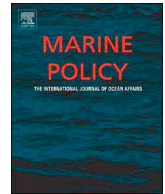




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The role of areas to be avoided in the governance of shipping in the greater Bering Strait region



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ABSTRACT

Commercial vessel traffic in the Bering Strait is increasing. The region is, however, remote from most forms of response to accidents or disasters. The Indigenous cultures of the Bering Strait region continue traditional practices, including hunting and fishing in the waters of the Bering and Chukchi Seas. Ecologically, the Bering Strait region is home to a spectacular abundance of seabirds, marine mammals, and marine productivity. The confluence of expanding maritime commerce, remoteness, vibrant Indigenous cultures, and extraordinary biological richness requires robust governance to promote maritime safety, cultural protection, and environmental conservation. The use of areas to be avoided (ATBAs) offers one mechanism to help achieve this goal, and three have already been adopted by the International Maritime Organization (IMO) along with shipping routes through the Bering Strait. This paper explores the potential for additional ATBAs to promote environmental conservation in both the Bering Strait itself and in the larger Bering-Chukchi ecoregion, as one component of a wider discussion also encompassing Indigenous and maritime concerns. The availability of reliable environmental information—particularly real-time data—is one important constraint on the design and delineation of ATBAs. Effective communication among mariners, Indigenous hunters, scientists, and waterway managers is also essential for ATBAs to be effective. If these conditions can be met, ATBAs can become an essential component of well-regulated shipping throughout this sensitive region.

1. Introduction

Located between Russia's Chukotskiy Peninsula and the United States' Seward Peninsula, the Bering Strait provides the only marine connection between the Pacific and Arctic Oceans (Fig. 1). The larger Bering Strait region is defined here to comprise the northern Bering Sea and the Chukchi Sea from St. Matthew Island in the south to Wrangel Island in the northwest and Point Barrow in the northeast. The region is home to the Chukchi, Iñupiaq, and St. Lawrence Island and Siberian Yupik peoples, who continue traditional hunting, fishing, traveling, and trading on the sea [1,2]. All marine mammal migrations between the Bering Sea in the Pacific Ocean and the Chukchi Sea in the Arctic must pass through the Bering Strait [3]. The same is true for ocean vessel traffic between the two oceans, making the Bering Strait a focal point for Arctic shipping [4]. Vessel traffic in the region is predicted to increase, bringing with it the potential for greater threats to the marine environment and to the peoples who rely on the ocean as a source of

food and cultural continuity.

Various management measures can be put in place to reduce the potential for conflicts among waterway users and to help promote safer and more environmentally protective shipping practices. International agreements developed and maintained by the International Maritime Organization (IMO) provide multiple tools to manage impacts from shipping. This paper focuses on just one of those tools—designation of Areas to be Avoided (ATBAs). Maritime considerations of safety and freedom of navigation, as well as Indigenous concerns about cultural impacts, are important considerations [2] but lie beyond the scope of this paper.

Section 2 provides background and context on shipping and the Bering Strait region, discusses the array of tools available to manage vessel traffic, and explains this paper's focus on ATBAs. Section 3 discusses ATBAs in greater depth, including their application to environmental conservation and ways they may be adapted to accommodate specific situations. Section 4 describes recent development and IMO

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Fig. 1. Map of the greater Bering Strait region, from St. Matthew Island in the south to Wrangel Island and Point Barrow in the north.

approval of three ATBAs in the Bering Strait region, while Sections 5 and 6 discuss the state of ecological knowledge in the Bering Strait region and the potential for designation of additional ATBAs.

2. Background and context

2.1. Increasing vessel traffic in the Bering Strait region

Between 2010 and 2016, the Bering Strait experienced roughly 400–500 vessel transits per year [5]. While there is inherent uncertainty regarding the future of vessel traffic in the region, the number of Bering

Strait transits and the amount of vessel traffic in the region are both expected to increase greatly in the decades ahead. Climate modeling suggests that navigable portions of the Arctic Ocean will expand spatially and temporally by midcentury [6,7], with a corresponding expansion of vessel-based commerce [8]. Specific quantification of projected increases in vessel traffic depend on a series of widely varying assumptions about industrial activity, global commerce trends, and environmental conditions, but near-term forecasts using a medium-growth scenario call for nearly a 300% increase in Arctic vessel traffic by 2025 [9].

Future increases in vessel traffic in the Bering Strait region will be

heavily influenced by development within the Arctic. On the Northern Sea Route, destination cargo vessel traffic, including oil and Liquefied Natural Gas (LNG) tankers and bulk carriers—is expected to increase with the completion of development of hydrocarbon projects in the Russian Arctic, such as LNG from the Yamal region, crude oil production from several fields, and coal exports. The Russian Government claims the quantity of goods shipped on the Northern Sea Route will increase by 800% from 2017 levels to 2024 [10]. In Alaska, the volume of vessel traffic related to community re-supply is expected to remain stable, but future development of oil and gas resources—both onshore on Alaska's North Slope and offshore—could result in a growth of vessel traffic serving the region.

2.2. The need for international collaboration

At its narrowest point, the waters of the Bering Strait lie entirely within the territorial seas of Russia and the United States. At the same time, the Bering Strait is recognized as an international strait. Under a legal principle known as transit passage, vessels have the right to use an international strait—without interference—to travel from one part of the high sea or exclusive economic zone to another [4]. Any rules governing shipping in the region must be set by the IMO, apart from domestic measures by Russia or the United States that would apply to vessels registered in that country or that are traveling to or from a port in that country [11]. In short, the Bering Strait requires collaborative international action to achieve sound governance [12].

What should that collaborative international governance entail? In addition to freedom of navigation, maritime safety is of paramount importance, as laid out in the International Convention for the Safety of Life at Sea (SOLAS) [13]. Under that convention, protecting local cultures and the environment are also important considerations, so long as they do not compromise freedom of navigation or maritime safety. As explained in the following section, a variety of tools are available to regulate international vessel traffic and to mitigate impacts from that traffic.

2.3. Examples of tools for international collaboration

IMO conventions offer different ways to address the impacts of international vessel traffic. For example, Annexes I, II, IV and V of the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL) provide for designation of Special Areas to protect specific parts of the ocean from discharge of oil, noxious liquids, sewage, and garbage. Similarly, Annex VI provides for establishment of Emission Control Areas (ECAs) designed to reduce emissions of sulfur oxides (SOX) and nitrogen oxides (NOX) in designated areas.

The recently enacted Polar Code provides new safety and environmental protection measures in Polar regions, including in the Bering Strait. The Polar Code introduced a broad spectrum of new binding regulations covering elements of “ship design, construction and equipment; operational and training concerns; search and rescue; and ... protection of the unique environment and eco-systems of the polar regions.” Mandatory environmental provisions occur through the amendment of MARPOL annexes I, II, IV and V.

While Special Areas, ECAs and the Polar Code are all important tools that can promote safer and more environmentally sound shipping, they do not direct vessel traffic away from specific portions of the ocean. SOLAS [13], however, gives IMO authority to adopt and implement ships' routing measures, which do direct vessel traffic. Routing measures include different types of vessel traffic lanes, which guide ships along certain paths. Significantly for this paper, routing measures also include ATBAs, which direct ships away from specific areas of the ocean. More than simply the counterpart to shipping lanes, ATBAs can be important when conditions (e.g., the presence of sea ice) force vessels to leave designated shipping lanes in addition to providing guidance in areas where shipping lanes have not been established.

Importantly, the different management tools described in the foregoing paragraphs are not mutually exclusive; they can be used in concert to provide multiple layers of protection. In fact, IMO provides that some areas of the ocean—regions with “recognized ecological, socio-economic, or scientific attributes where such attributes may be vulnerable to damage by international shipping activities”—may be designated as Particularly Sensitive Sea Areas (PSSA). PSSAs must be accompanied by one or more “associated protective measures,” which may include routing measures, ships reporting systems, emissions requirements, or discharge and equipment requirements.

2.4. Focus on ATBAs

Optimal governance of vessel traffic in the Bering Strait likely requires a combination of the tools described above—as well as advancements in communication, navigational aids, charting, and more [12]. While not diminishing the importance of a multi-pronged strategy for management of vessel traffic, this paper focuses solely on designation of ATBAs as one component of effective marine governance in the region.

As described in more detail in Section 4 below, the IMO recently approved a joint Russia-United States proposal for shipping routes through the Bering Strait and a U.S. proposal for three ATBAs in the northern Bering Sea [14] (Fig. 2). This is an important and welcome step. At the same time, to adequately address the full range of maritime governance needs, it may be necessary to designate additional ATBAs in the region. As explained below, even traditional ATBAs are flexible tools that may be tailored to suit the concerns of a particular region. In addition, with sufficient information and coordination, there is potential for designation of newer types of ATBAs that could be seasonal, adaptive, or dynamic in nature. The highly seasonal nature of the Bering Strait region—including cold, dark winters with considerable sea ice, sunlit open-water summers, and stormy autumns—suggests the utility of measures that can change to account for differing seasonal conditions and levels of traffic.

3. Areas to be avoided

3.1. Authority and definition

SOLAS [13] provides for adoption of routing measures to “contribute to safety of life at sea, safety and efficiency of navigation and/or protection of the marine environment.” Ships' routing measures “may also be used for the purpose of preventing or reducing the risk of pollution or other damage to the marine environment caused by ships colliding or grounding or anchoring in or near environmentally sensitive areas” [16]. Guiding vessel traffic safely “in or around or at a safe distance from environmentally sensitive areas” is one of many legitimate objectives of a routing system [16].

As noted above, an ATBA is a particular type of ships' routing measure, defined as “an area within defined limits in which either navigation is particularly hazardous or it is exceptionally important to avoid casualties and which should be avoided by all ships, or certain classes of ship” [16]. ATBAs may be mandatory or recommendatory in nature. Vessels are urged not to travel within the boundaries of a recommendatory ATBA, while vessels are generally prohibited from traveling within the boundaries of a mandatory ATBA. In general, ships show high compliance with IMO-designated ATBAs even when they are recommendatory, making ATBAs a strong contributor to effective governance of vessel traffic [17].

3.2. Guidance for designation of ATBAs

IMO guidance provides that ATBAs should be designated only when lack of adequate charting or aids to navigation could cause accidents, when local knowledge is required for safety, when an essential aid to

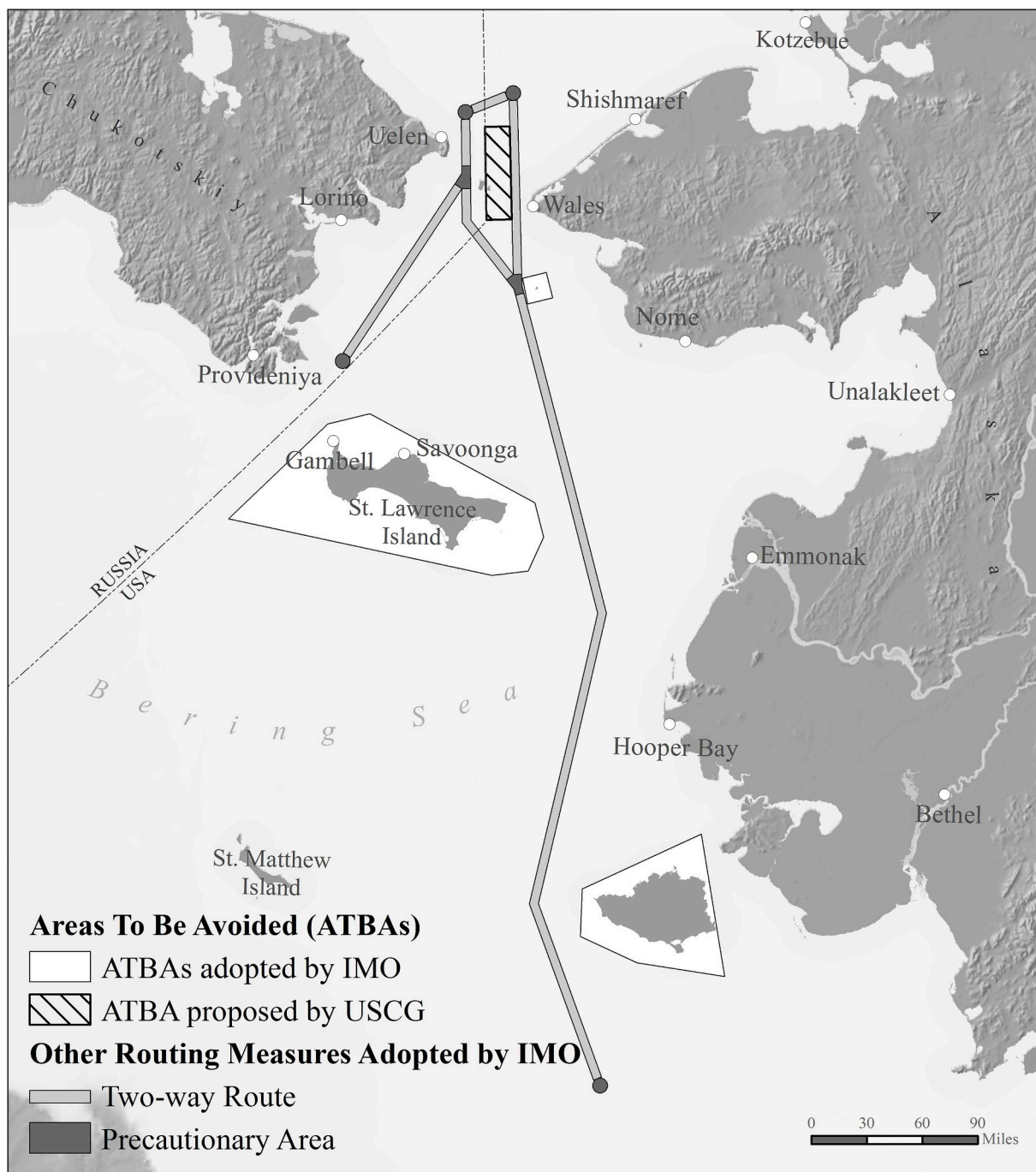


Fig. 2. Map of existing ATBAs and routing measures in the Bering Strait area, as adopted by the IMO [14], plus an additional ATBA proposed by the U.S. Coast Guard as part of its Port Access Route Study for the Bering Strait [15].

navigation may be at risk, or when “there is the possibility that unacceptable damage to the environment could result from a casualty” [16]. When IMO evaluates a routing system that is intended to protect the marine environment, it will consider whether the proposed routing measures will prevent or reduce significantly the risk of pollution or environmental damage and whether it will unreasonably limit navigation. IMO will not adopt an ATBA if it would impede ships’ progress through an international strait. Countries proposing new ATBAs should identify the reasons and need for the ATBAs, as well as the classes of ship to which the proposed ATBA will apply.

When planning a vessel routing system, IMO guidance recommends that governments take into account, among other things, “environmental factors, including prevailing weather conditions, tidal streams

and currents and the possibility of ice concentrations,” and “the existence of environmental conservation areas and foreseeable developments in the establishment of such areas” [16]. It encourages governments proposing routing measures to furnish IMO with relevant information including, among other things, information on “marine environmental considerations.” IMO guidance also urges governments to consult a variety of stakeholders at an early stage, including “organizations concerned with... environmental protection” [16].

3.3. Application of ATBA designations

Many ATBAs help safeguard vessels from especially dangerous locations, such as reefs, shoals, or other navigation hazards.

Environmental protection is often an additional factor justifying designation of these ATBAs [16]. For example, the IMO adopted an ATBA in the region of the Nantucket Shoals both due to “the great danger of stranding and for reasons of environmental protection.” An ATBA was created in waters surrounding Bermuda because of the danger of stranding on reefs “and for reasons of environmental protection.” On the west coast of North America, IMO adopted an ATBA off the coast of Washington “to reduce the risk of a marine casualty and resulting pollution and damage to the environment of the Olympic Coast National Marine Sanctuary.”

Still other ATBAs were adopted for the primary purpose of protecting the marine environment or marine wildlife. Off the coast of Florida, the IMO adopted ATBAs “to avoid risk of pollution and damage to the environment of these sensitive areas.” The IMO adopted ATBAs off the coast of California to avoid the risk of pollution in the Channel Islands National Marine Sanctuary. Similarly, IMO adopted an ATBA near the ports of Matanzas and Cardenas (Cuba) “for reasons of conservation of unique biodiversity, nature and beautiful scenery.” An ATBA off the coast of New Zealand was created to “avoid risk of pollution and damage to the environment.” In another example, an ATBA off of Cape Terpeniya (Sakhalin Island) was established “for reasons of conservation of unique wildlife in the area and of inadequate survey.”

Some ATBAs are one of several types of specific area-based protective measures associated with broadly delineated PSSAs [18]. In the Papahānaumokuākea Marine National Monument PSSA, the IMO adopted ATBAs as associated protective measures “to increase maritime safety, protection of the environment, preservation of cultural resources and areas of cultural importance significant to Native Hawaiians, and facilitate the ability to respond to developing maritime emergencies.” In another example, the IMO adopted an ATBA as an associated protective measure for the Saba Bank PSSA in the Caribbean Netherlands.

3.4. ATBAs and environmental conservation

Any vessel in transit poses a variety of environmental risks ranging widely in terms of probability of occurrence, magnitude of impact, spatial extent, and taxonomic groups at risk. ATBAs help to reduce these risks, which can be grouped into six main categories: oil spills, ship strikes, emissions, noise-related impacts, discharges, and invasive species.

Within the Arctic marine environment, an oil spill is considered the most significant threat from vessels [4]. Oil exposure has a wide range of acute and chronic effects on individual organisms and populations [19]. Taxon-specific life history traits, oil persistence, complex trophic interactions, and interacting indirect effects may impair ecosystem-scale recovery for decades or even indefinitely [20,21]. Although the probability of an oil spill is low, the potential for catastrophic consequences necessitates a cautious approach. ATBAs can reduce the risk of oil spills by keeping vessels away from dangerous waters, and can also reduce the adverse effects if the spill occurs away from environmentally sensitive areas such as marine mammal haulouts or seabird colonies.

Ship strikes, defined as a vessel making contact with an organism or another vessel, are another low-probability but high-consequence risk. There are longstanding records of vessel collisions with bowhead whales in the Pacific Arctic [22]. As vessel traffic increases worldwide, the incidence of ship strikes has and will continue to increase [23]. The overall risk of ship strikes will be reduced if ATBAs include areas of marine mammal concentration.

Emissions include a variety of gases and particulate matter that enter the atmosphere from ship engine exhaust or other ship operations. Emissions from Arctic shipping have been estimated for sulfur dioxide, nitrous oxide, ozone, and black carbon [24]. ATBAs would have little influence on overall emissions but could help reduce pollution at specific locations if ships are kept a farther distance away, for example from a coastal community or a seabird colony.

The three remaining risk categories – noise-related impacts, discharges, and invasive species – have so far proved more difficult to systematically quantify and track. Emerging analytical approaches have highlighted the issue of acoustic habitat degradation, with results indicating that commercial vessel traffic comprises the largest contributions to increased background noise and corresponding impacts on marine mammals [25,26]. Depending on regional and international regulations, vessels may discharge pollutants such as sewage and oily bilge water while in transit, with varying environmental impacts [1]. Finally, vessels have the potential to act as vectors for the introduction of invasive species [27], although many species may not be viable in new environments. ATBAs may eliminate or reduce the risk of these various impacts by simply not allowing vessels in a specific area. Although pollutant discharges, acoustic disturbance, or invasive species introductions in adjacent waters may spill into an ATBA, the relative risk of impact is reduced as fewer vessels transit these areas.

3.5. Tailoring ATBAs to specific situations

ATBAs can be tailored to address specific concerns in specific geographic locations; they are not one-size-fits-all [16]. Some ATBAs apply only to vessels that exceed a certain size. For example, the Cuba ATBA referenced above applies only to ships of 150 gross tonnes or greater. Many ATBAs apply specifically to vessels that exceed a certain size or carry dangerous cargoes, such as oil or hazardous substances. ATBAs can also incorporate exceptions that explicitly allow certain types of vessels to travel within the boundaries of the designated area. The Channel Islands ATBAs apply to most cargo ships, but explicitly allow cargo ships that are bound to and from ports on one of the islands within the area. The New Zealand ATBA generally applies to all vessels greater than 45 m in length, but makes exceptions for certain vessels including vessels of the Royal New Zealand Navy and fishing vessels engaged in fishing operations. The recently designated ATBA around St. Lawrence Island in the northern Bering Sea—see section 4 below—makes an exception for vessels traveling to the island, for example to deliver fuel and supplies.

3.6. Fixed and seasonal ATBAs

Most ATBAs are static in nature; they apply the same guidelines to an unchanging, fixed location at all times. However, ATBAs can be seasonal in nature and apply only during certain times of year [16]. For instance, in 2007, the IMO adopted a seasonal recommendatory ATBA in Roseway Basin, south of Nova Scotia, effective for ships 300 gross tonnes or greater in transit between June 1 and December 31. IMO adopted the ATBA to “significantly reduce the risk of ship strikes of the highly endangered North Atlantic Right Whale.” Similarly, in 2008, IMO adopted a seasonal recommendatory ATBA in the “Great South Channel” off the east coast of the U.S. that applies to ships of 300 gross tonnes or greater in transit between April 1 and July 31, again “to significantly reduce ship strikes of the highly endangered North Atlantic Right Whale.”

3.7. The potential for adaptive ATBAs: the White Sea experience

The seasonal ATBAs described in the preceding paragraphs are effective only during certain portions of the year, but their boundaries do not change from one year to the next. In some situations, however, it may be desirable to change ATBAs boundaries from year to year to provide more targeted protection to vulnerable species. While the IMO has yet to approve this sort of adaptive ATBA, Russian agencies and the port of Arkhangelsk have pioneered this approach to protect harp seals (*Pagophilus groenlandicus*) in the White Sea.

The population of harp seal is declining in the White Sea [28]. Harp seal pup abundance in the White and Barents Seas decreased from more than 300,000 animals in 1998–2003 to 123,000 in 2008 [29]. To

reduce negative pressure on the harp seal population, Russian federal agencies took several actions, including steps to reduce seal mortality from marine vessels transiting breeding haulouts. The areas of mass concentrations of breeding and young seals where shipping traffic had to be limited or totally stopped were identified using aerial and ship surveys. Survey data were used to produce special maps of seal distribution on the ice and of recommended routes for icebreakers and other ships to avoid seal concentrations during the reproductive season in early spring. Those maps were made available to captains of icebreakers and other ships by the Arkhangelsk Headquarters of Ice Operations. Since 2009, Arkhangelsk Port services have annually produced maps of breeding seal haulouts, which vary every spring. Those maps are based on observations from vessels, aerial surveys, and satellite images provided by various agencies, services, and institutes [30,31]. The maps are used to develop recommended shipping routes that are then sent out to vessel captains annually before the shipping season begins.

The location, size, time, and duration of these ATBAs vary from year to year. In this way, the coordinated annual work of many agencies and institutions is critical to identifying and avoiding important seal areas in the White Sea, showing the potential for adaptive ATBAs as a conservation tool that does not obstruct shipping.

3.8. The potential for dynamic ATBAs

Another option is truly dynamic ATBAs that respond and adapt in real time to environmental or biological changes, such as presence of ice, concentrations of marine mammals or presence of subsistence hunting activities. Despite the success of the adaptive seasonal ATBAs in the White Sea, the IMO has yet to implement an adaptive or dynamic ATBA. However, as real-time environmental data become more available and accessible, and as maritime communications and navigation technologies advance, dynamic ATBAs should be considered a viable option.

Dynamic ATBAs require the availability of relevant environmental information as well as the ability to transmit that information to vessel masters in real time or near-real time. Transmission of information from shore to ship could be accomplished in many ways. It may be particularly effective to harness the capabilities of maritime AIS systems that allow two-way communications between ship and shore. In this way, information about the dynamic ATBA could be transmitted to vessels only when relevant, and that information would appear directly on modern integrated shipboard information displays.

Dynamic ATBAs could be tightly targeted to reduce potential impacts of increasing vessel traffic while being minimally disruptive to waterway users and maritime operators. However, to be accepted by the maritime community, dynamic ATBAs would need acceptance from the full spectrum of marine stakeholders. In addition, they would require agreement about data sources, data reliability, and transmission of information to vessels. As one example, a dynamic ATBA has been set up off the northeast coast of the United States, to protect endangered North Atlantic right whales (*Eubalaena glacialis*) [32]. A mandatory reporting system set up by the U.S. Coast Guard and the National Oceanic and Atmospheric Administration requires vessels larger than 300 gross tonnes or greater to report when entering right whale habitat. Ships are then sent information about avoiding ship strikes and recent sightings of right whales. When aggregations of the whales are seen, ships are requested to slow down or avoid those areas. The system depends on the availability of near-real-time data as well as effective communication and awareness, and could be a model for other areas when those conditions can be met.

4. Designation of static ATBAs in the Bering Strait

4.1. U.S. Coast Guard process

In 2010, the United States Coast Guard (USCG) initiated a Port Access Route Study (PARS) [15] for the Bering Strait region with the purpose of determining “if ship routing measures can help reduce the risk of marine casualties and their impact on the environment, increase the efficiency and predictability of vessel traffic, and preserve the paramount right of navigation while continuing to allow for other reasonable waterway uses.” To determine the most appropriate routing measures, the USCG reviewed commercial traffic patterns, as well as bathymetric, subsistence, and ecological data in relation to potential vessel traffic. The USCG released several drafts of the study for public comment, and throughout the seven-year process consulted with various stakeholders to obtain their views. Of particular concern to local stakeholders was the need to protect subsistence activities from the potential impacts of increasing vessel traffic in the region, especially in the areas around Nunivak, King, St. Lawrence, and Little Diomedé Island.

The USCG considered relevant safety, environmental, and subsistence use concerns and, at the conclusion of the PARS process, recommended designation of a two-way vessel traffic route and four ATBAs around King, St. Lawrence, Nunivak, and Little Diomedé islands. The four proposed ATBAs were designed to complement the two way route: if ships transiting the region need to divert from the recommended route due to weather conditions, presence of ice, or other factors, the ATBAs would help ensure vessels do not venture into sensitive or potentially hazardous areas.

To facilitate IMO approval of these routing measures, the USCG collaborated with Russian officials to create a joint proposal to the IMO for two-way routes in the region. The joint proposal included proposed routes on both sides of the Bering Strait, not just in U.S. waters. Simultaneously, the USCG submitted three of the four recommended ATBAs in U.S. waters for IMO approval. The submission of the fourth ATBA around Little Diomedé has been put on hold to explore the potential of a transboundary ATBA that encompasses Russia's Big Diomedé Island.

4.2. IMO approval process

The Navigation, Communication, Search and Research (NCSR) subcommittee of the IMO reviewed the joint routing measures and the three ATBAs and recommended their approval to the Maritime Safety Committee for codification. In so doing, however, the committee substantially reduced the size of the St. Lawrence Island ATBA.

The USCG's proposed St. Lawrence Island ATBA was large in size and included an area well to the south of the island itself. This southern portion of the ATBA was included largely due to environmental concerns, not navigational safety concerns. IMO delegates at the NCSR subcommittee feared the large size of the St. Lawrence Island ATBA might hinder freedom of navigation in the region. Moreover, the NCSR subcommittee felt it was not the appropriate venue to consider the environmental concerns that motivated inclusion of waters to the south of St. Lawrence Island. Such concerns, the subcommittee felt, were more appropriately considered by the Marine Environmental Protection Committee.

The path of the proposed St. Lawrence Island ATBA paralleled the proposed Peninsula de Osa ATBA off the Pacific coast of Costa Rica, which was also reduced in size. These twin experiences indicate current IMO ATBA approval processes may favor ATBAs that are put forward with primarily safety-related rationale, such as ATBAs in known shoal waters. ATBAs justified primarily by environmental or subsistence-use considerations may be less likely to gain IMO approval. Alternatively, these types of ATBAs may need to take a different procedural path—one that includes consideration by the Marine Environmental Protection

Committee—to facilitate eventual IMO approval.

4.3. The potential for additional ATBAs, including on the Russian side of the Bering Strait

The three Bering Strait-region ATBAs approved by the IMO are all located on the U.S. side of the Bering Strait. As noted above, the U.S. and Russia are considering the merits of a fourth transboundary ATBA, which would encompass both Little Diomed Island (U.S.) and Big Diomed Island (Russia). So far, Russia has not proposed designation of ATBAs on its side of the Bering Strait region. Russia's track record of international cooperation in the region is strong, however, including pollution prevention agreements with the U.S. [33], a joint statement by the presidents of both countries recognizing the unique nature of the Bering Strait ecosystem and the importance of international cooperation [34], and of course jointly proposing Bering Strait shipping routes [35]. These actions, along with domestic actions such as creating oil-spill response stations in Provideniya and Pevek and the establishment of marine areas and consideration of additional ones within the Beringia National Park, suggest a strong interest in effective governance of vessel traffic in the region and a willingness to take international action to achieve it, for both maritime safety and environmental reasons. It is possible that ATBAs could play a role in Russia's future efforts in these regards. To date, neither the U.S. nor Russia has given robust consideration, in a public process, to the potential for seasonal, adaptive, or dynamic ATBAs in the Bering Strait region.

While IMO adoption of three ATBAs on the U.S. side of the Bering Strait is an important step forward, designation of additional protected areas may be necessary to promote safety and to protect the region's biological and subsistence resources. Additional ATBAs in the Bering Strait region could include seasonal, adaptive, or dynamic ATBAs where appropriate and where supported by sufficient data. As explained in the section that follows, some of these additional ATBAs may require more and/or different types of information about the region's marine ecosystem.

5. The state of ecological knowledge in relation to designating ATBAs in the Bering Strait region

Identifying and delineating ATBAs on the basis of ecological and cultural concerns requires reliable information. A recent compilation of ecological data from the region [36] provides the basis for such an evaluation with regard to ATBAs. For example, historic walrus data aided the justification for vessels not approaching known high walrus concentration areas around the King Island ATBA. Additional information is available from Russian sources, in those cases where Russian data have not already been contributed to international databases or otherwise been made publicly available. Table 1 presents a summary of the evaluation of available information for U.S. and Russian waters for sea ice and selected seabirds and marine mammals [36].

There is a reasonable amount of reliable information for the Bering Strait area and the wider region of the northern Bering Sea and Chukchi Sea to identify and designate fixed permanent or seasonal ATBAs in addition to those already adopted by the IMO. In other words, there is sufficient information gathered over a long enough period to provide confidence that important habitats, migratory corridors, and concentration areas can be identified for most of the species listed. While additional information gathered through research and monitoring would be encouraged, the information available now can support a conversation about additional ATBAs, to include the Indigenous residents of the region, maritime interests, government agencies, and other stakeholders.

To designate dynamic ATBAs, similar information is required, but on a real-time basis rather than as a multi-year retrospective. In this case, very little information is available at present. Sea ice is a special category, as it is routinely monitored with high spatial and temporal

Table 1

Generalized quality of available data on various environmental components with regard to information needs for designating fixed or seasonal ATBAs in the Bering Strait region [36]. Survey data for managing adaptive or dynamic ATBAs are insufficient, except for sea ice and potentially for selected satellite-tracked groups of birds and mammals.

Environmental Component	United States	Russia
<i>Physical Environment</i>		
Sea Ice	High	High
<i>Seabirds</i>		
Important Bird Areas (IBAs)	High	High
Overall bird density	High	Medium
Sea ducks	Medium	Medium
Loons	Medium	Medium
Murres	High	Medium
Puffins	High	Medium
Auklets	High	Medium
<i>Mammals</i>		
Polar bear	Medium	Low
Pacific walrus	High	Medium
Bearded seal	Low	Low
Ribbon seal	Low	Low
Ringed seal	Low	Low
Spotted seal	Low	Low
Steller sea lion	Medium	Low
Beluga whale	Medium	Low
Bowhead whale	High	Medium
Gray whale	Medium	Low
Humpback whale	Low	Low

resolution via satellite, though most vessels avoid sea ice where possible [37]. Satellite tagging has been carried out on many of the species listed, but this information includes the small handful of individuals that have been tagged and may not represent the full population. On-site observations are possible in some locations near shore or near the locations of vessels at sea, but the available spatial coverage is limited at best. In the near-term, it is unlikely that either satellite telemetry or surface-based observations will be widespread enough to support dynamic ATBA designations. Advances in the use of unmanned aerial vehicles (drones) may expand the ability to track the locations and movements of some species, which could help. Observations by coastal residents could likewise be utilized to a greater extent, but this remains subject to the limitations of the available spatial coverage. Nonetheless, as in the White Sea case, associations with specific habitats, such as the sea ice edge, could serve as proxies for ecologically sensitive areas such as breeding or feeding grounds. Further research is needed to explore the potential for dynamic ATBAs in this region.

Adaptive ATBAs, such as those used in the White Sea, are an intermediate category, requiring analysis of information collected less frequently. As an example for the Bering Strait region, this approach might be particularly useful for establishing seasonally adaptive ATBAs that recognize the course of marine mammal or seabird migrations. As with dynamic ATBAs, data availability is a major constraint, as there are no comprehensive programs in place at present that routinely gather data about marine mammal migrations or seabird concentrations. However, seasonally adaptive ATBAs in the Bering Strait region could be delineated based on wildlife concentration patterns from data summarized from recent years and decades [36]. Again, further research is needed to explore the potential for adaptive ATBAs in this region.

6. Conclusion: ATBAs as a governance tool in the Bering-Chukchi region

The region surrounding the Bering Strait area, from St. Matthew Island in the Bering Sea to Wrangel Island and Point Barrow at the northern margins of the Chukchi Sea, includes many areas of high ecological value and high cultural importance [36]. Commercial

shipping poses a threat to these areas, but one that can be mitigated through careful governance [12]. ATBAs can make a substantial further contribution to the management of vessel traffic in the region.

In some portions of the Bering Strait region, there is sufficient information about sea ice, seabirds, and marine mammals to support the identification and delineation of fixed ATBAs in addition to those that have already been designated. Similar to the USCG's PARS process, designation of additional ATBAs should be done in collaboration with Indigenous residents, who can contribute their own knowledge of culturally important sites, areas, and practices [2]. In addition, maritime interests and government regulatory agencies should ensure that the outcomes respect mariners' needs, including safety and freedom of navigation, and that compliance can be monitored effectively. ATBAs cannot by themselves address all the needs for governance of commercial vessel traffic in the region, but they can make a valuable contribution.

In addition to fixed ATBAs, the extreme seasonality and variability of the Bering Strait region in terms of sunlight, sea ice, and animal migrations suggests a role for seasonal, adaptive, or dynamic ATBAs. This approach would avoid restrictions at times of the year when they are of little benefit, and also avoid restrictions at times and places where the environmental concern is comparatively lower. As noted above, to be most effective, designation of adaptive and dynamic ATBAs may require additional or different kinds of ecological information. These types of ATBAs would also require effective communication and cooperation among the many different groups who may be affected.

In summary, commercial vessel traffic in the larger Bering Strait region is increasing, bringing with it the potential for environmental and cultural effects as well as risks to maritime safety. Effective governance can do a great deal to avoid or mitigate those effects. ATBAs are one such mechanism, and there is sufficient information to continue identifying and delineating ATBAs in the region with regard to environmental protection. Adaptive and dynamic ATBAs offer additional possibilities, though the availability of data is a major constraint at present. ATBAs can also benefit cultural protection and maritime safety, which should be part of the larger discussions and planning for further vessel traffic governance measures in the wider Bering Strait region.

Declarations of interest

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Appendix A. Supplementary data

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