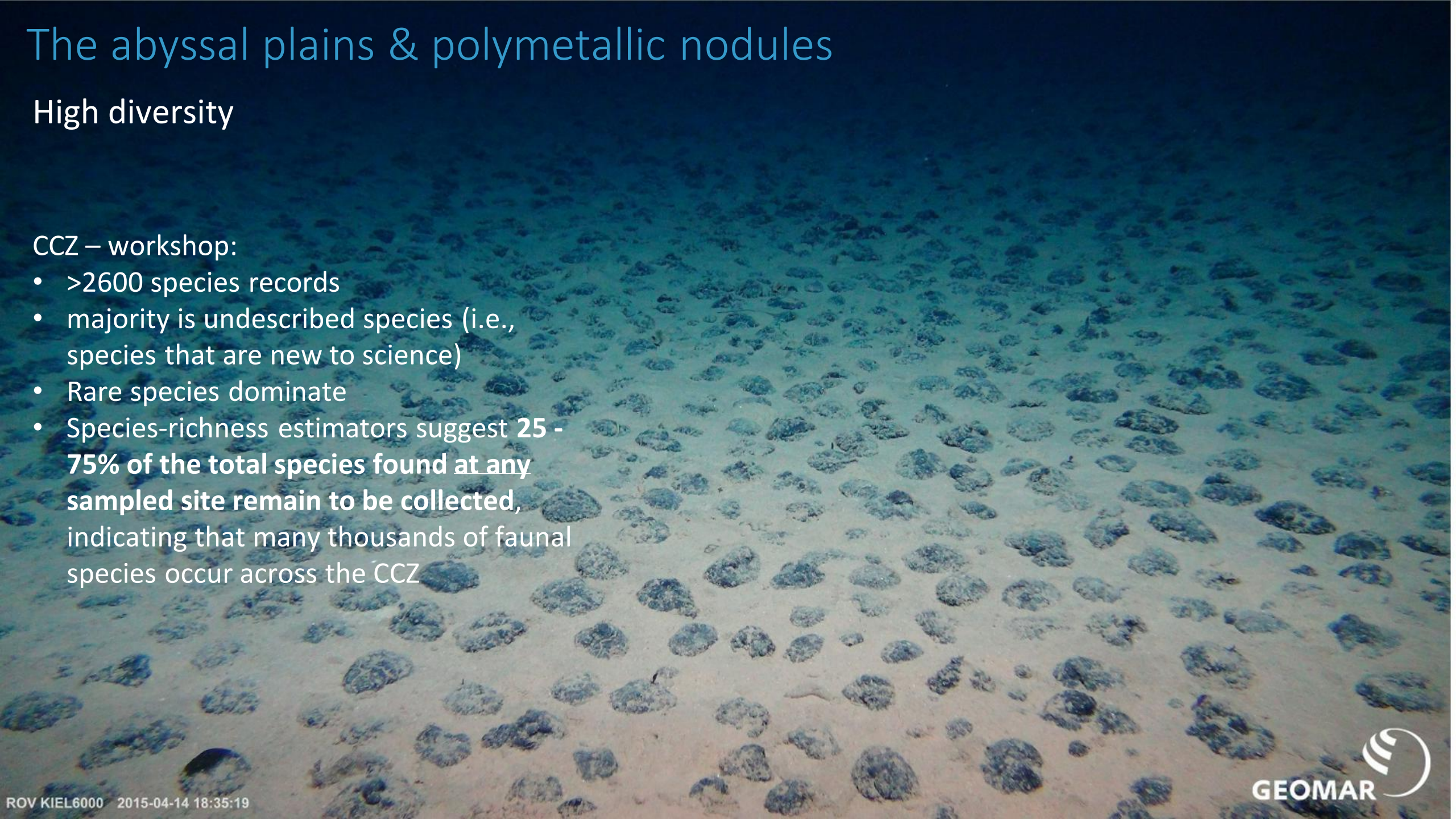
  Nodule cover positively related to megafaunal abundance and diversity
- APEIs based on habitat classification (depth, POC, nodule density), biodiversity not directly considered (but rule of thumb for connectivity of deep-sea organisms)

The abyssal plains & polymetallic nodules

High diversity

CCZ – workshop:

- >2600 species records
- majority is undescribed species (i.e., species that are new to science)
- Rare species dominate
- Species-richness estimators suggest **25 - 75% of the total species found at any sampled site remain to be collected**, indicating that many thousands of faunal species occur across the CCZ

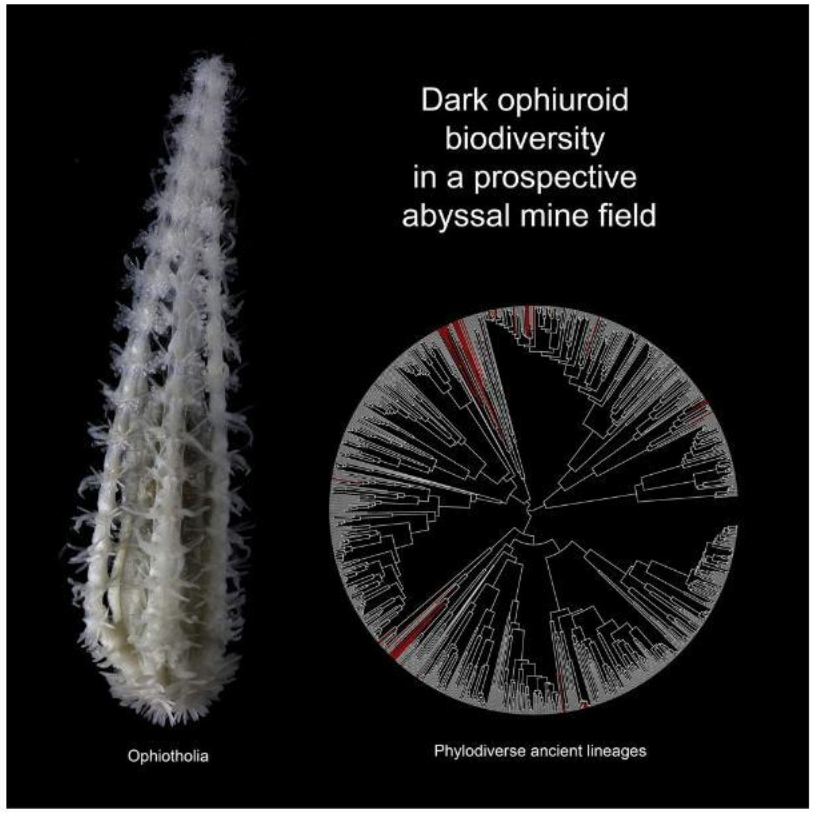


GEOMAR

Biodiversity – what and how many species do we find?

170 megafauna morphospecies in UK area

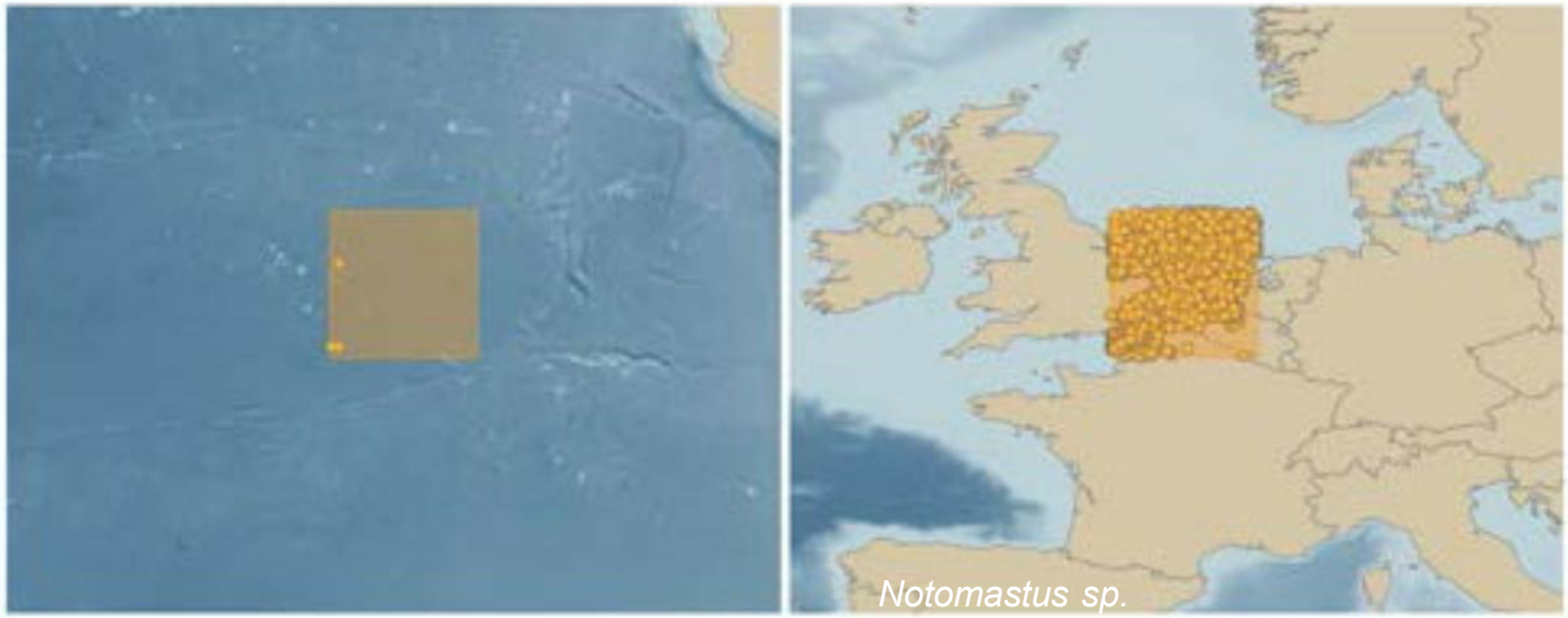
Amon et al. 2016



Unexpected high & hidden diversity
of brittlestars (archetypic species)

Christodoulou et al. 2019

Species ranges – where do we find which species?
A matter of sampling – true endemics or pseudo-endemics?

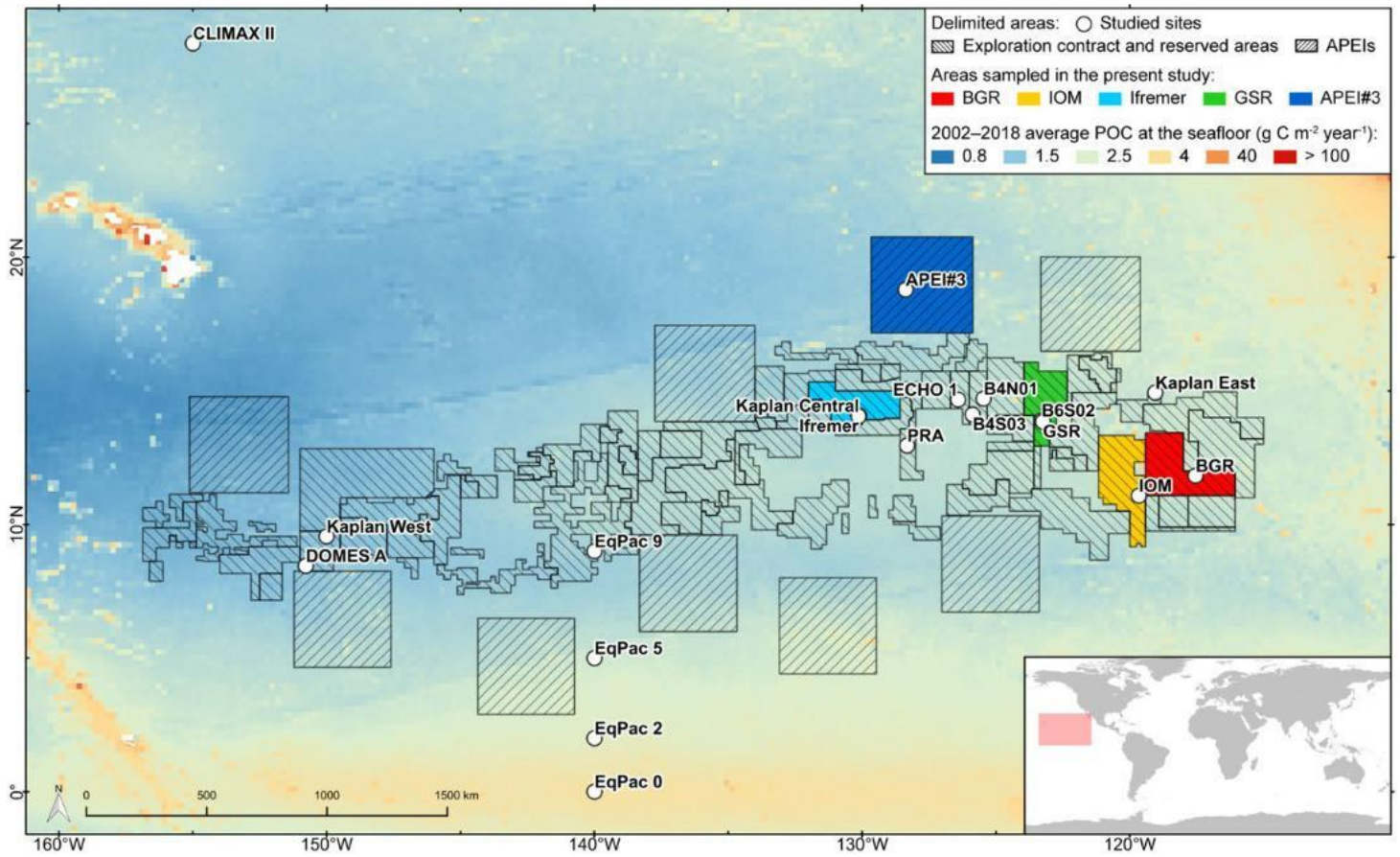


300,000 km² box
4 polychaete records

300,000 km² box
182,939 polychaete records

Glover et al. 2016:
very few OBIS records

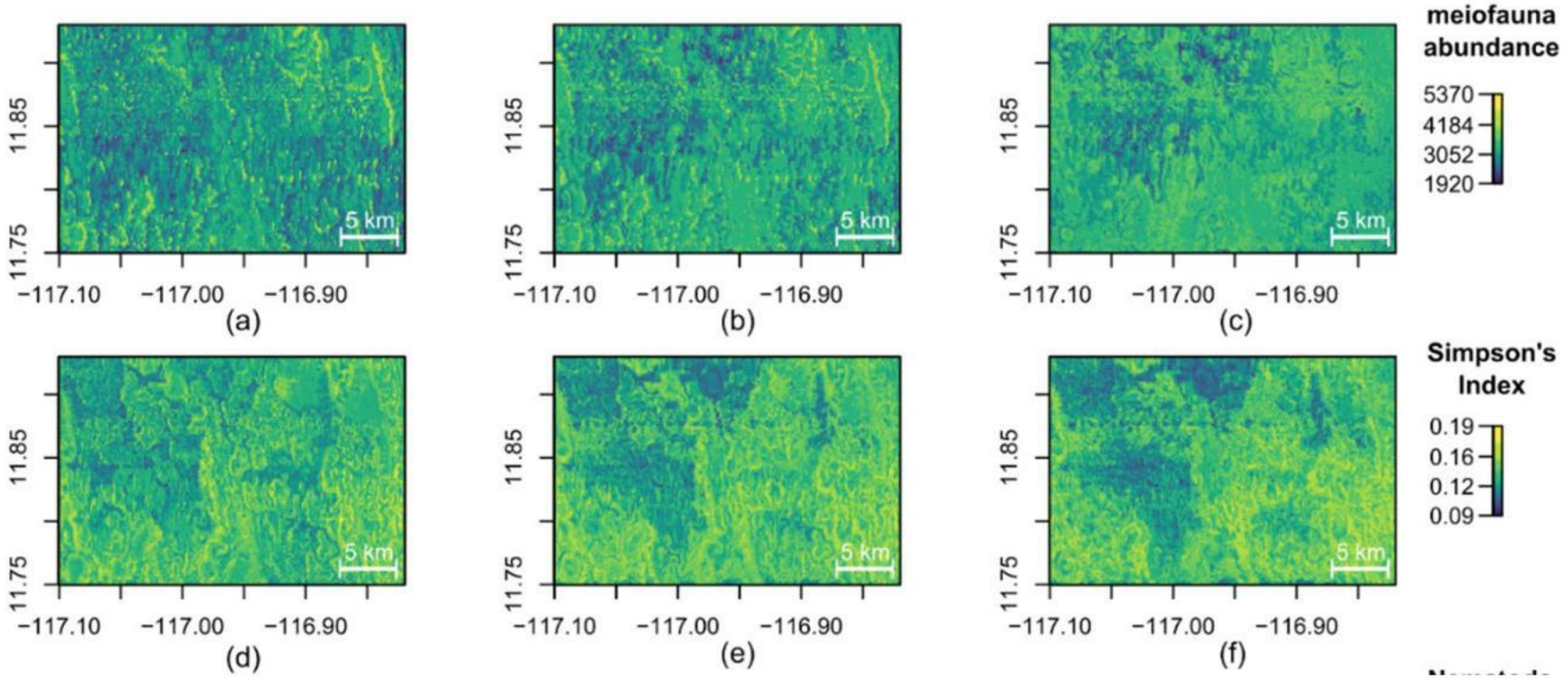
Species ranges – where do we find which species?



A total 275 polychaete morphotypes.
Only one morphotype was shared among all five study areas
49% only in one area

Bonifacio et al. 2019

Habitat distribution in the German exploration area (based on modelling): High spatial variability



backscatter & bathymetry

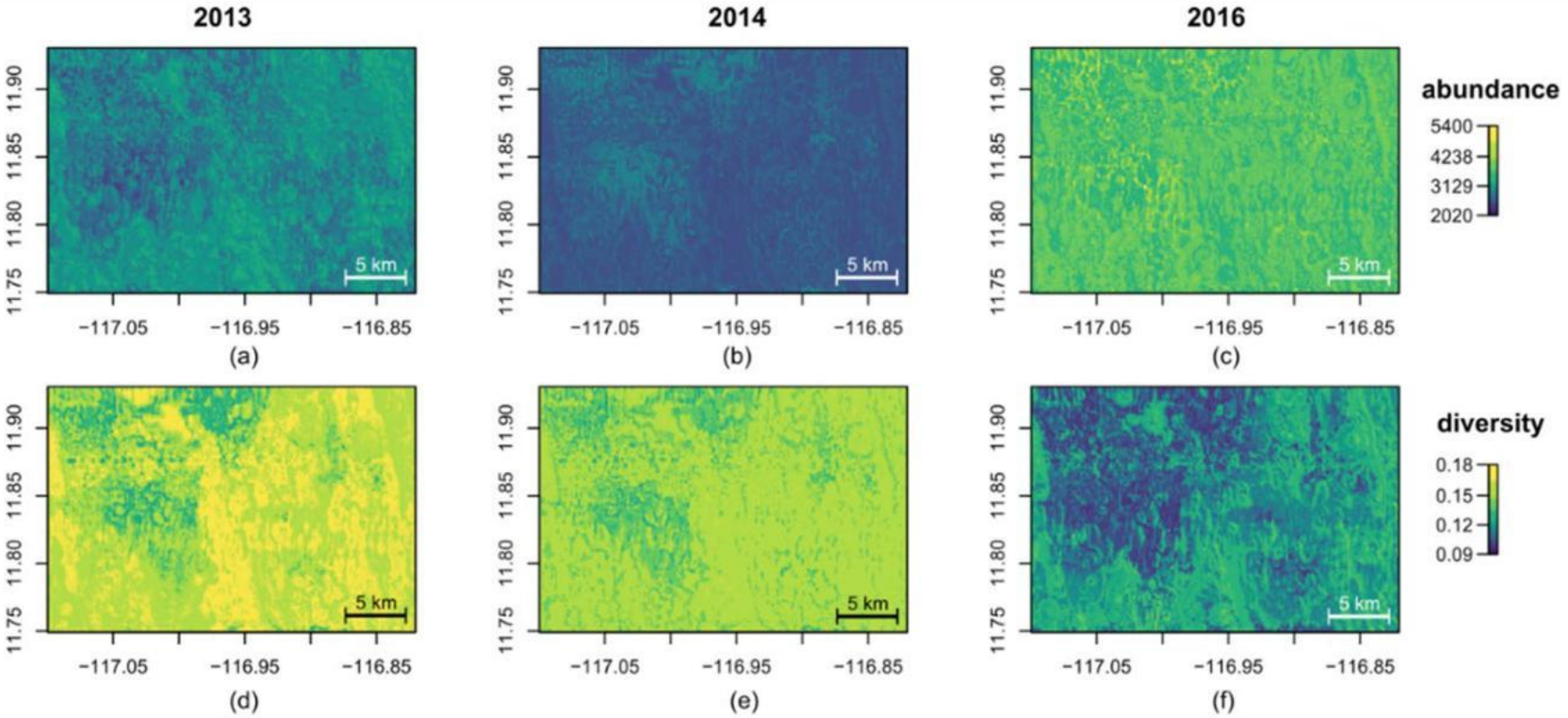
all available predictors

sediment & nodule parameters

-> robust predictor variables needed

Uhlenkott et al. 2021: Diversity 13:3

Distribution over time in the German exploration area (based on modelling): High temporal variability



-> high temporal variability and spatial variability: important to understand to be able to measure true mining impact (e.g. EIS), and to determine PRZ and IRZ!

->the CCZ is not uniform

->there is (very likely) no single indicator species for impact in the CCZ

Uhlenkott et al. 2021: Diversity 13:3

CORRECTED 11 APRIL 2019; SEE FULL TEXT

SCIENCE ADVANCES | REVIEW

ECOLOGY

Standards for distribution models in biodiversity assessments

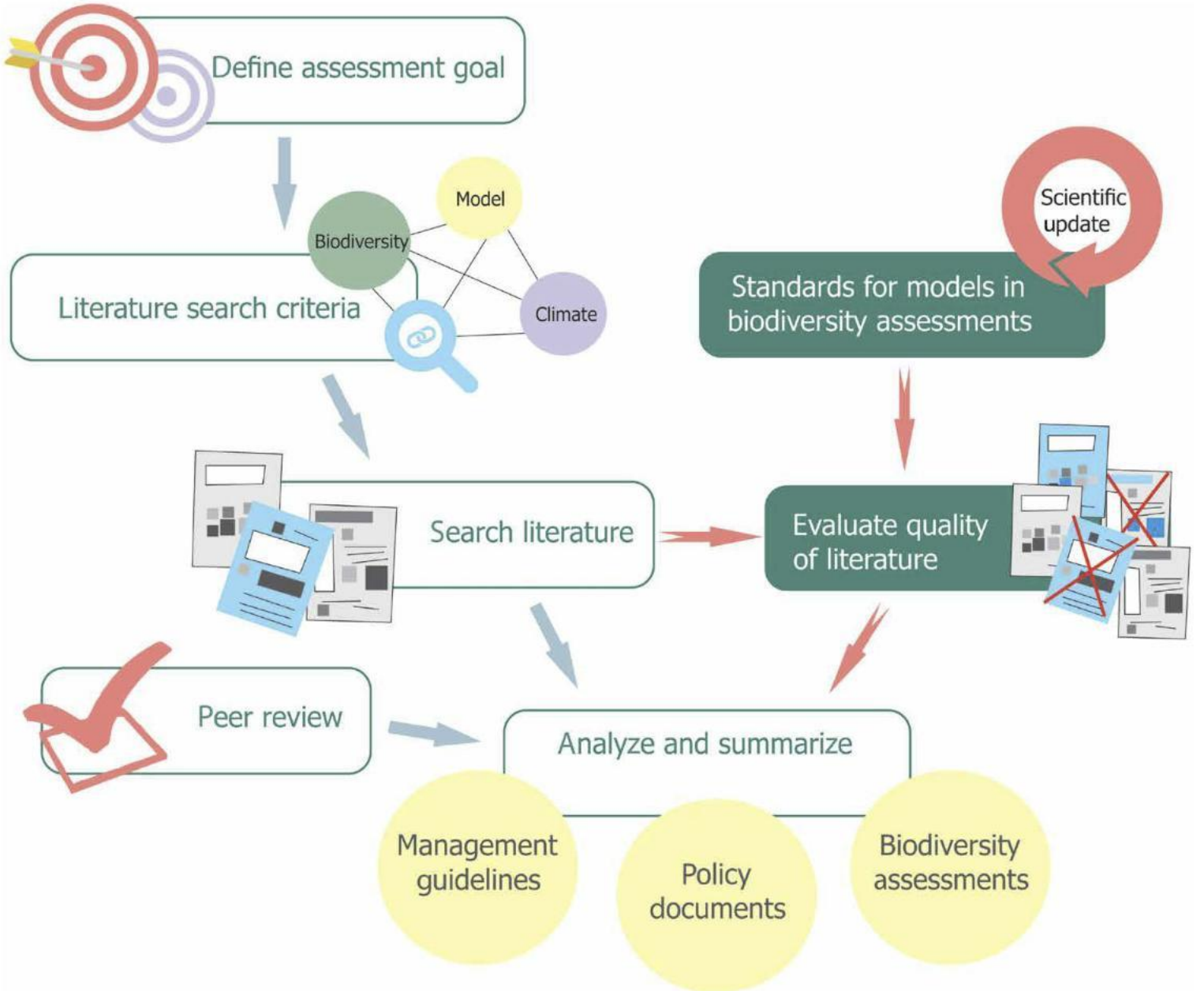
Miguel B. Araújo[1,2,3]*, Robert P. Anderson[4,5,6], A. Márcia Barbosa[3], Colin M. Beale[7], Carsten F. Dormann[8], Regan Early[9], Raquel A. Garcia[2,3,10,11], Antoine Guisan[12,13], Luigi Maiorano[14,15], Babak Naimi[2], Robert B. O'Hara[16,17], Niklaus E. Zimmermann[18,19], Carsten Rahbek[2,20]

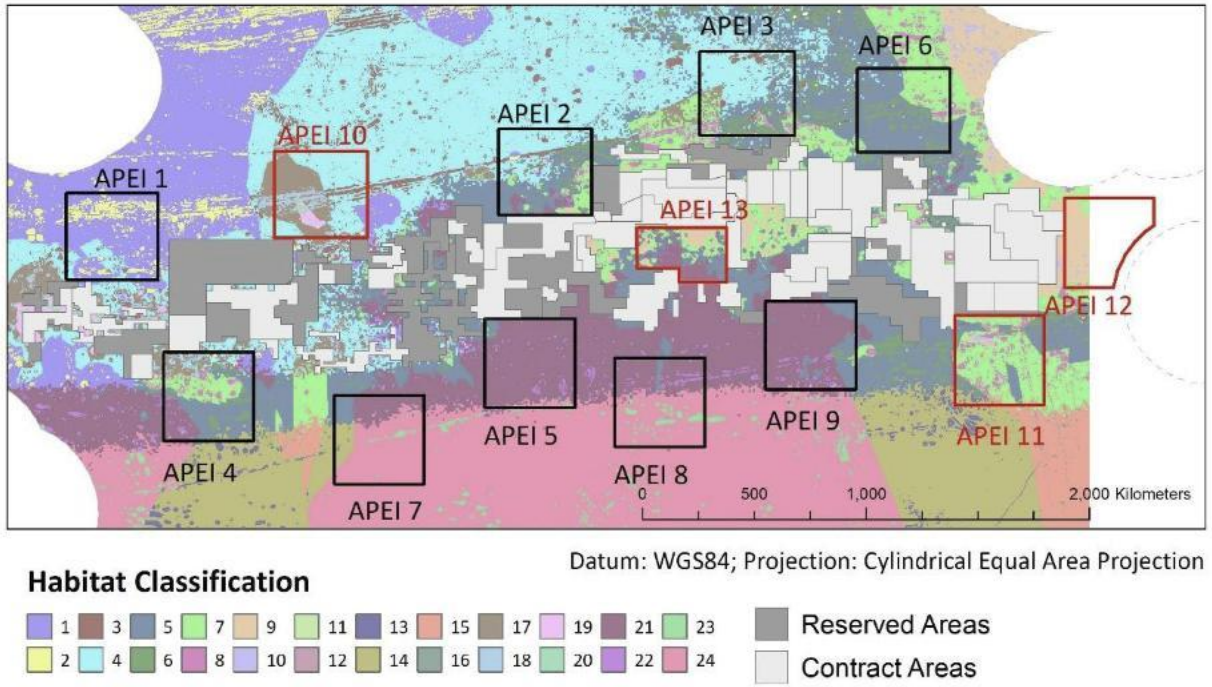
Demand for models in biodiversity assessments is rising, but which models are adequate for the task? We propose a set of best-practice standards and detailed guidelines enabling scoring of studies based on species distribution models for use in biodiversity assessments. We reviewed and scored 400 modeling studies over the past 20 years using the proposed standards and guidelines. We detected low model adequacy overall, but with a marked tendency of improvement over time in model building and, to a lesser degree, in biological data and model evaluation. We argue that implementation of agreed-upon standards for models in biodiversity assessments would promote transparency and repeatability, eventually leading to higher quality of the models and the inferences used in assessments. We encourage broad community participation toward the expansion and ongoing development of the proposed standards and guidelines.

Integrate standards to distribution models

Quality of model outputs depends on:

- quality of the "response variable" (usually **species occurrence data, well understood taxonomic identities**)
- quality of the "predictor variables" (usually **environmental data**),
- model building
- model evaluation





APEI – a very good **2-D** start BUT
CCZ is a large area: many more biodiversity baseline data are needed, **nodule habitat needs additional protection**

Some of the (many) open questions:
Are there sites/areas that are in need of protection in the CCZ? Where are those?
Guidelines and standards for IRZ and PRZ?
How severe is the mining impact?
At which scale is nodule removal serious harm – needs consideration of **temporal** and **spatial** scales.

3-D or 4-D REMPs?

2-D REMP: Nodules required to preserve abyssal epifauna

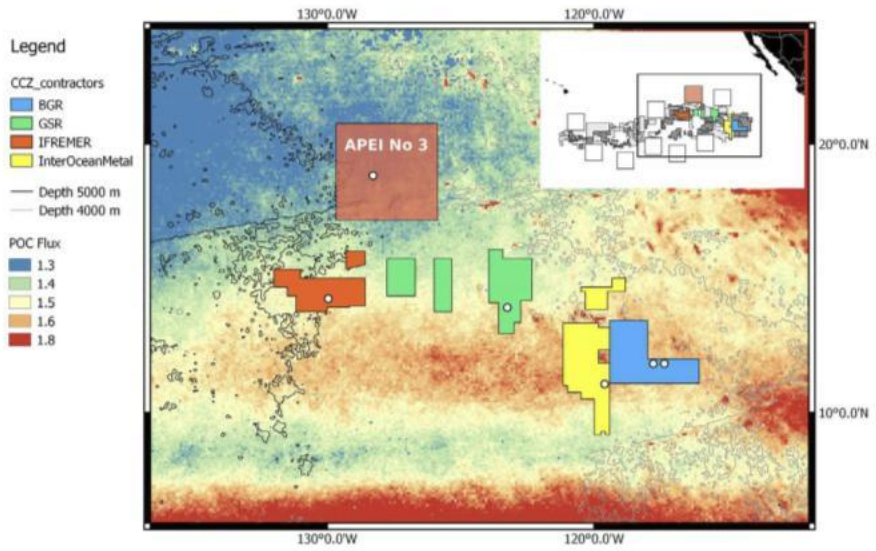
SCIENTIFIC REPORTS

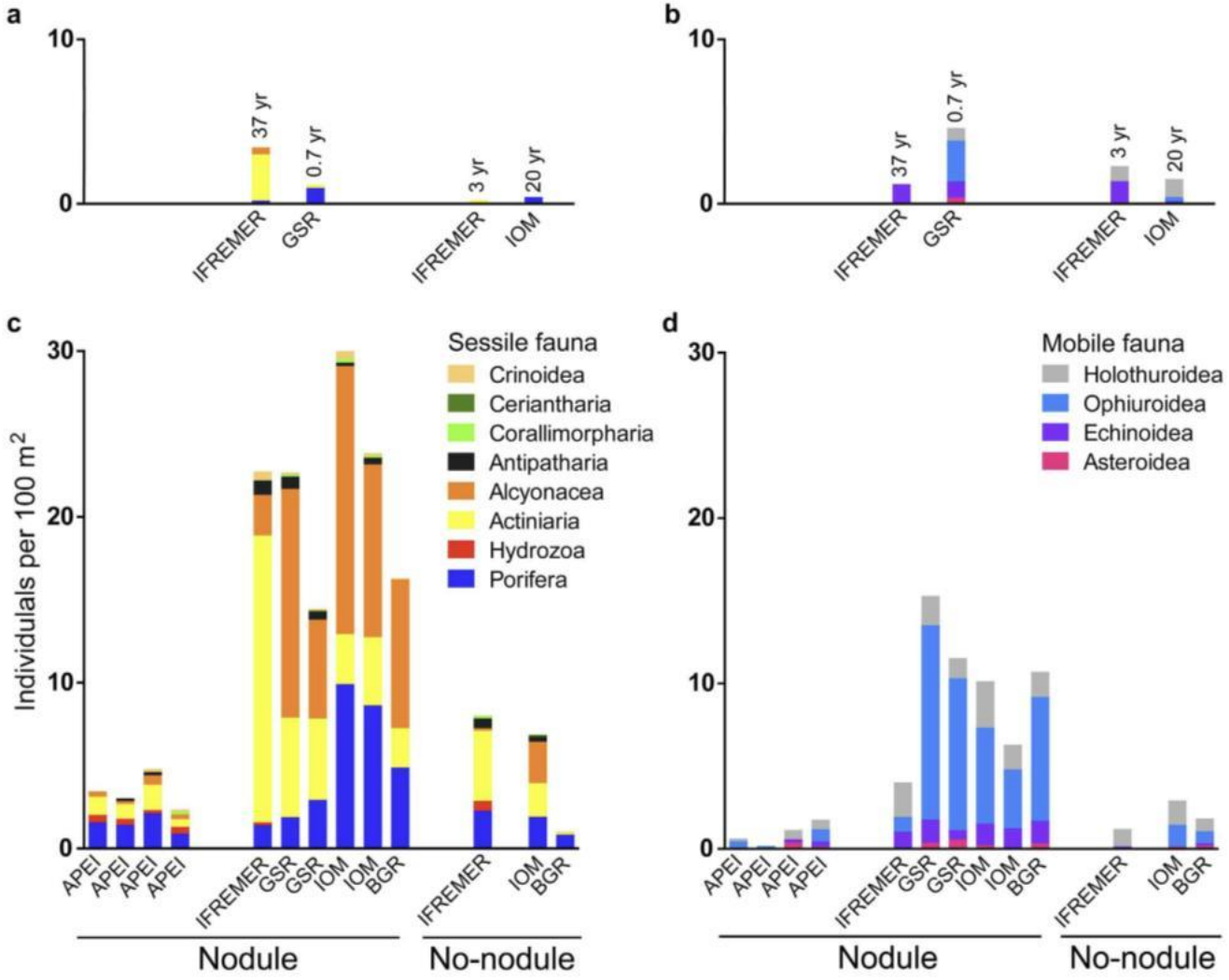
OPEN

Threatened by mining, polymetallic nodules are required to preserve abyssal epifauna

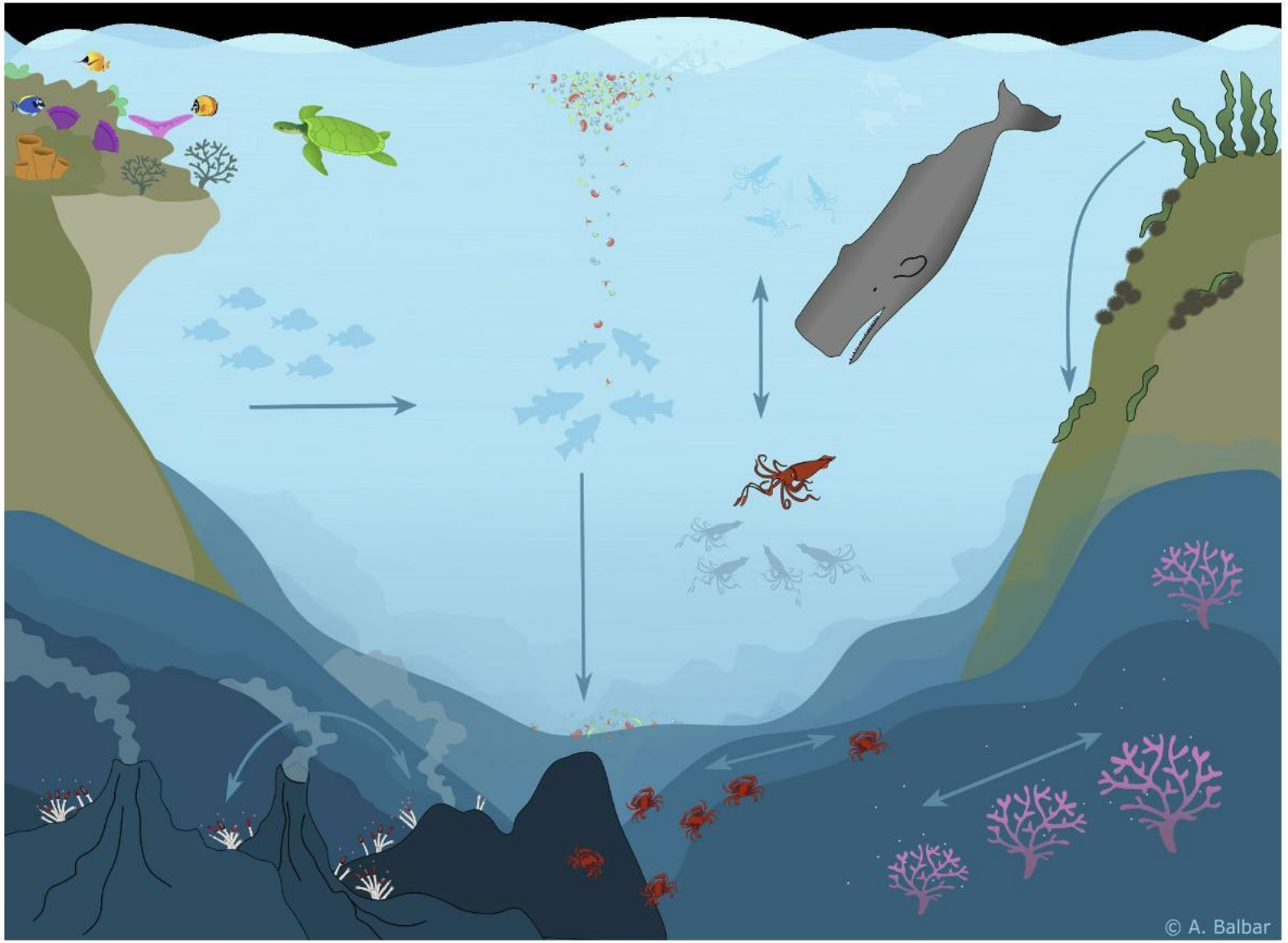
Received: 13 November 2015
Accepted: 09 May 2016

Ann Vanreusel[1,*], Ana Hilario[2,*], Pedro A. Ribeiro[3,4,*], Lenaick Menot[5,*] & Pedro Martinez Arbizu[6,*]



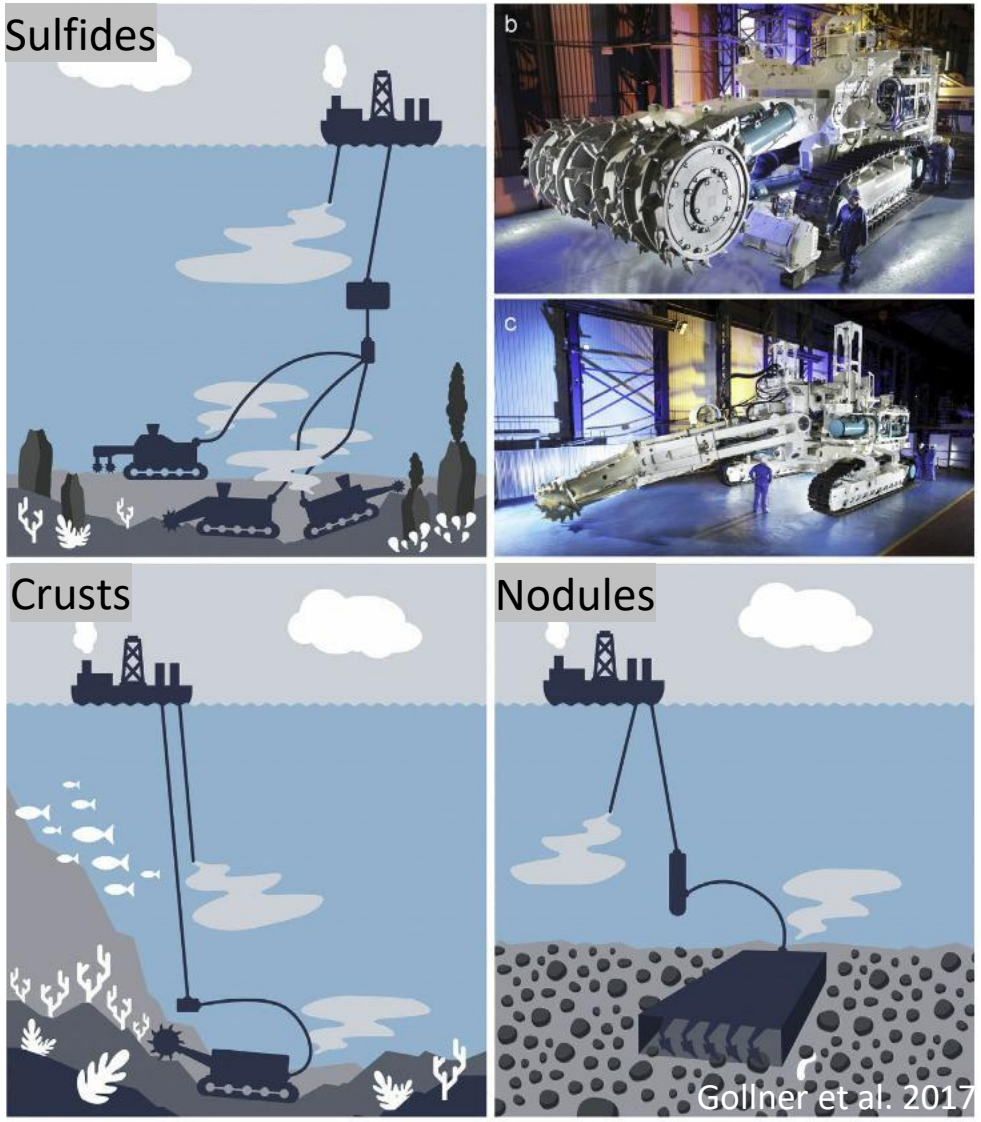


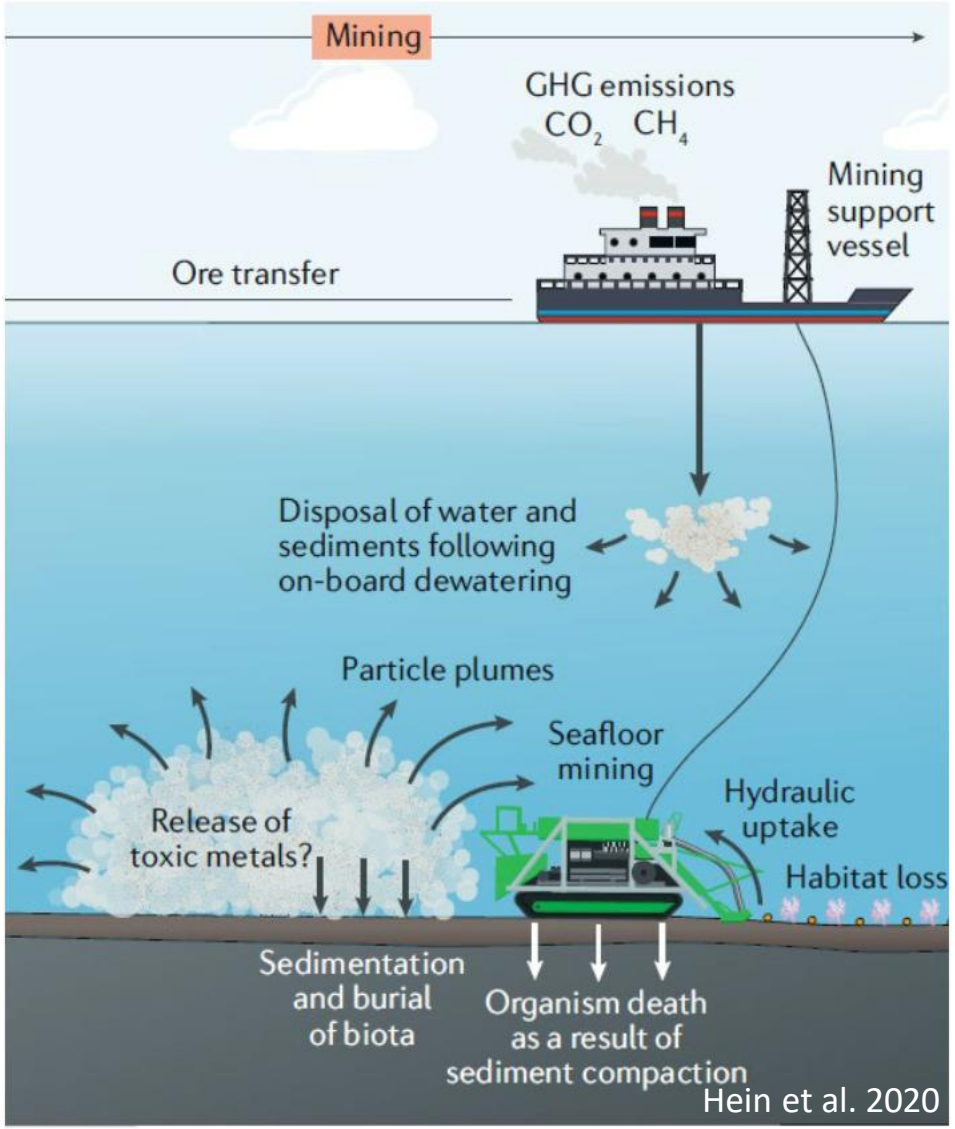
3-D REMP: bottom & water column



see Talk by Anna Metaxas

Environmental mining impact & time scales of recovery
(one part of the 4th dimension - time)





Main mining impacts:

- Removal of mineral resource

->Habitat loss,fragmentation & modification

- Sediment plumes (vehicle & return plume)

->burial, clogging of filter apparatus, toxic effects

- Sound & Light

Time scales:

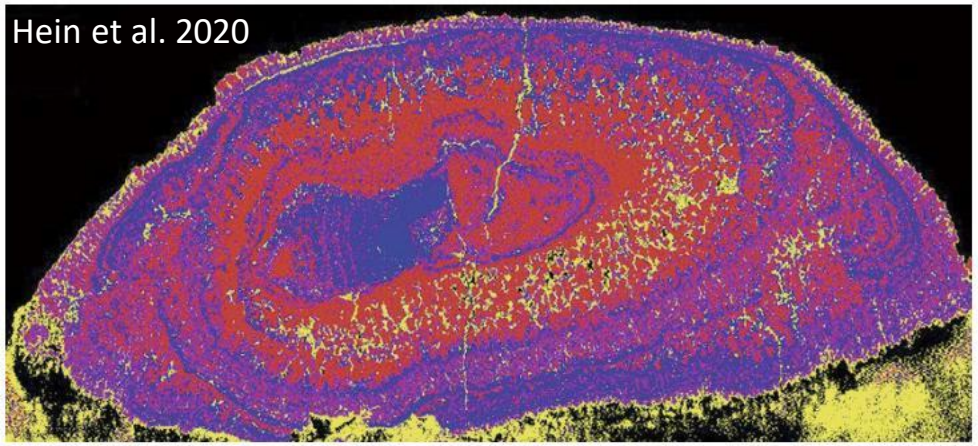
- **Geological timescales for resource recovery**
- From a few years to million years for community recovery at the mined area

Removal of nodules – Time scales of impact (the 4th dimension)

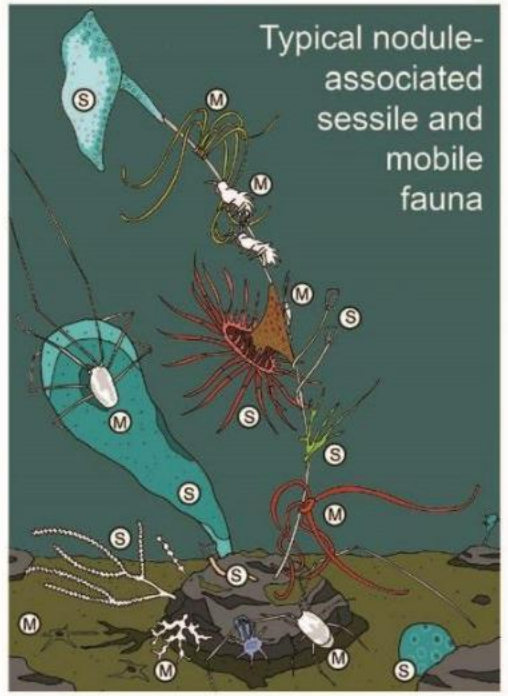
- **Removal of nodules = removal (loss) of nodule-obligate fauna on million year scale at the mined location** (nodule growth rate ~ a few mm per million years)
- Nodules are porous and have obligate epifauna (e.g. sponges) and (non-obligate?) infauna
- Nodules and their epifauna are critical for ecosystem function (e.g. food-webs)

-> **can restoration** (e.g.artificial nodules) **aid mitigation**? **If no = serious harm on geological time scale**

-> it needs are clear objective (e.g. if serious harm is accepted on geological time scale, what is the spatial scale that is accepted?)

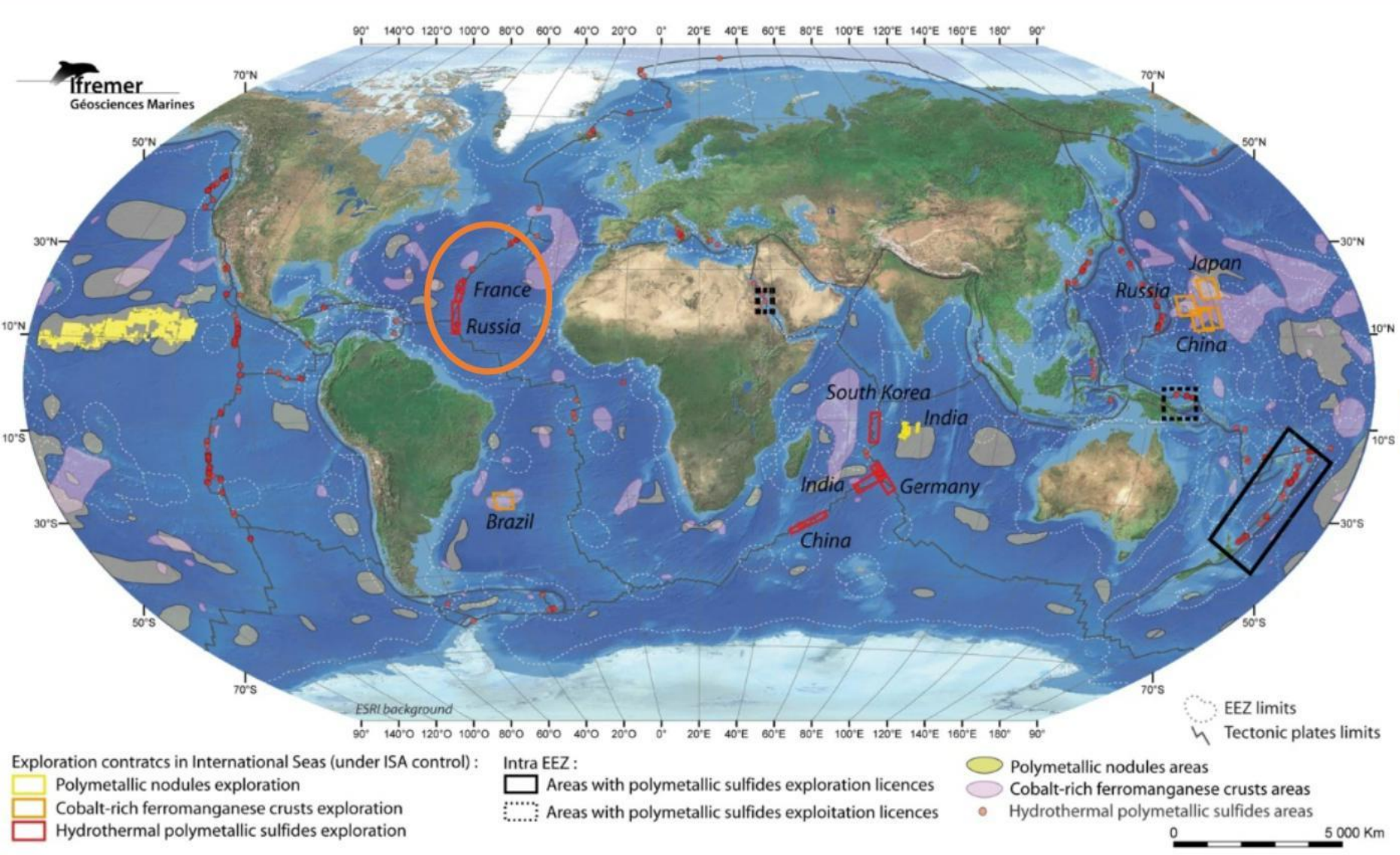


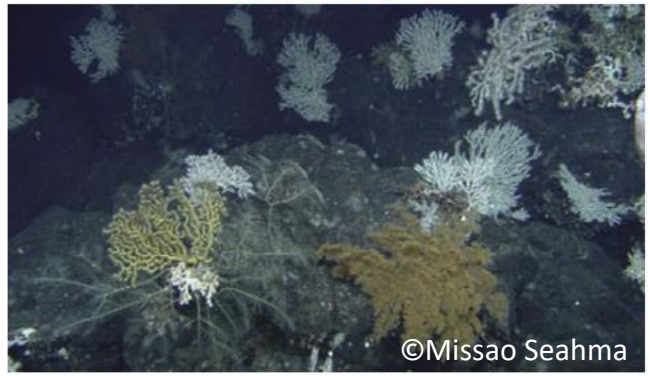
X- ray scan of a nodule cross section from the Clarion–Clipperton Zone with typical alternation of Mn- rich (red) and Fe- rich (purple) layers. Sediment (yellow) within the nodules is an indication of their high porosity.



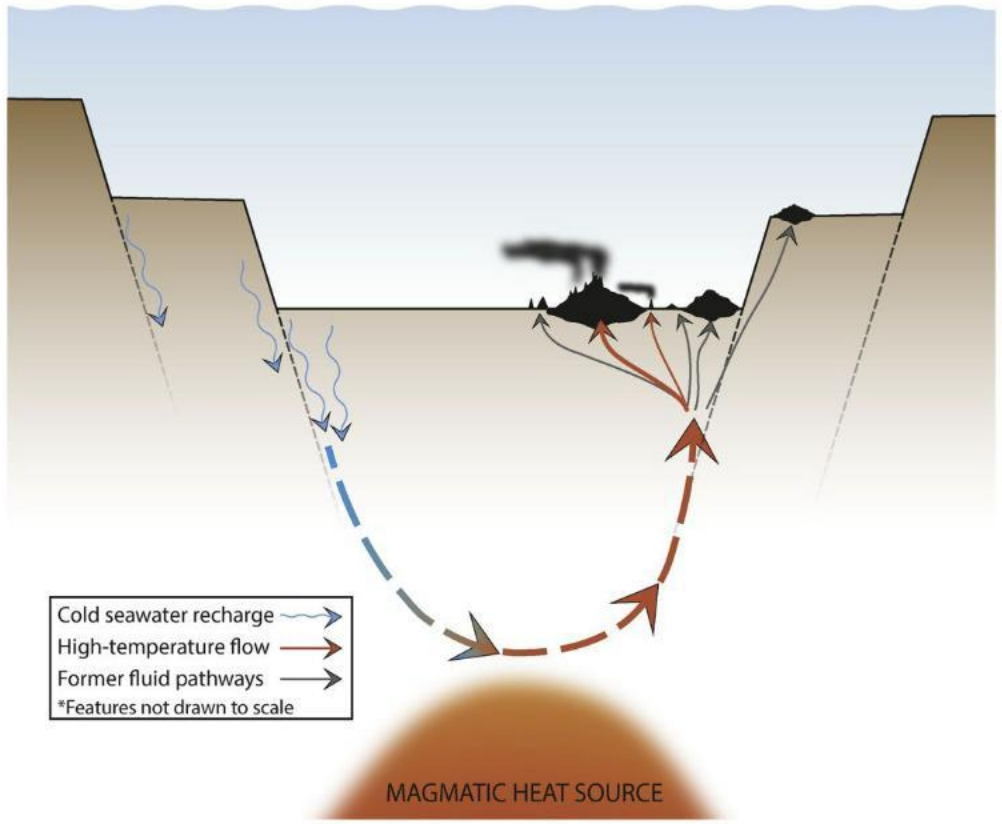
Deep-sea mineral resources

polymetallic nodules/abyssal plains, polymetallic sulfides/hydrothermal vents, cobalt-rich crusts/seamounts

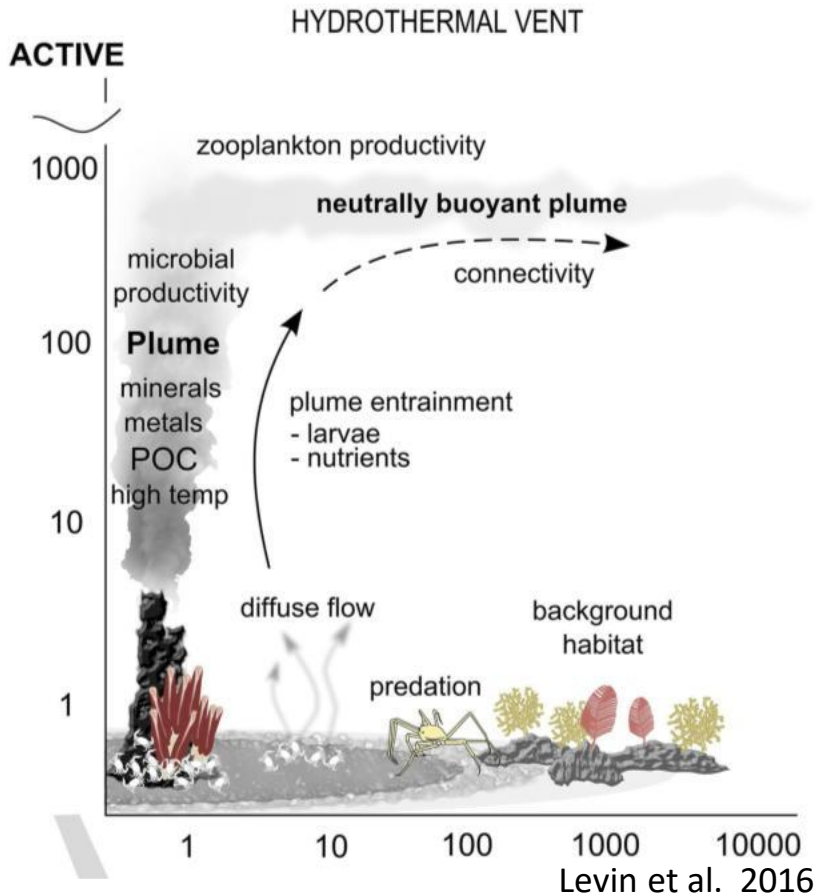




Ecological connectivity
Polymetallic Sulfides at Hydrothermal Vents

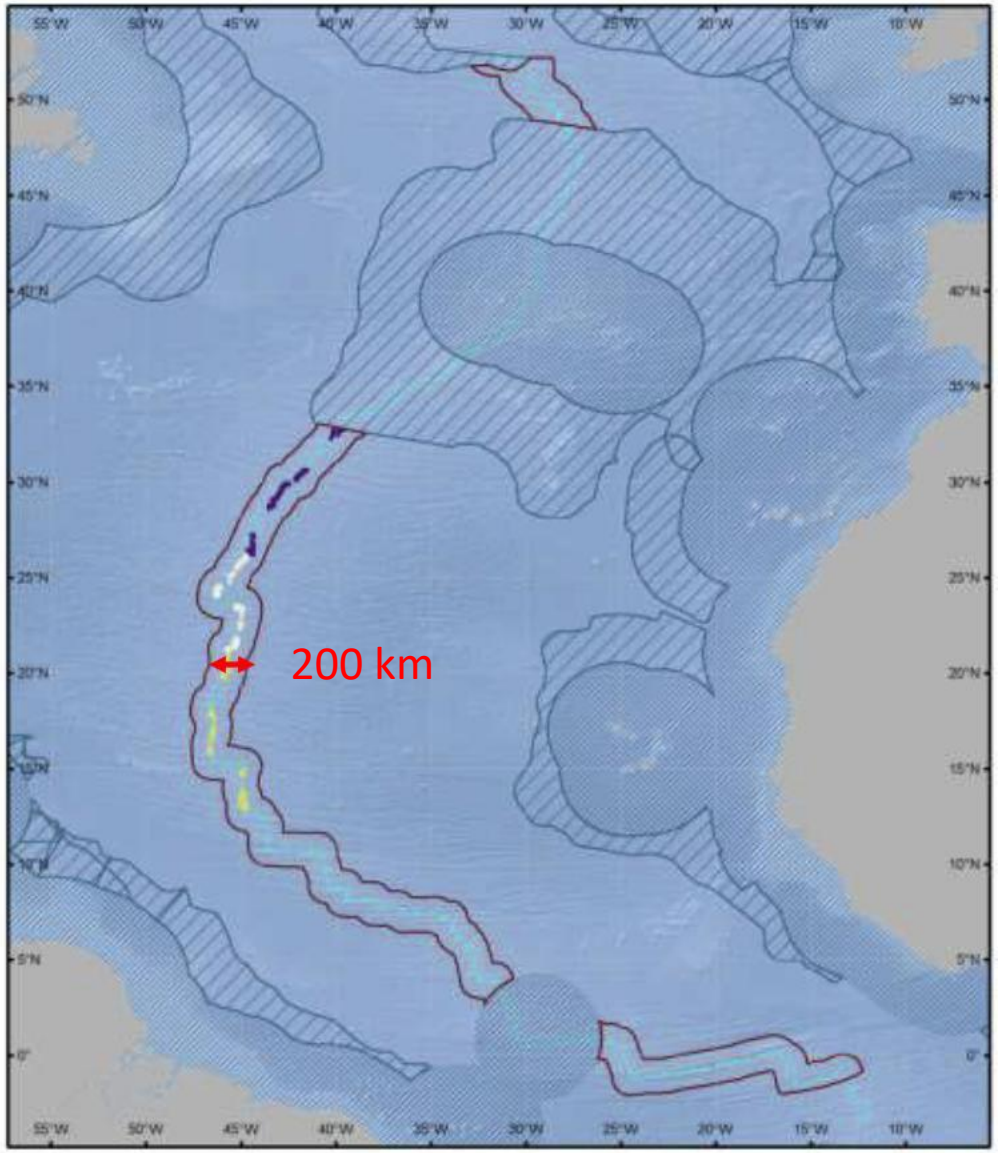


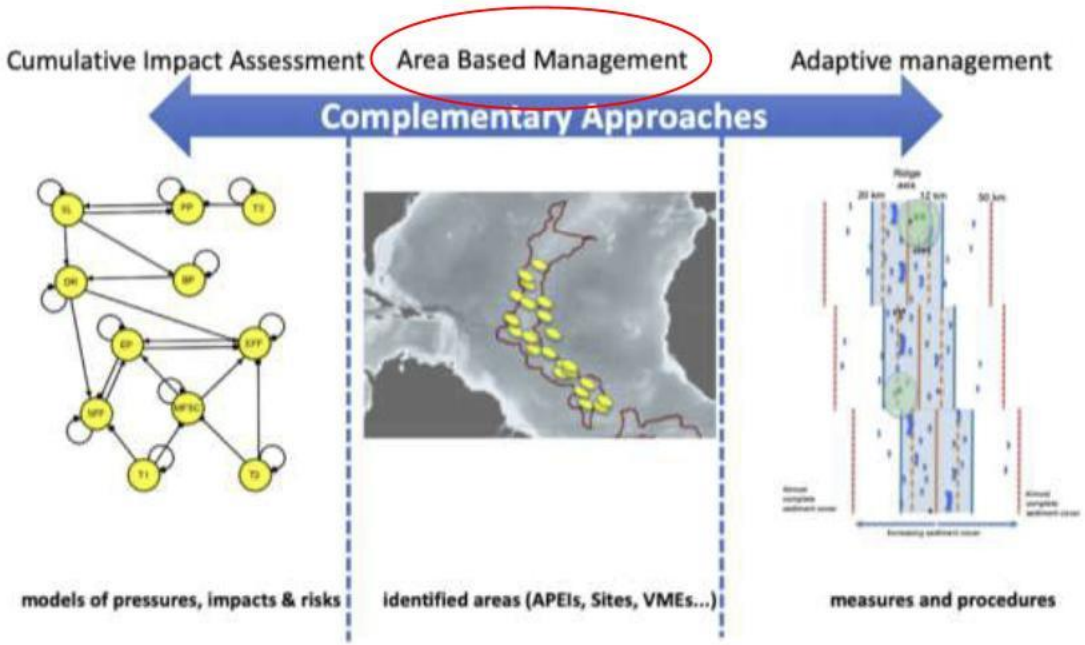
Jamieson & Gartman 2020



Levin et al. 2016

-> active vents & inactive vents & vent surrounding!


200 km
Full Extent of Workshop Scope
1,000 km
Workshop Scope
Ridge Axis
EEZ
ECS Submissions
Exploration Areas
Republic of Poland
IFREMER (France)
Russian Federation
Marine Geospatial Ecology Lab, Duke University (2019)


Cumulative Impact Assessment
Area Based Management
Adaptive management
Complementary Approaches
models of pressures, impacts & risks
identified areas (APEIs, Sites, VMEs...)
measures and procedures

The three types of tools

(1) **Sites in need of protection (SINPs)** are fine-scale sites, where there is observation or evidence of vulnerable or sensitive species/ecosystems. During workshop, based on FAO's criteria for vulnerable marine ecosystem (VME) (uniqueness, functional significance, fragility, structural complexity).

(2) **Areas in need of protection (AINPs)** are large-scale areas of ecological importance due to their uniqueness and/or biodiversity. During workshop, based on scientific criteria of the CBD for Ecologically or Biologically Significant Marine Areas (EBSAs).

(3) **Representative Areas using network criteria (not done yet)**

"Protection" Versus "in Need of Precaution"

->sufficient versus insufficient (?) data

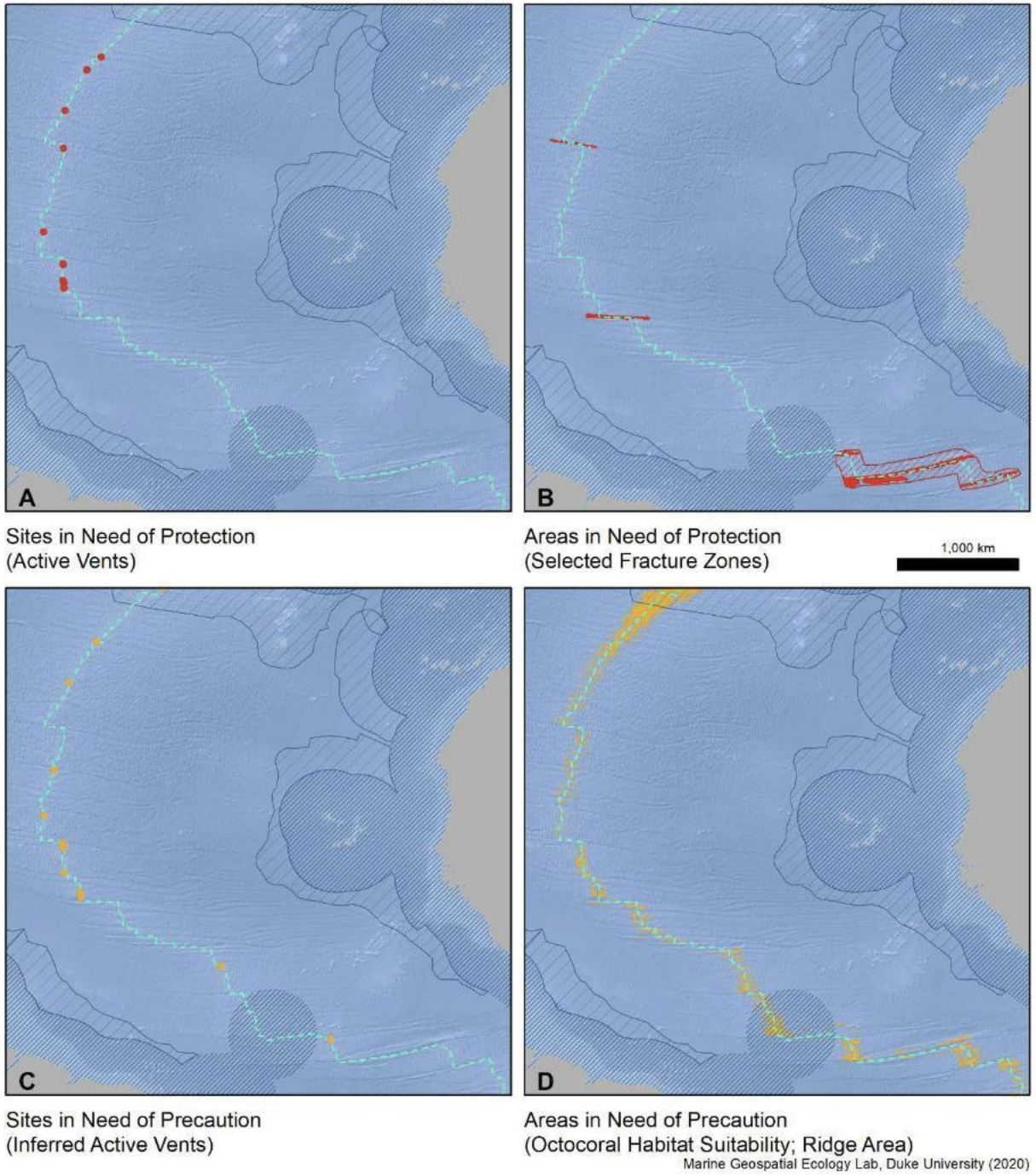
->inferred vent fields

->data from habitat suitability modelling: Octocoral presence

-> how do "we" get the needed data?

-> When is a model considered robust?

-> Transparency & scientific review should be at the basis!



Sites in Need of Protection (Active Vents)

Areas in Need of Protection (Selected Fracture Zones)

Sites in Need of Precaution (Inferred Active Vents)

Areas in Need of Precaution (Octocoral Habitat Suitability; Ridge Area)

Marine Geospatial Ecology Lab, Duke University (2020)

From ISA nMAR REMP workshop report (23.11 – 4.12.2020)

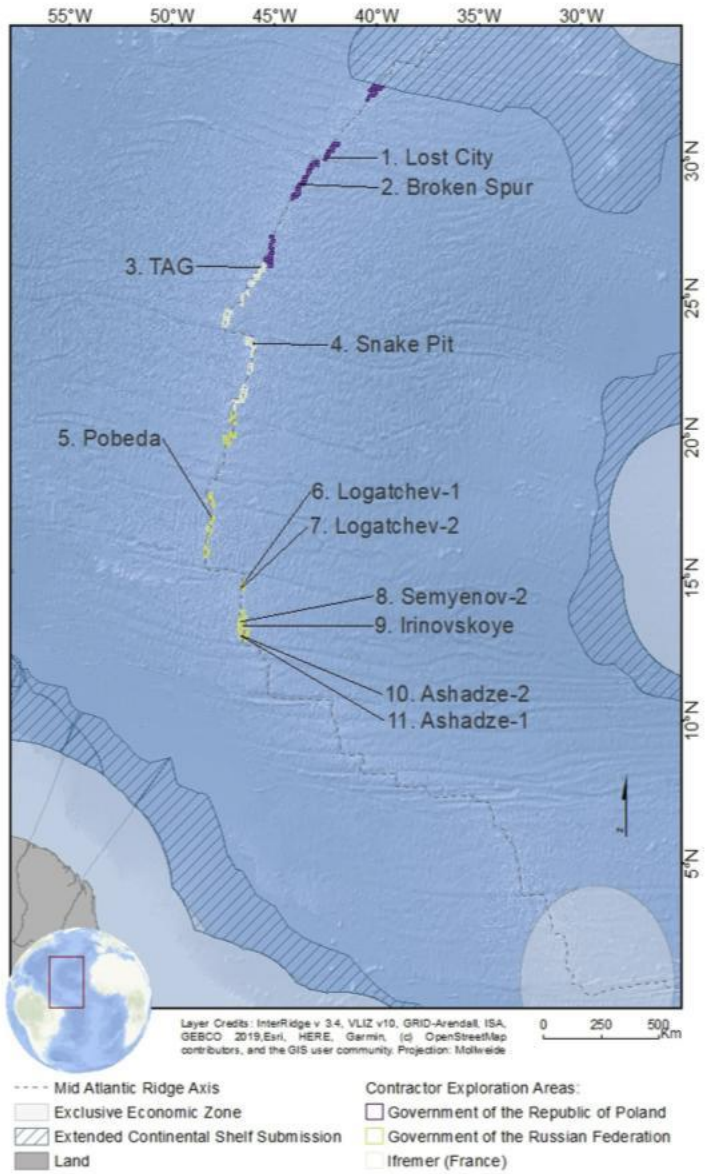
Unique vent fields along the nMAR

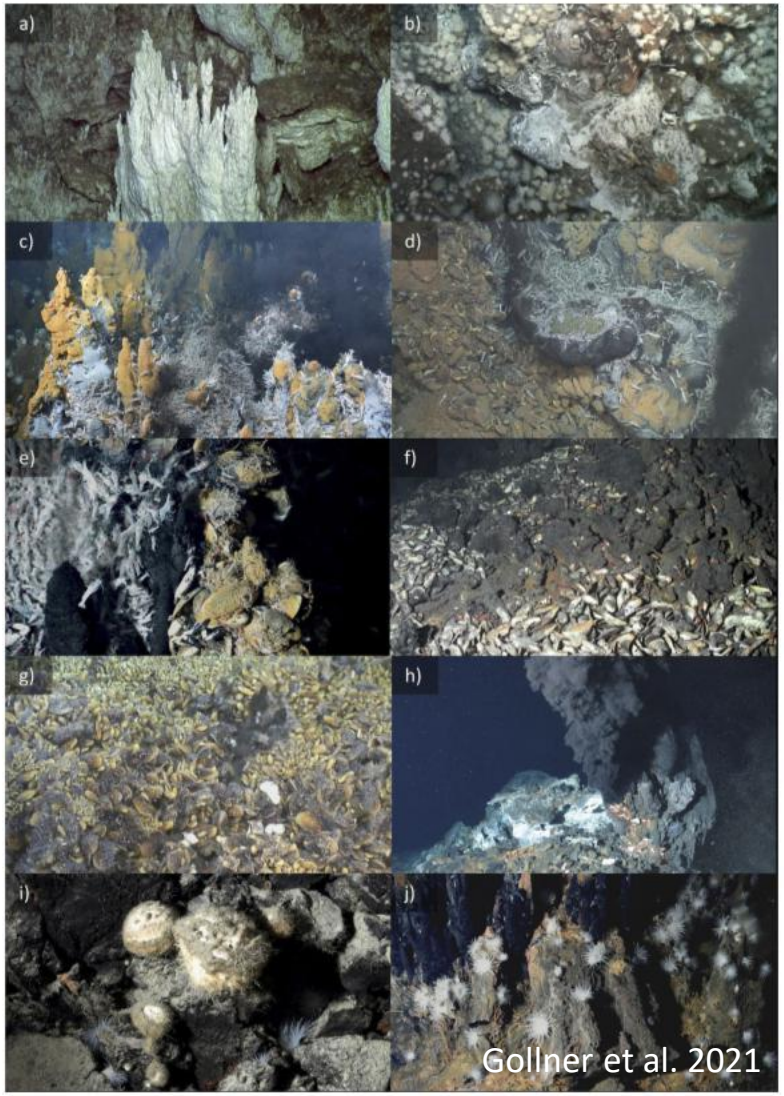
-> 11 vent fields suggested as sites in need of protection

->based on scientific knowledge (from the past ~40 years)

Locations of the 11 hydrothermal vent fields within the *Area* on the nMAR and of the exploration contract blocks (10 km x 10 km; not to scale) awarded by the International Seabed Authority to date.

From the InterRidge Global Database of Active Submarine Hydrothermal Vent Fields Version 3.4. PANGAEA.





Vent fields on the nMAR.
a)Lost City
b) Broken Spur
c) TAG
d) Snake Pit
e) Logatchev-1
f) Logatchev-2
g) Semyenov-2
h) Irinovskoe
i) Ashadze-2
j) Ashadze-1
Images copyright Ifremer

Application of scientific criteria for identifying hydrothermal ecosystems in need of protection

S. Gollner, A. Colaço,A. Gebruk, P.N. Halpin, N. Higgs, E. Menini, N.C. Mestre, P.-Y. Qian, J. Sarrazin, K. Szafranski, C.L. Van Dover

Criteria (e.g. uniqueness, functional significance, fragility,…) adapted from

FISHING

Food and Agricultural Organization (FAO)

Vulnerable Marine Ecosystems (VMEs)

MARITIME ACTIVITIES

International Maritime Organization (IMO)

Particularly Sensitive Sea Areas (PSSAs)

BIOLOGICAL DIVERSITY

Convention on Biological Diversity (CBD)

Ecologically or Biologically Significant Areas (EBSAs)

Highlights

- Criteria exist to assess vulnerability and importance of marine ecosystems.
- Nine criteria were applied to 11 hydrothermal vents on the Northern Mid-Atlantic Ridge.
- Suites of physico-chemical and biological attributes are unique at each vent field.
- **All vent fields meet multiple or all criteria for vulnerability and importance**.
- While further research always adds insight, **enough is known** about active hydrothermal vents now **to proceed with their protection (worldwide).**

ELSEVIER

Marine Policy

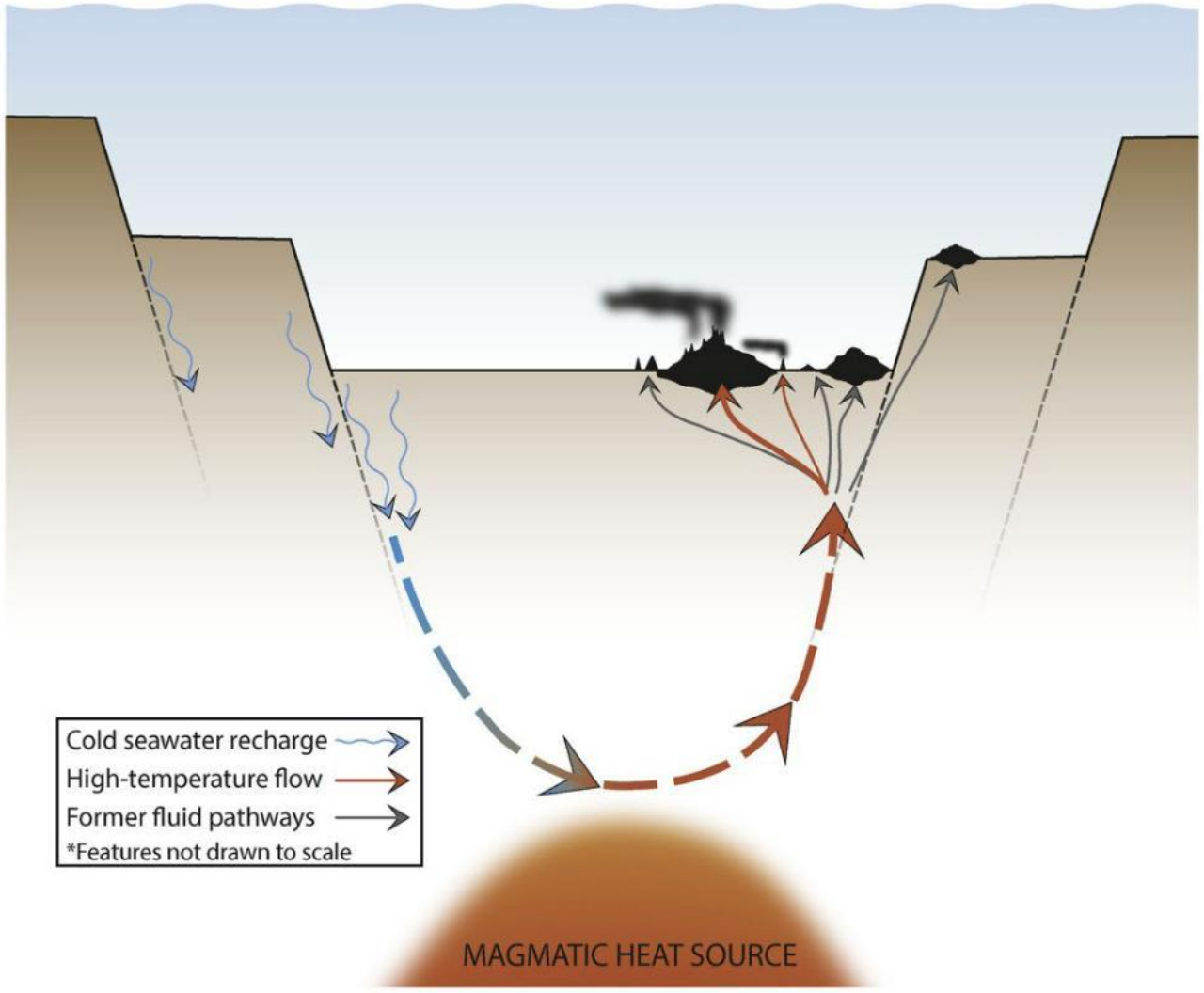
Volume 132, October 2021, 104641

Application of scientific criteria for identifying hydrothermal ecosystems in need of protection

S. Gollner [a], A. Colaço [b], A. Gebruk [c], P.N. Halpin [d], N. Higgs [e], E. Menini [d], N.C. Mestre [f], P.-Y. Qian [g], J. Sarrazin [h], K. Szafranski [i,j], C.L. Van Dover [d]

CRITERION	SUBCRITERIA	nMAR Vent Fields in the *Area* (North to South)										
		Lost City	Broken Spur	TAG	Snake Pit	Pobeda	Logatchev 1	Logatchev 2	Semenov	Irinovskoe	Ashadze 2	Ashadze 1
1. Uniqueness or rarity. An area or ecosystem that is unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include:	1.1 habitats that contain endemic species											
	1.2 habitats of rare, threatened, or endangered species; only in discrete areas											
	1.3 nurseries or discrete feeding, breeding, or spawning areas	?										
	1.4 unique or unusual biotic or abiotic features (chemical, physical, geological)											
2. Functional significance. A discrete area or habitats that are necessary:	2.1 for survival, function (e.g., feeding), spawning/reproduction, or recovery of species							?				
	2.2 for specific life history stages (e.g., nursery grounds or rearing areas, migratory routes for fish, reptiles, birds, mammals, invertebrates)	?						?				
	2.3 for rare, threatened, or endangered marine species							?				
3. Fragility.	3.1 An area that contains a relatively high proportion of sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events)											
4. Life-history traits that make recovery difficult. Ecosystems that are characterized by populations or assemblages of species with one or more of the following characteristics	4.1 slow growth rates							?				
	4.2 late age of maturity							?				
	4.3 low or unpredictable recruitment							?				
	4.4 long-lived species							?				
5. Structural complexity. An area or ecosystem that is characterized by:	5.1 complex physical structures created by biotic and abiotic features											
	5.2 ecological processes are dependent on these structured physical systems							?				
6. Biological diversity.	6.1 An area that contains comparatively higher diversity of ecosystems (including high diversity associated to complex structures), habitats, communities, or species, or has higher genetic diversity											
7. Biological productivity.	7.1 An area that has a particularly high rate of natural biological production. Such productivity is the net result of biological and physical processes which result in an increase in biomass							?				
8. Naturalness.	8.1 An area with a comparatively higher degree of naturalness due to lack of or low level of human-induced disturbance or degradation							?				
9. Ecosystem services. An area or ecosystem that provides or has high potential to provide:	9.1 provisioning services, such as food and energy, which are directly used by people (including marine genetic resources and bioprospecting, bioinspired materials, bioinspired processes)							?				
	9.2 regulating services, that cover the way ecosystems regulate other environmental media or processes (including climate regulation, biological pump, and carbon sequestration)							?				
	9.3 cultural services that are related to the cultural or spiritual needs of people. These include spiritual services, aesthetic services, recreation, education (e.g., an area that offers an exceptional opportunity to demonstrate natural phenomena), and science (e.g., a research area that has high scientific interest, increasing scientific knowledge; or e.g., an area that suitable for baseline monitoring conditions because it is in near natural condition)											
	9.4 supporting services, such as ecosystem processes and functions that underpin other three types of services (including primary production, nutrient cycling)											

3D Area based management tools



What is the size of SINPs?
What is the core zone?
What is the buffer zone?
->what is the footprint of the vent?

Science data needed as basis for effective REMPS

Baseline data:
-WHAT species and WHERE are they (endemic versus pseudo-endemic)?
-HOW are they connected?
-What is their ecosystem function?

->Standardized methods are needed (e.g. to avoid eDNA versus barcoding in eastern/western CCZ)
->Sampling to understand if ABMTs are really fit for purpose (modelling & **monitoring**)
->Who is responsible for monitoring in the various locations? Who is coordinating? Who has the competence?

Understanding resilience of communities to mining impact:
First test-mining in 2021 (it needs to time to analyze data)
-> note: a solid baseline is needed before test-mining, otherwise the impact can't be measured!
Removal of habitat on geological timescale – what is a "significant adverse impact"?
Effect of sound???

MIDWATER ECOSYSTEMS – very limited knowledge

Drazen et al. 2020