PAME MPA-network toolbox
2015-2017

Area-based conservation measures and ecological connectivity

PAME
Protection of the Arctic Marine Environment

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I. INTRODUCTION

Context

PAME's *Framework for a Pan-Arctic Network of Marine Protected Areas* (Arctic Council 2015) calls for the development of a Pan-Arctic Marine Protected Area (MPA) Network, recognizing that individual Arctic countries pursue MPA development based on their own authorities and priorities, and within the context of an ecosystem approach to management. The Framework offers a foundation of goals and objectives on which this toolbox builds. It also introduces definitions and concepts central to this report, including that Arctic MPA networks are comprised of both MPAs and "other area-based conservation measures" [1] ("other measures" from here on) that contribute to network vision and goals.

The vision for the Pan-Arctic Network of Marine Protected Areas (Arctic Council 2015)

An ecologically connected, representative and effectively-managed network of protected and specially managed areas that protects and promotes the resilience of the biological diversity, ecological processes and cultural heritage of the Arctic marine environment, and the social and economic benefits they provide to present and future generations.

The goals of the Pan-Arctic Network of Marine Protected Areas (Arctic Council 2015)

1. To **strengthen ecological resilience** to direct human pressures and to climate change impacts, to promote the long-term protection of marine biodiversity, ecosystem function and special natural and cultural features in the Arctic.
2. To **support integrated stewardship**, conservation and management of living Arctic marine resources and species and their habitats, and the cultural and socioeconomic values and ecosystem services they provide.
3. To **enhance public awareness** and appreciation of the Arctic marine environment and rich maritime history and culture.
4. To **foster coordination and collaboration** among Arctic states to achieve more effective MPA planning and management in the Arctic.

About PAME's Toolbox Project

PAME's "Toolbox" project aims to develop guidance to assist Arctic states in advancing their MPA networks by providing theory and tools that can be used to assess and protect the diversity of genes, species, populations, habitats, features, and ecosystems; their interactions and processes; and the ability to adapt to change.

This guidance is intended to inform decision-makers, practitioners, Indigenous peoples, and stakeholders involved in developing MPA networks and ecosystem-based management in the marine Arctic. Most Arctic states have established some MPAs, but are still in the early stages of filling gaps and connecting and managing MPAs as ecologically functional MPA

[1] *"The term "other effective area-based conservation measure", as used in Aichi Target 11, is evolving as this framework develops. Generally, the term is understood to refer to place-based / spatial conservation measures*

networks (CAFF & PAME 2016). The project also intends to foster collaboration on MPA network development between Arctic countries, Permanent Participants, Arctic Council Working Groups, and the conservation and science communities. Scientific literature, traditional and local knowledge, and experience from elsewhere in the world show that a systematic and participatory approach to building MPA networks greatly improves conservation effectiveness (Cicin-Sain and Belfiore 2005). Enabling collaboration and participation is an important aim of this project. As the stated in the Framework, the purpose of a pan-Arctic MPA network is both "to protect and restore marine biodiversity, ecosystem function and special natural features" and to "preserve cultural heritage and subsistence natural resources for present and future generations".

This Report

This report focuses on **area-based conservation measures** as tools for designing Arctic MPA networks. It also focuses on the incorporation of connectivity, one of four common elements of efficient MPA networks (see section II), in network design. It summarizes key findings and recommendations, as well as case studies, from the September 2016 PAME MPA workshop – *Science and Tools for Developing Arctic MPA Networks: Understanding Connectivity and Identifying Management Models* – held in Washington, D.C.

Section II explores opportunities that MPAs themselves and "other measures" present for MPA network design. It discusses the ecological utility of "other measures" and describes under what circumstances these measures may be particularly useful for bolstering conservation outcomes.

Section III summarizes lessons from scientific and applied work on integrating ecological connectivity into MPA networks to build ecological resilience[2]. Section IV presents tools for designing MPA networks using a variety of approaches and management measures, each of which may not be universally-applicable, but rather may be most effective in certain areas or under specific circumstances.

Finally, Section V concludes with identified knowledge gaps and suggested next steps to further this work. While the overall focus of this report is on ecological considerations, socio-cultural dimensions are an integral part of MPA networks that PAME will seek to explore in subsequent workshops[3]. This toolbox will be updated as new information and guidance becomes available throughout PAME's 2017-2019 work cycle.

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[2] *Ecological resilience is defined as "the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour "(Gunderson and Holling 2002), and as "the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity" (Walker et al. 2006).*

[3] *PAME's Framework for a Pan-Arctic Marine Protected Area Network stresses the importance of MPA networks for maintaining ecosystem services, i.e. the benefits people receive from nature. In such social-ecological context, resilience is defined as "the capacity of a social-ecological systems to absorb recurrent disturbances . . . so as to retain essential structures, processes and feedbacks" (Adger et al. 2005).*

Photo credit: NOAA

II. AREA-BASED CONSERVATION MEASURES: MPAs AND "OTHER MEASURES" IN MPA NETWORKS

Conservation science has documented well the ways in which MPAs contribute to effective and long-term biodiversity conservation. The benefits of MPAs and guidance on how to identify important areas for protection are summarized in publications by the International Union for Conservation of Nature (IUCN), the Convention on Biological Diversity (CBD), the Arctic Council, and others (see Framework for a Pan-Arctic Network of Marine Protected Areas [Arctic Council 2015], section 4.4). Not surprisingly, MPAs form the backbone of MPA networks when they are representative at regional scales, sizable, and spaced for specific conservation objectives. Recently, the conservation community has also increasingly recognized the importance of "other measures", area-based measures that are not formal MPAs but still contribute to conservation outcomes, in particular as a part of MPA networks.

MPA networks ideally involve area-based conservation measures that are mutually supportive; focused on sustaining key ecological features (e.g. species, habitats, ecologically and biologically significant areas, geophysical features, landscapes), ecological processes and services (such as subsistence use), and cultural values; and integrated in the management of the wider seascape. Designed in this way, a network can deliver more benefits than unconnected individual MPAs can provide on their own (IUCN-WCPA 2008). Such "ecological coherence" (Catchpole 2012) is considered in planning by using criteria that describe

different characteristics of a network, such as how well certain features are represented within the MPAs ("representativity" of biodiversity), how well those features are protected ("adequacy" of measure size, placement, replication, and management), and how these protected sites are ecologically linked to each other ("connectivity" of critical places for life stages of key species) (UNEP-WCMC 2008). "Other measures" have a role to play for strengthening each of these MPA network coherence criteria.

Figure 1 is a conceptual model showing the way in which MPAs and "other measures" operate within the context of ecosystem-based management. For MPA networks, MPAs are the core component, complemented by "other measures" that contribute to network objectives. These area-based conservation measures are located within a broader geographic region that also includes other management measures – both area-based (such as shipping lanes that are not part of an MPA network) and non-area based (such as regulations and practices that apply everywhere). Table 1 summarizes broad characteristics of MPAs and "other measures".

Figure 1. MPA Networks as Part of an Ecosystem Approach to Management. From "Framework for a Pan-Arctic Network of Marine Protected Areas" (Arctic Council 2015).

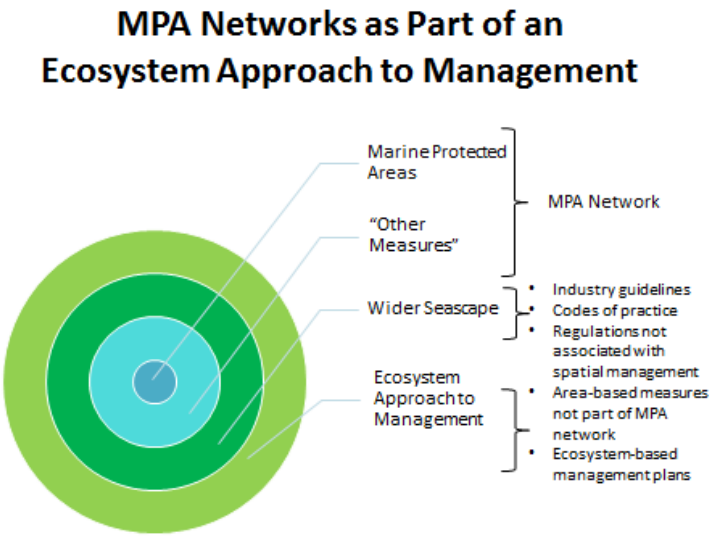

Table 1: Broad characteristics of MPAs and "Other Measures"[4]

Characteristic	Marine Protected Areas	"Other Measures"
Purpose	Conservation.	May be conservation, or conservation may be a recognized outcome and / or objective of an area established for another purpose.
Scope	Generally focused on entire ecosystem, though individual objectives may target specific elements of biodiversity (e.g. particular species, habitat).	Often focused on specific elements of biodiversity, including mitigating impacts of an activity on a species or habitat.
Duration	Typically permanent.	May be permanent or temporary.
Geographic location	Fixed.	May be fixed or dynamic (tied to specific environmental conditions or human activities).
Level of Protection	Ranges from multiple use to "no take".	Ranges from multiple use to "no take".
Implementation	Protected area agency(ies).	Can be implemented by a wide range of agencies and partners, including those regulating specific activities (e.g. shipping, fishing, hunting, energy, water quality).

A. The Ecological Context of Area-based Conservation Measures

1. Protection of Places of Sustained Importance for Biodiversity and Ecosystem Services

In marine ecosystems, *populations* of *species* interact with one another in *communities* and with the *geophysical environment* in one or more *habitats*. These interactions establish fundamental *ecosystem processes* (such as primary and secondary biomass production) and *functions* (such as food-webs, cycling of nutrients and carbon, and evolution) that are the engines of resilient ecosystems. By protecting the spaces where critical interactions take place through MPAs, conservation objectives linked to important components of Arctic biodiversity (in *italics* above) and associated ecosystem services[5] can be pursued.

In addition to protecting critical interactions, MPAs also provide protected space for ecosystems to function and adapt, while reducing stressors of various types as much as possible, thereby supporting resilience to change. Ecosystem properties that have been identified to guide ecosystem-based management include structural, functional, spatial, and phylogenetic diversity and redundancy, and modularity (the network organization of species

[4] *The IUCN provides guidance and definitions on MPAs (Day et al. 2012), while on "other measures", an IUCN-led Task Force is defining the term –"other effective area-based conservation measures"– clarifying the conservation context and how these measures can contribute to the CBD Aichi target 11 (CBD 2011). This table lists commonly agreed and practiced characteristics of "other measures" that are in line with the ongoing work of the Task Force. However, in the context of PAME's toolbox project, the focus is not on definitions or targets, but on the utility of area-based conservation measures – both MPAs and "other measures" – for achieving desired network conservation objectives and outcomes.*

[5] *Ecosystem services are defined as the benefits people obtain from ecosystems (Millennium Ecosystem Assessment 2005). For societal use they are often listed in categories such as supporting, provisioning, regulating and cultural ecosystem services, but on the ecosystem side bundles of services are inseparably linked across these categories (e.g. a certain species or habitat can provide both provisioning and cultural services).*

interactions) (Levin and Lubchenco 2008). To guide the identification of MPA candidate sites for the purpose of strengthening marine ecosystem resilience and adaptive capacities, identified ecosystem properties include species richness, habitats important for species of concern, functional redundancy (where different species contribute in equivalent ways to an ecosystem function), and response diversity (where species contributing to the same ecosystem function can respond to environmental change in diverse ways) (ICES 2011, Brock 2012). Where such detailed insights into Arctic ecosystems are sparse, proxies for ecosystem productivity (e.g. remotely sensed chlorophyll hotspots) and diversity (e.g. seafloor heterogeneity) can be used to identify bio-geophysical features that support the continued capacity of Arctic ecosystems to function and adapt (Christie and Sommerkorn 2011). Traditional and local knowledge may also be used to identify these features. Such features are important to consider for long-term area-based protection.

One important role for MPAs in a changing climate is to protect refugia – areas relatively buffered from climate change that enable persistence of valued physical, ecological, and socio-cultural resources (Morelli et al. 2016). These refugia exist because of locally unique combinations of physical characteristics, such as climate variables, oceanography, or topography, that influence e.g., habitat stability or species persistence at specific locations (e.g. areas of persistent multi-year ice that sustain ice-dependent ecosystems). Geophysical and biogeographic approaches are available to identify refugia. The Arctic Biodiversity Assessment (CAFF, 2013) recommends giving high priority for conservation planning to large, representative areas of habitat, including northern refugia areas, where unique Artic biodiversity has the best chance of surviving climate change.

MPAs can also support a range of ecosystem services. Indigenous communities are particularly concerned that food security and livelihoods could be threatened by establishing MPAs that restrict access and do not meaningfully engage Indigenous peoples in the process of developing MPAs. Some MPAs, such as Canada's newly established Anguniaqvia Niqiyuam Marine Protected Area (see Annex 2.A), acknowledge subsistence harvest as an objective. Through this type of approach, area-based conservation measures strive to maintain key ecosystem services, including through enhancing sustainable Indigenous management practices in those areas where Indigenous people reside.

2. Protection of Biodiversity on the Move

Biodiversity outside protected areas can be vulnerable to human pressures, potentially compromising MPA network conservation objectives. Some vulnerabilities will increase, and likely strain ecological linkages between MPAs, as industrial development advances into regions that have seen limited or no such pressures previously. Below we introduce aspects of functioning ecosystems that need consideration for protection as part of MPA networks.

Dynamic ecological features. Critical interactions in Arctic marine ecosystems, particularly those linked to sea ice, the sea ice marginal zone, or frontal systems, occur at places that are shifting locations, both within the season and from year to year, and additional change will exacerbate these variations. It will be difficult to protect these ecologically significant features through geographically fixed measures across their entire range.

Ecological linkages. All ecosystems are dependent on linkages. Arctic marine ecosystems are particularly so because they contain a high proportion of migratory species, such as some sea-birds and marine mammals, that spend only part of their life in the Arctic. Other important ecological linkages transfer energy or material (such as nutrients) between different parts of the marine ecosystem, for example between coastal and offshore environments, or between the water column and the seafloor. Within the Arctic, places that provide the conditions for primary production, feeding and/or reproduction of marine species are often separated by long distances, meaning individuals or (life stages of) whole populations are often on the move.

Range shifts. The effects of Arctic change are already leading to range shifts for whole populations, such as some fish species, and more changes are forecasted. Protecting these populations, their pathways, and their "new" habitat from additional pressures is one of the most important contributions to bolstering the adaptive capacity of Arctic marine ecosystems.

B. Benefits of Including "Other Measures" in MPA Network Design

While MPAs form the backbone of MPA networks, thoughtful inclusion of "other measures" can help strengthen networks in several ways.

For example, some "other measures**"** provide opportunities to protect a biodiversity element (e.g. species, habitat) or an ecologically important feature (e.g. seamount, upwelling) through a flexible, dynamic approach not tied to a permanently fixed geographic space (Jonas et al. 2014). The flexibility of some "other measures" provides an opportunity to enhance protection of ecosystem processes and biodiversity as species move, including through different life stages and as geographic ranges shift due to a changing environment (i.e., where certain locations may shift in importance or condition through time).

Other examples for the utility of "other measures" include safeguarding biodiversity by excluding or limiting specific threats or pressures during a critical period of time for biodiversity (e.g. in a species' life cycle, for a particular habitat, for an ecosystem process or function). Often, such measures are essential for achieving MPA network objectives and are needed in spaces between established MPAs. "Other measures" can also help address rapidly shifting human activities that may occur with, for example, decreasing sea ice cover or range shifts of commercially exploited species, and "other measures" can assist in advancing conservation goals while mitigating potential impacts to economic activities and facilitating regional partnerships between a wide range of stakeholder communities. Continued efforts to expand such partnerships can provide opportunities for improving the conservation outcomes of "other measures" and for considering more thoroughly how "other measures" contribute to MPA network objectives.

The flexibility of "other measures" may also contribute to protecting Arctic ecosystem services, i.e. the diverse values that people derive from biodiversity and ecosystems, in a changing environment. For example, healthy ecosystems and wildlife populations will continue to be essential for food security, industrially undeveloped seascapes could become even more important for growing tourism in the region, and the protection of some Arctic ecosystem services (e.g. carbon sequestration) is important from a global perspective.

“Other measures” may be helpful tools for safeguarding biodiversity, places, or ecosystem services in a precautionary approach.

Finally, using “other measures” may create opportunities to consider places where conservation is an outcome, rather than the primary objective of management efforts, into management strategy and overall network design. For example, many Indigenous and local community efforts linked to livelihood and culture maintain or strengthen ecosystem functions and valued services essential to sustainable livelihoods, food security, human wellbeing, and/or other cultural and spiritual aspects of resilient communities. The contribution of such efforts to area-based conservation may not typically be considered for a few reasons, including: 1) if governments do not recognize the efforts as formally designating protected areas; 2) the areas do not meet national or international definitions; and/or 3) those utilizing or managing the area do not wish it to be formally designated as a protected area. Considering the contribution of such community-based efforts to Arctic MPA network objectives can improve conservation outcomes.

Photo credit: NOAA

III. PROTECTING ECOLOGICAL LINKAGES: CONNECTIVITY AS PART OF MPA NETWORK DESIGN

Understanding and Applying Connectivity

For decades, conservationists have recognized that the maintenance of 'connectivity' between natural populations and between ecosystem types is an important conservation objective. The science of connectivity is concerned with landscape - or seascape – patterns that reveal the existence of networks of populations, habitats, or ecosystems. The design of functional MPA networks requires equal attention to the identification of important nodes (in this case the protected area) as well as the intervening pathways.

The importance and influence of connectivity in marine ecosystems is clear for many reasons: the fluid environment, the relatively common long-distance dispersal abilities, and the varied habitat requirements of many marine organisms during their full life cycle. In addition, networks of populations are believed to be particularly important for the persistence of marine species due to the common large fluctuations in recruitment. If populations cannot be 'rescued' by some distant regions through connectivity, the persistence of populations is more likely to be left to chance (Jones et al. 2009). For these reasons, the importance of connectivity in the design of marine protected area networks is a rapidly developing area of research. Further, traditional and local knowledge may recognize

and support the importance of connectivity, as it often encompasses holistic understandings of the relationships of components with an entire ecosystem.

Integrating Connectivity into Arctic MPA Network Design

There are four key steps for integrating connectivity into Arctic MPA network design (see Tool #4). This section will focus on the latter two of those steps, which address network connectivity, and discuss terms and concepts useful for integrating connectivity into MPA management and network design.

Identify Connections for species with planktonic life history phases

Most marine fish and invertebrate species have a planktonic phase in their life history and disperse some distance via currents before they become an adult. Thus, large-scale connectivity of many species' populations occurs via the dispersal of larvae. In designing networks of MPAs, stakeholders can preserve these meta-population dynamics by ensuring protected areas are spaced at a distance such that they can serve as sources and sinks to one another. To achieve this design objective for species with planktonic dispersal, scientists need some knowledge of dispersal behaviour and durations as well as the influence of current patterns for the species or communities of interest.

There are a number of approaches for estimating connectivity for species with a planktonic life history phase. Ideally, different methods are used in combination to help ascertain the direction, distance, and magnitude of flow between populations. Chosen strategies will likely be determined by what information is available, the planning process, and the stakeholder's tolerance for complexity. Approaches range from simple (e.g. 'rule of thumb') approaches to complex (e.g. spatially explicit population modelling).

Perhaps the simplest approach is to develop an operational guideline or 'rule of thumb' based on emergent properties of a system (e.g. species area curves for defining reserve size in a given ecosystem). This approach was utilized in the design of an MPA network along the west coast of the United States that utilized aggregated knowledge of larval dispersal from multiple methods for multiple species, resulting in a general guideline that MPAs should be placed within 50-100 km of each other (Carr et al., 2010). This simple approach has the advantages of being scientifically-based, intuitive for stakeholders, and extensible once additional information is obtained (Carr et al., 2010). Disadvantages are that it still requires – often difficult to acquire – information for pelagic larvae; simple measures such as pelagic larval duration (PLD) are often poor proxies for realized larval dispersal distances.

A more direct measure of demographic exchange between populations can be acquired through genetic techniques. Based on the knowledge that individuals within a reproductive population are more similar genetically than individuals in separated populations, scientists can estimate population connectivity between populations by measuring 'genetic distances' (Palumbi, 2003). This 'isolation by distance' method must be done species by species, but it can provide estimates of larval dispersal distances that can be used in MPA design (Palumbi, 2003). An even more direct, but short-term, measure of gene flow can be accomplished by parentage analysis. By genetically 'fingerprinting' large numbers of adults and juveniles in a region, one can possibly match parent and offspring and obtain a direct measure of how far a larva has dispersed and over what distances source populations have made contributions

to outlying areas (e.g., Planes et al., 2009). Genetic techniques are a powerful tool, particularly used in combination with other methods. However, they can be sampling- and resource-intensive.

Because direct measurement of dispersal is challenging and time intensive, many researches have turned to numerical simulations that couple hydrodynamic models with behavioural models of larval dispersal to develop testable hypotheses to inform sampling programs and to serve as the basis for design decisions. These spatially explicit population models incorporate spatial distribution of habitat patches, life history information for species in the community (e.g. larval dispersal and mortality rates), and ocean current patterns. Examples of this type of research include simulating dispersal of corals and coral reef fish at local (Paris et al. 2007, DeMartini et al. 2013) and regional (Kool and Nichol 2015, Treml et al. 2015) scales and the examination of commercially important fish species in the Mediterranean (Andrello et al. 2013, Pujolar et al. 2013).

To begin applying these techniques to the Arctic, initial first steps would be to synthesize information about larval dispersal for species or communities of interest in the Arctic, and to begin to adapt existing oceanographic circulation models for regions of interest.

Identify Connections for Active Swimmers and Flyers

Oceanographic features strongly influence the location of important habitat nodes for active swimming species (e.g. fish, marine mammals) and flyers (i.e. seabirds). However, the connectivity 'pathways' between these areas are often far less reliant on underlying oceanographic features (e.g. currents) and more dependent on the behavioral ecology of the specific species. Patterns of connectivity for active swimmers and flyers are decoupled from oceanographic features over significantly greater spatial and temporal scales than species with a planktonic life history phase.

Ice-obligate species remain closely associated with sea ice during their movements between important habitat nodes, but other species may move directly between nodes, even if that entails traversing through suboptimal habitat. This is particularly true for birds. Individuals may travel together in large groups or in a more diffuse manner. Movement behavior may be constrained by the physical environment (e.g. the narrowness of the Bering Strait) or a product of the social system of a particular species (e.g. beluga whales typically form pods of between 2-25 animals). Moreover, active swimmers and flyers are often logistically difficult to observe and sample in a representative manner, meaning data collected on their behavior is often spatially and temporally patchy.

Managers and others involved in the process may want to prioritize known or potential places, habitats, and/or oceanographic features and periods that represent important nodes for swimmers and flyers in MPA network design. Important corridors between these nodes can then be identified on a species-by-species basis based on data availability and the relevance of the species to the MPA objectives. Recent and ongoing efforts to identify important habitat nodes that may provide a useful source of information or model for undertaking this effort in the Arctic include the CBD-led process to identify Ecologically and

Biologically Significant Areas (EBSAs)[6] , the initiative led by the IUCN Joint Species Survival Commission/World Commission on Protected Areas Marine Mammal Protected Area Task Force to identify Important Marine Mammal Areas (IMMAs) in a number of regions [7], and national processes, such as the NOAA-led effort to identify Biologically Important Areas (BIAs) in the United States[8]. In addition, the International Whaling Commission has recommended that it work in collaboration with the Arctic Council Working Groups to identify high risk areas for cetaceans at appropriate geographical and temporal scales.[9]

Accounting for multiple species, with different habitat preferences and connectivity patterns, is not a simple exercise. Prioritization is necessary, while also keeping in mind the need for a precautionary, holistic approach that considers the cultural and socioeconomic values and ecosystem services provided. A combination of direct observations of migration (e.g. community-based observations, satellite telemetry studies, vessel surveys) and genetic information on population structure is likely to be most informative. A research and monitoring plan for future data collection may also be needed.

Identify Important Connections

The process of identifying important corridors for active swimmers and flyers begins with a synthesis and secondary analysis of available data and information on the migratory and movement behavior of the selected species based on satellite telemetry, genetics, aerial surveys, community-based observations, and traditional ecological knowledge, among other sources. The goal of this work is to i) spatially map connections between important habitat nodes (e.g. Fig 2), taking into account any temporal variability/seasonality, and ii) define the relative strength of the connection (e.g. the estimated proportion of the population that uses the connection). With this information, planners can develop a connectivity 'matrix', similar to that developed for passively dispersing larvae that can be used to directly inform management.

[6] *https://www.cbd.int/ebsa/*
[7] *http://www.marinemammalhabitat.org/*
[8] *http://cetsound.noaa.gov/important*
[9] *IWC (2016) Report of the Scientific Committee.*

Figure 2. Updated Bowhead Range map generated by the Alaska Department of Fish and Game (2011). "Bowhead whale subsistence harvest research" webpage, North Slope Borough official website.

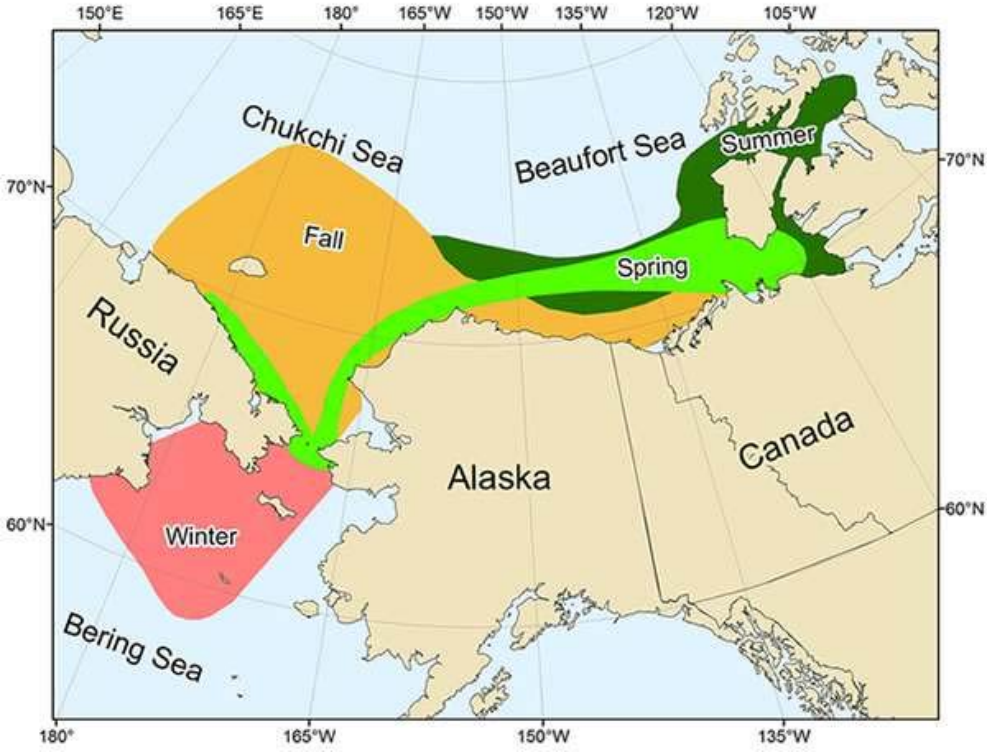

Photo credit: NOAA

IV. TOOLS FOR DESIGNING MPA NETWORKS

The following tools are presented to provide decision-makers, practitioners, Indigenous peoples, and stakeholders with practical ways to strengthen MPA networks and assess gaps and needs for MPA network development. Tables demonstrate the tool logic and use broad categories of both biodiversity and conservation measures. Applying the tools in concrete situations requires consulting the annexes where more detailed information is listed.

Tool #1: Aligning Area-based Conservation Measures with Important Biodiversity Categories

This tool lists areas important for categories of biodiversity (e.g. species, habitats, and ecosystems) and linked values and aligns them with available area-based conservation measures for addressing protection needs, in a general manner. A more detailed list of Arctic marine biodiversity categories and their potential protection needs can be found in Annex 1; a catalogue of area-based conservation measures used by Arctic countries is available in Annex 2; and Annex 3 presents anecdotal case studies of area-based conservation measures at work, analyzing their potential utility in MPA networks.

Areas important for Categories of Biodiversity[10]	Value(s)	Conservation Objective / Need	Options for Area-based Conservation Measures [11]
Areas or geophysical features with important habitats or ecosystems (e.g. coral gardens, marginal ice zone)	Sustain important ecosystem functions (e.g. productivity, diversity) or structure (e.g. food-webs, unique species).	Long-term protection of valuable and vulnerable habitat and of genetic diversity.	✓ MPAs ✓ Exclusion areas for harmful activities
Areas important for life history stages of different species (e.g. reproduction; foraging; spawning; wintering; nursery; staging areas of birds, marine mammals, fish)	Sustain populations of species important for ecosystem and/or human use values.	Long-term protection of open water, seafloor, ice-associated, and coastal features and habitats critical to key marine species and ecosystem processes. Long-term, temporary and/or impact-specific protection regimes for key areas (e.g. foraging) and/or during critical seasons (e.g. breeding, human use).	✓ MPAs ✓ Seasonal closures for take or access ✓ Year round measures preventing habitat degradation ✓ Exclusion areas for harmful activities ✓ Area regulations on impact/ disturbance
Movement corridors and migration routes of important species (e.g. marine mammals)	Connectivity for species important for ecosystem and/or human use values (e.g. food security).	Long-term, temporary and/or impact-specific protection regimes (e.g. from physical disturbance, installations) for key corridors and routes.	✓ Exclusion areas for harmful activities (seasonal) or (permanent) infrastructure ✓ Area regulations on impact/ disturbance

[10] *See Annex 1 for a list of important Arctic marine biodiversity categories (such as species, habitats, ecosystems and their linkages) along with their functions, vulnerabilities, and more specific options for area-based conservation measures.*

[11] *See Annex 2 for concrete examples of these measure categories applied in Arctic countries.*

Tool #2: Area-based Protection in a Changing Environment and/or for Biodiversity on the Move

This tool identifies characteristics of area-based conservation measures that apply to marine features viewed through the lens of a changing Arctic marine environment and for features, populations, species, or their life-stages that are mobile. These two issues are intimately linked – a changing environment often changes the mobility of biodiversity elements. The tool pinpoints features of high-level importance for the continued functioning of Arctic marine ecosystems and lists conservation objectives that support biodiversity resilience and adaptation in a changing environment. Background information for the elements of this tool can be found in Sections III and IV of this report.

Feature	Example	Scope	Conservation objective(s)	Characteristics of MPA or «Other Measure»
Oceanographic or ecological feature forecast to not change geographic location	Up-welling area, seamount, banks	Entire ecosystem	✓ Protecting ecosystem processes, functions, services; ✓ Protecting habitats and species; ✓ Protecting connectivity hubs and mobile link species; ✓ Protecting functional and response diversity in support of ecosystem resilience and adaptation; ✓ Reducing other pressures.	✓ Long term protection; ✓ Broad scope of protection.
Dynamic oceanographic or ecological feature forecast to change geographic location	Marginal ice zone, polar front, polynya, sheer zone	Entire ecosystem	✓ Protecting ecosystem processes, functions, services; ✓ Protecting habitats and species; ✓ Protecting connectivity hubs and mobile link species; ✓ Protecting functional and response diversity in support of ecosystem resilience and adaptation; ✓ Reducing other pressures.	✓ Dynamic in space (can move over time as needed or is stretched out across the dynamic range of the feature); ✓ Broad scope of protection.
Routes and corridors important for ecological connectivity	Areas linking larval and adult stages of ecologically important species, marine mammal movement corridors and migration routes, staging and resting areas along migratory sea bird flyways	Habitats, populations, species	✓ Protecting recruitment and genetic diversity; ✓ Protecting habitats, migrating populations, and critical life history stages of species; ✓ Protecting critical linkages in support of ecosystem resilience and adaptation; ✓ Reducing other pressures.	✓ Dynamic in space (can move over time as needed); ✓ Dynamic in time (e.g. seasonal protection); ✓ Conditional protection (e.g. goes into effect when certain conditions are met).

Feature	Example	Scope	Conservation objective(s)	Characteristics of MPA or «Other Measure»
Emerging and projected habitat(s) for species of concern or for ecosystem services	Future salmon rivers, refugia for sea-ice dependent species	Habitats, populations, species	✓ Supporting adaptive capacity of species/populations through facilitating range shifts and changing migration routes; ✓ Building conservation option redundancy (replicated sites).	✓ Conditional protection (e.g. safeguards that go into effect when certain conditions are met); ✓ Proactive area-management (e.g. activities allowed that are compatible with future protection of biodiversity or ecosystem services).

Tool #3: Management Measures Used by Different Activity Sectors

Different activity sectors' area-based management measures may have characteristics that are relevant to area-based conservation. The purpose of the tool is to point to how examples of commercial sectors' measures may contribute to specific conservation objectives of MPA networks. Annex 2 includes a rich list of concrete measures applied by Arctic countries, while Annexes 1 and 3 provide guidance for and examples of applying measures in the context of MPA network development.

	POSSIBLE MANAGEMENT MEAURES						
Activity	**Closed Area**			**Distance from Wildlife**	**Gear Restrictions or Require-ments**	**Speed limit**	**Emissions regulations (noise, discharge)**
	Permanent / Long Term	Seasonal	Dynamic in space				
Shipping	***Yes*** (Areas To Be Avoided [ATBAs], Particularly Sensitive Sea Areas [PSSAs])	***Yes*** (time, area closures)	***Yes*** (based on real-time informati on (e.g. whale sightings)	***Yes*** (e.g. placement of Traffic Separation Scheme away from important habitat or subsistence use areas)	***Yes*** (communi-cation equipment, geophysical equipment, marine mammal observers)	***Yes*** (e.g. in important habitat and corridor areas for marine mammals)	***Yes***
Commercial Fishing	***Yes***	***Yes*** (seasonal closures)	***Yes*** (rolling and condition al closures)		***Yes***		***Yes***
Tourism	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes*** (e.g. in important habitat and corridor areas for marine mammals)	***Yes***
Oil & Gas operations	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***	***Yes*** (e.g. for service vessels in important habitat and corridor areas for marine mammals)	***Yes***

Tool #4: Key Steps for Integrating Connectivity into Arctic MPA Management and Network Design

There are four key steps for integrating connectivity into Arctic MPA management and network design. The first two – 1) Define conservation objectives and 2) Synthesize information and identify important nodes (existing or potential MPAs) – focus on objectives for the network and the identification of the individual MPAs within that network. The third and fourth steps focus on network connectivity. Different methods are generally employed to 3) Identify connections for species with planktonic life history phases (e.g. many invertebrate and fish larvae) and 4) Identify connections for active swimmers and flyers. The full process of MPA network design is iterative; the knowledge gained in steps 2-4 are routinely re-examined in the context of the conservation objectives defined in step 1.

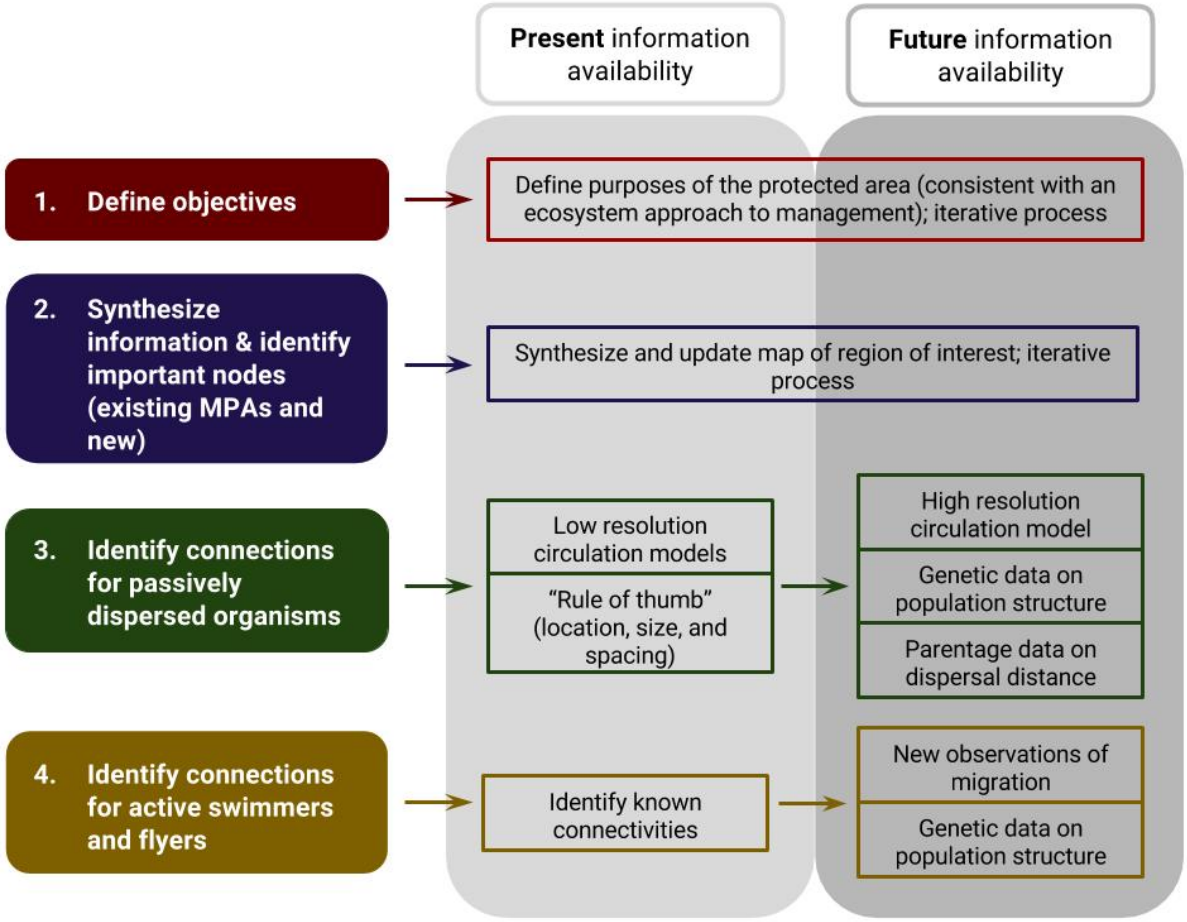

Photo credit: Getty Images

V. NEXT STEPS

This toolbox is intended to provide guidance on MPAs, "other measures" and ecological connectivity based on science and traditional and local knowledge that countries can use and build on to inform the design and implementation of MPA networks. Arctic States are in varying stages of designing and implementing MPA networks, and are using different approaches to do so. Given this diversity of approaches, different tools and examples may be useful to different states. This guidance promotes a flexible, results-based approach to MPA network development that can strengthen the conservation outcomes of the emerging pan-Arctic MPA network.

While the science of ecosystem and species connectivity has been growing for decades, its application to the design and implementation of MPA networks is still fairly new. Similarly, the science of biodiversity conservation in changing environments has advanced recently, but its application in practical conservation approaches has not kept step, especially for area-based conservation measures. This emerging and developing science can be informed by traditional and local knowledge of the people who have intimate relationships with the species and ecosystems. PAME and Arctic Council Working Groups can consider the following steps to advance Arctic MPA network development and management.

1. Identify important species, habitats, ecosystems, and ecosystem services that would benefit from collaborative approaches to MPA network design, considering also threats, connectivity, range shifts, and refugia in a changing Arctic. The scale of

consideration and assessment can vary from the state level to multilateral or pan-Arctic.

2. Working with other Working Groups (e.g. CAFF), synthesize and distribute data on Arctic biodiversity to inform MPA network planning. For example, synthesize habitat and ecological community mapping and coordinate habitat classification systems, especially of benthic habitats. Also, synthesize studies of identified keystone species to serve as a starting point for identifying areas important to Arctic connectivity.
3. Identify, through Arctic science and Indigenous and stakeholder communities, observing and monitoring needs and tools available to support area-based conservation measures, including dynamic measures. This should also include practices and tools for monitoring and assessing the effectiveness of area-based conservation measures.
4. Integrate emerging tools and guidance from the Arctic Council and other sources that could support countries' identification of important areas for ecological connectivity into the toolbox. These can range from complex, such as the ocean circulation model for the Arctic, to simple, such as "rules of thumb" regarding size and spacing of MPAs.
5. Support additional cooperative work to understand and plan for protection of ecological connectivity in a changing Arctic marine environment.
6. Support public outreach and education efforts on the impacts of a changing climate on biodiversity and the role of protected area networks in conserving biodiversity and its social and economic benefits.
7. Work closely with Permanent Participants and Indigenous and local communities to identify ways to further integrate traditional and local knowledge into the toolbox, aiming to consider livelihoods, food security, and cultural values into MPA network design and to enhance sustainable Indigenous management practices through MPA networks.
8. Explore how best to promote and facilitate the multiple values of protected areas – areas conserved and managed to meet the goals of multiple sectors and communities, as part of an ecosystem approach to management.

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ANNEX 1. Categories of Arctic Marine Biodiversity, and Options for Area-based Conservation

The following tables provide an overview of the key species and species groups found in Arctic marine ecosystems, along with brief descriptions of the main geophysical and ecosystem characteristics of the features or habitats in which they are generally found. Information on whether a species group is sedentary or mobile is also included. From there, the table presents some key protection needs of the species or species groups, as deduced from vulnerabilities recognized in key literature references on threats and stressors to Arctic marine biodiversity (listed below the tables). The Arctic Marine Shipping Assessment (AMSA iic) and its listing of species' vulnerabilities to petroleum development impacts and shipping was central in compiling this overview, as well as chapter 14.4: Stressors and Threats to Arctic Marine Ecosystem Biodiversity, in CAFF's Arctic Biodiversity Assessment (ABA). Finally, the tables list options for area-based conservation measures addressing those protection needs. These options are based on input on area-based conservation measures to this report from countries (Annex 2) and discussions at the project's science workshops.

The table is not exhaustive in terms of listing all important categories of biodiversity. The description is limited to species and groups most commonly included as "important" to the Arctic marine environment in reports produced for and used by relevant working groups of the Arctic Council (key references are listed below the tables).

As a result of this approach, the emphasis is on vertebrate species. This is not to say that invertebrates and algae are not important to the Arctic marine ecosystem -- on the contrary. The selection is based on available information, recognizing that Arctic marine habitats, invertebrate species, and ecosystem processes have not been comprehensively classified and only to a limited extent been mapped; this applies in particular to the benthos. However, the table links listed species with habitats, features and ecosystems where they are commonly found.

A. Fish

Species or species groups	Key ecosystem features or habitats where these are found	Sedentary or mobile	Protection needs, based on vulnerabilities to documented threats and stressors	Area-based conservation options
Small cod species spawning in winter under ice (Arctic cod, polar cod, navaga, saffron cod).	Sea ice (multi-year, pack ice); Sea ice (marginal ice zone, ice-influenced waters).	Semi-sedentary while breeding & feeding in/near sea ice. Mobile during migrations (active) and larval stages (passive).	✓ Protection of sea ice habitat from physical disturbance, large-scale take, contamination; ✓ Protection of areas large enough to account for year-to-year variations of spring & summer season sea ice and/or smaller areas effectively connected providing similar protection; ✓ Elimination/restriction of physical disturbance, large-scale take, contamination, from e.g. shipping, oil & gas, industrial fishing, military installations & activity, large-scale tourism, in dynamic areas of current and projected spring & summer sea ice.	✓ MPAs, (IUCN categories I-VI), protecting sea ice features and pelagic habitats important for spawning, feeding or wintering, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" limiting or banning harmful or disturbing human activities & infrastructure, incl. those affecting the sea bottom; ✓ "Seasonal closures" restricting harmful or disturbing activities during most vulnerable times (e.g. spring). ✓ IMO 'Areas To Be Avoided' (ATBA) for shipping; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, impacts of shipping, or support connectivity between MPAs.

Species or species groups	Key ecosystem features or habitats where these are found	Sedentary or mobile	Protection needs, based on vulnerabilities to documented threats and stressors	Area-based conservation options
Demersal (bottom) spawners (capelin, Atlantic and Pacific herring, Pacific cod); Sand eel (Barents Sea).	Sea bottom (soft-bottom, sandy, shallow subtidal); Water column (allowing vertical mobility and migrations); Upwelling areas; Continental shelf ledge, threshold, or transition areas; Deltas & estuaries; (wintering herring);	Mobile during feeding and migrations (active) and larval stages (passive).	✓ Protection of vital and vulnerable sea bottom spawning grounds (e.g. from oil & gas installations, or bottom-trawling); ✓ Protection of sea-ice spawning, feeding & wintering waters from physical disturbance, damage, contamination (e.g. from shipping, oil & gas, industrial fishing incl. bottom trawling, military installations & activity, large-scale tourism); ✓ Protection of breeding stocks from over-harvesting, and over-predation.	✓ MPAs (IUCN categories I-VI), protecting pelagic, benthic and/or sea ice habitats important for spawning, feeding or wintering, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" limiting or banning harmful or disturbing human activities & infrastructure, incl. those affecting the sea bottom; ✓ Seasonal, conditional, or 'rolling' closure of specific areas, limiting damaging or disturbing activities or extraction (e.g. bottom-trawling) during sensitive times of year (e.g. spawning); ✓ "Gear restrictions", limiting or banning use of particularly damaging equipment (e.g. bottom trawling) year-round or seasonally; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to restrict e.g. damaging trawling and shipping, impacts of shipping, or support connectivity between MPAs.

Species or species groups	Key ecosystem features or habitats where these are found	Sedentary or mobile	Protection needs, based on vulnerabilities to documented threats and stressors	Area-based conservation options
Pelagic (water column) spawners (e.g. Atlantic cod, walleye pollock, Greenland halibut).	Water column (allowing vertical mobility and migrations).	Adult cod & pollock highly mobile. Annual migrations. Halibut more sedentary. Passively mobile in larval stages.	✓ Protection from over-harvesting, and over-predation.	✓ MPAs (IUCN categories I-VI), protecting habitats important for spawning, feeding or wintering, either as large areas, or smaller areas effectively inter-connected; ✓ Seasonal, conditional, or 'rolling' closures, limiting damaging extraction or excessive fishing during particularly sensitive life-stages (e.g. spawning & larval 'blooms'); ✓ "Gear restrictions", limiting or banning e.g. damaging bottom trawling, year-round or seasonally; ✓ Sustainable fisheries management regimes ensuring long-term viability of populations.

Species or species groups	Key ecosystem features or habitats where these are found	Sedentary or mobile	Protection needs, based on vulnerabilities to documented threats and stressors	Area-based conservation options
Salmon (Pacific, sockeye, pink , chum, Atlantic), eulachon (candlefish N Pacific), coregonid whitefishes (Great Lakes, Pechora Bay, Siberian river estuaries, Chukchi Sea estuaries); Siberian sturgeon (Kara, Laptev); Cisco (Bering, Chukchi).	Rivers; Deltas & estuaries; Near-shore coastal waters; Freshwater lakes; Protected bays; Water column (allowing mobility and migrations).	Sedentary (spawning); mobile (anadrome) / migratory.	✓ Protection of salmon rivers, lagoons / estuaries and coastal zones from human disturbance, contamination, physical blocking of migration; ✓ Protection of wild stocks from parasites and genetic contamination from farmed salmon; ✓ Protection from over-harvesting.	✓ Traditional MPA categories (IUCN I-VI) restricting damaging human activities in vulnerable areas; ✓ 'National Salmon River' and / or Fjord, Bay, Estuary designation (as in Norway); ✓ Seasonal, conditional, or 'rolling' closures, limiting damaging or disturbing activities or excessive fishing during particularly sensitive life-stages (e.g. breeding /spawning & migrations); ✓ Sustainable fisheries management regimes ensuring long-term viability of populations.

Species or species groups	Key ecosystem features or habitats where these are found	Sedentary or mobile	Protection needs, based on vulnerabilities to documented threats and stressors	Area-based conservation options
Arctic char; lake trout.	Rivers; Deltas & estuaries; Near-shore coastal waters; Freshwater lakes.	Some populations mobile / migratory (anadrome). Some populations sedentary.	✓ Protection of key lakes, rivers, lagoons / estuaries and coastal zones from human disturbance, contamination, physical blocking of movement, particularly during vulnerable life-stages (e.g. breeding, spawning, migrations); ✓ Protection from over-harvesting.	✓ Traditional MPA categories (IUCN I-VI) restricting damaging human activities in specific vulnerable areas; ✓ 'National Char / Trout River' and / or Bay, Estuary or Lake designation (similar to Norway's National Salmon River measure); ✓ Seasonal, conditional, or 'rolling' closures, limiting damaging or disturbing extraction or excessive fishing during particularly sensitive life-stages; ✓ Sustainable fisheries management regimes ensuring long-term viability of populations.

B. Birds

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Alcids (e.g. thick-billed and common murres/ guillemots, little auk (dovekie), black guillemots; murrelets; razorbill, least-, crested- and parakeet auklets, puffins).	Bird cliffs; Near-shore coastal waters; Scree and rocky shores; Coastal tundra slopes; Polynyas & leads (wintering and spring migration); Upwelling areas; Continental shelf ledge, threshold, or transition areas; Open, undisturbed water allowing migration and wintering.	Mobile. Both flight and swim migrations; Some species / populations remain in Arctic year-round.	✓ Protection from oil spills and large-scale disturbance at times and places with large concentrations (spring & autumn staging and swim migrations, summer nesting & feeding, wintering in leads & polynyas); ✓ Specific disturbance protection of bird cliffs, including from helicopter & airplane; ✓ Prevention of introduction / eradication of rodents or other alien predators and egg-eaters from bird cliffs; ✓ Protection from over-harvesting.	✓ MPAs, (IUCN categories I-VI), protecting large extent of birds' feeding, breeding and nesting habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities & infrastructure, in key areas and during most vulnerable life-stages; ✓ "Seasonal closures" restricting harmful or disturbing activities in specific areas during most vulnerable life-stages. ✓ IMO 'Areas To Be Avoided' (ATBA) restricting harmful shipping in vulnerable areas; ✓ Particularly Sensitive Sea Area (PSSA) designation allowing countries to e.g. restrict shipping, impacts of shipping, or support connectivity between MPAs; ✓ Restrictions on distance, frequency and timing of airplane or helicopter or other disturbing activity near vulnerable areas (cliffs, breeding areas, polynya).

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Gulls (e.g. glaucous, ivory, black-backed, Ross's, Sabine, kittiwakes); Short-tailed shearwater; Short-tailed albatross; Fulmars; Storm-petrels; Skuas.	Numerous and varied habitats (generalists); Bird cliffs; Coastal waters; Sea ice (marginal ice zone, ice-influenced waters) (Ivory gulls, skuas); Polynyas & leads (Fulmars, albatross, petrels).	Mobile, but some remaining in Arctic year-round.	✓ Protection from oil spills and destructive disturbance at cliffs and feeding grounds for colony species (incl. air flyover restrictions); ✓ Prevention of introduction / eradication of rodents or other alien predators and egg-eaters from bird cliffs; ✓ Protection of marginal ice zone habitats & ecosystems (Ivory and Ross gulls) ✓ Protection from over-harvesting.	✓ MPAs (IUCN categories I-VI) protecting birds' feeding, breeding and nesting habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, in key areas and during most vulnerable life-stages; ✓ "Seasonal closures" restricting harmful or disturbing activities in specific areas during vulnerable life-stages (e.g. summer nesting & feeding); ✓ Restrictions on distance, frequency and timing of airplane or helicopter or other disturbing activity near vulnerable areas (cliffs, breeding areas, polynya).

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Seaducks (e.g. common, king, spectacled and Steller's eiders, long-tailed duck, scoters).	Coastal waters; Bays with islets and skerries; Intertidal flats; Polynyas & leads (winter, migration concentrations); Open water (banks, winter).	Mobile. Migratory.	✓ Protection from oil spills and large-scale disturbance at times and places with large concentrations (spring & autumn staging and swim migrations, near-shore summer nesting & feeding sites, winter refugia in leads & polynyas); ✓ Protection from over-harvesting; (- In some places, protection from polar bear, raven, and fox predation of eggs).	✓ MPAs (IUCN categories I-VI) protecting large extent of birds' feeding, breeding and nesting habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, in key areas and during most vulnerable life-stages; ✓ "Seasonal closures" restricting harmful or disturbing activities in specific areas during vulnerable life-stages (e.g. summer nesting & feeding); ✓ IMO 'Areas To Be Avoided' (ATBA) restricting harmful shipping in vulnerable areas; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, impacts of shipping, or support connectivity between MPAs; ✓ Management of harvesting (eggs & birds) of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Shorebirds / waders (e.g. red-necked and red phalaropes, spoon-billed & other sandpipers, red knot, dunlin, godwits, ringed plover, ruddy turnstone, others).	Coastal waters; Beaches; Coastal marshes and wetlands: Lagoons; Bays with islets and skerries; Intertidal flats.	Mobile. Migratory.	✓ Protection from oil spills and large-scale disturbance / destruction of coastal breeding, nesting and feeding habitats (e.g. near-shore areas and adjacent shores / beaches and waters, and sites / times with large concentrations of individuals during migration); ✓ Several species also need both habitat protection and protection from over-harvesting outside of Arctic (winter, spring, fall).	✓ MPAs (IUCN categories I-VI) protecting important areas of birds' feeding, breeding and nesting habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, in key areas and during most vulnerable life-stages; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times.
Geese (e.g. brent, barnacle, emperor, cackling, white-fronted, pink-footed, snow); Swans (incl. Bewick's, Kara Sea and Tundra - East Siberia).	Coastal tundra and grasslands; Coastal marshes and wetlands: Lagoons; Bays with islets and skerries; Intertidal flats; Freshwater lakes.	Mobile. Migratory.	✓ Protection from oil spills and large-scale disturbance at times and places (coastal waters and near-shore tundra) with large concentrations (spring & autumn staging / migration, summer nesting & feeding, wintering habitats south of Arctic); ✓ Protection from over-harvesting; ✓ Several species also need both habitat protection and protection from over-harvesting outside of Arctic (winter, spring, fall).	✓ MPAs (IUCN categories I-VI) protecting vital areas of birds' feeding, breeding and nesting habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, in key areas and during most vulnerable life-stages; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ Management of harvesting of vulnerable populations.

C. Marine Mammals

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Bowhead whales.	Sea ice (marginal ice zone, ice-influenced waters); Polynyas & leads; Open, undisturbed water (at appropriate depths) allowing movement and migration.	Mobile. Some seasonal concentrations, but in Arctic year-round.	✓ Protection from petroleum and mining infrastructure & development in breeding and wintering areas; ✓ Regulation and monitoring of shipping in breeding and wintering areas, and along known migratory routes; ✓ Regulation, monitoring & reporting of trawling in known whale areas; ✓ Protection from over-harvesting; ✓ Avoiding conflict with indigenous subsistence harvesting.	✓ MPAs (IUCN categories I-VI) protecting sea ice features and habitats important for breeding, feeding, wintering & migrations, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, shipping and seismic surveys; ✓ "Seasonal closures" restricting potentially harmful or disturbing activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) restricting harmful or disturbing shipping in vulnerable areas; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, impacts of shipping, ban seismic surveys, or support connectivity between MPAs; ✓ Management of harvesting of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Right whales (Atlantic, Pacific).	Upwelling areas; Continental shelf ledge, threshold, or transition areas; Coastal waters; Open, undisturbed water (at appropriate depths) allowing migration (warm water forms barrier).	Mobile.	✓ Protection from petroleum and mining infrastructure & development in breeding and wintering areas; ✓ Regulation and monitoring of shipping in breeding and wintering areas, and along know migratory routes; ✓ Regulation, monitoring & reporting of trawling in known whale areas.	✓ MPAs (IUCN categories I-VI) protecting ecosystem features and habitats important for breeding, feeding, wintering & migrations, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, and shipping; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) restricting harmful or disturbing shipping in vulnerable areas; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, impacts of shipping, seismic surveys, or support connectivity between MPAs.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Other baleen whales (blue, fin, sei, grey, humpback, minke).	Open, undisturbed water (at appropriate depths) allowing movement and migration; Upwelling areas; Continental shelf ledge, threshold, or transition areas; Coastal waters.	Mobile. Several species migratory. Some in Arctic year-round;	✓ Protection from petroleum and mining infrastructure & development in known breeding and wintering areas; ✓ Regulation and monitoring of shipping in breeding and wintering areas, and along known migratory routes; ✓ Regulation, monitoring & reporting of trawling in known whale areas; ✓ Protection from over-harvesting.	✓ MPAs (IUCN categories I-VI) protecting ecosystem features and habitats important for breeding, feeding, wintering & migrations, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, and shipping; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) restricting harmful or disturbing shipping in vulnerable areas; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, impacts of shipping, seismic surveys, or support connectivity between MPAs; ✓ Management of harvesting of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Beluga.	Sea ice (marginal ice zone, ice-influenced waters); Water column (allowing vertical mobility and migrations); Upwelling areas; Continental shelf ledge, threshold, or transition areas; Deltas & estuaries; Near-shore coastal waters; Bays & inlets; Glacier fronts in sea.	Mobile. Migratory.	✓ Protection from petroleum and mining infrastructure & development in vulnerable breeding, feeding, and wintering areas and key migration routes (incl. glacier fronts, leads, estuaries); ✓ Protection from over-harvesting; ✓ Avoiding conflict with indigenous subsistence harvesting.	✓ MPAs (IUCN categories I-VI), protecting vital beluga habitats, either as large areas, or as smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful human activities and infrastructure, including trawling, shipping, and seismic surveys; ✓ "Seasonal closures" restricting potentially harmful activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) for shipping. ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, limit impacts of shipping, or support connectivity between MPAs; ✓ Management of harvesting of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Narwhal.	Arctic species; Sea ice (marginal ice zone, ice-influenced waters); Polynyas & leads; Water column (allowing vertical mobility and migrations); Fjords and protected bays (East Greenland).	Mobile. Migratory	✓ Protection from petroleum and mining infrastructure & development in vulnerable breeding, feeding, and wintering areas and along key migration routes; ✓ Protection from over-harvesting.	✓ MPAs (IUCN categories I-VI), protecting sea ice features and habitats important for breeding, feeding and wintering, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, shipping & tourism; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) for shipping; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, limit impacts of shipping, or support connectivity between MPAs; ✓ Management of harvesting of vulnerable populations.
Other toothed whales (sperm, northern bottle-nose, orcas).	Open, undisturbed water (at appropriate depths) allowing movement and migration; Upwelling areas; Continental shelf ledge, threshold, or transition areas; Coastal waters;		✓ Protection from petroleum and mining infrastructure & development in known breeding and wintering areas, and along key migration routes; ✓ Regulation and monitoring of shipping in breeding and wintering areas, and along know migratory routes; ✓ Regulation, monitoring & reporting of trawling in known whale areas.	✓ MPAs (IUCN categories I-VI) protecting key ecosystem features and whale habitats, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, shipping & tourism; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ IMO 'Areas To Be Avoided' (ATBA) for shipping; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, limit impacts of shipping, or support connectivity between MPAs.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Walrus.	Coastal waters; Sea bottom (soft-bottom, sandy, shallow subtidal); Bays with islets and skerries (for haul-out); Beaches (for haul out); Polynyas & leads; Sea ice (marginal ice zone, ice-influenced waters); Open, undisturbed water allowing migration.	Arctic species; Mobile. Migratory.	✓ Protection from petroleum and mining infrastructure & development in known breeding, feeding / haul-out, migration, and wintering areas; ✓ Regulation and monitoring of shipping (incl. tourism) in breeding and wintering areas, and along know migratory routes.	✓ MPAs (IUCN categories I-VI), protecting habitats important for breeding, resting (haul-out), feeding and wintering, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, shipping & tourism; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, limit impacts of shipping, or support connectivity between MPAs; ✓ Management of harvesting and/or tourism disturbance of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Seals (spotted, ribbon, harp, hooded, ringed, bearded, harbor, grey); Steller Sea Lion; Northern fur seal (Bering).	Sea ice (marginal ice zone, ice-influenced waters); Sea ice (multi-year, pack ice); Water column (allowing vertical mobility and migrations); Polynyas & leads; Near-shore coastal waters; Bays with islets and skerries (for haul-out); Beaches (for haul out).	Mobile. Some species migratory	✓ Protection from petroleum and mining infrastructure & development in known breeding and wintering areas with high concentrations; ✓ Protection of areas with remaining multi-year sea ice that are breeding and whelping sites for ice-breeding seals (e.g. ringed); ✓ Protection from over-harvesting for certain species.	✓ MPAs (IUCN categories I-VI), protecting habitats important for breeding, resting / molting, feeding, wintering. Including marginal ice zone and coastal ice areas important for ringed seal breeding, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, shipping & tourism; ✓ "Seasonal closures" restricting harmful or disturbing activities at vulnerable times; ✓ Management of harvesting and/or tourism disturbance of vulnerable populations.

Species or species groups	Key ecosystem features or habitats	Sedentary or mobile	Protection needs	Area-based conservation options
Polar bear.	Sea ice (multi-year, pack ice) (feeding); Sea ice (marginal ice zone, ice-influenced waters) (feeding); Polynyas & leads (feeding); Near-shore coastal waters ; Scree and rocky shores (denning); Coastal tundra slopes (denning); Beaches.	Mobile. Arctic species;	✓ Protection of feeding and denning areas, including securing substantial areas of remaining multi-year sea ice; - Protection from petroleum and mining infrastructure & development, and of shipping in vulnerable feeding and denning areas; ✓ Protection from oil spills; ✓ Protection from over-harvesting.	✓ MPAs, (IUCN categories I-VI), protecting sea ice features and coastal habitats important for feeding and denning, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for potentially harmful or disturbing industrial activities;. ✓ "Seasonal closures" restricting harmful or disturbing activities during most vulnerable times (e.g. spring denning); ✓ Management of harvesting and/or tourism disturbance of vulnerable populations.
Sea otter.	Near-shore areas around islands and coastal habitats, Alaska Peninsula.	Mobile, but generally home range of a few km^2.	✓ Protection of feeding and breeding areas, on shore and at sea; ✓ Protection from petroleum and mining infrastructure & development, and of shipping in vulnerable feeding and breeding areas.	✓ MPAs, (IUCN categories I-VI), protecting ecosystem features and coastal habitats important for feeding and breeding, either as large areas, or smaller areas effectively inter-connected; ✓ "Exclusion areas" for harmful or disturbing human activities and infrastructure, including trawling, seismic surveys, shipping & tourism; ✓ "Seasonal closures" restricting harmful or disturbing activities during most vulnerable times; ✓ Particularly Sensitive Sea Area (PSSA) designation, allowing countries to e.g. restrict shipping, limit impacts of shipping, or support connectivity between MPAs; ✓ Management of harvesting and/or tourism disturbance of vulnerable populations.

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ANNEX 2. Examples of Area-based Conservation Measures Currently Used by Arctic Countries

The table below lists diverse existing area-based measures, including different types of marine protected areas and of "other area-based conservation measures" that contribute to the long-term conservation of important categories of Arctic marine biodiversity (e.g. important species and habitats). The table is compiled from the submissions by PAME members who had been asked to provide as many examples as possible of the different approaches countries use for area-based conservation applicable in the Arctic. It is not a comprehensive list of all areas where the different approaches are used within each country.

A template of the table was provided, along with the following guidance:

> "Protected areas –including MPAs- are defined by the International Union for Conservation of Nature (IUCN) as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values". The IUCN also provides a list to distinguish between categories of protected areas. See http://www.iucn.org/about/work/programmes/gpap_home/gpap_quality/gpap_pacategories/
>
> "Other area based conservation measures" includes area-based measures that are not MPAs, but have a conservation purpose. This term is not yet comprehensively defined and we therefore ask countries to be inclusive in listing measures in this category. The following (non-comprehensive) list of questions may be helpful as guidance for identifying and describing "other measures":
>
> - Does the measure have an expressed purpose to conserve or protect biodiversity, or might that purpose be achieved as a co-benefit of other management purposes or activities (either intended, or not intended, but nevertheless occurring)?
> - What is the protection target of the measure and how does it relate to species, habitats, features, or ecosystem processes?
> - Does the measure have fixed geographic coordinates and fixed seasonal/continuous time validity?
> - Is the management measure established for the long term or indefinitely?
> - Are there management objectives other than conservation or protection, and if so how do they relate to conservation objectives (e.g. can protection objectives be compromised by other objectives)?
> - Is the assessment of effective conservation/protection outcomes part of a screening process for that measure, and does the measure allow managers to address potential gaps over time?
> - Does the measure meet the definition of one of the IUCN protected area categories in practice but those governing the area don't agree to designation as a protected area?"

A. Marine Protected Areas

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
MPA (IUCN Ia) Strict Nature Reserve	Law on protection of the area. Human access is restricted to scientific research activities	Iceland	Human access is limited.	Geology features and natural evolution of ecosystems protected	Protection of a volcanic island and its ocean surroundings for research purpose; undisturbed biological evolution in progress	Disturbance from human activities, invasive species on a unique and pristine habitat	Surtsey, a volcanic island and its surrounded ocean area that limits human access; World heritage site	Protected by Law on protection of Surtsey /1965; Geographic coordinates applies.	
MPA (IUCN Ia) Strict Nature Reserve	Nature reserve	Norway	Restriction on the use of fishing gear that may damage the sea bottom.		The purpose of the protection is to preserve an almost untouched Arctic island and nearby seas, including the sea bottom, with a unique landscape, an active volcanic system, special flora and fauna and many historical remnants.		Jan Mayen	Nature conservation Regulations.	Applied in the Arctic
MPA (IUCN Ia) Strict Nature Reserve	Strict Nature Reserve	Russia	Prohibition of all human activities including fishing,	Polar bear, walrus, ivory gull, ecosystem of small arctic islands	Protection of almost untouched Arctic islands and coast together with adjacent marine aquatory for conservation of arctic	Disturbance from human activities (shipping, geological exploration)	Great Arctic Strict Nature Reserve	Protected by Federal Law (forever). Under management of Russian Ministry of	Applied in the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			shipping, oil/gas exploration etc. except scientific research and ecological tourism.		ecosystems and species			Nature Recourses and Ecology.	
MPA (IUCN Ia or Ib) Strict Nature Reserve or Wilderness Area	Restricted access Area	United States	Human access restricted or prohibited.	Varied – often coastal, nesting sites, haul-outs	Protection of species in critical habitat, or life stage	Disturbance from human activity, e.g., hunting, noise	Walrus Island State Game Sanctuary, Alaska	To protect sanctuary wildlife and other resources, access to Round Island and the waters within three nautical miles of the island has been restricted since 1989; access is allowed only by Access Permit and when Sanctuary staff are present, usually between May 1 and August 15.	Applied in the Arctic
MPA (IUCN Ia or Ib) Strict Nature Reserve or Wilderness	Extraction Prohibited / No Take Protected Area/	United States	Prohibits the take of living, geological, and cultural marine	Highly varied but often targets a focal species or habitat (i.e. coral, kelp bed, urchin)	Protection of pristine habitat from disturbance, restoration of ecosystem and species communities, conservation of biodiversity	Maintain or restore the intrinsic biodiversity and natural processes of pristine habitat,	California State Marine Reserves	Designated to protect protect the diversity and abundance of marine life, the habitats they	None currently in the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Area	Reserve		resources.		or enhancement of nearby fishery resources	species or ecosystem		depend on, and the integrity of marine ecosystems. Other MPAs of this type created as parts of the Pacific Island Monuments.	
MPA (IUCN II) National Park	National parks	Norway	Multiple use. The seabed is protected against fishing and other harvesting by diving, bottom trawling or dredging. Shrimp trawling is permitted in waters where the depth is 100 m or more.		To maintain large, continuous and largely undisturbed areas of natural environment on land and in the sea with intact habitats, ecosystems, species, natural ecological processes, landscapes, cultural heritage and cultural environments; some areas maintained as reference areas for research and opportunities to experience Svalbard's natural and cultural heritage.		Areas in the western part of Svalbard (in the eastern part of Svalbard there are nature reserves (MPA (IUCN I)) with the same managements objectives as for the national parks).	Regulated by the Svalbard environmental protection act.	Applied in the Arctic
MPA (IUCN II) National Park	National Park	Russia	Prohibition of most human activities including	Ecosystems of high arctic islands and ice marine aquatory; polar	Protection of almost untouched High Arctic islands and ice marine ecosystems as well as Arctic	Disturbance from human activities (tourism, military)	«Russian Arctic» National Park	Protected by Federal Law (forever). Under management	In the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			fishing, shipping, oil/gas exploration etc. except ecological tourism, scientific research and restricted military activity.	bear/ Atlantic walrus, seabird colonies	species			of Russian Ministry of Nature Resourses and Ecology.	
MPA (IUCN II) National Park	Exclusion area/gear restrictions (in National Park)	Sweden	Pelagic trawl/mobile bottom contacting gear prohibited. Fishing permitted only with area-specific mobile bottom contacting gear - "Koster trawl".	Protection of bottom habitats (e.g. deep corals, sponges, eelgrass meadows, sea pens and burrowing mega fauna).	Protection of species diversity and bottom habitats.	Habitat damage due to trawl/mobile bottom contacting gear.	Kosterhavet National Park	In Kosterhavet National Park, fishing is only permitted with a specific license, and in order to get the license the fishermen have to participate in an information course on the biological diversity in the area. Several areas in Kosterhavet National Park are closed year-around to fishing. The park is managed	Not applied in Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
								by the County of Västra Götaland through a council of representatives from county administration, local municipality, fisheries, community associations and Gothenburg University.	
MPA (IUCN III); Natural Monument or Feature	Regulation on protection	Iceland	Prohibits human activities that disturb geological features and the habitat attached; bottom contact fishing gears prohibited.	Hydrothermal vents	Protection of unique and rare geological features and associated habitat	Damage and destruction of sensitive geological features and associated habitat by direct contact	Hverastrýtur in two areas of Eyjafjörður, off the North coast	Protected by regulations adopted by the Ministry of the Environment and Natural Resources. Geographic coordinates apply.	
MPA (IUCN III); Natural Monument or Feature	Restricts extraction	United States		Highly varied but often targets a focal species or habitat (i.e. coral,	Protection of pristine habitat from disturbance, restoration of ecosystem and species communities,	Maintain or restore the intrinsic biodiversity and natural processes	Edgecumbe Pinnacles Marine Reserve in SE	Designated to strictly protect fragile coral and sponge ecosystem by	None currently in the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
				kelp bed, urchin)	conservation of biodiversity or enhancement of nearby fishery resources	of pristine habitat, species or ecosystem	Alaska	prohibiting the use of all recreational and commercial fishing gear (except pelagic troll gear used for salmon), and anchoring by fishing vessels on specific habitat.	
MPA (IUCN IV) Habitat/ Species Manage-ment Area	Regulations that perma-nently prohibit use of all bottom contact fishing gears	Iceland	Fishing activities that can harm the bottom are prohibited.	Cold water corals with associated species and bottom habitat	Protection of cold water corals	Damage and destruction of sensitive species by direct contact of bottom contact fishing gears	Coral areas off the south coast at Skeiðarárdýpi, Lónsdýpi, off Lónsdýpi and Papagrunn, Landgrunnskantur and Rósagarður	Regulation nr. 1095/2011 adopted by the Ministry of Industry and Innovation and regulated by the Directorate of Fisheries as part of Responsible Fishery management plan. Geographic coordinates apply.	
MPA (IUCN IV) Habitat/ Species	Gear restrictions	Norway	According to the regulations,	Coral reefs	Protection of bottom habitats	Habitat damage due to bottom contact trawl	18 coral reefs, incl Røstrevet, Korallen,	Pursuant to the Marine Resources Act of 6 June 2008,	Applied in the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Manage-ment Area			intentional and negligent destruction of known coral reefs is prohibited, and precaution is required when fishing in the vicinity of known cold-water coral reefs. Furthermore, a selection of coral reef-areas are granted special protection by a ban on the use of fishing gear which is dragged along the bottom (such as			fishing gear	Trænarevet.	the Norwegian authorities have adopted regulations to protect cold-water coral reefs. Eighteen coral reefs are designated areas protected from bottom-trawling (seven of the 18 areas also have restrictions on the use of nets, longline and traps). There are supplementary management measures in place to minimize negative impact (from fishing activity) on coral reefs in general/outside these zones. Some of these are situated in the Arctic.	

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			bottom trawl). A total of eighteen coral reefs are given this special protection (some of the 18 areas also have restrictions on the use of nets, longline and traps). Multiple use, but trawling on coral reefs (bottom trawl) is prohibited.						
MPA (IUCN IV) Habitat/ Species Manage-ment Area	Buffer zone	Russian	Prohibition of any geological exploration, oil/gas and mining development, fishing. Restriction of shipping.	Polar bear, walrus, grey & bowhead whales, seabirds	To protect the ice habitats as the feeding and migration areas of polar bear, walruses and seabirds.	Shipping, possible oil/gas exploration	Buffer zone of «Wrangel Island» Strict Nature Reserve	Protected by Federal Law. Under the management of «Wrangel Island» Strict Nature Reserve.	In the Arctic

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
MPA (IUCN V + VI) Protected Landscape/ Seascape or Protected Area with Sustainable Use of Natural Resources		Kingdom of Denmark	Hunting, fishing, collection of plants, eggs and limited access etc.	Flora and fauna with a focus on Arctic tern	Area protection (Ramsar Site)		Kitsissunnguit/ Grønne Ejland	Implemented via Governmental Executive order: Hjemmestyrets bekendtgørelse nr. 11 af 17. april 2008 om fredning af Kitsissunnguit. http://lovgivning.gl/lov?rid={33A08E57-CE09-47A7-867A-9497651EC5F8}	
MPA (IUCN V) Protected Landscape/ Seascape		Kingdom of Denmark	Collection of plants, flying and sailing etc.	Flora and fauna, natural and cultural values of the landscape	Area protection (World Heritage Site)		Ilulissat Isfjord	Implemented via Governmental Executive order: Hjemmestyrets bekendtgørelse nr. 10 af 15. juni 2007 om fredning af Ilulissat Isfjord. http://lovgivning.gl/lov?rid={C6681D09-AD38-44AA-88C1-0B5F9B0AC554} A management plan	

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
								has been made for the area: http://naalakkersuisut.gl/~/media/Nanoq/Files/Attached%20Files/Natur/DK/Ilulissat%20Isfjord/Forvaltningsplan%20for%20Verdensarvsomr%C3%A5det.pdf.	
MPA (IUCN V) Protected Landscape/ Seascape		Kingdom of Denmark	Hunting, fishing, agriculture, flying and sailing etc.	Natural and cultural values include the Ikate Tufa columns; flora and fauna with a focus on common seal; ensuring sustainable use of natural resources	Area protection		Ikka-fjorden (Ivittuut and Kangillinnguit)	Implemented via Governmental Executive order: Selvstyrets bekendtgørelse nr. 4 af 12. april 2010 om fredning af et område ved Ivittuut og Kangilinnguit. http://lovgivning.gl/lov?rid={80A814FF-16FE-42E1-BCF0-6F0E7ED70768}	
MPA (IUCN V) Protected Landscape/ Seascape		Kingdom of Denmark	Hunting, fishing, collection of eggs, flying	Flora and fauna with a focus on narwhal, and walrus	Area protection		Melville Bay	Implemented via Governmental Executive order: Hjemmestyrets	

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			and sailing etc.					bekendtgørelse nr. 21 af 17. maj 1989 om naturreservatet i Melville Bugt. http://lovgivning.gl/lov?rid={40C78374-0645-48B8-A846-1A50E9333611}	
MPA (IUCN V) Protected Landscape/ Seascape		Kingdom of Denmark	Hunting and fishing; access fee for the general public etc. See executive order for more information (in Danish).	Flora and fauna	Area protection (UNESCO Man and Biosphere, two Ramsar sites included)		North-East Greenland National Park	Implemented via Governmental Executive order: Hjemmestyrets bekendtgørelse nr. 7 af 17. juni 1992 om Nationalparken i Nord- og Østgrønland. http://lovgivning.gl/lov?rid={1FC9C99F-1BE0-494A-A663-4CA19ABEAF62}	
MPA (IUCN VI) Protected Area with Sustainable Use of Natural Resources	Oceans Act MPA	Canada	Restrictions include: (a) disturb, damage or destroy in the Areas, or	Beluga whales, Narwhal, and other marine species (anadromous fish, waterfowl and seabirds), their	To conserve and protect beluga whales and other marine species (anadromous fish, waterfowl and seabirds), their habitats and their	Habitat damage and destruction, commercial fishing, dredging, oil/gas exploration, mineral	Tarium Niryutait MPA	Tarium Niryutait MPA was created through a collaborative effort by Fisheries and Oceans Canada, the	Applied in the Western Arctic within the boundaries

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			remove from them, any living marine organism or any part of its habitat; or (b) carry out any activity in the Areas that is likely to result in the disturbance, damage, destruction or removal of a living marine organism or any part of its habitat. Several exceptions exist in the legislation with varying criteria.	habitats and their supporting ecosystem	supporting ecosystem -To ensure the long-term sustainable management of one of the world's largest summering stock of beluga whales and their habitat -To preserve the harvesting traditions of the Inuvialuit people in the ISR (Inuvialuit Settlement Region) -To prohibit specific activities or classes of activities that could potentially negatively impact beluga or any part of the ecosystem in the areas upon which they depend	exploration, shipping		Inuvialuit people, private industry, local stakeholders and governments. Clear co-management requirements and guidelines exist for effective management and monitoring strategies in the MPA.	of the Inuvialuit Settlement Region of the North West Territories
MPA (IUCN VI) Protected	Oceans Act MPA	Canada	Prohibited to carry out any	Beluga, bowhead whales, ring and	- To maintain the integrity of the marine environment	Habitat damage and destruction by	Anguniaqvia niqiqyuam	Anguniaqvia niqiqyuam MPA was	Applied in the

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Area with Sustainable Use of Natural Resources			activity that disturbs, damages, destroys or removes from the Marine Protected Areas any living marine organism or any part of its habitat or is likely to do so. Exceptions exist with varying criteria; including fishing, vessel navigation, dredging, safety or emergency, scientific research and monitoring, education and marine	bearded seals, Arctic char, Arctic cod, sea birds, polar bears; and their associated habitat (sea ice, polynya, nearshore and offshore waters)	offshore of the Cape Parry Migratory Bird Sanctuary (MBS) so that it is productive and allows for higher trophic level feeding by ensuring that the Cape Parry polynyas and associated sea-ice habitat, and the role of key prey species (e.g. Arctic cod), are not disrupted by human activities - To maintain the habitat to support populations of key species (i.e. beluga, Arctic char, ringed and bearded seals) -To preserve the harvesting traditions of the Inuvialuit people in the ISR (Inuvialuit Settlement Region) -To prohibit specific activities or classes of activities that could potentially negatively	marine tourism, educational activities and scientific research and monitoring; oil/gas exploration; mineral exploration	MPA	created through a collaborative effort by Fisheries and Oceans Canada, the Inuvialuit, local stakeholders, private industry, and governments. Clear co-management requirements and guidelines exist for effective management and monitoring strategies in the MPA.	Western Arctic within the boundaries of the Inuvialuit Settlement Region of the North West Territories ANMPA is the first MPA with a conservation objective based solely on traditional and local knowledge. The process of

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			tourism activities.		impact key species or any part of the ecosystem in the areas upon which they depend				creating the ANMPA through the partner-ship of the Govern-ment of Canada and the Inuvialuit is a prime example of the importanc e of collabora-tion and commit-ment to sustain an ecologicall y productive area and marine ecosystem

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
									identified and important to the Inuvialuit people that we may learn from to achieve successful conserva-tion of the marine environ-ment (Arctic Journal 2017).
MPA (May include all IUCN categories)	HELCOM MPA network	Finland	Legal measures vary between MPAs in the Baltic Sea network (see: www.helcom.fi/baltic-sea-trends/data-	EU Habitats Directive Annex I habitats and Annexes II, IV and V species, HELCOM HUB biotopes and Red-listed HELCOM Species and habitats/biotopes	Varies (more than 174 HELCOM MPAs in the 9 riparian countries of the Baltic Sea)	Yes (all relevant human activities are restricted but the restrictions vary between MPAs according to pressure and national policies	Multiple. See: www.helcom.fi/baltic-sea-trends/data-maps/biodiversity/helcom-mpas/ for details and www.helcom.f	The 2014 HELCOM MPA Recommendation (Rec. 35/1) defines the background and joint actions/measures that all HELCOM Contracting Parties	No

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			maps/biodiversity/helcom-mpas/).				i/action-areas/marine-protected-areas	agreed to follow. Each HELCOM Contracting Party also apply their respective own legislation relevant for these HELCOM MPAs (and other national MPAs). The HELCOM MPA database provides information on these national measures.	
MPA (May include all IUCN categories)	**National Nature Conserva-tion Act** (to which the EU's Habitat Directive is transposed) and other national legislation, e.g., the water act, fishing act,	Finland	Any activities that may be in conflict with the aim of the protection goals and objectives i.e. may result in the degradation of habitats or species for which the MPA is designated.	Species and habitats listed in the nature conservation act or water act, including the EU's Habitats Directive Annex I habitats and Annexes II, IV and V species	Varies. Different for each MPA since the focus is on the protection of specific species and habitats	Yes (all relevant human activities are restricted but the restrictions vary between MPAs)	Multiple. See www.Finlex.fi or www.talentumpro.fi/#suomenlaki which also provides access to Finland's legislation in English	Government and national legislation.	No

MPA (IUCN Protected Area category)	Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective for conservation of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
	building act. EU has the legal comp-etence for prof-essional fisheries in the marine areas of EU Member States.								

B. Examples of "Other Measures"

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Exclusion Areas	Kingdom of Denmark	No trawl fishing.	Greenland Halibut	*Protection of seafloor* habitats and the ocean ecosystems from the impacts of bottom trawling.	Disturbance on seafloor from fishing gear	Multiple sites, between 64°30'N and 68°N	Implemented via Governmental Executive order: Selvstyrets bekendtgørelse nr. 12 af 17. november 2011 om tekniske bevaringsforanstaltninger i fiskeriet. http://lovgivning.gl/lov?rid={0F40DF8E-7625-4C33-90EA-8A62F02061AB}	
Seasonal and spatial restrictions	Kingdom of Denmark	Seismic protection zones; Protection zones; Important areas to wildlife in Greenland.	Vulnerable wildlife, habitats, etc.	Protection of marine wildlife and habitats from disturbance from mineral resource activities	Disturbance from mineral resource activities	Seismic protection zones 2014 Protection zones Important areas to wildlife in Greenland	Guidelines for offshore hydrocarbon exploration activities in Greenland and EIA guidelines for offshore and mineral extraction activities, as well as specific environmental terms in approvals of offshore activities.	Applied in Greenland

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Area closure	Sweden, Kattegatt	Exclusion area/gear restrictions.	Fishing: only selective fishing gear that do not catch cod is allowed (e.g. bottom trawl without sorting grid)	Cod (Gadus morhua)	Increase of local cod stock	Depletion of local cod stock, due to high fishing mortality as a bycatch species	Large areas in the southeast Kattegat is closed year-around to all fishing. Adjacent areas are seasonally closed /restricted for fisheries. Bilateral agreement between Sweden and the Kingdom of Denmark.	Not applied in Arctic
Fishing rules	Russian Federation	No fishing (separately for gear types, e.g. bottom, pelagic trawls, Danish seine etc.).	Pollack, cod, haddock, Marine mammals, Spawning and nursery areas, haul-outs	Protection of species/habitat, species range/migration, etc. Protection of marine mammal haul-outs and migratory corridors.	Overfishing, mortality, bycatch. Habitats disturbance from fishing activity. Noise and visual disturbance.	Multiple areas in territorial waters and EEZ in Barents, Laptev and Bering seas	Fishing rules by Federal Fishery Agency, including permanent and seasonal spatial restrictions. Fishing rules for Far East basin (Chukchi, Bering, Okhotsk seas). http://fish.gov.ru/files/documents/otraslevaya_deyatelnost/lubitelskoe_rybolovstvo/Pravila_Dalnevostochnogo.pdf Fishing rules for North basin (Barents Sea). http://fish.gov.ru/files/	Applied in the Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
							documents/otraslevaya_deyatelnost/lubitelskoe_rybolovstvo/Pravila_Sevenogo.pdf Fishing rules for East Siberia basin (Laptev Sea). http://fish.gov.ru/files/documents/otraslevaya_deyatelnost/lubitelskoe_rybolovstvo/Pravila_Vostocho-Sibirskogo.pdf	
Regulations for marine mammal protection and hunting.	Russian Federation	No economic activities. Overflight restrictions.	Marine mammals. Haul-outs and feeding areas.	Protection of marine mammal haul-outs.	Disturbance to species from noise, human activity; disturbance of hunting activities during hunting season.	Multiple areas along the coast.	Order N 349 of the Ministry of Fisheries of the USSR from 30.06.1986. «Regulations for marine mammals protection and hunting» http://www.consultant.ru/cons/cgi/online.cgi?req=doc;base=ESU;n=7556#0	Applied in the Arctic
Exclusion Areas	United States	Oil and Gas Lease Sales Prohibited.	Marine mammal haul-outs and migratory corridors (e.g.	Protection of marine mammal haul-outs and migratory corridors.	Disturbance to species from noise, human	North Aleutian Basin, Hannah	These areas have been removed from consideration from Department of	Applied in Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
			walrus, bowhead whales)		activity; disturbance of hunting activities during hunting season.	Shoal, Barrow, and Kaktovik Subsistence Whaling Areas. Beaufort and Chukchi Seas oil and gas permanent exclusions and Northern Bering Sea Resilience Area (for oil and gas and commercial fishing)	Interior/ Bureau of Energy Management (DOI/BOEM) lease sales due to their importance for subsistence use by Alaska Natives as well as for their unique and sensitive environmental resources. (Specifically will not appear in BOEM's 5 year lease plan 2017-2022 & beyond).	
Seasonal Closure	United States	Prohibit or limit extraction or disturbances during critical life stage for particular species.	Variable, related to vulnerable life stage, migration or spawning season, or habitat vulnerability	Protect species/habitat during critical life stage, species range/migration, etc.	Habitat disturbance	Seasonal Crab Closures in Bristol Bay Area 516 Seasonal Closure to protect	Designated by FMC actions.	Applied in the Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
						red king crab when they are in a fragile molting condition		
Subsistence Area	United States	Prohibit or reduce commercial harvest and designate/protect areas for local subsistence harvest.	Locally targeted subsistence resource or method (e.g. crabbing)	Allocate resources for local community harvest and subsistence uses	Resource availability and viability for local harvest	Subsistence Crab Areas (St. Matthew Island)	The King and Tanner Crab Subsistence Areas were established via FMP action, which prohibits commercial crab fishing around St. Matthew Island and protects the shallow nearshore crab habitat for local harvest.	Applied in the Arctic
Regulation on Seasonal closure to bottom trawling	Iceland	Prohibit or limit extraction or disturbances during critical life stage for particular species.	Variable, related to vulnerable life stage, migration or spawning season	Protect species/habitat during critical life stage, species range/migration, etc.	Habitat disturbance	Seasonal Closures in Táin, Mehlsack and Ark Strait to protect cod spawning grounds.	Regulations adopted by the Ministry of Industry and Innovation and regulated and implemented by the Directorate of Fisheries as part of Responsible Fishery management plan. Geographic coordinates apply.	
Rolling Closure	United States	Close parts of a fishing area seasonally to all	Often large commercial	Increase stock, improve catch rate, control	Overfishing, mortality,	Gulf of Maine	NOAA NMFS via FMC action.	Not applied in Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		vessels or to specific gear types or species harvest for designated periods of time. Closures move across an area throughout a given year.	fisheries (e.g. Cod, Haddock in Gulf of Maine)	harvest, limit fish mortality and protect seasonal aggregations	bycatch	Rolling Closure		
Regulation on Rolling Closure	Iceland	Close parts of a fishing area seasonally to all vessels or to specific gear types or species harvest for designated periods of time. Closures move across an area throughout a given year.	Commercial fisheries (e.g. Cod, Haddock, Herring).	Increase stock, improve catch rate, control harvest, limit fish mortality and protect seasonal aggregations.	Overfishing, mortality	EEZ	Regulations adopted by the Ministry of Industry and Innovation and regulated by the Directorate of Fisheries as part of Responsible Fishery management plan. Geographic coordinates applies.	
Real-time closure	Norway	Real time closures are frequently used in the EEZ; fishers are obligated to leave fishing areas when the intermixture of juveniles exceeds certain limits.					Fisheries regulation. The Norwegian Coast Guard oversees that the closed areas and/or restrictions on activity are respected.	
Conditional closures	United States	Prohibit or spatially restrict extraction due to local condition of species or habitat.	Varies widely; often applied to shellfish for domoic acid or	Often to protect human health from toxins in shellfish	Human health impacts from consumption	California Crab Fishery Closures - e.g.	Often Implemented by Local Managing Agency in coordination with NOAA NMFS.	Applied based on immediate local

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		Usually temporary and short-term in response to immediate threat or risk.	water quality issues		of toxins or pollutants	Extraction of commercial and recreational crab prohibited due to high levels of domoic acid		conditions
Overflight Restrictions	United States	Overflights of aircraft below certain altitudes are prohibited.	Seabird and marine mammal habitat	Seabird nesting habitat, marine mammal haul-outs	Noise and visual disturbance	Olympic Coast NMS (minimum flight altitude of 2000')	Regulations restrict altitude of flight over the OCNMS to avoid disturbance to wildlife.	Not applied in the Arctic
By law, flight restrictions	Iceland	Flights of aircraft in proximity of bird cliffs is limited.	Seabird nesting sites	Seabird nesting habitat	Disturbance by noise and visual disturbance	Around Iceland´s coastline at all bird cliffs	By law nr. 64/1994 on protection and hunting of wild birds and mammals in order to avoid disturbance. Adopted by the Ministry of Environment and Natural Resources. No Geographic coordinates applies.	All around Iceland´s coast, applies at all main bird cliffs
Gear Restriction	Canada	Non-pelagic trawl/ mobile bottom contact gear prohibited.	Bottom habitat (e.g. deep corals, sea pen, sponges)	Protection of bottom habitat	Habitat damage due to bottom	Hatton Basin NAFO Area 0B2G	Fishery closure exists as a voluntary, year round restriction for all	Applied in Eastern Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
					contact trawl fishing gear. Habitat, fish populations, gear conflicts		gear types used in the Greenland Halibut and Northern/striped shrimp fisheries. Because there is a possibility that shrimp trawls can come into contact with the corals, and that this is a voluntary closure that is not observed by all industry partners, the closure does not meet Fisheries and Oceans Canada's criteria for "other effective area-based conservation measures". An expanded area in Hatton Basin is being pursued with industry and co-management partners as a formally legislated fishery closure to all gear types by 2017.	outside of Nunavut Settlement Area.
Gear Restriction	Canada	Restricted fishing activities for Greenland Halibut fishery gear	Narwhal-Coral Closure	Conservation of winter food source and overwintering habitat	Habitat damage due to bottom	Davis Strait, NAFO Area 0A	Fishery closure has been implemented as a year round closure for	Applied in Eastern Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		types (Non-pelagic trawl/ mobile bottom contact gear prohibited).		for narwhal, protection of cold water corals.	contact trawl fishing gear. Habitat, fish populations, narwhal populations, gear conflicts.		all gear types used in the Greenland Halibut fishery. Requirements were incorporated into Integrated Fishery Management Plan (IFMP) for Greenland Halibut management activities and was implemented for the 2008 season. No restrictions for Shrimp fishery are in place due to the target of shallower waters by those gear types. Despite this, it has been determined that this closure does not currently meet the criteria developed by Fisheries and Oceans Canada as an "Other effective area based management measure". In 2017, allowable activities in a portion of the area may be amended in a	outside of Nunavut Settlement Area.

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
							way that would satisfy the Other Measures guidance criteria.	
Gear Restriction	Norway	Restrictions to all types of gear that may come in contact with the bottom.	Bottom habitat (e.g. deep corals, sponges)	Protection of bottom habitat	Habitat damage due to bottom contact trawl fishing gear	(Several)	Fisheries regulations. Apply to areas deeper than 1000 meters in Norwegian EEZ. Only vessels with a special permit may commence fishing in the area after this date. Strict conditions apply and detailed plans for the exploratory fishery must be presented. Such plans shall contain descriptions on how damage to vulnerable marine ecosystems shall be avoided. Detailed reports on the fishing activities shall be sent to the authorities. An observer may be placed on board. The rules apply to all types of gear that may come in contact with the	Applied in Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
							bottom. Fishing with bottom trawl as well as gill net and long line are thus covered.	
Gear restriction / pilot MPAs	Norway	As part of the management measures for lobster, pilot MPAs were established in 2006. The provisions laid down in the regulation related to MPAs for lobster prohibit fishing in the MPAs except with hook and handline.	lobster		Lobster fisheries	Multiple (pilot MPAs)	Regulated by fisheries regulation, geographic coordinates apply.	Not applied in the Arctic
Gear Restriction	United States	Non-pelagic trawl/ mobile bottom contact gear prohibited.	Bottom habitat (e.g. deep corals, sponges)	Protection of bottom habitat	Habitat damage due to bottom contact trawl fishing gear. Habitat, fish populations, sea lion populations, gear conflicts	Aleutian Islands Habitat Conservation Area/ Bowers Ridge Habitat Conservation Area	Large areas in Alaska are closed year-round to fishing with non-pelagic trawl gear. These areas are designated by NOAA and the North Pacific Fishery Management Council (FMC) as part of Fishery Management Plans to protect sensitive bottom habitat.	Applied in Arctic
Gear Restriction	United	Closed to non-pelagic	Bottom Habitat	Protection of bottom	Habitat	Northern	This broad area has	Applied in

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
	States	trawling.	Soft Sediment. Shellfish stocks. Native communities.	habitat Protection of subsistence use areas by indigenous communities	damage to bottom-concern from local communities . Prevention of fishing without better understandi ng on ecosystem.	Bering Sea Research Area	been removed from commercial fishing (Non-pelagic gear) to prevent northward expansion of the commercial fishery-into Northern Bering Sea/ Bering Strait pending understanding of its impacts on the near-pristine ecosystem. http://www.npfmc.org/wp-content/PDFdocuments/rural_outreach/NBSRA_DiscPap_912.pdf	Arctic
Regulation on fishing gear restriction	Iceland	Non-pelagic trawl/ mobile bottom contact gear prohibited.	Spawning grounds, bottom habitat	Protection of Spawning grounds	Spawning grounds damage due to bottom contact trawl fishing gear	Off the west coast of Iceland in areas such as: Hrollaugseyjar; off the North and North east coast: Horn, Hraunhafnartang,	Some areas in Iceland are permanently closed to non-pelagic trawl gear. These areas are protected by regulations that are adopted by the Ministry of Industry and Innovation and regulated by the Directorate of Fisheries as part of Responsible	

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
						Langanesgrunn, Digranesfláki ; off the south coast: Sporðagrunnur	Fishery management plan. Geographic coordinates apply.	
"Stop, Report, and Move or Refrain" measures for fishing vessels	Norway	Fishing vessel have to keep track of all encounters with vulnerable habitats for each fishing operation, on a haul by haul basis. More than 30 kilos of live coral or 400 kilos of live sponges leads to an obligation to report the incident and move on to other fishing grounds at least 2 nautical miles away.	Vulnerable habitats		Bottom trawling	Multiple		Applied in the Arctic
Area of special shipping regime	Russian Federation	Shipping regime regulation.	Marine ecosystems	Safety-relevant characteristic and performance of vessels. Navigational measures	Risk of oil spill, pollution and dumping of garbage, sewage and	Northern Sea Route (territorial waters and EEZ from the Novaya	Order № 7 of the Ministry of Transportation from 17.01.2013. http://www.consultant.ru/document/cons_do	Applied in the Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
					exploitation waste	Zemlya Islands to the Cape of Dezhnev)	c_LAW_145233/	
International Maritime Organization (IMO) Area to be Avoided (ATBA)	United States	Ships' routing measure that comprises an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and should be avoided by all ships or certain classes of ships.	Applies widely	Reduce the risk of marine casualty and resulting pollution, protect the fragile and unique environment of the Aleutian Islands, and facilitate the ability to respond to maritime emergencies	Shipping impacts (groundings, noise, risk of fuel spill, pollution)	Aleutian Islands ATBA (5 areas where ships must stay 50 nautical miles from shoreline)	Most ATBAs adopted by IMO are recommendatory. Coastal states publicize ATBAs on official nautical charts, in notices to mariners, and by other public means. In the vast majority of instances, mariners voluntarily comply with recommendatory ATBAs.	Aleutian Islands; applied in Arctic
International Maritime Organization (IMO) Area to be Avoided (ATBA)	Iceland	Ships' routing measures limits sailing in certain proximity to the coastline and consists of a Two-way Route located between two Areas to be Avoided, a Traffic Separation Scheme (TSS) northwest of Gardskagi Point with attached Two-way	Fishing and spawning grounds, seabirds, marine mammals and other wildlife	Reduce the risk of marine casualty and resulting pollution, protect the fragile and unique environment off the south coast and facilitate the ability to respond to maritime emergencies. Prevent and reduce the risk of pollution or	Shipping impacts: groundings, risk of oil spills and other possible pollution	Applies off the south and southwest coast of Iceland	Routing systems are systems of predetermined routes and corollary measures that are "recommended for use by, and may be made mandatory for, all ships, certain categories of ships or ships carrying certain	Off the south and southwest coast of Iceland

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		Routes at both ends, and a Two-way Route west of the western ATBA with an attached TSS at its southern end.		other damage to the marine environment in the area caused by ships colliding, grounding or suffering other marine casualties or incidents in or near these environmentally sensitive areas and to enhance the overall maritime safety in the area			cargoes when adopted and implemented in accordance with the guidelines and criteria developed by the IMO and are designed to "contribute to the safety of life at sea, safety and efficiency of navigation, and/or protection of the marine environment. Agencies involved: The Environment Agency of Iceland, Icelandic Coast guard, Icelandic Transport Authority.	
Particularly Sensitive Sea Area (PSSA)	United States	Directs ships away from coral reefs, shipwrecks and other ecologically or culturally sensitive areas that may pose a navigation hazard. Vessels planning to pass through the Monument PSSA on their way to or from a U.S. port or place must notify managers when entering and	Applies widely	Protect sensitive areas from shipping impacts	Shipping impacts (groundings, noise, risk of fuel spill, pollution)	Papahanaumokuakea Marine National Monument (Hawaii)	International Maritime Organization (IMO) designation. To be identified as a PSSA, three elements must be present: (1) the area must have certain attributes (ecological, socio-economic, or scientific); (2) it must be vulnerable to damage by	Not yet applied in Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		exiting the area.					international shipping; and (3) there must be measures that can be adopted by the IMO to protect the attributes of the area from the vulnerability to damage by international shipping.	
Voluntary commercial fishery closure in Area Beyond National Jurisdiction	United States, Canada, Russia, Kingdom of Denmark and Norway	Prohibits commercial fishing by signatory countries pursuant to an RFMO.	Fisheries in areas beyond national jurisdiction	Prevents unregulated commercial high seas fishing until appropriate management mechanism(s) in place. Calls for greater scientific understanding	Commercial fishing	Central Arctic Ocean high seas closure (declaration signed by US, Canada, Russia, Kingdom of Denmark and Norway in 2015)	By states.	Applied in Central Arctic Ocean
Traffic separation scheme	Norway	Regulation of the flow of vessel traffic moving in different directions.			Reduces risk of accidents	Multiple, implemented in Norwegian territorial waters along the coast of Norway	Maritime traffic regulations.	Applied in the Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
Particularly valuable and vulnerable areas that require special attention	Norway	Multiple use, but restrictions on activities that may threaten the specific values or functions in each specific area (e.g. petroleum activity and trawling on coral reefs).		These are areas that on the basis of scientific assessments were identified as being of great importance for biodiversity and for biological production in the entire sea area; adverse impacts in these areas, especially when summarizing impacts from of climate change, might be long-lasting or irreversible; special caution will be required in these areas		Marginal ice zone (MIZ), polar front, the waters around Svalbard (incl Bjørnøya), Jan Mayen, Eggakanten, Lofoten to Tromsøflake t (bank area) and a 50 km zone outside the baseline from Tromsøflake t to the border with Russia	The areas are described in white papers on different sea areas (Barents Sea and Norwegian Sea) to the Norwegian Parliament. Any regulation in these areas should be conducted by relevant competent authority.	Applied in the Arctic
National salmon rivers, and fjords	Norway	Norwegian Parliament has established a network of 52 National salmon rivers (NSR) and 29 National salmon fjords (NSF). The purpose of NSF and NSR is to give the most	Wild salmon		Salmon farming	52 National salmon rivers and 29 National salmon fjords	The Norwegian Coast Guard oversees that the closed areas and/or restrictions on activity are respected.	Applied in the Arctic

Type of Measure	Country	Managed/ Restricted or Prohibited Activities	Species Group/ Habitat feature, ecosystem process protected or specially managed	Management objective relevant for conservation/ special management of feature, habitat, species, or ecosystem process	Threat/ pressure/ impact addressed	Names / Example(s)	How Implemented (e.g. governance, regime, management Agency, seasonality, geographic coordinates, etc.)	Comments (including any Arctic specificity of the measure)
		important salmon stocks in Norway special protection against possible negative impacts from certain activities in the rivers, and from salmon farming in the surrounding fjords and coastal areas. In many of the 29 NSF farming of anadromous fish is prohibited, and existing farms in these fjords had to relocate and move out. No new farm sites can be localized in the NSFs and farming at existing sites is subject to restrictions.						

ANNEX 3. "Other Measures" Case Studies

A. Rolling Closure of Fisheries (Iceland)

Key characteristic: flexible in time

All or parts of specific fishing areas are closed seasonally to all vessels or to specific gear types, or the harvesting of specific species in these areas are regulated for designated periods of time. Such closures can also move across an area throughout a given year.

How it relates to overall conservation of the ecosystem

As part of Iceland's Responsible Fishery management planning, such regulation of the commercial fisheries, for example for cod, haddock, and herring, reduce the harvesting pressures, and thus the overall human impacts on the marine ecosystem in the area affected. The goals of reducing these pressures include to increase stock by controlling the harvest and reducing over-fishing, limiting fish mortality and to protect seasonal aggregations of fish stocks.

The main commercial species (cod, haddock, herring) are key elements in the marine food chains and ecosystems, and by securing healthy and sustainable stocks of these fishes the Icelandic government is thus contributing to maintaining the overall health and function of the marine ecosystems in the areas where such closures are implemented.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

As these closures are primarily implemented to secure economically viable future harvests of key commercial species, they have some strengths – but also some limitations as measures to secure a circum-Arctic protection regime for wider ecosystem components. Securing sustainable stocks of the key species does build resilience of these stocks to other impacts, and does support connectivity in terms of securing viable populations for dispersion and migration, which then can function as both predators and prey in a larger ecosystem context.

However, the expressed goals of the measure are not necessarily to secure larger-scale ecosystem function or connectivity. As such, these measures have limited utility in terms of permanently filling gaps in space or function in a wider circum-Arctic area-based ecosystem protection regime.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

Such closures mainly target large-scale commercial fisheries, and are dependent upon national, federal, or even international data and management systems. They must also be enforceable and cover all potential actors in the relevant areas. As such, these measures are not particularly suited for delegation of decision-making, implementation, or monitoring to local levels.

B. Conditional Closures (USA)

Key characteristic: flexible in time

When some condition of the ecosystem component reaches a certain level, for example when the level of domoic acid in crabs or shellfish harvested for human consumption reaches toxic levels, the harvesting of the species in the area where these levels have been measured is prohibited or restricted. These measures are usually temporary and short-term in response to an immediate threat or risk, for example temporary California Crab Fishery Closures.

How it relates to overall conservation of the ecosystem

When harvesting of the shellfish is limited, the populations will experience less pressure and, depending on whether the closures persist through a reproduction cycle, will be able to grow. This can build resilience in these populations, and strengthen larger ecosystem functions in light of other pressures. However, reduced harvesting pressure of a single species can also cause disruptions to ecosystems that have adapted to higher harvesting pressures. For example, prey species of the crabs in question will experience higher predation in the areas with conditional crab fishing closures.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas? (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

The primary goal of this measure is not to protect the biodiversity element itself (e.g. crabs), but to protect humans from toxic levels of domoic acid. As such, though the measures can secondarily have a population-strengthening effect for the crabs, such measures are not necessarily particularly well-suited to filling gaps in a wider circum-Arctic area-based ecosystem protection regime.

However, other types of conditional closures, which do specifically protect key ecosystem components from particular threats at given, especially vulnerable life-stages, can certainly provide increased ecosystem resilience at critical times, which in turn can benefit the larger and longer-term goals of conservation in a wider MPA network context.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

These closures are generally applied based on immediate local conditions. They are often implemented by a Local Managing Agency in coordination with NOAA NMFS. As such, they are suitable for local partnerships and delegation of administration, management, and monitoring.

C. Rolling Closures of Fisheries (USA)

Key characteristic: flexible in space

The closures can be implemented throughout the range of the fish species being targeted (e.g. cod and haddock), but within the country's EEZ. The goals of the closures include to increase stocks, improve catch rates, control harvested amounts vs standing productive stock, limit fish mortality, overfishing and bycatch, and protect seasonal aggregations of the fish in question.

The result is that parts of the fishing areas are "lost" seasonally to all vessels or to specific gear types, or that specific species are not harvested in certain areas for designated periods of time. This "loss" entails also that the species and habitats (e.g. seabed or kelp forest) being fished are "protected" from adverse impacts at these times.

How it relates to overall conservation of the ecosystem

Rolling closures of commercial fisheries reduce harvesting pressures on certain species, and reduce noise, emissions and other disturbances at those times from the overall environment.

The key species (cod, haddock) are key elements in the marine sub-arctic food chains and ecosystems, and by securing healthy and sustainable stocks of these through rolling closures the US government contributes to maintaining the overall health and function of the marine ecosystems in the areas where such closures are implemented.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas? (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

See example 1 above, under 'Dynamic in TIME', from Iceland, as the two examples have many similarities. Particularly:

The goals of the measure are not necessarily to secure larger-scale ecosystem function or connectivity. As such these measures have limited utility in terms of permanently filling gaps in space or function in a wider circum-Arctic area-based ecosystem protection regime. However, in areas where other protection measures are not possible or have not been considered, a rolling closure of specific pressures on certain key ecosystem components, such as cod, does allow for the build-up of greater ecosystem resilience in the area, which in any case is important.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

These measures are not particularly suited for delegation of decision-making, implementation, or monitoring to local levels.

D. Gear Restrictions & Fisheries Closures Related to Moving Populations / Stocks (Norway)

Key characteristic: flexible in space

If a fisherman's catch in an area contains a mix of juveniles and adult fish of a given species, where the ratio of juveniles exceeds a certain limit, the vessels must stop fishing and leave the area. In practice this entails a protection from fishery pressures on that stock of fish in that area. As the stock with that juvenile proportion moves, the area granted such protection moves with it. Such real-time closures are frequently used in the Norwegian EEZ. The Norwegian Coast Guard oversees that the closed areas and/or restrictions on activity are respected.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas? (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

Such measures, i.e. restrictions to harvesting or other disturbing activities affecting populations that are moving, *can* be important and effective in terms of protecting mobile biodiversity elements, and in terms of providing, enabling or supporting connectivity between "safe havens" for species that otherwise are vulnerable when moving between such "havens."

This particular measure, as practiced in Norway, does not necessarily have the effect of ensuring connectivity between various 'safer' locations for the fish species managed in this way, nor is that the intent of this measure. However, the way in which the measure is set up, and monitored and enforced with Coast Guard support, could be used as a model in a wider ecosystem context to strengthen resilience and connectivity of mobile or transient marine species in the Arctic.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

On a smaller scale, protection of certain species or species groups that are on the move through a designated larger area, for all or parts of the year, can be effectively managed at local scales, for example by co-management and/or indigenous management structures. Further offshore, at national scales, or outside EEZs these measures will likely not be suitable for being managed locally, but should rather be managed at national, federal, or regional levels.

E. Targeted protection of marine mammal habitats, combined with hunting and harvesting regulations in the Chukchi & Bering Seas (Russia).

Key characteristic: Habitat protection combined with harvesting restrictions

The measure provides targeted protection of key marine mammal habitats, specifically walrus haul-outs, and their surroundings, through restrictions on fishing, ship and boat traffic, tourism and other 'visits', disposal of waste, other sources of pollution, extractive or other forms of economic activity (except re-cultivation), and air traffic lower than 4000 m. Rules pertaining to the hunting of all marine mammals, including for subsistence, are stipulated in the same regulation. These rules apply across all of Russia's Arctic EEZ and territorial waters.

How it relates to overall conservation of the ecosystem

As these measures ensure that key habitats covering large and connected areas are protected from a wide range of detrimental activities and impacts, they provide a high degree of overall coastal ecosystem protection. At the same time they allow a well-regulated subsistence harvest of marine mammals, based on existing needs and traditions. For example, almost all near-shore waters of the Chukotka Peninsula, out to 3-5 nautical miles, are protected through such measures.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas? (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

Though this measure was developed without specific reference to ecosystem-based management principles, it does provide significant protection from a wide range of detrimental activities and impacts over large, interconnected coastal areas, without establishing formal MPAs. The measure can thus be a valuable tool for or component of a Pan-Arctic MPA network, while at the same time allowing traditional harvesting within sustainable limits. If well-implemented, such measures can build coastal ecosystem resilience, ensure connectivity between important coastal habitats, and secure key coastal ecosystem processes, functions and services.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

This tool can help protect extensive areas which do not need or cannot be protected as formal MPAs. Negative human impacts, including those from commercial and industrial activities, are minimized, while subsistence hunting, local non-extractive visits, and sustainable tourism is allowed, within the limits of specific regulations. This enables the interests of local and indigenous people to be met, while also meeting the conservation interests of the broader public.

F. "Stop, Report, and Move or Refrain" Measures for Fishing Vessels (Norway)

Key characteristic: flexible in space

In Norway, the ecological value of cold-water corals and sponges is recognized, as is their vulnerability to bottom trawling. Fishing vessels therefore have to keep track of all encounters with such vulnerable habitats during each fishing operation, on a haul by haul basis. If a vessel registers more than 30 kilos of live coral or 400 kilos of live sponges in a haul, then they must register and report the incident, including the time and location, and move on to other fishing grounds at least 2 nautical miles away.

In this way, coral and sponge resources that were not previously mapped are registered and listed for consideration for future protection.

How it relates to overall conservation of the ecosystem

Securing the protection of the highly productive and biologically important habitats connected to deep, cold-water corals and sponge communities is of great importance to the maintenance and survival of the larger marine ecosystems of the Arctic, as they provide breeding grounds, food, protection, and host high levels of biodiversity.

Utility as a component in a Pan-Arctic Network of Marine Protected Areas? (i.e. Does it support resilience, connectivity, ecosystem processes, functions & services?)

As additional coral reefs and sponge communities are registered and mapped through this mandatory measure for Norwegian trawlers, information is made available to government planners and managers on areas that need further protection. This is important in terms of designing cohesive and functional networks of marine protected areas in the arctic.

How implemented? (i.e. Does it contribute to more inclusive and representative conservation?)

Managing a registration and regulatory system for mapping vulnerable habitats in cooperation with large-scale industrial trawlers operating at great depths offshore is more suited for central government responsibility than for local community or indigenous representative participation and responsibility. However, at different and more local levels, introducing a mechanism for "precautionary protection" when vulnerable and / or valuable ecosystem elements or functions are suspected found or identified, are quite conducive to implementation through multi-stakeholder and rights-holder partnerships.

ANNEX 4. Connectivity Case Studies

A. Connected Network of Priority Areas for marine conservation in the Russian Arctic Seas.

Techniques: Systematic planning of MPA network: Marxan analysis and experts verification.

In the Russian Arctic there are more than 100,000 km^2 of MPAs, and their total area is only about 2.4% of the Russian EEZ in the Arctic. All these protected areas were created at different times via an *ad hoc* approach; therefore, they do not form a representative ecologically connected network. To increase the effectiveness and ensure a thoroughly integrated system of MPAs, a study based on systematic conservation planning approach was conducted in Russia from 2014-2016, rather than the implementation of a set of isolated protected areas,

The goal of the research was formulated as: "*to design a geographically and ecologically connected and representative network of conservation areas that protects and promotes the resilience of the biological diversity and ecological processes of the Russian Arctic marine environment, taking into account economic development and ongoing climate change, and act as a whole, complementing each other.*"

A group of experts from a number of governmental and nongovernmental institutions used Marxan's algorithm to produce initial results, and then discussed and refined them with experts to identify 47 priority conservation areas in the Russian Arctic. Seven EBSA criteria for were used as a basis, and four more criteria were added by Russian experts: representativeness, genetic diversity (which is representativeness on the population level), maintenance of ecosystem functions/structures, and areas/species important for traditional lifestyle of indigenous peoples.

MPA network planning encompassed several levels of biodiversity: populations of certain species, thus addressing the population level; habitats important for species, thus operating at the species level; and the community level was addressed by including entire areas hosting spatial complexes of different benthic and pelagic communities. Finally, inclusion of biogeographical regions was used to assess the level of distinctiveness of floras and faunas. Benthic conservation features were selected with the primary aim of providing representation of biogeographical units and habitat types. Types of habitats were defined by geomorphological (i.e. bottom topography, coastline), sedimentological and oceanographical (including tidal regime and polynyas) characteristics. Conservation features for vertebrates included species distribution (i.e. for keystone, mass, commercial and endangered, threatened or protected species of fish, birds and marine mammals) and distinctive parts of their distribution ranges, such as breeding, feeding and other important areas. In total, the research identified 428 conservation features that should be included in the MPA network.

The methodology based on Marxan analysis was supplemented by extensive post analysis that was instrumental in filling the gaps inevitable in the formal approach. As Marxan isn't able to fully incorporate the connectivity factor (Ardron et al., 2010, Roff & Zacharias, 2011), this assessment was performed by experts.

The ecological and geographical connectivity analysis for each of the conservation features was performed by experts, who made necessary corrections to the data and fully incorporated the corrected data into the Marxan assessment. For the purpose of this research, connectivity was interpreted as both an ecological and a geographical factor; the ecological dimension covered trophic connections, e.g. beluga whale and Arctic cod are supposed to be protected in the same area, while the geographical factor accounted for connections between different habitats of the same species/population, e.g. feeding, whelping areas, migration corridors between them. This analysis was made and data was incorporated into the final version of the MPA network for key habitats, ranges and communities for 60 marine mammals, 32 birds, and 33 fish.

The resulting network covers nearly 25% of the Russian Arctic seas, and guarantees proportional representation of their biodiversity and allows for geographical and ecological connectivity. It also allows for sustainability and naturalness conservation for all conservation features which should be protected in the 47 selected areas (see Pic.1). For each selected area, conservation features were ranked as “very important”, “significant” and “others”.

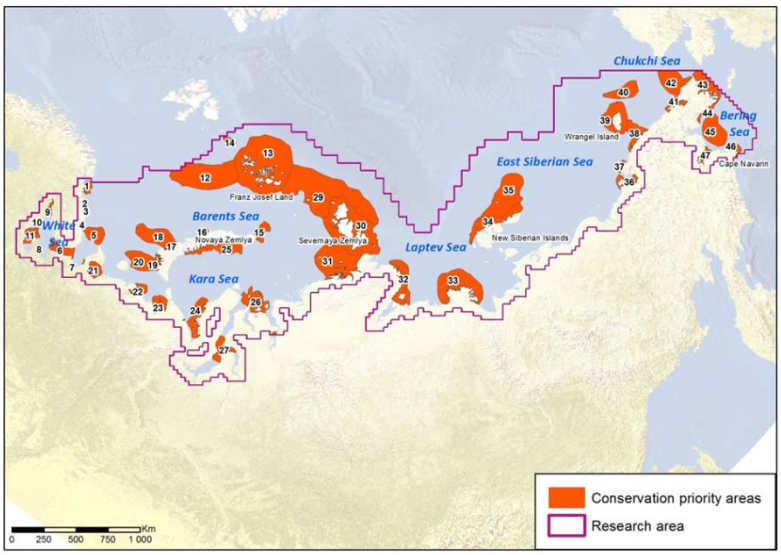

Figure 1 Area of the project and selected priority conservation areas.

The first attempt to apply systematic conservation planning to the selection of protected areas in the Russian Arctic seas revealed that the available data for this vast area, comprising about third of the Arctic Ocean, was unevenly distributed and highly heterogeneous. However, even this data was sufficient to identify a network of marine areas that met the EBSA criteria. In contrast with other large-scale works that applied an integrated habitat classification, the present research used several independent habitat classifications in various combinations. Thus, the present dataset includes a list of representative and distinctive areas which could be modified, provided more comprehensive data is available. The present study presents an approach to how Marxan could be used as a decision support tool with repeated expert analysis of results and post-Marxan analysis. This iterative procedure allowed for the identification of a more balanced and connected system of conservation priority areas spread rather evenly throughout the Russian Arctic seas. The system encompassed both offshore and coastal zones, ranging from relatively small shallow coastal lagoons and fjords with distinct features to extensive areas covering various biotopes in the shelf and upper slope zones. The case study demonstrates that an approach that combines Marxan and post-Marxan analysis, along with the resulting network, could become the first step towards systematic planning of the marine priority conservation areas in the pan-Arctic region.

B. California Marine Life Protection Act Marine Protected Area Network

Techniques: Generalized "Rules of Thumb" for MPA location, size, and spacing[12]

In California, the Marine Life Protection Act (MLPA) initiative led to the creation of a network of MPAs covering 852 square miles, or approximately 16%, of the State's coastal waters. To ensure that the MPA network was designed with best available science, and in keeping with the objectives of the law, the state of California assembled a Science Advisory Team. This Science Team developed simple 'rule of thumb' guidelines to help stakeholders design MPA networks that were tailored to their region's unique ecological, economic, and recreational attributes. The advantages of this approach included unified minimum standards based on sound ecological principles, flexibility, accessibility to decision makers, and a methodology that could be applied utilizing currently available information.

The Science Team synthesized large volumes of information for each region from published papers, spatial datasets, white papers, agency reports, unpublished data, expert opinion, and anecdotal information. With this information and basic ecological principles, the Team developed guidance for four aspects of spatial configuration: habitat representation, habitat replication, MPA size and spacing. Based on basic ecological observations that unique marine communities are associated with different habitats, the Team made recommendations about what should be encompassed by an MPA, specifying "… *that key habitats from within each subregion [should be] represented in MPAs."* To buffer from random and catastrophic events, the Team advised that *"…. at least three to five replicate MPAs should be designed for each habitat type within each biogeographical region*."

To determine size guidelines for the MPAs, the Science Team examined the movement patterns of adult populations of many fish and invertebrates. To protect a large proportion of the species with small to medium home ranges, the Team recommended that "….*MPAs should have an alongshore extent of at least 5-10 km (3-6 mi or 2.5-5.4 nmi) of coastline,* and preferably 10-20 km (6-12.5 mi or 5.4-11 nmi)." They recognized that larger MPAs would be needed to fully protect marine birds, mammals, and migratory fish. To allow species to move to different depth ranges during their life cycle as well as protect the diversity of species that live at different depths, the Science Team recommended that *" … MPAs should extend from the intertidal zone to deep waters offshore."* Finally, to identify appropriate spacing to promote connectivity, the Science Team used multiple methods to estimate larval dispersal distances for many species fish and invertebrates along the coast of California. They identified patterns of dispersal concluded that "…. based on currently known scales of larval dispersal, MPAs should be placed within 50- 100 km (31-62 mi or 27-54 nmi) of each other."

The synthetic nature of these 'rules of thumb' results in a versatile and robust approach to MPA design. If rules had been derived for specific species, they would not be broadly applicable. In addition, by identifying and addressing sources of uncertainty, the rules are arguably robust to uncertainties in the future.

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[12] *Saarman E, Gleason M, Ugoretz J, Airamé S, Carr M, et al. (2013) The role of science in supporting marine protected area network planning and design in California. Ocean Coast Manage 74: 45–56. doi: 10.1016/j.ocecoaman.2012.08.021 AND Carr, M.H., E. Saarman, M.R. Caldwell (2010) The role of "rules of thumb" in science-based environmental policy: California's marine life protection act as a case study. Stanford Journal of Law, Science and Policy, 2 (2010), pp. 1–16*

C. Caribbean and Gulf of Mexico Coral Reefs

Techniques: Coral larvae dispersal model and Marxan analysis[13]

While there already is an established network of MPAs in the Caribbean, the current MPA network does not take into account connections that exist between individual reefs. These connections, or connectivity, are crucial to identify since reefs do not exist in isolation; they depend on reefs in other locations for larvae, also known as recruits, which are carried by ocean currents to different locations. As such, integrating connectivity into MPA design has the potential to create more effective protected areas since it acknowledges the relationships between key areas.

To ascertain coral reef connectivity in the Caribbean and the Gulf of Mexico region, Schill et al. constructed a coral larvae dispersal model, integrating data on distinct reef locations, ocean currents, and dispersal parameters such as pelagic larval duration and larval mortality into one model. A dispersal network which quantified the probabilities of larvae from one reef settling onto another reef was then built from the model, depicting how strongly reefs are connected via larval dispersal. Subsequently, a Marxan analysis was used to identify important areas for conservation efforts. Marxan analysis is a software commonly utilized for conservation planning and the algorithm identifies the top areas that satisfy specific conservation targets while at the same time trying to reduce the predefined costs. For this study, several different scenarios were compared including a normal Marxan scenario, a Marxan scenario that integrates connectivity, a scenario without regional stratification, and a stratified scenario that separates the area into 10 ecoregions.

The combined usage of a larval dispersal model and Marxan analysis can answer a variety of different connectivity questions that can then be applied to management strategies. From the constructed larval dispersal network, the study was able to gain more insight into Caribbean and Gulf of Mexico reef connectivity, including estimating which reefs contribute the most larvae to other reefs and which reefs are the most self-sustainable. The network also highlights the importance of international cooperation since larvae do not stay within the boundaries of a country's EEZ; reefs in Honduras, for instance, contribute a large portion of their larvae to other countries. Using Marxan analysis, the study identified the stratified scenario that integrates coral connectivity as the most effective choice since reefs that were highly connected from across the region were prioritized. Also, when the reefs from this Marxan scenario were compared to the current MPA network, it was found that 77% of highly connective reefs were not included. Ultimately, this case study demonstrates how one can measure connectivity of coral reef ecosystem while also highlighting how this information can be used to better inform management strategies.

[13] *Schill S.R., Raber G.T., Roberts J.J., Treml E.A., and B.J. Halpin. 2015. No reef is an island: integrating coral reef connectivity data into regional-scale marine protected area networks. PLos ONE 10(12): e0144199.*

D. Southern Baltic, Kattegat, Skagerrak, and eastern North Sea - Selecting networks of marine protected areas for multiple species with different dispersal strategies

Technique: Dispersal modeling, optimization, metapopulation analysis, comparison of simulated and empirical data[14]

Summary:
To ensure MPA networks maximize their effectiveness by protecting multiple species with different dispersal abilities (e.g. larval distance and duration) within a community, there is a need to find an optimal "consensus" network of MPAs. Jonsson and colleagues demonstrate how a consensus network can be identified that considers both the protection needs for each individual species and also possible protection strategies for multiple species, by choosing MPAs that have positive effects on several species simultaneously.

Jonsson et al. first constructed a simulated larval community with four types of dispersal strategies with contrasting pelagic larval durations and drift depths. The study area was partitioned into grid cells and connectivity was estimated by calculating the proportions of simulated larvae that moved from site *i* to site *j*; these data were used to create a connectivity "matrix". Mean dispersal distance and dispersal direction were also calculated. Using Eigenvalue perturbation theory (EPT), the authors first identified optimal networks for each single dispersal strategy and then identified the consensus network for the entire community. In brief, EPT finds an optimal subset of network of MPAs that maximizes the growth rate of the whole metapopulation when it is at low abundance. The performance of the resulting consensus network was compared with the existing network of MPAs using metapopulation modelling.

Second, a more realistic community based on a threatened deep-rocky reef was constructed using modeled data of habitat distribution and empirical data on realistic larval traits. As for the simulated community, EPT-based optimal networks were calculated for each individual dispersal strategy and then a consensus network for the whole community was identified. The performance of the optimal network was then evaluated using the metapopulation model, through comparisons to both random networks and the existing MPA network.

Despite few overlapping MPA sites for the optimal networks based on single dispersal strategies, the consensus network performed well for the 3 of 4 contrasting strategies used in the first simulation study. For the realistic study using data from the threatened rocky-reef community, the consensus network performed equally well compared to solutions for single species. Different dispersal strategies were also protected jointly across the MPA network (93% of sites); in contrast to simulations of the existing MPA network (2% of sites). Consensus networks based on connectivity were therefore found to be significantly more efficient compared to existing MPAs.

The findings of this study suggest that a consensus MPA network that protects an entire community containing species with multiple dispersal strategies can be identified using this

[14] *Jonsson, P. R., Jacobi, M. N., and P. Moksnes. 2016. How to select networks of marine protected areas for multiple species with different dispersal strategies. Diversity and Distributions, 22:161-173.*

approach. In addition, existing MPA networks should be evaluated following this framework to identify modifications or additions that may significantly improve their effectiveness.

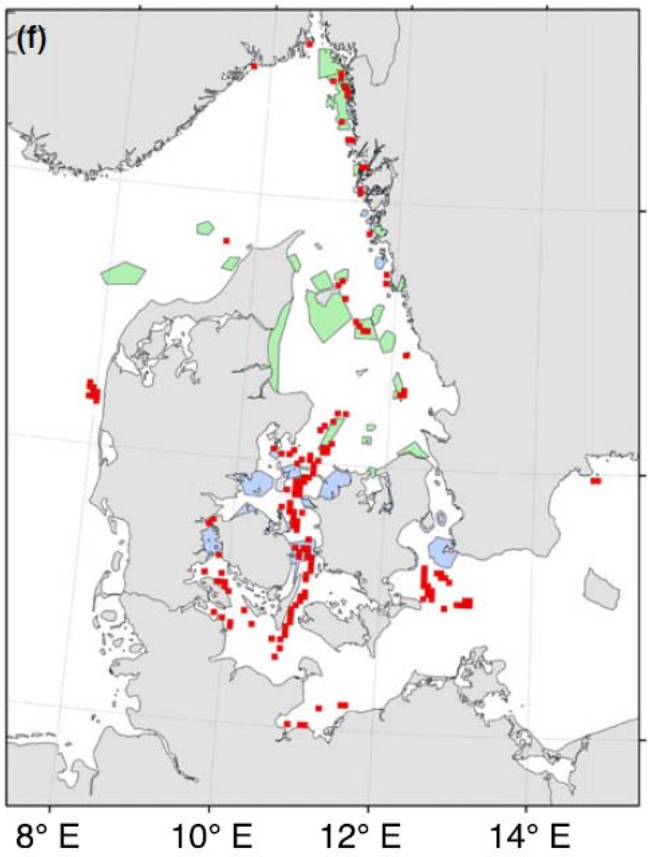
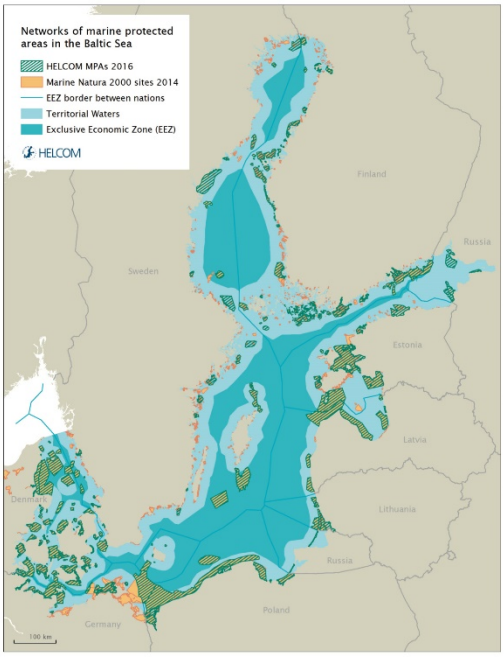


Figure 3, Panel f: Shows the consensus network (red squares) for the five dispersal strategies identified for the realistic deep-rocky reef community. Also show in the present MPA network as blue (Natura 2000) or green (OSPAR MPAs) polygons.

ANNEX 5. MPA Network Coherence Case Study

A. Developing a regionally connected, coherent MPA network in the Baltic Sea

MPAs have been a key method for the conservation of marine ecosystems, habitats and species in the Baltic Sea for decades and have grown significantly in recent years (HELCOM 1994, HELCOM 2010, HELCOM 2016, figure 1). In 2003, HELCOM and OSPAR (2003), at the joint ministerial meeting (JMM) in Bremen, decided to ensure that the set of MPAs should be coherent, and form a network instead of being just a collection of sites. In 2010, the Baltic Sea was the first regional sea to reach the 10% target of marine protection called for in the Convention of Biological Diversity Aichi Target 11 In 2016, the joint HELCOM MPA network of the nine contracting parties consisted of more than 174 MPAs and these protected almost 12% of the Baltic Sea (map from HELCOM 2016, below right). But is this MPA network coherent?



In 2008, an EU-funded project called BALANCE published a report on the "Ecological coherence and principles for MPA assessment, selection and design" (Andersson et al. 2008). This study used benthic marine landscape maps (benthic broad habitat types) and human pressures and acknowledged four criteria: *representation*, *adequacy*, *connectivity* and *replication*. The methods included statistical analyses of geographical data, GIS and the decision support tool MARXAN. The study showed that the network was not coherent and identified gaps and recommendations to improve coherence. The study recommended that HELCOM:

1. Improve ecological knowledge (how much should be protected, migration);
2. Intensify mapping efforts on ecological and physical features and make existing data available;
3. Be clear when formulating the goals, targets and criteria for individual MPAs and network of MPAs and ensure that these are as practical and applicable as possible
4. Be aware that the EU's Habitats Directive only includes a limited set of biodiversity features (habitats and particular species);
5. Ensure effective management of MPAs;
6. Incorporate analyses of direction (of mobile/migrating species) when assessing connectivity;
7. Incorporate socio-economic values in the MPA site selection process;
8. Consider MPAs as a tool in an overarching spatial planning and management process and use them together with other management tools;
9. Practice MPA network planning as an adaptive process that should be constantly improved.

In 2010, HELCOM followed up on the BALANCE study and assessed coherence of the HELCOM (MPA) network (HELCOM 2010) of 159 MPAs (Baltic Sea Protected Areas, BSPAs). The study found:

- *Adequacy:* the network was adequate in terms of MPA size but failed to conform to the given HELCOM MPA (BSPA) selection criteria and, was not adequate in terms of biotopes, species, or pressures. However, the conclusions were limited due to the coarse resolution of the GIS layers.
- *Representation:* the network did not ensure a full representation of all indicator species. The marine landscape representation showed that most landscapes were inadequately represented with < 20% of the total area lying within the MPAs. (The 20% was/is commonly used as a limit by the European Union when assessing the representation of habitats and species in the Natura 2000 network.)
- *Replication:* the minimum target of three replicates of each species was not achieved. The replication of indicator species and biotopes should be acknowledged when developing the MPA network.
- *Connectivity:* there is a need to improve the connectivity for many of the habitat types. The species-specific analysis showed a good connectivity for species with the largest dispersal distance (100 km) but species with a short dispersal distance were less well connected, e.g. *Fucus vesiculosus* (Bladder wrack).

In 2016, HELCOM carried out its most recent MPA network coherence study of 174 sites, and was able to draw on improved data in quality and quantity. The study found that it is highly unlikely that the HELCOM MPA network would be coherent but it also concluded that detailed information e.g. on the spatial distribution of species and biotopes is still needed (HELCOM 2016, Table 1).

Table 1. The scores of the main criteria and final aggregated outcome of the ecological coherence assessment (from HELCOM 2016).

Main criterion	Score	Likelihood	Ecological coherence of the HELCOM MPA network
REPRESENTATIVITY	1.1	LIKELY	It is very unlikely that ecological coherence is reached.
REPLICATION	1.2	LIKELY	
ADEQUACY	0.6	UNLIKELY	
CONNECTIVITY	0.3	VERY UNLIKELY	

At the time of the report only 67% of HELCOM MPAs have management plans and monitoring, a necessity for MPA effectiveness assessments, only occurs in 64% of HELCOM MPAs. This means that although HELCOM has achieved the 10% cover target of the Convention of Biological Diversity (CBD) Aichi Target 11 much work remains before all of the Aichi Target 11 is fully reached in the Baltic Sea.

The most important message from this long process is that a multinational MPA network with nine countries involved can be developed in a joint fashion while each country still remains fully in charge of their own set of MPAs in this network.

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PAME

Protection of the Arctic Marine Environment

ARCTIC COUNCIL