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ARTICLE

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Climate Change and Institutional Resilience in Arctic Environmental Governance

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Abstract

This article highlights recent successes and failures in efforts to manage Arctic marine living resources to improve our understanding of institutional resilience—that is, the ability of cooperative institutions to maintain their performance despite severe disruptions to their operating environments. Rising ocean temperatures and other impacts of climate change may alter the spatial distribution of fish stocks, including their relative attachment to exclusive economic zones and their availability on the high seas. As evident in the examined Arctic cases, which involve the world's largest stocks of cod, herring and mackerel, such changes may complicate core resource management tasks, including the regulatory task of reaching an agreement among user states on quotas and other restraints that align with scientific advice. The cross-case variance in regulatory resilience to climate-related and other changes in cooperative circumstances sheds light on general propositions regarding the drivers and inhibitors of institutional resilience, including institutional characteristics and the severity of the political challenges posed by changing circumstances.

Keywords

Arctic; climate change; environmental governance; fishery management; institutional resilience

1. Introduction

An important part of Arctic environmental governance is provided by a set of international institutions established to manage marine living resources. Fisheries in the marine Arctic target stocks with extraordinary productivity, including the world's largest populations of pollock (in the Bering Sea), cod (in the Barents Sea), and herring and mackerel (in the Nordic Seas; Arctic Portal, 2023). Annual Arctic landings

amount between 7–8 million tonnes (Hoel, 2020, p. 216) or some 8% of the world's capture fishery supply. Among vessels sufficiently large to carry automatic identification system transceivers, those engaging in fishing typically account for more than half of the annual vessel trips in the region, comfortably exceeding all other activities, including in terms of hours of operation (Silber & Adams, 2019, p. 5).

The Arctic fishery is mostly conducted in waters under national jurisdiction. No commercial harvesting occurs on the high seas of the central Arctic Ocean, the Chukchi Sea or the Beaufort Sea. The adjacent Bering Sea is home to immensely valuable pollock fisheries, but these target separate stocks and lie within the exclusive economic zones (EEZs) of Russia and the US. Thus, it is only in the Northeast Atlantic part of the Arctic Ocean, notably the Barents and Nordic Seas, that management of commercially weighty Arctic fisheries occurs at the international level, which is our focus here.

This article is about *institutional resilience*. In studies of ecosystems, resilience refers to "the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist" (Holling, 1973, p. 17). Applied to governance systems, institutional resilience refers to their ability to maintain institutional performance despite negative changes in their external circumstances, including by adapting individual institutions or their relationships (Stokke et al., 2022; Young, 2010, p. 379). Here, I focus on the regulatory aspect of institutional resilience, which concerns continuity in the ability to reach an agreement on regulatory measures that reflect the best available knowledge of what constitutes sustainable harvesting pressure. I first elaborate on how climate change may amplify the challenges faced when managing the use of transboundary living resources. I then document the ability of those operating the relevant regional management regimes to adopt sustainable regulatory measures despite climate-related challenges and report the institutional adaptations necessary to obtain them.

Cross-case diversity in such ability allows the evaluation of certain propositions concerning the factors that promote or inhibit regulatory resilience derived from the scholarship on institutional resilience, which has focused either on institutional properties that may enable rapid adaptation to changing environments or, from a more agency-sensitive point of departure, on the malignancy of the collective action problem that must be overcome to achieve such adaptation. The concluding section summarizes the findings and relates them to current policy debates on the appropriateness of maintaining Arctic cooperative ties across the deepening East–West divide in view of Russia's military aggression in Ukraine.

2. Climate Change and Regulatory Challenges

Climate change raises issues of institutional resilience because higher ocean temperatures and greater variability in oceanic conditions, such as sea ice extent, salinity and stratification, typically complicate resource management. Among the possible consequences of such changes are: shifts in the abundance, geographical distribution, and migratory patterns of commercially and ecologically important fish stocks. Such shifts pose challenges to all the main tasks involved in the management of renewable resources.

Generally, the performance of living resource management institutions hinges on making and implementing authoritative decisions about balancing resource use, including allocation among those involved, and resource conservation to ensure future availability. According to Stokke (2012), this general problem of balancing use and conservation can usefully be divided into three management tasks: cognitional, regulatory,

and behavioural. The regulatory task, which is the focus of this article, is closely intertwined with the other two. The cognitional management task is to provide scientific advice based on a shared, well-founded understanding of how various levels of harvesting pressure will affect the state of the stocks in question and their long-term ability to provide employment, resource yield, food security, and food web stability. An international institution that performs well on the cognitional task by providing advice perceived by decision-makers as credible, salient, and legitimate is also more likely to perform well on the regulatory task of achieving an agreement among all or most user states on the corresponding conservation measures (Mitchell et al., 2006; Stokke, 2012).

Good regulatory performance is also more likely if the behavioural task of enforcing compliance among target groups is performed well—for instance, through intrusive procedures for verification, review, and response (Stokke, 2014). This is because strong compliance systems encourage states to take on regulatory commitments by reducing the risk that the expected benefits from stronger regulation—healthier stocks and greater future yields—will be reaped by freeriding outsiders who are unwilling to join or comply.

Unfortunately, this entwinement of regulatory performance with the cognitional and behavioural tasks also implies that changes undermining one of the other two tasks can easily spill over into the regulatory domain. Thus, climate change can amplify existing challenges related to the regulatory performance of fishery regimes both directly and indirectly. Directly, shifts in a stock's zonal attachment—that is, its occurrence in the various EEZs that states have established along their coasts and in waters beyond national jurisdiction—often put pressure on existing quota allocation arrangements (e.g., Pinsky et al., 2018, p. 1189). Indirectly, greater variability in oceanic conditions may render scientific assessments and scientific advice more uncertain or contested, and greater availability in waters beyond national jurisdictions may encourage new entrants to fisheries and narrow the jurisdictional basis for key compliance activities, notably at-sea inspections (Stokke, 2019).

The cases of Arctic resource management examined here exhibit both the direct and indirect effects of spatial stock shifts on regulatory performance. During the first decade and a half of the 2000s, the world's largest stocks of mackerel and herring expanded their areas of distribution, amplifying existing challenges to sustainable management. For many years, both stocks had been concentrated in the Norwegian Sea, but especially the Northeast Atlantic mackerel stock grew considerably in size and became more available in the adjacent Iceland and Greenland Seas (Nøttestad et al., 2016). An immediate regulatory challenge posed by these shifts was the emergence of two new entrants to the mackerel fishery—Iceland and Greenland, both claiming shares of the total quota—which was exacerbated by the Faroe Islands' demand for a greater share due to the change in this stock's zonal attachment (Østhagen et al., 2022).

Coping with this direct effect was further complicated by the indirect effect of new difficulties in providing credible and legitimate scientific advice. A dispute arose over the different survey methodologies favoured by researchers from the various user states, nurturing suspicions that the inputs to the advisory process were distorted by political considerations (Gänsbauer et al., 2016) despite being nested in the well-respected procedures of the International Council for the Exploration of the Sea (ICES; Lassen et al., 2013). Adding to the cognitional challenge, retrospective assessments showed that the ICES had underestimated the mackerel stock for several years, partly due to its changing distribution (Spijkers & Boonstra, 2017, p. 1842). Earlier studies have shown that low accuracy in the scientific predictions of how a

stock will respond to harvesting pressure can reduce decision-makers' propensity to maintain quotas within the scientific recommendations (Stokke, 2012).

In short, the wide spatial shifts of both mackerel and herring have significantly worsened the conditions for performing well on the regulatory management task, both directly by generating competing claims for larger quota allotments and indirectly by complicating the provision of consensual scientific advice.

More modest, yet significant, spatial shifts have been recorded for two stocks managed jointly by Norway and Russia in the Barents Sea. The most important among them, Northeast Arctic cod, occurs mostly in the EEZs of Norway and Russia, but in some years, it is also available in profitable amounts in the high seas "Loophole" area of the Barents Sea (Stokke, 2022a). Since the early 2000s, a combination of relatively high ocean temperatures and a large stock size has induced a northward and eastward expansion, with somewhat greater zonal attachment to the Russian EEZ than previously (Stiansen et al., 2022, p. 111). A similar development has been observed for several other stocks, including Greenland halibut, which used to be managed exclusively by Norway but was recognized as a shared stock in 2009 (Jørgensen, 2022, p. 160). As with the pelagic stocks in the Nordic Seas, the spatial shifts occurring in the Barents Sea have also led to requests for renegotiating quota allocations (Jørgensen, 2022), thus making the regulatory management task more difficult.

The generic challenge to fishery management stemming from the impacts of climate change is hardly new. Shifts in the abundance and spatial distribution of commercial fish stocks, often affecting various harvester groups differently, occurred prior to the recent warming and can be driven also by other processes. Rather, climate change tends to amplify certain mutually reinforcing challenges to regulatory performance, sometimes to the extent that institutional adaptation is required if performance is to be maintained. As I argue in the next section, the institutional adaptations made in the Arctic management processes under examination may illuminate the ongoing debate regarding the modes, drivers, and inhibitors of institutional resilience.

3. Regulatory Resilience in Arctic Fishery Governance

Grading institutional resilience is important if we want to use empirical cases to evaluate propositions regarding the drivers of and impediments to resilience. The endpoints of such a scale are full resilience (i.e., performance levels are maintained despite deteriorating external conditions) and institutional collapse. The scale should allow a meaningful differentiation between cases located between these extremes. Therefore, assessing the levels of regulatory resilience, in our case, involves examining whether climate-related or otherwise induced stock shifts lead to a decline in the regulatory performance of the management bodies responsible for these stocks and whether institutional adaptation has played a role in preventing or mitigating such a decline.

3.1. Regional Management Bodies

The institutions established to manage fisheries in the Northeast Atlantic segment of the Arctic differ considerably in cohesiveness and scope of membership: tight and narrow for stocks in the Barents Sea and loose and broad for those in the Nordic Seas. For Northeast Arctic cod, Greenland halibut, and several other stocks shared by Norway and Russia in the Barents Sea, legally binding national catch quotas and technical

regulations applicable throughout the areas of distribution are adopted annually by the Joint Norwegian–Russian Fisheries Commission (JNRFC; see Hønneland, 2012; Jørgensen, 2022; Stokke, 2012). This bilateral regime was established in the mid-1970s as part of the process of claiming 200-mile EEZs following the consensus reached in the United Nations Conference on the Law of the Sea (Stokke, 2012). Scientific advice on cod, halibut, and other shared stocks is provided by the ICES, with its solid reputation for impartiality and advanced peer-review procedures for insulating the advisory process from political pressure (Lassen et al., 2013). Close institutionalized cooperation also characterizes the compliance side of this regime, including sharing vessel quota information and inspection data and having direct lines of communication between the two member states' enforcement agencies (Stokke, 2022a).

The governance structure for managing pelagic stocks in the Nordic Seas is far more fragmented and is thus best characterized as an institutional complex (Stokke, 2022b; on such complexes, see Oberthür & Stokke, 2011). In this case, too, scientific advice from the ICES forms the basis for annual negotiations between the user states, but the regulatory task is more decentralized. This is because pelagic stocks are available in the high-seas Smutthavet in the Norwegian Sea and migrate across a larger number of EEZs, including those of the EU, Iceland, the Faroe Islands, Greenland and, following Brexit, the UK. Moreover, whereas in the JNRFC, the starting points of annual negotiations are agreed operationalization of basic conservation principles, such as a precautionary approach, and clearly defined harvest control and allocation rules, the pelagic fishery regime complex proceeds on a stock-by-stock basis, involving two multilateral and numerous bilateral venues. Thus, the regulatory core of the pelagic regime complex is an annual multilateral fishery consultation process among countries with acknowledged coastal state rights. Although such consultations sometimes produce inclusive agreements on the total allowable catch (TAC) and its allocation, agreements are often limited to a subset of countries capable of harvesting stocks within their own EEZs or on the high seas.

The outcomes of these multilateral stock-specific consultations, regarding pelagic stocks in the Nordic Seas, form the basis for subsequent bilateral negotiations between the relevant coastal states concerning quota exchanges and mutual access to each other's EEZs. They also set the parameters for decisions within the North-East Atlantic Fisheries Commission (NEAFC), whose competence mainly covers the high seas, including a segment of the high seas of the central Arctic Ocean. As elaborated in the next subsection, the fragmented institutional complex for managing pelagic stocks in the Nordic Seas exhibits greater regulatory performance variability than the tightly structured bilateral Barents Sea fishery regime.

3.2. Adaptations and Performance

In recent years, during which fish stocks have experienced substantial shifts in their spatial distributions, regional fishery management bodies have often found it difficult to agree on regulatory measures that are in line with the best available scientific advice. A simple, yet roughly valid, and widely applicable way of evaluating regulatory performance across cases and over time is to observe the proportions of the TAC authorized by user states that are in line with the best available advice on harvesting pressure. This measure yields a performance score of 1 when decision-makers fully heed scientific advice and progressively lower scores as decision-makers deviate from scientific advice, allowing a comparison of performance levels across cases and over time.

For the four internationally managed Arctic stocks examined here, the data needed to calculate regulatory performance scores are available in *ICES Advice*, an annual publication which reports the ICES's inputs to governments and international commissions responsible for managing fish stocks and ecosystems in the Northeast Atlantic. Table 1 summarizes key information about the regulatory processes for the four stocks under study and illustrates the procedure for calculating regulatory performance scores, using figures from 2012 as an example year.

Table 1. Case summaries and procedures for measuring regulatory performance, using 2012 as an example.

	Cod	Halibut	Mackerel	Herring
Regulatory body	JNRFC		Complex of multilateral and bilateral institutions	
Advisory body	ICES			
Recommended TAC	751	15	639	833
Actual TAC	751	18	927	833
2012 regulatory performance score	*1.00*	*0.83*	*0.69*	*1.00*

Notes: TAC (in thousand tonnes), including internationally agreed quotas and those set unilaterally by user states outside such agreements; the formula for calculating regulatory performance scores is: Recommended TAC/Actual TAC, whenever the actual TAC is higher than or equal to the recommendation; whenever the TAC is set below the recommendation, the regulatory performance score is 1 since the entire TAC is in line with the recommendation. Source: ICES (2021a, 2021b, 2022a, 2022b).

As shown in Table 1, in 2012, regulatory performance was impeccable for cod and herring, relatively good for Greenland halibut, and rather poor for mackerel. For mackerel, no international agreement on quotas was reached that year and the sum of the multilaterally and unilaterally set quotas (927,000 tonnes) was considerably higher than the level recommended by scientists (639,000 tonnes; ICES, 2022a), yielding a less than impressive regulatory performance score of 0.69, in this particular year.

As shown in Figure 1, the overall pattern of poorer regulatory performance for mackerel than for the other stocks is also observable over a longer period, but it is also evident that both management structures can deliver high-level performance. Among the four stocks under examination, Northeast Arctic cod clearly had the best regulatory record, despite a very low score in 2007, when scientists recommended a particularly sharp quota cut compared to the previous year (ICES, 2021a). In all other years, the regulatory performance score for cod was 0.9 or higher, often reaching the highest possible level. Arguably, achieving such performance levels is a remarkable feat, given that cod is the commercially most important stock managed by the JNRFC and thus of keen industry interest and that its spatial distribution shifted during the period under study, making it relatively more abundant in Russia's EEZ than before. Despite this spatial shift, Russia requested no modification of the quota-sharing arrangement (Jørgensen, 2022) and the JNRFC succeeded in reaching an agreement on both the TAC and its allocation every year. Overall, the bilateral management regime has proven highly resilient to the regulatory challenges posed by the northward and eastward shifts of the valuable Northeast Arctic cod stock.

The JNRFC's regulatory record for Greenland halibut is also relatively good, although, in 2010, its performance dropped from a string of top scores to levels ranging between 0.8 and 0.9. The year 2010 was the first in which Greenland halibut was managed as a shared stock (ICES, 2021b), after Russia's decade-long claim that a change in its area of distribution had occurred and implied joint rather than exclusively Norwegian decision-making

as well as a greater quota share for Russia.

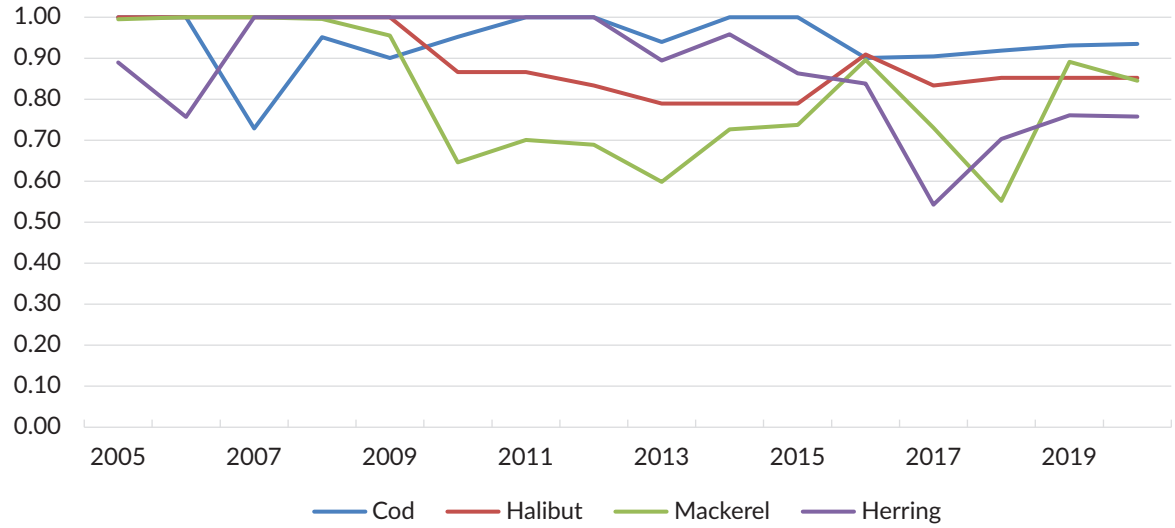

Figure 1. Regulatory performance scores for four stocks in the Barents and Nordic Seas (2005–2020). Source: ICES (2021a, 2021b, 2022a, 2022b).

Jørgensen's (2022) account of the Greenland halibut case suggests that the lack of a direct challenge to the unilaterally set halibut quotas in the period up to 2010 required institutional adaptation. In 2001, Norway agreed to establish a joint research programme to assess the scientific basis of Russia's claim as well as two working groups to map the stock's zonal attachment (Jørgensen, 2022, p. 159). The working groups' reports to the JNRFC confirmed that this stock's centre of gravity had shifted North and East and led to the more permanent institutional adaptation implied by Norway's recognition of Russia's right to the stock as a coastal state and a 51/45 quota-sharing arrangement, leaving 4% of the annual quota to third countries (Jørgensen, 2022, p. 160).

The drop in regulatory performance for Greenland halibut, from 2010 onwards, reflects the fact that the agreement on quota allocation was partly reached at the expense of conservation. For the first time in the period under study, the total quota for this stock was set higher than the scientific recommendation—indeed, sufficiently high for Norway's total catch to remain stable in absolute terms despite the increase in Russia's share (ICES, 2021b). In sum, the JNRFC has proven relatively resilient to the challenge posed by the spatial shift of Greenland halibut but not to the same extent as for cod, since the institutional adaptation needed to reach an agreement involved a substantial deviation from the best scientific advice on harvesting pressure, as shown in Figure 1.

Regarding the regional herring stock, the complex of institutions responsible for management in recent decades has involved five parties recognized as coastal states: Norway, Russia, Iceland, the Faroe Islands, and the EU. The latter was replaced by the UK, in 2021, when the Brexit transition period expired. Greenland and (since 2021) the EU participate as observers. Figure 1 shows a single year of low performance early on, followed by a series of high scores until a drop in 2014, with scarce improvement afterwards. Disagreements on allocation accompanied both the early and more recent regulatory difficulties. In 2004, Norway suspended a five-party allocation agreement that had been in place for many years, arguing

that zonal attachment shifts suggested that it should be granted a higher share of the quota than its roughly 60% (Bjørndal & Ekerhovd, 2014). However, other user states also intensified their harvesting activities, especially on the high seas, and a new deal on allocation, applicable from 2007 onwards, involved only modest changes (ICES, 2022b). This inclusive agreement broke down in 2013 due to Faroese aspirations for a greater share (Norway Government, 2013, p. 8), and despite occasional allocation agreements among some of the user states, no inclusive allocation agreement has been reached since then.

As noted by Gullestad et al. (2020, p. 1018), a solely TAC-based assessment may underestimate regulatory performance for herring because the user states have agreed on a management strategy for this stock, including a recently agreed harvest control rule for determining the total quota, and they honour earlier commitments to technical regulations, such as minimum size limits and associated area closures. However, an agreement on how to cap a TAC is of little use if the parties disagree on its allocation. Considering that the sum of unilaterally set quotas after the 2013 cooperation breakdown has overshot the recommended harvesting pressure by as much as 30% (ICES, 2022b; Figure 1), it is hard to avoid the conclusion that the regulatory resilience of the herring arrangement to the stock's spatial shifts over the past decade has been rather low.

A similar conclusion can be reached regarding Northeast Atlantic mackerel. In this case, regulatory difficulties arose as early as 2009 and have been perpetuated ever since. As in the case of herring, the Faroe Islands were the first recognized coastal state to challenge the existing allocation agreement and suspended their trilateral agreement with the EU and Norway. The disagreement soon widened when two newcomers to the fishery, Iceland and Greenland, also claimed rights to the stock as coastal states (Gullestad et al., 2020, p. 1018). A partial allocation agreement was reached with the Faroe Islands and later with Greenland, both having obtained considerably larger shares of the agreed quota than previously. In contrast, Iceland has not decided to join the mackerel agreement. Based on unilaterally set quotas, this country has taken approximately 15% of the total mackerel catch in recent years, compared to negligible levels before the stock shift (ICES, 2022a).

As with herring, the user states have recently agreed on a mackerel harvest control rule and an overall management strategy and continue to harmonize their technical regulations. However, the adaptive efforts of those operating the mackerel arrangement have failed to prevent a long series of dismal regulatory performance scores. This series of regulatory failures began in 2010, and performance has remained low ever since. Indeed, as Figure 1 indicates, the sum of multilaterally and unilaterally set mackerel quotas during the period without an inclusive allocation agreement overshot the scientifically recommended harvesting pressure by an even wider margin than for herring: 37% on average.

3.3. Regulatory Resilience Summarized

All four stocks under examination have altered their areas of distribution in ways that have impacted their relative attachments to the region's EEZs. For all stocks, except Northeast Arctic cod, which is managed bilaterally under the JNRFC, these shifts have led to requests for renegotiating the quota allocation agreements. The user states responsible for managing these stocks have tried to adapt to such requests. However, such efforts have yielded a stable and inclusive new agreement only for Greenland halibut, which is also managed by the bilateral JNRFC. For the two stocks managed by the multilateral loosely structured institutional complex responsible for pelagic fisheries in the Nordic Seas, the spatial shifts that began in the

early 2000s have led to a steep decline in regulatory performance, implying relatively low levels of regulatory resilience. Can this variance in regulatory resilience across cases and over time help answer more general questions regarding the conditions that promote or inhibit institutional resilience?

4. Explaining Institutional Resilience

The scholarly debate on the drivers and inhibitors of institutional resilience has been greatly influenced by two complementary strands of human–environment analysis: One pinpointing certain institutional properties and the other focusing more explicitly on the configuration of interests and power capabilities among those engaging in activities that require governance. Albeit from different points of departure, both approaches identify factors likely to affect the collective capacity to respond rapidly to disruptive changes in the environment.

4.1. Institutional Properties

One line of research on institutional resilience draws inspiration from the literature on ecological resilience (notably, Holling, 1973), with its inclination towards complex systems thinking and functionalist explanations. Adapting concepts originally developed for examining ecosystems, this line of thinking typically associates resilience with the capacities for learning, institutional diversity, and decentralized decision-making (e.g., Berkes et al., 2003; Folke, 2006; Gunderson & Holling, 2002).

Central to the notion of learning capacity are structures for monitoring environmental changes and producing adequate responses to them based on earlier experience (Berkes et al., 2003). All the management processes examined here are well endowed with such capacities, since the ICES, an international organization established more than a century ago and benefiting from the membership of the world's leading national fishery research institutions, plays a central role in the development of stock assessment and the provision of consensual advice. Nevertheless, since its role is equally prominent for all the Arctic stocks under study, institutional characteristics that promote environmental sensitivity and learning cannot explain the diversity of the observed outcomes.

A major argument in support of a link between institutional diversity and resilience is the greater flexibility inherent in being able to choose from various venues when devising solutions to environmental governance problems (e.g., Keohane & Victor, 2011). Among the processes examined here, such diversity is clearly greater in the institutional complex for managing stocks in the Nordic Seas, not least because the decentralized mode of negotiating TACs and their allocation allows some user states to enter into mutually beneficial quota agreements, even in years when consensus among all user states is unachievable. However, although such partial agreements are clearly superior to a situation with no institutional means for regulatory coordination, we have seen in the previous section that the resilience of the complex of institutions responsible for pelagic stocks in the Nordic Seas has been clearly inferior to that of the tighter Barents Sea fishery regime centred on the JNRFC.

Yet another institutional feature identified in the ecologically inspired line of resilience research is nimbleness—that is, a certain degree of normative fluidity or permissiveness allowing those operating an institution to depart from, or pragmatically adapt, existing norms if this is conducive to problem-solving

(Heldeweg, 2017). In the contexts of Arctic and global ocean governance, for instance, Young (2012, 2020) has noted such nimbleness among the merits of institutional components that are legally non-binding and therefore adaptable without cumbersome intergovernmental negotiations and national ratification procedures. The cases examined here, however, mostly point in the opposite direction: The clearly defined and well-established procedural and substantive management rules developed in the Barents Sea regime seem to promote resilience more reliably than the normatively looser management of pelagic stocks.

As for procedural rules, decision-making by consensus predominates in practice in all the management processes examined here, as it does in international environmental governance more generally. For the JNRFC, this rule is formalized in its constitutive documents. In the complex of institutions partaking in the management of pelagic stocks in the Nordic Seas, each state may veto an inclusive agreement by refusing to join it. Each member has indeed done so at one time or another. The formal or de facto consensus rule implemented in both regimes examined here places obvious limits on their ability to respond rapidly and effectively to changing circumstances whenever members disagree on how to respond.

Preventing or handling regulatory disagreements is precisely the role intended for the substantive rules for decisions on conservation and allocation that an increasing number of fishery management regimes have adopted, encouraged by the development and diffusion of the precautionary approach to fishery management during the 1990s (Stokke, 2001). As noted in the previous section, the states managing pelagic stocks in the Nordic Seas have recently agreed on harvest control rules that place caps on the TACs to be adopted for herring and mackerel based on pre-agreed biological reference points, including the size of spawning stocks, but disagreements on allocation have prevented them from collectively keeping within these TACs.

In contrast, in the early 2000s, the JNRFC adopted long-term management plans with specific harvest control rules for all major shared stocks (Kvamsdal et al., 2016). These rules complemented quota allocation agreements that had been fixed in the regime's early years, including a 50/50 division of the most important stock—Northeast Arctic cod. These harvest control rules—based on biological reference points and, in the case of cod, an inter-annual quota stability clause—have greatly facilitated agreements on regulatory responses to observed stock variations (Stokke, 2012). In the Barents Sea fishery regime, annual decisions on conservation and allocation are usually reached more by calculation than by negotiation. According to Jørgensen (2022), the long-standing success of this rigidly rule-based less-than-nimble management system, in terms of the most valuable stock, explains why a party (Norway), when asked to give up a portion of its share of a less valuable stock (Greenland halibut), agreed to do so after the scientific working group confirmed that its zonal attachment had changed.

To summarize the argument so far, the strand of resilience research inspired by ecosystem analysis and highlighting institutional properties that facilitate rapid adaptation to changing circumstances can account for part of the diversity of the observed outcomes. However, the findings reported here support only some of the causal propositions in the relevant literature. Thus, while the capacities for scientific monitoring and experience-based responses stand out as crucial in Arctic fishery governance, the merits of institutional diversity and nimbleness are not supported by the cases examined here. On the contrary, the tightly structured Barents Sea regime with its rather rigid decision rules has greatly facilitated the annual negotiations on conservation and allocation. The larger set of states managing pelagic stocks in the Nordic Seas have tried to establish similar allocation keys for herring and mackerel, but none of those have enjoyed

the longevity of their Barents Sea counterparts.

As I argue in the following section, however, it would be misleading to imply that such longevity is a matter of institutional choice. Rather, it reflects the political fact that rigid allocation keys are susceptible to a loss of legitimacy whenever large changes in stocks' zonal attachments occur. This observation brings us to the second strand of institutional resilience analysis, which is premised on the notion that some challenges posed by changing circumstances are simply more difficult to handle than others.

4.2. Problem Structure

The second strand of institutional resilience scholarship drawn upon here started from economics and political science, focusing on collective action and how local communities in diverse regions and sectors have succeeded in managing scarce common resources more frequently and durably than predicted in Hardin's (1968) metaphor of the tragedy of the commons (e.g., Ostrom, 1998). While several of the policy implications from the ecological-resilience and local-governance studies converge and can provide lessons for international institutions (Young, 2017), those highlighting decentralisation and capacity for self-organisation are less applicable. This is partly due to formal and informal controls that government bureaucracies typically exercise over international institutions and partly because the social and psychological mechanisms that promote resilience in local institutions are weaker at the international level (e.g., Jagers et al., 2020). Compared to the ecological strand, the collective action line of resilience research is considerably more attentive to agency and configurations of interests and power, thus providing complementary explanations for the diversity of resilience outcomes in Arctic fishery governance. Of central interest are the number of actors involved and the extent of changes in stocks' spatial distributions.

The number of states or other entities that have access to fisheries matters because the fewer the actors who must agree on regulatory constraints, the lower the risk that one or more parties will exploit the freeriding option of avoiding commitments or compliance—or both (Olson, 1971). In fishery management, such problem malignancy (Underdal, 2002) can be compounded if a stock's rising occurrence on the high seas provides greater opportunities for freeriding behaviour. Both of those malignancy drivers are prominent in the management of mackerel and herring, which involves the EU (mackerel), the Faroe Islands (both), Greenland (mackerel), Iceland (both), Norway (both), and Russia (herring), rather than the two states managing cod and halibut.

The extent of change in a marine stock's spatial distribution matters because small changes in zonal attachment from one year to another are less likely to complicate the provision of scientific advice or lead to politically motivated requests for the renegotiation of existing allocation arrangements. As Stiansen et al. (2022) remind us, mackerel and herring migrate over wider ocean areas than demersal species, so changes in their spatial distributions have been more extensive than those observed in groundfish, such as cod. Adding to the problem's dynamism, the spatial distribution of pelagic species is closely related to stock size (Stiansen et al., 2022)—a factor which also tends to fluctuate more widely for pelagic species than for the major stocks managed under the bilateral Barents Sea fishery regime.

Rapid changes in stock distributions draw attention to another problem which may affect the states' ability to devise effective institutional adaptations: the state of knowledge regarding the expected duration of a stock shift. Even in the contested pelagic stock management processes, the relevant scientific body has provided consensual advice on the extent of distribution changes (Stokke, 2022c), but the expected duration of such changes is still surrounded by scientific uncertainty (e.g., Stiansen et al., 2022).

Judging by the cases examined here, this uncertainty has an ambiguous effect on management resilience. Østhagen et al. (2022) showed that disagreement on whether the current wide distribution of mackerel is cyclical or climate-driven (and thus durable) has fostered hard-line policies on both sides of the dispute. In contrast, Jørgensen (2022) listed scientific uncertainty among the drivers of resilience for the Barents Sea regime, arguing that it may have restrained Russia from requesting a new cod division key, as it did for the less valuable Greenland halibut, as well as for redfish and saithe. In the future, the current 50/50 division of cod may again compare favourably, from Russia's perspective, with the stock's zonal attachment.

Thus, a problem structure account of institutional resilience complements the analysis of institutional properties. It underscores that the problem of managing cod in the Barents Sea is more benign than that encountered in the Nordic Seas, both because the number of players is smaller than for the pelagic stocks and because the spatial distribution changes are less extensive for cod than for the others. These differences in problem structure give cause for caution when interpreting the findings concerning institutional characteristics reported herein: the higher regulatory resilience displayed for cod, with its rigid conservation and allocation decision rules, may be due to lower problem malignancy rather than superior institutional characteristics. That caveat is less relevant for Greenland halibut: Its zonal shift, documented by the joint scientific working group, was no less extensive than those of the pelagic stocks in the Nordic Seas, yet regulatory resilience was clearly superior both before and after the working-group report.

5. Conclusions and Implications for Arctic Regional Cooperation

In this study, I examined the relationship between climate change and regulatory performance in four cases of Arctic environmental governance. The findings reveal considerable diversity across institutions and over time in terms of the ability of those operating management bodies to maintain levels of agreement on measures for conservation and allocation that reflect the best scientific advice, especially when stocks' spatial shifts pose additional challenges. Notably, the centralized and institutionally firm Barents Sea fishery regime, with its long-standing harvest control rules and rigid allocation keys for the shared stocks, has proven considerably more resilient than the loosely structured complex of multilateral and bilateral institutions responsible for managing pelagic stocks in the Nordic Seas. In a second step, I examined whether this diversity supports the propositions put forward in the literature on institutional resilience, highlighting certain institutional properties and characteristics of the collective action problem posed by climate-related or otherwise induced spatial stock shifts.

The conclusion derived from this analysis must be considered with caution. On the one hand, evidence from the management processes examined here suggests that strong institutions (on institutional strength, see Underdal, 2004) with clear procedural and substantive rules for setting the TAC and allocating it to regime members are more rather than less prone to adapt adequately to changing circumstances. This empirical pattern challenges widely held beliefs about the merits of institutional diversity and normative nimbleness in

governance areas characterized by variability and uncertainty. In the more resilient cases examined here, substantively ambitious conservation rules and clearly defined allocation rules are perceived as assets worthy of protection, motivating participants to uphold cooperation and seek regulatory agreement, even when this requires costly concessions or foregoing short-term benefits derived from unilateral action. On the other hand, although cases involving a strong institution obtain overall higher resilience scores, especially the cod case also poses a more benign management problem, because the number of negotiating parties is lower and the extent of spatial shift is lesser. Thus, a clearer answer regarding the advantages and disadvantages of firm decision rules for regulatory resilience can be provided by expanding the number of cases, to obtain greater diversity in the configuration of scores on institutional strength and malignancy, both within and beyond the empirical domain of living resource management.

The results reported here, including the finding that the bilateral Barents Sea fishery regime has proven highly resilient to the challenges posed by major stocks' spatial shifts, warrant some concluding remarks on the contested policy issue of how those operating cooperative institutions across the renewed East–West divide should respond to Russia's full-scale invasion of Ukraine in 2022. For instance, work under the Arctic Council, a prominent circumpolar forum for addressing issues associated with climate change and sustainable development in the Arctic (Lavelle, 2022), was suspended by the seven Western Arctic states shortly after the invasion. In the area of fishery science, the ICES decided, in March 2022, to suspend Russian researchers' participation.

Although Norway has joined the EU and US economic sanctions against Russia, cooperation under the JNRFC has been largely exempt from the general freeze in bilateral relations. Collaborative interaction between military agencies from the two coastal states was, in principle, suspended after Russia's annexation of Crimea in 2014, but coast guards' cooperation on fishery inspection and search and rescue operations has continued, even after the full-scale invasion. In fact, both Russia and Norway have thus far appeared eager to shield, to the extent possible, their long-standing cooperation on fisheries from the disruptive effects of the war in Ukraine. However, such resilience to disruptive geopolitical changes cannot be taken for granted because security concerns and alliance loyalty tend to prevail over economic and environmental concerns when in conflict.

Yet, while cooperative breakdown scenarios in Arctic fishery governance cannot be ruled out, continued resilience remains a more likely outcome. After all, cooperation across geopolitical fault lines is the rule, not the exception, in Arctic fishery management. The early years of the JNRFC coincided with a period known as the "second Cold War," with the 1979 Soviet invasion of Afghanistan being a low point. No less than the Ukraine case, that invasion was a flagrant violation of international law, triggering widespread condemnation and waves of political, economic, and cultural sanctions. Yet, their positions on opposite sides of the rapidly widening geopolitical divide did not undermine any of the cooperative arrangements that Norway and the Soviet Union had established in the fisheries area, including mutual access to each other's EEZs, parallel systems of inspection in disputed waters, and fixed allocation keys for their shared stocks (Stokke, 2012).

The best explanation for these cooperative advancements in a period of geopolitical crisis is that these arrangements allowed both parties to maximize their gains from extended coastal state jurisdiction. Once established, institutions that serve significant mutual interests are often shielded from subsequent fluctuations in general political relations. In Arctic fisheries, such mutual interests are reinforced by the

normative notion that when a stock is shared by neighbouring states, cooperative management is not a retractable benefit comparable to reciprocal market access under a trade agreement but a legal and moral responsibility to ensure sustainable resource use.

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Conflict of Interests

The author declares no conflict of interests.

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