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Relevance of a Particularly Sensitive Sea Area to the Bering Strait Region: a Policy Analysis Using Resilience-Based Governance Principles

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ABSTRACT. The Bering Strait, separating the North American and Asian continents, is a productive social–ecological marine system that is vulnerable to increasing maritime traffic. In other parts of the world, the International Maritime Organization (IMO), an agency of the United Nations, has designated similar marine systems as a Particularly Sensitive Sea Area (PSSA) in an effort to protect vulnerable resources from international shipping. We present information about the 14 existing PSSAs around the world and the political process by which designation is achieved. We examine specific characteristics of the Bering Strait system that are relevant to a PSSA application; these include vulnerable resources such as marine mammals and their contribution to the food and cultural security of indigenous communities, threats to these resources from shipping activities, and the viable mitigation options to reduce these threats. We then use five criteria derived from empirical research on resilience-based governance to analyze whether a PSSA designation would promote the resilience of marine mammal populations and indigenous communities to increased maritime activities. Despite the elusiveness of a definitive answer, we conclude that although the designation is not a perfect fit from a theoretical standpoint, it still holds the potential to benefit marine mammals and indigenous communities in terms of resilience. We conclude by identifying critical challenges and trade-offs that practitioners would need to negotiate when attempting to apply theoretical governance principles via real-world policy tools.

Key Words: *Arctic; ecosystem services; indigenous; international shipping; law; marine protected area; praxis; transboundary; whale*

INTRODUCTION

Experts from multiple fields of the social and natural sciences have advanced frameworks and principles for steering human–environment interactions in directions that promote their long-term health and sustainability. These efforts are usually through management approaches that account for both the environmental and social dimensions of a given system. Prominent examples include: principles of ecosystem stewardship (Chapin et al. 2009), ecosystem-based management (McLeod and Leslie 2009), integrated management (Sorensen 1997), adaptive management (Allen and Gunderson 2011), adaptive co-management (Armitage et al. 2007), design principles for sustainable management of common-pool resources (Ostrom 1990), and resilience-based governance (Garmestani and Benson 2013), the focus of this article.

Despite these advances, there is a practical need to move beyond academic explorations of what good governance may theoretically look like, and better understand the process of implementing broad-scale practices that support resilient human–environment interactions. Scholars have begun unraveling this component of the policy process by offering critiques of resilience-based governance research and the resultant frameworks it calls for. Legal scholars, for example, have brought to light multiple ways that governance for social–ecological resilience may not be compatible with the processes inherent in dominant legal systems of western societies (Doremus 1991, Doremus 2003*a*, *b*, Ebbesson 2010, Ruhl 2010, Ruhl and Fischman 2010, Holt et al. 2011, Ruhl 2012).

Taking these critiques seriously, we engage a core group of five resilience-based governance principles, including two derived from legal studies and the policy sciences, to explore a case study of protecting transboundary marine environmental and cultural resources in the Arctic through an international policy tool called a Particularly Sensitive Sea Area (PSSA). By doing so, we are able to assess whether the designation would foster resilience within this social–ecological system. Our discussion underscores important lessons for practitioners and scholars interested in taking the core group of principles from social–ecological governance frameworks and implementing them through specific real-world policy tools. Our analysis exposes tensions between theory and practice and prompts further questions concerning whether the protective status offered by a PSSA is (a) viable, and (b) likely to be an effective governance tool for promoting resilience.

Although comparing a policy option to a set of theoretical principles—even when the principles are derived from empirical studies—may not provide conclusive evidence of the policy's eventual effectiveness, such analysis is useful in at least two main measures. First, it can provide guidance in decision-making contexts where uncertainty is high. In our case study, given the potentially nonlinear rate of Arctic industrialization, environmental change, and the high number of other variables influencing the social–ecological system, accurately predicting future system states quantitatively is difficult, if not impossible. Thus, there is value in demonstrating that a given policy option meets a set of principles that have been shown in other cases to promote resilience. Second, an analysis based on theoretical criteria opens the door for a discourse on praxis, i.e., the practical application of theory. In addition to exploring whether a PSSA will foster system resilience, we wish to offer insights for resilience practitioners. How can they incorporate the trade-offs and challenges of the policy process into developing frameworks promoting social–ecological health and sustainability?

Background

Whereas environmental scholars use terms that are similar to "resilience-based governance" (Anderies et al. 2006, Plummer and Armitage 2007, Chapin et al. 2009), they have generally focused on desired institutional outcomes, while failing to adequately

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define the procedural mechanisms underlying the concept, which are an inherently social set of political and deliberative processes. Garmestani and Benson (2013) were two of the first scholars to use the specific term "resilience-based governance." They use the concept in relation to U.S. law, exploring a legal framework that would incorporate the insights of resilience science by accounting for complexity and unpredictability in social–ecological systems. However, such a framework, which they call "reflexive law," is largely absent in the U.S. Reflexive law would allow "for iterative processes in the law and policy processes"... it "seek[s] to determine the organizational and procedural aspects of regulated action," and it "incorporate[s] top-down, as well as bottom-up aspects of data collection and integration into the management paradigm" (Garmestani and Benson 2013). Reflexive law would be better synchronized with inherent patterns and processes of social–ecological systems than current U.S. laws, which are predominately top-down, noniterative, and outcome-focused. Reflexive law would facilitate adaptive management and adaptive governance, both of which are "vehicles for putting resilience theory into practice" (Garmestani and Benson 2013).

Garmestani and Benson (2013) usefully distinguish between adaptive management and adaptive governance. Both share the basic tenet of being able to change the rules, i.e., the institutions that steer human interactions with the environment in response to new knowledge about environmental and social conditions. The most important difference, however, is that adaptive management occurs through conventional institutions of rulemaking and enforcement, e.g., by the U.S. Departments of the Interior and Commerce; whereas adaptive governance includes the influence of not only the government but also a range of other actively-engaged actors, e.g., nongovernmental organizations, corporations, and community groups, and can include informal norms of behavior, as well as more formalized rules. Governance is more concerned with power sharing between actor groups at different scales than is management, which usually occurs at a single scale (Garmestani and Benson 2013).

We return to the concept of resilience-based governance later in our paper, identifying five main principles and using the principles as an assessment rubric for our case study. Importantly, identifying the core principles of resilience-based governance is not simply a semantic exercise but has real-world ramifications, as stakeholders increasingly use resilience as a normative policy goal (Robards et al. 2011, Cote and Nightingale 2012). We now present our case study: the proposition of establishing a Particularly Sensitive Sea Area (PSSA) in the Bering Strait.

A BERING STRAIT PARTICULARLY SENSITIVE SEA AREA

Our case study focuses on the Bering Strait: the transboundary marine area separating Alaska in the United States from Chukotka in the Russian Federation. We limit the geographic scope of our assessment to the area from St. Lawrence Island north through the Bering Strait to Point Hope in the northeast, and Wrangel Island in the northwest. We focus on the specific policy tool of a PSSA designation to protect this area because it is an international social–ecological policy tool that has been designed to mitigate threats to local resources from international activities. It is the only tool of the International Maritime Organization (IMO) that allows for local cultural and ecological resources, as opposed to vessel or mariner safety, to be the justification for environmental protections through the regulation of international vessel traffic. Consequently, we expect the international deliberations about the legal application of this tool to protect local ecosystem services, which would come at the expense of "freedom of navigation," will offer valuable insights into the implementability of multiscale institutions that can facilitate social–ecological resilience.

Key Bering Strait ecological and cultural resources

The Bering Strait region encompasses the Bering Strait itself, an 85 km-wide passage that connects the North Pacific Ocean and Bering Sea to the Chukchi Sea and Arctic Ocean; and the Anadyr Strait, a 70 km-wide passage separating St. Lawrence Island in Alaska from Chukotka. This transboundary region is globally significant for marine, avian, and coastal biological diversity. It is home to a wide array of indigenous subsistence communities dependent on marine life for their food and cultural security. The International Union for the Conservation of Nature (IUCN) has designated 13 ecological and biological sensitive areas in the Arctic as a whole and three of these are in the Bering Strait region alone. Some species such as the Western Arctic bowhead whale (*Balaena mysticetus*), ~17,000 animals, and Pacific walrus, (*Odobenus rosmarus divergens*), >150,000 animals, have almost their entire population pass through the area twice each year (Robards 2013).

Profound reduction and changing patterns of sea-ice cover in recent years, a result of climate change, are affecting wildlife distribution and the food security of subsistence hunters (Robards et al. 2013). Changing sea ice, combined with strong currents, globally iconic aggregations of Arctic wildlife, and over 20,000 indigenous people living in coastal villages who are reliant on local marine ecosystem services, make this region a challenging, but necessary, area for mitigating the cumulative risks of climate change, new industrial developments, and international shipping.

Particularly Sensitive Sea Areas

The International Maritime Organization (IMO) is the United Nations agency responsible for the safety and security of international shipping and the prevention of marine pollution from vessel activities. The IMO pursues its objectives through creating and implementing an authoritative and universally applicable regulatory framework for international shipping. One component of the IMO's purview is the designation of various marine protected areas around the world to mitigate threats of shipping, including Particularly Sensitive Sea Areas (PSSAs), which are one specific type of protected area. The IMO (2013) states that a "Particularly Sensitive Sea Area is an area that needs special protection through action by the IMO because of its significance for recognized ecological or socioeconomic or scientific reasons and which may be vulnerable to damage by international maritime activities."

In practice, a PSSA is an international legal status that allows countries to promulgate regulations, called Associated Protective Measures (APMs), for all vessels in their waters, not just their own flagged vessels or those visiting their own ports. This includes vessels in innocent passage or in "international waters" such as narrow straits separating different countries, like the Bering and Anadyr straits.

Associated Protective Measures serve as the "teeth" of the PSSA policy tool. Each APM is linked to specific marine ecosystem services, with the goal of sustaining those services in the face of threats from vessel traffic. The following suite of mandatory APMs have been authorized in existing PSSAs around the world: (1) ship routing schemes, (2) ship reporting programs, (3) ship pilotage programs, (4) no anchoring areas, (5) areas to be avoided, and (6) Special Area status, which is another IMO tool focused on preventing marine pollution from international vessel traffic (Table 1). The IMO is granted the power from United Nations member countries to authorize enforcement of APMs through international legal precedent, including the Convention on the Law of the Sea (Ünlü 2004). However, it is the individual countries that carry the legal authority to monitor and enforce the rules in their own waters. Because of the high-level authoritative status of the IMO, PSSA designation grants marine areas unparalleled international recognition compared to many other marine protective statuses (Roberts 2007).

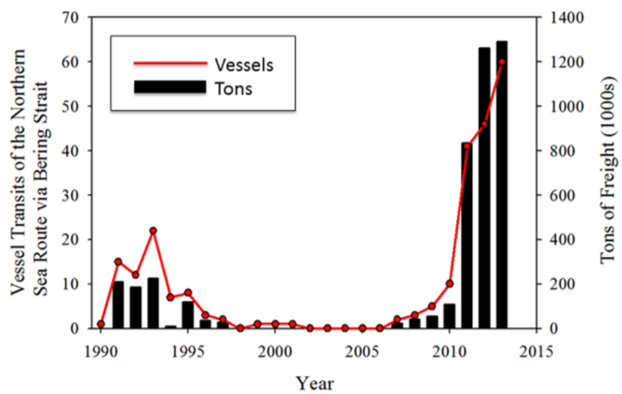
The application assessment process within the IMO has changed since the first PSSA was designated in 1990 and a revised set of guidelines from 2005 is in effect today. To start, a PSSA designation for an international strait requires the different coastal states with authority over that area to submit a mutually-agreed to application to the IMO. This application must pass a three-part stepwise test. First, the area must possess significant resources in at least one of three categories: (1) ecological, (2) social, economic, and cultural, or (3) scientific and educational. Second, those resources must be shown to be vulnerable to the impacts of international maritime traffic. Third, the demonstrated vulnerabilities must be realistically reducible through the implementation of APMs.

To gain insight into whether a PSSA status is appropriate for the Bering Strait, we reviewed the successful applications for the 14 existing PSSAs. Key features of each area that made it viable for PSSA designation and the associated APMs are presented in Table 1. We also show the diverse character and magnitude of vessel traffic at the time of designation of the existing PSSAs (Table 2). Particularly Sensitive Sea Areas range from iconic marine environments like the Great Barrier Reef, to highly industrialized transportation zones like the Baltic Sea, which has over 65,000 vessel transits/yr, to relatively pristine ecosystems like the waters of Papahânaumokuâkea Marine National Monument in Hawaii. However, what all PSSAs share is possession of significant resources that are vulnerable to international shipping, and those vulnerabilities can be protected through an appropriate APM.

Risk factors in the Bering Strait resulting from maritime traffic

According to Commander James Houck of the 17th District of the U.S. Coast Guard, about 500 vessels transited the Bering Strait in 2012 (James Houck, *personal communication*). Vessel traffic through the Bering and Anadyr straits is expected to increase significantly over the next decade and beyond, as: (1) the Arctic warms; (2) industrial activities, such as mineral and oil and gas extraction, expand; and (3) as the Northern Sea Route and Northwest Passage become more active transglobal shipping routes (Smith and Stephenson 2013). Already cargo on the Northern Sea Route has increased by an order of magnitude since 2007, with over 1.3 million metric tons of cargo transported in 2013 by 71 vessels (Northern Sea Route Administration 2014), up from only two vessels in 2007 (Fig. 1). Arctic shipping has transitioned from what had previously been called "experimental" shipping activities (Brigham 2010) to at least a more routine use of the Northern Sea Route. Increases in vessel traffic supporting the massive mining efforts that dot the Arctic landscape, which are termed destination traffic, are also evidenced by a suite of new vessel lines linking United States, Canadian, and Russian ports (Arctic Marine Shipping Assessment 2009).

Fig. 1. Reported vessel traffic on the Northern Sea Route, 1990–2013.



Note: Although transits are regarded as those vessels passing between the Barents and Bering Seas via the set of waterways between Kara Gate (at the southern tip of Novaya Zemlya) and the Bering Strait, this is only a small proportion of the vessel traffic entering the Northern Sea Route which includes cabotage and import/export (Northern Sea Route Administration 2014).

For our analysis, we focus on the known impacts that vessel traffic could have on the significant ecological and cultural resources represented by: (1) iconic populations of bowhead whales (*Balaena mysticetus*) and gray whales (*Eschrichtius robustus*), i.e., cetaceans, that congregate in vast numbers in this region, and (2) indigenous food and cultural security along the coasts of the Bering Strait region. Other ecosystem services are present in the region, but are beyond the scope of a single manuscript. Aggregations of whales in shipping lanes elsewhere, including Alaska, have resulted in persistent ship strikes and the death of whales (e.g., Neilson et al. 2012, Silber et al. 2012). In the Bering Strait region, whale strikes by ships could impact conservation and food security, and trigger other political processes, i.e., actions at the International Whaling Commission through subsistence quotas or nationally via the Marine Mammal Protection Act. Without policies that proactively address the risks created when large vessels transit hotspot areas for marine mammals, or areas that support indigenous subsistence practices, negative impacts on marine mammal populations and indigenous food security are expected.

Implementing a Particularly Sensitive Sea Area in the Bering Strait

The Bering Strait meets the basic criteria necessary for a PSSA designation from the IMO. The area: (1) possesses significant resources from the necessary resource categories, i.e., marine

Table 1. Existing PSSAs[†] and whether APMs were proactively or reactively responding to threats.

PSSA	Countries	Examples of ecological resources	Examples of social, economic, and cultural resources	Examples of scientific and educational resources	APM(s)	Was designation proactive or reactive to ecological degradation?
Great Barrier Reef	Australia	Coral reefs and related species	Traditional fishing and tourism	Broad range of natural phenomenon	Pilotage, reporting	Largely proactive
The Sabana-Camagüey Archipelago	Cuba	Marine species and landscapes	Fishing and tourism	Cayo Coco research center	Areas to avoid	Largely proactive
Malpelo Island	Columbia	Mangroves, coral, beaches, fish,	Fishing	Established research collaborations	Areas to avoid	Largely reactive to illegal fishing and increased pleasure cruising
Sea around the Florida Keys	United States	Coral reefs and marine mammals	Fishing and tourism	Draws international scientists	Areas to avoid, and no anchoring areas	Largely reactive, but phrased in terms of “preventing damage”
Wadden Sea	Denmark, Germany, Netherlands	Tidal flats and seals	Fishing and tourism	Established scientific institutions	Routing	Largely proactive, area is already protected by numerous measures
Paracas National Reserve	Peru	Marine mammals, birds, and flora	Tourism	Educational programs carried out	Areas to avoid	Largely proactive, no serious previous impacts mentioned
Western European Waters	Belgium, France, Ireland, Portugal, Spain, U.K.	Marine mammals, shellfish, and unique landscapes	Seafood industry and tourism	Established biodiversity research	Reporting	Largely proactive but phrased in terms of reacting to threat of marine pollution from shipwrecks
Torres Strait Extension of Great Barrier Reef	Australia, Papua New Guinea	Coral, marine mammals, fish	Indigenous hunting	Collaborative indigenous and scientific research	Pilotage, routing	Largely proactive, with some mention of pollution thought to come from ships
Canary Islands	Spain	Marine mammals, high biodiversity	Tourism	Established international research	Areas to avoid, routing, reporting	Largely proactive
Galapagos Archipelago	Ecuador	Marine mammals, sea birds, mangroves	Small-scale fishing	Collaborative local and scientific programs	Area to avoid, reporting, routing	Largely proactive, with some reference to ship groundings
Baltic Sea Area	Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden	Wetlands, sea birds, fish	Fishing and tourism	History of data collection	Routing, areas to avoid, Special Area	Largely reactive to pollution and substantial number of vessel accidents in the near past
Papahânaumok-uâkea Marine National Monument	United States	Marine mammals, coral reefs, fish	Numerous sacred cites	Baseline for undisturbed ecosystem	Areas to avoid, reporting	Largely proactive
Strait of Bonifacio	France, Italy	Fish, flora	n/a	Potential for sustainable resource management research	Routing, reporting, pilotage	Largely reactive to series of vessel groundings in recent past
Saba Bank in the Caribbean Sea	Netherlands	Coral reefs and related species	Small-scale fishing	Baseline for undisturbed ecosystem	No anchoring area, area to avoid	Largely proactive, with minor mention of previous anchor damage to reef

[†]All data from IMO application documents.

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Table 2. Vessel usage in the PSSA prior to designation by the IMO.

PSSA	Implementation year[†]	# vessels/yr annually in PSSA and immediate vicinity at the time of designation	Primary vessel types
Great Barrier Reef	1990	2,000 ships passing through PSSA area each year (IMO 2001*a*)	Tanker, cargo, recreational/tourism vessels
Sabana-Camagüey Archipelago	1997	Hundreds of vessel trips[‡]	Tanker, cargo
Malpelo Island	2002	1,139 vessels in vicinity of PSSA area (IMO 2001*b*)	Tanker, cargo, local fishing vessels
Sea around Florida Keys	2002	8,000 large cargo ships transit PSSA area (IMO 2001*c*)	Tanker, cargo, cruise ships
Wadden Sea	2002	Tens of thousands of vessel trips[§]	Tanker, cargo, passenger, fishing, special purpose, recreational
Paracas National Reserve	2003	4,740–6,420 vessels in vicinity of PSSA area (IMO 2002)	Tanker, cargo
Western European Waters	2004	43,209 vessels in PSSA area (IMO 2003*a*)	All types
Torres Strait	2005	1,008 vessels making 3,136 voyages in PSSA area (IMO 2003*b*; adapted figure)	Tanker, cargo, fishing vessels
Canary Islands	2005	1,500 vessels pass through PSSA area (IMO 2003*c*)	Tanker, cargo, fishing
Galapagos Archipelago	2005	156 vessels made port call in PSSA area (IMO 2003*d*; adapted figure)	Tourism, fishing, Cargo/Container
Baltic Sea Area	2005	65,000 vessels entered PSSA area (IMO 2003*e*)	Tankers, cargo, container
Papahânaumokuâkea Marine National Monument	2007	75 vessels voluntarily reported within PSSA area (IMO 2007; adapted figure) 34 vessels in PSSA area on average: 1994–2004 (Franklin 2008)	Freighters, tankers, fishing, research
Strait of Bonifacio	2011	2,984 mandatory vessel reports in PSSA area (IMO 2010)	Tanker, cargo, passenger, fishing, recreational
Saba Bank in the Caribbean Sea	2012	200 vessels pass through PSSA area (IMO 2012)	Tanker, cargo

[†]Varies in some cases from year of IMO resolution.
[‡]http://pssa.imo.org/sabana/maps.htm;
[§]http://pssa.imo.org/waddensea/maps.htm;

mammals, indigenous cultural practices, and food security; (2) those resources are vulnerable to international maritime traffic, i.e., via ship strikes or disturbance of subsistence; and (3) the resources could realistically be protected by measures used in other PSSAs (Table 3). Mandatory reporting, ship routing schemes, areas to be avoided, and IMO Special Areas are potential candidates for mitigating our identified risks. However, although each of these APMs have precedents elsewhere, speed restrictions for vessels have no PSSA precedent to date, but are likely one of the most valuable tools for reducing fatal vessel strikes on large cetaceans (Laist et al. 2014). Any of these measures also offer opportunities for officials to monitor and enforce marine vessel activity from afar via vessel tracking systems, which is a particularly important consideration in such a sparsely populated, remote region.

Given that a PSSA designation is a reasonable scenario for the Bering Strait in that it is theoretically consistent with the language and role of a PSSA, as well as existing precedents, we now ask if a PSSA designation would promote social–ecological resilience in the system. To reflect on this, we draw on five theoretical principles.

RESILIENCE-BASED GOVERNANCE PRINCIPLES

Here, we identify three principles of resilience-based governance that integrate the central governance themes within current resilience and social–ecological system literatures (e.g., Young 2002*a*, Folke et al. 2005, Berkes et al. 2007, Olsson et al. 2007, Carpenter 2008, Brondizio et al. 2009). These principals include the core ideas that institutions that guide human–environment interactions must: (1) be ecosystem-based; (2) consider cross-scale impacts; and (3) be adaptive in order to foster resilience. However, recent critiques from scholars of legal and policy studies emphasize that rules of environmental governance must also be legitimate, which is largely a function of social perception, and implementable through law, which is a function of the process of extant legal systems. Therefore, we add the two principles of legitimacy and implementability, thus grounding the established theoretical ideals of system function with the political and legal realities of operationalization.

Principle 1: institutions must be ecosystem-based

The rules that steer human–environment interactions must fit the complexity of the ecosystems they are intended to govern (Young 2002*a*). Context-specific, ecosystem-based rules accounting for all ecosystem services are needed because ecosystems and their human users are heterogeneous over space and time, generally making one-size-fits-all approaches ineffective (Daily and Matson 2008, Crowder and Norse 2008). The operationalization of in-depth local observations and knowledge of natural processes, which is often derived from the bottom-up through local research and, sometimes indigenous, stakeholders is also widely regarded as a critical component of ecosystem-based approaches (Tengö et al. 2014). Ecosystem-based governance can be thwarted by outdated institutional structures that fail to address complex environmental interactions across space, time, and system components, resulting in the erosion of resilience. Nevertheless, numerous case studies suggest that bottom-up pilot

Table 3. Selected examples of Bering Strait resources, vulnerabilities, and mitigation tools.

Bering Strait Resource	Resource's vulnerability to shipping	PSSA mitigation tools
Ecological		
Large cetaceans	Ship strikes that kill animals	Vessel speed Areas to be avoided Routing Reporting
Critical wildlife habitats	Disturbance that displaces animals away from critical habitats	Areas to be avoided
Social, cultural, and economic		
Ability of hunters to be successful and safe	Disturbance that displaces animals away from communities or where wakes swamp hunters on ice	Areas to be avoided Routing Reporting Communication
Health of subsistence resources	Pollution	Special Areas

programs supported by top-down structures can help overcome these barriers (Osterblom et al. 2010).

Principle 2: Institutions must be cross-scale

Rules of environmental governance must function effectively across scales or levels in order to promote resilience, as the connections between ecosystems and people who use them transcend any single scale or level (Young 2002*b*, Olsson et al. 2007). Rules that exhibit congruence between the international, national, and subnational scales, i.e., multilevel governance, are often difficult to achieve because stakeholders can possess different and conflicting priorities (Adger et al. 2005, Brondizio et al. 2009) and even fundamentally different types of environmental knowledge (Ahlborg and Nightingale 2012). Conflicts across scales can be managed through strong social networks and leaders that bridge organizations, policy levels, and system scales, or enhance knowledge flow (Olsson et al. 2006, Bodin and Crona 2009). Polycentric governance, emphasizing the functional overlap in multilevel governance systems, has also been shown to be responsive to novel conditions (Fabricius et al. 2007, Biggs et al. 2012).

Principle 3: Institutions must be adaptive

Rules steering human–environment interactions must be flexible enough to change, incrementally or entirely, should new environmental and social conditions render them ineffective (Nelson et al. 2007, Rijke et al. 2013). The ability of social systems to incorporate knowledge from past ecological experiences, in the existing or analog systems, into future decisions, i.e., to reflect and learn, is central to effective adaptive governance (Folke et al. 2005). Social systems are increasingly expected to adapt proactively to anticipated ecological changes to maintain resilience, given the increasing rapidity and unpredictability of change (Ash et al. 2012). The capacity to adapt the rules of human–environment interaction, both reactively and proactively, is a keystone of resilience-based governance.

Principle 4: Institutions must be legitimate

For rules to be legitimate, multisector stakeholders at various levels and scales must collaborate in some manner during policy formation, implementation, and amendment (Cosens 2013). From a normative stance, environmental governance must represent the wills of affected groups, as resilience itself could prove undesirable if the social system is undemocratic (Lebel et al. 2006). The preferences of local stakeholders can be trumped by the priorities of larger-scale groups under the banner of accomplishing "the greater good" which includes such concepts as "freedom of navigation" (e.g., Robards and Greenberg 2007, Tyler and Jackson 2014). Conversely, powerful small-scale special interests can overpower the democratic process of larger groups in some circumstances to accomplish their own security (Irvin and Stansbury 2004, Robards and Lovecraft 2010). The presence of power dynamics emphasizes the need to consider normative aspects of environmental institutions (Wang and Ching 2013, Lovecraft 2008). Legitimate environmental policies can also help assure compliance through what Agrawal (2005) describes as "environmentalities," where the subjects of governance view the rules as part of their own identities, sometimes because they have a meaningful voice in creating and implementing them (Plummer and Armitage 2007).

Principle 5: Institutions must be implementable

To promote resilience, rules for ecosystem governance must be implementable through existing legal frameworks (Ruhl 2010). It makes little difference if a policy tool is ecosystem-based, adaptive, cross-scale, and legitimate if the laws that would implement the tool are not viable or do not support proper functioning. The legal sciences challenge resilience thinking on this front by showing that courts of law generally favor stability over adaptability and can thereby be at odds with the other requirements of resilience-based governance (Ebbesson 2010, Ruhl and Fischman 2010). For resilient social–ecological systems, there must be congruence among not only the ecosystems and the rules that govern them but also among the rules and the legal frameworks that bring the rules into being and control their adaptation. Nonimplementable rules, either formal or informal, like those offered up by many well-intentioned, but unrealistic academic theoreticians, do little to stem unsustainable human–environment interactions (Garmestani and Benson 2013).

ANALYSIS AND DISCUSSION

We break this section into two parts: (1) the political issues around the question of whether a PSSA could be adopted for the Bering Strait, and (2) the likely results should a PSSA be adopted and

Table 4. Bering Strait system properties and the related political/scientific decisions that would facilitate the operationalization of resilience-based governance principles through the PSSA designation.

Resilience-based governance principle	System properties	Political/scientific decisions
Ecosystem-based	The Bering Strait ecosystem is clearly bounded and well-studied, but rapidly changing given global climate change and social/economic factors.	For the PSSA application to be ecosystem based, it would need to understand and address the protection of ecosystem function or key processes. The specific justification for a PSSA (as required) in this case study is the safety and health of cetaceans in a migration bottleneck, which is a more traditional, species-specific focus than ecosystem-based (for example, protecting the high primary production for the region). Nevertheless, the inclusion of human interests within the ecosystem, including of the safety of hunters and the health of subsistence resources (through minimizing discharges) reflects important ecosystem-based considerations.
Cross-scale	Stakeholder groups at the local, subnational, national, and international scales have substantial interest in how the Bering Strait is governed–economically as well as environmentally; both economic and environmental drivers across scales affect the system.	The process of selecting APMs needs to accommodate the sometimes conflicting, environmental, economic, and political considerations that occur across scales, and affectively address cross-scale interactions. Understanding trade-offs will be a critical consideration in cross-scale analyses of the chances of a successful application or the effects of a PSSA designation.
Adaptive	There is reasonable ecological and social baseline data about the Bering Strait, but data on the local rates and processes of ecological or social change are often lacking. Directional change in system properties is predicted to continue in the foreseeable future.	Although the IMO has been reticent to apply adaptive or seasonal protective measures under a PSSA designation, seasonal application of APMs and monitoring of key system variables would be essential if seeking to ensure an optimal link between economic, social, and ecosystem needs in the Bering Strait. However, political trade-offs with an adaptive approach could support more static protective measures.
Legitimate	Although there is historical precedent for a strong focus on the freedom of navigation across the world's oceans, there has been minimal attention to the voice of indigenous coastal food security in IMO policy decisions. However, at least in the U.S., there is relatively strong recognition of indigenous rights and formal processes of tribal consultation or co-management. In addition State-Federal relations may exacerbate existing cross-scale political tensions.	Russia and the U.S. federal government would have to assure that subnational and international stakeholder groups support the associated protective measures. These would reflect the needs and interests of indigenous subsistence hunters as well as regional governments. Conversely, shipping and national security interests would need to support actions that impact policy positions concerning the established legitimacy of freedom of navigation elsewhere.
Implementable	The national governments that would be tasked with enforcing the associated protective measures are stable and both legal systems possess the capacity to enforce rules.	National governments would have to choose to commit financial resources to effective monitoring tools (e.g., through vessel monitoring and reporting of seasonal risks to cetaceans), enforcement, and prosecution to proactively prevent negative impacts on cetaceans, ecosystems, and cultures. There may be a role for maritime insurance to also monitor actions that jeopardize the health and safety of indigenous groups or iconic coastal aggregations of wildlife.

implemented. Two of the resilience-based governance principles fall broadly under the first category, cross-scale and implementable, and three fall under the second, ecosystem-based, adaptable, and legitimate. We identify how key characteristics of the Bering Strait system lend themselves to, or constrain, the implementation of each principle of resilience-based governance (Table 4).

Political Issues

Does a PSSA function effectively across scales?

Many hurdles would have to be overcome for a Bering Strait PSSA to function effectively as an institution of cross-scale governance. Because of the overarching international importance of freedom of navigation, the national priorities of the United States and the Russian Federation might align more closely with the priorities of transnational shipping corporations than with the priorities of local subsistence hunters or marine mammal conservation. Such cross-scale tensions could inhibit the initial PSSA application process if more economically or international maritime freedom-motivated stakeholders protest the designation.

In addition, based on the top-down structure of the PSSA application process, there is no evidence that a Bering Strait PSSA would help alleviate the historic cross-scale hostility on the part of the State of Alaska toward attempts by the United States federal government to create policies that might adversely affect Alaska's economic interests, as regulating maritime traffic in the Bering Strait might be perceived to do. There is a long-standing tension, for example, between the state and federal governments with respect to who can profit from commercial activity in the Arctic offshore environment, including the Bering Strait (e.g., Paulin 2013).

Is a PSSA implementable?
Although implementablity through existing legal and political systems is a key component of successful environmental policy (Cumming 2013), and PSSAs have been successfully implemented around the world, questions remain about whether the United States and Russian Federation possess the political will to create a Bering Strait PSSA at this time. It is notable that an international park spanning the Bering Strait that was proposed in 1990 by U. S. President Bush and Soviet President Gorbachev has still not emerged. The PSSA application process requires committed resources and prolonged collaboration, both scientifically and politically. Although the United States and Russian Federation possess such resources, current tensions between the countries might make a partnership unlikely. If such tensions can be overcome, both countries possess the technological capacity to monitor and enforce the APMs.

The existence of stable legal systems in both nations is critical for implementability as well, since it would ultimately be the onus of the United States and Russian Federation to confront shipping companies if the companies failed to abide by the protective measures. The relative simplicity of the APMs that the IMO could apply in the Bering Strait, e.g., clearly defined shipping lanes, vessel notifications, and automated electronic tracking, is favorable for effective monitoring and enforcement. However, the potential exists for those negatively impacted by increased regulation to attempt to hinder the progress of the application process.

Likely Results

Is the institution ecosystem-based?
The environmental science contained in the PSSA application would have to address the complexity and interconnectedness of this transboundary ecosystem. The application would also need to address the ecological changes occurring in Bering Strait. However, it is unclear whether the PSSA application would include local-scale and Traditional Ecological Knowledge, as this is not a current requirement of the IMO.

Roberts (2007) argues that the increased level of regional environmental knowledge generated through a successful PSSA application is one of the main benefits of achieving the designation; this is consistent with the strong emphasis on learning within the resilience literature (Tschakert and Dietrich 2010). By highlighting the connections between animals, their habitats, and vessels, PSSAs avoid the pitfall of protecting specific species rather than overall systems, which other environmental laws, e.g., the U.S. Endangered Species Act, have often fallen into (Benson 2012). Overall, PSSAs achieve a good institutional fit with the environment by invoking protective measures that target the particular ecosystem services of each area, rather than attempting to protect the environment through blanket policies.

Are the institutions adaptive?
A Bering Strait PSSA might not be adequately adaptive to handle the rapidly changing Arctic environment. Although it is hypothetically possible for the coastal states, the United States and Russian Federation, to apply to the IMO to amend an APM following its implementation (Ünlü 2004), there is no precedent of this occurring. Nor does the IMO offer a clearly defined process for the adaptation of APMs if needed, e.g., guidelines for monitoring change, thresholds of change to qualify for an amendment, or an amendment timeline. An entirely new institutional mechanism would need to be developed to give countries the power to change APMs to achieve this principle. From within the resilience literature, Walker (2012) poses the question: "What are the rules for changing the rules?" In the case of the PSSA policy tool, there are no rules for changing the rules. There is no clear process, for example, to change areas to be avoided if whales alter their migratory patterns, or for scaling back mandatory reporting measures if marine traffic flows subside. Institutional rigidity, or the inability to adapt, can lead to dysfunctional governance practices in a changing environment (e.g., Carpenter and Brock 2008).

Are the institutions perceived as legitimate?
Because the PSSA application and designation processes do not contain a formalized mechanism to ensure the participation of the State of Alaska and Chukotka regional governments or indigenous groups, it is possible that a PSSA would be perceived as illegitimate by key stakeholders. Some applications for existing PSSAs do emphasize indigenous use of marine areas for nutritional and cultural purposes, but there is no required inclusion of indigenous issues at the IMO. There is a Permanent Forum on Indigenous Issues at the United Nations, but the link between this forum and the IMO is beyond the scope of this discussion. Cosens (2013) writes: "[C]hanges to governance needed to foster ecosystem resilience will not be adopted by democratic societies without careful attention to their effect on the social system itself." Particularly Sensitive Sea Areas are arguably undemocratic institutions, initiated, pursued, and regulated by government agencies at the national and international scale. Inadequate participation in policy processes can leave stakeholders or subadministrative units feeling resentful, thereby delegitimizing the policy (Cosens and Williams 2012). Greater emphasis on stakeholder inclusion in the PSSA application process would be required to fulfill this principle.

A second component of legitimacy is the perception of contemporary need for a PSSA. Is there a current problem or is this about a perceived problem for the future, i.e., after some threshold in vessel traffic is reached? Although PSSAs have generally, but not always, reacted to a recognized problem, proactive examples do exist with low transit numbers such as in the northwest Hawaiian Islands. For the Bering Strait, the relatively few transiting vessels perhaps warrant closer attention to the value of proactive voluntary measures within the APMs (Huntington et al. 2015). Governments and international shipping companies, who are likely to view mandatory regulations as an imposition on maritime freedoms or an impediment to their efficient operation, are likely to be more amenable to such voluntary measures. Voluntary measures foster social learning, facilitate adaptive change, and could foster new environmentalities which are central tenets of resilience approaches. Furthermore, additional protective measures known to reduce impacts to whales such as restriction on speed, which have no precedent in PSSAs elsewhere, could be explored. However, for the protective measures we identify, international compliance with voluntary measures may not always be adequate (McKenna et al. 2012), supporting the value of a policy testing period in which compliance and effectiveness can be assessed prior to finalizing APMs for a PSSA application.

CONCLUSION

The social–ecological system of the Bering Strait, which includes migratory whale populations and the indigenous subsistence communities that rely on those whales for food and cultural security, is increasingly at risk from the impacts of international shipping. The number of large ships and volume of cargo products transiting the strait is increasing, driven by both national and global economic factors, and facilitated by shrinking sea ice and more advanced vessels and infrastructure. These novel conditions within the social–ecological system are largely unaddressed in current policy and are challenging to mitigate, perhaps not surprising given that they are only now emerging as potential problems. This finding aligns with Holling's (2012) recent statement about the rapidity of global changes and the difficulty of making an adequate institutional response: "All that can be done now is to focus on some fundamental developments [in the operationalization of resilience theory] that slow the worst problems and also dramatically explore several real options that are promising gambles."

Here, we have analyzed the potential of an IMO PSSA protected area designation to mitigate the current and potential threats of increased maritime activities, and by doing so to enhance the resilience of the current subsistence system. A PSSA designation would be an imperfect policy tool, if assessed purely against five theoretical principles of resilience-based governance. However, we conclude that a PSSA represents a promising gamble if seeking a real-world policy tool that could mitigate the risks presented by Arctic shipping in the Bering Strait region for both marine mammals and indigenous food security.

From an academic perspective, future research could continue to address the series of challenges and trade-offs related to operationalizing resilience theory that we have identified (Table 5).

Understanding the relation between these challenges and the status of the system in the face of increased international shipping is of wide interest both to those living in this region, and to scholars seeking to better link resilience-oriented academic frameworks to real-world environmental governance needs.

Table 5. Key challenges and tradeoffs for operationalizing resilience-based governance

Reconciling different priorities across scales and in areas of multiple jurisdictional oversight.
Institutionalizing effective processes for adaptive environmental policies.
Achieving adequate stakeholder participation to ensure legitimacy at local, regional, national, and international scales.
Generating political will to act proactively (especially in transboundary areas).
Balancing environmental protection with economic or maritime freedom.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/issues/responses.php/7081

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