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Research on the Administrative Law Boundaries for Arctic Coastal States in Controlling the Impacts of Climate Change on Atlantic Salmon Resources

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Abstract: Climate change is profoundly changing the sea balance of nature between the Arctic and Atlantic Oceans. Atlantic salmon populations are facing multiple pressures such as habitat reconstruction, migration path shift and decreased survival of juveniles. There are significant faults in the current administrative law framework of the Arctic coastal states in dealing with the identification of transboundary ecological damage liability and the division of fishery management rights, there is no effective interface between the legal obligations of Arctic Council Member States and climate change adaptation legislation. In view of this, the study puts forward measures such as controlling coastal development activities by delimiting ecological red lines, establishing carbon sink trading mechanisms to promote transnational cooperation in emission reduction, and using satellite remote sensing technology to implement monitoring and early warning of migratory channels, this paper aims to break through the limitations of existing collaborative legal governance and provide institutional support for Arctic countries to build a climate-resilient fisheries management system.

1. Introduction

Salmon resources are important in their respective ecosystems and provide food for a large number of carnivores, including whales, otters, birds, seals, bears, and many invertebrates, it also provides nutrients for many terrestrial plants and animals after its dead and decayed. While providing food, salmon transport nutrients from the ocean to freshwater habitats, which plays an important role in maintaining the structure, function and processes of streams and terrestrial ecosystems[1]. In recent years, the sea water temperature has continued to rise, the ocean acidification has intensified, and extreme meteorological events have occurred frequently, resulting in the disorder of the migration law and the decline of the recovery ability of the fish population[2]. Although the Arctic coastal states have established the basic framework for the protection of fishery resources through the Arctic Council and other platforms, they are still weak in dealing with jurisdictional conflicts and legal vacuums caused by climate change. This study focuses on the path of boundary optimization of administrative law, and explores how to improve the effectiveness of transnational governance through legal tool innovation, so as to provide institutional guarantee for maintaining the sustainability of salmon resources.

2. Transboundary Impacts of climate change on Atlantic salmon stocks

(1) Restructuring effects of climate change on the habitat distribution of Atlantic salmon

The environmental changes in the Arctic Ocean are gradually changing the living space of Atlantic salmon. The continuous increase of seawater temperature leads to the decrease of dissolved oxygen content in surface waters, which directly affects the normal development of salmon eggs in the spawning ground. Changes in salinity have forced adult salmon to migrate to colder waters, causing a massive shrinkage of their normally stable spawning areas. The acceleration of Arctic melting ice changes the current pattern, shifts the path of ocean currents carrying nutrients, and forces salmon to expand their foraging range to high-latitude waters. The phenomenon of habitat fragmentation has intensified. Many historical spawning areas have lost their ecological functions due to water temperature exceeding the threshold, and the channels for population gene exchange have been physically blocked. Fisheries authorities have seen salmon concentrations shift to northern Norwegian Sea and southern Barents Sea, putting pressure on traditional fishing grounds to be redrawn. The high sensitivity of salmon to habitat temperature leads to the direct transformation of environmental changes into population distribution pattern adjustment. At present, there is no effective international legal framework to deal with this dynamic reconstruction process.

(2)The migration path of salmon caused by the rise of seawater temperature

Ocean warming is reshaping the seasonal movement of Atlantic salmon. Spring warming disrupts the circadian rhythm of salmon migration, and some populations begin to migrate to freshwater rivers before the ice is completely melted, as a result, the juvenile fish stayed in the estuary for a longer time. The difference in surface water temperature aggravates the stratification of the ocean. Salmon is forced to change the vertical migration depth in order to find the appropriate temperature, and the increase in energy consumption weakens the physiological reserve during the breeding period. Expansion of hot summer waters to higher latitudes forces migratory populations to bypass areas of heat stress at greater distances[3] , and new routes for salmon populations to bypass Svalbard have been observed off the northern coast of Norway. The delay of autumn cooling disrupted the time window for salmon to return to the sea, and some individuals stayed in freshwater environment for overwintering because they missed the best period of entering the sea. The migration path offset leads to the dislocation between the fishing operation area and the actual distribution area of fish, and the existing fishery management zoning is difficult to cover the changed biological activity hotspots. Littoral states have yet to establish joint early warning mechanisms for path monitoring of straddling migratory stocks, and temperature-driven ecological changes continue to challenge the response speed of traditional fisheries management models.

(3)The inhibitory mechanism of ocean acidification on the survival rate of juvenile fish in the context of accelerated ice melting

The rapid melting of the Arctic ice cap has led to the injection of a large amount of fresh water into the ocean, the decrease of surface seawater salinity has broken the original chemical equilibrium, and the imbalance of carbonate dissolution ratio directly affects the acidity and alkalinity of water. When microorganisms decompose the organic matter carried by glacial meltwater, a large amount of oxygen is consumed, the dissolved oxygen content in coastal waters continues to decline, and the area of low oxygen is expanding year by year. The mucus layer on the body surface of juvenile fish is gradually eroded in acidic water, and the weakening of skin barrier function makes it easier for external pathogens to invade the body, and the load on the immune system is far beyond the normal level. The decrease of calcium carbonate saturation not only threatens the shell formation of calcified organisms such as shellfish, but also interferes with ion exchange channels in juvenile fish, resulting in the decline of osmoregulation ability. The impaired sensory system directly affects the sensitivity of juveniles to avoid natural enemies, and the abnormal olfactory function makes it difficult to identify

safe habitats, and the predation efficiency decreases synchronously. The number of plankton at the bottom of the food chain is reduced due to acidification, which makes it more difficult for young fish to obtain nutrients[4]. With the continuous degradation of the original shelter sites such as coral reefs, the probability of exposure of juvenile fish to natural enemies has increased significantly, and the natural recovery cycle of the population has been artificially prolonged. Addressing these challenges requires dynamic monitoring of changes in acidification areas, timely adjustment of marine protected area ranges, targeted protection of key areas where juvenile fish are concentrated, and simultaneous development of artificial breeding techniques to tolerate acidic water quality, ensure the sustainable supplement of fishery resources.

(4) Frequent extreme weather events impact traditional fisheries management models

Global climate anomalies have led to a sharp increase in the frequency of extreme weather such as typhoons and marine heat waves, and the historical data and static management framework that traditional fisheries rely on have gradually lost their effectiveness. The high-intensity typhoon directly destroyed the offshore aquaculture facilities, the sedimentary structure of the fish spawning ground was disturbed by the huge waves, and the habitat restoration cycle was far beyond the natural breeding rhythm. The abnormal increase in sea temperature has forced commercial fish to migrate to high latitudes or deep waters, the original fishery resources have been sharply reduced, and the fishing area has been forced to expand to disputed waters[5]. The freshwater carried by the storm surge poured into the estuary area, and the drastic fluctuation of salinity caused the large-scale death of osmotic pressure-sensitive species such as shrimp, and the survival rate of larvae was close to zero after being carried out to sea. The current fishing quota system can not match the sudden fluctuation of resources, the division of administrative jurisdiction conflicts with the migration path of fish, and the multinational fishery negotiation is deadlocked. In order to improve management flexibility, it is necessary to establish a real-time monitoring and dynamic evaluation system, use drones to track the distribution of fish, and combine with climate models to predict the impact range of extreme events.

3. The existing framework of collaborative governance of administrative law in the Arctic coastal states

(1)Legal sources of the obligation to protect fishery resources of Arctic Council Member States

International United Nations Convention on the Law of the Sea and regional agreements together form the core framework for Arctic fisheries management, and member states have signed multilateral treaties to clarify their responsibilities for resource conservation, sovereign states need to translate international obligations into domestic legislation to regulate fishing practices. The guidance issued by the Arctic Council does not have the force of enforcement, but it provides a unified standard for countries to formulate fishery policies and reconcile the conflict between fishing quotas and ecological protection goals. Domestic legal systems often have Exclusive Economic Zone rules requiring vessels to install monitoring equipment and submit fishing data, but enforcement is limited by a regulatory vacuum outside sovereign borders and gaps in the high seas. The Vague Division of law enforcement power in the disputed waters has led to the over-exploitation of resources. Some countries have unilaterally strengthened control by expanding the scope of jurisdiction, which has triggered reciprocal countermeasures from neighboring countries. The lack of climate change adaptation provisions in legal texts exacerbates the implementation dilemma. Existing laws and regulations do not fully consider the changes in fish migration paths caused by ice melting, and the standards for the establishment of protected areas are out of line with the actual ecological needs. To improve the legal coordination mechanism, it is necessary to integrate transnational monitoring data, establish a real-time information sharing platform, and promote member states to embed dynamic adjustment clauses in the revision of domestic laws to ensure that the distribution of responsibilities

and ecological changes evolve synchronously. To enhance the legitimacy of non-governmental organizations' participation in oversight mechanisms, third-party entities should be granted formal authority to report illegal fishing activities, while simultaneously addressing structural deficiencies in the enforcement capabilities of sovereign states.

(2)The status quo of jurisdictional conflicts in the determination of transboundary ecological damage liability

There are significant differences in the principles of liability and compensation standards for ecological damage in the Arctic countries. The difference in the identification of causality between the continental law system and the maritime law system makes it difficult to reach a consensus on cross-border pollution incidents. When acidification or pollutants caused by industrial activities in one country spread to the waters of other countries, the injured state advocates the application of the principle of strict liability, while the injuring state maintains that fault liability requires proof of subjective fault. The abuse of the principle of sovereign immunity further hampers the process of accountability. Some countries refuse to accept the consequences of transnational environmental litigation on the grounds of“State action”, and judicial remedies are virtually unavailable. The dispute mediation mechanism established by the Arctic Council lacks enforcement power. When member states choose arbitration or litigation procedures by themselves, the results of judgments are often not enforceable across borders due to inconsistent standards for the application of laws. Driven by economic interests, countries tend to reduce the environmental costs of domestic enterprises and selectively ignore the cumulative effect of transboundary damage. To break the jurisdictional deadlock, it is necessary to build a unified framework of liability standards, clarify the monitoring obligations and data admissibility rules of cross-border pollutant migration, and establish a permanent arbitration tribunal to enforce jurisdiction over major ecological damage cases. Relevant departments should promote the recognition of the effectiveness of extraterritorial judgments by domestic courts, improve the enforcement procedures through bilateral agreements, and ensure that the responsible subjects can not use sovereign obstacles to avoid compensation obligations.

(3)The legal vacuum in the Arctic states' fisheries management rights

Since the high seas of the Arctic have gone beyond the limits of National Exclusive Economic Zone, the international fisheries management rules are fragmented, and the existing convention system does not clearly define the jurisdiction of migratory fish. When the Arctic coastal states expand their continental shelf sovereignty claims according to domestic laws, disputes over fishing rights in the overlapping areas occur frequently, and the phenomenon of overfishing by multinational fishing vessels in the disputed waters has not been effectively curbed for a long time. Climate change has promoted the migration of Atlantic salmon and other species to high-latitude waters, resulting in a mismatch between the traditional fishery boundary and the actual distribution range of fish, and the fixed management rules are difficult to match the dynamic resource flow. Although the international law of the sea stipulates that the living resources of the high seas belong to the common property of all mankind, it has not established a specific quota allocation mechanism, the traditional fishing rights of the coastal indigenous communities are gradually being marginalized. The principle of flag state jurisdiction has led some states to allow their vessels to use destructive fishing gear on the high seas, and physical damage to spawning grounds from bottom trawling has continued to accumulate, regional conservation measures are reduced to paper terms due to the lack of cross-border enforcement powers. To fill the legal loopholes, it is necessary to reconstruct the governance hierarchy of Arctic fisheries, set up a special working group under the framework of the United Nations, coordinate countries to redefine the fishing area and fishing period, and take the ecological threshold as the core basis for the adjustment of management rights. We will encourage coastal states to sign binding joint law enforcement agreements, authorize multinational patrols to conduct on-site

evidence collection and penalties for illegal fishing on the high seas, and use satellite monitoring technology to reduce the actual scope of regulatory blind spots.

4. The implementation path of the boundary optimization of administrative law

(1)The delineation of ecological red lines to limit the intensity of offshore industrial development

The Arctic littoral states can establish the boundaries of the ecological red line through legislation, and include key habitats such as spawning grounds and migratory corridors under permanent protection, states are required to give priority to marking the coordinates of ecologically sensitive areas when revising marine spatial planning. Sovereign states need to establish joint review committees, implement basin-wide environmental impact pre-assessments for seabed mining and oil and gas extraction projects that cross the Red Line, and attach ecological restoration deposit clauses to industrial development permits. The coordination mechanism under the framework of the Arctic Council can set differentiated management and control standards, the periglacial zone and the permafrost zone are subject to stricter development bans, and the northward movement of habitats due to warming needs to trigger a dynamic adjustment procedure of the Red Line Range. Some countries resist the rigid constraints of the red line on the grounds of the right to economic development, and advocate the reservation of flexible development space in sovereign waters. Regional governance institutions should introduce an ecological damage recovery system, non-compliant developers are required to bear the long-term costs of habitat functional restoration. To strengthen the Red Line supervision, it is necessary to integrate satellite remote sensing data of coastal states, build a real-time monitoring network of biological activity covering the Arctic Ocean, and automatically identify illegal discharge of ships or bottom trawling operations. The relevant departments should push the domestic courts to recognize the cross-border legal effect of ecological red lines, authorize environmental protection organizations to bring public interest litigation against projects that undermine the integrity of red lines, and fill the defects of lagging administrative law enforcement through judicial relief.

(2)Carbon sink trading mechanism to stimulate coastal countries' emission reduction actions

Arctic coastal states can incorporate seagrass beds and salt marsh wetlands into the carbon sink asset accounting system, create an Arctic carbon credit trading market, and allow member states to obtain tradable carbon emission quotas through the restoration of degraded coastal zones. Sovereign states need to establish a unified carbon sink measurement certification standard, entrust a third party to verify the carbon sequestration rate and storage changes of the blue carbon ecosystem, and prevent data fraud from distorting the market incentive mechanism. The current climate convention does not clarify the rules for cross-border trading of marine carbon sinks, and some countries unilaterally identify the property rights of carbon sinks in other countries' sea areas through domestic laws, causing disputes over sovereignty and resource ownership. The income distribution of carbon sink projects should give priority to protecting the rights and interests of indigenous communities, requiring buyers to pay an additional premium for ecological services, so as to avoid market mechanisms aggravating the livelihood vulnerability of traditional coastal fishermen. The Arctic coastal states can lead the formulation of a regulatory framework for carbon sink derivatives, limit the manipulation of abnormal fluctuations in carbon credit prices by speculative capital, and establish an Arctic Green Development Fund to support the transformation of low-carbon fishing technology. Relevant departments should strengthen policy coordination between the carbon sink market and national emission reduction targets, use the proceeds from carbon credit auctions for marine ecological restoration projects, and form a virtuous cycle of emission reduction actions and fishery resource restoration.

(3)Monitoring by satellite remote sensing and establishing a dynamic early warning system for migratory channels

Arctic littoral states could deploy joint high-resolution Aqua to track salmon runs around the clock and integrate data on surface water temperature, current speed and plankton density to generate three-dimensional dynamic models. The fishery management departments of various countries share the original satellite data stream, develop the prediction algorithm of species migration probability, and identify the risk of spawning ground position deviation or migration channel blockage in advance. The Arctic coastal states need to lead the establishment of standardized data processing protocols, eliminate the technical barriers of member states in image resolution accuracy and data encryption level, and ensure that the early warning information is synchronized at the second level in cross-border emergency response. Sovereign states legislate to force fishing vessels to install satellite positioning terminals, send back fishing coordinates and net depth in real time, and use dynamic early warning systems to detect abnormal operating densities in population gathering areas, automatically triggers the electronic fence and sends interception instructions to the coastal state's law enforcement vessels. Due to the distortion of remote sensing signals caused by cloud cover or sea ice reflection in some areas, it is necessary to set up underwater sonar arrays in the fjords and nearshore shallow waters, and calibrate the satellite data deviation by acoustic marking the size and trajectory of fish. The early warning results are directly connected to the national fishery license approval platform, and the fishing license issuance in the disputed sea area is automatically frozen during the peak migration period. Spatial control is used to reduce the interference of human activities with the natural migration rhythm.

5. Conclusion

In response to the impact of climate change on Atlantic Salmon Resources, Arctic coastal states need to break through traditional sovereignty barriers and establish a Dynamic equilibrium framework for ecological protection and resource utilization. Only by incorporating the protection of salmon migration channels into the cross-border legal cooperation system, and establishing rigid constraints on ecological data sharing and law enforcement linkage, can the crisis of habitat fragmentation caused by warming be alleviated.

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