Approaches for spatial planning

Area Based Management Tools



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WORKSHOP ON THE REGIONAL ENVIRONMENTAL MANAGEMENT PLAN FOR THE AREA OF THE NORTHERN MID-ATLANTIC RIDGE 25-29 November 2019, Évora, Portugal

ABMT vs Non-ABMT approaches

June 2018, Szczecin, Poland



"...including the primary goal of facilitating seabed mining while maintaining biodiversity, protecting unique and representative habitats, and preserving ecosystem function through *both* <u>area-based management tools</u> (ABMTs) and <u>non-ABMTs (e.g.</u> ...management measures)."

Cumulative Impact Assessment Area Based Management

Adaptive management









measures and procedures

models of pressures, impacts & risks

identified areas (APEIs, Sites, VMEs...)

	Cumulative Impact Assessment	Area Based Management	Adaptive Management	
Who (stakeholders)	multi-sectoral stakeholders	sectoral, scientific & conservation stakeholders	sectoral stakeholders, contractors	
What (products)	models linking pressures to risks for biodiversity	management area maps (APEIs, VMEs)	adaptive measures & guidelines	
When (timing)	a priori and/or ongoing	<i>a priori</i> mapping with opportunistic or periodic updates	applied during exploration / mining operations	
Where (scope & scale)	bioregional or management problem defined	ecoregional / ocean basin scope	exploration / mining areas	
How (process)	risk/loss models	proactive, criteria based, data dependent	adaptive, measures based, encounter triggered	
Why (benefits)	links drivers, pressures and impacts with values	provides area specific protection and buffers for representative ecosystem features	facilitates mining operations within measures and procedures	

Scale

Bioregional

Management region (REMP)

Active exploration or extraction areas

Cumulative Impact Assessment



Area Based Management



Adaptive management



nested & complementary approaches

Cumulative Impact Assessment



models of pressures, impacts & risks

identified areas (APEIs, Sites, VMEs...

Area Based Management

Adaptive management



measures and procedures

First workshop will focus on scientific synthesis and description, in particular with objectives to:

✓ review and analyze ecosystem data

- synthesize environmental data, faunal distribution, faunal dispersal capabilities and distances, genetic connectivity, patterns of biodiversity, community structure, ecosystem function, and ecological proxy variables
- ✓ review current exploration activity within contract areas and distribution of resources
- define the planning area, drawing on information on mineral provinces and biogeography
- describe potential areas that could be protected from exploitation in order to achieve effective protection of the marine environment, through the designation of areas of particular environmental interests (APEIs) and/or potential sites in need for protection to maintain ecological balance of the marine environment from harmful effects of mining activities, as a means to ensure effective protection for the marine environment under Article 145 of the Convention, which is further informed by Article 194 (5).

Review of scientific tools and approaches for spatial planning



Spatial management tools will play a significant role in the development and implementation of regional environmental management plans (REMPs)

It is important and timely to discuss the types of *available tools*, *approaches* and *considerations* required to develop robust and effective REMPs

Approaches



- Criteria based approaches
 - Site criteria
 - Network criteria
 - ABMT tools: APEIs, Sites in need of protection, Areas of elevated precaution...
- REMP ABMT implementation:
 - Expert knowledge elicitation / mapping
 - Implementing criteria
 - Evaluating ABMT configurations

Criteria references:



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Plans (REMPs)

International Seabed Authority Secretariat

Environmental Management of Deep-Sea Chemosynthetic Ecosystems: Justification of and Considerations for a Spatially-Based Approach Technical Study: No. 9



Designating networks of chemosynthetic ecosystem reserves in the deep sea

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ABSTRACT

From the moment of their

scientific value. At the same

other sectors are either

ecosystems. There is a nee

chemosynthetic ecosyster

concerned stakeholders.

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SEMPIA

complexes on land, SMS deposits have long been exploited for their ores

vents that emit diffuse and/or focused hydrothermal fluid and support

symbiont-hosting invertebrate taxa that rely on uptake of inorganic compounds in the hydrothermal fluid to support microbial chemo-

synthesis (4). Large inactive, or "extinct" SMS accumulations on mid-

ocean ridges are less studied than active vent systems. They generally

lack biomass-rich assemblages of vent-endemic taxa but likely support

highly diverse and complex benthic communities (5, 6). SMS deposits at

inactive vents may be the preferred target for commercial mining based

on environmental considerations (7), estimated size of the ore bodies

(8-10), and the practicalities of avoiding equipment exposure to the

The United Nations Convention on the Law of the Sea (UNCLOS) sets out the legal framework for seabed mining beyond the limits of na-

tional jurisdiction (referred to as "the Area"). The convention, along

with the 1994 Implementing Agreement, established the International Seabed Authority (ISA) as the regulatory agency for deep-sea mining

in the Area. The ISA is also charged with, among other things, ensuring effective protection of the marine environment from harmful effects arising from mining-related activities on the seabed (UNCLOS

article 145). These responsibilities include the need to adopt and periodically review environmental rules, regulations, and procedures for the

high-temperature, acidic conditions at active vents (11).

SCIENCE ADVANCES | RESEARCH ARTICLE

OCEANOGRAPHY

A strategy for the conservation of biodiversity on mid-ocean ridges from deep-sea mining

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Mineral exploitation has spread from land to shallow coastal waters and is now planned for the offshore, deep seabed. Large seafloor areas are being approved for exploration for seafloor mineral deposits, creating a urgent need for regional environmental management plans. Networks of areas where mining and mining impacts are prohibited are key elements of these plans. We adapt marine reserve design principles to the distinctive biophysical environment of mid-ocean ridges, offer a framework for design and evaluation of these networks to support conservation of benthic ecosystems on mid-ocean ridges, and introduce projected dimate-induced changes in the deep sea to the evaluation of reserve design. We enumerate a suite of metrics to measure network performance against conservation targets and network design criteria promulgated by the Convention on Biological Diversity. We apply these metrics to network scenarios on the northern and equatorial Mid-Atlantic Ridge, where contractors are exploring for seafloor massive sulfide (SMS) deposits. A latitudinally distributed network of areas performs well at (i) capturing ecologically important areas and 30 to 50% of the spreading ridge areas, (ii) replicating representative areas, (iii) maintaining along-ridge population connectivity, and (iv) protecting areas potentially less affected by climate-related changes. Critically, the network design is adaptive, allowing for refinement based on new knowledge and the location of mining sites. provided that design principles and conservation targets are maintained. This framework can be applied along the global mid-ocean ridge system as a precautionary measure to protect biodiversity and ecosystem function from impacts of SMS mining.

INTRODUCTION itate and can accumulate as seafloor massive sulfides (SMS also referred Mid-ocean ridges are located at divergent oceanic plate boundaries, to as polymetallic sulfides). Where uplifted and exposed as ophiolite where volcanism associated with seafloor spreading creates new oceanic crust. In these regions, seawater percolates through seafloor cracks and (1), They are now targeted for mining at the seabed (2). At slow seafloor fissures to depths where it reacts with host rock at high temperature and spreading rates (<4 cm year-1), SMS deposits may accumulate over pressure, stripping the rock of metals such as copper and zinc. The thousands of years and can be of sufficient size and ore quality to be heated, chemically modified fluid is thermally buoyant and rises to exit of commercial interest (2, 3). Some large SMS deposits on the seabed the seafloor through hydrothermal vents, where metal sulfides precip- are located at "active" hydrothermal vents, operationally defined as

Mattine Geospatial Endographia Disk in of Marine Science and Conservation. Notes in the second science of the science of the second science of the second science of the science of the science of the science of the second science of the science of th grative Oceanography Division, Scripps Institution of Oceanography, UC San Diego, La Jolla, CA 92093, USA. "Deep-Ocean Stewardship Initiative and Deep Ocean Observing Jala, CA 2020, USA: Toep-Coan Sewardale Institute and Deep Coan Observing Strateg, Unreventy of Sortherspect, Unreventy Nada Sottamport, UK, "MMI Inst Southerspect Company, Unreventy Nada Sottamport, UK, "South An-odation for Native Science, South Native Institute, Cana, April, UK, "Soliton V atture of Coanadoga, Ratan In Academy of Science, Natan, "NUSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, Nata, "NUSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, "NUSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, "NUSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, "NuSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, "NuSA Classi Marking, Coanadoga, Ratan In Academy of Science, Natan, "NuSA, UK, "Soliton, UK, "Soliton, UK, "Soliton, UK, UK, "Soliton, UK,

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Criteria based approaches

- The selection of areas for protection in spatial planning are often based on criteria that must be interpreted through <u>quantitative</u> <u>regional analysis</u> and / or <u>qualitative scientific expert judgment</u> or a combination of these approaches.
- These criteria may be based on attributes or properties of *individual species*, *ecological communities*, *habitats* or broader *ecosystems*.
- These criteria may focus on the *inherent attributes* of the species or habitat or may focus on the *vulnerability* of the species or habitat to disruption or damage.

Criteria based approaches

There is significant agreement and overlap of the general criteria used in marine spatial analysis

Organization	CBD	FAO	IMO	UNESCO	RAMSAR	Birdlife	IUCN
Site criteria	EBSA	VME	PSSA	WHS	RAMSAR	IBA	KBA ^a
Uniqueness or rarity	1	✓	✓	\checkmark	1	1	✓
Special importance for life history stages of species	1	1	1	1	1	1	1
Importance to threatened or endangered species	1	1	1	1	1	1	1
Vulnerability, fragility, sensitivity or slow recovery	1	1	1	X	?	X	?
Productivity	1	X	1	1	X	X	?
Biodiversity	1	X	1	✓	1	X	?
Naturalness	1	X	1	1	1	X	?
Structure	X	1	1	X	X	X	?
Historical geomorphological importance	X	X	X	1	X	X	X

^a The KBA criteria are currently under review and is likely to be expanded to be more inclusive.

These criteria are targeted to identify *individual sites*

Criteria based approaches

Site criteria

Uniqueness or rarity

Special importance for life history stages of species Importance to threatened or endangered species Vulnerability, fragility, sensitivity or slow recovery Productivity Biodiversity

biodiversity

Naturalness

Structure

Historical geomorphological importance

While these criteria guide the identification of **individual sites** they generally require **regional analyses** to assess the importance of a site in the regional context

Site value / Regional value

(numerator / denominator)

Example: for a site to be selected for high biodiversity you would need to have reference information on the expected range of regional diversity.

Two levels of criteria: site criteria and network criteria

Site criteria

- Uniqueness or rarity
- Special importance for life history
- Importance for threatened, endangered or declining species or habitats
- Vulnerability, fragility or slow recovery
- Biological productivity
- Biological diversity
- Naturalness

Annex I of CBD Decision IX/20.

Network criteria

- representativity
- connectivity
- replication
- adequacy

These criteria often require gap analysis and network analysis...

Annex II of CBD Decision IX/20.

Two levels of criteria: site criteria and network criteria

Site criteria /

Network criteria

Box 1. Network criteria and conservation objectives for APEIs on a mid-ocean ridge based on CBD Marine Protected Area network criteria. Viability under climate change is newly integrated into the adequacy/viability criterion.

(1) Important areas

(a) Placement of APEIs within the network should capture areas considered to be ecologically and/or evolutionarily important based on best available science. APEIs should conserve 100% of identified important areas.

(2) Representativity

(a) APEI should conserve 30 to 50% of each habitat type (for example, the spreading ridge, seamounts, and transform faults) within each management unit.

(b) APEIs should be representative of the biophysical seascape (for example, depth, slope, and POC flux to the seafloor) within each management unit.

(3) Connectivity

(a) The APEI network should minimize the average and maximum distances between core areas to the greatest extent possible to conserve all dispersal scales and to ensure exchange across the entire network.(4) Replication

(a) APEIs should be replicated within biogeographic provinces
(where the size of the management unit permits) to capture along-axis variation in faunal composition and protect against localized catastrophes.
(5) Adequacy/viability

(a) The APEI network should protect 30 to 50% of the total management unit.

(b) Each APEI unit within the network should include a core area of sufficient length and width to maintain viable populations and ecosystem function.

(c) Each APEI unit within the network should include an appropriately sized buffer zone to protect core areas from indirect mining effects.

(d) Viability under climate change

(i) Projected biophysical conditions (temperature, pH, dissolved O_2 concentrations, and POC flux to the seafloor) in APEIs should include the range of current conditions across the study area.

(ii) APEIs should include at least 30% of the area projected to be least affected by reasonable climate change scenarios (based on predicted changes in temperature, pH, dissolved O₂ concentrations, and POC flux to the seafloor). Dunn et al. 2018

Dinard Guidelines: Example of a process to address a specific feature

Spatial Design of Chemosynthetic Ecological Reserves (CERs)

- Identify chemosynthetic sites that meet the Convention on Biodiversity criteria for Ecologically and Biologically Significant Areas (EBSAs) or are otherwise of particular scientific, historical, or cultural importance for priority consideration for protection.
- Define the regional framework for protection of biodiversity. Natural management units (biogeographic provinces and bioregions within these) form the ecological framework within which CERs should be established for the protection of chemosynthetic ecosystems.
- Establish the **expected distribution patterns** of chemosynthetic habitats to provide a spatial framework for capturing representativity.
- Establish CERs and design replicated networks of CERs within bioregions, using guidelines for size and spacing that ensure connectivity and that take into account the pattern of distribution of chemosynthetic habitats, which may vary from semi-continuous to widely dispersed.
- Define human uses and the levels of protection for each CER to achieve the conservation goal.

Approaches



- Criteria based approaches
 - Site criteria
 - Network criteria
- Scales of ABMT tools (APEIs, Sensitive Sites...)
- REMP ABMT implementation:
 - Expert knowledge elicitation / mapping
 - Implementing criteria
 - Evaluating ABMT configurations

Two scales of analysis: coarse filter & fine filter

Coarse filter approach: targeting the representation of broad ecosystem features and gradients

Fine filter approach: targeting unique sites that may be of particularly high values or at particularly high risk

The expectation is that the majority of protection value can be captured by the designation of large, coarse filter areas and then supplemented by specific fine filter targets to capture regionally unique and / or vulnerable sites that may otherwise be missed in the process.

Note: These terms or similar terms have been used in the spatial planning literature since the early 1980s (TNC 1982)

Areas of Particular Environmental Interest (APEI)

APEIs are generally described as: "<u>Large areas</u> with <u>self-</u> <u>sustaining populations</u> and a <u>broad range of habitat variability</u>. Those should not be affected directly by physical activity or indirectly by mining effects such as plumes, although the degree of impacts raised by potential deep-sea mining is still unknown." (ISBA/17/LTC/7)

APEIs are an archetypical example of a "course filter" approach.

Areas of Particular Environmental Interest (APEI)

APEI Criteria	Assessment Approach		
large areas	spatial analysis of ecosystem extent vs. relative areas		
self-sustaining populations	metapopulation & dispersal distance connectivity analysis		
broad range of habitat variability	Habitat models & representativity analysis		
no direct mining effects	disturbance & recovery models		
no indirect mining effects	physical models (plumes)		
unknown impacts	precautionary approach		

The need to investigate a fine scale protection tool for the ISA deep sea mining context

Experience and lessons learned from CCZ-EMP as well as the long-term experience from CBD and FAO may enable ISA with the spatial planning tools to scientifically **describe and identify sites**, **at a finer scale**, **in need for protection** to preserve ecological balance of the marine environment, as stipulated in article 145 of the Convention

- ✓ Areas of Particular Environmental Interest (APEIs)
- Sites in need for protection to maintain ecological balance of the marine environment

Site level example: FAO Vulnerable Marine Ecosystems (VME)

FAO VMEs have been used, within the context of managing deep sea fisheries, as identifier for specific habitats and ecosystems that are particularly valuable due to their uniqueness or rarity, their structure forming characteristics and/or also for potential fragility or slow recovery from disturbance, being defined as areas that meet one or more of the following criteria:

✓ Uniqueness or rarity

- \checkmark Functional significance of the habitat
- ✓ Fragility
- ✓ Life-history traits of component species that make recovery difficult
- ✓ Structural complexity

http://www.fao.org/in-action/vulnerable-marine-ecosystems/en/

Combined coarse filter area and fine filter site approaches

APEI <u>areas</u>: provide broad area protection of habitats, gradients and connectivity

<u>Sites</u> in need of protection:

provide protection for unique and vulnerable sites

Potentially supplemented with Environmental Management Measures:



https://sites.google.com/site/waldorfwatch/_/rsrc/1347828608553/atlantis-and-aryans/atlantic%20floor.jpg

The Area Based Management Tools (**ABMT**s) considered for REMPs will vary between regions and mineral types and may require different approaches and thresholds to ensure effective management.



The Clarion-Clipperton CCZ-EMP example

- ✓ should take into account *biophysical gradients* which affect the biogeography of marine biodiversity in the planning region;
- ✓ should protect a *full range of habitat types* found within each subregion;
- ✓ should be *large enough* to maintain minimum viable population sizes for species potentially restricted to a subregion;
- ✓ should be surrounded by a *buffer zone* to ensure that biota and habitats in the protected area are not affected by anthropogenic threats occurring outside the APEIs; and
- ✓ The boundaries should be *straight lines* to facilitate rapid recognition and compliance.



The Clarion-Clipperton CCZ-EMP example

9 rectangular APEIs composed of 200km x 200km core areas with 100km buffer zones providing **400km x 400km** final APEI units.

The simple spatial design of these APEIs reflects both a desire to use parsimonious criteria, but also reflect the matching the limits of spatial precision to the data and knowledge limitations in the region



APEIs configurations for different regions Appropriate size, shape configuration specifications may necessarily differ



Spatially precise versus spatially coarse approaches

General reasons for proposing large, simple shape areas

- ✓ Need to protect contiguous habitats and gradients
- ✓ Need to preserve biological and genetic connectivity
- ✓ Needs to buffer areas from impacts
- ✓ Lack of precision due to imprecise knowledge
- ✓ Desire to use simple shapes to facilitate navigation & compliance



Spatially precise versus spatially coarse approaches

<u>Caveat</u>: Increased spatial precision will require increased quality and coverage of data



Spatially precise, site approach



Spatially coarse, large APEI approach

A suggested portfolio of ABMTs

A purposefully configured **mixed** portfolio combining large areas to protect and buffer intact gradients of habitats augmented with **specific** sites in need of protection may provide the most flexibility to satisfy both mining interests and protection needs.



A suggested portfolio of ABMTs

Also: a portfolio of ABMT areas could include **areas of increased precaution**, or other categories of use in addition to closure areas.

The areas could require more intensive pre-use exploration, mapping, monitoring and potential remediation.



REMP APEI spatial planning process

What could a REMP portfolio of coarse scale APEI *areas* supplemented with fine scale *sites* in need of protection look like?

Could a combined strategy satisfy both the need to provide broad *representative habitat protection* as well as *vulnerable site* protections?



Cumulative Impact Assessment Area Based Management

Adaptive management





measures and procedures

Take Home Messages

- Area Based Management Tools can be **<u>complemented</u>** with non-ABMT tools
- Combined <u>coarse</u> and <u>fine scale</u> ABMTs can provide increased flexibility and more robust protection of both broad habitat areas and vulnerable sites
- Spatial planning requires both <u>site criteria</u> as well as <u>network criteria</u>
- Increased spatial precision will require increased data coverage and detail
- Defining the appropriate biogeographic <u>spatial extent</u> of a REMP is a fundamental step in the planning process
- Defining <u>tractable evaluation criteria</u> for assessing different network configurations (size, spacing, placement...) will be fundamental to REMP planning
- Planning for an <u>adaptive management</u> to anticipate changes in data, knowledge, new technologies, area relinquishment... will likely be required





Discussion





Commission