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ACCESS

Arctic Climate Change, Economy and Society

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D5.82 – Final test and delivery of the Marine Spatial Planning Tool

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Contents

Executive Summary

Marine Spatial Planning (MSP) is increasingly used to manage the demands on marine space, where several different users may compete for resources or space, to ensure that activities at sea are as sustainable and efficient as possible. To help member states coordinate activities that take place at sea, the European Parliament endorsed a Directive for Marine Spatial Planning in April 2014. MSP is seen as a cornerstone of the Commission's Blue Growth Strategy and of the EU Integrated Maritime Policy.

Marine Spatial Planning provides a practical way to organise the use of marine space and the interactions of its users, both spatially and temporally. MSP aims to balance the demands for development with the need to preserve ecosystems, while also achieving social and economic objectives. Many countries already designate or zone marine space, but conflicts can arise where management plans have been developed on a sector-by-sector basis, without sufficient consideration of the effects on other users or the environment.

As sea-ice coverage in the Arctic diminishes, the potential for future economic exploitation increases, most notably in fisheries, oil and gas exploitation, shipping and tourism – the sectors covered by ACCESS Work Packages 2 – 4. Failure to plan for cross-sectoral management could potentially lead to negative environmental impacts and user-user or user-environment disputes or conflicts. The Arctic Ocean is surrounded by five coastal states and contains a large area of high seas. Resources and ecosystems extend across political boundaries, highlighting the need for planning and governance to be developed and coordinated at a regional rather than national level.

ACCESS Task 5.8 provides for the development of an MSP tool, enabling the integrated study of information from all sectors under review, and the associated human activities related to and within these sectors. Where a specific activity is envisaged, a Marine Spatial Plan may be developed to assess the impact on existing systems. It is beyond the scope of the ACCESS to produce such a plan, but instead we establish a framework with which interdisciplinary planning could be effected. Use of a Geographical Information System (GIS), which acts as a coordination tool, receiving inputs from all work packages, allows us to visualise, store, manage, integrate and interrogate data from all sectors. The MSP tool contains a combination of both relevant publically available data, and data and results generated by ACESS partners. Users can visualise the various uses of marine space and easily identify overlapping activities. Supporting data, e.g. regulatory, temporal and spatial information, is accessed by hyperlinked documents. The MSP tool is by its nature organic and so will continue to evolve over the life of the project as new data and results become available. We provide the MSP tool in two forms; an online GIS available via a web browser without the need for specialist software, and a desktop ArcGIS project.

In the following report we use three case studies to demonstrate the GIS tool. These highlight both cross-sectoral conflicts across the Arctic Ocean as a whole, and also

focus on two regions under pressure from increasing economic exploitation; the Barents Sea and the Chukchi Sea and Bering Strait region.

Retreating summer sea-ice is opening up new areas for potential hydrocarbon development, while successful submissions for continental shelf beyond 200 M under UNCLOS article 76 will provide coastal states with sovereign rights to resource exploitation. Both of these scenarios, coupled with ever improving technology for gas and oil extraction in deeper water, could well lead to increased hydrocarbon exploitation in the Arctic.

The decline in summer sea-ice is also opening up the Arctic for shipping. The two main shipping routes, the Northern Sea Route and the North West Passage, are located largely along the shallow water continental shelf - areas of significant hydrocarbon prospectivity, and possible increasing conflict between different economic sectors. Commercial fishing activities in areas beyond national jurisdiction in the central Arctic Ocean may also become significant as sea-ice cover decreases. Current legislation is inadequate to fully protect these areas.

The Bering Strait is a pinch-point between the Pacific and Arctic Oceans. All commercial transit shipping traffic through the Arctic must either enter or exit through the Bering Strait. Increased hydrocarbon exploration and exploitation in the Chukchi, Beaufort and East Siberian Seas will lead to increasing shipping activity through this region. Increasing economic activity may have a significant detrimental effect on key cetacean species (e.g. bowhead and fin whales, belugas and narwhals) through increases in underwater noise, pollution and danger of vessel strikes, while climate change may add additional stresses with changes in migratory patterns and prey distribution. This not only has important implications for conservation, but also for the local communities for whom marine mammals have both important resource and cultural significance. MSP will prove a vital tool to mitigate against the impacts of human activities on Arctic cetaceans, for example, through careful planning of shipping lanes, temporal or spatial closures of feeding or calving areas, and management of sources of underwater noise.

The Barents Sea is another area rich in living natural resources, while also experiencing increasing economic activity in the hydrocarbon and shipping sectors. An integrated management plan is in place for the Norwegian Barents Sea-Lofoten area; integrating fisheries, oil and gas, transport and conservation management measures. Model results suggest that the Barents Sea area will continue to be a significant fisheries resource, highlighting the need for trans-boundary management. Resolution of the Norwegian-Russian Barents Sea maritime boundary dispute in 2011 has opened up new areas for hydrocarbon exploitation, while recent large increases in the volume of petroleum products shipped along the Russian and Norwegian coasts has led to a greater number of vessel movements.

These examples highlight the need for trans-boundary MSP. Living and non-living resources, ecosystems, and species distributions, all cross borders, while the effects of climate change will be seen on a regional scale. Truly effective Marine Spatial Planning needs to be considered at a multi-national, Pan-Arctic scale.

ACRONYMS

ACCESS	Arctic Climate Change, Economy and Society
AIS	Automatic Identification System
AMAP	Arctic Monitoring and Assessment Programme (one of six Arctic Council working groups)
CAFF	Conservation of Arctic Flora and Fauna (one of six Arctic Council working groups)
CARA	Circum-Arctic Resource Appraisal
CBD	Convention on Biological Diversity
DEFRA	Department for Environment, Food and Rural Affairs
EBM	Ecosystem-based Management
EBSA	Ecologically or Biologically Significant Areas
EPPR	Emergency Prevention, Preparedness and Response
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical Information System
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organization
IMP	Integrated Marine Policy
IOC	Intergovernmental Oceanographic Commission
IUCN	International Union for Conservation of Nature
LME	Large Marine Ecosystem
LNG	Liquefied Natural Gas
MEA	Millennium Ecosystem Assessment

MESMA	Monitoring and Evaluation of Spatially Managed Areas
MSP	Marine Spatial Planning
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	North East Atlantic Fisheries Commission
NORDREGIO	Nordic Centre for Spatial Development
NPD	Norwegian Petroleum Directorate
NRDC	Natural Resources Defense Council
OSPAR	Mechanism by which fifteen governments and the European Union cooperate to protect the marine environment of the North-East Atlantic
PAME	The Protection of the Arctic Marine Environment Working Group (one of six Arctic Council working groups)
RFMO	Regional Fisheries Management Organisation
SMA	Spatially Managed Area
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
USGS	United States Geological Survey
WP	Work Package

1. Introduction

This report describes and demonstrates the Marine Spatial Planning Tool developed under Work Package 5's Task 5.8 ("*Development and delivery of an integrated Marine Spatial Planning system*") of ACCESS. It is delivered at month 37 of the project as scheduled, and will be further refined with the addition of forthcoming deliverables due from the Work Packages 1, 2, 3 and 4 during the final 12 months of the ACCESS project. An updated version of this report, showcasing implementation of case studies and scenarios will be available as part of the cross-sectoral synthesis deliverable D5.91, due in month 48.

We start with an introduction to the concepts and aims of Marine Spatial Planning (MSP), how these are applied, and look at the scope of the MSP tool developed under ACCESS. This will necessarily focus on the sectors covered by ACCESS Work Packages (WP) 1 – 5 and Arctic specific issues.

Section 3 provides a user manual for the MSP tool, while Section 4 covers the data included in the Geographical Information System (GIS), both from publically available sources and also data provided and anticipated from the ACCESS deliverables. Finally, in Section 5 we demonstrate the use of the tool with some illustrated examples.

At the date of this report the MSP tool GIS is largely populated with publically available data. The majority of the ACCESS deliverables which will feed data and results into the GIS have due dates within the final year of the project (Months 36 to 48). The GIS will evolve over the coming year as more data are added, and will provide a key tool in the development of the final ACCESS synthesis report (D5.91).

2. Marine Spatial Planning

2.1 Introduction to Marine Spatial Planning

The Intergovernmental Oceanographic Commission (IOC) defines Marine Spatial Planning as

> "*a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process*".

While in the UK, the Department for Environment Food and Rural Affairs (DEFRA) states that MSP is

> "*a practical way to create and establish a more rational organization of the use of marine space and the interactions between its uses, to balance demands for development with the need to protect marine ecosystems, and to achieve social and economic objectives in an open and planned way*".

Spatial planning has become an essential tool for terrestrial land use planning and management in response to social, economic and environmental problems. However, spatial planning for the future use of marine areas is a fairly new concept. Although marine areas are typically well regulated or allocated, this has largely been done within the individual economic sectors and at present there are few frameworks that facilitate integrated marine spatial planning (Douvere, 2008).

In response the European Commission's adoption of the Integrated Maritime Policy (IMP) for the EU in October 2007, the Commission produced a "*Roadmap for Maritime Spatial Planning*" in November 2008[1] (European Commission, 2008). The rationale for the MSP Roadmap is clearly relevant for ACCESS, and is given as:

> "*Increased activity on Europe's seas leads to competition between sectoral interests, such as shipping and maritime transport, offshore energy, ports development, fisheries and aquaculture and environmental concerns.*
>
> *Climate change, in particular the rise of sea levels, acidification, increasing water temperatures, and frequency of extreme weather events is likely to cause a shift in economic activities in maritime areas and to alter marine ecosystems. MSP can play an important role in mitigation, by promoting the efficient use of maritime space and renewable energy, and in cost-efficient adaptation to the impact of climate change in maritime areas and coastal waters.*
>
> *MSP is a tool for improved decision-making. It provides a framework for arbitrating between competing human activities and managing their impact on the marine environment. Its objective is to balance sectoral interests and*

[1] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52008DC0791&from=EN

achieve sustainable use of marine resources in line with the EU Sustainable Development Strategy."

MSP is seen as a cornerstone in the Commission's Blue Growth strategy. In April 2014 the European Parliament endorsed a Directive for Marine Spatial Planning.[2] Once adopted by ministers, Member States must transpose the directive into their national legislation by 2016, and draw up their national maritime spatial plans by 2021.

Marine Spatial Planning provides a practical way to organise the use of marine space and the interactions of its users, both spatially and temporally. MSP aims to balance the demands for development with the need to preserve ecosystems, while also achieving social and economic objectives.

Most countries already designate or zone marine space for a number of human activities such as maritime transportation, oil and gas development, offshore renewable energy, and offshore aquaculture. Not all uses are compatible with one another, and may compete for ocean space or have adverse effects on each other. Problems have therefore arisen when management plans have been developed on a sector-by-sector, case-by-case basis without much consideration of effects either on other human activities or the marine environment.

Consequently, this situation has led to two major types of conflict (Ehler & Douvere, 2009):

User – user conflicts e.g. hydrocarbon exploration/extraction and fishing, dredging and aquaculture.

User – environment conflicts e.g. hydrocarbon exploration and cetaceans, trawling and habitat destruction.

Successful MSP must take into account the spatial and temporal diversity of the sea, understanding and mapping these distributions is a key step in the process. Marine Spatial Planning is a future-oriented process, offering a way to address and manage potential conflicts in advance, as well as predicting how these may change due to climate change or other pressures. Future accident/disaster scenarios can also be explored, planned for, and as far as possible mitigated against. Successful MSP can have significant economic, social and environmental benefits. Ehler & Douvere (2009) list some of the most important benefits of Marine Spatial Planning (Table 1).

Ecological/Environmental Benefits

[2] http://europa.eu/rapid/press-release_IP-14-459_en.htm

• Identification of biologically and ecologically important areas • Identification and reduction of conflicts between human use and nature • Allocation of space for biodiversity and nature conservation; marine protected areas • Identification and reduction of the cumulative effects of human activities on marine ecosystems
Economic Benefits
• Greater certainty of access to desirable areas for new private sector investments • Identification of compatible uses within the same area of development • Reduction of conflicts between incompatible uses • Improved capacity to plan for new and changing human activities, including emerging technologies • Better safety during operation of human activities • Promotion of the efficient use of resources and space • Streamlining and transparency in permit and licensing procedures
Social Benefits
• Improved opportunities for community and citizen participation • Identification of impacts of decisions on the allocation of ocean space for communities and economies onshore (e.g., employment, distribution of income) • Identification and improved protection of cultural heritage, identification and preservation of social and spiritual values

Table 1: Benefits of Marine Spatial Planning defined by Ehler & Douvere (2009)

2.2 Ecosystem-Based Management

Although user-user conflicts in the use of maritime space, as outlined above, may have significant adverse effects, the biggest concern today is the impact of human activities on the marine environment (user-environment conflicts). Several recent studies, including the Millennium Ecosystem Assessment (MEA), have highlighted a continued decline in biodiversity in the world's oceans. Cumulative impact of the effects of over-fishing, pollution, habitat destruction and climate change are posing a significant threat to marine ecosystems (Worm *et al.*, 2006; Crowder & Norse, 2008; Halpern *et al.*, 2008). Ecosystem-Based Management (EBM) is a governance and management approach which aims to maintain an ecosystem in a healthy, resilient and productive state (Stelzenmüller *et al.*, 2013), while considering the entire ecosystem, including humans.

The OSPAR Commission define an ecosystem approach to sea use management as:

> "*The comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of goods and services and maintenance of ecosystem integrity*" (Douvere & Ehler, 2009).

The MEA report of 2005 defines ecosystem services as benefits people obtain from ecosystems and distinguishes four categories of ecosystem services, where the so-called supporting services are regarded as the basis for the services of the other three categories:

i. Provisioning Services e.g. food, fresh water;

ii. Regulating Services e.g. climate regulation, pest and disease control;

iii. Cultural Services e.g. recreation and tourism, cultural benefits;

iv. Supporting Services e.g. soil formation, nutrient cycling.

Ecosystem-Based Management has become widely accepted as a key framework for delivering sustainable development, and MSP is recognized as an effective means of implementing EBM in the marine environment (Douvere, 2008, Katsanevakis *et al.*, 2011). However, MSP can only plan and manage human activities in marine areas, not marine ecosystems or components of ecosystems.

Task 5.7 (led by the Beijer Institute) of the ACCESS Work Package 5 specifically addresses Ecosystem Based Management, with a focus on the impact of climate change on the provisioning of ecosystem services (Task 5.7.1) and building a framework for EBM (Task 5.7.2). Task 5.7.1 will map how the different activities in the Arctic are connected to each other using information from Work Packages 2-4 and from tasks 5.7.1 and 5.8, the MSP tool.

2.3 Marine Spatial Planning Frameworks and Implementation

Coastal states have started the process of MSP within waters under their jurisdiction, to integrate economic exploitation and social benefits with the duty to protect the marine environment and protect biodiversity. These rights and duties, towards exploitation of resources and protection of the marine environment, are reflected in two important global conventions; the United Nations Convention on the Law of the

Sea (UNCLOS) and the Convention on Biological Diversity (CBD). Examples of developing MSP initiatives include the Barents Sea Integrated Management Plan; the Canadian Beaufort Sea; the Scottish Pentland Firth and Orkney waters; several US coastal states; the Netherlands; Germany; Belgium and the Australian Great Barrier Reef[3].

An effective Marine Spatial Plan should apply EBM, balancing ecological, economic and social goals and objectives towards sustainable development. The plan should be integrated across all relevant sectors and agencies, both nationally and regionally, and should be adaptive and anticipatory, with focus on the long-term, typically with a 10 – 20 year horizon. MSP needs to be an iterative process that learns and adapts over time. The IOC highlights six characteristics of effective Marine Spatial Planning (Table 2).

Ecosystem-based, balancing ecological, economic and social goals and objectives towards sustainable development
Integrated, across sectors and agencies, and among levels of government
Place-based or **area-based**
Adaptive, capable of learning from experience
Strategic and anticipatory, focused on the long-term
Participatory, stakeholders actively involved in the process

Table 2: Characteristics of effective Marine Spatial Planning (Ehler & Douvere, 2009).

The IOC has produced a 10-step approach to Marine Spatial Planning (Figure 1). This figure highlights the need for stakeholder involvement throughout the entire MSP process. The involvement of stakeholders at all stages of MSP; development, implementation, monitoring and evaluation, is key to a Marine Spatial Plan's success. MSP aims to achieve multiple objectives (social, economic, and ecological) and should therefore reflect as many expectations, opportunities, or conflicts occurring in the area as possible, as well as respecting the rights of residents and indigenous peoples.

[3] http://www.unesco-ioc-marinesp.be/msp_around_the_world

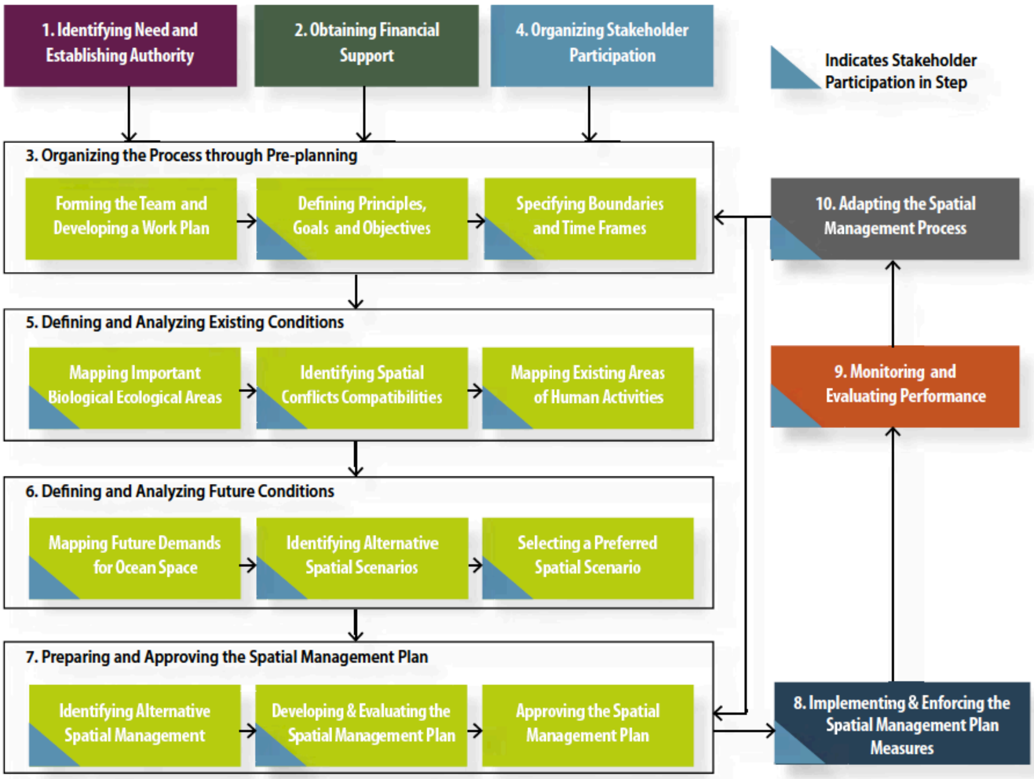

Figure 1: The 10-step approach to Marine Spatial Planning proposed by the IOC (Ehler & Douvere, 2009). Blue shading in the bottom left corners of boxes highlights the need for stakeholder involvement in that step.

Stelzenmüller *et al.* (2013) present a generic framework for the implementation of ecosystem based marine management and its application (Figure 2). The framework is designed to apply the overarching principles of ecosystem based management to monitor, evaluate and implement Spatially Managed Areas (SMAs) in offshore waters. The seven-step framework has been proposed through the EU funded MESMA (Monitoring and Evaluation of Spatially Managed Areas) programme[4], and is being developed and tested with nine case studies within European marine waters. While the IOC 10-step approach shown above includes implementation and enforcement of the marine spatial plan (step 8), through regulations, permits and licences, the MESMA framework is concerned with assessment and evaluation of SMA within existing regulatory regimes.

In section 3 we discuss the MESMA framework in more detail in relation to the ACCESS MSP tool.

[4] http://www.mesma.org

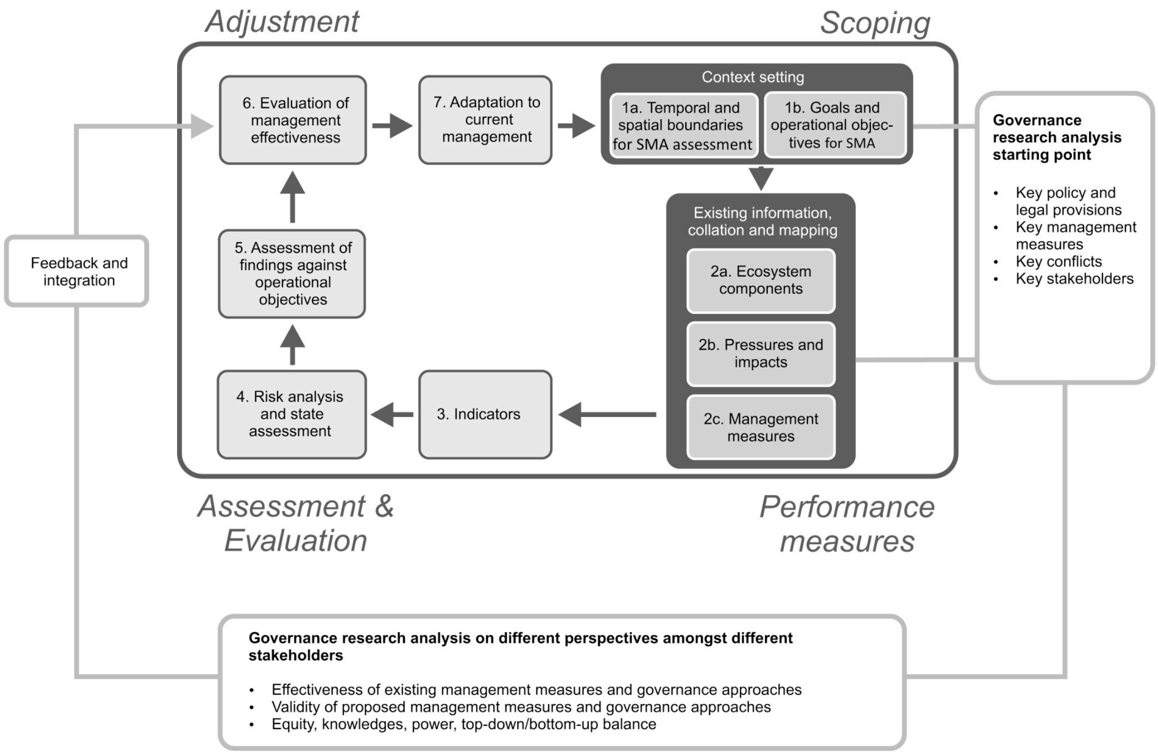

Figure 2: Flowchart showing the proposed MESMA framework with seven key steps to monitor and evaluate spatially managed areas (from Stelzenmüller *et al.*, 2013).

3. The ACCESS Marine Spatial Planning Tool

As sea-ice coverage in the Arctic diminishes the potential for future economic exploitation increases, most notably in fisheries, oil and gas exploitation, shipping and tourism – the sectors covered by ACCESS WP 1 - 4. Failure to plan for cross-sectoral ecosystem-based management could potentially lead to negative environmental impacts and disputes or conflicts. Figure 3 shows examples of potential cross-sectoral conflicts or compatibilities for the Arctic.

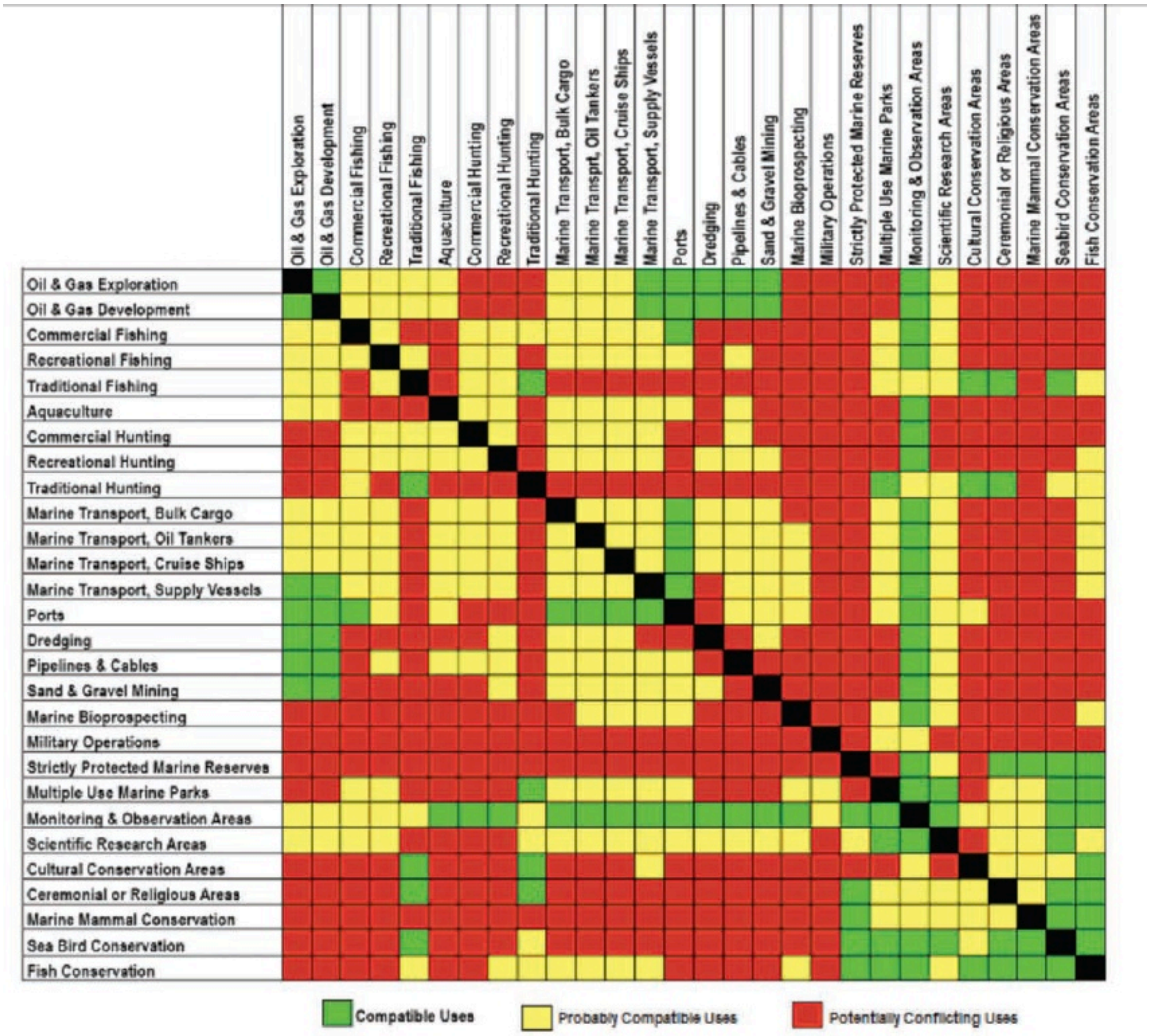

Figure 3: Preliminary identification of potential compatibilities or conflicts in the Arctic (The Aspen Institute, 2011)

From Figure 3, potential conflicts can be seen between most industries and conservation; whether mammal, seabird, or fish, potentially leading to a loss of biodiversity. Traditional fishing is another area where increased economic exploitation may have negative impacts from multiple sectors. In Section 6 we explore some of these potential conflicts through a series of Arctic examples.

The Arctic Ocean is surrounded by five coastal states and contains a large area of high seas. Individual ecosystems extend across political boundaries, highlighting the need for management plans and governance to be developed at a regional rather than national level. Examples include the development of a Regional Fisheries Management Organisation (RFMO) or Arrangement for part of the Central Arctic Ocean (see, for example, Molenaar, 2014), and the recent Arctic Council agreement on Oil Pollution Preparedness and Response (EPPR)[5].

In 2011 the Arctic Council established an Expert Group on Arctic EBM, who produced a report "*Ecosystem-Based Management in the Arctic*" in May 2013.[6] The report includes recommendation of a policy commitment, a set of principles for EBM in the Arctic, and priority activities including the need to develop an overarching EBM goal for the Arctic Council.

International conventions are of importance for all maritime areas, including the Arctic: The United Nations Convention on the Law of the Sea (UNCLOS) is of relevance as it provides for the division of seas and oceans into maritime zones, some of which must be delimited by coastal states in order to have legal effect, yet equally of importance is the principle of freedom of navigation guaranteed under UNCLOS, which is conditional upon rules and standards on maritime safety and protection of the marine environment being met. The International Maritime Organisation (IMO)[7] establishes internationally recognised rules and standards for shipping and maritime transport such as traffic separation schemes. The London Convention Protocol[8] (1996) introduces the precautionary principle which constitutes a major change of approach to the regulation of depositing waste materials in the sea. Under UNCLOS Article 89, no state can unilaterally claim sovereignty or sovereign rights on the high seas, and as a result cannot claim jurisdictions for MSP (Maes, 2008). Although countries are committed to preventing harm to the environment and biodiversity beyond areas of national jurisdiction under UNCLOS and the CBD, few assessment procedures exist (Ardron *et al.*, 2008).

The High Seas are a particular international component of the marine environment of the Arctic Ocean - Under the 1982 UNCLOS Convention, resources of the water column are available for exploitation by states external to the Arctic community (Part VII)[9], while sovereign rights to the exploitation of the resources of the underlying

[5] http://www.arctic-council.org/eppr/agreement-on-cooperation-on-marine-oil-pollution-preparedness-and-response-in-the-arctic/
[6] http://www.arctic-council.org/index.php/en/document-archive/category/449-ebm
[7] IMO: www.imo.org
[8] http://www.admiraltylawguide.com/conven/protodumping1996.html
[9] Article 87: Freedom of the high seas
1. The high seas are open to all States, whether coastal or land-locked. Freedom of the high seas is exercised under the conditions laid down by this Convention and by other rules of international law. It comprises, inter alia, both for coastal and land-locked States:
(a) freedom of navigation;
(b) freedom of overflight;
(c) freedom to lay submarine cables and pipelines, subject to Part VI;

seabed, and sub-seafloor may well belong to an Arctic coastal state (under Part VI) - this dual management regime is one which needs very careful planning and lends itself to the process of MSP.

By way of further complexity, it is recognised that the Arctic Ocean has a special status under the 1982 convention, and can be considered as a semi-enclosed sea in accordance with the provisions of Article 122[10]. The Arctic coastal states would naturally seek to "coordinate the management, conservation, exploration and exploitation of the living resources of the sea" and "to invite, as appropriate, other interested States or international organisations to cooperate with them in furtherance of the provisions of this article"[11]. A MSP clearly would help address any tension which could result from the joint operation of Parts XI and VII.

3.1 Aims and scope

The long term effects of climate change on the Arctic Ocean, as demonstrated/ discussed within the ACCESS project are key to the MSP tool developed here. The MSP tool needs to address the temporal and spatial variability of the ice cover, type and impact on Arctic activities.

ACCESS Task 5.8 provides the development of an integrated MSP tool, enabling the integrated study of information from all the sectors under review in ACESS, and each of the associated human activities related to and within these sectors. ACCESS will not produce a Marine Spatial Plan, but rather a system with which interdisciplinary planning could be effected, and which will act as a coordination tool, receiving inputs from WP1-4. The use of a Geographical Information System (ArcGIS[12]) allows us to visualise, store, manage, integrate, interrogate and access data from all sectors. Users of the MSP tool will have access to all the compiled data and analyses for the geographic or thematic area of interest, and would be able to identify relevant layers/data of potential significance to the issue under review/assessment. Analysis and interpretation will require objective and independent selection of which factors are of primary, secondary and subordinate effect - and this process could be an iterative one, arriving at different management options. Data will be accessed through embedded links in the supporting GIS. In particular, regulatory, spatial and

(d) freedom to construct artificial islands and other installations permitted under international law, subject to Part VI;
(e) freedom of fishing, subject to the conditions laid down in section 2;
(f) freedom of scientific research, subject to Parts VI and XIII.
2. These freedoms shall be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas, and also with due regard for the rights under this Convention with respect to activities in the Area.

[10] Article122: Definition
For the purposes of this Convention, "enclosed or semi-enclosed sea" means a gulf, basin or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States.

[11] Article123: Cooperation of States bordering enclosed or semi-enclosed seas

[12] hppt://www.esri.com/software/arcgis

temporal information included will be accessed by hyperlinked documents. Users will be able to visualise the various uses of marine space and easily identify overlapping activities leading to both user-user and user-environment conflicts. Figure 4 shows some of the complex interactions (both user-user and user-environment) for one sector in the offshore Arctic.

The ACCESS project has a number of key factors which add complexity to the development of a spatial planning tool. These include: difficulties related to cross-national/cross boundary issues; variations in the project's spatial focus between specific local targets and the entire Arctic region; and the requirement to address long term temporal variability. The MSP tool by its very nature is organic and will evolve over the life of the entire project.

It is not intended that the ACCESS MSP will seek to quantify each of the parameters/characteristics/relevant factors of influence to an activity or event potentially occurring in the Arctic Ocean. With the GIS and MSP tool, ACCESS will have compiled the most comprehensive data set for the management of the Arctic environment, for establishing scenarios to test planned activities and for predicting the impacts on the environment by users at all scales. The numerically assessed parameter approach has been used elsewhere (Halpern *et al.*, 2008), and while this is beyond the scope of this current work, it can readily be developed as a next stage from the framework established in this project.

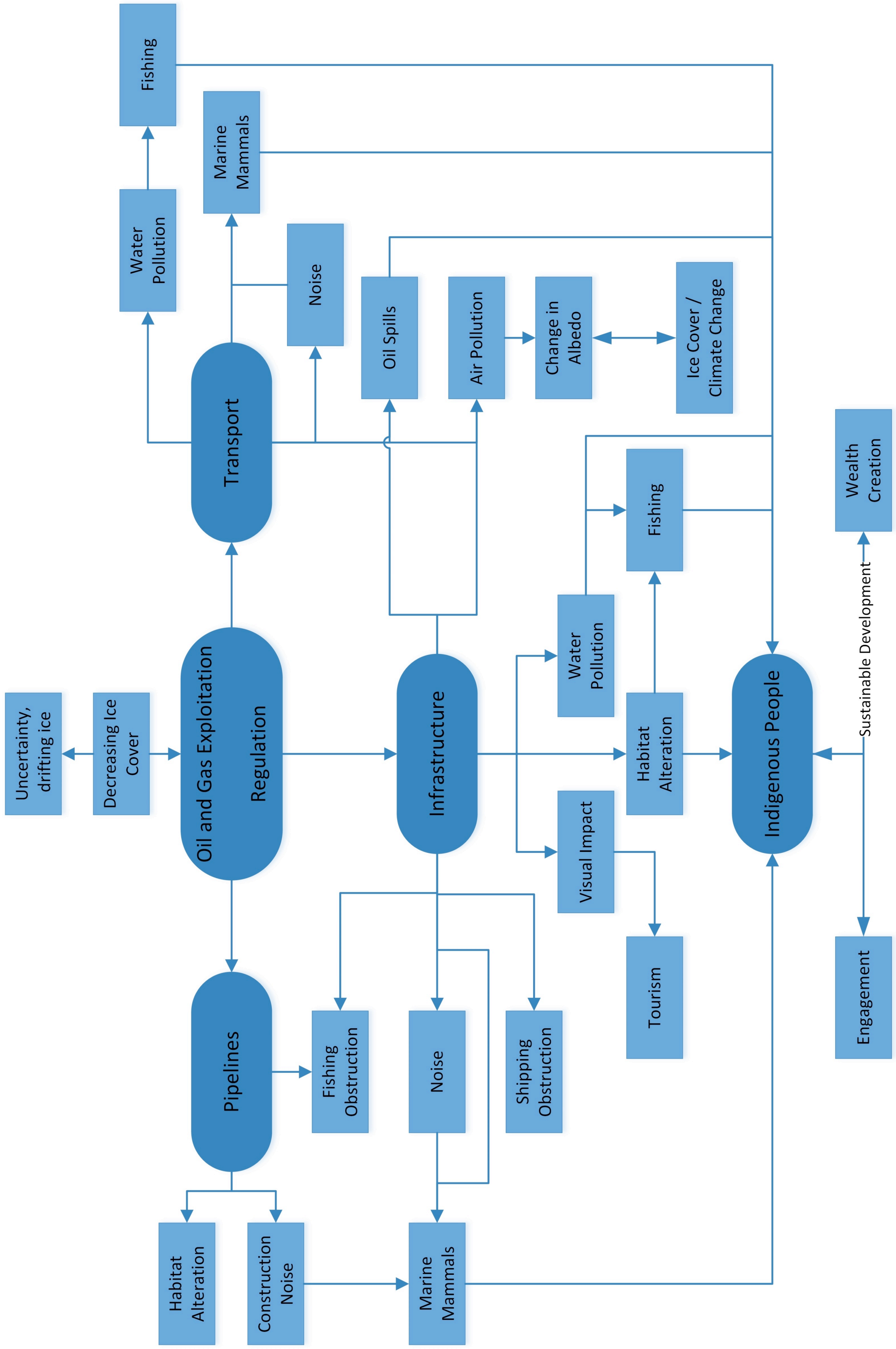

Figure 4: Example of some complex interactions/conflicts which may arise from increased hydrocarbon exploitation.

We can describe the ACCESS MSP tool in terms of the framework provided by the MESMA project, and described in Section 2, above. The MESMA framework contains seven steps (Figure 2), not all of which are being addressed fully by ACCESS. The tool presented here could be used by other organisations to develop spatial management of the Arctic further. Table 3 lists the MESMA framework steps and the areas covered by the MSP tool. Links to other areas of governance covered in ACCESS Work Package 5 can be clearly seen also. The engagement of stakeholders is key at several steps.

Step	MESMA framework	ACCESS MSP tool
Step 1	Context setting: Temporal and spatial boundaries, and goals and operational objectives	Spatial and temporal boundaries are defined by the project; the Arctic region, and 30 years into the future
Step 2	Existing information, collation and mapping	This is the main focus of the MSP tool developed under ACCESS; including both existing data, and new data and results from the ACCESS deliverables (see Section 4)
Step 3	Indicators	Indicators developed under ACCESS will be included in the MSP tool where possible, equally data from the MSP tool can feed into indicators
Step 4	Risk analysis and state assessment	Quantitative analysis of performance will not be carried out, but the GIS can be used to identify areas of increased pressure (ACCESS deliverable D5.31)
Step 5	Assessment of findings against operational objectives	Links to steps 3 and 4.
Step 6	Evaluation of management effectiveness	Step 6 is covered under WP 5's tasks on governance (D5.11, D5.21)
Step 7	Adaptation of current management	Again this is covered under the deliverables on governance, specifically D5.41

Table 3: The ACCESS MSP tool and other Work Package 5 deliverables in the context of the MESMA framework.

3.2 MSP issues beyond the scope of this report

It is important to note that the ACCESS MSP tool was not intended to produce a Marine Spatial Plan for the Arctic. As identified in the OCEAN.2010.1 call for proposals, ACCESS has 'discuss[ed] policy and governance options, including marine spatial planning, for sustainable development". ACCESS has delivered a fully populated database within a GIS specifically designed for geospatial analysis in a temporal framework of 30 years of climate change.

The ACCESS approach has been a qualitative one, and relies on collective assessment of planning options by stakeholders and user groups. It could be further developed to a semi-quantitative resource, but would necessitate extensive evaluation of parameters. This is both outside the scope of this report, and could encounter significant difficulties in independent numerical assignment - as attribution of values to many key parameters could be highly subjective.

While the ACCESS MSP tool covers the whole Arctic Ocean region, it is not possible to deliver detailed analysis for the entire region (partly due to lack of available data for some areas – see section 5, below). Selected areas and themes have been targeted to demonstrate the MSP tool.

The majority of deliverables for the sectoral work packages in the ACCESS programme (WP2-4) are due in the final year of the project. At this stage in the programme (Month 37), many have still to be submitted and, consequently, the GIS is currently incomplete. The MSP tool will continue to develop over the final year of the project as more deliverables and data are input, and we will provide an update in Month 48.

4. The MSP Tool GIS and User Manual

The GIS element of the MSP tool consists of two options; an on-line GIS which is accessible via a web browser, and a bespoke desktop ArcGIS project which can be used by those with access to the ArcGIS software. Figure 5 illustrates a skeleton schema of the desktop ArcGIS, where all data identified from publically available data sources as well as those provided by ACCESS partners are stored and will be readily available as Arc shapefiles or Arc gridded data. Relevant data and results from new deliverables will be added as they are made available over the coming year.

Both the online and the desktop options operate hyperlink functionality providing access to reports, data, added information etc. Both systems provide the ability to very readily recognise the overlapping use of marine space, a key component to better understanding the challenges of spatial planning and management. For those with access to a desktop ArcGIS, usage of the MSP tool will be a familiar exercise. However in order to help understand the functionality of the on-line GIS we provide the reference guide below.

Below we include a quick reference for viewing maps in the ArcGIS.com map viewer. The ACCESS online GIS has been developed to provide project partners with an online GIS, viewable from simply a web browser without the need for specialist software. The online GIS is available through the WP5 page on the ACCESS Wiki (https://wiki.met.no/access/start).

Figure 6 shows an example screen from the online viewer with controls and options numbered according to the reference guide below.

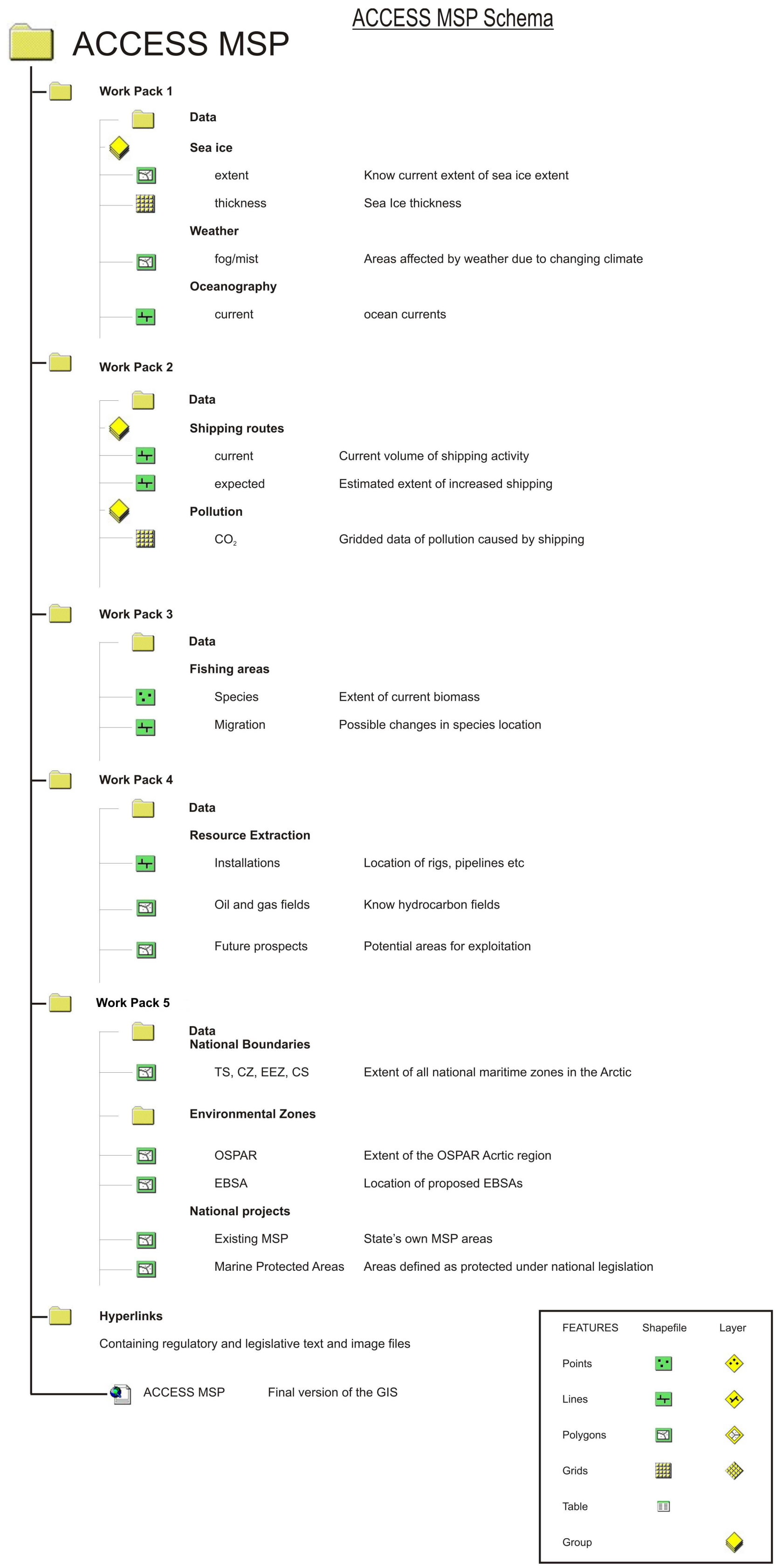

Figure 5: Example ACCESS MSP tool GIS schema.

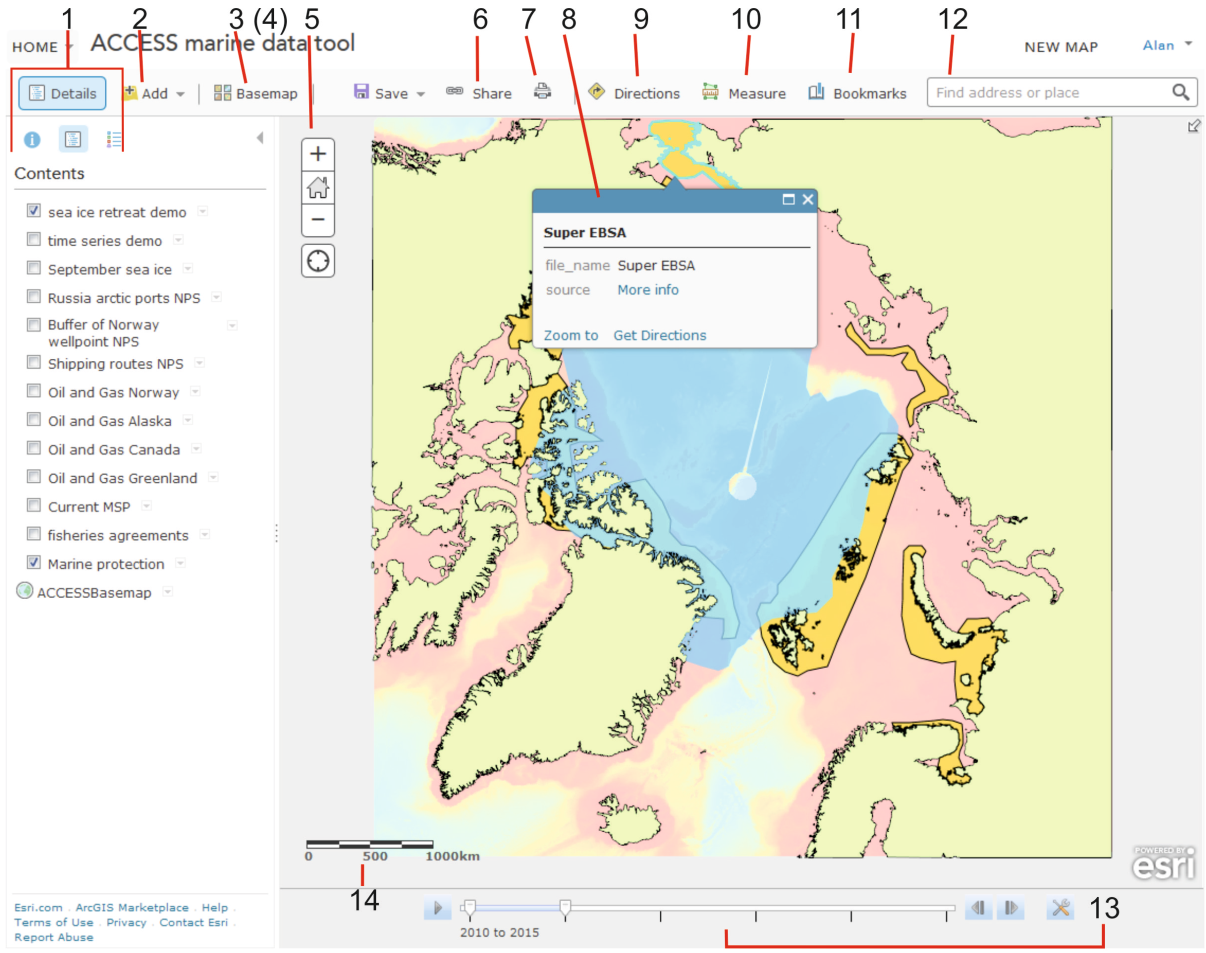

Figure 6: Example screen from the online GIS viewer. Labelled numbers correspond to sections below.

1. See map details

Details include options to see information about the map, the map contents, and a legend.

- About button displays descriptive information about the map such as a summary, who owns the map, the last modification date, user ratings, and a link to more detailed information.
- The Contents button displays the list of the layers in the map. Click the name of the group layer to see the individual layers within the group. Uncheck the box to the right of the name to turn off (not display) the layer. Check the

box to the left of the name to turn on (display) the layer. Click the arrow to the right of the layer name and click Description to open a page with detailed information about the layer.

- The Legend button displays a legend for layers in the map. You will not see a legend for basemaps, layers that are not accessible externally, layers that have not been checked in the Contents list, or on layers where the map author has hidden the legend.

2. Add

Use this button to add your own data into the map. These data can only be viewed locally and will not be incorporated into the project. Any data to be included permanently and made visible to a wider audience must be uploaded by the administrator.

3. Basemap

Use this button to select pre-defined basemaps. However for the ACCESS on-line tool, a tailor made North Pole Stereographic projection basemap has been generated specifically for viewing the data from a polar perspective.

4. Edit features

If you see an Edit button, you are viewing a map with an editable feature layer (and you have privileges to edit features). Use the option to add, change, or remove the features in the map.

5. Navigate

- To zoom, use the Zoom in button + or the Zoom out button −, the mouse and scroll wheel, or the arrow keys on the keyboard. To zoom in, you can also press and hold the Shift key and drag a box on the map.
- To zoom the map to its initial extent, click the Default extent button. You can also browse the map to a predefined extent through a bookmark.
- To pan, use your mouse and scroll wheel or the arrow keys on your keyboard.
- To find your current location, click the Find my location button. You may need to authorize the site to access your location information. Your results may vary based on your connection type, Internet Service Provider, physical location, network, and browser.
- To open an overview map, click the arrow in the upper right corner.
- If you have a Mac with OS X 10.6 or greater, you can take advantage of multitouch gestures by dragging two fingers to pan and zoom the map. The default behavior is to pan. To zoom, press and hold the Shift key to zoom in or out. Dragging two fingers toward you zooms in; dragging two fingers away zooms out.

6. Share

If you see a Share button, you have privileges to share a map. Your sharing options depend on your privileges and can include posting maps on a social networking site, sending an email with a link, embedding maps in a website or blog, and creating apps with maps.

7. Print

Use Print to create a printer-friendly image of your map. Layers that are not accessible externally, KML, and time-aware layers do not appear on a printed map. If you print a map using your browser print button, other layers and logos may be missing as well.

8. View pop-ups

Pop-ups bring to life the attributes associated with each feature layer in the map such as data source, references, hyperlinks etc. They display images and charts and can link to external web pages.

9. Get directions

When you are signed in with an organizational account, the map viewer includes a Directions button that you can use to get a set of turn-by-turn driving directions. Not relevant to ACCESS.

10. Measure

Use Measure to measure the area of a polygon, the length of a line, or view the coordinates of a point.

11. Access bookmarks

Use Bookmarks to access a set of pre-defined locations on the map. If you are a map author, you can create bookmarks.

12. Locate addresses and places

Use the geocoder at the top of the map viewer to find locations on the map such as addresses, places, intersections, cities, points of interest, monuments, and geographic entities. The geocoder shows suggestions as you type. Your map is automatically zoomed to the closest match and a pop-up appears at the location. If the location isn't what you wanted, click the "Not what you wanted?" link in the window and select a different location from the list. Note, in the ACCESS on-line tool, only locations within the limits of the tailor-made North Pole Stereographic projection basemap will be visible.

13. View data over time

If you see a time slider at the bottom of the map, you can play the map to see how the information changes over time, and hence view temporal changes.

14. Understand map scale

The scale bar shows the scale of the map which is set by the basemap. If you zoom beyond the visibility of the basemap, the map may not draw correctly. Your administrator sets the default units for the scale bar (and measure tool, directions, and analysis). United States standard sets the units to miles, feet, and inches; metric sets the units to kilometres, meters, and centimetres. You can change the units you see by updating your profile.

5. Data included in the MSP Tool

The MSP tool will contain a combination of both publically available data, and data and results generated by ACCESS partners.

5.1 Non-ACCESS data

Extensive searches have been made to identify and locate publically available data which are relevant to the ACCESS project. These data have been downloaded as shapefiles for direct import to the GIS where possible, or alternately have been imported from data tables, or digitised from maps. Annex 1 shows a list of key datasets which have been included in the GIS, along with details of the region/country covered and links to the data source. Over the remaining year of the project the database will continue to be developed.

One of the challenges of the ACCESS MSP tool is that the region of interest covers five coastal states as well as an area of high seas. Data availability varies considerably between different countries, and for Russia in particular it was hard to find online sources of data.

5.2 ACCESS data and deliverables

Many of the ACCESS deliverables are due in the final year of the project, so are not available at this stage. All reports which have been delivered prior to Month 37 have been examined to determine if they contain any data or results suitable for inclusion in the GIS, and lead authors contacted where appropriate. This approach will be continued for the final year of the project. The MSP tool will therefore continue to develop over the entire lifetime of ACCESS. Table 4 lists some tasks which have been identified as having primary outputs suitable for inclusion in the GIS.

Work Package	Parameters	Task
WP1	Ice extent, type, thickness & drift over time (month/year)	1.2.1 to 1.3.1
	Future predictions & accuracy	1.5.1 to 1.6.1
	Water temperature & salinity	1.3.2
	Atmospheric changes	1.4
WP2	Shipping routes – present & future	2.1.1, 2.1.3, 2.1.5, 2.5.3
	Tourism	2.6.2
	Air Pollution	2.4.1
	Noise propagation	2.4.3, 2.4.4 2.4.6
	Governance & Indicators	2.8.1, 2.8.2, 2.9
WP3	Future fisheries	3.1, 3.3, 3.4
	Aquaculture	3.2
	Marine mammal ranges	3.6
	Indicators	3.7
WP4	Environmental risk/oil spill response	4.4
	Pollution – air & ocean	4.5.1, 4.5.2
	Noise propagation	4.5.3, 4.5.5
	Governance	4.6
	Indicators	4.7
WP5	Existing Regulation & future options	5.1, 5.2
	Fisheries Zones, RFMOs	5.1.2
	Indigenous Peoples	5.5, 5.6
	Ecosystem-based management	5.7

Table 4: ACCESS tasks identified as having output which may provide input to the MSP tool. (This is an indicative list only and should not be considered complete).

6. Case Studies

In the following section we present three case studies which demonstrate the Marine Spatial Planning tool. The first example sets the context over the Arctic Ocean, while the following two examples look at regions under pressure from increasing economic exploitation.

Case Study A

Case Study A highlights possible cross-sectoral conflicts over the Arctic Ocean region as a whole (Figure 7). Retreating summer sea-ice is opening more areas to potential development. Successful outer continental shelf submissions beyond 200 M under UNCLOS Article 76 will also provide coastal states with sovereign rights to sub-seabed resource exploitation[13]. Both of these scenarios could well lead to increased hydrocarbon exploitation, especially as improved technology is allowing oil and gas extraction in ever deeper water worldwide.

As well as hydrocarbon exploitation, retreating sea-ice is also opening up the Arctic to shipping. Figure 7 shows the two main shipping routes; the Northern Sea Route and the North West Passage. Both routes are located largely along the shallow water continental shelf, where the USGS have identified significant hydrocarbon prospectivity, shown by the areas highlighted in green.

While many of the predicted increases in economic activity will take place over the continental shelf or in coastal state's EEZs, as the central Arctic Ocean becomes ice-free this allows the potential for commercial fishing activities in the areas beyond national jurisdiction. Current legislation is inadequate to fully protect these areas.[14]

It is recognised that the establishment of continental shelf areas beyond 200 M presents a further complication in that any coastal state successful in securing its exploration rights on the seabed and within the subsoil would be in potential conflict with those states seeking to exploit the resources in the superjacent water column under the regime of the high seas. The operation of this dual legal regime has largely been untested, but any instances will have great significance for the Arctic Ocean in the decades to come.

[13] http://www.un.org/Depts/los/convention_agreements/texts/unclos/part6.htm
[14] See ACCESS deliverable D5.21

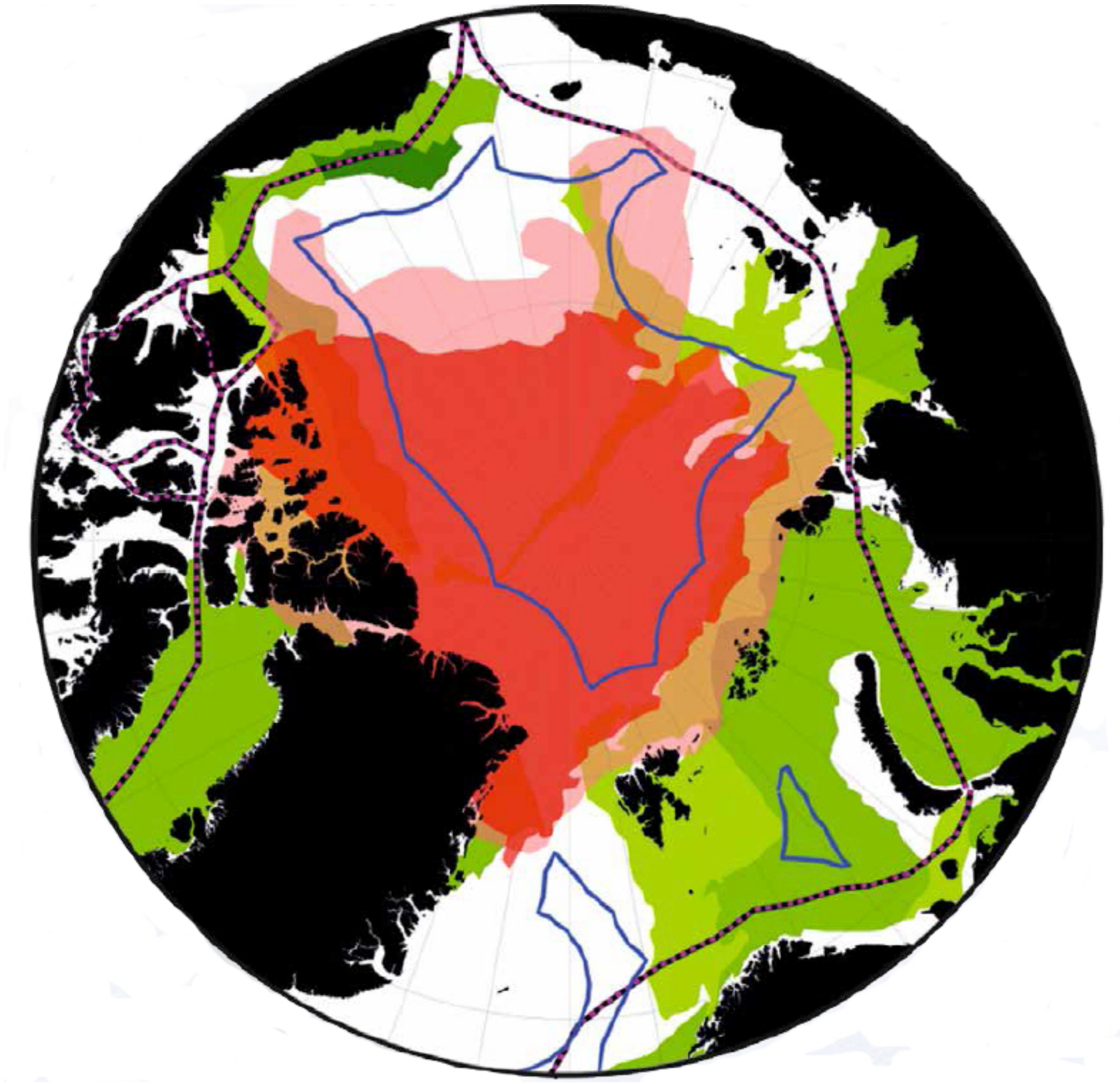

Figure 7: The Arctic Ocean showing areas of potential conflict. Pink shaded area shows the sea-ice extent in September 2010, while red shows the decreased extent in September 2012. Geological provinces in the Arctic with estimated significant undiscovered oil[15] are shown in green (light green shows low potential, to dark green as highest potential). Blue line shows coastal states 200 M limits, while pink and black dashed lines show the Northern Sea Route and North West Passage.

In the following two case studies we look briefly at two key regions where increasing economic activity will lead to increased pressure on ecosystems.

[15] USGS - http://energy.usgs.gov/RegionalStudies/Arctic.aspx

Case Study B

The second case study looks at the Chukchi Sea and Bering Strait region (Figure 8). From south to north, the Bering Sea, Bering Strait and Chukchi Sea provide the linkage from the North Pacific to the Arctic Ocean. At its narrowest point the Bering Strait is only 80 km wide and represents a “pinch-point” between the Pacific and Arctic Oceans. Hydrocarbon exploration and exploitation in the Alaskan and Canadian Chukchi and Beaufort Seas is increasing, while in the Russian East Siberian Sea Rosneft and ExxonMobil have agreed joint licence areas.[16] Figures 3 and 4 outline some of the user-user and user-environment conflicts that may result from increased hydrocarbon exploitation. In addition to environmental risks associated with the oil platforms and drilling/extraction activities (e.g. oil spills, acoustic noise, pollution), increased shipping activity (supply vessels, rig movements) through the Bering Strait is inevitable.

Increased commercial transit shipping traffic along the Northern Sea Route and North West Passage must all either exit or enter the Arctic through the Bering Strait. Figure 8 shows the ranges of the bowhead and fin whale in this area of the Arctic. The bowhead whale, along with belugas and narwhals, are present in the Arctic all year round and are significantly affected by changes in their environment caused by climate change (Reeves *et al.*, 2013). According to Reeves *et al.* (2013) more than half of the Arctic range of these three whale species overlaps known or suspected offshore hydrocarbon provinces. Hydrocarbon exploration and exploitation leads to significant increases in underwater noise, while increasing vessel traffic escalates the risk of ship strikes, pollution and noise.

Increased economic activity in these areas, coupled with changing climatic conditions (which could lead to changes in migratory patterns and prey distribution), therefore has not only significant implications for the conservation of the cetacean species and their habitats, but also for the local communities who depend on marine mammals for both food supply and cultural cohesion. MSP will prove a vital tool to mitigate against the impacts of human activities on Arctic cetaceans, through careful planning of shipping lanes, temporal or spatial closures of feeding or calving areas, and sources of underwater noise, for example.

[16] http://www.ogj.com/articles/print/volume-111/issue-4/exploration---development/exxonmobil-rosneft-expand-artic.html

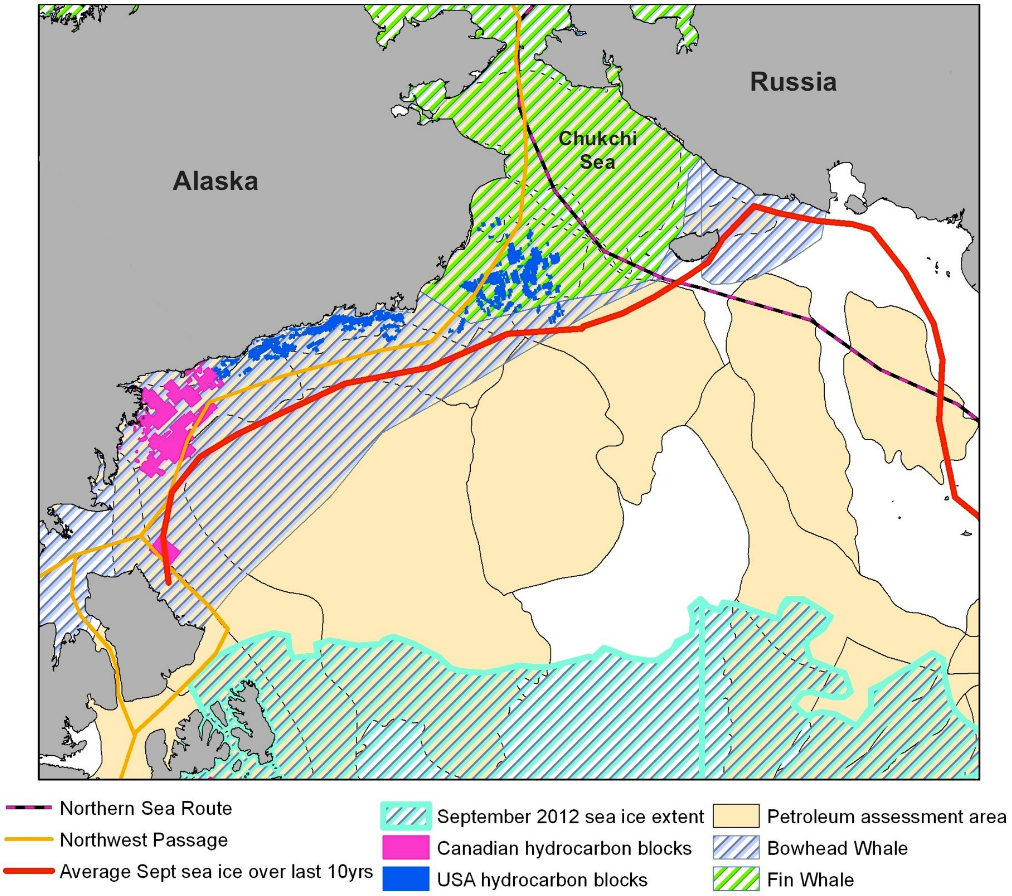

Figure 8: The Bering Strait and Chukchi Sea region. Blue and green hatched areas show bowhead and fin whale ranges (IUCN Red List), hydrocarbon blocks are shown in blue and pink, while the orange and pink/black lines show the North West Passage and Northern Sea Route shipping routes respectively. Tan coloured areas show potential hydrocarbon provinces of the USGS Circum-Arctic Resource Assessment (Gautier *et al.*, 2009). The September 2012 sea-ice extent is shown by the hatched area outlined in pale blue.

Case Study C

Case Study C is focused on the Barents Sea. In this example we include data and results from ACCESS deliverables D3.11 and D4.54. The Barents Sea is an area of rich living natural resources, while also experiencing growing exploitation of hydrocarbon resources, and an increase in maritime transport. As a result this is an area where coordination and regulation of these activities is required to manage interactions between different economic sectors, and also with the natural environment. An integrated management plan is already in place for the Norwegian Barents Sea-Lofoten area, integrating fisheries management measures with those for oil and gas, transport and nature conservation.[17] The plan covers Norwegian waters only; no marine spatial plans are in place for Russia.

Figure 9 shows data from all the economic sectors covered by ACCESS; fisheries, shipping and oil and gas. Results from deliverable D3.11 show calculated cod stock density for August 2057. The modelled results suggest that climate change does not lead to significant changes to cod stock from the present day, but do highlight that this area will continue to be a significant fisheries resource. Cod stocks are predicted to be high around the boundary between the Norwegian and Russian EEZ's and the Loophole (area of high seas between Norway and Russia, and an area which has been subject to regional fishing disputes[18]), and also further east in Russian waters offshore Novaya Zemlya, highlighting the need for trans-boundary management. The establishment of the Joint Norwegian-Russian Fisheries Commission in the 1970's has contributed towards sustainable management of the Barents Sea fisheries.[19]

The hydrocarbon sector is well developed in both the Norwegian and Russian sectors of the Barents Sea. In 2011 the maritime boundary dispute between Russia and Norway in the Barents Sea was resolved, opening up new areas for hydrocarbon exploitation.[20] The Barents Sea is undoubtedly a major hydrocarbon province and exploration is likely to extend further offshore in the future. Retreating sea-ice may allow further northwards exploitation of hydrocarbons.

The Barents Sea is also an area of increasing shipping activity, which has recently seen large increases in the volume of petroleum products shipped along the Norwegian and Russian coasts. Shipping along the Northern Sea Route (including LNG) also passes through the Barents Sea. Reduction in summer ice extent is opening up the area to the north of Novaya Zemlya as a potential shipping route (see deliverable D2.16) which could significantly increase vessel traffic through the Barents Sea in southwest – northeast directions.

The Barents Sea is clearly an area facing increasing pressure from shipping, fisheries and oil and gas exploitation, and the need for spatial planning for sustainable development is clear. As well as potential user-user conflicts, user-environment conflicts are highly probable too. Figure 9 shows, for example, the distribution of Minke whales, as well as one of several identified areas of heightened ecological significance within the Barents Sea Large Marine Ecosystem (LME – see D4.54). Minke whales are just one of many marine mammal species found in the Barents Sea. Increasing economic activity will lead to increased acoustic disturbance for marine mammals (see D4.5.1 and 4.5.2), and possibly result in changes in their distribution. Pollution and vessel strikes are significant threats to marine wildlife and habitats too.

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[17] http://www.regjeringen.no/Upload/MD/Vedlegg/Svalbard%20og%20polaromraadene/Forvaltningsplan%20Barentshavet/PDF0080506_engelsk-TS.pdf

[18] ftp://ftp.fao.org/fi/document/ec-sfs/2002/Stokke-Barents-FAO-Bergen.pdf

[19] http://www.fisheries.no/resource_management/International_cooperation/Fisheries_collaboration_with_Russia/#.U2jfE82-O8s

[20] http://www.regjeringen.no/upload/ud/vedlegg/folkerett/avtale_engelsk.pdf

Figure 9 also highlights the need for trans-boundary MSP; geological (hydrocarbon) provinces, ecosystems, fish stocks and species distributions all cross borders. Equally the effects of climate change will be seen on a regional scale. Truly effective MSP and EBM in the Arctic needs to be considered at a pan-Arctic, multi-national, scale (Ehler, 2014).

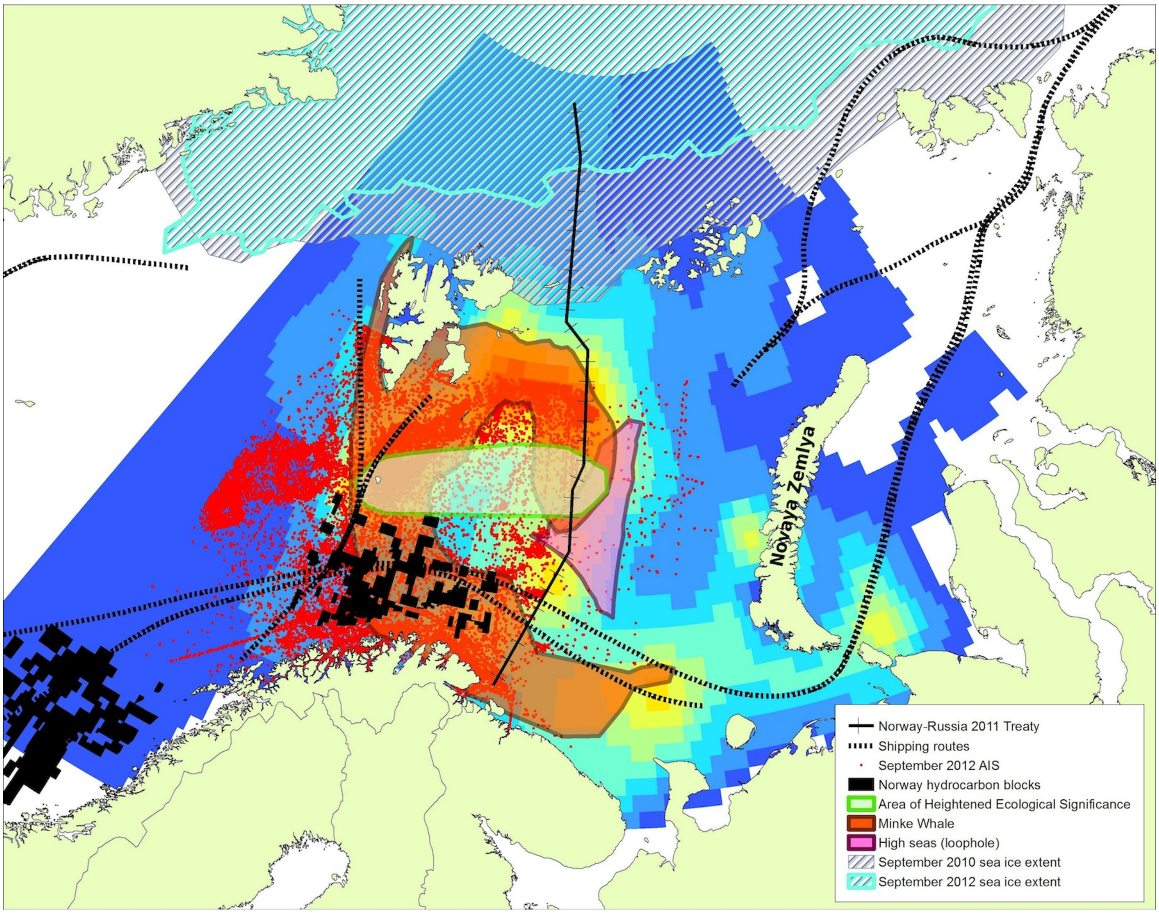

Figure 9: ArcGIS map showing different economic sectors in the Barents Sea. Coloured background grid shows predicted cod stocks for August 2057 (from D3.11) – cold colours show low density, while warm colours show higher density. Red dots show vessel AIS data from September 2012 (from D4.54), while dashed black lines show principal shipping routes. Maritime boundary between Norway and Russia is shown by the black ticked line, while the pink polygon shows the Loophole. Norwegian hydrocarbon exploration blocks are shown by black rectangles. Also shown are Minke Whale distribution, an ecologically significant area, and 2010 and 2012 summer sea-ice extents.

7. Observations and Recommendations

The ACCESS MSP tool has been developed to address a specific geographical issue, and is designed to offer a non-political, pan-national data integration system for the purposes of planning proposed or mitigating against unforeseen events or activities. Using the concepts of ecosystem-based management and practical methodologies of data and relationships analyses with a powerful geographical information system, users of the MSP tool will be able to visualise and assess in a qualitative way the factors relevant to sustainable development in the region, as they are affected by long term climate change.

The implementation of the ACCESS MSP requires a considerable body of further work which falls beyond the scope of the current project. Critical directions for the next steps will include:

- The quantification of the MSP factors in as objective and independent way as possible, in order to allow for comparative, numerical evaluations of risk, success potential, and economics of strategy options;

- The refinement of our analyses of a number of key, representative areas of the Arctic Ocean. A Marine Spatial Plan for the Arctic Ocean was never a feasible objective for a project of the scale of ACCESS, but we can use the examples described above as proxies for exploring the activities across the region;

- The engagement of the principal stakeholders and users of the region, including all pan-national governance elements (such as the Arctic Council) is needed to take forward this pilot MSP tool in a concerted manner to ensure its structured development into a practical and standardised resource within and across national borders;

- The Arctic States who have commenced developing Marine Spatial Plans within their own national and regional agencies should be encouraged to: meet to review the potential for coordinating effort to improve the product; pool resources and expertise; and establish a means by which as far as possible, a standardisation of approach and basic supporting data exists.

The majority of deliverables in the ACCESS programme are due in the final year of the project. At this stage in the programme (Month 37), many have still to be submitted and, consequently, the GIS is currently incomplete. The MSP tool will continue to develop over the final year of the project as more deliverables and data are input, and we will provide an update in Month 48.

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Annex 1: Publically available datasets included in the GIS, and data resources

Dataset	Region	Data Source
WP1		
Ice Concentration	Arctic	Ocean and Sea Ice SAF SSMIS Sea Ice Concentration Maps on 10 km Polar Stereographic Grid http://osisaf.met.no/p/ice/
Ice Edge	Arctic	Ocean and Sea Ice SAF Sea Ice Edge Maps on 10 km Polar Stereographic Grid http://osisaf.met.no/p/ice/
Ice Type	Arctic	Ocean and Sea Ice SAF Sea Ice Types on 10 km Polar Stereographic Grid http://osisaf.met.no/p/ice/
Ice Drift	Arctic	Ocean and Sea Ice SAF Sea Ice Motion Maps with 48 hours span, on 62.5 km Polar Stereographic Grid http://osisaf.met.no/p/ice/
WP2		
Current Shipping Routes	Norway	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=30:norway&Itemid=166
	Russia	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=31:russian-federation&Itemid=166
	US	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=32:united-states&Itemid=166
	Canada	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=26:canada&Itemid=166

	Greenland	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=28:greenland&Itemid=166
	Circumpolar	PAME http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=33:circumpolar-routes&Itemid=166
Northern Sea Route	Russia	Northern Sea Route Information Office. Information on shipping and logistics along the NSR http://www.arctic-lio.com/
Ports	Arctic	http://www.arcticdata.is/index.php?option=com_phocadownload&view=category&id=12:arctic-ports&Itemid=166
	Russia	Northern Sea Route Information Office. Information on individual ports http://www.arctic-lio.com/arcticports
Search & Rescue	Arctic	Northern Sea Route information Office. Arctic Search and Rescue agreement areas map http://www.arctic-lio.com/nsr_searchandrescue
WP3		
FAO areas	Global	UN Food and Aquaculture Organisation (FAO) Geo-network http://www.fao.org/geonetwork/srv/en/main.home?uuid=ac02a460-da52-11dc-9d70-0017f293bd28
ICES areas	Global	International Council for the Exploration of the Sea http://geo.ices.dk/
OSPAR regions	North East Atlantic	OSPAR regions and boundary http://www.ospar.org/content/content.asp?menu=01511400000000_000000_000000
NAFO areas	North West Atlantic	North West Atlantic Fisheries Organisation http://www.nafo.int/data/frames/data.html
NEAFC area	North East Atlantic	North East Atlantic Fisheries Commission http://www.neafc.org

Herring fisheries agreements	Norway	Five party agreement on management of the Norwegian spring-spawning herring stock http://www.regjeringen.no/en/archive/Stoltenbergs-2nd-Government/Ministry-of-Foreign-Affairs/Nyheter-og-pressemeldinger/pressemeldinger/2007/five-party-agreement-on-management-of-th.html?regj_oss=1&id=444848
Arctic Char distribution	Arctic	Arctic Biodiversity Trends 2010. CAFF http://abds.is/publications/view_category/7-arctic-char
WP4		
USGS Basins	Arctic	USGS Circum-Arctic Resource Appraisal (CARA) http://energy.usgs.gov/RegionalStudies/Arctic.aspx - 3886226-gis-data
Oil & Gas Assessment area	Arctic	Arctic Oil and Gas 2007. AMAP (Note: This is different to the AMAP area) http://www.amap.no/oil-and-gas-assessment-oga
Resources in the Arctic	Arctic	NORDREGIO (Nordic Centre for Spatial Development) Map of resources (oil & gas and mining) http://www.nordregio.se/en/Maps--Graphs/05-Environment-and-energy/Resources-in-the-Arctic/
Licences	Norway	Norwegian Petroleum Directorate (NPD) Factpages http://factpages.npd.no/ReportServer?/FactPages/geography/geography_all&rs:Command=Render&rc:Toolbar=false&rc:Parameters=f&IpAddress=1&CultureCode=en
	USA	Bureau of Ocean Energy Management, Alaska Cadastral Data http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Alaska.aspx - GIStable
	Canada	Aboriginal Affairs and Northern Development Canada. Shapefiles of licences https://www.aadnc-aandc.gc.ca/eng/1100100036298/1100100036301
	Greenland	Naalakkersuitut Government of Greenland http://www.govmin.gl/index.php/minerals/current-licences Interactive map at http://licence-map.bmp.gl/
Wells	Norway	Norwegian Petroleum Directorate (NPD) Factpages http://factpages.npd.no/ReportServer?/FactPages/geography/geography_all&rs:Command=Render&rc:Toolbar=false&rc:Parameters=f&IpAddress=1&CultureCode=en

	USA	Bureau of Ocean Energy Management, Alaska Cadastral Data http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Alaska.aspx - GIStable
	Canada	Aboriginal Affairs and Northern Development Canada. Regional maps of licences and wells https://www.aadnc-aandc.gc.ca/eng/1100100036125/1100100036129
	Greenland	Naalakkersuitut Government of Greenland, Exploration wells http://www.govmin.gl/index.php/petroleum/exploration-wells
WP5		
Bathymetry	Arctic	International Bathymetric Chart of the Arctic Ocean http://www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html
Maritime Boundaries	Global	Flanders Marine Institute (VLIZ) http://www.marineregions.org/
Outer Continental Shelf Submissions	Global	UN Commission on the Limits of the Continental Shelf http://www.un.org/Depts/los/clcs_new/commission_submissions.htm
Indigenous Peoples of the Arctic Countries	Arctic	Arctic Council PDF map http://www.arctic-council.org/images/maps/indig_peoples.pdf
Marine Protected Areas	Arctic	CAFF protected areas http://arcticdata.is/?option=com_phocadownload&view=category&id=22:2010&Itemid=157
Large Marine Ecosystems	Arctic	PAME (http://www.pame.is/) http://www.lme.noaa.gov/index.php?option=com_content&view=article&id=177&Itemid=75
Super EBSA	Arctic	IUCN/NRDC Workshop Report, November 2010 http://cmsdata.iucn.org/downloads/arctic_workshop_report_2011_2.pdf
Marine Mammal Ranges	Arctic	IUCN Red List http://www.iucnredlist.org/
Boundaries of the Arctic Council Working Groups	Arctic	Comparison plot of the boundaries of the different Arctic Council Working Groups http://www.grida.no/graphicslib/detail/boundaries-of-the-arctic-council-working-groups_8385

CAFF area	Arctic	Conservation of Arctic Flora and Fauna http://arcticdata.is/index.php?option=com_phocadownload&view=category&id=23&Itemid=156
AMAP area	Arctic	Arctic Monitoring and Assessment Programme (Arctic Council) http://www.amap.no/documents/doc/amap-area-gis/868
Northwest Territories Delimitation	Canada	Delimitation line from the Northwest Territories Land and Resources Devolution Agreement https://www.aadnc-aandc.gc.ca/eng/1100100036298/1100100036301 - curr
Population and Demography	Arctic	NORDREGIO (Nordic Centre for Spatial Development) Maps of populations and demography http://www.nordregio.se/en/Maps--Graphs/