European Commission stakeholder consultation on seabed mining

Fields marked with * are mandatory.

Identification

Are you answering this questionnaire on behalf of an organisation or as an individual?*

(x) on behalf of an organisation ( ) as an individual

Your name.*

Text of 3 to 100 characters will be accepted

This will not be published.

Dr. Jennifer Riley

Contact e-mail.*

Text of 4 to 100 characters will be accepted

This will not be published and will only be used to verify with you that your views are correctly represented in the published results.

jennifer.riley@noc.ac.uk

What is the name of the organisation?*

Text of 2 to 300 characters will be accepted

National Oceanography Centre (NOC), on behalf of the NOC Association

Is your organisation listed in the EU's Transparency Register?*

[ ] yes [x] no [ ] do not know

What type of organisation is it? If the main activity is research, please indicate "research" whether you are a public or private body. National geological surveys should be indicated as "research".*

( ) public authority ( ) private (x) research ( ) civil society what type of research organisation?*

- (x) public research institute
- ( ) private research
- ( ) university
- ( ) other

Where are you based?*

- ( ) Austria
- ( ) Belgium
- ( ) Bulgaria
- ( ) Croatia
- ( ) Cyprus
- ( ) Czech Republic
- ( ) Denmark
- ( ) Estonia
- ( ) Finland
- ( ) France
- ( ) Germany
- ( ) Greece
- ( ) Hungary
- ( ) Ireland
- ( ) Italy
- ( ) Latvia
- ( ) Lithuania
- ( ) Luxembourg
- ( ) Malta
- ( ) Netherlands
- ( ) Poland
- ( ) Portugal
- ( ) Romania
- ( ) Slovakia
- ( ) Slovenia
- ( ) Spain
- ( ) Sweden
- (x) United Kingdom
- ( ) OTHER

What is your main interest? You may tick more than one box.*

between 1 and 8 choices

- [x] surveying and prospecting
- [ ] extraction
- [ ] processing
- [ ] equipment manufacture
- [ ] shipbuilding (vessels and offshore structures)
- [ ] legal issues
- [x] environmental impact
- [ ] impact on other industries

please explain your interest further (optional)

The National Oceanography Centre (NOC) Association brings together the Natural Environmental Research Council (NERC) funded marine scientists across the UK. It is currently comprised of the National Oceanography Centre, its Delivery Partners: British Antarctic Survey, Plymouth Marine Laboratory, Scottish Marine Institute, Sea Mammal Research Unit, British Geological Survey, Marine Biological Association, Sir Alister Hardy Foundation for Ocean Science, and 29 UK universities. Furthermore, it acts as a strategic platform to enhance the influence of the marine science community on funders, policy makers and the influence of the communities' science on society. Much of the work of the NOC Association is research and academia based. As such there is no intrinsic commercial interest in seabed mining from a NOC Association perspective, the community has a direct interest and extensive knowledge base of the deep-sea environments, from the habitats and geology to the ecosystems and organisms living there. Thus the main interest in this consultation lies with the environmental impact of seabed mining and the seafloor mineral resource assessment through deep sea exploration and geophysical surveying.

Aggregate Extraction

The sea provides a significant proportion of some countries' sand and gravel requirements for construction or beach nourishment.
Do you wish to answer questions on this?

*

- (selected) Yes, I would like to answer questions on this issue
- No, I will pass to the next section

Is this a useful way of maintaining an adequate supply of material for construction and beach nourishment
*

- we would not manage without it
- (selected) we believe it is or could be a useful addition to land-based sources
- we do not need it

please explain (optional)

Although as an organisation we are not familiar with the precise numbers associated with the aggregate extraction industry, it is clear that it provides significant work for many people and organizations.

What is your involvement*

- not involved
- (selected) already involved
- expect to be involved in future
- would be involved if legislative framework were more favourable

please provide more details (optional)

Some NOC Association partners, for example those located at University College London have conducted sub-surface interpretations of aggregate extraction sites. NOC association partners have been involved in shelf sea studies that may provide useful baseline data for assessing the impact of the aggregates industry. This includes development of new benthic monitoring and surveying techniques using cutting-edge technology, such as autonomous underwater vehicles and novel sensors. Other partners, such as those at the University of Portsmouth are not immediately involved but would expect to become involved in the future, through the assessment of the environmental impacts of aggregate extraction, sea bed stability, investigations into the impact of chemical fluxes and seabed integrity. For example, research carried out at the University of Portsmouth looks at the effects of sediment disturbance on strictly anaerobic microbes involved in the sulphur cycle. This type of research could help to better determine the environmental impacts of seabed mining.

What (if anything) is limiting the economic potential of this activity?

	significant	relevant	minor	no opinion
limited access to finance*	○	○	○	●
inadequate port facilities*	○	○	○	●
over-stringent licensing conditions *	○	○	●	○
lengthy, unclear or bureaucratic licensing conditions - independent of whether they are too stringent, is their implementation over-bureaucratic?*	○	○	○	●
volatility of prices*	○	○	○	●
shortage of skilled labour*	○	○	○	●
shortage of suitable sites*	○	○	●	○
technology shortcomings*	○	○	●	○
local opposition*	○	●	○	○
lack of knowledge of whereabouts of deposits*	●	○	○	○
taxation*	○	○	○	●
competition with other users for resources (eg fisheries)*	●	○	○	○

please explain your answer or indicate another factor (optional)

Lack of knowledge about the whereabouts of deposits is one factor limiting the economic potential of this activity. Consequently further work increasing the knowledge base of where deposits are located is needed to increase the economic potential of this resource. Furthermore, aggregate extraction has significant impacts on the seabed and the surrounding water column. For example if aggregate extraction occurs in an area which is important for fish spawning this may have implications for stock preproduction, recruitment and mortality. As such other stakeholders (particularly those involved with fisheries) have strong views regarding whether extraction should go ahead in an area. This can limit the economic potential of aggregate extraction in an area.

The environmental impact of aggregate extraction is -

	better	the same	worse	no opinion
better or worse than fishing?*	○	○	●	○
better or worse than extraction on land?*	●	○	○	○
better or worse than oil and gas extraction*	○	●	○	○

please explain your answer (optional)

This is a very objective question. Aggregate extraction is of course destructive, however, its activity is confined to licensed areas. With regards fishing the question need clarification to specify the type of fishing being undertaken. For example, trawling is extremely destructive and currently not confined to limited areas, therefore could be perceived as worse than aggregate extraction. However the impact of nets and line to fish pelagic species could be seen as less destructive to the seabed habitat. Extraction on land is more obvious and tangible to the larger populations who have a greater awareness of the terrestrial environment. Therefore from this perspective the environmental impact of aggregate extraction in the sea is better that on land (as indicated in our response). However, a greater awareness does not always mean that there is a greater impact. Therefore again the answer is be dependent on the perspective of the question and the parameters by which better or worse are measured. Oil and gas extraction is a different matter and not really directly comparable.

What EU action would be helpful?

	priority	useful	not useful	no opinion
research on environmental impact*	●	○	○	○
research on technology*	○	●	○	○
promoting freely accessible seabed maps together with information on geology, ecosystems and habitats *	●	○	○	○
promote exchange of good practice*	●	○	○	○
develop code of corporate responsibility*	●	○	○	○
facilitate mobility of labour*	○	○	●	○
further support to initiatives such as the Extractive Industry Transparency Initiative (includes requirement for disclosure of payments to governments)*	○	○	○	●
strengthen EU environmental legislation such as that on environmental impact and mining waste. These are mostly applicable only for waters of EU countries. *	○	●	○	○

please explain your answer or indicate another area where the EU could act (optional)

Shallow water mining of higher value commodities.

This mostly involves dredging in water depths up to 500 metres. It includes the mining of iron sand, tin, diamonds, gold and phosphate rock.

Do you wish to answer questions on this?*

- (selected) Yes, I would like to answer questions on this
- ( ) No, I will skip this and move to the next section

could this contribute twoards a sustainable and economical supply of raw material for EU industry and agriculture?*

- ( ) yes, otherwise we risk shortages
- (selected) it is a useful addition to land-based sources
- ( ) we do not need it

please explain (optional)

What is your involvement?

- ( ) we are already involved
- ( ) we are still assessing the opportunities
- ( ) we would assess environmental impact
- (selected) we can see ourselves being involved in next 10 years
- ( ) we do not believe that we will be involved

please explain (optional)

Mining in shallow waters involves removing large volumes of the surface and subsurface sediments in order to be able to extract minerals of interest. Such stripping of sediments brings about great impact and damage to coastal ecosystems, some of which are highly fragile. Shallow water marine ecosystems are comprised of a range of organisms including many microscopic species (e.g. nematode worms and bacteria), critical for nutrient cycling, which is essential for sustaining production in coastal areas. Environmental assessment before extraction activities are undertaken is essential to ensure that environmental impacts are minimized. Furthermore, mitigation and restorative strategies are needed to ensure that ecosystems are preserved and further knock on environmental impacts are prevented. Such knock on effects may ultimately be seen in higher trophic levels such as demersal and pelagic fish species. Removing large amounts of surface and subsurface sediments may also have an impact on the physical properties of shallow water environments, impacting on current flow and sediment stability and transport dynamics. It is therefore essential that the physics and sediment transport in shallow water coastal environments are fully understood in order to ensure that there are no unforeseen impacts e.g. from sediment transport downstream effecting other ecosystems outside the mining area. Some of the work carried out by NOC focuses on the coastal regions and includes work on sediment dynamics. Every year millions of tonnes of sediment from the sea and the River Mersey are dredged from Liverpool Bay. Much of this material is transported back to where it is dredged from by the sea currents within a month. Dredging is not just costly; contaminated sediments can damage the environment. The iCOASST project (http://www.icoasst.net/), which NOC scientists are involved with uses computer modeling to track sediment movement and predict changing coastlines. Working collaboratively with CEFAS, NOC researchers have identified safer places to dispose of dredged material in the Estuary. Work such as this could be used to help monitor seabed mining activities in shallow coastal regions. It is therefore envisaged that in the future the NOC Association could work to monitor shallow water mining activities around coastal regions, playing a role in better understanding the environmental impact of such activities on the physical environment and biological communities in shallow waters around coastal regions.

What (if anything) is driving economic interest?

	significant	relevant	not important	no opinion
advances in technology*	○	●	○	○
limited access to raw materials from terrestrial sources*	○	●	○	○

please explain (optional)

where is your primary interest?

at most 3 choice(s)

- [ ] waters of EU countries on European continent
- [x] waters of overseas territories of EU countries
- [x] waters of non-EU countries

Which shallow water deposits do you think will become economically interesting in the next 10 years (optional question)?

at most 7 choice(s)

- [ ] tin
- [ ] phosphates
- [x] diamonds
- [x] gold
- [ ] rare earths
- [x] iron sands
- [ ] other

please specify*

Diamond and Gold have always been profitable resources. Much prospecting for iron sands has already been undertaken around New Zealand in preparation for mining activities.

please explain (optional)

What (if anything) is limiting the economic potential of this activity?

	significant	relevant	minor	no opinion
limited access to finance*	○	○	●	○
inadequate port facilities*	○	○	●	○
over-stringent licensing conditions *	○	○	●	○
lengthy, unclear or bureaucratic licensing conditions - independent of whether they are too stringent, is their implementation over-bureaucratic?*	○	●	○	○
volatility of prices*	○	●	○	○
shortage of skilled labour*	○	○	●	○
shortage of suitable sites*	○	●	○	○
technology shortcomings*	○	●	○	○
local opposition*	○	○	●	○
lack of knowledge of whereabouts of deposits*	○	●	○	○
taxation*	○	○	○	●
competition with other users for resources (eg fisheries)*	●	○	○	○

please explain your answer or indicate another factor (optional)

The environmental impact of shallow water mining is:

	better	worse	about the same	no opinion
better or worse than fishing*	○	○	○	◉
better or worse than mining on land*	○	○	○	◉
better or worse than oil and gas extraction *	○	○	○	◉

please explain your answer (optional)

The impact of shallow water mining on the environment will very much depend on the techniques used and the areas that are mined. Where large amounts of sediment are removed from the sea bed the impact is likely to be great especially where there is a diverse and high biomass ecosystem within and dependent on the sediments (see previous answer). However, if mining is undertaken in areas where there are low levels of faunal abundance impacts may be less. Consequently, there is a pressing need to ensure that there is a good environmental understanding of the whole ecosystem present in an area, from the microscopic through to the larger economically viable species (e.g. fish).

What EU action would be helpful?

	priority	useful	not useful	no opinion
research on environmental impact*	◉	○	○	○
research on technology*	◉	○	○	○
promoting freely accessible seabed maps together with information on geology, ecosystems and habitats *	◉	○	○	○
promote exchange of good practice*	○	◉	○	○
develop code of corporate responsibility*	○	◉	○	○
facilitate mobility of labour*	○	○	○	◉
further support to initiatives such as the Extractive Industry Transparency Initiative (includes requirement for disclosure of payments to governments)*	○	○	○	◉
strengthen EU environmental legislation such as that on environmental impact and mining waste. These are mostly applicable only for waters of EU countries. *	○	○	○	◉

please explain your choice or suggest another action that EU could take (optional)

Deep sea mining

Deep sea mining involves mining activities that take place at large depths. Mining can take place both within national jurisdictions and in areas beyond national jurisdiction (ABNJ or international waters). Deep sea mining is aimed at mining higher value commodities, such as copper, cobalt, nickel and rare earth elements. Do you wish to answer questions on this?*

◉ Yes, I would like to answer questions on this

○ No, I would like to skip this and move to the next section could this contribute towards a sustainable and economical supply of raw material for EU industry and agriculture?*

- ( ) yes, otherwise we risk shortages
- (•) it is a useful addition to land-based sources
- ( ) we do not need it

please explain your answer (optional)

The oceans contain a vast potential source of minerals and given that land based resources are finite, deep sea mining activities could be invaluable to secure a future supply of raw materials. However, the deep seas are some of the most pristine places left on Earth. With the notion of deep sea mining becoming more of a reality in the coming decades there are environmental, legal and technical challenges that need to be overcome. Communities across Europe face these challenges. Consequently, there is a need to balance competitive and economic interests with ecosystem concerns and the need to protect some of the least known and untouched environments on the planet. Currently there are no mineral commodities that are sourced exclusively from a marine environment. However, security of supply also requires political and social security of source – and this is more feasible n the open seas. Also, some commodities such as tellurium, cobalt and rare earth elements (REEs) are especially enriched in marine deposits. Coupled with low overburden and high grades, the marine deposits are environmentally attractive as they can be extracted with less ecological impact than land-based deposits.

What is your involvement?*

Involvement could include prospecting, extraction, processing, providing equipment

- (•) We are already involved
- ( ) We are still looking at the opportunities
- ( ) We would monitor environmental impact
- ( ) We could see ourselves being involved in next 10 years
- ( ) We do not believe that we will be involved

Which deposits are of primary interest for you?*

at most 4 choice(s)

- [x] polymetallic nodules
- [x] polymetallic sulphides
- [x] cobalt-rich crusts
- [ ] rare earth element-rich deep-sea sediments
- [ ] no opinion

Where do you believe that most mining activity will take place?*

- ( ) in jurisdictional waters
- (•) in international waters
- ( ) no opinion

What (if anything) is driving economic interest?

	significant	relevant	not important	no opinion
advances in technology*	◉	○	○	○
limited access to raw materials from terrestrial sources*	◉	○	○	○

please explain (optional)

As deep-sea mining moves increasingly into international waters it will be important to work with international regulatory authorities, such as the International Seabed Authority. It is likely that future growth is likely to be driven by government licenses in much the same way that oil and gas exploration currently works. Currently, access is limited due to political and social uncertainties in many host countries. Deposit grades are diminishing on land, making extraction less efficient. Technological advances (the green economy) are pushing demand for 'e-tech' elements. Technological advances have the potential to make exploration, assessment and extraction more effective (although this requires development). There are various EC funded projects focusing on deep-sea mining and resource exploitation, which NOC Association members participate in. The MIDAS project (www.eu-midas.net) focuses on managing the impacts of deep sea resource exploitation whilst the project Blue Mining (www.bluemining.eu) works to address all aspects of the deep-sea mining value chain from resource discovery and assessment to exploitation and the legal and regulatory frameworks. As economic interest in deep-sea mining grows it will be important to ensure that the knowledge gathered from such research projects is translated into the necessary policy to ensure that the deep-sea environment is sustainably managed. Utilisation of the marine environment, whether it be for scientific research or economic development requires significant cross-disciplinary collaboration. When focusing on the economic interests driving the exploitation of the deep sea there will be a need to ensure that cross sectorial collaborative working practices are adopted to ensure that both political and scientific sectors are working together to develop long term, sustainable economic growth.

What (if anything) is limiting the economic potential of this activity?

	significant	relevant	minor	no opinion
limited access to finance*		X		
inadequate port facilities*				X
over-stringent licensing conditions *			X	
lengthy, unclear or bureaucratic licensing conditions - independent of whether they are too stringent, is their implementation over-bureaucratic?*				X
volatility of prices*		X		
shortage of skilled labour*	X			
shortage of suitable sites*	X			
technology shortcomings*	X			
local opposition*		X		
lack of knowledge of whereabouts of deposits*		X		
taxation*				X
competition with other users for resources (eg fisheries)*			X	

please provide more details or indicate other factors that might limit the activity (optional)

Knowledge of where and what resources exist can be a major limitation on the activity of deep-sea mining. Without knowing the location, density and chemical composition (and therefore economic value) of mineral resources (mainly polymetallic nodules, cobalt crusts and massive sulphides), mining could not occur in a cost effective manner. For nodules, there is detailed relevant information available for parts of the Clarion Clipperton Fracture Zone in the eastern Pacific Ocean. This is a region of the abyssal seafloor(>4000-m water depth) where the International Seabed Authority has granted exploration licenses to companies and other organisations. In order to realistically assess the likely impacts of mining, it is also important to acquire appropriate knowledge about the biological, geological and hydrographic characteristics of the environmental setting in which these deep-sea mineral deposits are located. This should include both the pelagic and benthic realms and their associated biological communities. It is important not to underestimate the physical impact that mining will have on deep seabed sediments and hard substrates, including hydrothermal structures. Strategies need to be put in place to help identify the location and extent of deposits in the deep sea. This includes the further development of exploitation tools. However, this requires knowledge and skills, which are currently restricted in supply. Thus there is a demand to train a new generation of highly skilled individuals with the educational capacity to help enhance the activity of deep-sea mining.

the environmental impact of deep-sea mining is:

	probably worse	probably better	it depends how it is done and where it is done	no opinion
better or worse than fishing?*	○	○	●	○
better or worse than mining on land?*	○	○	●	○
better or worse than offshore oil and gas extraction*	○	○	●	○

please provide more details of your views on environmental impact (optional)

The deep sea, which is the largest habitat on earth, is still largely unexplored and scientists expect that there are many thousands of species still to be discovered in the deep-sea environment. Moreover, our knowledge of the geographical ranges of deep-sea species is still rudimentary, particularly for the smaller size classes (meiofauna, macrofauna). This makes the risk of causing the extinction of species in any one area very difficult to assess. The way in which these abyssal ecosystems function, for example, in terms of carbon sequestration, is also poorly understood. Consequently it is difficult to establish exactly what the environmental impact of deep-sea mining would be, as it is strongly dependent on factors such as where and how the resource is extracted and the biological characteristics of the mined area. At present, exactly how a resource will be extracted is unknown as the technology is not yet mature. Consequently the direct impacts of the technology used to extract resources are unknown. However, the main likely impacts from the currently available technologies include sediment dispersal from the machinery plume, reinjection of waste sediments, and disturbance of the existing sediments, which could impact on pelagic and benthic organisms and their larvae / reproductive stages through changes in water quality, smothering, mechanical damage etc.; geochemical changes in the exposed sea-bed, which may alter seabed chemistry, and impact on the recruitment of species to a mined area; increased vessel traffic; underwater noise and light which could impact on marine animals, especially mammals, within a few kilometers of the mining area. In addition, the nodules themselves, which develop extremely slowly, provide a substrate for a diverse assemblage of sessile organisms, mainly large protozoans. Nodule extraction will eliminate this important habitat for millions of years. Where a resource is extracted from is also critical in determining the impacts of extraction on the environment and associated biological communities. The deep sea is incredibly varied in terms of its biological diversity and activity. If mineral resources are to be mined from deep abyssal plains, where biological activity and benthic biomass may be lower, than in shallower areas (although biodiversity is very high), then the environmental impact is likely to be smaller. In comparison, if mining is to take place around hydrothermal vents, where there is intensive biological activity and a concentration of biomass, the environmental impact is likely to be far greater. Consequently, measures may need to be developed and applied to help minimise these impacts. For example where endemic species are high in an area (e.g. at hydrothermal vents), industrial activity should either be restricted or the activity mitigated by instating temporary refuge areas upstream of the mining site, to allow recruitment back into the downstream mining area post activity. However this latter option may prove to be difficult in the case of vent mining since many species are highly adapted to the particular conditions in the vicinity of vents. The vent conditions could not be replicated in other areas. However, it should be noted that extreme under sampling of the ocean floor makes endemism difficult to establish for deep sea species, particularly those that are not scientifically described. For many habitats, we don't know if endemic species are common or if most species have wide distributions. Establishing the level of endemism in an area will involve studies of local biodiversity combined with an extensive database of species distributions at regional and global scales. Thus a broad regional and global exploration strategy for the deposits needs to be developed in order to better understand the impacts of deep sea mining. Such a strategy should cover the area to be mined and other sites globally for comparative purposes. In order to do this detailed research projects following in the footsteps of projects such as HERMES (http://www.eu-hermes.net) and HERMIONE (http://www.eu-hermione.net) need to be undertaken globally. Furthermore, the importance of deep sea research focusing on mapping and understanding the distribution of ecological communities in the deep sea needs appropriate valuation in the European research landscape. A broad regional and global exploration strategy for the deposits needs to be developed in order to better understand the impacts of deep sea mining, such a strategy should cover the area to be mined and other sites globally for comparative purposes.

What EU action would be helpful?

	priority	useful	not useful	no opinion
research on environmental impact*	●	○	○	○
research on technology*	●	○	○	○
promoting freely accessible seabed maps together with information on geology, ecosystems and habitats *	●	○	○	○
promote exchange of good practice*	●	○	○	○
develop code of corporate responsibility*	●	○	○	○
facilitate mobility of labour*	○	○	●	○
further support to initiatives such as the Extractive Industry Transparency Initiative (includes requirement for disclosure of payments to governments)*	○	●	○	○
strengthen EU environmental legislation such as that on environmental impact and mining waste. These are mostly applicable only for waters of EU countries. *	○	●	○	○
support a pilot project to test technology under realistic conditions*	●	○	○	○
actively support network of marine protected areas in areas beyond national jurisdiction*	●	○	○	○

please explain your choices or suggest alternative courses of action (optional)

There is a growing need for a better-defined European policy in the area of deep-sea mining. The policy should address the issue of deep-sea mining in an integrated, practice-oriented and transparent manner. In order to ensure that Europe is established, as a leading player the EU should take an integrated approach, covering all aspects of the marine mining value chain from basic research, to potential commercialisation opportunities. This would ensure that all environmental, technical, legal, regulatory, economic and political aspects of deep-sea mining, both in international and national jurisdictional waters are considered. A key area of cooperation across Europe might include collaborative work across the value creation chain related to marine mining, covering key aspects such as: • Geophysical exploration using new or modified tools and technologies; • Geological evaluation, site selection and resource definition by drilling; • Environmental and biological characterisation, baseline collection and monitoring; next generation sequencing approached for the assessment of biological diversity and activity. • Impact assessment and biological hazard assessment, including assessment of impact at pilot projects. • Development and testing of robotic tools to support monitoring, infrastructure maintenance and sustainable mining operations; • Development of environmental, technical and safety standards • Public outreach, looking at public awareness/acceptance Such work would help develop the technology and knowledge base for effective mineral exploration, assessment and extraction at a commercial scale, and help answer some of the most basic fundamental questions such as: • What is the resource potential of an area? • How can we explore and measure the resource potential? • How can we extract resource potential? • What are the characteristics of the biological communities in areas likely to be mined? Having this understanding would then allow a more complete consideration of the environmental impact of deep-sea mining, accounting for the nature, extent and location of the mining activity as well as the extraction methodology to be used.

Anything else

Are there any other points you would like to bring up?

Deep-sea mineral resources may provide a significant resource for Europe - especially for commodities essential to high-technology and green industries. However, there are many unknowns about the location, composition, concentration, and size of the resources. These require geological and technological developments in seafloor exploration strategies. Consequently it is critical that further knowledge on these subjects is gathered, through coordinated research into seabed mining. Such research into seabed mining should also be complemented by basic research into the seabed environment to provide essential knowledge against which the environmental impact of activities can be measured. Basic research can include both the better understanding of deep-sea communities as well as the development of technology to better record and access such remote environments. Furthermore, promotion of access to oceanic platforms for such research purposes should be promoted to enhance capability at a European scale. There is an urgent need to understand the impact of seabed mining activities in the deep sea environment to help improve the sustainability of this nascent industry. Influencing industry practice at this early stage would set precedents for future activities, for example even small improvements in the design and operational mode of mining equipment could significantly reduce environmental impact of the activities at no or little cost to the industry. To effectively do this we need to engage in research on the disturbance process in biological systems, for example faunal responses to impact, connectivity, resilience and resistance of deep-water ecosystems. This can be done using a variety of methods, including monitoring pilot mining activities in field situations and lab or field based manipulative experiments. There are various impacts of seabed mining about which more information is needed. One scientific issue about which little is known, is the impact of sudden or unintentional deoxygenation of the deep sea waters during the mining process. This could come about when fresh rock faces are exposed to the water column through the mining process. As the rock face comes in contact with the water column it may oxidise and thereby reduce the oxygen content in the water column. This may have detrimental impacts for the marine life near the sea floor. Potential solutions may be found by bring a constant air supply from the surface to the mining area to ensure that there is sufficient oxygen saturation across the newly exposed rock faces. In order to better understand such processes and if such solutions are suitable there needs to be much more research undertaken in this area. Mining of any type will cause an increase in suspended particulate matter in the water column. Such suspended matter will have impacts on the ecosystems in the water column. Such plumes of suspended material are unlikely to remain confined to the mining area. Ocean currents and prevailing bathymetry are likely to carry the particulate material away from the mining site. This could impact other ecosystems away from the mining site. Therefore it is essential that the prevailing currents, bathymetry and the typical rates of sedimentation are known in order to assess the extent and range of impacts caused by suspended material. Typical sedimentation characteristics are important to know because if communities are not used to high sedimentation rates (e.g. those on abyssal plains) then a sudden input of material from the mining process may cause significant damage to an ecosystem. There is a lot that we do not understand in the marine system. Intensive extraction in this poorly understood environment could lead to significant damage and other potential problems (e.g. sub-marine slope failures, damage to benthic communities down-current from extraction sites). However, appropriate management at the international level could help to both prevent and mitigate any long-lasting problems associated with deep-sea mining. One such strategy for mitigation is the support of the instatement of Marine Protected Areas in both European jurisdictional and international waters. However in light of the development of industrial activity in regions where MPAs may be instated closely regulated Marine Spatial Planning policies at the European and national levels which is based on the most advanced ecological, industrial and economic evidence.

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