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Cooperation under Sanctions: Divergent Outcomes and Fisheries-Quota Continuity in Norway–Russia Arctic Relations, 2016–2026

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ABSTRACT

Norway and Russia have followed divergent national paths and, since 2022, increasingly adversarial relations, yet their bilateral fisheries regime has continued to operate. This coexistence is rarely measured. This study builds a structured case study with stated decision rules (H1–H6) and two rival theoretical predictions, and applies them to public indicators for 2016–2026. Fossil CO_2 emissions and Northern Sea Route (NSR) cargo indicate divergence; the Northeast Arctic cod quota relative to joint scientific advice indicates cooperation, with haddock as a comparison stock. Norway's sanctions of 7 July 2025 are the conflict event. Emissions diverge (−0.90 and +31.0 Mt per year) with no detectable break after the 2022 invasion, and a 2022 break in NSR cargo growth is rejected (adjusted p = 0.264). For cod, the original rule (every quota within ±10% of advice) fails because of the 2016 and 2017 quotas; a disclosed post hoc revision restricted to quotas agreed after the invasion is not rejected (maximum +9.1%). For haddock the revised rule fails: the 2024 and 2025 quotas exceeded the advice by 10.5% and 21.6%, after sharp falls in advice. The 2026 quotas were agreed 164 days after the sanctions, with deviations of +5.8% (cod) and 0.0% (haddock). The spillover prediction is rejected; the insulation prediction is not rejected for cod but is rejected for haddock. The rules were fixed after the data were inspected and the conflict is a single episode, so the findings are descriptive.

Keywords: Barents Sea; cod quota; scientific advice; neorealism; liberal institutionalism; Northern Sea Route; structured case study; rejectable hypotheses

1 | INTRODUCTION

1.1 | Background

Arctic ice melt and retreat provide shipping routes, open hydrocarbon and mineral provinces, and moves fish stocks, thus bringing Arctic climate policy into the domain of sovereignty, resource security and military posture (Hansen-Magnusson and Gehrke 2025).

It is particularly evident at the border between Norway and Russia, where the Barents Sea and a long-standing fisheries agreement have endured times of sharp political tension (Honneland 2014; Gronnevet 2016;

Osthagen 2016). Norway's climate policy and petroleum activity have been subjects of criticism (Rendon-Betancur and Dyer 2026), while the Northern Sea Route development has been kept high on Russia's agenda (Mikhailova and Tabata 2024).

The fisheries regime provides a particularly quantifiable source of the measure of cooperation. Scientific advice, based on a harvest control rule, is used to set the quotas annually by the bilateral commission for shared Northeast Arctic cod and for haddock. This distance can be determined for each year between the agreed total allowable catch (TAC) and the advice. A large gap above the advice is indicative of bargaining about the stock, while a gap that is near zero is indicative of the parties following the scientific procedure. This distance is the cooperation indicator used in the study.

1.2 | Problem statement

There are two conflicting theories of the effect that conflict has on cooperation. The neorealist argument about the importance of gains relative to others suggests that gains in one area should bleed into gains in other areas (Waltz 1979). Established institutions have the power, according to a liberal institutionalist, "to buffer cooperation from conflict in other parts of the world" (Keohane 1984; Nye 1977). In practice, the Norwegian–Russian fisheries regime has weathered previous crises (Honneland 2014; Osthagen 2016; Byers 2017), but scientific and institutional collaboration with Russia has been reduced since 2022 (Andreeva 2023; Koivurova and Shibata 2023; Misund 2025; Rees and Buntgen 2024) and climate shifts have made reaching agreement on quotas in line with scientific advice more difficult for states.

It's been a record short since recently. Norway has imposed sanctions on two Russian fishing firms on 7 July 2025. Despite this the states agreed the cod quota for 2026 and a joint research program on 18 December 2025. It is unknown whether this co-existence is a stable pattern or whether it is an impression that has been created by the selection of descriptions. The question is important for practice because a shared stock needs to be jointly managed and for theory. Resilience (Stokke 2024) and spillover are usually described in words, so neither claim can be checked against a stated standard and can be supported by choosing the right episode.

The problem is thus the absence of outcome-based, rejectable tests, for one dyad of four linked questions. **PS1:** do national outcomes diverge? **PS2:** do conflict events change them? **PS3:** does a cooperation output stay close to a scientific benchmark through a conflict event? **PS4:** which of the two theories does that outcome contradict? These identifiers are carried through gaps (G), objectives (O), questions (RQ), hypotheses (H), and indicators (V) (Table E1).

1.3 | Research gap

The literature on this dyad has three parts that are rarely joined (Section 2). One part examines why cooperation persists or lapses, mainly through legal, perspective-based, or document-based accounts (Honneland 2014; Osthagen 2016; Byers 2017; Koivurova and Shibata 2023; Misund 2025; Hammer 2025). A second part documents divergence in the policy texts and discourses of Arctic states (Zhao et al. 2026; Rendon-Betancur and Dyer 2026; Mikhailova and Tabata 2024). A third part evaluates regimes by their outputs, outcomes, and impacts, but not through a yearly benchmark for this dyad (Stokke 2012, 2024).

To the best of the researchers' knowledge, no study has measured the following together, under explicit decision rules, and two gaps follow. **G1 (PS1, PS2):** divergence in national outcomes, and whether a conflict event changed it, has been described in texts but not tested against rejection rules. **G2 (PS3, PS4):** the distance between a cooperation output and joint scientific advice has not been followed year by year through a conflict event and used to judge rival theories. These are gaps of measurement and integration, not a claim that coexistence has never been observed. They rest on the targeted search in Section 4.4 and would be refuted by a study meeting this description.

1.4 | Research objectives

The aim of the study is to assess, as a structured case study with public indicators and stated decision rules, whether divergent national outcomes and a conflict event can coexist with continued bilateral fisheries cooperation between Norway and Russia. Four specific objectives follow.

- **O1 (PS1; G1).** To measure whether Norwegian and Russian fossil CO_2 emissions follow divergent trajectories (H1).
- **O2 (PS2; G1).** To test whether the 2022 invasion produced a detectable break in the emissions trajectories (H2), and whether 2022 is the best-fitting break year in the growth of Northern Sea Route (NSR) cargo (H3).
- **O3 (PS3; G2).** To test whether agreed cod quotas stayed close to joint scientific advice (H4), whether the 2026 quota was agreed on time after the 2025 sanctions (H5), and whether the quality of agreement worsened (H6), and to repeat these tests on haddock as a comparison stock (C1).
- **O4 (PS4; G2).** To establish which of two rival predictions, neorealist spillover or liberal-institutional insulation, is rejected by these outcomes (Table 2), and to state criteria for later data (Table 3).

O1 and O2 supply the context: divergent national paths and whether the invasion changed them. O3 and O4 carry the core question about cooperation.

1.5 | Research questions

The overarching question is: *can divergent national outcomes and a conflict event coexist with continued bilateral fisheries cooperation between Norway and Russia, and what do measurable indicators reveal about the relations between these domains?* The joint presence of divergent outcomes, a conflict event, and continued cooperation is called the *dual pattern*. Four research questions break it down.

- **RQ1 (divergence; PS1, G1, O1).** Do Norwegian and Russian fossil CO_2 emissions follow opposite trends, and does the 2024 observation stay on the 2016–2023 trend? (H1)
- **RQ2 (conflict and divergence; PS2, G1, O2).** Did the 2022 invasion break the emissions trajectories (H2), and is 2022 a better break year for NSR cargo growth than other years (H3)?
- **RQ3 (conflict and cooperation; PS3, G2, O3).** (a) Did agreed Northeast Arctic cod quotas stay close to joint scientific advice (H4)? (b) Was the 2026 quota agreed on time after the 2025 sanctions (H5)? (c) Did the quality of agreement worsen relative to the pre-invasion years (H6)? (d) Does haddock, a comparison stock, give the same answers (C1)? Closeness to advice is read as adherence to a shared procedure, not as proof of broader cooperation.
- **RQ4 (theory; PS4, G2, O4).** Which of the two rival predictions is rejected by these outcomes? (Table 2)

The study distinguishes three groups of indicators (V1–V5, Table 5): a conflict event (the sanctions of 7 July 2025, the date of invasion is used as the dating point), divergence indicators (emissions and NSR cargo) and a cooperation indicator (the quota relative to advice). These data do not allow the testing of the relationship of H1 with cooperation (Section 3.4). There is a stated test and rejection rule for each hypothesis (Table 1); there are also criteria for later data (Table 3). The dyad is a case, which is deliberately favourable, and coexistence would demonstrate that it is possible, but not typical (Yin 2018).

1.6 | Coverage, contributions, and structure

While the frame is a baseline of 2016-2023 and a 2024 to 2026 focal window, not all indicators span the entire frame. Emissions end in 2024, and NSR cargo in 2025. The seven quotas set prior to the invasion (2016-2022) are compared to the four quotas agreed after the invasion (2023-2026) for quotas and advice to 2026. The information is presented in Table 4.

The three contributions of the article are 1) it poses and tests coexistence as falsifiable hypotheses using the public indicators; 2) it differentiates the public indicators that can test hypotheses of coexistence and those that cannot; and 3) it reports on the failure of a decision rule (H4a). Section 2 reviews the literature, Section 3 states the hypotheses, Section 4 describes data and methods, Section 5 reports the tests (Table E1 in Appendix E traces every problem, gap, objective, question, hypothesis, indicator and result), Section 6 discusses them, and Section 7 concludes.

2 | LITERATURE REVIEW AND RESEARCH GAP

2.1 | Institutional resilience and bilateral cooperation

A first body of work, largely qualitative or document-based, examines why cooperation between Norway and Russia, and between Russia and the West more broadly, has persisted or lapsed. Honneland (2014) analyses bargaining over precautionary fisheries management; Osthagen (2016) examines maritime cooperation as “high north, low politics”; Hammer (2025) studies joint fisheries science as an epistemic community; Gronnevet (2016) credits the Joint Fisheries Commission, and its scientific cooperation and decision rules, for a stock in excellent condition, and considers how the sanctions after 2014 might affect that cooperation; Jorgensen (2022) attributes the resilience of the regime to the Commission’s record of compromise and its growing use of scientific expertise in allocation. Byers (2017), using complex interdependence (Nye 1977), shows that most military and economic cooperation between Russia and Western states was suspended after 2014, while fisheries, search and rescue, and Arctic Council cooperation continued. Stokke (2024) compares the resilience of institutions for Arctic cod, herring, and mackerel and argues that it varies with institutional characteristics and the severity of the challenge. Koivurova and Shibata (2023) argue that Russia’s 2022 invasion ended the “Arctic exceptionalism” that had allowed cooperation despite wider tension, and ask whether treaty-based cooperation has held up better than cooperation in soft-law bodies such as the Arctic Council, citing the central Arctic Ocean fisheries agreement as a case that continued. Misund (2025) examines Norwegian–Russian relations in polar science since February 2022 and notes that Norway’s adherence to the sanctions has exceptions, including fisheries research and management in the Barents Sea.

These studies document institutional resilience: cooperation has been uneven across domains but has survived political shocks. None compares an institutional output with a measurable benchmark under a stated decision rule, and none tests whether cooperation continues through a specific conflict event.

2.2 | Divergent policies and outcomes

A second body of work analyses what states say and do. Zhao et al. (2026) analyse 107 Arctic security-policy documents (59 of them official) from eight Arctic states and two observer states and report broad consensus on climate and environmental concerns but sharp divergence in territorial and resource-related strategies. Mikhailova and Tabata (2024) find that Russia kept the Northern Sea Route a priority after February 2022 but shifted its emphasis toward domestic purposes, and Rendon-Betancur and Dyer (2026) examine the discourses through which Norway's climate policy and petroleum activity are justified. These studies characterise intentions and narratives, not outcomes over time within one dyad.

2.3 | Research gap and rationale

G1 (PS1, PS2; RQ1, RQ2; H1–H3). Divergence in policy texts is documented (Zhao et al. 2026; Rendon-Betancur and Dyer 2026; Mikhailova and Tabata 2024), but divergence in measured outcomes, and whether the 2022 invasion changed it, has not been tested against explicit rejection rules. **G2 (PS3, PS4; RQ3, RQ4; H4–H6, P1, P2).** Accounts of cooperation after 2022 are legal, perspective-based, or document-based (Koivurova and Shibata 2023; Misund 2025; Hansen-Magnusson and Gehrke 2025), and the persistence of quota-setting relative to joint advice through sanctions has not been compared with a measurable benchmark.

2.4 | Further evidence on science and cooperation

Work on Arctic science after 2022 documents what is lost when cooperation stops. Andreeva (2023) argues that ending cooperation with Russia in the Arctic Council could seriously harm Arctic climate research, and Rees and Buntgen (2024) describe widening data gaps. The quota-to-advice deviation is an output measure (Stokke 2012). None of these studies compares a cooperation output with a scientific benchmark year by year through a sanctions episode, which is what H4–H6 do.

3 | HYPOTHESES, DECISION RULES, AND PROSPECTIVE CRITERIA

3.1 | From theory to testable implications

Two theories supply directional expectations about the relation between conflict and cooperation. Neorealism assumes that states are sensitive to relative gains, so that conflict in one domain should spill over into cooperation in another (Waltz 1979). Liberal institutionalism, including the theory of complex interdependence, holds that institutions insulate cooperation from strain in other domains (Keohane 1984; Nye 1977). Section 3.3 converts each into one operational prediction that the available indicators can reject. Neorealists also allow cooperation on low-politics issues such as fisheries, so P1 is a demanding reading and its rejection is weak evidence against neorealism. The operationalisation is the study's own: the rejection of a prediction rejects that operational reading, not the theory as a whole. Constructivist, securitisation, and regime-complexity accounts are not tested.

The conflict event is the sanctions episode of 7 July 2025, with the invasion of February 2022 as a dating point for the divergence indicators. Divergent emissions are not an act of one state against the other, and NSR cargo measures activity on a route, so both are divergence indicators, not conflict indicators.

3.2 | Hypotheses and decision rules

Each hypothesis answers one research question and serves one objective (Table E1). All tests use $\alpha = 0.05$. The verdicts are assessments of one case against stated rules; they are not inferences to a population of dyads. Exact permutation tests are one-sided where the direction is part of the hypothesis. No correction for multiple testing is applied; each hypothesis is judged on its own rule. A hypothesis is "not rejected" when none of its rejection conditions is met, and "rejected" when any is met; non-rejection is never described as proof.

Table 1

Hypotheses, relations tested, and rejection conditions

ID	Relation	Testable statement	Test and data	Rejected if (α = 0.05)
H1 (RQ1; O1)	Divergence	Norwegian and Russian fossil CO_2 stay on divergent baseline trajectories into 2024.	(a) OLS trend of CO_2 on year, 2016–2024; (b) 95% prediction interval from the 2016–2023 linear trend, evaluated at 2024. Source: EDGAR.	(a) the two slopes do not have opposite signs, or either 95% CI includes zero; (b) either 2024 value lies outside its prediction interval.
H2 (RQ2; O2)	Conflict → divergence	The 2022 invasion did not break the emissions trajectories: all 2022–2024 observations lie inside the 2016–2021 prediction intervals.	Linear trend 2016–2021 (n = 6, 4 degrees of freedom), 95% prediction interval at 2022, 2023, 2024, for Norway and Russia (6 observations).	any of the 6 observations lies outside its interval.
H3 (RQ2; O2)	Conflict → divergence (rival, war-centred)	NSR cargo growth slowed at 2022: the 2022 split is the best-fitting split.	Exact permutation test of mean log growth before vs after each candidate split (nine growth rates), one-sided, adjusted for the search over four splits (max-t, 9! orderings).	the 2022 split is not the best-fitting split, or its adjusted p ≥ 0.05. (Rejection refutes this account, not other explanations.)
H4a (RQ3; O3)	Cooperation (original rule)	Agreed cod quotas stay within ±10% of scientific advice in every year.	Percentage deviation of TAC from advice in all eleven quota years, 2016–2026. Sources: IMR–PINRO (2025a); JNRFC records.	any deviation exceeds ±10%.
H4b (RQ3; O3)	Cooperation (revised, post hoc)	Quotas agreed after the invasion (2023–2026) stay within ±10% of advice, and their largest deviation does not exceed the largest deviation of the quotas agreed before it (2016–2022).	Same series: four post-invasion quotas against seven pre-invasion quotas.	any post-invasion deviation exceeds ±10%, or the post-invasion maximum exceeds the pre-invasion maximum.
H5 (RQ3; O3)	Conflict → cooperation	After the sanctions of 7 July 2025 the 2026 quota was agreed in time and stayed within ±10% of advice.	Date of the bilateral agreement relative to 1 January 2026 (and, descriptively, to the dates of the four preceding cycles); deviation of the 2026 TAC from 2026 advice (285,000 t against 269,440 t). Source: Norwegian government records.	no agreement is concluded before 1 January 2026, or the 2026 deviation exceeds ±10%.
H6a (RQ3; O3)	Conflict → cooperation	The quality of agreement after the sanctions is no worse than before the invasion: the 2026 deviation lies within the range of the 2020–2022 deviations (0.0% to +7.0%).	Compare the 2026 deviation with the minimum and maximum of the three pre-invasion pairs of 2020–2022.	the 2026 deviation lies outside 0.0% to +7.0%.
H6b (RQ3; O3)	Conflict → cooperation	The same, on the extended baseline: the 2026 deviation lies within the range of the 2016–2022 deviations (0.0% to +11.1%).	Compare the 2026 deviation with the minimum and maximum of the seven pre-invasion pairs.	the 2026 deviation lies outside 0.0% to +11.1%.

Table 1 lists the six questions and the rule that would make each fail. H1 asks whether the two countries stay on opposite paths. H2 and H3 ask whether the 2022 invasion changed anything. H4 to H6 ask whether the quota stays close to the scientists' advice. Fixing the failure rules first keeps the test honest.

3.3 | Theory-derived predictions

Neorealist spillover (P1) and liberal-institutional insulation (P2) make opposite predictions about the cooperation track after the sanctions (Table 2), so the same data can reject one without rejecting the other. Because P1 and P2 are mirror readings of the same evidence (H4b, H5, and H6), however, they constitute one test with two labels, not two independent tests. H1 is implied by both theories and does not discriminate between them.

Table 2

Rival theory predictions and rejection conditions

ID	Theory and core expectation	Operational prediction (the study's operationalisation)	Prediction is rejected if
P1	Neorealism: conflict spills over into cooperation (relative-gains concerns)	After the sanctions the cooperation track fails: no agreement before 1 January 2026, or the 2026 deviation leaves the pre-invasion range (0.0% to +7.0%, H6a; 0.0% to +11.1%, H6b).	H5 and H6 are both not rejected (cooperation did not fail).
P2	Liberal institutionalism: institutions insulate cooperation from conflict	H4, H5, and H6 all hold: quotas stay within ±10% of advice (H4a as originally written, H4b as revised), the agreement is on time, and the deviation stays within the pre-invasion range.	any of H4, H5, H6 is rejected.

Table 2 gives each theory one prediction. The first is that conflict will spread and the fish agreement should collapse. The second is that institutions bolster cooperation, and it should live. The last column indicates what the result would be to make each wrong. They share the same evidence and are 1 test with 2 labels.

3.4 | Rule for the dual pattern

The dual pattern (Section 1.5) is not accepted if H1, H4, H5 and H6 are not all rejected and is rejected if one of these is rejected. H4 can be in two states, so the pattern has two verdicts: rejected by the original rule (H4a does not pass) and not rejected by the revised rule (H4b does pass). Both are reported; the first is detected as strict and the second as exploratory (Section 3.5). The comparison stock is reported in addition to the verdict and is not part of it. H2 and H3 are reported but are not conditions of the pattern, because they concern the effect of the invasion on divergence, not coexistence. The relation between divergence and cooperation cannot be tested: both tracks trend, and a correlation between two short trending series would be spurious. The cross-track evidence therefore comes only from H4–H6, and the pattern asserts coexistence in the same period, not that either track affects the other.

3.5 | Status of the tests

The rules in Table 1 were fixed after the series had been inspected: they are falsifiable but not pre-registered. After the quota and advice series were checked against the official joint tables (Section 4.6), three rules were changed and a comparison stock was added. Each change is reported here.

First, the fuller series (eleven quota years, not the four first available) contradicts the original H4: two pre-invasion quotas exceeded the advice by more than 10%, so H4a is reported as rejected. Second, H4b was added; it applies the same tolerance to quotas agreed after the invasion and compares their maximum deviation with the pre-invasion maximum. H4b is a post hoc revision written after H4a failed, and it can pass because the failing years lie before the conflict; readers who reject the revision should rely on H4a. Third, the H6 band is now also given on the extended 2016–2022 baseline (H6b), and the original band is kept as H6a. Fourth, haddock was added as a comparison stock, and the rules of H4–H6 were applied to it unchanged (comparison analysis C1, Section 5.4). Table D1 lists all changes in order. No other rule was changed.

3.6 | Prospective falsification criteria

Two criteria were set for data not available when the rules were first fixed (Table 3). The EDGAR 2026 report contains 2025 emissions, but its fossil-CO_2 table could not be retrieved, so F1 remains open. The agreement on the 2027 quotas has been published by the Ministry of Industry, Commerce and Fisheries, but neither its page nor the protocol of the 57th session could be opened by the researchers, so no 2027 quota is used and F2 remains open. Two further prospective criteria are added in Section 6.8.

Table 3

Criteria for later data and their status

ID	Data due	Pre-specified band	Falsified if	Status (2 November 2026)
F1 (H1)	Harmonised EDGAR emissions for 2025 and 2026	95% prediction intervals from the 2016–2023 linear trend. Norway: 2025 [38.5, 42.7], 2026 [37.5, 42.0] Mt. Russia: 2025 [1,863.0, 2,140.3], 2026 [1,881.3, 2,179.3] Mt.	any of the four observations lies outside its band.	Open. The 2025 data exist (EDGAR 2026 report) but the fossil-CO_2 table was not retrievable; 2026 is not yet published.
F2 (H4, H5, H6)	2027 cod quota and joint advice	(i) $\lvert \text{TAC/advice} - 1 \rvert \leq 10\%$; (ii) a bilateral quota agreement concluded before 1 January 2027; (iii) deviation within 0.0% to +7.0%.	(i) fails (H4), (ii) fails (H5), or (iii) fails (H6).	Open. The 2027 advice is published (JRN-AFWG 2026); the official agreement text could not be read, so no 2027 quota enters any test.

Table 3 covers data that arrived later. F1 sets safe ranges for 2025 and 2026 emissions; a value outside the range fails it. F1 is still open because the emissions file could not be downloaded. F2 requires the 2027 quota to be close to the advice and agreed before 1 January 2027. It stays open because the official agreement text could not be read.

4 | DATA AND METHODS

4.1 | Design and temporal coverage

The study is run for the time horizon 2016–2026 (emissions to 2024, NSR cargo to 2025, quotas to 2026), with a baseline–window design. The trend for each indicator is estimated over the years 2016-2023 and focused on 2024-2026. There are different degrees of coverage of indicators due to lag in publication (Table 4). On purpose, Norway and Russia were selected as a bilateral dyad and are treated as such. The design was not causal and not pre-registered (Section 3.5).

Table 4

Temporal coverage: baseline, focal window, and latest observation by indicator

Indicator	Baseline observations	Focal-window observations	Latest year used
Fossil CO_2 emissions (Norway, Russia)	2016–2023 (8)	2024 (1)	2024
Invasion test on emissions (H2)	2016–2021 (6)	2022–2024 (3)	2024
NSR cargo	2016–2023 (8)	2024–2025 (2)	2025
Cod and haddock TAC (each)	2016–2022 (7; agreed before the invasion)	2023–2026 (4)	2026
Scientific advice (paired with TAC, each stock)	2016–2022 (7 pairs)	2023–2026 (4 pairs)	2026

Note. Counts in parentheses are numbers of observations. 2025 emissions (EDGAR 2026 report) and the 2026 NSR outturn were not used; no values were imputed.

Table 4 shows how many years are available. Emissions are halted in 2024, and there is one year after the baseline. NSR cargo has two. The quotas are best covered up to 2026: seven have been agreed before the invasion and four since. Every result needs to be interpreted with the understanding that there is less certainty of the results in a few years.

4.2 | Variables, sources, and construct validity

Table 5

Variable definitions, units, sources, coverage, and handling of missing years

Variable	Definition and unit	Source	Coverage	Handling of missing years
V1 Fossil CO_2 emissions	Fossil CO_2 from fuel combustion, Mt per year; Norway and Russia	Crippa et al. (2023)	2016–2024	Values as compiled from the 2025 release; the 2026 release (Crippa et al. 2026) has 2025 data but was not retrievable; no imputation
V2 NSR cargo	Total annual cargo carried on the Northern Sea Route, Mt	Gunnarsson (2021) and Lukin (2020) for 2016–2019; Investment Portal of the Arctic Zone (2022, 2024), Friskila (2023), Rosatom (2025), and Rosatom (2026) for 2020–2025 (Appendix A)	2016–2025	2016–2019 follow scholarly compilations of NSR Administration figures, as rounded there; 2022 = 34.034 Mt (Rosatom reports 34.1); 2026 outturn not yet available
V3 Cod TAC and advice	Agreed total allowable catch, Northeast Arctic cod, t	IMR–PINRO (2025a), Table of advice, catch, and management; Ministry of Industry, Commerce and Fisheries (2025) (2026 TAC)	2016–2026	None missing; no 2027 quota is used (Section 3.6)
V4 Haddock TAC and advice	Agreed TAC and advised catch, Northeast Arctic haddock, t	IMR–PINRO (2025b), Table 6; Ministry of Industry, Commerce and Fisheries (2025) (2026 TAC)	2016–2026	None missing; 2026 TAC equals the advice (153,293 t)
V3, V4 Scientific advice	Advice for the same stock, t	ICES for 2016–2022; JRN-AFWG for 2023–2026 (IMR–PINRO 2025a)	2016–2026	None missing; 2026 advice is 269,440 t
V5 Conflict event	Documented sanctions and agreements	Official Norwegian government records (Ministry of Foreign Affairs 2025; Ministry of Industry, Commerce and Fisheries 2025)	2025	Only events documented by official records are used; no newspaper source is used

Table 5 shows the source of each number, the years it represents and how gaps were addressed. There was no guesstimate for the gap. The strongest rows are the quota rows; the weakest are the emissions.

The indicators are not measures of policy content or intent but outcomes. National emissions are linked to the economic cycle, NSR cargo is linked to project timing as well as policy, and the quotas are linked to harvest control rules for stock assessment. The tests thus focus on results rather than causes. The 2022 quota

was agreed in 2021, before the invasion. The cod quota is the main indicator of cooperation and the haddock quota a comparison; search and rescue, environmental monitoring, and the Arctic Council are not measured.

Provenance of the advice. Advice for the 2016–2022 quotas came through the International Council for the Exploration of the Sea (ICES). Russia was suspended from ICES in 2022 and later withdrew. From the advice for 2023 onward the assessment was made by the bilateral Joint Russian–Norwegian Arctic Fisheries Working Group (JRN-AFWG), which the joint report says should not be considered ICES advice (IMR–PINRO 2025a). This paper uses "scientific advice" for both series. The change of advisory body coincides with the invasion and is a possible source of a break (Section 6.4).

4.3 | Statistical procedures

H1. Each emissions series is regressed on year (OLS, 2016–2024, n = 9) and checked with the Theil–Sen slope and the Mann–Kendall test (Sen 1968; Mann 1945; Kendall 1975). Robustness is examined by leaving out 2020–2021, by dropping each year in turn, and for serial dependence by Newey–West standard errors (lag 1, small-sample scaling), the Durbin–Watson statistic, and a t-test of the mean first difference. A straight line is fitted to 2016–2023 and the 2024 value is compared with its 95% prediction interval (t distribution, 6 degrees of freedom).

H2. A straight line is fitted to 2016–2021 (n = 6, 4 degrees of freedom) and the 95% prediction interval is evaluated at 2022, 2023, and 2024 for each emissions series. The intervals are wide, so only large breaks can be detected.

H3. Annual growth is 100 times the change in the natural logarithm of cargo. For a candidate break year the mean growth before and after the split is compared by the pooled t statistic, and its exact permutation distribution is obtained by enumerating all assignments (84 or 126 for one split). Because the best split is chosen after inspection, the adjusted p-value is the share of all 9! = 362,880 orderings in which the largest t over the four splits (2019–2022) is at least as large as the observed t.

H4, H5, and H6. The percentage deviation of each agreed quota from the advice is computed as TAC divided by advice, minus one, and compared with the ±10% tolerance, a stipulated threshold and not an empirically derived one. H4a applies it to all eleven years; H4b applies it to the four quotas agreed after the invasion and compares their maximum with the pre-invasion maximum. H5 uses the dates of the documented sanctions event and agreement. H6 compares the 2026 deviation with the minimum and maximum of the pre-invasion deviations, on the narrow (2020–2022) and extended (2016–2022) baselines. As a descriptive check on whether adherence changed, the pre- and post-invasion deviations are compared with an exact permutation test on ranks (ties handled). Comparison analysis C1 applies H4a, H4b, H5, and the H6 bands unchanged to haddock, and pools the 22 stock-years (rank test and Fisher's exact test on the counts above +10%); the two stocks are set by the same commission, so pooled observations are not independent. An exploratory rank correlation is used to identify each deviation to the change in advice (20 pairs; 2015 excluded because the 2014 advice is not in the series). There are logical combinations of these hypotheses, P1 and P2 (Table 2).

Rationale for the tests. A prediction interval is appropriate for H1 and H2 because it includes scatter around the trend and the uncertainty in the trend. The nine growth rates do not meet the distributional

assumptions required for the more common permutation tests, and the max-t adjustment allows for the best split to be decided on after inspection for the purposes of H3. The tolerances of H4 and H5 are specified in the table, and in Section 5.4, the sensitivity of each verdict to the tolerance is reported.

Limits of inference. All p-values are indicative with 9 or 10 observations. The p-values from the OLS, Mann–Kendall and permutation tests are valid under the assumption of independent or exchangeable observations; if serial dependence is not examined in the other p-values, their values can be too small to be meaningful. There are no random numbers in all the permutation tests because they are exact (full enumeration). The calculations were performed with Python (version 3.13, with NumPy 2.5 and SciPy 1.18), and the data and scripts are available as supplementary material.

The gap statement is based on targeted searches of publisher and repository pages and general web searches spanning the period 2014-2026. Academic articles in English on Arctic governance, climate policy, route development or on the cooperation between Norway and Russia were kept. DOIs were not machine-verified as Crossref was queried. Scopus and Web of Science were not searched, and it is not a systematic review, so a gap claim is made to the best of the researchers' knowledge.

4.5 | Validity and robustness

Construct validity. Each indicator is a proxy: emissions is a proxy for energy use, not climate policy; NSR cargo is a proxy for route activity, not intent; the quota-to-advice deviation is a proxy for whether a procedure is followed, not good will. **Internal validity.** The invasion and the sanctions don't get a result assigned to them. Statistical conclusion validity. The series has 6-11 observations, so the power is low, and limits are reported with each observation. **External validity.** The study does not measure the frequency of cooperation after conflict but rather accounts for one dyad, two stocks, and one sanctions episode.

4.6 | Data verification and revisions (2 November 2026)

The quota series, the advice series and the NSR series were verified with the best possible sources available, and only official records, research reports or corporate or government statistical releases were utilised – no newspaper or news-agency sources support any value. The history table of the joint advice report (IMR–PINRO 2025a) was re-read in full for this version, and the 2026 TAC was checked with the announcement of the Ministry (Ministry of Industry, Commerce and Fisheries 2025).

Haddock advice and TAC for 2016–2026 come from the history table of the haddock report (IMR–PINRO 2025b). The 2027 advice was published by the working group (JRN-AFWG 2026), but the 2027 agreement could not be read, so it is excluded. NSR totals for 2016–2019 were checked against two scholarly compilations (Gunnarsson 2021; Lukin 2020). Those for 2020–2025 come from Rosatom and government-portal releases (Investment Portal of the Arctic Zone 2022, 2024; Rosatom 2025, 2026) and, for 2022, a research-centre report (Friskila 2023). Agreement dates are taken from the Ministry (Ministry of Trade, Industry and Fisheries 2022; Ministry of Industry, Commerce and Fisheries 2025); the sessions of 2023 and 2024 are documented by the Directorate of Fisheries (2023, 2024), but those documents give no date.

Three limits remain. The fossil-CO_2 values come from the 2025 EDGAR release (Crippa et al. 2023) and were not re-checked against the 2026 release (Crippa et al. 2026), whose country-level fossil-CO_2 file could

not be opened; H1 and H2 should be re-run on it before submission. The releases already differ: 2024 total GHG emissions for Norway are 53.76 Mt CO_2eq in the 2025 report and 52.15 in the 2026 report (Crippa et al. 2023, 2026), so values depend on the release used. The NSR totals for 2016–2019 are the rounded values of scholarly compilations of NSR Administration figures (7.5, 10.7, 20.2, and 31.5 Mt; Gunnarsson 2021; Lukin 2020); Appendix B shows that the H3 verdict does not depend on them. The 2027 quota is excluded because no official text of it could be read.

5 | RESULTS

Each subsection states the rule from Table 1, applies it, and records the verdict. "Focal window" always means the years actually observed for the indicator concerned (Table 4). Sections 5.7 and 5.8 then set the findings against earlier research and theory and list what was not observed.

Principal findings. (1) Norwegian fossil CO_2 fell by 15.6% and Russian fossil CO_2 rose by 15.8% between 2016 and 2024, and the 2024 values lie inside both baseline bands (H1). (2) No break in emissions was detected after the 2022 invasion (H2, low power), and a 2022 break in NSR growth was rejected, because the slowdown dates to 2019–2020 (H3). (3) The original rule that quotas stay within ±10% of advice fails, because the 2016 and 2017 quotas were 11.1% and 10.6% above it (H4a); the revised rule for the four post-invasion quotas is not rejected (maximum +9.1%; H4b). (4) The 2026 quota was agreed 164 days after the sanctions, before the year-end deadline, at +5.8% from the advice and inside both pre-invasion bands (H5, H6). (5) Spillover (P1) was rejected, and insulation (P2) was not under the revised rule. (6) Divergence and cooperation could not be tested.

5.1 | The divergence series

Russian emissions exceeded Norway's by a factor of 37 in 2016 and 50 in 2024. Norwegian fossil CO_2 fell from 47.37 to 40.00 Mt (−15.6%) between 2016 and 2024, whereas Russian fossil CO_2 rose from 1,734.64 to 2,009.15 Mt (+15.8%). NSR cargo rose from 7.5 Mt in 2016 to a peak of 37.9 Mt in 2024 (a 5.1-fold increase) and was 37.02 Mt in 2025 (−2.3%; Table 6). Figure 1 shows the emissions series and Figure 2 the NSR series.

Table 6

Annual NSR cargo and growth, 2016–2025

Year	NSR cargo (Mt)	Annual change (%)	Annual log growth (%)
2016	7.5	—	—
2017	10.7	+42.7	+35.5
2018	20.2	+88.8	+63.5
2019	31.5	+55.9	+44.4
2020	32.97	+4.7	+4.6
2021	34.85	+5.7	+5.5
2022	34.03	−2.3	−2.4
2023	36.25	+6.5	+6.3
2024	37.90	+4.5	+4.4
2025	37.02	−2.3	−2.3

Note. The 2016–2019 values are the rounded figures of Gunnarsson (2021) and Lukin (2020). Data for 2020 and 2021 are taken from the Investment Portal of the Arctic Zone (2022); the 2022 value (34.034 Mt) is from Friskila (2023; data from Rosatom is 34.1 Mt, which rounds from either); the 2023 value is from the Investment Portal of the Arctic Zone (2024); the 2024 value is from Rosatom (2025); and the 2025 value is from Rosatom (2026). Sensitivity to the uncertain values is in Appendix B (Section 4.6).

Table 6 shows cargo on the Northern Sea Route. It had a quick increase from 7.5 million tons in 2016 to 31.5 in 2019 but nearly stalled, remaining at 33–38 million tons. Cargo dipped by 2.3% in 2022 and by 2.3% in 2025. The large slip-down was prior to the war.

5.2 | H1: divergent emissions trajectories (RQ1)

Table 7

Trend estimates, 2016–2024 (n = 9)

Series	OLS slope (Mt/yr)	OLS 95% CI	Sen slope (95% CI)	Mann–Kendall τ (p)	R^2
Norway CO_2	−0.90	[−1.12, −0.68]	−0.92 [−1.23, −0.67]	−0.89 (<0.001)	0.93
Russia CO_2	+31.04	[18.80, 43.28]	+30.68 [22.57, 48.25]	0.83 (0.001)	0.84

Notes. Sen = Theil–Sen slope; CI = confidence interval. With nine observations, all intervals are indicative.

Table 7 shows the direction of emissions. Norway has lost approximately 0.9 million tonnes per year, and Russia gained approximately 31. The ranges exclude zero, and all three methods agree. There is a fair fit of a straight line, as R^2 values of 0.93 and 0.84 indicate.

Table 8

Robustness of the trend estimates

Robustness check	Norway slope (Mt/yr)	Russia slope (Mt/yr)
Baseline OLS	−0.90 (SE 0.09)	+31.04 (SE 5.18)
Excluding 2020 and 2021	−0.92 (SE 0.09)	+30.36 (SE 3.15)
Leave-one-year-out range	−0.97 to −0.81	+28.63 to +32.28
Newey–West (lag 1) 95% interval	[−1.12, −0.68]	[25.30, 36.77]
Residual lag-1 autocorrelation (Durbin–Watson)	0.02 (1.63)	−0.55 (3.06)
Mean first difference (t-test p)	−0.92 (p = 0.024)	+34.31 (p = 0.21)

Note. SE = standard error of the OLS slope.

Table 8 examines if the outcome is fragile. Because the pandemic years (2020 and 2021) are excluded, or any one year is excluded, the slopes aren't much different. With serial dependence, Norway's result remains unchanged, while Russia's direction remains unchanged but is less precise.

Rule (a) does not rely on the pandemic years (2020–2021, Table 8), and neither slope changes if that year is omitted, nor do either change if any one year is omitted, so that the rule does not depend on the 2020–2021 period or on any single observation. The residual of the Norwegian result is essentially uncorrelated (with almost no residual autocorrelation), and the Newey–West interval is close to the OLS interval because of serial dependence. The residual autocorrelation is negative for Russia, the Newey–West interval is narrower than the OLS interval, and the mean of the first differences is +34.3 Mt but not statistically significant (p = 0.21) due to the 2020 decrease and the 2021 increase. The direction of the Russian trend is therefore strong, and the accuracy is not.

Table 9

The 2024 observation against the 2016–2023 baseline trend (rule b)

Series (2024)	Observed	Baseline-trend forecast	95% prediction interval	Deviation	Inside interval?
Norway CO_2 (Mt)	40.00	41.37	[39.41, 43.33]	−3.3%	Yes (near lower bound)
Russia CO_2 (Mt)	2,009.15	1,973.02	[1,843.61, 2,102.43]	+1.8%	Yes

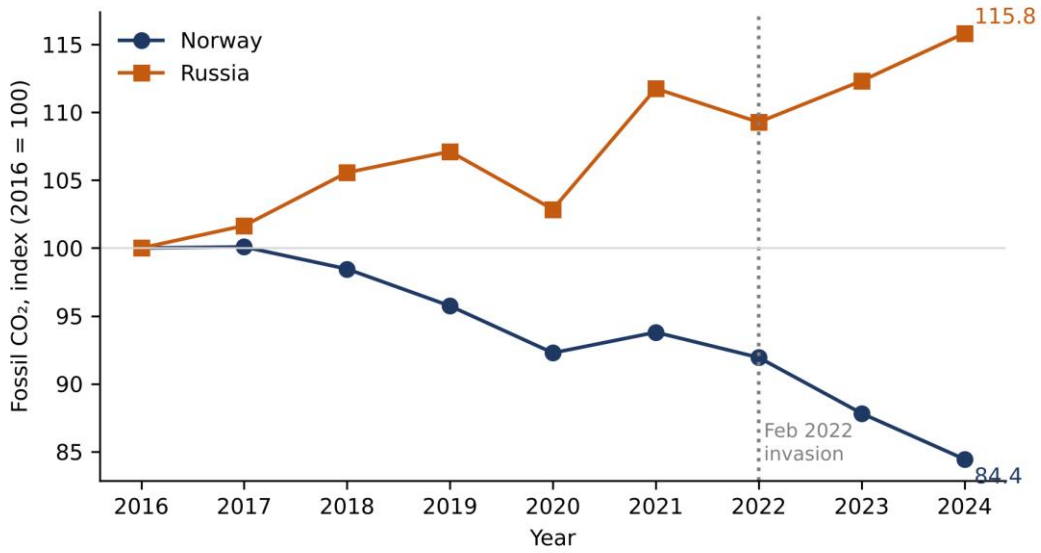
Table 9 asks whether 2024 stayed on the old path. A safe range was drawn through the 2016–2023 time span. Both Norway and Russia were slightly outside of the range, but not far. No special events took place in 2024.

Indexed to 2016 = 100, the 2024 values are 84.4 for Norway and 115.8 for Russia (Figure 1). The harmonized data for 2025 and 2026 are not available yet; hence, testing is made for one focal window year, H1.

Verdict H1: not rejected. Both rules (a) and (b) are satisfied. The outcome is limited to results; it does not condemn or validate any claim regarding the reasons of the different trajectories. Criterion F1 (Table 3) extends the test to 2025–2026.

Figure 1

Fossil CO_2 emissions of Norway and Russia, 2016–2024, indexed (2016 = 100). The dotted line marks the 2022 invasion.



5.3 | H2 and H3: conflict and divergence (RQ2)

H2 (did the invasion break the emissions trajectories?). A line was fitted to 2016–2021 and extended to 2022–2024 (Table 10). All six post-invasion observations lie inside their 95% prediction intervals. **Verdict H2: not rejected.** The pre-invasion window has only six points and four degrees of freedom, so the intervals are wide (for example, Russia 2024: 1,758.6 to 2,226.5 Mt). Concretely, by 2024 a departure from the 2016–2021 trend of less than about 3.1 Mt for Norway (7.5%) or 234 Mt for Russia (12%) could not have been detected. The result shows no detectable change of trajectory; it does not show that the invasion had no effect.

Table 10

Post-invasion emissions against the 2016–2021 trend (test of H2; 95% prediction intervals, 4 df)

Series	Slope 2016–2021 (Mt/yr)	Year	Observed (Mt)	Forecast (Mt)	95% prediction interval	Inside?
Norway CO_2	−0.774	2022	43.55	43.11	[40.62, 45.60]	Yes
		2023	41.60	42.34	[39.56, 45.11]	Yes
		2024	40.00	41.56	[38.46, 44.66]	Yes
Russia CO_2	+31.68	2022	1,895.47	1,929.16	[1,741.33, 2,117.00]	Yes
		2023	1,948.30	1,960.84	[1,751.27, 2,170.42]	Yes
		2024	2,009.15	1,992.53	[1,758.60, 2,226.45]	Yes

Table 10 asks whether the invasion broke the emissions trend. A line was drawn through 2016–2021 and 2022, 2023 and 2024 were checked against it. All six values are inside the safe range, so no break is seen. But only six years went into the line and the ranges are wide, so this means 'no break detected', not 'no effect'.

H3 (did NSR growth slow at 2022?). A linear trend gives +3.31 Mt per year over 2016–2025, but the series is non-linear: growth averaged 8.0 Mt per year between 2016 and 2019 and 0.9 Mt per year between 2019 and 2025. A continuous piecewise-linear fit with a break in 2019 describes the series far better than one with a break in 2022 (Figure 2; descriptive, not a test). The growth-rate splits in Table 11 apply the rule of H3. H3 is a deliberately simple reading of the war-centred account: it tests whether growth slowed at 2022, not whether policy changed (Mikhailova and Tabata 2024).

Table 11

Growth-rate splits for NSR cargo, 2016–2025 (test of H3)

Split of the nine growth rates	Mean log growth before (%)	Mean log growth after (%)	t	Unadjusted exact p	Adjusted p (max-t)
After 2019 (3 vs 6 intervals)	47.8	2.7	7.64	0.012	0.012
After 2020 (4 vs 5 intervals)	37.0	2.3	3.15	0.024	0.030
After 2021 (5 vs 4 intervals)	30.7	1.5	2.23	0.032	0.067
After 2022 (6 vs 3 intervals)	25.2	2.8	1.40	0.143	0.264

Notes. Growth is the mean annual change in log values × 100. Unadjusted p-values are one-sided exact permutation p-values (all 84 or 126 assignments). Adjusted p-values allow for the search over the four candidate splits (all 9! = 362,880 orderings). The adjusted and unadjusted values coincide for the 2019 split because only 4,320 of the 362,880 orderings (1/84), those that place the three largest growth rates first, reach the observed maximum t of 7.64.

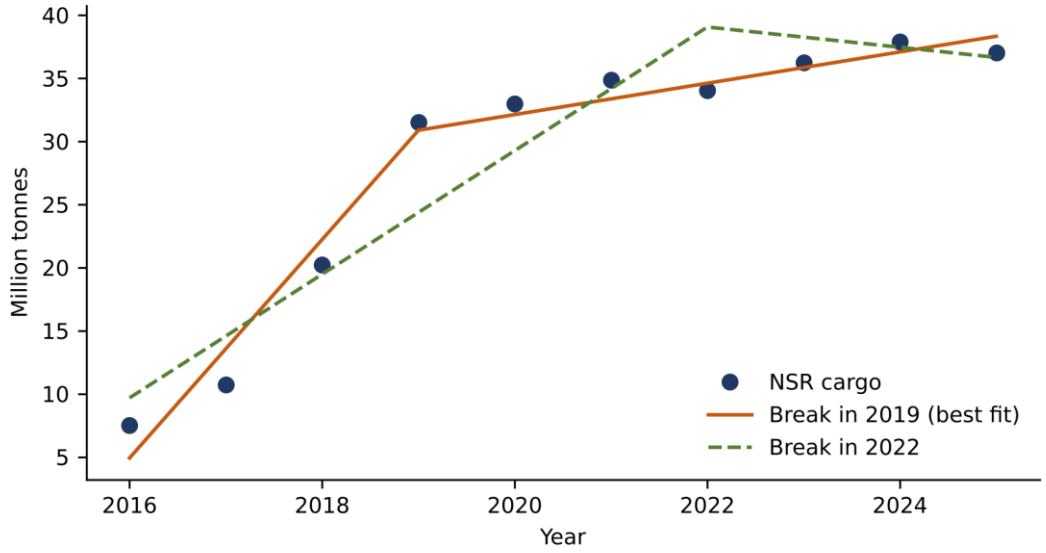
Table 11 enquires about when NSR growth slowed. A total of four years were split. The 2019 split is most obvious with growth around 48% prior to the split and around 2.7% since the split (p = adjusted p = 0.012). The 2022 split is weakest (adjusted p = 0.264). The slowdown was in 2019 and 2020, not during the invasion.

The war-centered account makes the prediction that the split that best fits the data for 2022 is the one that has an adjusted p-value of less than 0.05. The 2022 split has the lowest t (1.40) of the four splits and an adjusted P-value ($P<0.05$) of 0.264. **Verdict H3: rejected.** This removes one account; it does not identify what caused the slowdown. As exploratory context only, the best split falls after 2019 (adjusted p = 0.012) and the split

after 2020 also passes (0.030), so the slowdown predates the invasion. The verdict holds for the rounded 2022 and 2025 values (Table B1) and for alternative 2016 values of 6.9 and 7.27 Mt (Table B2).

Figure 2

NSR cargo (Mt), 2016–2025, with continuous piecewise-linear fits for a break in 2019 (best fit) and a break in 2022 (descriptive).



5.4 | H4, H5 and H6: conflict and cooperation (RQ3)

Table 12

Agreed Northeast Arctic cod TAC against scientific advice, 2016–2026 (test of H4)

Quota year	Advice issued by	Advice (t)	Agreed TAC (t)	Deviation	Agreed
2016	ICES	805,000	894,000	+11.1%	before invasion
2017	ICES	805,000	890,000	+10.6%	before invasion
2018	ICES	712,000	775,000	+8.8%	before invasion
2019	ICES	674,678	725,000	+7.5%	before invasion
2020	ICES	689,672	738,000	+7.0%	before invasion
2021	ICES	885,600	885,600	0.0%	before invasion
2022	ICES	708,480	708,480	0.0%	before invasion
2023	JRN-AFWG	566,784	566,784	0.0%	after invasion
2024	JRN-AFWG	453,427	453,427	0.0%	after invasion
2025	JRN-AFWG	311,587	340,000	+9.1%	after invasion
2026	JRN-AFWG	269,440	285,000	+5.8%	after sanctions
Mean (SD), quotas 2016–2022				+6.4% (4.6)	
Mean (SD), quotas 2023–2026				+3.7% (4.5)	

Notes. Advice and TAC for 2016–2026 are from the history table of the joint advice report (IMR–PINRO 2025a); the 2026 TAC was cross-checked against the Norwegian government's announcement; no 2027 quota is used (Section 3.6). The quota for a given year is agreed in the preceding autumn, so the 2022 quota (agreed in 2021) precedes the invasion. For 2016–2022 the advice was issued through ICES; from 2023 it was prepared by the bilateral JRN-AFWG, outside ICES (Section 4.2). The 2021 and 2022 values are consistent with the control rule's limit on annual change. The maximum deviation, before invasion, was +11.1%; after the invasion, it was +9.1%. For pre- and post-invasion deviations (ties treated as missing): $p = 0.38$ (descriptive) by exact permutation test on the ranks of the deviations.

Table 12 shows a comparison between the cod quota and the advice. The plus sign (+) indicates that the quota was increased. In 2016 and 2017, the gap was above 10%. It fell to zero in 2021–2024, rose to 9.1% in

2025, then fell to 5.8% in 2026. The mean difference following the invasion is less (3.7% vs. 6.4%), although the difference is small and may be due to chance.

Figure 3

Agreed Northeast Arctic cod TAC and scientific advice (thousand tonnes), 2016–2026.

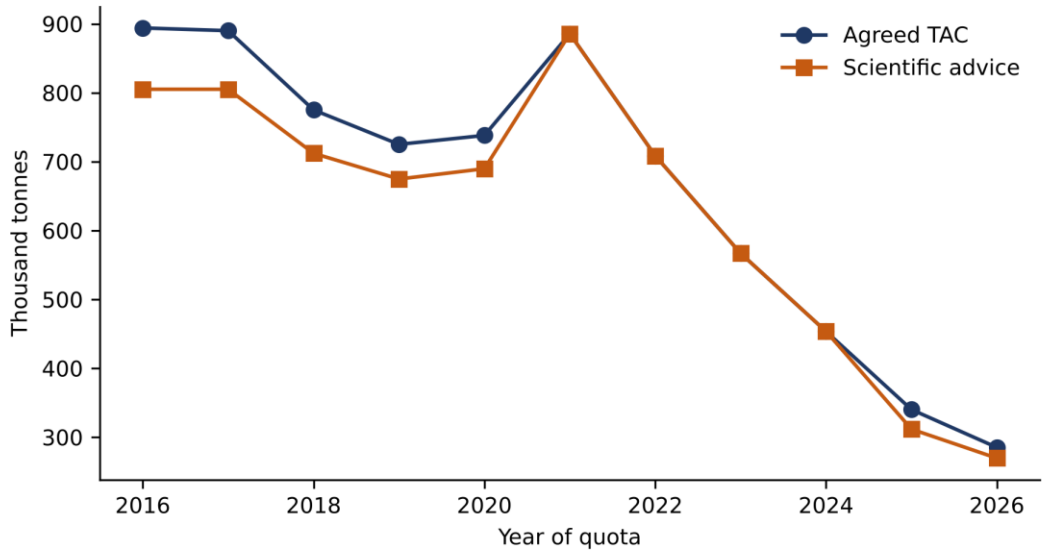
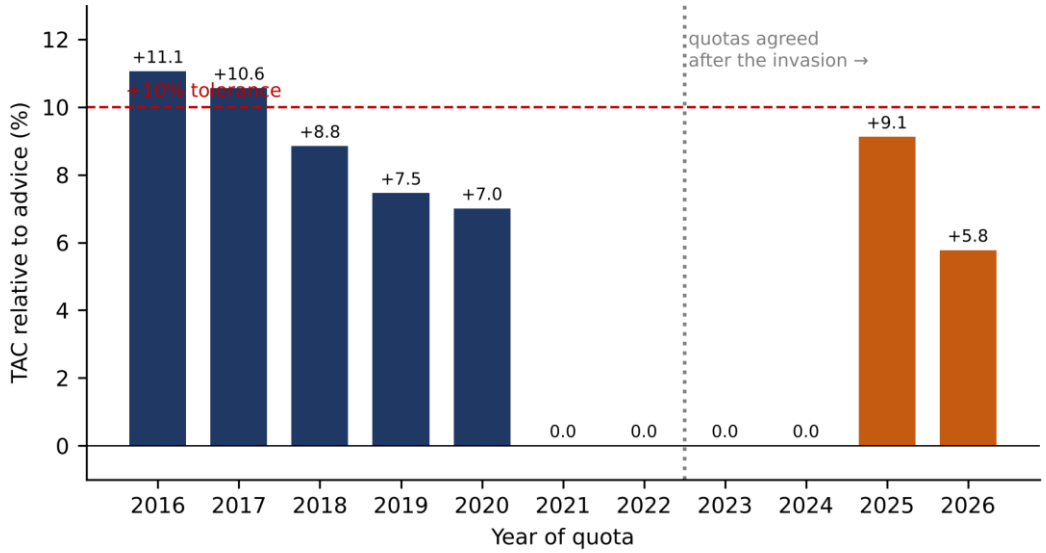


Figure 4

Percentage deviation of the agreed cod TAC from scientific advice, 2016–2026, with the +10% tolerance. Dark blue: quotas agreed before the invasion; orange: quotas agreed after it.



H4a (original rule). Two of the eleven deviations exceed ±10%: the quotas for 2016 (+11.1%) and 2017 (+10.6%) (Table 12, Figure 4). **Verdict H4a: rejected.** Both exceedances lie before the conflict, and why they occurred is not tested here. The harvest control rule's cease the change cap on annual change then brings the gap back to 0.0% in 2021 and 2022, and the 2023 and 2024 quotas are again identical to the advice. On 25 October 2022, the first quota agreement after the invasion for 2023 was announced (Ministry of Trade, Industry and Fisheries 2022).

H4b (revised rule). All four post-invasion quotas lie within ±10% of the advice: 0.0%, 0.0%, +9.1%, and +5.8%. The largest, +9.1% in 2025, is below the pre-invasion maximum of +11.1%. **Verdict H4b: not rejected.** Three qualifications apply. First, H4b is a post hoc revision written after H4a failed, and another cut-off could have been chosen. Second, the 2025 quota (340,000 t) is 28,413 t above the advice of 311,587 t, and the joint report records it as set above the advice; at a tolerance below 9.1% H4b would be rejected. Third, the 2025 quota was agreed before the July 2025 sanctions, because quotas are set in the preceding autumn. Deviations do not differ clearly before and after the invasion (mean +6.4% against +3.7%; exact permutation test on ranks, $p = 0.38$).

Table 13

Event record for H5 and H6

Element	Date or value	Source	Rule
Sanctions: Norway aligns with EU listing of Norebo and Murman Seafood (asset freeze; ports and territorial waters closed to their vessels; as a rule, no fishing licences in the Norwegian economic zone)	7 July 2025	Ministry of Foreign Affairs (2025)	Direct evidence of conflict (Section 3.1)
Bilateral agreement on 2026 quotas: cod 285,000 t, haddock 153,293 t, joint research programme for 2026	18 December 2025 (164 days after the sanctions)	Ministry of Industry, Commerce and Fisheries (2025)	Agreement before 1 January 2026: met
Deviation of 2026 cod TAC from 2026 advice	+5.8%	IMR–PINRO (2025a); Ministry of Industry, Commerce and Fisheries (2025)	Within ±10% (H5): met; within 0.0% to +7.0% (H6a): met; within 0.0% to +11.1% (H6b): met
Bilateral agreement on 2027 quotas (Ministry page and protocol of the 57th session)	not read	the page and the protocol could not be opened	Excluded: no 2027 value enters any test
Earlier cycles: 2023 quotas (52nd session) announced by the Ministry; 2024 quotas (53rd) and 2025 quotas (54th) fixed in documents of the Directorate of Fisheries	25 October 2022; dates of the 53rd and 54th sessions not stated	Ministry of Trade, Industry and Fisheries (2022); Directorate of Fisheries (2023, 2024)	The 18 December 2025 announcement fell 54 days later in the calendar year than the 25 October 2022 announcement, the only earlier cycle with an official date

Note. The responsible minister said that the listing of the two Russian companies had influenced the 2026 talks (Ministry of Industry, Commerce and Fisheries 2025). The listing froze the companies' assets, closed Norwegian ports and territorial waters to their vessels, and as a rule denied them fishing licences in the Norwegian economic zone (Ministry of Foreign Affairs 2025).

Table 13 lists the key events. Norway sanctioned two Russian fishing companies on 7 July 2025. On 18 December 2025, 164 days later, the two countries agreed the 2026 quotas; the cod quota was 5.8% above the advice. An agreement on the 2027 quotas has since been published, but its text could not be read, so it is not used.

H5. The rule is fulfilled by both the agreement date, 164 days after the sanctions, and the date of the 2026 deviation (+5.8%). **Verdict H5: not rejected.** This is a weak test, since it is possible to complete the test by the end of the year. The only earlier event that had been officially announced was on 25 October 2022, 54 days before the 2026 agreement, and the minister stated that the listing of the two companies had had an impact on the negotiations (Ministry of Industry, Commerce and Fisheries 2025). The sanctions seem to have thrown a spanner in the works but not into the negotiations so far, just on an earlier date.

H6. The 2020–2022 deviations (+7.0%, 0.0%, 0.0%) give the narrow band of 0.0% to +7.0% (H6a); the 2016–2022 deviations give the extended band of 0.0% to +11.1% (H6b). The 2026 deviation (+5.8%) lies inside both. **Verdict H6a: not rejected. Verdict H6b: not rejected.** The extended band rests on seven pre-

invasion pairs, but only one post-sanctions observation exists. The 2025 quota (+9.1%) would fall outside H6a but not H6b; it predates the sanctions, however, and does not bear on H6.

Comparison stock: haddock (C1). The cod result could be specific to cod, so the rules were applied unchanged to Northeast Arctic haddock, which is set by the same commission on advice from the same bodies (Table 12b, Figure 5). The result differs. Haddock quotas equalled the advice in eight of eleven years, but exceeded it by 13.2% in 2019, 10.5% in 2024, and 21.6% in 2025. H4a is therefore rejected for haddock (2019), and H4b is rejected too: two of the four post-invasion quotas lie beyond +10%, and the 2025 deviation is above the pre-invasion maximum of +13.2%. For the quota agreed after the sanctions (2026) the haddock TAC equals the advice, so H5 and H6 are not rejected.

Table 12b

Northeast Arctic haddock: agreed TAC against scientific advice, 2016–2026, with the cod deviation for comparison

Year	Haddock advice (t)	Haddock TAC (t)	Haddock deviation	Change in haddock advice	Cod deviation (Table 12)
2016	244,000	244,000	0.0%	n/a	+11.1%
2017	233,000	233,000	0.0%	−4.5%	+10.6%
2018	202,305	202,305	0.0%	−13.2%	+8.8%
2019	152,000	172,000	+13.2%	−24.9%	+7.5%
2020	215,000	215,000	0.0%	+41.4%	+7.0%
2021	232,537	232,537	0.0%	+8.2%	0.0%
2022	178,532	178,532	0.0%	−23.2%	0.0%
2023	170,067	170,067	0.0%	−4.7%	0.0%
2024	127,550	141,000	+10.5%	−25.0%	0.0%
2025	106,912	130,000	+21.6%	−16.2%	+9.1%
2026	153,293	153,293	0.0%	+43.4%	+5.8%

Notes. Haddock advice and TAC for 2016–2026 are from the history table of the haddock report (IMR–PINRO 2025b); The 2016 advice is stated as "< 244,000 t". From 2023 the advice was prepared by the JRN-AFWG, outside ICES. Exact permutation test on ranks, haddock pre- against post-invasion deviations: p = 0.41 (descriptive).

Figure 5

Percentage deviation of the agreed TAC from scientific advice for cod and haddock, 2016–2026, with the +10% tolerance.

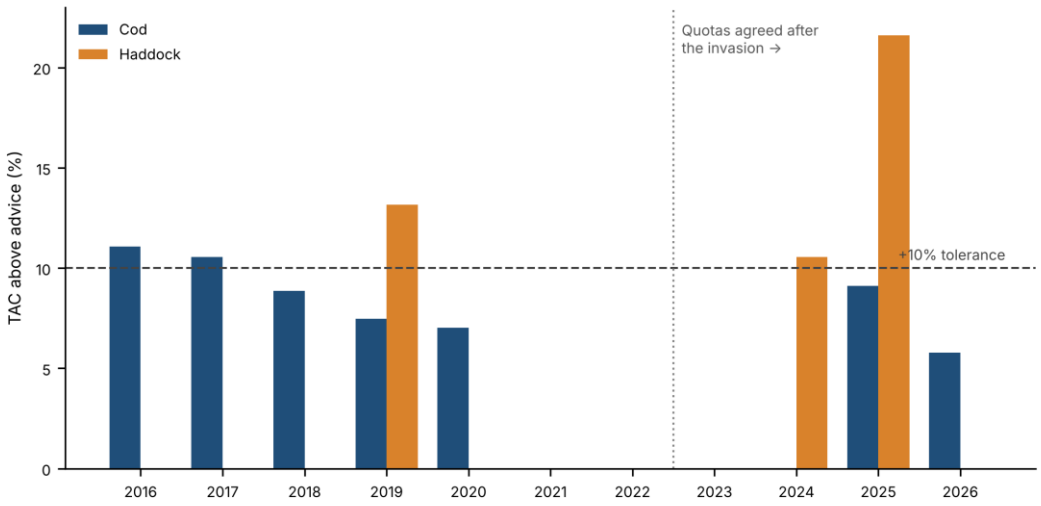


Table 12b repeats the test for haddock. Most years the quota equals the advice, but it was higher in 2019, 2024 and 2025. The 21.6% gap in 2025 is the largest in the study, so haddock lacks the calm that cod shows after 2022. The 2026 quota again equals the advice.

Pooling both stocks, 3 of 14 pre-invasion and 2 of 8 post-invasion stock-years exceed +10% (Fisher's exact test $p = 1.0$), and the mean deviation is 4.1% before and 5.9% after (rank test $p = 0.79$; the pairs are not independent). Adherence did not change measurably: it improved for cod and worsened for haddock. Exceedances follow sharp falls in advice. Haddock advice fell by 24.9% for 2019, 25.0% for 2024, and 16.2% for 2025, and cod advice fell by 31.3% for 2025. Across the 20 stock-years with a previous advice, the rank correlation between the deviation and the change in advice is −0.36 ($p = 0.11$; exploratory). Three of the 14 stock-years with a falling advice exceed +10%, against one of the 6 other years (cod 2017).

5.5 | Rival theory predictions (RQ4)

Table 14 applies the rejection conditions of Table 2. Cooperation did not fail after the sanctions: the agreement was concluded before the year-end and the deviation stayed inside both pre-invasion bands. P1 (spillover) is therefore rejected on every version of the rule. P2 (insulation) is not rejected for cod under the revised rule and is rejected under the original rule, because H4a fails through two quotas agreed before the invasion. If haddock is P2, it is rejected under the two rules (2019, 2024, and 2025); therefore, the verdict depends on the stock. The biggest indication of strain in the data is the late date of the 2026 agreement. It is not considered to be spilling in this context (no agreement prior to 1 January or deviation outside the band), but if the definition of spillover were tightened and based on timing, it would be more difficult to object. Both verdicts are based on one sanction episode and the operational readings of the theories used here.

Table 14

Verdicts on the rival theory predictions

ID	Theory	Evidence	Verdict
P1	Neorealism (spillover)	Agreement 164 days after sanctions; 2026 deviation +5.8% (H5, H6a, H6b not rejected)	Rejected (n = 1 episode)
P2	Liberal institutionalism (insulation)	Cod: H4b, H5, H6 not rejected; H4a rejected through the 2016–2017 quotas. Haddock: H4a and H4b rejected (2019; 2024, 2025); H5, H6 not rejected	Cod: not rejected under the revised rule. Haddock: rejected. Mixed

Table 14 provides the verdict on the theories. There were no spillover predictions made, and no spillovers occurred, so it is rejected. Based on the theory of insulation, it was predicted that cooperation would prevail. It largely did it for cod; it did not for haddock. Both results are based on one sanctions event.

5.6 | Summary of verdicts

Table 15

Verdicts by relation

Relation	Hypothesis	Rejection rule (short form)	Key result	Verdict
Divergence	H1	Slopes not opposite or CI includes zero; 2024 outside interval	−0.90 and +31.0 Mt/yr; both 2024 values inside bands	Not rejected
Conflict → divergence	H2	Any of 6 post-invasion values outside 2016–2021 intervals	All 6 inside; wide intervals	Not rejected (low power)
	H3	2022 not best split or adjusted p ≥ 0.05	2022 split smallest t; adjusted p = 0.264	Rejected
Cooperation (original rule)	H4a	Any of eleven deviations beyond ±10%	2016 +11.1%, 2017 +10.6%	Rejected
Cooperation (revised rule)	H4b	Post-invasion deviation beyond ±10%, or post-invasion maximum above pre-invasion maximum	Post-invasion maximum +9.1% (2025); pre-invasion maximum +11.1%	Not rejected (post hoc revision)
Conflict → cooperation	H5	No agreement before 1 January 2026, or deviation beyond ±10%	Agreed 18 December 2025; +5.8%	Not rejected (n = 1)
	H6a, H6b	2026 deviation outside 0.0% to +7.0% (H6a) or 0.0% to +11.1% (H6b)	+5.8%	Not rejected in both (n = 1)
Comparison stock (haddock, C1)	H4a, H4b, H5, H6	Same rules as for cod	H4a rejected (2019 +13.2%); H4b rejected (2024 +10.5%, 2025 +21.6%); H5 and H6 not rejected (0.0%)	Mixed: P2 rejected for haddock
Divergence ↔ cooperation	—	Not testable (short, trending series)	—	No verdict
Dual pattern, cod (Section 3.4)	H1, H4, H5, H6	Any of the four rejected	H4a rejected; H4b, H1, H5, H6 not rejected	Rejected under the original rule; not rejected under the revised rule. Not supported for haddock

Table 15 is the scorecard: one row per hypothesis, with rule, result and verdict. E missions spread apart and don't exhibit any break in emission. A break in growth in cargo in 2022 is not accepted. The old cod rule is not valid, and the new cod rule is valid. After the invasion, the haddock rules do not apply. The 2026 agreement was in time and close to the advice. No conclusive evidence is given.

As indicated in Table 15, the dual pattern for cod only survives when the cooperation rule is only applied in the post-invasion years; in either iteration it is not sustainable for haddock. The NSR slowdown is not considered to be related to the war, spillover is not considered, and insulation is not considered for COD under the revised rule. This is less than confirmation: the rules were adjusted after inspection, the changed rule was as a result of failure, and the conflict evidence consists of one episode.

5.7 | Comparison with earlier research and theory

Table 16 sets each result against earlier findings and theoretical expectations, taken from the cited studies at the level of abstracts (Section 4.4).

Table 16

Present results compared with earlier research and theoretical expectations

Earlier work or theory	What it found or expected	What this study found	Relation
Honneland (2014); Osthagen (2016)	Bilateral fisheries cooperation is resilient under political tension.	Post-invasion quotas within 9.1% of advice (H4b); pre-invasion quotas up to 11.1% above it (H4a); 2026 agreement 164 days after sanctions (H5).	Consistent; extends to the 2025 sanctions for one output.
Byers (2017)	After 2014 military and economic cooperation was suspended while fisheries cooperation continued (complex interdependence).	The cooperation output continued after the 2025 sanctions (P2 not rejected).	Consistent; one further episode.
Stokke (2024)	Resilience varies with institutional characteristics and the severity of the challenge.	One stock and one severity level; institutional characteristics not measured.	Not contradicted; variation cannot be tested.
Hammer (2025)	Joint fisheries science works as a well-functioning epistemic community.	2026 joint advice was available and the 2026 quota is 5.8% above it; the agreement includes a joint research programme.	Consistent in outcome; quality of scientific cooperation not measured.
Koivurova and Shibata (2023)	The invasion ended Arctic cooperation as it had been; whether treaty-based cooperation is more resilient than soft-law cooperation is examined, with the central Arctic Ocean fisheries agreement as a case that continued.	No deterioration in the treaty-regime output (H4–H6); the Arctic Council is not examined.	Not contradicted; compatible with treaty-based resilience.
Misund (2025)	Norway's sanctions have exceptions, including fisheries research and management in the Barents Sea.	Joint advice and the quota agreement continued, consistent with the exception; frequency of contact not measured.	Not contradicted; different level.
Andreeva (2023)	Ending cooperation with Russia in the Arctic Council could seriously harm Arctic climate research.	The Arctic Council is not examined; the bilateral fisheries advice continued after 2022.	Not contradicted; different channel.
Hansen-Magnusson and Gehrke (2025)	Arctic governance may be reconfigured away from the Arctic Council.	The bilateral quota output was unchanged; reconfiguration not measured.	Not testable here.
Zhao et al. (2026)	Policy texts diverge on territorial and resource strategies.	Emissions diverge in outcomes (H1).	Consistent in direction; texts versus outcomes.
Mikhailova and Tabata (2024)	Russia kept the NSR a priority after February 2022 but shifted its emphasis toward domestic purposes.	No 2022 break in NSR cargo growth (H3 rejected); the slowdown dates to 2019–2020.	Qualifies: a policy change is not visible as a break in cargo totals.
Rendon-Betancur and Dyer (2026)	Norwegian White Papers defend further Arctic oil extraction through climate-obstruction discourses.	Norwegian fossil CO_2 fell by 15.6% (2016–2024).	Different level; no inference about discourse.
Rees and Buntgen (2024)	The war disrupted Russian–Western science collaboration and widened data gaps.	Bilateral advice continued, but the 2025 emissions values could not be retrieved.	Not contradicted; data gaps are visible in this study.
Stokke (2012)	Regimes are evaluated by output, outcome, and impact.	The deviation is an output measure; outcome and impact are not measured.	Consistent; outcome and impact not measured.
Neorealism (Waltz 1979)	Conflict spills over into cooperation; outcomes diverge between rivals.	No spillover observed (P1 rejected); divergence observed (H1).	Spillover reading rejected; divergence does not discriminate.
Liberal institutionalism (Keohane 1984; Nye 1977)	Institutions insulate cooperation from conflict.	Insulation prediction not rejected (P2).	Consistent, on one episode.

Table 16 compares the results with earlier work. Research indicates that fisheries cooperation held up under stress, and the data in this table confirm that this was indeed the case for the years since the invasion. This study does not contradict studies that report less science cooperation, as it measures the quota rather than the frequency of scientist meetings. After 2022, Russia's route policy turned toward domestic purposes; however, there is no break in the cargo.

Three patterns emerge. The present result is consistent with earlier research results on fisheries cooperation (Honneland 2014, Osthagen 2016, Byers 2017, and Hammer 2025), while studies of the conflictual dynamics in the field of science and institutional cooperation after 2022 (Andreeva 2023, Koivurova and Shibata 2023, Misund 2025, and Rees and Buntgen 2024) do not contradict the result. Second, the NSR policy shift after 2022 (Mikhailova and Tabata 2024) has no counterpart as a break in cargo growth. Third, the divergence result agrees with text-based evidence (Zhao et al. 2026).

5.8 | What was not observed, and what was not tested

Table 17 lists outcomes that could have occurred but were not observed, each with the test that would have revealed it.

Table 17

Outcomes that could have occurred but were not observed

Outcome that could have occurred	What was observed	Test
A break in the emissions trajectories after the 2022 invasion	None detected: all six post-invasion values inside the 2016–2021 intervals	H2 (low power)
A 2022 break in NSR cargo growth	Not observed: the 2022 split had the smallest t of four (adjusted p = 0.264); the slowdown dates to 2019–2020	H3
A reversal of the emissions trends in 2024	Not observed: both 2024 values inside the baseline bands (Norway near the lower bound)	H1
Quotas drifting far from the advice after the invasion	Cod: not observed (post-invasion maximum +9.1%, 2025). Haddock: observed (2024 +10.5%, 2025 +21.6%). Pre-invasion exceedances also occurred (cod 2016–2017, haddock 2019)	H4a (rejected), H4b (cod not rejected; haddock rejected)
A missed or delayed quota agreement after the sanctions	Not observed: agreement on 18 December 2025, 164 days after the sanctions, before the year-end	H5
A worse quota deviation after the sanctions than before the invasion	Not observed: cod +5.8% (2026) against pre-invasion ranges of 0.0% to +7.0% and 0.0% to +11.1%; haddock 0.0% in 2026	H6a, H6b
Spillover of the sanctions conflict into the cooperation output	Not observed	P1 (rejected)
Cargo reaching the 80 Mt target of Presidential Decree No. 204	Not met: 37.9 Mt in 2024 (47.4%); annual cargo has stayed between 33.0 and 37.9 Mt since 2020	Descriptive; no hypothesis

Note. **"Not observed"** means that the stated rejection rule was not met. It does not show that the outcome is impossible, because the series are short and some tests have low power (H2).

Table 17 contains items that might have occurred. Following the invasion, cod quotas have not moved far from the advice, but haddock quotas have in 2024 and 2025. The deal in 2026 was not delayed, and there was no spill-over. 'Not observed' does not imply that the test was not conducted. Cargo delivery of 47% of the 80 million-ton target was achieved.

6 | DISCUSSION

6.1 | Interpretation of the findings

Conflict and divergence (O1, O2). Under all estimators, both Norwegian and Russian emissions are decreasing while 2024 remains on the baseline path (H1). Post-invasion emissions are consistent with the range expected by the pre-invasion trend (H2), and the time of the NSR slowdown is not war-centered (H3).

The divergence thus seems to have been in progress prior to the invasion and was not perceptibly affected by it.

Conflict and cooperation (O3). The original rule fails on the full series because of the 2016 and 2017 quotas (H4a). The four post-invasion quotas (2023–2026) stayed within 9.1% of the advice (H4b), and the 2026 agreement came 164 days after the sanctions, before the year-end deadline but later in the year than the one earlier cycle with an official date, with a deviation inside both pre-invasion bands (H5, H6).

The revised rule does not work for haddock, the comparison stock (2024 + 10.5%, 2025 + 21.6%), except for the 2026 quota, which matches the advice. Adherence was not measurably different between the two stocks (3/14 stock-years before the invasion, 2/8 after the invasion), and exceedances occurred when there was a reduction in advice (exploratory). Three factors mitigate this weight: the recommendations are from a harvest control rule, so closeness is a measure of procedure and not of goodwill; the sanctions are a single episode; and the recommendations in H4b came after the failure of H4a.

Divergence and cooperation. This association was not tested. There is coexistence only if both existed at the same time.

6.2 | Relation to earlier research

The results agree with the qualitative literature on the resilience of the bilateral fisheries regime (Honneland 2014; Gronnevet 2016; Jorgensen 2022; Osthagen 2016; Stokke 2024; Byers 2017) and add a measured benchmark: through the sanctions, the cod quota stayed within a stated distance of scientific advice. They do not contradict reports that cooperation changed after 2022 (Koivurova and Shibata 2023; Rees and Buntgen 2024), which concern other channels. The NSR result qualifies Mikhailova and Tabata (2024), since cargo growth shows no break in 2022 (Table 16).

6.3 | Implications for theory

It is a neorealist argument that suggests that the spread of conflict will lead to cooperation. No spillover found: The sanctioned quota was agreed on in time and within the pre-invasion range; thus, P1 is rejected. Under the revised rule, liberal institutionalism generates the expectation of insulation, which is not the case. Four qualifications apply. This is not a test of P1 and P2 but just one test. The dyad and the domain love cooperation (a shared stock, a long-standing regime, and a science-based rule), and thus the evidence for insulation is weaker here, and the evidence against neorealism is weaker here. There can be no proof of the generalization of insulation in one episode. The verdict, though, depends on the stock: under this new rule, cod is insulated but NOT FOR haddock.

6.4 | A rule that failed, and the change of advisory body

Tested on only the four pairs first available (2020–2022 and 2026), the cooperation rule would have passed, with a maximum deviation of +7.0%. On the full series it is rejected. The revision to H4b is defensible, since the conflict begins in 2022, but also convenient, so it is flagged as post hoc and the original verdict is reported beside it.

The change of advisory body adds a limit. Until the 2022 quota the advice came from ICES, in which both states took part; from 2023 it came from the bilateral JRN-AFWG (IMR–PINRO 2025a). A group made

up of the two parties could produce advice that anticipates what the commission will accept. Exact equality, as for cod in 2023 and 2024, is what anticipation would produce, but also what strict adherence would produce. A benchmark produced outside the bilateral group would be a stronger test; none is available for the years after 2022.

6.5 | Alternative explanations and what cannot be established

Four readings fit the evidence as well as insulation does. First, *shared interest*: both states depend on one stock, so cooperation may follow from interest, not from institutional insulation. Second, *a binding rule*: a harvest control rule and an advisory group of the two parties make closeness to advice the easy outcome, which would produce the cod results without any insulation. Third, *a narrow conflict*: Norway's measures have so far been targeted. Russian-flagged vessels have been kept out of most Norwegian ports since autumn 2022, and two Russian companies lost access to Norway's ports and, as a rule, to fishing licences in its economic zone after the 2025 listing (Ministry of Foreign Affairs 2025), while the quota agreement continued. Such a narrow conflict would not be expected to spill over, although it limits what the case can show about wider strains in the regime. Fourth, *pressure when advice falls*: the exceedances for both stocks follow falls in advice, before and after the invasion, so bargaining over the stock, not the war, may explain them. Separating them needs more stocks and dyads.

The emissions-break test (H2) is low-powered, and H6 is based on one observation after sanctions. The study does not explain the reasons for the divergence of emissions, for the slowing of NSR growth, or why the parties followed the advice, nor does it explain that the pattern extends beyond these two stocks.

6.6 | Contribution

The study introduces outcome-oriented assessment of divergence and assessment of cooperation and conflict, which are partially qualitative assessments with a little quantitative content (G1 and G2). Coexistence is not new, but the unsavory circumstances and the honest admission of failure are new.

6.7 | Implications

The central methodological lesson from the study of Arctic cooperation is that claims of coexistence, if limited to outcomes, can be formulated as 'rejectable conditions' and tested against public indicators, even for one dyad, when low-powered claims are reported. In the short-term, the record is consistent with a quota rule based on scientific advice as a buffer against political conflict, but this is not tested for. Monitoring should be to observe the timing of the annual agreement and the distance between the quota and advice. Neither shows clear deterioration for cod, although the 2025 cod quota was 9.1% above the advice and the 2024 and 2025 haddock quotas 10.5% and 21.6% above. For theory, insulation and spillover should be tested in more than one domain.

6.8 | Criteria for later data

Table 3 gives the status of the first two criteria. F1 and F2 both stay open: F1 until the 2025 fossil-CO_2 values are retrieved, and F2 until the official text of the 2027 agreement can be read.

Two genuinely prospective criteria are added, fixed before the data exist. F3: the 2028 quota is agreed before 1 January 2028 with a deviation within ±10% and within 0.0% to +11.1%. F4: the 2026 fossil-CO_2 values lie inside the F1 bands for 2026. Failure of F3 would reject H4b, H5, and H6b for that cycle.

6.9 | Limitations and future research

The verifications of the rules were made during the series, and there was no pre-registration of the verdicts, as H4 had to be revised after it failed. The series are short (nine to eleven observations), the inference is indicative only, and only the H1 tests were tested for serial dependence. Focal window seen unevenly: 1 emission see, 2 NSR cargo emissions see, and 5 post-invasion quotas. The measure of conflict is one event, while there are two output indicators from one commission for cooperation, and the ±10% tolerance is given. A relationship between divergence and cooperation has yet to be tested, and it is documented as coexistence but not a mechanism. The only comparison possible is a second stock set by the same commission, and the design does not reveal what cooperation might have been like in the absence of the conflict. The emissions are from the 2025 EDGAR release and have not been re-checked against the 2026 EDGAR release. NSR 2016-2019 is rounded to one decimal. The orientation of the advice series changes in 2023, in parallel with the invasion, such that the two are inseparable (Section 4.2), and after that, the two parties generate the advice independently (Section 6.4). Further stocks and dyads and a re-run of H1 and H2 using the current EDGAR release should be added in the future.

7 | CONCLUSION

This study focused on one of the questions identified in Section 1.2 (whether conflict and cooperation exist together within the Norway–Russia dyad) to find an answer. It sought to answer research questions RQ1–RQ4, to test six hypotheses with rejection rules, and to compare it to two alternative predictions, O1–O4. Based on evidence from November 2026, five conclusions follow. The first is the divergence of emissions, and in 2024 they were within the emission limits (H1; O1, RQ1). Second, no break in emissions was detected after the 2022 invasion (H2, low power), and a 2022 break in NSR growth was rejected (adjusted $p = 0.264$), because the slowdown dates to 2019–2020 (H3; O2, RQ2). Third, the original cooperation rule failed: the 2016 and 2017 quotas exceeded the advice by 11.1% and 10.6% (H4a). Fourth, the four quotas agreed after the invasion stayed within 9.1% of the advice (H4b, a post hoc revision), the 2026 quota was agreed 164 days after the sanctions, later in the year than the one earlier cycle with an official date but before year-end, with a deviation of +5.8% inside both pre-invasion bands (H5, H6) (O3, RQ3). For haddock, the comparison stock, the revised rule fails (2024 +10.5%, 2025 +21.6%), and pooled across both stocks adherence did not change measurably. Spillover was therefore rejected (O4, RQ4), and insulation was not rejected for cod under the revised rule but was rejected for haddock. Fifth, the relation between divergence and cooperation could not be tested. The dual pattern is rejected under the original rule and not rejected under the revised one for cod, and in neither form is it confirmed. The decisive evidence will be the 2028 quota cycle and re-checked emissions (Section 6.8).

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APPENDIX A. DATA SERIES USED

Table A1

Annual series

Year	Norway CO_2 (Mt)	Russia CO_2 (Mt)	NSR cargo (Mt)	Agreed cod TAC (t)	Advice (t)	TAC vs advice
2016	47.37	1,734.64	7.5	894,000	805,000	+11.1%
2017	47.41	1,763.24	10.7	890,000	805,000	+10.6%
2018	46.64	1,831.13	20.2	775,000	712,000	+8.8%
2019	45.35	1,858.00	31.5	725,000	674,678	+7.5%
2020	43.71	1,784.20	32.97	738,000	689,672	+7.0%
2021	44.43	1,938.46	34.85	885,600	885,600	0.0%
2022	43.55	1,895.47	34.034	708,480	708,480	0.0%
2023	41.60	1,948.30	36.254	566,784	566,784	0.0%
2024	40.00	2,009.15	37.90	453,427	453,427	0.0%
2025	n/a	n/a	37.02	340,000	311,587	+9.1%
2026	n/a	n/a	n/a	285,000	269,440	+5.8%

Notes. Emissions are fossil CO_2 from fuel combustion as compiled from the 2025 EDGAR release (Crippa et al. 2023) and were not re-checked against the 2026 release. NSR cargo is total annual cargo: the 2016–2019 values are the rounded figures of Gunnarsson (2021) and Lukin (2020), who rely on the NSR Administration; 32.97 Mt (2020) and 34.85 Mt (2021) are from the Investment Portal of the Arctic Zone (2022); 34.034 Mt for 2022 is from Friskila (2023; Rosatom reports 34.1 Mt); 36.254 Mt for 2023 is from the Investment Portal of the Arctic Zone (2024); 37.9 Mt for 2024 is a Rosatom figure (Rosatom 2025); and 37.02 Mt for 2025 is a Rosatom figure (Rosatom 2026). Advice and TAC: IMR–PINRO (2025a). n/a = not available or not retrieved.

Table A1 holds all the raw numbers in one place. Each row is one year. The columns show emissions, cargo, quota, advice and the gap. A cell marked ‘n/a’ means no checked value is available for that year. Anyone can use this table to repeat the calculations.

Data provenance. Emissions are from the EDGAR dataset (Crippa et al. 2023). NSR cargo for 2016–2019 is taken from two scholarly compilations (Gunnarsson 2021; Lukin 2020), and for 2020–2025 from a government investment portal, a research-centre report, and Rosatom publications. Cod quotas and advice are from the joint report series of the Institute of Marine Research and the Polar Branch of VNIRO and from Norwegian government announcements; the sanctions event and the 2026 agreement are from official Norwegian government records. Official records and corporate releases are listed in the reference list as sources of data and are not scholarly publications; no newspaper or news-agency source is used. Open items are listed in Section 4.6.

APPENDIX B. SENSITIVITY OF THE NSR RESULTS TO ROUNDED OR PRELIMINARY VALUES

Table B1

Sensitivity of the NSR growth analysis to the 2022 and 2025 values

2022 value (Mt)	2025 value (Mt)	Best split after	Adjusted exact p	Adjusted exact p, 2022 split
33	36.0	2019	0.012	0.273
33	37.02	2019	0.012	0.291
33	38.0	2019	0.012	0.291
34	36.0	2019	0.012	0.241
34	37.02	2019	0.012	0.264
34	38.0	2019	0.012	0.286
35	36.0	2019	0.012	0.218
35	37.02	2019	0.012	0.222
35	38.0	2019	0.012	0.222

Notes. Values are recomputed with the 2022 and 2025 cargo replaced as shown, all other values unchanged. The p-value of the 2022 split has been recalculated in all nine combinations, with m ranging between 0.22 and 0.29, which is unchanged from the H3 verdict (rejected). The main text uses 2022 = 34.034 Mt and 2025 = 37.02 Mt, which gives 0.264 (the 34.0 Mt row).

Table B1 investigates if the result of the NSR is affected by two uncertain numbers. Nine combinations were tried, as the values for 2022 and 2025 may have been slightly wrong. In each case, it's still the very best split after 2019. The 2022 split always stays weak, between 0.22 and 0.29. So, the end is still the same.

Table B2

Sensitivity of the NSR growth analysis to the uncertain 2016 and 2019 values (2022 = 34.034 Mt, 2025 = 37.02 Mt)

2016 value (Mt)	2019 value (Mt)	t, 2019 split	Adjusted exact p, 2019 split	Adjusted exact p, 2022 split
6.90	31.50	9.87	0.012	0.271
6.90	31.53	9.91	0.012	0.271
7.27	31.50	8.45	0.012	0.257
7.27	31.53	8.47	0.012	0.257
7.50	31.50	7.64	0.012	0.264
7.50	31.53	7.66	0.012	0.264

Note. 6.9 Mt is a press figure (until 1 December 2016) and not a full year figure; 7.27 and 31.53 Mt are other figures that have been reported in secondary sources. In the six combinations (H3), the verdict remains the same.

Table B2 does the same test is conducted for the early years. The 2016 cargo tonnage is sourced from different reports. Values of 6.9, 7.27, and 7.5 million tons were tried for 2016 and two values for 2019. The split wins each time through 2019. The 2022 split is always a bust. But it has nothing to do with uncertainty in the initial results, because the answer is the same.

APPENDIX C. REPRODUCIBILITY

The supplementary archive includes (i) a data workbook with all of the series used, formulas for the deviations and summary statistics, and a corrections log; (ii) analysis.py, which produces the statistics in Tables 6–11 and the bands in Table 3 (exact enumeration of all permutation tests, no random seed is used); (iii) cod_stats.py, which produces the statistics in Table 12 and the tolerance sensitivity; (iv) sens2016.py, which produces the statistics in Table B2; (v) stocks.py, which produces the statistics in Table 12b, the pooled

comparison, and the serial-dependence check in Table 8; and (vi) figs.py and fig5.py, which produce Figures 1–5. Environment: Python 3.13, NumPy 2.5, SciPy 1.18, Matplotlib 3.11. The permutation p-values in Table 11 and Tables B1 and B2 were recomputed from the series in Table A1.

APPENDIX D. CHRONOLOGY OF RULES AND CHANGES

Table D1

What was planned, what was changed, and why

Stage	Change	Reason	Effect on verdicts
1. Original manuscript	H1–H6 stated; H4 required every quota to lie within ±10% of advice; tested on the four advice–quota pairs then available	Initial design	H4 not rejected on four pairs (maximum +7.0%)
2. Verification of the cod series	Full eleven-year series (2016–2026) taken from the joint table	Source check	H4a rejected (2016 +11.1%, 2017 +10.6%)
3. Revisions after the failure of H4a	H4b added (quotas agreed after the invasion; maximum compared with the pre-invasion maximum); H6b added beside H6a	Post hoc; so that the test concerns cooperation under conflict and does not rest on one pair	H4b and H6b not rejected
4. Method corrections	Exact Mann–Whitney test (invalid with ties) replaced by a permutation test on ranks; NSR 2022 value updated from 34.0 to 34.034 Mt (Friskila 2023)	Method and source corrections	Rank test $p = 0.38$ on the current series; adjusted p for the 2022 split 0.269 → 0.264
5. Revisions after review	Haddock added as a comparison stock with unchanged rules (C1); serial-dependence checks added for H1; verdict language framed as assessment of one case	Reviewer-style critique of construct validity, single stock, and serial dependence	H4b rejected for haddock; P2 mixed; H1 unchanged in direction

Note. The tolerance of ±10% and the bands of H6 were never tuned to the haddock results; the haddock rules are those of cod.

APPENDIX E. TRACEABILITY OF PROBLEMS, GAPS, OBJECTIVES, QUESTIONS, HYPOTHESES, INDICATORS AND RESULTS

Table E1

Unique identifiers and their links

Problem	Gap	Objective	Research question	Hypothesis or prediction	Indicator	Test	Reported in	Verdict
PS1	G1	O1	RQ1	H1	V1	OLS, Theil–Sen, Mann–Kendall; 2024 against prediction interval	Tables 7–9; Figure 1	Not rejected
PS2	G1	O2	RQ2	H2	V1	2022–2024 against 2016–2021 prediction intervals	Table 10	Not rejected (low power)
PS2	G1	O2	RQ2	H3	V2	Exact permutation test, max-t over four splits	Tables 6, 11, B1, B2; Figure 2	Rejected
PS3	G2	O3	RQ3a	H4a	V3	Deviation within ±10%, all eleven years	Table 12; Figures 3, 4	Rejected
PS3	G2	O3	RQ3a	H4b	V3	Same tolerance, post-invasion quotas	Table 12	Not rejected (post hoc)
PS3	G2	O3	RQ3b	H5	V3, V5	Agreement before 1 January 2026; deviation within ±10%	Table 13	Not rejected (n = 1)
PS3	G2	O3	RQ3c	H6a, H6b	V3, V5	2026 deviation inside pre-invasion band	Table 13	Not rejected (n = 1)
PS3	G2	O3	RQ3d	C1 (H4–H6 on haddock)	V4	Same rules, comparison stock	Table 12b; Figure 5	Mixed
PS4	G2	O4	RQ4	P1 (spillover)	V3, V5 (from H5, H6)	Logical combination	Tables 2, 14	Rejected
PS4	G2	O4	RQ4	P2 (insulation)	V3, V4, V5 (from H4–H6)	Logical combination	Tables 2, 14	Not rejected for cod (revised rule); rejected for haddock
PS1–PS4	G1, G2	O1–O4	RQ1–RQ4	Dual pattern (H1, H4–H6)	V1, V3, V5	Rule in Section 3.4	Table 15	Rejected (original rule); not rejected (revised rule, cod)
PS1, PS3	G1, G2	O1, O3	RQ1, RQ3	F1 (H1); F2 (H4–H6); F3, F4 (prospective)	V1, V3	Bands and thresholds fixed in advance	Table 3; Section 6.8	F1 open; F2 not falsified; F3, F4 pending

Table E1 is the map of the whole paper. Read one row from left to right: the problem, the gap it leaves, the objective, the question, the hypothesis, the data, the test, where the result is, and what happened. Each code (PS, G, O, RQ, H, V) is used only once and retains the same meaning in all of its uses.