ARTICLES

ARCTIC ANADROMY AND CONGESTED REGIME GOVERNANCE

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SUMMARY

The Tana River in northernmost Norway is the most diverse Atlantic salmon river in the world. Its native salmon population has declined dramatically and resulted in a fishing ban that has affected indigenous life and distressed the local economy. Concern is mounting over the secondary infestation of Pacific pink salmon, transplanted decades ago, which creates a potential threat to the river's genetic diversity and challenges the regime structures of international fisheries. This Article reviews the problem of anadromy in the context of the Tana River, and suggests that international regime theory must adopt a broadened ecosystem approach to the Arctic that accounts for this and other consequences of transplanted species into waters where they never were before.

The Tana River in the sub-Arctic region of Finnmark in northernmost Norway is the most diverse Atlantic salmon river in the world. It is one of Europe's largest virgin river deltas. Its native salmon population has declined dramatically, and existential concerns have resulted in a fishing ban that has affected indigenous Sámi traditional life and the local economy. Now, concern is mounting over an additional and unexpected threat—the secondary infestation of pink salmon, transplanted by the Soviets from Pacific waters into the Kola Peninsula decades ago.

Salmonids are anadromous species. They spawn in freshwater, migrate to the open sea, and then return to begin and end their life cycle. Secondary spread of the invasive Pacific salmon into the Tana and adjacent Norwegian rivers creates a potential threat to the genetic diversity of the river and surrounding plant and animal life. The threat of anadromy potentially challenges the regime structures of international fisheries, complicating solutions and understandings of the problem and the generative international relations grammar that can contribute to a coordinated solution.

This Article discusses the significance of anadromy to international law, literally and metaphorically reviewing the problem in the context of the Tana River. After laying out background in Part I, Part II notes the anadromous life cycle of salmonids and uses it as a metaphor to investigate the secondary spread of pink salmon to Norwegian Atlantic salmon rivers, focusing on the Tana. Structural problems facing international regime governance in the Anthropocene, and the biological elision and cohabitation of lifestyles of salmonids on the high seas, challenge the grammar and structure of regime theory and its language of convergence and complexity.

Part III deals with these challenges and the unranked (heterarchic) challenges to overlapping and deficient governance structures in the contested and congested waters of international fisheries. Part IV concludes this discussion by focusing on contributions of informal and localized regime structures, speculating as well that the prodromal period of species transplantation, animated by climate change, is coming to an end, and that adaptations to regime theory are needed to conform to the coming elision of biological species into newfound geospace.

I. Background

The sub-Arctic Tana River runs 256 kilometers (km) (159 miles) from south to north along the Norwegian-Finnish border.[1] It forms from the confluence of the Anárjokha and Karasjok (Kárášjohka in Sámi) headwaters, located in the

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1. The river is called Teno in Finnish, Tenojoki in Sámi, and Deatnu in Northern Sámi. This Article uses the Norwegian name, Tana.

heart of Sámi country in Karasjok Township, Norway.[2] Its final stretch courses through Finnmark County in northeastern Norway and debouches into the Tanafjord, which leads to the Barents Sea. In total, the Tana is 361 km long.[3] Thirty-one percent of its total catchment area of 16,380 km² drains in Finland, and the remainder in Norway. This Arctic wetland system creates the fifth-longest river in Norway.[4] It is Finnmark's largest river and one of the county's 18 salmon-spawning watercourses leading to the sea.[5]

A. *The Most Diverse Salmon River in the World*

The Tana delta is one of Europe's largest virgin river deltas.[6] The geography of the Tana basin has been shaped over millennia by water and sediment discharges following ice jam breakups and floods.[7] Tundra heaths, peat bogs, sheltering forests, and surrounding highlands shape the river terraces of the delta,[8] creating a fluvial geomorphology of "ripple-like bedforms" (linguoid bars) and sandy dunes.[9] It is rich in waterfowl, seals, rare Baltic whitefish, sea trout, 19 species of ducks, 22 species of waders, biodiverse plant life—and Atlantic salmon (*Salmo salar*).[10]

Fifteen tributaries flow into its main channel and 36 sub-tributaries connect to them, creating breeding grounds for approximately 30 "unique genetic salmon groups specific to that river."[11] Norway is home to more than 400 watercourses with Atlantic salmon and approximately one-quarter of the world's healthy population.[12] A 2012 report found that the Tana supports the largest wild stock of Atlantic salmon in the world.[13] It was then described as "one of the few remaining large river systems that still support abundant Atlantic salmon with little or no human impact."[14]

The Tana is Norway's and Finland's most productive, natural salmon river.[15] Petroglyph carvings attest to the ancient importance of salmon to human settlements in the Finnmark region.[16] Salmon remain foundational to local Sámi traditional culture and their 2,000-3,000-year settlement history,[17] popular to sports anglers worldwide,[18] and significant to the livelihood of other Finnish and Norwe-

2. Eirin Annamo & Gunnar Kristiansen, Challenges in Flood Risk Management Planning: An Example of a Flood Risk Management Plan for the Finnish-Norwegian River Tana 14, 17 (Norwegian Water Resources and Energy Directorate, Report No. 16-2012, 2012). Karasjok is home to Sámediggi, the Sámi Parliament, and the Sámi capital. *See* Northern Norway, *The Sami Parliament at Karasjok*, https://nordnorge.com/en/artikkel/the-sami-parliament/ (last visited Jan. 20, 2022).
3. Mapacarta, *Tana River*, https://mapcarta.com/13900080 (last visited Jan. 20, 2022).
4. World Atlas, *Longest Rivers in Norway*, https://www.worldatlas.com/articles/longest-rivers-in-norway.html (last visited Jan. 20, 2022) (behind the Glomma, Pasvikelva and Ivalo, Numedalslågen, and Gudbrandsdalslågen and Vorma Rivers).
5. Finnmark's salmon spawning rivers include Grense Jakobselva, Karpelva, Munkelva, Neidenelva, Klokkerelva, Nyelva, Vesterelva, Bergbyelva, Vestre Jakobselva, Storelva (Vadsø), Skallelva, Komagelva, Sytefjordelva, Kongsfjordelva, Risfjordelva, Sandfjordelva (Gamvik), Tanaelve, and Altaelva. *See* Odd Terje Sandlund et al., *Pink Salmon in Norway: The Reluctant Invader*, 21 Biological Invasions 1033, 1037 (2019).
6. Ramsar Sites Information Service, Ramsar Information Sheet: Norway Tanamunnigen sec. 3, at 1 (2018), https://rsis.ramsar.org/RISapp/files/RISrep/NO1197RIS_1803_en.pdf. *See also* Miljøstatus, *Nasjonale laksevassdrag og laksefjorder* [*National Salmon Rivers and Salmon Fjords*], https://miljostatus.miljodirektoratet.no/Tema/Ferskvann/Laks/Nasjonale-laksevassdrag-og-laksefjorder/ (last updated May 4, 2021) (mapping Norway's 52 national salmon rivers and 29 national salmon fjords).
7. Annamo & Kristiansen, *supra* note 2, at 15.
8. *Id*. at 14.
9. John D. Collinson, *Bedforms of the Tana River, Norway*, 52 Geografiska Annaler: Series A Physical Geography 31 (2017).
10. Ramsar Sites Information Service, *supra* note 6, sec. 1, at 1; *see also* Annamo & Kristiansen, *supra* note 2, at 15.
11. Panu Orell & Jaakko Erkinaro, *River Teno Salmon*, Luke Nat. Res. Inst. Fin., https://www.luke.fi/en/natural-resources/fish-and-the-fishing-industry/fish-resources/salmon-2/river-teno-salmon/ (last visited Jan. 20, 2022) ("The River Teno [Tano] fosters c. 30 genetically differentiated salmon populations.").
12. *See* Torbjørn Forseth et al., *The Major Threats to Atlantic Salmon in Norway*, 74 ICES J. Marine Sci. 1496, 1497, 1498 (2017) (presenting a map of Norwegian Atlantic salmon watercourses).
13. *See* Status of the River Tana Salmon Populations 4 (Tana Monitoring and Research Group, Report No. 1-2012, 2012), https://www.luke.fi/wp-content/uploads/2017/05/2012_Tana_status_report_final.pdf (presenting the first report of the group).
14. *Id.* at 4 ("except for fishing"). Finland and Norway signed a new Tana Monitoring and Research Group Memorandum of Understanding in December 2017, although the objectives regarding management of the salmon stocks remained the same. The first status assessment of the reestablished Tana Monitoring and Research Group was issued in 2018. *See* Status of the Tana/Teno River Salmon Populations in 2017 (Morten Falkegård & Jaakko Erkinaro eds., Tana Monitoring and Research Group, Report No. 1-2018, 2018).
15. *See* Varanger Activities Camp, *Tana River*, http://varangerkite.no/activities/nature-adventure/tana-river/ (last visited Feb. 4, 2022) (noting it is also Europe's most productive salmon river, with catches up to 250 tons per year).
16. *See* United Nations Educational, Scientific, and Cultural Organization (UNESCO), *Rock Art of Alta*, https://whc.unesco.org/en/list/352/ (last visited Jan. 20, 2022) (detailing the engravings of circumpolar fauna dating from around 5,000 B.C.E.).
17. *See* Skuvlaalbmá Áslat Niilas Áslat-Aslak Holmberg, *Bivdit Luosa*—To Ask for Salmon: Saami Traditional Knowledge on Salmon and the River Deatnu 2 n.2 (2018) (M.A. thesis, Arctic University of Norway (UiT)) (discussing the notion of traditional Sámi fishing culture in the Deatnu River valley and the specific meaning and use of Sámi weir (*buoddu*), grillnet (*njánggofierbmi*), and drift net (*golgadat*) techniques); Juha Hiedanpää et al., *Beliefs in Conflict: The Management of Teno Atlantic Salmon in the Sámi Homeland in Finland*, 66 Env't Mgmt. 1039, 1041 (2020). *See also* Steinar Pedersen, *The Coastal Sámi of Norway and Their Rights to Traditional Marine Livelihood*, 3 Arctic Rev. on L. & Pol. 51, 52 (2012) (noting the loss of indigenous rights relating to thousands of years of traditional practices regarding fishing and the use of adjacent terrestrial resources, pinpointing problems associated with tradable fish quotas). *See* Svetlana Vinogradova, *Russian Sámi in Context of Indigenous Security*, *in* Understanding the Many Faces of Human Security: Perspectives of Norther Indigenous Peoples 190, 196 (Kamrul Hossain & Anna Petrétei eds., Brill 2016) (noting that salmon fishing often is more determinative of traditional Sámi lifestyle than reindeer herding).
18. *See* North Atlantic Salmon Conservation Organization (NASCO), The Management Approach to Salmon Fisheries in Norway 1 (2014) [hereinafter NASCO Management Approach] (noting from official Norwegian records that approximately 50% of the salmon catch by fixed gear is caught in Finnmark County).

gian locals.[19] The Tana is "the most diverse salmon river in the world."[20]

B. *The Threatened Kingfish*

Atlantic salmon were commonly found throughout waterways of Europe, the British Isles, the Baltic North, and in all major North American rivers north of the Hudson River.[21] Habitat degradation, dams and culverts, overfishing, disease, predation, inbreeding, and climate change have taken tolls.[22] Two centuries of "slow and steady decline" have depleted, endangered, or extirpated worldwide populations of the "King of Freshwater Fish."[23] Despite this withering trend, which has reduced Norwegian Atlantic salmon stocks to levels half of what they were in the late 1980s,[24] the north Norwegian salmon stock has remained "quite stable for the past 30 years, with one significant exception: the Tana River."[25]

Concerns regarding the health of the Tana's salmon stock arose in 2009.[26] Atlantic salmon fishing catch statistics dropped dramatically, from 52,638 kilograms (kg) to 26,958 kg.[27] Norway and Finland created the Tana Monitoring and Research Group to monitor, evaluate, and advise on the status of its salmon stocks.[28] The river system remains intensively surveilled with four sonar, two video, and three established snorkeling sites.[29] Norwegian officials noted a long-term negative spawning trend in 2012, particularly on stretches of the Upper Tana, and called for a new treaty with Finland to more strictly regulate Tana fisheries.[30]

By 2017, a disturbing decline in salmon stock prompted a Norwegian-Finnish fishing agreement to reduce the salmon take by 30%.[31] Mindful of the impact on local and indigenous populations and of Norway's obligations under International Labour Organization Convention 169 on Indigenous and Tribal Peoples,[32] the agreement based fishing restrictions on the precautionary principle,[33] and on other international instruments that support sustainable environmental stewardship.[34] The European Parliament defines the principle "as a general principle of Community law requiring the authorities to take appropriate measures to prevent specific potential risks to public health, safety, and the environment, by giving precedence to the require-

19. *See* Saara-Maria Salonen, *Ban on Salmon Fishing on River Teno Is Affecting Local Economy and Traditional Livelihoods*, Barents Observer (June 9, 2021), https://thebarentsobserver.com/en/node/8466 (noting the "first time ever" ban and its effects on the traditional Sámi way of life); *see also* Press Release, Ministry of Agriculture and Forestry of Finland, Ban on Salmon Fishing in the River Tenojoki (Tana) Watercourse Proposed for the 2021 Season—Opportunities to Fish for Other Species Increased (Apr. 7, 2021), https://valtioneuvosto.fi/en/-/1410837/ban-on-salmon-fishing-in-the-river-tenojoki-tana-watercourse-proposed-for-the-2021-season-opportunities-to-fish-for-other-species-increased (noting specifically the "tough" impact on local residents and the "right of the Sámi").
20. Salonen, *supra* note 19.
21. Michael H. Schiewe, *Salmon*, *in* 6 Encyclopedia of Biodiversity 522, 527 (2d ed. 2013).
22. *See* National Oceanic and Atmospheric Administration (NOAA) Fisheries, *Atlantic Salmon (Protected)*, https://www.fisheries.noaa.gov/species/atlantic-salmon-protected (last visited Jan. 20, 2022).
23. *See* World Wildlife Fund et al., The Status of Wild Atlantic Salmon: A River by River Assessment (2001) (presenting a worldwide assessment funded by the Norwegian Ministry of Agriculture, the World Wildlife Fund, and the European Freshwater Program). The moniker was coined by the 17th-century English pastoralist and fishing enthusiast, Izaak Walton. *See* Izaak Walton & Charles Cotton, The Complete Angler: Or, the Contemplative Man's Recreation, Being a Discourse on Rivers, Fish-Ponds, Fish, and Fishing 126 (London, L.A. Lewis 1839).
24. Vitenskapelig Råd for Lakseforvaltning [Scientific Council for Salmon Management], Status of Wild Atlantic Salmon in Norway 2018, at 2 (2018), https://www.vitenskapsradet.no/Portals/vitenskapsradet/Pdf/Status%20of%20wild%20Atlantic%20salmon%20in%20Norway%202018.pdf (attributing also quality decline to escaped farmed salmon and human impacts); *id*. at 11.
25. Irene Vanja Dahl, *International Regulations and Guidelines on Transboundary Salmon Stocks: Case Study of the Tana River*, 11 Arctic Rev. on L. & Pol. 157, 158 (2020).
26. Hiedanpää et al., *supra* note 17, at 1040-41. For a graphic depiction of Norwegian and Finnish catch of salmon on the Tana from 1972-2011, see Deanučázádaga Guolástanhálddahus/Tanavassdragets Fiskeforvaltning [Tana River Fisheries Management [Sámi/Norwegian]], *Catch-Statistics*, http://tanafisk.no/en/statistikk/fangststatistikk (last visited Jan. 20, 2022).
27. Norway, *River Tana Incl. Tributaries (Norwegian Part), Finnmark, Norway*, http://norway.bendiksen.org/rp.php?r=20234.Z (citing Statistics Norway) (last visited Jan. 20, 2022).
28. Status of the River Tana Salmon Populations, *supra* note 13, at 4.
29. Jaakko Erkinaro, Pink Salmon—The Case of the Border River Tana, Presentation at the International Seminar on Pink Salmon in the Barents Region and in Northern Europe (Oct. 27, 2021). *See also* Sonja Lydia Kimo Pedersen, Evaluation and Use of a Monitoring Method to Estimate Atlantic Salmon Spawning Run (2021) (M.A. thesis, UiT) (testing methods for surveilling aquatic creatures in the Máskejohka, the lowermost tributary of the Tana).
30. *See* NASCO Management Approach, *supra* note 18, at 1. Up to this time, the border region had been regulated by a 1989 agreement. *See generally Overenskomst mellom Kongeriket Norge og Republikken Finland om felles forskrifter om fisket i Tanaelvas fiskeområde (1. mars 1989)* [*Agreement Between the Kingdom of Norway and the Republic of Finland on Common Rules for Fishing in the Tana River Area, 1 March 1989*], *reprinted in* Finnish and Norwegian in N:o 94 Suomen säädöskokoelman [Finnish Code of Legislation] n:o 797-802, https://www.maanmittauslaitos.fi/sites/maanmittauslaitos.fi/files/old/v89_saanto.pdf. An updated Tana Agreement came into force in 2017. *See Avtale mellom Norge of Finland om Fisket I Tanavassdraget* [*Agreement Between Norway and Finland on Fishing in the Tana Watercourse*] (May 1, 2017), https://lovdata.no/dokument/TRAKTAT/traktat/2016-09-30-16. The agreement requires fishers to immediately destroy any *pukkellaks* caught in the Tana. *See id*. Kapittel 6, §31 (*Pukkellaks, regnbueørret og eventuelle andre fremmede arter som fanges, skal avlives straks* [Pukkellaks, rainbow trout, and any other alien species should be killed immediately]).
31. *See* Hiedanpää et al., *supra* note 17, at 1040-41.
32. International Labour Organization, *C169—Indigenous and Tribal Peoples Convention, 1989 (No. 169)*, https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C169 (last visited Jan. 20, 2022). Norway ratified the convention June 19, 1990. *See* International Labour Organization, *Ratifications of C169—Indigenous and Tribal Peoples Convention, 1989 (No. 169)*, https://www.ilo.org/dyn/normlex/en/f?p=1000:11300:0::NO:11300:P11300_INSTRUMENT_ID:312314 (last visited Jan. 20, 2022). Article 23 obligates countries to recognize and strengthen traditional activities such as fishing; Part II details respect for indigenous peoples and their relationship with land use and respect for nomadic life.
33. *See Avtale mellom Norge og Finland om fisket i Tanavassdraget* (TRA-20160930-016), *adopted* Apr. 9, 2016 (entered into force Jan. 5, 2017), pmbl. (*understreker sitt ansvar i henhold til internasjonale konvensjoner og behovet for å verne og sikre fiskebestandene i Tanavassdraget gjennom formålstjenlig regulering av fisket basert på føre-var-prinsippet* [emphasizes its responsibility in accordance with international conventions and the need to protect and secure the fishing stocks in the Tana watercourse through appropriate regulation of fishing based on the precautionary principle]).
34. *See id*. (referencing United Nations Convention on the Law of the Sea art. 66 (1982) (anadromous stocks), the Convention on Biological Diversity (1992), the Convention for the Conservation of Salmon in the North Atlantic Ocean (1982), Guidelines for Salmon Fisheries Management (of the *Avtale mellom Norge og Finland*), and the United Nations International Covenant on Civil and Political Rights art. 27 (1966) (minority rights)).

ments related to the protection of those interests over economic interests."[35]

Although described as restless,[36] shambolic,[37] and potentially overbroad,[38] the precautionary principle received circumscribed attention by the International Court of Justice[39] and recognition by the European Union.[40] It finds a place in numerous environmental and fishing agreements and codes of conduct.[41] Finnish and Norwegian Sámi activist organizations opposed the regulations, labeling them an encroachment on their Sámi-ness.[42]

The Tana's salmon stock continued to diminish. By 2020, a status assessment found that the "overall stock status in most salmon populations of the Tana system [was] poor,"[43] and that returning spawning stocks "were at very low levels in all surveyed tributaries" and at an "all time low" for two tributaries.[44] Confirming the "very gloomy" downtrend, a 2021 report indicated that the salmon returning to the Tana watercourse (*Tanavassdraget*) numbered half the tally in 2018, which itself "was not a good year."[45] The study identified "overexploitation as a major factor affecting all stocks needing recovery in the Tana," and recommended that fishing pressure "should be kept as low as possible to enable stock recovery."[46]

Finnish and Norwegian authorities jointly took the "crucial" (*avgjerande*) next step of banning rather than limiting salmon fishing along the entire Tana watercourse,[47] including its tributaries, the Tanafjord, and four adjacent coastal municipalities.[48] In July 2021, the problem took a turn for the worse. The Norwegian municipality of Sør-

35. European Parliamentary Research Service, The Precautionary Principle: Definitions, Applications, and Governance 6 (2016) (quoting the judgment in the case of *Artegodan v. Commission*, T-74/00, ¶ 184 (Nov. 26, 2002)). In 1984, Canada, Denmark, the European Union, Norway, Russia, the United Kingdom, and the United States established the Convention for the Conservation of Salmon in the North Atlantic Ocean (France observing), 1982 O.J. (L 378), https://eur-lex.europa.eu/eli/convention/1982/886/oj, *reprinted in* NASCO, Handbook of Basic Texts 7-20 (1984). The Convention created a council, a secretariat, and three regional commissions (North American, North-East Atlantic, West Greenland) to study and coordinate salmon stocks. It, too, adopted the "precautionary approach" to identify undesirable outcomes and measures to avoid or correct them. *See* NASCO, *Agreement on Adoption of a Precautionary Approach*, Doc. CNL(98)46 (1998), https://nasco.int/wp-content/uploads/2020/04/pa_agreement.pdf [hereinafter *Agreement on Adoption of a Precautionary Approach*].
36. Timothy O'Riordan & Andrew Jordan, *The Precautionary Principle in Contemporary Environmental Politics*, 4 Env't Values 191 (1994). There is some discussion about usage and "whether it is theoretically permissible to speak of precaution as being principled." Nathan Dinneen, *Precautionary Discourse. Thinking Through the Distinction Between the Precautionary Principle and the Precautionary Approach in Theory and Practice*, 32 Pol. & Life Scis. 2, 16 (2013). Accordingly, some usages prefer "precautionary approach." The distinction does not amount to a difference for purposes of this Article.
37. *See generally* Timothy O'Riordan & James Cameron, The History and Contemporary Significance of the Precautionary Principle (1994).
38. Jonathan Remy Nash, *Standing and the Precautionary Principle*, 108 Colum. L. Rev. 494 (2008) (assessing the potential overreach of the concept in relation to standing requirements).
39. Case Concerning Pulp Mills on the River Uruguay (Arg. v. Uru.), Judgment, 2010 I.C.J. Rep. 14, ¶ 164 (Apr. 20) (noting "a precautionary approach may be relevant" in statutory interpretation). *See also* Gabcikovo-Nagymaros Project (Hung. v. Slovk.), Judgment, 1997 I.C.J. Rep. 7, ¶¶ 51-54 (Sept. 25) (steering clear of applying the principle, but indicating that ecological imperatives presenting grave and imminent peril could excuse a state from performing acts otherwise deemed illegal).
40. *See* Consolidated Version of the Treaty on the Functioning of the European Union, art. 191, 2012 O.J. (C 326), https://eur-lex.europa.eu/eli/treaty/tfeu_2012/oj (holding that "Union policy on the environment . . . shall be based on the precautionary principle and on the principles that preventive action should be taken").
41. Most recently, the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, 2019 O.J. (L 73) 3, entered into force on June 25, 2021 (employing the precautionary approach to prevent unregulated fishing in the high seas portion of the central Arctic Ocean, an area the same size as the Mediterranean Sea, covering 2.8 million km^2). The agreement perfected the interim measures of the Nuuk Statement of Feb. 26, 2014, https://www.pewtrusts.org/-/media/assets/2014/09/arcticnationsagreetoworkonintern ationalfisheries-accord.pdf, and the Declaration Concerning the Prevention of Unregulated High Seas Fishing in the Central Arctic Ocean of July 16, 2015, https://www.regjeringen.no/globalassets/departementene/ud/vedlegg/folkerett/declaration-on-arctic-fisheries-16-july-2015.pdf, which embraced the precautionary approach and recognized the straddling nature of fishing stocks under the fisheries jurisdiction of the coastal states and in the high seas portion of the central Arctic Ocean. *See also* Jose Felix Pinto-Bazurco, International Institute for Sustainable Development, The Precautionary Principle 5 (2020), https://www.iisd.org/system/files/2020-10/still-one-earth-precautionary-principle.pdf (noting, inter alia, the inclusion of the precautionary principle in the 1992 Convention on Biological Diversity, the 1992 United Nations Framework Convention on Climate Change, and the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks); Serge M. Garcia, Food and Agriculture Organization of the United Nations, The Precautionary Approach to Fisheries and Its Implications for Fishery Research, Technology, and Management: And Updated Review, https://www.fao.org/3/w1238e/w1238e01.htm (last visited Jan. 20, 2022) (reviewing trends and objectives of the precautionary approach in the contexts of the Law of the Sea Convention, the United Nations Food and Agriculture Organization (FAO), the International Council for the Exploration of the Sea (ICES), the International Maritime Organization, the International Center for the Living Aquatic Resources Management, and the Commission for the Conservation of the Antarctic Marine Living Resources).
42. Michael Barrett, *Northern Norwegian Islands in Moratorium Over Fishing Rights*, Local (July 21, 2017), https://www.thelocal.no/20170721/northern-norwegian-islands-in-moratorium-over-fishing-rights/ (discussing the formation of the activist Norwegian Sámi group, Ellos Deatnu, and the expansion of that organization in the Finnish adjacent river area of Dálvadas). *See also* Camilla Brattland & Tero Mustonen, *How Traditional Knowledge Comes to Matter in Atlantic Salmon Governance in Norway and Finland*, 71 Arctic 375, 381 (2018) (noting complaints of a lack of regard for Sámi traditional knowledge and customary practice, as well as a lack of consultation); Martta Alajärvi, *Local People Demand Full Self-Determination Over the Teno River System*, Barents Observer (July 12, 2017), https://thebarentsobserver.com/en/life-and-public/2017/07/local-protesters-demand-full-self-determination-over-teno-river-system (noting the backlash among local protestors over the fishing controls placed on the Tana); Hiedanpää et al., *supra* note 17 (investigating management tension and the interface of scientific and traditional knowledge).
43. Status of the Tana/Teno River Salmon Populations in 2020: Report From the Tana Monitoring and Research Group 4 (2020), https://brage.nina.no/nina-xmlui/bitstream/handle/11250/2722482/1_2020.pdf.
44. *Id.* at 21 (citing the Buolbmátjohka/Pulmankijoki and Njiljohka/Nilijoki tributaries).
45. Tom Moffatt, *ASF Rivernotes 6 Aug 2021 European Roundup*, Atl. Salmon Fed'n (Aug. 6, 2021), https://www.asf.ca/news-and-magazine/river-notes/asf-rivernotes-6-aug-2021-european-roundup (quoting Panu Orell statement on Norwegian Broadcasting Corp.).
46. Status of the Tana/Teno River Salmon Populations in 2020, *supra* note 43, at 114. The study defined "overexploitation" as "the extent of a reduction in spawning stock below the spawning target." *See id.* at 10.
47. *Stans i laksefisket i Tanavassdraget i 2021* [*Stop Salmon Fishing in the Tana Watercourse in 2021*], Regjeringa.no [Gov't Nor.] (Apr. 7, 2021), https://www.regjeringen.no/no/aktuelt/stans-i-laksefisket-i-tanavassdraget-i-2021/id2842690/ (citing as justification Article 16 of the Tana Agreement, but allowing for the expansion of fishing for pike and sea trout (*gjedde og sjøaure*)).
48. *See* Press Release, Ministry of Agriculture and Forestry of Finland, *supra* note 19; Press Release, Ministry of Agriculture and Forestry of Finland, Finland and Norway Negotiate on Very Strong Restrictions on Salmon Fishing in River Tenojoki (Tana) Next Summer Due to Extremely Poor Stock Status (Mar. 25, 2021), https://valtioneuvosto.fi/en/-//1410837/finland-and-norway-negotiate-on-very-strong-restrictions-on-salmon-fishing-in-river-

Varanger, with its administrative center at Kirkenes near the border with Russia, banned salmon fishing on the Karpelv, Munkelv, and Klokkerelv, due to record low Atlantic salmon numbers.[49] Reasons for the dramatic decline in salmon stock animate multiple discussions; however, climate change and the "explosive invasion of pink salmon" were identified as causes.[50]

The fishing ban immediately affected local community economies.[51] Coastal and riverine Sámi populations again protested. Although meant to restore the ecological balance of the river, the ban ironically contributed to another, potentially devastating consequence already in the making for the Tana—an invasion of non-native *pukkellaks*, or pink (humpback) salmon (*Oncorhynchus gorbuscha*).

As a bellwether for the fate of the wild Atlantic salmon, as a barometer of riparian health, and as a metaphor for the effects of climate change and global governance, the Tana watercourse represents a complex regime of accumulating and accelerating anthropogenic burdens, making it a focal point of intense observation.[52]

II. Invasive Threats and the Keystone Species

Salmon are a "keystone species,"[53] essential to "generally nutrient-poor temperate and northern ecosystems."[54] They feed numerous species of vertebrate predators.[55] Their "spawned-out carcasses" deliver nutrients to riparian and lacustrine (lake-related) ecosystems.[56] Their marine life accumulates, absorbs, and transports chemicals such as nitrogen, phosphorous, and carbon upriver, subsidizing wildlife and plant habitats with nutrients known to come from the sea.[57]

Salmon spawn in tributary-specific rivers. They bury their eggs in river gravel and cobble stone nests (redds) from October to December. Hatchlings (first called alevin, later called fry) appear in April and May. Following a period of two to five years of freshwater rearing, they smolt (mature and obtain their silverly sheen), migrate to the sea, and mature. Satellite transmitter data reveal how salmon from different sets of rivers all along these stretches of the Atlantic Ocean hone in on different areas of the North Atlantic to feed.[58] The fish that survive the high natural pelagic mortality rate then return to the same natal tributary to spawn,[59] often in the same section of river where they were born.[60] This homing characteristic segregates, differentiates, and accounts for local adaptations among salmon populations.[61]

A. *Pacific Pink Salmon (*Pukkellaks*)*

Pink salmon are native to the northern parts of the Pacific Ocean.[62] They populate the waters surrounding Alaska, the Bering Sea, and the Sea of Okhotsk.[63] They remain an important source of revenue and amount to 41% of the total Pacific salmon catch by weight, with Russia accounting for 75% of the ocean take.[64]

In the late 1950s, seeking to increase the supply of this valuable resource,[65] Soviet officials unsuccessfully trans-

tenojoki-tana-next-summer-due-to-extremely-poor-stock-status (noting the ban's extensions to Nordkapp, Lebesby, Gamvik, and Berlevåg).

49. *See* Atle Staalesen, *Invasive Pink Salmon Are Surging in the European Arctic, Even as Native Atlantic Salmon Decline*, Arctic Today (July 12, 2021), https://www.arctictoday.com/invasive-pink-salmon-are-surging-in-the-european-arctic-even-as-native-atlantic-salmon-decline/.
50. *See id*.
51. *See* Saara-Maria Salonen, *Glimmer of Hope for the Salmon of the Teno River*, Barents Observer (Oct. 5, 2021), https://thebarentsobserver.com/en/2021/10/glimmer-hope-salmon-teno-river (noting "major negative effects on the local economy," but indications that the ban is protecting and increasing the size of spawning stock); Salonen, *supra* note 19 (reporting sudden cancelation of more than 70% of tourist bookings in the Lapland region of northernmost Finland).
52. Robin-Ivan Capar, *Despite the Fishing Ban, There Are Still Very Few Salmon in the Tana Watercourse*, Nor. Today (July 12, 2021), https://norwaytoday.info/news/despite-the-fishing-ban-there-are-still-very-few-salmon-in-the-tana-watercourse/; *see also Vil stoppe fiske på Tana-laks* [*Will Stop Fishing for Tana-Salmon*], Miljø-Direktoratet [Env't Directorate] (Mar. 24, 2021), https://www.miljodirektoratet.no/aktuelt/nyheter/2021/mars-2021/vil-stoppe-fiske-pa-tana-laks/ (quoting the director of the Norwegian Environment Agency, Ellen Hambro, who called the Tana the "world's most important salmon river" and noting that most of its 30 populations of salmon are not sustainably harvestable [*Vi fremmer forslaget for å beskytte laksen i verdens viktigste laksevassdrag mot overbeskatning. Tanaelva har rundt 30 bestander, og de fleste av disse har ikke et høstbart overskudd*]).
53. Mary F. Willson & Karl C. Halupka, *Anadromous Fish as Keystone Species in Vertebrate Communities*, 9 Conservation Biology 489 (1995).
54. *Id*.
55. *Id*.
56. *Id*. at 490.
57. John Whitfield, *Fish Fertilize Trees*, Nature (Oct. 1, 2001), https://www.nature.com/news/2001/011001/full/news011004-4.html.
58. *See* tracking map, Moffatt, *supra* note 45.
59. *See* Pål Mugaas, *Salmon—Salmo Salar*, Norske Lakseelver [Norwegian Salmon Rivers] (June 26, 2015), https://lakseelver.no/nb/news-2015/laks-salmo-salar. Two percent of spawning eggs survive to the smolt stage. Only 5% of mature salmon survive ocean life, although research now indicates perhaps only 3% survive and return to spawn. *See id*. Some populations of Atlantic salmon complete their life cycle in freshwater, never venturing to the sea. These "landlocked" populations are more commonly found in North America, but some exist in northern Europe. *See Atlantic Salmon (Salmo Salar)*, *in* Safety Assessment of Transgenic Organisms in the Environment, Vol. 7: OECD Consensus Documents 107, 110 (2017).
60. *Atlantic Salmon (Salmo Salar)*, *supra* note 59, at 111.
61. *Id*. at 116.
62. Norwegian Institute for Nature Research (NINA), *Pink Salmon*, https://www.nina.no/english/Biodiversity/Alien-Species/Pink-salmon (last visited Jan. 20, 2022).
63. Laine Welch, *Alaska Salmon: Second Only to Russia?*, Nat'l Fisherman (June 21, 2017), https://www.nationalfisherman.com/alaska/alaska-salmon-second-only-russia (based on tracking reports of the North Pacific Anadromous Fish Commission (NPAFC), which monitors the take of its five Members—Canada, Japan, Korea, Russia, and the United States).
64. *See id*. The NPAFC monitors seven species of anadromous fish, including six salmon species—Chinook (king), cherry, chum (dog), coho (silver), pink, sockeye (red)—and steelhead trout. *See* NPAFC, *Species*, https://npafc.org/species/ (last visited Jan. 20, 2022). Wild Atlantic salmon stock is monitored by NASCO (*see* NASCO, https://nasco.int/), which was established by the Convention for the Conservation of Salmon in the North Atlantic Ocean, *supra* note 35.
65. *See* Alexander Zubchenko, Why Has the Transplantations Been Successful in Russia? Which Factors Decide the Success of the Establishment of Self-Reproducing Stocks, Comments at the Pink Salmon in the Barents Region Conference 7 (Feb. 7, 2018), https://www.statsforvalteren.no/siteassets/fm-troms-og-finnmark/miljo-og-klima/internasjonalt-samarbeid/pukkellaks/abstract-report_pink-salmon-meeting_2018_final.pdf ("The main goal . . . was to create an additional base of raw materials for harvesting through the use of the White and Barents Seas food supplies"). *See also* Tor Atle Mo

planted fertilized pink salmon eggs from Sakhalin Island into rivers of the Kola Peninsula in northwest Russia, close to the Norwegian border.[66] Persistent restocking programs from Russia's more northerly Ola River in Magadan Oblast between 1985 and 1999[67] led to the establishment of a stock in the White Sea area.[68] Norwegian hatcheries also experimented with pink salmon for purposes of net pen production between 1963 and 1975, and the Søgne River was stocked with pink salmon in 1976, with no recaptures, however.[69]

Although now more generally recognized as a potential threat to native biodiversity,[70] the intentional or accidental introduction of non-native organisms has a long human history involving mammals, birds, reptiles, amphibians, invertebrates, plants, and fish.[71] For many years, the introduction of alien species "was considered a nature management technique."[72] The Soviets, for example, elevated such intentional transfers to the level of comprehensive government policy, introducing "more than 900 different aquatic species" between ecosystems.[73] Reasons of economy, subsistence, and recreation account for the intentional practice.[74]

The transplantation of pink salmon has been intensely studied,[75] as has another of the salmonid species, the brown trout (*Salmo trutta*).[76] The brown trout is a close relative of the Atlantic salmon and is a highly valued and challenging sport fish.[77] It is a known stocking substitute to compensate for the loss of anadromous salmonids.[78] Its globetrotting relocation from native waters of Europe and North Africa in the late 19th century is often regarded as a success story today,[79] and perhaps as a template for the transplantation of other salmonid species. Scientists, however, also study the brown trout in terms of its status as a global invader, a pervasive and negatively impacting species despite its worldwide commercial and recreational appeal.[80]

B. Secondary Spread

One adverse consequence of the introduction of non-native species is the potential *secondary spread* of the alien species to areas beyond their targeted introduction.[81] Unforeseen

et al., Forslag til handlingsplan mot pukkellaks [Proposed Action Plan Against Pukkellaks] 27 (Miløddirektoratet, Rapport M-2003/2021, 2021) (*Den viktigste motivasjonen for at arten ble overført fra Stillehavet til Kvitsjøen på 1950-tallet var at det ble betraktet som en potensiell ressurs for fiskeriene* [The most important motivation for the species being transferred from the Pacific Ocean to the White Sea in the 1950s was that it was considered a potential resource for the fisheries]).

66. *See* Kjetil Hindar et al., Assessment of the Risk to Norwegian Biodiversity and Aquaculture From Pink Salmon (Oncorhynchus Gorbuscha). Scientific Opinion of the Panel on Alien Organisms and Trade in Endangered Species (CITES) of the Norwegian Scientific Committee for Food and Environment 9 (VKM, Report No. 2020:1, 2020) [hereinafter VKM Report] (referencing Sakhalin Island); Odd Terje Sandlund, *Norway's New Invaders: The Pink Salmon*, NTNU Univ. Museum (Apr. 30, 2018), http://blogg.vm.ntnu.no/naturviten/2018/04/30/norways-new-invaders-the-pink-salmon/?lang=en (referencing Kola Peninsula).
67. M. Yu. Alekseev et al., *Distribution, Spawning, and the Possibility of Fishery of Introduced Pink Salmon (Oncorhynchus Gorbusha Walbaum) in Rivers of Murmansk Oblast*, 10 Russian J. Biological Invasions 109, 109-10 (2019) (noting the earlier spawning cycle of the successfully transplanted fish); *see also* VKM Report, *supra* note 66, at 34-35.
68. Sandlund, *supra* note 66.
69. VKM Report, *supra* note 66, at 36.
70. *See* Rodolphe Elie Gozlan, *Introduction of Non-Native Freshwater Fish: Is It All Bad?*, 9 Fish & Fisheries 106 (2008) (addressing risk perceptions associated with non-native freshwater fish introductions).
71. Sandlund et al., *supra* note 5, at 1034. Between 1968 and 1971, "1573 translocations of 49 species of fish into 678 water bodies were made" in Russia. *See* Alekseev et al., *supra* note 67, at 109. Accidental bioinvasions are commonly related to contaminated transport pathways such as shipping ballast and hull biofouling, horticulture replantings for purposes of aesthetics, fuel, carbon sequestration, settlement expansion, and animal escape. *See* Conservation of Arctic Flora and Fauna (CAFF), Arctic Invasive Alien Species 4 (2017). "At any given moment some 10,000 different species are being transported between bio-geographic regions in ballast tanks alone." Nicholas Bax et al., *Marine Invasive Alien Species: A Threat to Global Biodiversity*, 27 Marine Pol'y 313 (2003).
72. Jan H. Sundet & Alf Håkon Hoel, *The Norwegian Management of an Introduced Species: The Arctic Red King Crab Fishery*, 72 Marine Pol'y 278 (2016).
73. *Id.*
74. *See*, *e.g.*, Christopher R. Rossi, *The Migingo Island Dispute Between Kenya and Uganda*, 42 Brook. J. Int'l L. 659 (2017) (discussing the reasons and repercussions of introducing the non-native Nile perch (*Mbuta*) into Lake Victoria).
75. *See* Natalia V. Gordeeva et al., *Variability of Biological and Population Genetic Indices in Pink Salmon, Oncorhynchus Gorbuscha Transplanted Into the White Sea Basin*, 55 J. Ichthyology 69 (2015); Natalia V. Gordeeva et al., *Genetic Changes in Pink Salmon Oncorhynchus Gorbuscha Walbaum During Acclimatization in the White Sea Basin*, 39 Russian J. Genetics 322 (2003) [hereinafter Gordeeva et al., *Genetic Changes*]; Vilhelm Bjerknes, Evidence of Natural Production of Pink Salmon Fry (Oncorhynchus Gorbuscha Walbaum) in Finnmark, North Norway (1977); E.L. Bakshtansky, *Pink Salmon in the Kola Peninsula*, *in* Salmon Ranching 245 (James Ernest Thorpe ed., Academic Press 1980); E.L. Bakshtansky, *The Impact of the Environmental Factors on Survival of the Far Eastern Young Salmon During the Acclimatization of the Latter in the Northwest Part of the USSR*, *in* ICNAF Environmental Symposium 477 (International Commission for the Northwest Atlantic Fisheries, Special Publication No. 6, 1964).
76. Javier Lobón-Cerviá, *Princess of the Streams: The Brown Trout Salmo Trutta L. as Aquatic Royalty*, *in* Brown Trout: Life History, Ecology, and Management 1 (Javier Lobón-Cerviá & Nuria Sanz eds., Wiley 2018) (noting the brown trout is one of the most widely sought-after, studied, and managed salmonid species in the world).
77. *See* U.S. Fish and Wildlife Service, *Brown Trout: Salmo Trutta*, https://www.fws.gov/southeast/wildlife/fishes/brown-trout/ (last updated Jan. 9, 2020) (noting as well its introduction to North America from Europe in 1883, its current worldwide presence, and conservation challenges caused by its displacive preying effect on brook trout).
78. Jouni K. Salonen et al., *Atlantic Salmon (Salmo Salar) and Brown Trout (Salmo Trutta) Differ in Their Suitability as Hosts for the Endangered Freshwater Pearl Mussel (Margaritifera Margaritifera) in Northern Fennoscandian Rivers*, 62 Freshwater Biology 1346, 1348 (2017).
79. *See* Hugh R. MacCrimmon & T. Larry Marshall, *World Distribution of Brown Trout, Salmo Trutta*, 25 J. Fisheries Rsch. Bd. Can. 2527 (2011); Øystein Skaala, *Tema: Brown Trout*, Inst. Marine Rsch. (May 26, 2020), https://www.hi.no/en/hi/temasider/species/brown-trout; Side Channel Productions, *The Introduction: New Zealand's Brown Trout Story*, YouTube (Aug. 16, 2018), https://www.youtube.com/watch?v=SUqrqGPMcO8; T.A. Lasenby & Steven J. Kerr, Brown Trout Stocking: An Annotated Bibliography and Literature Review 5 (2001) (extensively reviewing literature on the benefits of stocking brown trout). *Cf.* Sundet & Hoel, *supra* note 72 (noting, inter alia, the financial rewards associated with the introduction of the red king crab).
80. Phaedra Budy & Jereme W. Gaeta, *Brown Trout as an Invader: A Synthesis of Problems and Perspectives in North America*, *in* Brown Trout: Biology, Ecology, and Management 525 (Javier Lobón-Cerviá & Nuria Sanz eds., Wiley 2018); *see also* Austin Burrill, Brown Trout; and Their Ecological Impacts as an Invasive Species 9 (2014), https://depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2015/09/Salmo_trutta_Burrill_2014.pdf (referring to it as the "ideal invader").
81. *See* M. Jake Vander Zanden & Julian D. Olden, *A Management Framework for Preventing the Secondary Spread of Aquatic Invasive Species*, 65 Canadian J. Fisheries & Aquatic Scis. 1512, 1512-13 (2008). Norway defines secondary spread (introduction) as "the result of an intentional or unintention-

effects of such spread rank invasive species as the second-biggest threat to biodiversity after habitat destruction.[82] Scientific information is incomplete, but evidence suggests that the influx of pink salmon can damage local Atlantic salmon, sea trout, and Arctic char populations, and possibly entire ecosystems.[83]

Pink salmon compete in an ecosystem with other species. They are aggressive and crowd out native species from their riffles and holding pools.[84] They alter river morphology, introduce pathogens,[85] and create oxygen sags with their mounting carcasses after spawning.[86] These and other ecological effects of pink salmon on Atlantic salmon "are basically unknown."[87] Generally, fish biologists stress prevention of biological invasions as the cornerstone of every management strategy because once an alien species establishes a population beyond its implanted locality or native range, its subsequent spread is "usually impossible to eradicate or prevent."[88]

The spread of *pukkellaks* advanced slowly for several decades, but began to accelerate along major Norwegian coastal areas after 2015.[89] Evidence indicates a correlation between ocean surface temperatures and the number of pink salmon returning to nest.[90] Increasing sea surface temperatures and reduced ice cover in waters south of Norway's Arctic Ocean archipelago, Svalbard, suggest that "climate warming over the next 50 years will facilitate the secondary spread of circumpolar pink salmon populations in Arctic rivers."[91]

C. Stemming the Spread

The local fishing and hunting association in Sør-Varanger reported catching eight pink salmon in all of 2017; 2,700 were trapped in only nine days in 2021.[92] Nationally, at least 70,000 *pukkellaks* had been caught in Norwegian rivers by August 2021, 65,000 alone in Troms and Finnmark—a number four times the recorded catch in 2019.[93] Between that time, volunteer associations of anglers formed to stem "overwhelming" biannual migrations of pink salmon into Norwegian rivers.[94] Earlier large captures of pink salmon in Norway's rivers occurred in the 1960s and 1970s, but these harvests were thought to have aimlessly strayed from the Russian seeding efforts along the Kola Peninsula. The 2017 influx of pink salmon—dramatic far beyond Norwegian waters[95]—sounded invasive alarms, as their large numbers indicated they had permanently adapted to local waters.[96]

al introduction into a new area, when the species disperses from that point of entry into areas it could not have reached without the initial (primary) human-mediated introduction." Norwegian Ministry of Environment, Strategy on Invasive Alien Species 7 (2007).

82. *See* GRID-Arendal, *Marine Invasive Pathways in the Arctic*, https://www.grida.no/resources/13343 (last visited Jan. 20, 2022); *see also* CAFF, *supra* note 71, at 6 (ranking invasive alien species among the most significant global drivers of biodiversity loss).
83. NINA, *Pukkellaks*, https://www.nina.no/pukkellaks (last visited Jan. 20, 2022) (noting large migrations upriver of pink salmon produce "*negative effekter på lokal laks, sjøørret og sjørøye . . . . Dette kan påvirke andre fisk og hele økosystem*" [negative effects on local salmon, sea trout and Arctic char . . . This can affect other fish and the entire ecosystem]).
84. *See Concerns Raised That Invasive Pacific Pink Salmon Could Pose Threat to Native Species*, Thejournal.ie (July 1, 2021), https://www.thejournal.ie/pacific-pink-salmon-alert-inland-fisheries-5482665-Jul2021/ [hereinafter Thejournal.ie]. For more on salmon aggression, see Thomas P. Quinn, *Variation in Pacific Salmon Reproductive Behaviour Associated With Species, Sex, and Levels of Competition*, 136 Behavior 179, 196 (1999) (noting pink salmon aggressive behavior vis-à-vis Pacific salmon and also noting that female Atlantic salmon provide little or no defense of the redd sites after spawning); regarding Pacific salmon's crowding out effect, see T.J. Martinell, *Pacific Salmon Population Explosion*, Lens (Apr. 10, 2018), https://thelens.news/2018/04/10/pacific-salmon-population-explosion/; Erkinaro, *supra* note 29 (presenting video on female pink salmon aggressive behavior); NINA, *supra* note 83 (suggesting a displacement threat to river mussels, which use Atlantic salmon and trout tongues as hosts for the larval stage).
85. *See* Thejournal.ie, *supra* note 84.
86. Helge M. Markusson, *Pink Salmon: Problem or Resource?*, Framsenteret [Fram Ctr.] (Dec. 22, 2020), https://framsenteret.no/nyheter/2020/12/22/pink-salmon-problem-or-resource/ (quoting oxygen depletion concerns of University of Alaska Fairbanks professor Mark S. Wipfli); *see also* Jason B. Fellman et al., *Interactive Physical and Biotic Factors Control Dissolved Oxygen in Salmon Spawning Streams in Coastal Alaska*, 81 Aquatic Sci. art. 2 (2019), https://doi.org/10.1007/s00027-018-0597-9. *But see* Forseth et al., *supra* note 12, at 1505 (noting spawning habits of pink salmon close to estuaries render competition with Atlantic salmon juveniles a minor problem).
87. Forseth et al., *supra* note 12, at 1505. The interminglement of pink and Atlantic salmon broodlines are not known, although research indicates that their spawning cycles are "reproductively isolated from each other." Sandlund et al., *supra* note 5, at 1035. Additionally, deciphering contributions to the population decline of Atlantic salmon remains a major scientific obstacle given what little is known about the marine mortality and lifestyle of salmon. Eva B. Thorstad et al., *Atlantic Salmon in a Rapidly Changing Environment—Facing the Challenges of Reduced Marine Survival and Climate Change*, 31 Aquatic Conservation 2654, 2656 (2021) (discussing unknowns of the Atlantic salmon marine phase); Thomas P. Quinn, The Behavior and Ecology of Pacific Salmon and Trout 53 (2005) (noting "the great majority of salmonids that migrate to sea do not return").
88. Vander Zanden & Olden, *supra* note 81, at 1513.
89. Atle Staalesen, *Alarm Bells Ringing for Atlantic Salmon. An Invasive Species From the Pacific Appears to Take Its Place*, Barents Observer (July 8, 2021), https://thebarentsobserver.com/en/climate-crisis/2021/07/there-almost-no-atlantic-salmon-left-norwegian-arctic-rivers-invasive-species. Scientists ponder over the nature of the *pukkellaks*' migratory behavior. Some evidence suggests their "homing instinct is not as exact in the introduced new areas in the North Atlantic and Barents Sea," which, if true, may pose its own set of invasive riverine problems. Eero Niemelä et al., Office of the Finnmark County Governor Department of Environmental Affairs, Pink Salmon in the Barents Region: With Special Attention to the Status in the Transboundary Rivers Tana and Neiden, Rivers in North West Russia, and in East Canada 4 (2016).
90. *See* VKM Report, *supra* note 66, at 14; *see also* Gordeeva et al., *Genetic Changes*, *supra* note 75, at 322 (showing that pink salmon naturally reproduced only in the periods of warming of the North Atlantic).
91. *See* VKM Report, *supra* note 66, at 14. The northward migration of animal and marine life, vegetation zones, tree lines, and more formed key findings of the 1994 Arctic Climate Impact Assessment, including the projected shift northward "on both land and sea, bringing new species into the Arctic while severely limiting some species currently present." Susan Joy Hassol, Impacts of a Warming Climate: Arctic Climate Impact Assessment 10 (2004), https://www.amap.no/documents/download/1058/inline.
92. *See* Staalesen, *supra* note 89.
93. Jørn J. Fremstad, *Norske Elver Flommer Over av Pukkellaks* [*Norwegian Rivers Flooded Over by Pukellaks*], NINA (Aug. 18, 2021), https://www.nina.no/english/About-NINA/News/article/norske-elver-flommer-over-av-pukkellaks.
94. *See* Rolf E. Sch. Kollstrøm, *Norwegian Association for Hunters and Anglers Local Department, Sør-Varanger (Sør-Varanger JFF)*, *in* Pink Salmon in the Barents Region 21 (2018).
95. *See* Ingebright Uglem et al., *The Pink Salmon Invasion in Norway 2017*, *in* Pink Salmon in the Barents Region, *supra* note 94, at 19.
96. *Id. See also* Anne Olga Syverhuset, *Rekordmange pukkellaks i Norge 2019* [*Record Number of Pukkellaks in Norway 2019*], NINA (Apr. 29, 2020), https://www.nina.no/english/News/article/rekordmange-pukkellaks-i-norge-2019.

Pink salmon have a two-year life cycle, with offspring returning every other year to spawn.[97] Unlike Atlantic salmon, these alternating broodlines head to sea a few days or weeks after hatching and spend only one year in the sea before returning. This accelerated life-span amounts to one of the fastest growth spans among salmonids.[98] It creates odd-year and even-year spawning fluctuations that alter riverine ecological balance. Anglers refer to these alternating pink-salmon runs as "pink years" and "non-pink" years.[99] Odd-year broodlines are more plentiful and dominant.[100] Data collected since 1960 indicate "almost all" peak year influx of pink salmon occurs in odd years.[101]

Pink salmon have now appeared in Swedish, Danish, Finnish, British, Irish, French, German, and Icelandic watersheds, as well as in the waters surrounding the Faroe Islands, Greenland, and on the eastern side of Canada.[102] Atlantic salmon cohabitate these waters and range in the northern stretches of the Atlantic Ocean from northern coastal Portugal to Pechora in Russia.[103] Little is known of the pelagic interactions of pink and Atlantic salmon.[104] However, *pukkellaks* spawners have now been recorded in rivers "all along the Norwegian coast" and most recurringly in rivers of eastern and western Finnmark and Troms.[105]

Researchers conclude "with very high confidence" that the pink salmon colonization of Norwegian rivers will continue.[106] In response, Norway's Climate and Environment Ministry has budgeted 15.3 kroner (1.8 million USD) in 2022 for floating grate traps to stem the 2023 run.[107] Norwegian Environment Agency now ranks pink salmon as "high risk" on the Norwegian Biodiversity Information Centre's list of invasive species,[108] a designation not universally shared in neighboring Russia,[109] among some Norwegians,[110] and elsewhere.[111]

While international conferences convene to address the "exponential" influx of pink salmon,[112] and while scientists collect data on their numbers to assess their ecological impact and adaptive life history,[113] local fishing and conservation groups deploy to mitigate infestation while avoiding bycatch.[114] An assortment of gill nets, traps, seines, board weirs, harpoons, hand nets, and gigging techniques are now in use.[115] Recent hauls of the highly valued "King of Fish" have been turned into dog food to avoid waste and spoilage. Pacific salmon are well-respected culinary items; however, their biological condition and taste degrade

97. NOAA Fisheries, *Pink Salmon*, https://www.fisheries.noaa.gov/species/pink-salmon (last visited Jan. 20, 2022).
98. *See* VKM Report, *supra* note 66, at 102.
99. Phil Monahan, *Fish Facts: Pink Salmon (Oncorhyncus Gorbuscha)*, Orvis News (July 21, 2021), https://news.orvis.com/fly-fishing/fish-facts-pink-salmon-oncorhyncus-gorbuscha.
100. *See* James R. Irvine et al., *Increasing Dominance of Odd-Year Returning Pink Salmon*, 143 Transactions Am. Fisheries Soc'y 939 (2014) (suggesting climate change conditions are benefitting odd-year returning pink salmon).
101. *See* VKM Report, *supra* note 66, at 37-38 (assessing yearly catch from 1960-2019).
102. *See* NINA, *supra* note 62; Colin Bean, A Perspective on Pink Salmon in Scotland, Presentation at the International Seminar on Pink Salmon in the Barents Region and in Northern Europe sec. 1 (Oct. 27-28, 2021) (reviewing the spread of pink salmon).
103. *See* ICES, Atlantic Salmon From the Northeast Atlantic 19 (2020), https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/sal.neac.all.pdf; Mugaas, *supra* note 59.
104. Sandlund et al., *supra* note 5, at 1035.
105. VKM Report, *supra* note 66, at 85.
106. *Id.* at 103. *See also* Henrik Hårdensson Berntsen et al., NINA, Pukkellaks i Norge: kan vi forutse hvor den etablerer seg i fremtiden? Nåværende og mulig fremtidig utbredelse [Pukkellaks in Norway: Can We Predict Where It Is Establishing in the Future? Current and Possible Future Distribution] (2021) (modeling current and future trends).
107. *Vil være godt forberedt til neste pukkellaks-invasjon* [*We Will Be Well Prepared for the Next Pukkellaks Invasion*], Miljø-direktoratet [Env't Directorate] (Sept. 9, 2021), https://www.miljodirektoratet.no/aktuelt/nyheter/2021/september-2021/vil-vare-godt-forberedt-til-neste-pukkellaksinvasjon/.
108. NINA, *supra* note 62.
109. Kristina Kalinina & Ksenia Novikova, *Norway Wants to Eradicate Humpback Salmon—In the Neighboring Country the Fish Are Eaten With Pleasure*, NRK (July 29, 2019), https://www.nrk.no/tromsogfinnmark/norge-vil-utrydde-pukkellaksen-_-i-nabolandet-spises-fisken-med-glede-1.14639056 (contrasting Russian culinary views of *Gorbusha* and Norwegian views of *pukkellaks*' endangerment of wild Atlantic salmon habitat in Norway). *But see* Zubchenko, *supra* note 65 (stating "[t]oday's knowledge leaves no doubt that the decision to transplant pink salmon . . . was a mistake. . . . The opinion of a number of researchers and managers who consider replacement of Atlantic salmon by pink salmon possible is not acceptable.").
110. Anniken Pedersen et al., *Russian Intruder Is a Danger to Norwegian Wild Salmon—Now Fish Entrepreneurs Want to Make Money From It*, NRK (June 25, 2021), https://www.nrk.no/tromsogfinnmark/frykter-at-pukkellaks-fra-russland-skal-odelegge-norsk-villaksen-_-det-vil-svein-lyder-gjore-noe-med-1.15547612 (profiling commercial fishing interests in *pukkellaks* from the Norwegian Raw Fish Association); Knut Anders Finnset & Sveinung Åsali, *Huge Demand for Humpback Salmon: Do You See the Difference?*, NRK (July 6, 2021), https://www.nrk.no/tromsogfinnmark/stor-ettersporsel-etter-pukkelaks_-og-na-skal-den-utskjelte-fisken-forskes-mer-pa-1.15565046 (reporting on strong demand for *pukkellaks* among Tromsø fishmongers, research interest in its resistance to parasites, and prospects of its commercial value akin to king crab harvests); Anja Ariel Tørnes Brekke, *Går mot rekordår—men hva er egentlig greia med pukkellaks?* [*Heading Toward Record Year—But What's Actually the Matter With Pukkellaks?*], NRK (Oct. 12, 2021), https://www.nrk.no/tromsogfinnmark/hva-er-egentlig-greia-med-pukkellaks_-1.15571338 (reporting "*hvorfor sier noen at pukkellaksen er en kjemperessurs*"? [why does someone say that the pukkellaks are a huge resource?]); Jan Gunnar Furuly, *Pukkellaksen invaderer norske elver: Sjømatgründeren jubler, og forskerne tviler* [*The Pukkellaks Invade Norwegian Rivers: The Seafood Entrepreneur Cheers, and the Scientists Doubt*], Aftenposten (Oct. 26, 2021), https://www.aftenposten.no/norge/i/y4mEbA/pukkellaksen-invaderer-norske-elver-sjoematgrunderen-jubler-og-forske (discussing the growing contraposition of opinion about the value of the fish).
111. *See* Geoff Bartlett, *Pink Salmon Caught in N.L. Likely From Russian Stocking Program*, CBC (Sept. 20, 2017), https://www.cbc.ca/news/canada/newfoundland-labrador/pink-salmon-newfoundland-labrador-russia-1.4297983 (reporting on the presence of pink salmon in Canadian waters off Newfoundland and Labrador and lack of concern by a representative of the Atlantic Salmon Federation given that "we have tried to introduce them . . . before and it didn't work").
112. *See*, *e.g.*, Henrik H. Berntsen, Presentation at the International Seminar on Pink Salmon in the Barents Region and in Northern Europe sec. 1 (Oct. 27-28, 2021).
113. *See*, *e.g.*, Kolarctic CBC Project No. KO197, Trilateral Cooperation in Our Common Resource; the Atlantic Salmon in the Barents Region (2011); Kolarctic CBC Project No. KO4178, Conserving Our Atlantic Salmon as a Sustainable Resource for People in the North; Fisheries and Conservation in the Context of Growing Threats and a Changing Environment (2020) (referencing international cooperative efforts).
114. Bycatch is the "incidental capture of non-target species." It is described as a "major problem" resulting in a "staggering" amount of discarded marine life. World Wildlife Fund, *Bycatch: Overview*, https://www.worldwildlife.org/threats/bycatch (last visited Jan. 20, 2022).
115. *See* VKM Report, *supra* note 66, at 104-05 (listing common methods of removal).

quickly once they stop feeding and drinking as they reenter freshwater to spawn.[116]

Researchers conclude that the labor-intensive volunteer efforts, absent international cooperation, are unlikely to stem the migration.[117] Fervent efforts to model the ecological intrusion of pink salmon—and to plan against the ticking two-year cycle of the next and probably much more significant pink salmon run—challenge global governance theorists and Arctic specialists as much as this looming threat challenges scientific and local volunteer angling communities. Focusing on fundamentals of anadromy provides clues for how governance structures need to be rethought in an age of biological creep.[118]

III. Anadromy's Challenges to Regime Theory and Governance

Pink salmon are anadromous fish. They link freshwater and salt water ecosystems by migrating up rivers from the sea to spawn.[119] Their ability to adapt to starkly different habitats (a process called osmoregulation[120]) makes them among "the world's most studied fish."[121] Economists and anthropologists track salmonids for their significant economic and cultural value.[122] Environmentalists observe their commingled life cycle, which exposes them to intense pressures across multiple ecosystems.[123] Evolutionary biologists debate their placement along anadromy's evolutionary arc.[124] Indeed, anadromy has intrigued biologists for as long as salmon have been studied.[125]

Anadromy represents a curious form of adaptive behavior. It intermixes residential and migratory life histories, which themselves often vary, making anadromous lifestyles "notoriously difficult" to model.[126] Anadromy starkly contrasts freshwater and marine faunas, and yet it intricately and rather unobtrusively represents ontological developments taking place in eddies, between adfluvial streams and tributaries, and between tributaries and main channels.

Anadromous species, such as salmonids, maneuver within brackish estuaries fed by infiltrating and exfiltrating tidal surges. They feed in backwaters and commingled inland alkalinities and then move to coastal waterways and finally to open sea ecosystems, only to reverse the process with such fidelity and precision as to return to the site of natal origin to renew the cycle. Salmonids are the epitome of widely roaming fish, and yet they are paradoxically anchored in place.[127] Osmoregulation is but one of the elusive characteristics that challenges the governance of salmonids.

A. Regime Convergence and Complexity

Regimes can be as broad as the law of the sea or as narrow as a tributary. They may represent geophysical spaces or imaginary riffle pools. They pliably resonate within major schools of international relations,[128] but have been criti-

116. Hanne Wilhelms & Anniken Pedersen, *Fjernet 3600 pukkellaks på en uke:- Staten er nødt til å ta regningen* [*Removed 3600 Pukkellaks in One Week: The State Has to Pick Up the Tab*], NRK (July 10, 2021), https://www.nrk.no/tromsogfinnmark/3600-pukkellaks-fjernet-fra-vestre-jakobselv_-vil-at-staten-tar-regningen-1.15569951. *See also* Kurt Jacobson, *In Defense of the Lowly Pink Salmon*, Alaska Mag. (June 21, 2017), https://alaskamagazine.com/authentic-alaska/in-defense-of-the-lowly-pink-salmon/ (reflecting the culinary opinion of a food and travel chef); Lidunn Mosaker Boge, *Pukkellaksen er en ypperlig matfisk* [*The Pukkellaks Is a Top-Notch Fish Food*], Nofima (Jan. 5, 2022), https://kommunikasjon.ntb.no/pressemelding/pukkellaksen-er-en-ypperlig-matfisk?publisherId=9232871&releaseId=17923646 (reporting on favorable quality assessments by researchers at the Norwegian food research institute, Nofima); Marine Science, *Salmon Reproduction*, https://www.marinebio.net/marinescience/05nekton/sarepro.htm (last revised June 21, 2006) (noting the rapid biophysical and internally disintegrating changes to returning salmon).

117. Mo et al., *supra* note 65, at 23 ("*Uttak av pukkellaks er arbeidskrevende og kan ikke baseres på dugnadsinnsats*" [Culling of pukkellaks is labor intensive and cannot be based on voluntary efforts]), and 27 (*"I disse vassdragene er det nødvendig å samarbeide med naboland for å gjøre tiltak og overvåke utviklingen*" [In these watercourses, it is important to work together with neighboring countries to take measures to monitor developments]).

118. For more on marine invasions thought to be related to warming oceans, see João Canning-Clode & James T. Carlton, *Refining and Expanding Global Climate Change Scenarios in the Sea: Poleward Creep Complexities, Range Termini, and Setbacks and Surges*, 23 Diversity & Distribs. 463 (2017) (noting invasion dynamics in the North Sea, the Arctic, and off the coasts of Portugal, France, Australia, and the Southern Hemisphere); Christopher R. Rossi, *Norway's Imperiled Sovereignty Claim Over Svalbard's Adjacent Waters*, 18 German L.J. 1497 (2017) (discussing invasive snow crabs in the waters of the High Arctic); Jannike Falk-Petersen & Claire W. Armstrong, *To Have One's Cake and Eat It Too: Managing the Alien Invasive Red King Crab*, 28 Marine Res. Econ. 65 (2013) (discussing the spread of red king crab from released regions in the Barents Sea into Norwegian coastal waters and fjords); João Canning-Clode et al., *"Caribbean Creep" Chills Out: Climate Change and Marine Invasive Species*, 6 Plos One 1 (2011), https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0029657&type=printable (reviewing invertebrate species invasions into the U.S. southern and mid-Atlantic coasts from the Caribbean).

119. Nicolas Schtlekzelle & Thomas P. Quinn, *A Metropolitan Perspective for Salmon and Other Anadromous Fish*, 8 Fish & Fisheries 297, 297 (2007). Some salmonids (sockeye, masu salmon, and rainbow and cutthroat trout) have nonanadromous populations. Quinn, *supra* note 87, at 5.

120. *See How Salmon Adjust From Fresh Water to Salt Water, and Back Again*, Evolution News (Aug. 28, 2015), https://evolutionnews.org/2015/08/how_salmon_adju/ (discussing osmoregulation).

121. Audun H. Rikardsen et al., *Redefining the Oceanic Distribution of Atlantic Salmon*, 11 Sci. Reps. art. 12266 (2021), https://doi.org/10.1038/s41598-021-91137-y.

122. *See generally* Knut Marius Myrvold et al., NINA, The Social, Economic, and Cultural Values of Wild Atlantic Salmon (2019) (presenting an extensive literature review and meta-analysis of the values associated with wild Atlantic salmon). Salmon are the most commercially valuable anadromous species. *See* William T. Burke, *Annex 1—1982 Convention on the Law of the Sea Provisions on Conditions of Access to Fisheries Subject to National Jurisdiction*, https://www.fao.org/3/x5608e/x5608e09.htm (last visited Jan. 20, 2022).

123. *See* Yann Czorlich et al., *Evolution in Salmon Life-History Induced by Direct and Indirect Effects of Fishing*, BioRxiv (Jan. 8, 2021), https://doi.org/10.1101/2021.01.08.425869.

124. *See generally* Julian J. Dodson et al., *Contrasting Evolutionary Pathways of Anadromy in Euteleostean Fishes*, 69 Am. Fisheries Soc'y Symp. 63 (2009) (debating the ancestral character state leading to anadromy among salmoniforms).

125. Schiewe, *supra* note 21, at 526.

126. Steven F. Railsback et al., *Facultative Anadromy in Salmonids: Linking Habitat, Individual Life History Decisions, and Population-Level Consequences*, 71 Canadian J. Fisheries & Aquatic Scis. 1270, 1270 (2014).

127. William T. Burke, *Anadromous Species and the New International Law of the Sea*, 22 Ocean Dev. & Int'l L. 95 (1991).

128. *See*, *e.g.*, Diplomatic Investigations (Herbert Butterfield & Martin Wight eds., 1968) (associating regime theory with the Grotian tradition and the English school); 36(2) Int'l Org. (1982) (presenting 12 leading essays on regime theory); Robert O. Keohane, After Hegemony: Cooperation and Discord in the World Political Economy (1984)

cized for their lack of elasticity and for underemphasizing dynamic elements of change.[129] A study of anadromous salmonid lifestyle helps to understand challenges of Arctic regime analysis. Arctic regimes were constructed for a cryogenic issue area that is now melting away.

Salmon life cycles intrigue scientists for their very ability to navigate across ecosystems. Salmon life cycles should also intrigue social scientists for adding texture to the neologisms of global governance,[130] regime complex,[131] regime complexity,[132] regime shifting,[133] and to the formative definition of a "regime." Salmon are not static, in ways that regimes can be. They are international and local, and highly migratory and fixed. Fishing regimes tend to reflect compartmentalized geographical, jurisdictional, and epistemic parameters.[134] The most cited usage defines a "regime" as the convergence of expectations around implicit or explicit norms and procedures governing a specific issue area.[135] If only salmon were so obliging.

B. *Fitting Together Regime Pieces*

Like the idealized state system, which configures units in a tightly fitted arrangement of gapless sovereignties bounded by borders, regime theory presents jigsaw-puzzle pieces of rules and principles bounded by issue areas devolving from states, but possibly including non-state actors formally or informally.[136] Convergence implies a relational connection within regime structures whereby the rules and principles are perceived to be associated with one another within a bounded sphere.[137] Salmon problematize the element of convergence in regime theory, as evidenced by the multiplicity of regime structures that impact anadromous management.[138] This multiplicity conditions the field of global

(associating regimes with institutionalism); Robert Axelrod, The Evolution of Cooperation (1984) (liberalism); Nik Hynek, *Regime Theory as IR Theory: Reflections on Three Waves of "Isms,"* 11 CEJISS 11 (2017) (situating regime theory within schools of neoliberal and neorealist convergence, knowledge-based theories (cognitivism), and radical constructivist/post-structuralist approaches).

129. Susan Strange, *Cave! Hic Dragones: A Critique of Regime Analysis*, 36 Int'l Org. 479 (1982).

130. For a canvassing of neologisms of global governance, see Rosalba Belmonte & Philip G. Cerny, *Heterarchy: Toward Paradigm Shift in World Politics*, 14 J. Pol. Power 1, 4-6 (2021) (discussing neologisms of global governance such as functional differentiation, fragmentation, multiscalarity, deterritorialization, neomedievalism, landscapes, rhizomatic politics, and heterarchy).

131. Kal Raustiala & David G. Victor, *The Regime Complex for Plant Genetic Resources*, 58 Int'l Org. 277, 279 (2004) (introducing the term in the context of the global environment and defining it as "an array of partially overlapping institutions governing a particular issue-area"). Regime complexes build on the work of Oran Young, *Institutional Linkages in International Society: Polar Perspectives*, 2 Glob. Governance 1 (1996) (referring broadly to "international institutions construed as sets of roles, rules, and relationships that define social practices and guide behavior of participants at the international level"); Vinod K. Aggarwal, *Reconciling Multiple Institution: Bargaining, Linkages, and Nesting*, *in* Institutional Designs for a Complex World: Bargaining, Linkages, and Nesting (V.K. Aggarwal ed., Cornell Univ. Press 1998); Olav Schram Stokke, *Regimes as Governance Systems*, *in* Global Governance: Drawing Insights From the Environmental Experience 27 (Oran R. Young ed., 1997) (discussing regime clusters); Laurence R. Helfer, *Regime Shifting: The TRIPs Agreement and New Dynamics of International Intellectual Property Lawmaking*, 29 Yale J. Int'l L. 1, 14 (2004) (conglomerate regimes). More recently, see Amandine Orsini et al., *Regime Complexes: A Buzz, a Boom, or a Boost for Global Governance*, 19 Glob. Governance 27, 29 (2013) (defining a regime complex as a network of three or more international regimes that relate to a common subject, exhibit overlapping membership, and generate substantive, normative, or operative interactions as potentially problematic); and Michael J. Struett et al., *Navigating the Maritime Piracy Regime Complex*, 19 Glob. Governance 93 (2013) (arguing that regime complexes can themselves create obstacles to cooperation).

132. Karen J. Alter & Sophie Meunier, *The Politics of International Regime Complexity*, 7 Persps. on Pol. 13 (2009) (referring to nested, overlapping, and parallel international regimes distinguished by a lack of hierarchy).

133. Oran R. Young, *International Regimes: Problems of Concept Formation*, 32 World Pol. 331 (1980) (connecting regime disintegration to major changes in underlying power capabilities); Donald J. Puchala & Raymond F. Hopkins, *International Regimes: Lessons From Inductive Analysis*, 36 Int'l Org. 245 (1982) (emphasizing radical regime transformation in accordance with political power distributions); Robert O. Keohane, *The Theory of Hegemonic Stability and Changes in International Economic Regimes, 1967-1977*, *in* Change in the International System 131 (Ole R. Holsti et al. eds., Routledge 1980) (accounting for regime change over time in terms of changes in available relative power resources); Benjamin Cohen, *Balance-of-Payments Financing: Evolution of a Regime*, *in* International Regimes 315 (Stephen D. Krasner ed., Cornell Univ. Press 1983) (stylizing regime change as norm-governed); Helfer, *supra* note 131, at 14 (construing regime shifting as a strategy "to alter the status quo ante by moving treaty negotiations, law making initiatives, or standard setting activities from one international venue to another").

134. *See* Andrea Sofie Hansen Aspelund, A Visitor That Has Come to Stay? The Case of Pink Salmon (*Oncorhynchus Gorbuscha*) in Norway 25-46 (2020) (M.A. thesis, UiT) (reviewing international, regional, and municipal legal managerial frameworks, as well as scientific institutions and committees involved in pink salmon environmental impact).

135. Stephen D. Krasner, *Structural Causes and Regime Consequences: Regimes as Intervening Variables*, 36 Int'l Org. 185, 186 (1982) (specifically defining regimes as "implicit or explicit principles, norms, rules and decision-making procedures around which actors' expectations converge in a given area"); *see also* Ernst B. Haas, *Why Collaborate? Issue-Linkage and International Regimes*, 32 World Pol. 357, 397 (1980) (referring to regimes as "norms, procedures, and rules agreed to in order to regulate an issue-area"); Robert Keohane & Joseph Nye, Power and Interdependence 19 (1977).

136. *See* Helfer, *supra* note 131, at 10.

137. *See id*. at 11-12.

138. United Nations Convention on the Law of the Sea, *opened for signature* Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 16, 1994) [hereinafter LOS Convention]; United Nations Agreement Relating to the Conservation and Management of Straddling Fish Stocks and Migratory Fish Stocks, Aug. 4, 1995, 34 I.L.M. 1542 (Fish Stocks Agreement); Convention for a North Pacific Marine Science Organization (PICES) (entered into force Mar. 24, 1992), https://meetings.pices.int/about/convention; Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean (entered into force Feb. 16, 1993), *reprinted in* North Pacific Anadromous Fish Commission Handbook (3d ed. 2016), https://npafc.org/wp-content/uploads/2017/08/Handbook-3rd-E-English.pdf; Convention for the Conservation of Salmon in the North Atlantic Ocean, *supra* note 35; Agreement to Promote Compliance With International Conservation and Management Measures by Fishing Vessels on the High Seas (entered into force Apr. 24, 2003), https://www.fao.org/3/x3130m/x3130e00.htm; FAO, *Code of Conduct for Responsible Fisheries*, https://www.fao.org/fishery/code/en (last visited Jan. 20, 2022) (adopted in resolution Oct. 31, 1995).

Fisheries are often managed by regional fisheries management organizations (RFMOs) and bilateral fisheries commissions. The FAO's constitution establishes institutional relationships with two types of regional fishery bodies (via Article VI: the Fishery Committee for the Eastern Central Atlantic (CECAF) and the European Inland Fisheries and Aquaculture Advisory Commission; and via Article XIV: the Asia-Pacific Fishery Commission (APFIC) and the Regional Commission for Fisheries). Relevant Pacific Ocean regional fishing bodies include the APFIC, the Pacific Salmon Commission, the Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea, the NPAFC, the North Pacific Fisheries Commission, and PICES. Relevant Atlantic Ocean regional fishing bodies include the CECAF, the Joint Norwegian-Russian Fisheries Commission, the North East Atlantic Fisheries Commission, the Northwest Atlantic Fisheries Organization, and NASCO. Ancillary conventions such as the bilateral Pacific Salmon Treaty (United States and Canada) and other conventions relating to climate change, pollution, environmental assessment, and sustainable development add to the rising density of these

environmental governance and "the network of international environmental organizations and conventions," including the "spaces between them."[139]

The orthodox discussion of sovereignty delimits this sphere within sovereignty's container of the state. As a regime, sovereignty focuses on perimeters, borders, interstices, gaps, and no-man's-lands, all filled by extensions of jurisdiction based on appropriative means to establish good title to territory, such as discovery, occupation, recognition, cession, possession, conquest, acquiescence, or accretion.[140] Here, states are presumed to be the font of authority that organize sovereignty regimes; they legitimize territorial understandings of that authority through geographical expression.[141] The invasive complexity of anadromous migration presents an opportunity to examine the adaptive pliability of international regimes, as certain species converge in places where they do not belong, or, perhaps, once did not belong.

C. *Anadromy's Heterarchic Challenges to Governance*

Regime complexity literature focuses on the rising density of transnational rules and institutions in a regime complex.[142] Jurisdictional conflict or overlap may result in a type of division of labor that promotes institutional deference or the acceptance of rules or practices crafted by another organization.[143] In terms of Arctic institutions, this interplay, sometimes described as "haphazard" and fast-forming, has nevertheless created a "participatory heterogeneity" that has involved national and provincial governments, indigenous organizations, and civil society groups.[144]

This heterogeneity may generate dynamic interactions between regimes. It also may promote "flexibility and revisability in the interests of adaptation to change and inclusiveness,"[145] thus strengthening processes and restricting factions.[146] The 1995 Fish Stocks Agreement and the 2021 Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean[147] exemplify the dynamism of regime change. They supplemented the Law of the Sea Convention by focusing on species in the high seas, which indirectly involves those species that move in and between jurisdictional spaces.[148]

However, compartmentalized regime structures can present shortcomings and sharply conflictual orientations that actually promote the fragmentation of global governance schemata.[149] A lack of "agreed-upon means to assert a hierarchy" of governance rules complicates the "politics of cooperation."[150] This disagreement may flatten policymaking options, promote unranked (heterarchic) decisionmaking,[151] foster an impinging and noncooperative sense of regionality,[152] promote ambiguity and inertia,[153] and create a cross-purpose or negating swirl among new and preexisting regimes.[154] International fisheries law "is noticeably fragmented and non-hierarchical."[155] Regime

regimes. *See generally* Mariko Kawano, *Implementation of the Rules of the UNCLOS Through Universal and Regional Organizations*, *in* Global Challenges and the Law of the Sea 9 (Marta Chantal Ribeiro et al. eds., Springer 2020).

139. John Vogler, *The European Contribution to Global Environmental Governance*, 81 Int'l Affs. 835 (2005).

140. *See generally* Georg Schwarzenberger, *Title to Territory: Response to a Challenge*, 51 Am. J. Int'l L. 308 (1957) (canvassing sovereignty's connection to territorial control).

141. *See* John Agnew, *Sovereignty Regimes: Territoriality and State Authority in Contemporary World Politics*, 95 Annals Ass'n Am. Geographers 437 (2005) (referring to orthodox understanding of state sovereignty deficient for understanding reality).

142. *See* Karen J. Alter & Kal Raustiala, *The Rise of International Regime Complexity*, 14 Ann. Rev. L. & Soc. Sci. 329, 330 (2018) (noting 2,400 intergovernmental organizations, 37,000 organizations engaged in international politics, and hundreds of thousands of international agreements, and defining a regime complex as "a set of overlapping and perhaps even contradictory regimes that share a common focus"); Gráinne De Burca et al., *New Modes of Pluralist Global Governance*, 45 N.Y.U. J. Int'l L. & Pol. 723, 733 (2013) (detailing the rise and stagnation of comprehensive regimes from the mid-1990s); Alexander Betts, *Institutional Proliferation and the Global Refugee Regime*, 7 Persps. on Pol. 53, 54 (2009) (describing new institutional proliferation in the field of refugee protection).

143. *See generally* Tyler Pratt, *Deference and Hierarchy in International Regime Complexes*, 72 Int'l Org. 561 (2018) (exploring the practice of institutional deference).

144. Olav Schram Stokke, *International Institutions and Arctic Governance*, *in* International Cooperation and Arctic Governance: Regime Effectiveness and Northern Region Building 164, 165 (Olav Schram Stokke & Geir Hønneland eds., Routledge 2010).

145. De Burca et al., *supra* note 142, at 754.

146. Robert O. Keohane et al., *Democracy-Enhancing Multilateralism*, 63 Int'l Org. 1 (2009) (discussing complementarities between multilateralism and constitutional democracies by strengthening processes and restricting factions).

147. *See supra* note 41.

148. United Nations Division for Ocean Affairs and the Law of the Sea, *Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, U.N. Doc. A7Conf. 164/37 (Sept. 8, 1995); Trond Bjørdal & Gordon Munro, The Management of High Seas Fisheries Resources and the Implementation of the U.N. Fish Stocks Agreement of 1995, at 1 (Center for Fisheries Economics, Working Paper No. 06/02, 2002) (crediting the Fish Stocks Agreement with "increasing the number of regimes" to alleviate a worldwide fisheries management crisis involving straddling and highly migratory fish stocks); Rachael Tiller et al., *Resilience to Exogenous Shocks in Environmental Management Regimes in the Arctic—Lessons Learned From Survivors*, 9 Polar J. 133, 135-36 (2019) (noting the institutional layering of subject matter atop the Law of the Sea Convention).

149. C. Randall Henning, *Avoiding Fragmentation of Global Financial Governance*, 8 Glob. Pol'y 101 (2017); *see also* C. Randall Henning, Tangled Governance: International Regime Complexity, the Troika, and the Euro Crisis (2017).

150. Alter & Raustiala, *supra* note 142, at 331.

151. *See* Belmonte & Cerny, *supra* note 130, at 4 (describing heterarchy as "[a] range of diverse governance processes involving distinct but overlapping social, political, and economic processes and institutions" that increasingly undermine the segmentary differentiation of the state-centric model); Philip G. Cerny & Alex Prichard, *The New Anarchy: Globalisation and Fragmentation in World Politics*, 13 J. Int'l Pol. Theory 378, 381 (2017) (discussing multiscalarity, or the uneven variety of new and old scales of interaction that allows agents to seek levers of influence beyond the power of the state).

152. Stokke, *supra* note 144, at 179-80.

153. *See* Alter & Raustiala, *supra* note 142, at 339 (noting the preference for ambiguity and stasis that regime complexity may provide for states favoring the status quo).

154. Jagdish Bhagwati, *US Trade Policy: The Infatuation With Free Trade Agreements*, *in* The Dangerous Drift to Preferential Trade Agreements (Jagdish Bhagwati & Anne O. Krueger eds., AEI Press 1995) (introducing the gastronomic metaphor of the spaghetti bowl to describe the entanglement of free trade agreements).

155. Erik J. Molenaar & Richard Caddell, *International Fisheries Law: Achievements, Limitations, and Challenges*, *in* Strengthening International

rivulets and crosscurrents create backwaters and eddies that provide safe havens for state inaction.

1. Assessing the Threat?

Norway's minister of fisheries emphatically declared Norway's desire to be free of *pukkellaks* in its rivers.[156] Neighboring views from Russia are harder to pinpoint. Russia's newly assumed leadership of the Arctic Council promises "responsible governance for a sustainable Arctic."[157] What that priority means in terms of the precautionary principle remains sublime. A comparison of annual progress reports submitted to the international organization specifically created to conserve the Atlantic salmon suggests a divergence of opinion between Russia and Norway on *pukkellaks*: Russia's report does not reference pink salmon; Norway's report is replete with references labeling them a threat.[158]

Norwegian scientists have remarked that the dearth of information from Russia about the pink salmon populations now in the Kola Peninsula and in sub-Arctic Russian rivers precludes any proper appraisal of the regional situation and managerial response. Information about Atlantic salmon and pink salmon lifestyles in the central Arctic Ocean does not exist. Framing a responsible Arctic governance agenda for Atlantic salmon, mindful of the growing importance of the precautionary principle, is part of an invigorated scientific research effort.[159] And yet Russia, although the first to ratify the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, "expressed significant doubts about the necessity or even the desirability of moving forward" with the agreement,[160] even though the ability to fish in most of this area ("probably the least understood part of any of the world's oceans"[161]) is not yet even possible.

China's recent announcement that it is a "near-Arctic state," coupled with the release of its 2018 Arctic white paper adding the Polar Silk Road to its greater Belt and Road Initiative,[162] explicitly interprets sustainability in terms of resource utilization.[163] While a so-called Cambrian explosion or intense proliferation of action plans takes hold in the field of climate governance, a lack of Arctic coordination on *pukkellaks* may feed general criticisms about regime complexes as tending toward "fragmented, polycentric," and "uncoordinated" institutional pursuits.[164] This splintering invites a coming world of neomedievalism,[165] where the disconnecting interests of sovereign states yield limited and partial governance solutions and assessments that compete with fragmented substate strata and localized politics.[166]

2. Structural Elision, Structural Division, and Problems for Regime Grammar

Anadromy complicates the understanding of a regime, and the "theoretical deadlock" that situates regime theory between the Scylla of globalization and the Charybdis of fragmentation.[167] Anadromy does not tightly fit into social scientific classifications of regime complexes, or their continued spread.[168] Anadromy describes a process of biological elision—a sliding between systems—whereas regimes

Fisheries Law in an Era of Changing Oceans 3, 5 (Richard Caddell & Erik J. Molenaar eds., Bloomsbury Academic 2019).

156. *Fiskeriministeren fikk pukkellaks på første kastet* [*The Minister of Fisheries Got a Pukkellaks on the First Cast*], iLaks.no (June 28, 2021), https://ilaks.no/fiskeriministeren-fikk-pukkellaks-pa-forste-kastet/.

157. Russia's Chairmanship Priorities for the Arctic Council 2021-2023, at 1 (2021).

158. *See* NASCO Council, *Annual Progress Report on Actions Taken Under the Implementation Plan for the Calendar Year 2020—Russian Federation*, Doc. CNL(21)26 (2021), https://nasco.int/wp-content/uploads/2021/11/CNL2126_Annual-Progress-Report_Russian-Federation.pdf (omitting mention of pink salmon and mentioning signs of disease among adult Atlantic salmon in the Kola and the Tuloma Rivers, fishing bans in the Varzuga and Kola Rivers, and "[w]ork on further developing the inventories of salmon rivers of Murmansk region [and the study of] [s]almon juvenile densities in small rivers of Kola Bay and [the White Sea basin]"). *But see* NASCO Council, *Annual Progress Report on Actions Taken Under the Implementation Plan for the Calendar Year 2020—Norway*, Doc. CNL(21)28 (2021), https://nasco.int/wp-content/uploads/2021/04/CNL2128_Annual-Progress-Report_Norway.pdf (mentioning 17 times the threat of pink salmon).

159. *See* Peter B. Danilov, *US, China, and Russia Plan Joint Research in Order to Regulate Arctic Fishing*, High N. News (Aug. 2, 2021), https://www.highnorthnews.com/en/us-china-and-russia-plan-joint-research-order-regulate-arctic-fishing (reporting on efforts based on the Agreement to Prevent Unregulated High Seas Fisheries to jointly research and track current Arctic catch levels among nine countries and the European Union).

160. David Balton, *No. 9: The Arctic Fisheries Agreement Enters Into Force*, Polar Points (June 25, 2021), https://www.wilsoncenter.org/blog-post/no-9-arctic-fisheries-agreement-enters-force.

161. David Balton, *Moving Forward on Arctic Ocean Governance*, *in* Whither the Arctic Ocean? Research, Knowledge Needs, and Development En Route to the New Arctic 53, 60 (Paul Wasserman ed., BBVA Foundation 2021).

162. State Council, People's Republic of China, China's Arctic Policy pt. II (2018), http://english.www.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm.

163. *See id.* pt. III.

164. Kenneth W. Abbott, *The Transnational Regime Complex for Climate Change*, 30 Env't & Plan. 571 (2011). A Cambrian explosion borrows from the taxonomy of fossil research pertaining to rapid diversification of marine families between the Late Cambrian and Late Ordovician eras. For a seminal paleontological presentation, see J. John Sepkoski Jr., *A Kinetic Model of Phanerozoic Taxonomic Diversity II. Early Phanerozoic Families and Multiple Equilibria*, 5 Paleobiology 222 (1979).

165. Jörg Friedrichs interpreted "new medievalism" to mean a complicated web of societal identities, held together by the antagonistic organizational claims of the nation-state system and the transnational market economy. *See generally* Jörg Friedrichs, *The Meaning of New Medievalism*, 7 Eur. J. Int'l Rels. 475 (2001) [hereinafter Friedrichs, *The Meaning of New Medievalism*]; Jörg Friedrichs, *The Neomedieval Renaissance: Global Governance and International Law in the New Middle Ages*, *in* Governance and International Legal Theory 3 (Ige F. Dekker & Wouter G. Werner eds., Martinus Nijhoff 2004) (associating new medievalism with "a return to a situation where several authorities have overlapping and competing competencies, without the existence of a clear body of rules determining which set of prescriptions takes precedence").

166. *See* Thomas Risse & Ursula Lehmkuhl, Governance in Areas of Limited Statehood—New Modes of Governance? (DFG Research Center, SFB-Governance Working Paper Series No. 1, 2006) (discussing the governance problematique in terms of limited statehood).

167. Friedrichs, *The Meaning of New Medievalism*, *supra* note 165, at 479.

168. Laura Gómez-Mera, International Regime Complexity (2021), https://doi.org/10.1093/acrefore/9780190846626.013.648 (noting the recent academic portaging of regime complexes beyond global environmental governance, including now trade and investment, migration and refugees, finance and development, energy, food security, global health, and more).

more often frame political and structural divisions for social purposes.

Regimes create social structures.[169] They consolidate prevailing patterns or sets of rules that regulate government and its interactions with society.[170] They segment and compartmentalize attitudinal phenomena, where "behavior follows from adherence to principles,"[171] and where discretion is limited to the regime's domain,[172] which itself is driven by an orderly, underlying "generative grammar."[173]

The problem of anadromous biological elision, construed as an invasion, potentially affects the social structure and grammar of ecosystems such as the Tana. At the same time, this invasion is generating community-level responses that appear, to date, to be the most effective response, and part of a well-accepted observation that entrepreneurial private actors play an under-acknowledged role in filling gaps in regime complexes.[174] Gaps in macro-regime grammar suggest that the "driver"[175] of a coordinated response can originate from bottom-up controls that may affect regime structures and facilitate international cooperation. A review of the structural and grammatic deficiencies of major governance regimes highlights the need for invigorated local responses.

3. Governance Deficiencies

Anadromous secondary spread admittedly challenges this grammar. Consider the operations of the North Pacific Anadromous Fish Commission (NPAFC).[176] This commission describes itself as a regional fisheries management organization (RFMO).[177] It performs scientific and enforcement activities within a specific geographic area.[178] A disinterested review of its operations concluded, however, that "the NPAFC cannot be fully assessed against all criteria generally ascribed to RFMOs," because of the "unique context in which it operates" and the "broader framework" necessarily implied by anadromous elision and regime interminglement.[179] The review panel pinpointed international law's struggle: "Anadromy, when coupled with rules on allocation of state jurisdiction, gives rise to a number of unique management problems."[180]

The NPAFC and its RFMO counterpart, the North Atlantic Salmon Conservation Organization (NASCO), are regimes intended to structurally manage two anadromous salmonid species according to their natural habitats in the North Atlantic and North Pacific Oceans. The pink salmon's spreading colonization of the Atlantic Ocean suggests the structurally anachronistic formalism created by two intergovernmental organizations that were conceived as oceans apart. The NPAFC's updated performance review report recommends the continuation of comprehensive overviews and reports of North Pacific salmonid stock[181]; NASCO's implementation plan for 2019-2024, fortified by an evolving framework to confront dwindling stocks,[182] prioritizes monitoring and mitigation efforts associated with projected large increases in pink salmon.[183]

Trajectories of change or adaptation within regimes, naturally bound to the issue area, geography, or path for which the regime was created, may establish self-reproducing policy corridors that create a path dependence.[184] Here, "path dependence refers to the causal relevance of preceding stages in a temporal sequence," where "practices of an earlier point in time affect the possible outcomes of a sequence of events occurring at a later point in time."[185] Consequently, current rules and practices constrain and shape new rules and practices, as suggested by the geo-

169. Young, *supra* note 133, at 332.
170. Sunday E.N. Ebaye, *Regimes as Mechanisms for Social Order in International Relation*, 3 Af. J. Pol. Sci. & Int'l Rels. 117 (2009). *See also* Marc A. Levy et al., *The Study of International Regimes*, 1 Eur. J. Int'l Rels. 267 (1995).
171. Puchala & Hopkins, *supra* note 133, at 246.
172. John Gerard Ruggie, *International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order*, 32 Int'l Org. 379, 380 (1982).
173. *Id*.
174. *See* Mirijam Gaertner et al., *Invasive Plants as Drives of Regime Shifts: Identifying High-Priority Invaders That Alter Feedback Relationships*, 20 Diversity & Distribs. 733 (2014); Jessica F. Green & Graeme Auld, *Unbundling the Regime Complex: The Effects of Private Authority*, 6 Transnat'l Env't L. 259, 260 (2017).
175. The term "driver" adapts definitions employed by the Millennium Ecosystem Assessment. A driver of ecosystem change "is any natural or human induced factor that directly or indirectly causes a change in an ecosystem. A direct driver unequivocally influences ecosystem processes. An indirect driver operates more diffusely." Direct drivers "include climate change, plant nutrient use, land conversion leading to habitat change, and invasive species and diseases." Gerald C. Nelson, *Drivers of Ecosystem Change: Summary Chapter*, *in* 1 Millennium Ecosystem Assessment 73, 74 (Rashid Hassan et al. eds., 2005), https://www.millenniumassessment.org/documents/document.272.aspx.pdf.
176. The NPAFC is an international intergovernmental organization established by the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean, *supra* note 138 (Member countries include Canada, Japan, the Republic of Korea, the Russian Federation, and the United States).
177. *See generally* North Pacific Anadromous Fish Commission (NPAFC) Performance Review Panel Report (2010), https://npafc.org/wp-content/uploads/Performance-Review-Report.pdf [hereinafter NPAFC Report] (assessing performance in relation to the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean, Article 66 of the LOS Convention, and other relevant international instruments). By the terms of the treaty, NPAFC's region is the international waters of the North Pacific Ocean and its adjacent seas north of 33°N beyond the 200-mile exclusive economic zones of the coastal states. *See* NPAFC, *About NPAFC*, https://npafc.org/about/ (last visited Jan. 20, 2022).
178. *See* NPAFC Report, *supra* note 177, at 6.
179. *Id*.
180. *Id*.
181. NPAFC, List of Actions on Prioritized Recommendations From the NPAFC Performance Review Report (2019), https://npafc.org/wp-content/uploads/LoA-Prioritized-April-2019.pdf.
182. *See Agreement on Adoption of a Precautionary Approach*, *supra* note 35; NASCO Council, *NASCO Plan of Action for the Application of the Precautionary Approach to the Protection and Restoration of Atlantic Salmon Habitat*, Doc. CNL(01)51 (2001); NASCO Council, *Resolution by the Parties to the Convention for the Conservation of Salmon in the North Atlantic Ocean to Minimise Impacts From Aquaculture, Introductions and Transfers, and Transgenics on Wild Salmon Stocks*, Doc. CNL(06)48 (2003) (consolidated); NASCO Council, *NASCO Guidelines on the Use of Stock Rebuilding Programmes in the Context of the Precautionary Management of Salmon Stocks*, Doc. CNL(04)55 (2004).
183. NASCO, *NASCO Implementation Plan for the Period 2019-2024—Norway*, Doc. IP(19)18rev3, Action A4-1, at 23 (rev. Oct. 2021), https://nasco.int/wp-content/uploads/2021/11/IP1918rev3_Revised-Implementation-Plan_Norway.pdf.
184. James Mahoney, *Path-Dependent Explanations of Regime Change: Central America in Comparative Perspective*, 36 Stud. Compar. Int'l Dev. 111 (2001).
185. Paul Pierson, *Increasing Returns, Path Dependence, and the Study of Politics*, 94 Am. Pol. Sci. Rev. 251, 252 (2000) (quoting William Sewell).

specific orientations of the NPAFC and NASCO, and perhaps by the different perspectives of environmental and fisheries authorities.

NASCO has worked for more than two decades to "conserve, restore, enhance and rationally manage Atlantic wild salmon through international co-operation taking account of the best available scientific information."[186] Yet little, if any, information exists on the interactions between pink and Atlantic salmon in marine areas. Moreover, deciphering the stressors contributing to the population decline of Atlantic salmon remains a major scientific obstacle, given what little is known about the marine mortality and lifestyle of salmon.[187]

Borrowing by analogy from the Convention on Biological Diversity, where the "lack of scientific certainty about the various implications of an invasion should not be used as a reason for postponing or failing to take appropriated eradication, containment and control measures,"[188] NASCO embraces the precautionary approach and an ecosystem-based approach notwithstanding acknowledged definitional uncertainties associated with both.[189] Likewise, the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean prophylactically protects an almost entirely unknown ecosystem the size of the Mediterranean Sea.[190] Pressures of mounting rational management and a globalizing interest in the resources of the High Arctic present commercial possibilities that accelerate a scientific need to know what constitutes a sustainable use of the geospace.

Article 66 of the United Nations Convention on the Law of the Sea established the international legal regime pertaining to anadromous species.[191] "Considerable" attention to the peculiar life history of these species formed the basis for the article,[192] which grants to the state of origin "the primary interest in and responsibility for" these fish stocks "in all waters landward of the outer limits of its exclusive economic zone."[193] Except where economic dislocations would occur for states other than the state of origin,[194] the general principle holds: fishing for anadromous species should be conducted and managed by the coastal state of origin.[195] The intention, modified only by the economic dislocation "escape clause,"[196] was to "suppress" the salmon rights of high seas fishing by preferencing the interests of salmon-origin states.[197]

Numerous working papers (*travaux préparatoires*) connect the managerial priority of the coastal state of origin to maintaining a habitat in the particular river system to which anadromous species return.[198] While coastal states are granted "sovereign rights" over the living resources within their exclusive economic zones,[199] and "primary interest" over anadromous stock in their internal rivers,[200] persistent and more relevant tensions arise when coastal states assert management authority over anadromous fish throughout their migratory range.[201] After many years of conflict,[202] this tension has resulted in a near-ban on fishing on the high seas for anadromous species.[203]

Pukkellaks, however, introduce added twists to the regulatory grammar associated with the question of salmon migration and the limits of national jurisdiction. *Pukkellaks* never originated in the Kola Peninsula, the Barents Sea, the Atlantic Ocean, or in the rivers and tributaries across northern Finnmark and elsewhere. They do now. They also do not merely migrate through the pelagic waters of neighboring states. They colonize adjacent internal waters, problematizing the rights of the coastal state to determine the total allowable catch for marine living resources within an exclusive economic zone, and shading the meaning of the

186. NASCO, *About*, https://nasco.int/about/ (last visited Jan. 20, 2022).
187. Thorstad et al., *supra* note 87, at 2656 (discussing unknowns of the Atlantic salmon marine phase).
188. Convention on Biological Diversity, *Alien Species That Threaten Ecosystems, Habitats, or Species*, COP 6 Decision VI/23, Annex A, guiding principle 1 (2002), https://www.cbd.int/decision/cop/?id=7197.
189. NASCO Council, *Strategic Approach for NASCO's "Next Steps,"* Doc. CNL(05)49 (2020), https://nasco.int/wp-content/uploads/2020/02/strategicapproach.pdf. *See also* O'Riordan & Cameron, *supra* note 37.
190. *See* Balton, *supra* note 160 (noting no commercial fishing has ever taken place in the area covered by the agreement and that not enough is known of the ecosystem "to have any reliable basis on which to manage a commercial fishery").
191. *Article 66—Anadromous Stocks (II)*, *in* United Nations Convention on the Law of the Sea Commentary Online 667 (Center for Oceans Law and Policy, University of Virginia 2014), *available at* https://referenceworks.brillonline.com/entries/united-nations-convention-on-the-law-of-the-sea/*-LAOS_9780792324713_665_679.
192. *Id.* at 668.
193. LOS Convention, *supra* note 138, art. 66(1) (primary interest), and art. 66 (2) ("all waters landward").
194. *See id.* art. 66(3)(a) (granting to the state of origin the right to establish, following consultation, the total allowable catch "except in cases . . . result[ing] in economic dislocation for a state other than the state of origin"). *See also* Treaty Between the Kingdom of Norway and the Russian Federation Concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean, Sept. 15, 2010, *reprinted in* Irene Dahl, *Maritime Delimitation in the Arctic: Implications for Fisheries Jurisdiction and Cooperation in the Barents Sea*, 30 Int'l J. Marine & Coastal L. 120, 140 (2015) (incorporating "the need to avoid economic dislocation" language).
195. Burke has posited the question that customary international law may now recognize the authority of the state of origin to prohibit high seas harvesting of salmon.
196. John Warren Kindt, *The Law of the Sea: Anadromous and Catadromous Fish Stocks, Sedentary Species, and the Highly Migratory Species*, 11 Syracuse J. Int'l L. & Com. 9, 15 (1984).
197. Yvonne L. deReynier, *Evolving Principles of International Fisheries Law in the North Pacific Anadromous Fish Commission*, 29 Ocean Dev. & Int'l L. 147, 153 (1998).
198. *Article 66—Anadromous Stocks (II)*, *supra* note 191, at 668. McDorman notes the United States and Canada worked together to secure this provision during negotiations. *See* Ted L. McDorman, *A Canadian View of the Canada-United States Pacific Salmon Treaty: The International Legal Context*, 6 Willamette J. Int'l L. & Disp. Resol. 79, 80-81 (1998).
199. LOS Convention, *supra* note 138, art. 56(1) (providing that the coastal state within its 200 nautical-mile exclusive economic zone has "sovereign rights for the purposes of exploring and exploiting, conserving and managing the natural resources, whether living or non-living").
200. *Id.* art. 66(1) (primary interest in and responsibility for anadromous river stocks).
201. *See* Constance Sathre, *Salmon Interception on the High Seas: A Continuing Controversy Between the United States and Japan*, 16 Env't L. 731, 732 (1986).
202. *See generally* Harry N. Scheiber, *Japan, the North Atlantic Triangle, and the Pacific Fisheries: A Perspective on the Origins of Modern Ocean Law, 1930-1953*, 6 San Diego Int'l L.J. 27 (2004) (centralizing historical discussion around the 1937-1938 Bristol Bay Incident involving Japanese factory-ship interruptions of salmon migrations and that threat to the Alaska, British Columbia, and Washington State fishing and canning industries).
203. Andrew Serdy, *Postmodern International Fisheries Law, or We Are All Coastal States Now*, 60 Int'l & Compar. L.Q. 387, 418 (2011) (referencing LOS Convention art. 66).

state of origin within the Article 66 terms of the convention. Indeed, the age of climate change and eutrophication[204] will increasingly call into question the idea of a species' "nativeness."[205] Moreover, because of the enormous proliferation and commercial potential of *pukkellaks*, fishers now seek to reintroduce their harvest before the pink salmon reenter exorheic river systems—suggesting an inversion of the decades-long movement to restrict the culling of salmon stock on the high seas.

These nuances impact the shared transboundary Tana River, with salmon spawning on both sides of the Finnish and Norwegian banks. The drafters of Article 66 "probably did not envisage a shared river situation"[206] in consideration of the state of origin. Extrapolating to Norway and Finland joint responsibilities for the management of such stocks appears reasonable,[207] although the challenge for regime theory remains to establish "a more solid and thorough legal foundation."[208]

Finnish and Norwegian governance policies for transboundary salmon migrations along the same river basin, such as the Deatnu/Tana and Näätämö/Neiden Rivers, have been criticized for a lack of synchronization.[209] Managerial disputes have risen to the level of Norway's Storting and the Sámi Parliament,[210] challenging communications and relations between the closest of allies. And while it is recognized that cooperation with neighboring Russia is essential in order to coordinate an effective response,[211] and notwithstanding a long and cooperative fishing relationship between Norway and Russia,[212] no coordinated response to *pukkellaks* has been forthcoming. Russia's response remains sublimely unclear.

4. Contested (and Congested) Multilateralism

The rising density of international regimes and their complexity motivate multiple attempts to recast the dynamic life cycle of global governance regimes.[213] Nonlinear or abrupt "surprises" in marine ecosystems have invigorated discussion of regime shifts caused by anthropogenic stressors.[214] The rise of *contested multilateralism* has identified state and non-state actors as agents to challenge the missions and practices of existing multilateral institutions.[215]

A passive expression of contested—if not congested—multilateralism may be reflected by the significant growth in Arctic conferences (led by Arctic Frontiers and the Arctic Circle Assembly) and the perceived need for more cross-sectoral discussion.[216] The emergence of the Arctic as a global arena,[217] or the self-professed inclusion of newly

204. Eutrophication is the over-enrichment of estuaries and coastal waterways with nutrients and inputs (e.g., algal blooms) that create low-oxygen (hypoxic) water levels (in severe cases, dead zones), large amounts of carbon dioxide, and decreased pH levels of seawater (acidification). *See* NOAA National Ocean Service, *What Is Eutrophication?*, https://oceanservice.noaa.gov/facts/eutrophication.html (last updated Feb. 26, 2021).

205. *See* Sundet & Hoel, *supra* note 72, at 282 (suggesting that the idea of species' "nativeness" will increasingly be questioned as they extend their distribution areas due to climate change and eutrophication); Hanno Seebens et al., *Non-Native Species Spread in a Complex Network: The Interaction of Global Transport and Local Population Dynamics Determines Invasion Success*, 286 Proc. Royal Soc'y B 8 (2019), https://royalsocietypublishing.org/doi/full/10.1098/rspb.2019.0036 (suggesting general findings for species spread in complex systems, concluding that spatial-temporal propagule pressures "may become the norm rather than the exception for facilitating global spread of non-native species"). The problematization of nativeness is embedded in Article I(1)(f) of the Convention on the Conservation of Migratory Species of Wild Animals, which employs the concept of range states (meaning but not defining "the areas of land or water that a migratory species inhabits . . . on its *normal* migration route" (emphasis added)).

206. Dahl, *supra* note 25, at 161 (reading Article 66 in conjunction with Article 2, which proffers a strict conception of territorial sovereignty within the meaning of the LOS Convention).

207. *See id*. at 160 (concluding "both Norway and Finland should be regarded as 'state of origin'").

208. *Id*. at 161.

209. Brattland & Mustonen, *supra* note 42.

210. *See*, *e.g.*, Regjeringen.no, *Prop. 54 S (2016-2017), Samtykke til inngåelse av avtale mellom Norge og Finland om fisket i Tanavassdraget av 30. september 2016* [*Consent to Enter Into an Agreement Between Norway and Finland on Fishing in the Tana Watercourse, September 30, 2016*], https://www.regjeringen.no/no/dokumenter/prop.-54-s-20162017/id2537548/ (last visited Jan. 20, 2022); *Sametingets merknader til statsråd Vidar Helgesens svar til Kontroll- og konstitusjonskomiteen av 4. mai 2017, vedrørende behandlingen av Prop. 54 S (2016-2017)* [*The Sámi Parliament's Remarks to State Minister Vidar Helgesen's Reply to the Control and Constitution Committee of May 4, 2017, Regarding the Consideration of Prop. 54S (2016-2017)*], Stortingets Kontor-og konstitusjonskomite [The Parliamentary Office and Constitution Committee] (May 10, 2017); *Forslag til avtale mellom Norge og Finland om fiske i Tanavassdraget* [*Proposal for an Agreement Between Norway and Finland on Fishing in the Tana Watercourse*], Áššii/Sak SR 129/16 (Aug. 29, 2016) (presenting Sámi objections (*saksfremstilling*) to process and inclusion with regard to Norwegian and Finnish Tana River discussions).

211. Mo et al., *supra* note 65, at 27 (concluding: *I disse vassdragene er det nødvendig å samarbeide med naboland for å gjøre tiltak og overvåke utviklingen. Dersom han har som målsetting å redusere forekomsten av pukkellaks i hele utbredelsesområdet i Barentshavet og det nordlige Atlanterhavet er det nødvendig å etablere et samarbeid med Russland for samordnede tiltak for å redusere pukkellaks i elver* [In these watercourses, it is important to cooperate with neighboring countries in order to measure and monitor developments. If one has a goal of reducing the prevalence of pukkellaks throughout the entire region of the Barents Sea and the North Atlantic, it is necessary to establish and cooperate with Russia to coordinate measures to reduce pukkellaks in rivers]).

212. *See generally* Geir Hønneland, *East-West Collaboration in the European North*, 65 Int'l J. 837 (2010) (noting the "flourishing network of collaboration . . . between Russia and its neighbouring Nordic countries," but also periods of discord, such as during the 1990s); Geir Hønneland, Kvotekamp og kyststatssolidariet: Norsk-russisk fiskeriforvaltning gjennom 20 år [Quota Struggle and Coastal Solidarity: Norwegian-Russian Fisheries Management Throughout 20 Years] (2006) (presenting a decades-long review of Norwegian-Soviet/Russian management strategies of fish stocks in the Barents Sea). *See also* FAO Fisheries and Aquaculture Division, *Joint Norwegian-Russian Fisheries Commission (JointFish)*, https://www.fao.org/fishery/en/organization/rfb/jointfish (last visited Jan. 20, 2022) (creating in 1976 a bilateral commission to jointly manage the most important fish stocks in the Barents Sea and the Norwegian Sea).

213. *See* Karen J. Alter, The Promise and Perils of Theorizing International Regime Complexity in an Evolving World 5 (iCourts, Working Paper Series No. 261, 2021).

214. *See generally* Camilla Sguotti & Xochitl Cormon, *Regime Shifts—A Global Challenge for the Sustainable Use of Our Marine Resources*, *in* YOUMARES 8—Oceans Across Boundaries: Learning From Each Other 155 (Simon Junglbut et al. eds., Springer 2018) (defining regime shifts as "the additive effects of anthropogenic stressors (e.g., fishing, climate change) [that play] a fundamental role in causing unexpected and sudden shifts between system states").

215. *See generally* Julia C. Morse & Robert O. Keohane, *Contested Multilateralism*, 9 Rev. Int'l Orgs. 385 (2014) (introducing the concept of contested multilateralism).

216. *See* Beate Steinveg, *Exponential Growth and New Agendas—A Comprehensive Review of the Arctic Conference Sphere*, 12 Arctic Rev. on L. & Pol. 134 (2021).

217. *See generally* The Global Arctic Handbook (Matthias Finger & Lassi Heininen eds., 2019) (rethinking the geographical region of the Arctic as part of the globalized world); Marc Lanteigne, *How to Balance on the Ice: Great Power Politics and Emerging Arctic Security*, *in* The Arctic in World Affairs: A North Pacific Dialogue on Will Great Power Politics

emergent "near-Arctic" states such as China and India,[218] also suggests an invigorated restructuring of Arctic geopolitics, as do the periodic calls for a more encompassing Arctic treaty.[219]

Frictional expressions of contested multilateralism emphasize incipient tensions within the Arctic Council regime structure,[220] and a sense of clubbish stewardship among card-carrying circumpolar states.[221] Such clubbishness affects the global governance complex, which has been criticized generally for terminological obsessions[222] and opacity.[223] Circumpolar powers have actively responded to these criticisms by declaring that only they can exercise supervisory stewardship over the Arctic. Their conclusion obviates any "need to develop a new comprehensive international legal regime to govern the Arctic Ocean."[224]

The Convention on Biological Diversity, binding on Norway and Finland, obligates states to conserve and sustain biological diversity, and to develop national strategies to accomplish these duties. The Convention (Article 5) obligates Parties to cooperate on matters of mutual interest. Article 8(h) maintains that Parties shall "as far as possible and as appropriate . . . prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." Conservation measures are also supported by the NASCO Convention, which obligates its Parties through its council, secretariat, and three regional commissions (North America, West Greenland, and the North-East Atlantic (NEAC)) to regulate salmon fishing stock that migrate beyond the jurisdiction of the coastal state north of 36°N latitude. Importantly, the Russian Federation assumed obligations acceded to by the USSR and has worked with Denmark (in respect to the Faroe Islands and Greenland), the European Union, and Norway in NEAC to regulate salmon stocks in the delimited jurisdictional maritime areas covered by NEAC (44°W longitude thence due south to 59°N latitude, thence due east to 42°W longitude and thence due south).

NEAC covers "maritime areas" and not rivers and watercourses. However, Irene Dahl has noted that NASCO's "'conservation and rational management of salmon stocks,' could be undermined if the measures were not to apply to salmon *rivers*."[225] If reflective of a customary rule of international law, Article 66(3)-(5) of the Law of the Sea Convention obligates states of origin and other states "to cooperate with respect to prescriptive and enforcement measures of conservation of anadromous stocks."[226] Absent an understanding of pink salmon populations in the Kola Peninsula and across the Arctic Ocean, and absent an understanding of the migratory patterns and commingling with Atlantic salmon, the obligation to prescriptively cooperate and conserve anadromous stock may approach the character of a *pactum de contrahendo*, which is an agreement to conclude an agreement based on future contingencies.[227]

This principle is sometimes regarded as providing much-needed breathing space for clarification of indeterminate circumstances. It is also disparagingly treated as a backwater of treaty law for wrapping inferential obligations in the formalistic attire of a substantive agreement.[228] Only time will tell what the future holds for the management of anadromous stock.

IV. Conclusion

International regimes compartmentalize responses to biological invasion, and often help to identify responses that are situationally specific at international, national, and local levels. Anadromy complicates these responses by exploiting interstitial gaps or crosscurrent overlaps in governance structures. Piecemeal local responses, acknowledged by many scientists to be insufficient in the long run, help to fill gaps or bridge overlaps and appear to be the best line of resistance to *pukkellaks* in the short term.

The Tana Agreement between Finland and Norway responds to *pukkellaks* penetrations into Atlantic salmon breeding rivers by reducing overexploitation fishing pressures along the river, but it leaves unaddressed habitat risks that are the product of what appears to be a massive secondary spread,[229] perhaps even facilitated by warming Arctic waters. Norway's environmental director has praised

Threaten Arctic Sustainability? 39 (Lawson W. Brigham et al. eds., East-West Center 2020) (noting the internationalization of the Arctic and the interests of, inter alia, Germany, Japan, and the United Kingdom).

218. State Council, *supra* note 162 (announcing: "Geographically, China is a 'Near-Arctic State'"); *India and the Arctic*, India Ministry External Affs. (June 10, 2013), https://mea.gov.in/in-focus-article.htm?21812/India+and+the+Arctic (recapping that "[t]oday India's interests in the Arctic region are scientific, environmental, commercial as well as strategic").

219. *See* Charles H. Norchi, *An Arctic Treaty in an Age of Contagion?*, JONAA (May 2020), https://www.jonaa.org/content/an-arctic-treaty-in-an-age-of-contagion (noting calls for a special Arctic Treaty and circumpolar state disinterest in the idea).

220. *See* Klaus Dodds, *The Ilulissat Declaration (2008): The Arctic States, "Law of the Sea," and Arctic Ocean*, 33 SAIS Rev. Int'l Affs. 45 (2015).

221. *See* Christopher R. Rossi, *The Club Within the Club: The Challenge of a Soft Law Framework in a Global Arctic Context*, 5 Polar J. 8, 11 (2015) (noting leaked classified diplomatic cables supporting views of the Arctic 5—the five circumpolar powers, Canada, Denmark, Norway, the Russian Federation, and the United States—as an informal niche government group within the Arctic Council).

222. *See* Alter, *supra* note 213, at 5.

223. *See* Kennette Benedict, *Global Governance*, *in* International Encyclopedia of the Social & Behavioral Sciences 6232, 6237 (Neil J. Smelser & Paul B. Baltes eds., Elsevier 2001) (noting the unresolved problem of upholding standards nongovernmental actors created through unelected processes).

224. Ilulissat Declaration, Arctic Ocean Conference (2008), https://www.regjeringen.no/globalassets/upload/ud/080525_arctic_ocean_conference-_outcome.pdf (asserting the stewardship role over the Arctic Ocean of the five circumpolar powers).

225. Dahl, *supra* note 25, at 163.

226. Barbara Kwiatkowska, *Straddling and Migratory Fish Stocks in the New Law of the Sea: Reconciling Rights, Freedoms, and Responsibilities*, *in* Essays in Honour of Wang Tieya 463, 474 (Ronald St. John MacDonald ed., Martinus Nijhoff 1994).

227. *See generally* Christopher R. Rossi, *A Case Ill Suited for Judgment: Constructing "A Sovereign Access to the Sea" in the Atacama Desert*, 48 U. Miami Inter-Am. L. Rev. 28 (2017) (discussing problems associated with articulating and enforcing *pacta de contrahendo*, or agreements to conclude future agreements).

228. *See id.* at 47. *See also* Antonio Cassese, *The Israel-PLO Agreement and Self-Determination*, 4 Eur. J. Int'l L. 564, 566 n.6 (1993) (summarizing Ulrich Beyerlin's view in *Pactum de Contrahendo und Pactum de Negotiando im Völkerrecht?* [*Pactum de Contrahendo and Pactum de Negotiando in International Law?*] 36 ZaöRV 407 (1976)).

229. *See* Dahl, *supra* note 25, at 184.

local actors and their invaluable efforts to stand guard at the mouth of sub-Arctic waterways and fjords.[230] However, absent a unified or coordinated response with Russia and Finland, much less a meeting of the minds with Russia over the nature and extent of the *pukkellaks* problem, a more inventive, less segmented response to Arctic anadromy's effect on the fundamentals of regime theory may find support.

Pukkellaks present yet another prodromal example of elision that is symptomatic of the changes coming to the Arctic. Previously recorded biological examples of such secondary spread have involved transplanted red king crabs, now migrating into new stretches of the Barents Sea,[231] snow crabs crawling into colder Arctic waters surrounding Norway's Svalbard archipelago,[232] and omnivorous piscivores such as cod, who are moving increasingly northward and disrupting life of Arctic bottom-dwellers.[233] Not all of these examples result directly from human transplants or adulterations to natural habitat, but they all represent a Cambrian change in ecosystemic incubation, portending more invasive explosions to come.

Perhaps the most predictable secondary spread of transplanted species into the Arctic relates to farmed salmon fishing. Escaped farmed salmon is a known "vector for diseases and parasites" afflicting wild salmonid populations.[234] Norway is the world's second largest fish and seafood exporter,[235] and the leading producer of farmed salmon.[236] Atlantic salmon, farmed in marine cages, dominate Norway's aquaculture industry.[237] Norwegian aquaculture revenue accounts for 7.9% of the country's exports.[238] Salmon production is a "core" (*kjerneområder*) component of this industry, part of a projected 550 billion kroner (64 billion USD) industry by 2050.[239] This projection estimates a fivefold increase in growth for the salmon industry alone.[240]

Facilitating the sustainable growth of the seafood industry is part of the government's national ocean strategy.[241] However, climate change and increasing coastal sea temperature likely will continue to push Atlantic salmon farming into the cooler fish-farming waters of North Norway, potentially portaging pathogens and novel parasites from warmer waters,[242] risking as well the homogenization of the ecosystem through escapes and interbreeding, and creating a pincer-like problem for the management of wild salmon stocks and estuaries, which already have been identified as "important challenges" in the short term and "main issues to address" in the long term.[243]

Efforts to define acceptable thresholds for escaped farmed salmon and the effects of parasitic sea lice on wild stock remain under investigation. A Norwegian Ministry of Climate and Environment white paper already confirmed "a northward shift" in salmon farming and noted possible problems for the industry in southern Norway by 2070 due to rising sea temperatures.[244] One foreboding indicator of the fate of the wild Atlantic salmon originates with the Norwegian Environment Agency, which deems "essential" work originating since 1986 to create a gene bank program to deep-freeze wild Atlantic salmon milt to one day reestablish populations.[245]

Coordinating an intentional response to pressures facing the habitat of Atlantic salmon in the Tana River and other

230. Tommy Hansen, *Anbefaler tiltak mot pukkellais* [*Recommended Measures Against Humpback Salmon*], Vol.no (June 24, 2021), https://www.vol.no/nyhetsstudio/2021/06/24/Anbefaler-tiltak-mot-pukkellaks-24165652.ece (referencing Miljødirektor Ellen Hambro: *Uten [lokale aktørers] uvurderlige innsats ville utfordringene med pukkellaks vært enda vanskeligere å løse* [Environmental Director Ellen Hambro: Without the invaluable efforts of [local actors], the challenges of pukkellaks would be even more difficult to solve]).
231. *See* GRID-Arendal, *Red King Crab Native and Invasive Distribution*, https://www.grida.no/resources/7734 (last visited Jan. 20, 2022) (mapping the spread of the red king crab from Sørøya, Norway, in the west to Kolguev Island, Russia, in the east, and to around 72°N). Red king crabs were first introduced into the Barents Sea in 1960; they are now spreading southwards and northwards from their previous central and eastern Barents Sea locations. *See* Atle Staalesen, *Arctic Crab Invasion Reaches New Shores*, Barents Observer (Nov. 14, 2019), https://thebarentsobserver.com/en/ecology/2019/11/arctic-crab-invasion-reaches-new-shores.
232. *See* Rossi, *supra* note 118.
233. Lisbet Jære, *Species on the Move*, BarentsWatch (Feb. 23, 2018), https://www.barentswatch.no/en/articles/Species-on-the-move/.
234. Weronika Strzyżyńska, *Norway Reveals Plans for River Trap System to Protect Wild Salmon*, Guardian (Oct. 21, 2021), https://www.theguardian.com/environment/2021/oct/21/norway-reveals-plans-river-trap-system-to-protect-wild-salmon (quoting Norwegian environmental ministry advisor, Håvard Vedeler Nilsen).
235. Ulf Johansen et al., *The Norwegian Seafood Industry—Importance for the National Economy*, 110 Marine Pol'y 1 (2019).
236. Norwegian Ministry of Trade, Industry, and Fisheries, Blue Opportunities: The Norwegian Government's Updated Ocean Strategy 15 (2019); FAO, The State of World Fisheries and Aquaculture: Sustainability in Action 75 (2020).
237. Kim-Anh Tempelman Mezzera & Nina Sæther, Norwegian Institute of Bioeconomy Research, The State of Biodiversity for Food and Agriculture in Norway 27 (2016).
238. Johansen et al., *supra* note 235 (noting in comparison that petroleum revenue constitutes 38.5% of Norway's exports).
239. Verdiskaping Basert på Produktive Hav i 2050 [Value Creation Based on Ocean Productivity in 2050], at 34 (2012), https://www.sintef.no/globalassets/upload/fiskeri_og_havbruk/publikasjoner/verdiskaping-basert-pa-produktive-hav-i-2050.pdf (reporting on the findings of a working group appointed by the Royal Norwegian Society of Sciences and the Norwegian University of Science and Technology).
240. Johansen et al., *supra* note 235. The government plan to increase national production of farmed salmon from more than one million tons to more than five million tons has exposed "latent" and "intensifying" environmental and oversite criticism from local communities and an increasing reluctance to host aquaculture sites. Jennifer L. Bailey & Sigrid Sandve Eggereide, *Mapping Actors and Arguments in the Norwegian Aquaculture Debate*, 115 Marine Pol'y 1 (2020).
241. Norwegian Ministry of Trade, Industry, and Fisheries, *supra* note 236, at 15.
242. Verdiskaping Basert på Produktive Hav i 2050, *supra* note 239, at 26. Norway experienced parasitic spread of *Gyrodactylus salaris* in 46 salmon rivers in the 1970s and 1980s from imported salmon and rainbow trout smolt and fingerlings. Norwegian Ministry of Environment, *supra* note 81, at 16. Eradicating the parasite cost 1 billion NOK (115 million USD). Thorstad et al., *supra* note 87, at 2660. Northern Norway's cooler waters reduce the cost of lice control, improve the health status of the farmed fish, and contribute to the increasing attractiveness of the region, which already accounts for five of the six top breeders. *See* Aslak Berge, *Northern Dominance on Profit Among Norway's Largest Salmon Farmers*, SalmonBusiness (Aug. 2, 2017), https://salmonbusiness.com/northern-dominance-on-profit-among-norways-largest-salmon-farmers/.
243. Mezzera & Sæther, *supra* note 237, at 27.
244. Norwegian Ministry of Climate and Environment, Norway's Integrated Ocean Management Plans, Meld. St. 20 (2019-2020), Report to the Storting (White Paper) 71 (2021) (citing Nofima Research Institute projections on farmed fishing and temperature trends).
245. Norwegian Environment Agency, *Gene Banks for Wild Salmon*, https://nettarkiv.miljodirektoratet.no/hoeringer/tema.miljodirektoratet.no/en/Areas-of-activity1/Species-and-ecosystems/Salmon-trout-and-Arctic-char/Gene-banks-for-wild-salmon/index.html (last visited Jan. 20, 2022).

wild salmon runs of North Norway will necessarily have to triangulate and balance human, biological, and natural pressures. A possible managerial strategy to the *pukkellaks* invasion might parallel Norway's response to the invasive Arctic red king crab.[246] Here, Norway created a management regime to maintain "a viable, long-term fishery that would compensate for the problems created by the crab for traditional groundfish fisheries in eastern Finnmark."[247] The high economic value of the red king crab "shifted" the policy perception from eradication efforts to management plans in order to capture the benefits from king crab fishing while devising a management plan to limit its geographical expansion.[248]

Such a management scheme introduces a concession to alien species within the evolving construction of the ecosystem approach to environmental management.[249] Although widely defined and interpreted,[250] it has received support in various international organizations and codifying bodies.[251] A commonly included component calls for maintaining an ecosystem's integrity and capacity for self-organization.[252]

However, the description of an ecosystem approach endorsed through the Convention on Biological Diversity refers to it as "a *strategy* for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way."[253] Humans and their interactions with nature are integral components of many ecosystems,[254] and a focus is placed on the structure, processes, and functions of the system[255] to present ecosystems as dynamic complexes that do not necessarily correspond to established spatial usages such as biomes and ecological zones.[256] This widening of an ecosystem's spatial orientation comports with the Food and Agriculture Organization of the United Nations' (FAO's) Ecosystem Approach to Fisheries, which "strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions."[257]

Ecosystem-based management schemes have been employed, ironically to protect the pink salmon from the destruction of estuarian habitats caused by steelhead and cutthroat trout, overfishing, and hatchery operations.[258] They may provide a partial solution to the problem of Arctic anadromy until that time when regime structures can more appropriately account for structural gaps caused by biological elision, governmental intransigence, or, as in the case of salmon farming, human-sponsored species transplantation into Arctic waters.

246. Similar to pink salmon history, the red king crab was introduced from the Russian Far East to the Kola Bay by the Soviets "during the 1960s and once during the 1970s." Sundet & Hoel, *supra* note 72, at 278.
247. *Id.* at 281.
248. *Id.* at 279.
249. *See id.* at 282 (acknowledging the "impossibility" of eradication efforts and identifying the yo-yo economic effects of unrestricted fishing on processing plants).
250. *See generally* Vito De Lucia, The "Ecosystem Approach" in International Environmental Law chs. 4-5 (2019) (reviewing the multiplicity of ecosystem approaches and the underlying ecological framework of ambiguity).
251. Owen McIntyre, *The Emergence of an "Ecosystem Approach" to the Protection of International Watercourses Under International Law*, 13 RECIEL 1, 5 (2004).
252. Jutta Brunnée & Stephen J. Toope, *Environmental Security and Freshwater Resources: A Case for International Ecosystem Law*, 5 Y.B. Int'l Env't L. 41, 55 (1994).
253. Convention on Biological Diversity, *Ecosystem Approach*, COP 5 Decision V6, para. A1 (2000) (emphasis added), https://www.cbd.int/decision/cop/?id=7148.
254. *Id.* para. A2.
255. *Id.* para. A3.
256. *See id.*
257. The Ecosystem Approach to Fisheries; Issues, Terminology, Principles, Institutional Foundations, Implementation, and Outlook 6 (FAO, FAO Fisheries Technical Paper No. 443, 2003).
258. Willa Nehlsen, *Prioritizing Watersheds in Oregon for Salmon Restoration*, 5 Restoration Ecology 25 (1997) (discussing protections for the pink salmon in the Tillamook Bay watershed in Oregon in the United States).