Global Initiatives

Protection and conservation of deep-seabed resources

- Dinard Workshop – Chemosynthetic Ecosystem Reserves
- Sète Workshop – Restoration
- VentBase – Environmental Impact Assessment
- DOSI – Strategies for sustainable use of resources
- MIDAS – Managing Impacts

Global initiatives

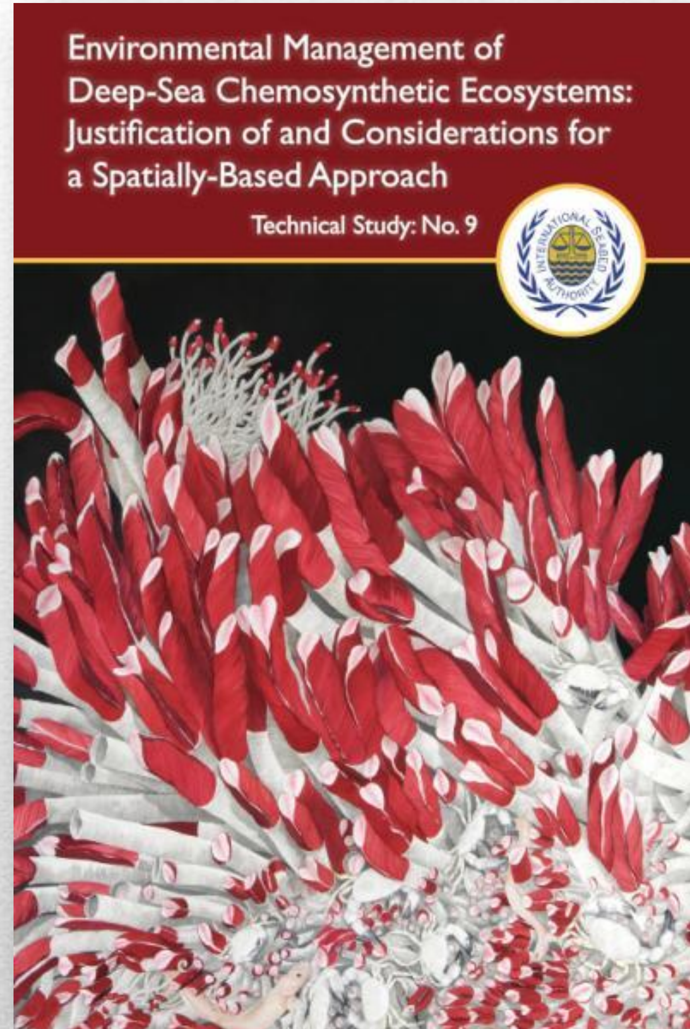
ISA Technical Study: No. 9

Conveners:

CL Van Dover, C Smith

Participants:

31 individuals, 15 countries (contractors, science, policy, economics, ISA)



Dinard 2010 – Chemosynthetic Ecosystem Reserves

WORLD Hydrothermal Vent Marine Protected Areas

CANADA	*Endeavour Marine Protected Area*
MEXICO	*Guaymas Basin and Eastern Pacific Rise Sanctuary*
PORTUGAL	*Azores Marine Protected Areas*
UNITED STATES	*Mariana Trench National Monument*
NEW ZEALAND	*Benthic Protection Areas*
INTERNATIONAL	*Antarctic Vents (e.g., Scotia Rise vents below 60S)*

Conservation Goal

To protect the natural diversity, ecosystem structure, function, and resilience of seep and vent communities.

OBJECTIVES

builds on CBD IX/20 Annex 2 and CBD EBSA Criteria

- Biodiversity
- Connectivity
- Replication
- Adequacy/viability
- Representativity
- Sustainable use

Dinard 2010 – Chemosynthetic Ecosystem Reserves

Detailed and Extensive Risk Register (Expert Opinion)

Activity	Nature of impact	Likelihood of activity at seeps or vents (globally)	Overall intensity of direct impact	Spatial scale of activity[1]	Anticipated duration of activity	Frequency o activity at a
Direct commercial activities						
Exploration for commercial resources						
Phase I: exploration and prospecting	Noise and light (L-M), pressure wave (L), some bottom contact (L), removal of organisms and substrata (L-M), sampling fluids (L-M), habitat disturbance (L), plume generation (L)	High	Low	Regional	Days	Moderate
Phase II: exploration and prospecting, including environmental impact assessment	Removal of organisms and substrata (H), sampling fluids (L-M), habitat disturbance (H), plume generation (L), noise and light (L-M)	High	Low	Regional	Months to years	Moderate
Test drilling	Removal of organisms and substrata (H), habitat disturbance (H), plume generation (L-M), noise and light (L-M)	High	Low	Point	Days to months	Low
Extraction of commercial resources						
Extraction - seafloor massive sulphides (vents)	Removal of organisms and substrata (H), habitat disturbance (H), plume generation (L-M), noise and light (L-M)	High	High	Local	Years	NA (one-tir use)[2]
Extraction - gas hydrates (seeps)	Habitat disturbance (H), loss of habitat heterogeneity (H), sediment deposition (M-H), catastrophic mass wasting (M-H)	Moderate to high	High	Regional	Years to decades	NA (one-tir use)
Extraction - oil and gas	Habitat disturbance (H), loss of habitat	High	Low to	Local	Years to decades	Na (one-tin

Guidelines for spatial design

- Identify chemosynthetic sites that meet EBSA criteria* or are otherwise scientifically, historically, culturally, or for other reason merit priority consideration for protection
- Define regional framework for protection of biodiversity ('natural management units')
- Establish expected distribution patterns of habitats to capture representativity
- Establish replicated networks of reserves within management units

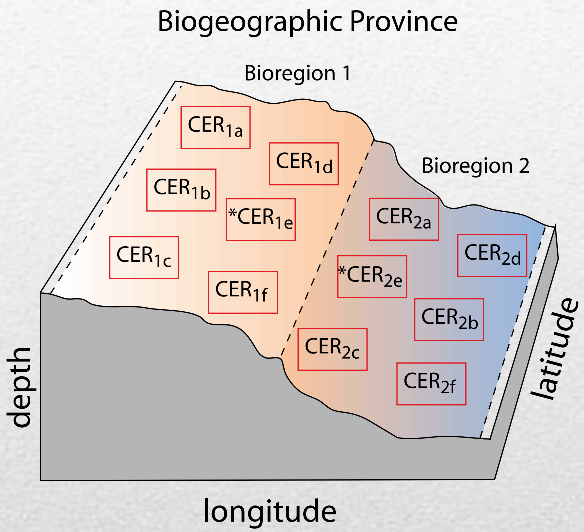
EBSA CRITERIA

1. uniqueness or rarity
2. special importance for life history of species
3. importance for threatened, endangered or declining species and/or habitats
4. vulnerability, fragility, sensitivity, slow recovery
5. biological productivity
6. biological diversity
7. naturalness

Design guidelines for networks of Chemosynthetic Ecosystem Reserves (CERs)

Management Units

- Biogeographic Provinces
  - Bioregions
    - Reserve networks
      - Replicates



Guidelines for best management practices

Design and implementation

- two-level approach to identifying reserves (extraordinary value, networks)
- define human uses and levels of protection
- establish reserves in transparent and consultative manner
- governance within existing governance regimes where possible
- test for efficacy of reserve networks
- use adaptive management strategies

Guidelines for best management practices

Managing impacts of activities within CERs

- reserves that include activities with potential to cause significant harm should require EIAs for these activities
- reserves should be monitored to assess spatial and temporal impacts of cumulative activities in the region
- a set of prescriptive criteria should be established before multi-use activities begin, to trigger closer monitoring or cessation of activities that jeopardize the conservation goal within a bioregion

Workshop Goal

to identify key issues, knowledge gaps, and opportunities in deep-sea restoration policy, science, and practice

Sète 2012 – Restoration

Sète 2012 – Restoration

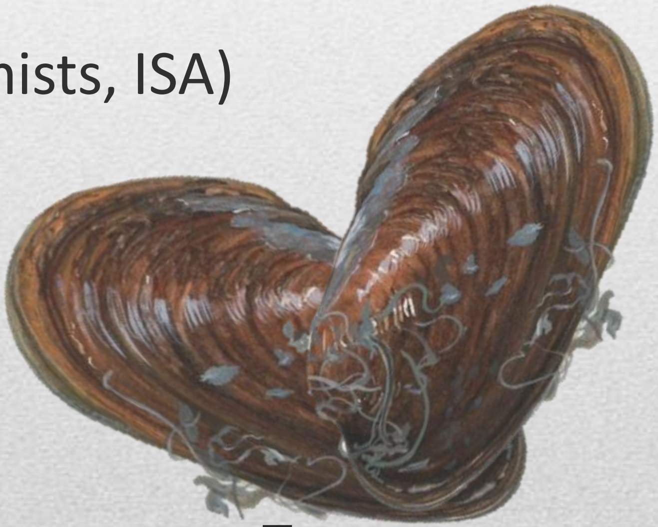
Co-Convenors:

CL Van Dover, J Aronson, S Smith, L Pendleton

Participants:

15 individuals, 7 countries

(contractors, science, policy, economists, ISA)



Desiderata

- Definition
- Opportunity and need
- Deep-sea ecosystem services and stakeholders
- Principles and attributes of restoration
- Decision parameters
    - Socio-economic
    - Ecological
    - Technological
- Case Studies

Contents lists available at ScienceDirect

Marine Policy

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

ELSEVIER

MARINE POLICY

Ecological restoration in the deep sea: Desiderata ☆

C.L. Van Dover [a,*], J. Aronson [b], L. Pendleton [c], S. Smith [d], S. Arnaud-Haond [e], D. Moreno-Mateos [f], E. Barbier [g], D. Billett [h], K. Bowers [i], R. Danovaro [j], A. Edwards [k], S. Kellert [l], T. Morato [m], E. Pollard [n], A. Rogers [o], R. Warner [p]

[a] Marine Laboratory, Nicholas School of the Environment, Duke University, 135 Marine Lab Road, Beaufort, NC 28516, USA
[b] Centre d'Ecologie Fonctionnelle et Evolutive (CEFE/CNRS-UMR 5175), Montpellier, France
[c] Nicholas Institute for Environmental Policy Solutions, Duke University, Durham, NC 27708, USA
[d] Nautilus Minerals, 303 Coronation Drive, Milton, Queensland, Australia
[e] Ifremer, Bd Jean Monnet, BP 171, 34203 Sète Cedex, France
[f] Jasper Ridge Biological Preserve, Stanford University, Woodside, CA 94062, USA
[g] Department of Economics and Finance, 1000E University Avenue, Laramie, WY 82071, USA
[h] National Oceanography Centre, University of Southampton Waterfront Campus, European Way, Southampton SO14 3ZH, UK
[i] Biohabitats, 2120 Noisette Blvd, Suite 106B, North Charleston, SC 29405, USA
[j] Department of Life and Environmental Sciences, Polytechnic University of Marche, Via Brecce Bianche, 601321 Ancona, Italy
[k] School of Biology, Ridley Building, Newcastle University, Newcastle upon Tyne NE1 7RU, UK
[l] School of Forestry & Environmental Studies, Yale University, 195 Prospect Street, New Haven, CT 06511, USA
[m] Centre of IMAR, Departamento de Oceanografia e Pescas, Universidade dos Açores and LARSyS Associated Laboratory, 9901-862 Horta, Portugal
[n] The Biodiversity Consultancy, EURC, 72 Trumpington Street, Cambridge, CB2 1RR, UK
[o] Department of Zoology, Tinbergen Building, South Parks Road, Oxford, OX1 3PS, UK
[p] Australian National Centre for Ocean Resources and Security, University of Wollongong, Building 233, Innovation Campus, Squires Way, North Wollongong, New South Wales 2522, Australia

A R T I C L E I N F O

Article history:
Received 24 March 2013
Received in revised form
13 July 2013
Accepted 17 July 2013

Keywords:
Deep-sea resource use
Restoration science
Marine policy
Hydrothermal vents
Cold-water corals

A B S T R A C T

An era of expanding deep-ocean industrialization is before us, with policy makers establishing governance frameworks for sustainable management of deep-sea resources while scientists learn more about the ecological structure and functioning of the largest biome on the planet. Missing from discussion of the stewardship of the deep ocean is ecological restoration. If existing activities in the deep sea continue or are expanded and new deep-ocean industries are developed, there is need to consider what is required to minimize or repair resulting damages to the deep-sea environment. In addition, thought should be given as to how any past damage can be rectified. This paper develops the discourse on deep-sea restoration and offers guidance on planning and implementing ecological restoration projects for deep-sea ecosystems that are already, or are at threat of becoming, degraded, damaged or destroyed. Two deep-sea restoration case studies or scenarios are described (deep-sea stony corals on the Darwin Mounds off the west coast of Scotland, deep-sea hydrothermal vents in Manus Basin, Papua New Guinea) and are contrasted with on-going saltmarsh restoration in San Francisco Bay. For these case studies, a set of socio-economic, ecological, and technological decision parameters that might favor (or not) their restoration are examined. Costs for hypothetical restoration scenarios in the deep sea are estimated and first indications suggest they may be two to three orders of magnitude greater per hectare than costs for restoration efforts in shallow-water marine systems.

Sète 2012 – Restoration

Is Restoration Favored?

		Salt Marsh	Deep-Sea Coral	Hydrothermal Vent
Socio-Economic	Ecosystem Benefits			?
	Governance			
	Cost			
	Societal Pressure			?
	Financial Incentives			
	Wider Socio-Economic Impacts			
Ecological	Ecological Vulnerability			
	Wider Ecological Benefit			?
	Natural Recovery		?	
	Large Relative Ecological Impact			
Techno.	Success			
	Technical Feasibility			?
	Technological Advancement			

Case Study

Solwara 1 Rehabilitation Plan (5-yr program)

Immediate Objective

- Re-establish 3-D mounds and fauna

Scale

- 2 states (active, inactive)
- 4 conditions (high, medium, low density transplants plus control areas)
- 3 replicates per condition

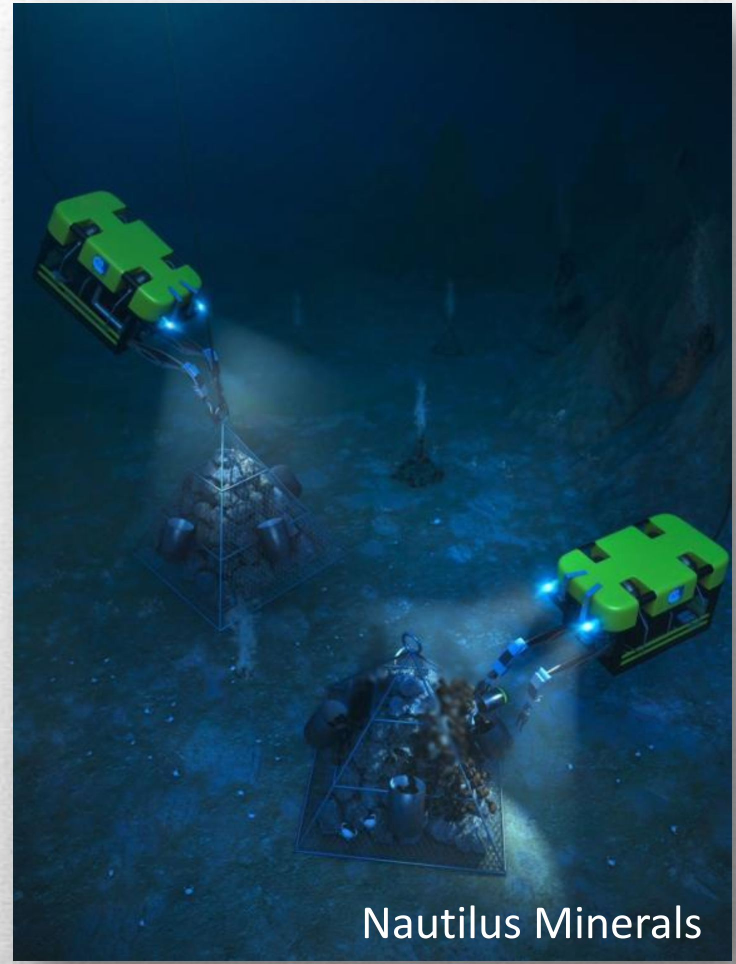
Measure of Success

- Survival
- Growth
- Recruitment
- Increased associated diversity

Sète 2012 – Restoration

Case Study

Solwara 1
Rehabilitation Plan
(5-yr program)



Sète 2012 – Restoration

Restoration Costs: academic restoration project, hydrothermal vent

Total Direct Costs Hydrothermal Vent (72 m^2 or 0.007 ha)	
Project Manager (1 mo per year, 5 yrs)	$60 K
Lab Technician (12 mos per yr, 5 yrs)	$390 K
3-D Substrata (18 edifices)	$36 K
Miscellaneous supplies ($4K per year)	$20 K
Time-lapse cameras (9 x $50K each)	$450 K
Substratum deployment cruises (ROV; 27d @ $65K per d x 3 years)	$975 K
Transplant and camera deployment cruise (ROV; 27d @ $65K per d)	$1,755 K
Monitoring cruises (AUV, ROV; 7d @ $80K per d x 3 years)	$1,680 K
TOTAL	$5.366 Million

Sète 2012 – Restoration

Restoration Cost Comparisons

	Cost per Hectare
COASTAL WATERS	
San Francisco S Bay Salt Marsh	$500,000
Columbus Iselin Reef	$3,760,000
DEEP SEA (academic)	
Darwin Mounds Stony Corals	$75,000,000
Solwara 1 Hydrothermal Vent**	$740,000,000

The additional cost of deep-sea restoration is due primarily to costs of ships and deep-submergence assets.

**Industry costs for restoration practice could be reduced significantly through simultaneous operations – i.e. mineral development and restoration activities could be done using the same vessels and support ROVs.

Sète 2012 – Restoration

Conveners: P Collins, R Kennedy

Aim: to set standards for data requirements of ecological assessment of SMS deposits

VentBase 2012 – EIAs

ELSEVIER

Marine Policy

Volume 42, November 2013, Pages 334–336

VentBase: Developing a consensus among stakeholders in the deep-sea regarding environmental impact assessment for deep-sea mining–A workshop report

Patrick Colman Collins[a], Bob Kennedy[a], Jon Copley[b], Rachel Boschen[c], Nicholas Fleming[d], James Forde[a], Se-Jong Ju[e], Dhugal Lindsay[f], Leigh Marsh[b], Verity Nye[b], Adrian Patterson[a], Hirome Watanabe[f], Hiroyuki Yamamoto[f], Jens Carlsson[g], Andrew David Thaler[h]

[a] Marine Ecology Research Laboratory, Department of Zoology, School of Natural Sciences, National University of Ireland, University Road, Galway, Ireland

[b] Ocean and Earth Science, National Oceanography Centre, Southampton, University of Southampton Waterfront Campus, United Kingdom

[c] National Institute for Water and Atmospheric Research, Greta Point, Wellington School of Biological Sciences, Victoria University Wellington, Wellington, New Zealand

[d] School of Biological Sciences, Queen's University Belfast, Northern Ireland

[e] Korea Institute of Ocean Science and Technology, Korea

[f] Japan Agency for Marine-Earth Science and Technology, Japan

[g] School of Biological and Environmental Sciences, University College Dublin, Science Centre-West, Belfield, Dublin 4, Ireland

[h] Duke Marine Laboratory, Nicholas School of the Environment, Duke University, 135 Duke Marine Lab Road, Beaufort, NC 28516, USA

ELSEVIER

Marine Policy

Volume 42, November 2013, Pages 198–209

A primer for the Environmental Impact Assessment of mining at seafloor massive sulfide deposits

Patrick Colman Collins[a], Peter Croot[a], Jens Carlsson[b], Ana Colaço[c], Anthony Grehan[a], Kiseong Hyeong[d], Robert Kennedy[a], Christian Mohn[e], Samantha Smith[f], Hiroyuki Yamamoto[g], Ashley Rowden[h]

[a] School of Natural Sciences, National University of Ireland Galway, Ireland

[b] School of Biology and Environmental Science, University College Dublin, Ireland

[c] Centre of IMAR of the University of the Azores, Department of Oceanography and Fisheries, and LARSyS Associated Laboratory, Rua Prof. Doutor Frederico Machado, 4, 9901-862 Horta, Portugal

[d] Korea Institute of Ocean Science and Technology, South Korea

[e] Department of Bioscience, Aarhus University, Roskilde, Denmark

[f] Nautilus Minerals Inc., Australia

[g] Institute of Biogeoscience, Japan Agency for Marine Earth Science and Technology, Japan

[h] National Institute of Water and Atmospheric Research, New Zealand

VentBase 2012 – EIAs

VentBase 2012 – EIAs

1. Scoping study
   - Collection, evaluation, synthesis of project relevant information
2. Environmental survey
   - Hydrographic
   - Geological
   - Geochemical
   - Mineralogical
   - Ecological
     - Composition, distribution, abundance, demographics, dynamics, connectivity, underlying process
     - [Identification of key indicator species]
3. Ecological Risk Assessment
4. Mitigation Strategies
   - Protected areas
   - Monitoring

DOSI

DEEP-OCEAN STEWARDSHIP INITIATIVE

a union of experts and ideas from across disciplines and sectors

strategies for sustainable use of deep-ocean resources

Leads

L Levin (SIO, USA)

E Escobar (UNAM, Mexico)

M Baker (University of Southampton, UK)

K Gjerde (IUCN, Poland)

DOSI 2013– Deep-Ocean Stewardship Initiative

Working Groups

- Ecosystem-Based Management (EBM) in the deep ocean
- Knowledge gaps and global ocean assessments
- Transparency, compliance and industry engagement
- Awareness and building capacity in developing nations
- Deep-sea genetic resources
- Communication and networking
- Responsible and sustainable deep-sea fisheries

Priorities

- Environmental management
- Environmental integrity
- Information sharing

DOSI 2013– Deep-Ocean Stewardship Initiative

Environmental Strategy Collaborative (Proposal)

GOALS (polymetallic sulfides, cobalt crusts)

1. To assemble environmental knowledge from multidisciplinary, international, cross-sectoral experts to underpin ecosystem- and resource-based management decisions taken by the ISA.

1. To recommend a roadmap for scoping and obtaining the information the ISA will require to fulfill its environmental management obligations.

Environmental Strategy Collaborative (Proposal)

ORGANIZING COMMITTEE

M Lodge (co-chair)	International Seabed Authority
C Van Dover (co-chair)	Duke University Marine Laboratory
D Billett	LTC (ISA) National Oceanography Center
E Escobar	LTC (ISA), UNAM
K Gjerde	High Seas Policy Advisor, IUCN
R Howorth	Chair, LTC (ISA), SOPAC
L Levin	Scripps Institution of Oceanography
S Mulsow	Resources and Environmental Monitoring, ISA
S Smith	Nautilus Minerals
P Weaver	Seascape Consultants, Ltd; MIDAS Project

Environmental Strategy Collaborative (Proposal)

Table 1. Workshop Scope: Topical Areas

Deep-Sea Ecosystems
- Coral and hard substrata communities
- Vent communities
- Sediment communities
- Connectivity
- Ecosystem services

Physical Processes
- Dispersal
- Ecotoxicology
- Sediment transport and burial
- Food and larval flux
- Diffusive limitation

Monitoring
- Methods and Metrics
- Cumulative impacts

Modeling
- Dispersal, habitat
- Ecosystem
- Geospatial design of ecological networks

Environmental economics
- Ecosystem services
- Cost-benefit analysis
- Incentives for green industry practices
- Benefit sharing

Mitigation
- Spatial and temporal planning
- Environmental engineering and new technologies to serve environmental management
- Restoration science and practice

Cross-sectoral considerations
- Legal issues
- Decision making when there is uncertainty
- Cross-sectoral perspectives and priorities
- Funding for regional-scale work
- Triple-bottom-line (people, planet, profit) approach to decision making and applicability to the deep sea
- Cooperation and transparency
- Management of resource-use conflicts
- Compliance and enforcement
- Research agenda for actionable science
- Adaptive management

Capacity building and benefit sharing
- Priorities
- Mechanisms

MIDAS 2013 – Managing Impacts

GOAL: Recommendations for best practices to mining industry, legislation (baseline assessments, monitoring)

European Commission Framework 7; Project Coordinator: Prof. Phil Weaver

32 European partners: natural and social science, industry, law, civil society

- SMS
- Cobalt crusts
- Mn nodules
- REE
- Methane hydrates

3 years, beginning 1 November 2013

Key Points

- Recent workshops and new global initiatives build on work of the ISA and others to consider environmental management in the deep sea
- Strategic, replicated networks of Chemosynthetic Ecosystem Reserves are important management tools that protect marine ecosystems and mitigate against the impact of human activities
- Restoration of the deep sea following a major anthropogenic disturbance will be costly and all but impossible; as a consequence, efforts to avoid, minimize, and offset impacts should be significantly enhanced
- VentBase, DOSI, and MIDAS are new global, multisectoral initiatives that aim to support development of environmental baselines, strategic environmental assessments, environmental impact assessments, and ecosystem-based management of deep-sea ecosystems.