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Future Illegal, Unreported and Unregulated Fishing Trends in a Warming World A Global Horizon Scan

Lauren Young, Cathy Haenlein and Grace Evans

With: Sophie Benbow, Zara Bending, Alex Caveen, Steven J Cooke, Alfonso Daniels, Aaron Delano-Johnson, Colleen Devlin, Nafeesa Esmail, Steve Farrer, Trisha Gupta, Kevin Kun He, Tom Hlavac, Barbara Hutniczak, Samuel Jardine, Matti Kohonen, Dmitry Lajus, Vardhan Jayant Patankar, Vladimir Radchenko, David L Roberts, Laurenne Schiller, John Simeone, Andrew Song, Nathan G Taylor, Carlos Eduardo (Cadu) Villaça and Catherine Workman









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Abbreviations

CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
EEZ	exclusive economic zone
FAO	UN Food and Agriculture Organization
IPCC	Intergovernmental Panel on Climate Change
IUU	illegal, unreported and unregulated
MCS	monitoring, control and surveillance
MPA	marine protected area
RFMO	regional fisheries management organisation
SIMP	Seafood Import Monitoring Program
UNODC	UN Office on Drugs and Crime

Executive Summary

Illegal, unreported and unregulated (IUU) fishing is a multifaceted global threat, occurring worldwide in inland waters, exclusive economic zones (EEZs) and on the high seas. Comprising everything from small-scale, near-shore activity to industrial-scale, long-distance operations, the current IUU fishing threat has the potential to evolve significantly in a warming world.

These evolutions stand to occur as fish populations themselves respond to a warming climate. Alongside critical stressors such as overfishing, oceanic warming is set to continue to contribute to an ongoing overall decline in fish populations globally. In parallel, there is evidence that key species are shifting poleward and to deeper waters, with declines in marine catch potential expected in the tropics. Combined with the effects of melting sea ice, changing weather patterns and the growth of marine heatwaves, among other factors, the impact on aquatic ecosystems is potentially highly destabilising.

These disruptive environmental changes have a range of potential implications for IUU fishing activity. The need to anticipate future trends across the threat landscape is thus pressing.

This paper presents the results of a global horizon scan conducted to explore the impacts of climate change on IUU fishing over the next 10 years and beyond. The scan gathered globally available information by eliciting submissions from contributors worldwide, with a group of expert assessors collating and prioritising trends based on their 'novelty', 'plausibility' and 'potential impact'.

The scan produced a ranked list of 20 priority trends, categorised into four thematic areas. While the scan considered both emerging threats and opportunities, most of the 20 priority trends speak to emerging challenges, with potential options to address them where feasible and appropriate.

The first group of trends emerging from the scan covers evolving IUU fishing issues linked to **shifting fish stocks and distributions**. A number of these have the potential to challenge existing management and enforcement frameworks. Potential trends identified relate to an emerging 'race to fish' in the Arctic; ice loss and rising demand in the Antarctic; climate change impacts on the Humboldt Current System; novel interactions between mobile industrial fleets and smaller vessels; and domestic fishery closures potentially altering the length of supply chains.

The second group of trends relates to **contested maritime boundaries and ungoverned spaces**. Potential emerging trends include risks arising where fish cross between EEZs, and where sealevel rise feeds into maritime boundary disputes; evolving intersections between IUU fishing and geopolitical tensions in the South China Sea; the rising importance of IUU fishing in maritime security discourse; and the push to expand marine protected area (MPA) cover despite unresolved issues around the policing of MPA borders.

The third group of trends relates to **evolving socioeconomic and criminological dynamics** across small-scale IUU fishing and larger-scale operations. Potential issues include the incentivisation of IUU activity as livelihoods are undermined; risk-taking and vulnerability in the face of extreme weather; reliance on illegal labour practices in the face of reduced profitability; and evolving criminal tactics and patterns of crime convergence with growing seafood scarcity.

The fourth group of trends relates to **challenges and opportunities for monitoring and enforcement**. Potential emerging issues relate to vessel monitoring capabilities to detect climate-driven changes in IUU activity; gaps around the evaluation of interventions; persistent weaknesses in the transnational response; port infrastructural upgrades; and mounting public pressure for transparency.

To support efforts to address these trends, this paper offers a set of broad considerations for the range of stakeholders involved in the global response to IUU fishing. With future policy unable to address climate impacts in isolation, these are designed to be considered in the wider context of other evolving aspects of fisheries management.

- Advance planning is essential. Many identified potential impacts of climate change are
 rooted in already visible trends, with advance action needed given the time required to
 update multilateral agreements, for example. Dedicated monitoring is needed to track
 changes in fish stocks relative to specific governance arrangements, as are forwardlooking fisheries crime assessments.
- Vessel-monitoring capabilities must be bolstered to detect climate-driven changes in activity. IUU fishing vessels could exhibit greater spatial mobility as they pursue shifting fish stocks, yet numerous gaps persist in vessel identification and monitoring capabilities. Gaps in state-level capacity to analyse unprocessed data continue to act as a barrier, with sustained work to build analytical capacity required.
- Enforcement must be strengthened and adapted to a climate-changed future. With perpetrators of large-scale IUU fishing potentially becoming increasingly geographically mobile, gaps in international cooperation must be addressed. Systematic evaluation of existing enforcement, mitigation and deterrence methods is also needed to inform future interventions. Beyond this, challenges around the policing of expanding MPAs must be addressed.
- Enhanced transparency and traceability must be pursued. As fish distributions shift and potentially alter the length of supply chains, responses continue to be hindered by a lack of transparency. Fishing-specific transparency legislation should be passed, ultimate beneficial ownership registries expanded, and schemes such as the Fisheries Transparency Initiative supported.

- Geopolitical stakes woven into fishing activity must be accounted for. As stocks of key species decline and their distributions shift, new juxtapositions of marine biomass concentration and fishing effort across jurisdictional boundaries risk altering the geopolitical stakes involved. A clear focus on fisheries is needed as part of wider efforts to build mutual trust and cooperation in affected areas.
- Resilience among artisanal fishing communities must be strengthened. In a range of locations, climate change could affect the vulnerabilities facing fishing-dependent communities as key species shift out of reach to deeper, cooler waters. Evidence-based measures must be enacted to enhance resilience to climate change, including long-term 'pro-poor' strategies to strengthen adaptive capacities.
- **High-volume IUU fishing must be treated with the severity it deserves**. With IUU fishing often treated as a minor issue, the disconnect between crime type and response could grow, as shifting fishing grounds potentially increase IUU actors' reliance on sophisticated organised criminal operations. National legislation must be updated such that large-scale IUU fishing qualifies as a serious crime per the UN Convention Against Transnational Organized Crime, with enforcement responses tailored to address shifting crime convergence.

Introduction

LLEGAL, UNREPORTED AND unregulated (IUU) fishing is a global problem – one that harms both aquatic ecosystems and human security. It occurs worldwide in inland waters, exclusive economic zones (EEZs) and on the high seas, comprising everything from small-scale, nearshore activity to industrial-scale long-distance operations. Increasingly recognised as a form of transnational organised crime, large-scale IUU fishing operations are known to intersect with other forms of criminal activity.¹ Although challenging to quantify, the global revenue lost to IUU fishing has been valued at up to \$23 billion annually – equal to around 20% of global seafood catch.² In terms of environmental harm, IUU activity adds to other pressures including overfishing, with an increasing proportion of global fish stocks fished beyond biologically sustainable limits – a proportion that stood at over 35% in 2019.³

Looking forward, there is potential for IUU fishing activity to evolve significantly in a warming world, with current patterns of operation already shifting as a result of climate change.⁴ Indeed, as fish populations and distributions shift in a warming climate, IUU actors may be forced to adapt, altering their modus operandi. Where livelihoods and food security are affected by climate change, among other stressors, fishers engaging in legitimate practices may be driven into IUU activity.⁵ At the same time, a warmer future could challenge existing governance

- Cathy Haenlein, 'Below the Surface: How Illegal, Unreported and Unregulated Fishing Threatens our Security', *RUSI Occasional Papers* (July 2017); Asia/Pacific Group on Money Laundering, 'APG Yearly Typologies Report 2022: Methods and Trends of Money Laundering and Terrorism Financing', July 2022.
- 2. It should be noted that the few available estimates vary widely. See UN Food and Agriculture Organization (FAO), The State of World Fisheries and Aquaculture 2016: Contributing to Food Security and Nutrition for All (Rome: FAO, 2016), p. iii; David J Agnew et al., 'Estimating the Worldwide Extent of Illegal Fishing', PLOS ONE (Vol. 4, No. 2, February 2009); Channing Mavrellis, 'Transnational Crime and the Developing World', Global Financial Integrity, 27 March 2017, <https://gfintegrity.org/report/transnational-crime-and-the-developing-world/>, accessed 2 February 2023.
- 3. FAO, The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation (Rome: FAO, 2022).
- 4. William W L Cheung, 'Climate Change Effects on Illegal, Unreported and Unregulated Fishing', Nippon Foundation Nureus Program, 22 February 2016, <https://nereusprogram.org/works/ climate-change-effects-on-illegal-unreported-and-unregulated-fishing/>, accessed 9 September 2022.
- 5. Megan Bailey and Rashid Sumaila, 'Destructive Fishing and Fisheries Enforcement in Eastern Indonesia', *Marine Ecology Progress Series* (Vol. 530, 2015), pp. 195–211.

frameworks, cooperative mechanisms and enforcement models, as well as presenting potential opportunities for national and global efforts to counter IUU fishing.⁶

The need to anticipate these issues is pressing. Despite the 2015 commitment made at the UN Framework Convention on Climate Change Paris Conference to limit global temperature rise to 1.5°C above pre-industrial levels, current predictions show that the world is unlikely to do so.⁷ Globally, the impact of climate change on aquatic species is already being felt. Some species, depending on their mobility and habitat connection, are responding by shifting their distributions poleward and to deeper waters.⁸ Although some species are predicted to respond positively, there are indications that future changes in water temperatures could have a negative impact on many aquatic species.⁹

Meanwhile, climate change has the potential to gradually alter interactions between humans and the aquatic environment. Fish is a key source of protein in human diets¹⁰ and shifts in sea temperature, salinity, weather systems and sea level have the potential to alter not only current patterns of distribution, but also human patterns of (legal and illegal) fishing, processing and consumption. To name but a few potential pathways, the impact of climate change on fish stocks could affect yields and fishing-dependent livelihoods, while rising temperatures and sea levels could affect human migration to and from coastal areas, the viability of fisheries infrastructure and the nature of IUU fishing dynamics.¹¹ In parallel, global seafood consumption looks set to continue to grow, having risen at more than twice the rate of population growth since the 1960s.¹²

Scanning the Horizon

Little research has sought to formally analyse the links between climate change and IUU fishing, and specifically how the former could impact the latter over the medium term. As a result, this

- Elizabeth Mendenhall et al., 'Climate Change Increases the Risk of Fisheries Conflict', Marine Policy (Vol. 117, 2020); Rosemary Rayfuse, 'Climate Change and Antarctic Fisheries: Ecosystem Management in CCAMLR', Ecology Law Quarterly (Vol. 45, 2018), pp. 53–81; Kathleen A Miller et al., 'Governing Marine Fisheries in a Changing Climate: A Game-Theoretic Perspective', Canadian Journal of Agricultural Economics (Vol. 61, No. 2, 2013), pp. 309–34.
- 7. UN News, 'UN Climate Report: It's "Now or Never" to Limit Global Warming to 1.5 Degrees', 4 April 2022.
- 8. Elvira S Poloczanska et al., 'Responses of Marine Organisms to Climate Change Across Oceans', *Frontiers in Marine Science* (Vol. 3, 2016).
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- 10. FAO, *The State of World Fisheries and Aquaculture 2018: Meeting the Sustainable Development Goals* (Rome: FAO, 2018), p. 2.
- 11. Mendenhall et al., 'Climate Change Increases the Risk of Fisheries Conflict'.
- 12. Jonathan H C Kelman, 'Why Climate Change and State Subsidies Will Collide to Create Fishery Conflict', *Journal of Strategic Security* (Vol. 13, No. 4, 2020), pp. 96–108.

paper constitutes the first dedicated effort to look ahead at the particular ways in which climate change stands to impact on IUU fishing.

Horizon scanning is a recognised technique for detecting future developments through a systematic evaluation of potential threats and opportunities.¹³ It brings together experts across relevant subject areas to critically analyse and synthesise available data and explore viable solutions. Previous horizon scans have focused on environmental crimes, such as illegal wildlife trade, against the backdrop of scans for global conservation issues conducted over 10 years.¹⁴ Yet IUU fishing has been neglected, with no previous horizon scanning (to the best of the authors' knowledge), and limited research to date on the future trajectory of this phenomenon or its intersections with climate change.

This global horizon scan aims to equip those charged with disrupting IUU fishing with information that will enable them to anticipate the challenges and opportunities of tomorrow. It seeks to identify emerging trends to inform proactive responses by governments, international organisations, NGOs and the private sector. The need for this input is stark: effective planning in a disruptive global environment depends on advance knowledge of these trends to mitigate threats and take up available opportunities.

The research for this paper examined the impact of climate change on IUU fishing, drawing out potential positive and negative developments, including opportunities and challenges. While the scan focuses only on the impact of climate change on IUU fishing, the importance of this work is amplified by the fact that IUU fishing itself risks exacerbating climate change. With fish playing a vital part in the ocean's carbon sequestration role by capturing carbon through feeding and exporting it to the deep ocean through excretion,¹⁵ a continuing decline in fish stocks stands to reduce the amount of carbon absorbed, contributing to warming temperatures.¹⁶

In exploring these issues, the paper identifies threats and opportunities emerging over the next decade that are likely to evolve over the longer term. The main research question is: how will climate change impact the IUU fishing threat worldwide and the effectiveness of responses in

- Attila Havas and K Matthias Weber, 'The Role of Foresight in Shaping the Next Production Revolution', in OECD, *The Next Production Revolution: Implications for Governments and Business* (Paris: OECD Publishing, 2017), pp. 299–324.
- 14. Nafeesa Esmail et al., 'Emerging Illegal Wildlife Trade Issues: A Global Horizon Scan', *Conservation Letters* (Vol. 3, Issue 4, 2020); William J Sutherland et al., 'Ten Years On: A Review of the First Global Conservation Horizon Scan', *Trends in Ecology & Evolution* (Vol. 34, No. 2, 2019), pp. 139–53.
- 15. Grace K Saba et al., 'Toward a Better Understanding of Fish-Based Contribution to Ocean Carbon Flux', Limnology and Oceanography (Vol. 66, Issue 5, 2021), pp. 1613–2093; UN Environment Programme, 'Business Unusual: How "Fish Carbon" Stabilizes our Climate', 24 October 2018, <https://www.unep.org/news-and-stories/story/business-unusual-how-fish-carbon-stabilizes-ourclimate>, accessed 26 January 2023.
- 16. U Rashid Sumaila and Travis C Tai, 'End Overfishing and Increase the Resilience of the Ocean to Climate Change', *Frontiers in Marine Science* (Vol. 7, July 2020), pp. 1–8.

the next 10 years and beyond? Drawing on the results identified, the paper outlines a set of key considerations for stakeholders across multiple sectors.

Methodology

Figure 1: Key Stages of the Horizon-Scanning Process



Source: Author generated.

Research was conducted between September 2021 and September 2022 and is based on analysis of primary and secondary data, comprising a rigorous review of existing literature and the execution of a global horizon scan.

First, a review of existing literature was conducted to assess current knowledge on the intersection between IUU fishing and climate change. A broad definition of literature was used, covering peer-reviewed research, policy briefs and blogs by recognised experts, reports by NGOs, government documents and evaluations. Standard review search strings were used, with defined inclusion criteria covering relevance and credibility and focused searches of Google and Google Scholar were conducted using combinations of selected keywords.

Following this, a horizon scan was undertaken, adapting Delphi-like techniques¹⁷ used in other scans¹⁸ to gather globally available information and collate and prioritise future trends. The scanning process comprised a series of phases, with the literature review used throughout to inform investigation, verification and other key aspects of the process. The first phase comprised a global call for participation, hosted on an open online platform that accommodated 29 languages. To avoid bias from unintentionally limiting reach, a wide net was cast, with the call disseminated via individuals ($n\approx 2,000$), networks and mailing lists ($n\approx 15$), regional fisheries management organisations (RFMOs) ($n\approx 25$), and social media (n=28 posts, eliciting $n\approx 49,000$ impressions and engagements).

The call elicited up to three emerging trends from contributors, who were asked to consult their networks, conduct their own research and draw on their own experiences. This resulted in 81 submissions, from participants with an array of expertise and professional backgrounds, including fishers; representatives of government agencies, RFMOs and NGOs; investigative journalists; private sector actors; and academics across criminology, conservation, financial crime, law and political science. In total, 148 individual trends were submitted, with duplicates merged and submissions incompatible with the research requirements removed by the facilitators, including those that only addressed a knowledge gap, perceived need, opinion or promotion. Submissions were anonymised, omitting identifiable information to guarantee objectivity in the subsequent analysis. This resulted in a consolidated list of 95 trends, thematically organised.

The consolidated list was then circulated to a group (n=27) of 'assessors', a subset of the original contributor pool (n=81), chosen for their well-researched contributions and to balance specific expertise, background, geographic focus, ethnicity and gender. The assessor group, which comprises the full list of authors of this paper, provided regional and global expertise, with experience across all seven oceans, seas from the Gulf of Mexico to the South China Sea, freshwater ecosystems such as the Amazon basin, and polar regions. Assessors were asked to score trends anonymously and independently (on a scale of 0-1,000) for 'novelty', 'plausibility'

Nibedita Mukherjee et al., 'The Delphi Technique in Ecology and Biological Conservation: Applications and Guidelines', *Methods in Ecology and Evolution* (Vol. 6, Issue 9, 2015), pp. 1097– 109.

^{18.} See, for example, Esmail et al., 'Emerging Illegal Wildlife Trade Issues'.

and 'potential impact'. Assessors were also asked to indicate whether they were familiar with each as an independent measure of novelty. Raw scores were converted to z-scores¹⁹ and ranked,²⁰ with the top 46 trends shortlisted. The assessor group was then given the opportunity to retain any non-shortlisted trends, based on justified reasoning and sound evidence as to why potentially significant trends should not be discounted. Four trends were 'saved' through this process, resulting in 50 trends.

The trends were divided and randomly assigned to assessors to investigate via targeted literature scans and verification exercises. Each trend was examined by two assessors, with neither the original contributor. Findings were presented and each trend was analysed by the wider assessor group through five virtual workshops and an interactive online workspace. This process culminated in a second round of anonymous scoring and feedback by assessors. Scores were again converted into z-scores and ranked. Based on assessor feedback, 10 of the trends were combined, resulting in a ranked list of 40, with the top 20 selected as priority trends.

Last, the facilitators edited the descriptions of the top 20 trends for clarity and consistency, and grouped them into four categories: shifting fish stocks and distributions; contested maritime boundaries and ungoverned spaces; evolving socioeconomic and criminological dynamics; and challenges and opportunities for monitoring and enforcement. To clarify their policy relevance, the facilitators elicited additional issue-specific expertise as required, through consultations with assessors and wider stakeholders. The list of 20 priority trends is presented in this paper, with trends 21–40 summarised briefly in the Appendix as potential avenues for further research.

Limitations

The first limitation that should be recognised relates to horizon scans collectively, as their usefulness can only be judged retrospectively, based on whether trends occurred as predicted and findings led to informed proactive responses.²¹ Second, the research examined the specific impact of climate change on IUU fishing, limiting the potential to explore other factors that may also have an impact. Third, although assessors were carefully selected, a degree of subjectivity is inevitable. Assessors' understanding of the issues is shaped by their specific expertise, potentially leading them to perceive certain trends as more significant than others. Many of the original submissions were shaped by cases that contributors had experienced first-hand, scenarios to which assessors may have had limited exposure. Similarly, the predictive nature of the research means that assessors' judgement of issues will be influenced by the documentation of evidence or lack thereof – a common challenge in horizon scanning. Fourth, for a number of the issues identified, baseline statistics are incomplete or unavailable, with the scanning process unable to quantify key phenomena in all cases, alongside qualitative experience and impressions. Last,

^{19.} The z-scores were calculated by first calculating the mean and standard deviation of each assessor's set of scores, then standardising each item score in the set by subtracting the mean and dividing by the standard deviation.

^{20.} Bonnie C Wintle et al., 'Point of View: A Transatlantic Perspective on 20 Emerging Issues in Biological Engineering', *eLife* (Vol. 6, November 2017).

^{21.} Sutherland et al., 'Ten Years On', pp. 139–53.

the hidden nature of much IUU fishing means that not all potential trends were necessarily identified during this research. For example, although inland fisheries were not excluded from the horizon scan, most submissions focused on the marine environment, with research that has an explicit inland fisheries lens potentially valuable in the future.

A further set of challenges relates to conceptual questions around the term 'IUU fishing' itself. This is understood to refer to a range of activity, comprising three distinct areas. 'Illegal fishing' is understood as any fishing activity by domestic or foreign vessels or individuals in waters under jurisdiction of a state or RFMO, undertaken without permission or in contravention of laws, regulations and management measures. 'Unreported fishing' is understood as activities that have not been reported or have been misreported to the relevant authority. 'Unregulated fishing' refers to activities in areas or for stocks not covered by conservation or management measures, which are conducted in a manner inconsistent with the conservation of living marine and freshwater resources under international law.²² All three components were included in the study, with submissions invited in relation to all activity covered by the above definitions. However, as very different phenomena, the breadth of these activities required research participants to be clear as to which component each issue related to, with accurate identification of future trends and potential mitigating action depending on clear differentiation.

Structure

The findings are presented over five chapters. Chapter I presents the overarching results of the horizon scan and the categorisation of the top 20 trends into four thematic areas. Chapters II–V present trends under each thematic area, analysing links as appropriate. The Conclusion draws together the findings and presents a series of considerations for those charged with formulating current and future responses to IUU fishing.

^{22.} FAO, International Plan of Action to Prevent, Deter, and Eliminate Illegal, Unreported and Unregulated Fishing (Rome: FAO, 2001), p. 2.

I. Overview of Findings

HE HORIZON SCAN conducted for this paper resulted in a final list – ranked by novelty, plausibility and potential impact – of 20 trends concerning the future of IUU fishing in a warming world. The trends describe evolutions in IUU fishing dynamics that could be hastened by climatic change over the next 10 years and beyond, based on emerging real-world evidence. Many are trends for which society is relatively unprepared, and which will require a change in practice or policy, or investment in further research. Many are dualistic, presenting both threats and opportunities for policymakers and practitioners. Some are relevant to specific geographies, whereas others have global relevance.

The top 20 emerging trends fall into four broad thematic areas, as follows (see Figure 2).

Shifting fish stocks and distributions. As the world's waters warm, increases in marine catch potential in certain regions and decreases in others have the potential to challenge existing management and enforcement frameworks (Trend 1). In the Arctic, warming waters are causing some of the most significant shifts in fish stocks globally, with this and declining sea-ice coverage risking a trigger to 'race to fish' in key locations (Trend 3). In the Antarctic, accelerating climate-driven changes, ice loss and rising demand for key species risk bolstering opportunities for IUU actors (Trend 6). In Peru and Chile, climate change risks shifting the Humboldt Current System²³ out of its current state of productivity, altering incentives for IUU activity (Trend 14). Globally, meanwhile, shrinking stocks (due to climate change, overfishing and other factors) and the changing distribution of stocks could necessitate greater mobility of vessels, causing potentially novel interactions between mobile industrial fleets and smaller, spatially constrained vessels (Trend 12). Last, as fish are forced to move to cooler, deeper waters, domestic fishery closures could alter the current length of supply chains, affecting options for fish laundering (Trend 7).

Contested maritime boundaries and ungoverned spaces. Issues under this theme arise from the propensity of climate change to feed into conflicts over fisheries resources – known as 'fisheries conflict'²⁴ – as fish cross between EEZs and as shifting low-water lines potentially bring into play new jurisdictional issues (Trend 8). In the South China Sea, existing geopolitical tensions risk being deepened as climate change interacts with historic pressures such as overfishing to deplete and displace fish stocks, with potentially more frequent incursions by fishers across disputed EEZ boundaries (Trend 17). Here and in other hotspots, recognition of the interlocking nature of IUU fishing and other threats could see IUU fishing assume rising importance in maritime security discourse (Trend 20). Last, issues surrounding maritime boundaries extend to

^{23.} The Humboldt Current System is a cold, low-salinity ocean current flowing north along the western coast of South America.

^{24.} Colleen Devlin et al., 'The Causes and Consequences of Fisheries Conflict Around the Horn of Africa', *Journal of Peace Research* (Vol. 59, No. 6, 2022), pp. 890–902.

those delineating marine protected areas (MPAs). Here, a growing international push to expand MPA cover is underway despite unresolved enforcement challenges that often fail to deter IUU fishing in these areas and on their borders (Trend 19).

Evolving socioeconomic and criminological dynamics. In terms of small-scale IUU fishing, rising sea temperatures and declining stocks risk further disrupting coastal communities' ability to survive through legal fishing, with implications for the uptake of IUU practices (Trend 5). Elsewhere, fishery-dependent livelihoods could be squeezed by extreme weather events, potentially fuelling a 'perfect storm' of risk-taking and vulnerability (Trend 10). For larger operators, pressure on profitability risks incentivising illegal labour practices, with growing numbers of climate refugees potentially offering a ready pool of labour (Trend 18). Meanwhile, for perpetrators of systematic IUU activity, the potential need to adopt more sophisticated organised criminal tactics as fish stocks decline could see responses increasingly outpaced, where national legislation fails to criminalise large-scale IUU fishing such that this qualifies as serious crime (Trend 15).²⁵ At this level, where IUU fishing intersects with other crimes, patterns of convergence could evolve, with growing scarcity of key resources determining the attractiveness of other commodities as complements or substitutes (Trend 11).

Challenges and opportunities for monitoring and enforcement. The first key challenge in this area pertains to the unpreparedness of many states to detect climate-driven changes in IUU fishing activity, due to ongoing gaps in vessel identification and monitoring capabilities (Trend 4). Similarly, a lack of systematic evaluation of interventions to disrupt IUU fishing could complicate decision-making on where to allocate future resources – a key issue where fishers exhibit shifting patterns of activity with which responses must keep pace (Trend 13). Across such activity, the transnational dimensions of IUU fishing will remain relevant, with a risk that coordination and other gaps in the international response will remain weaknesses (Trend 16). Meanwhile, future infrastructure upgrades at ports could alter market access for IUU fishing products (Trend 9). Last, opportunities lie in mounting public pressure for transparency of ownership and access agreements, as domestic fishers bring home smaller catches (Trend 2).

Figure 2: Top 20 Trends Categorised into Four Thematic Areas



Source: Author generated.

These themes, including the full set of trends within each, are presented in the following chapters.

II. Shifting Fish Stocks and Distributions

NE OF THE main themes arising from the scan concerns the way in which changes in fish stocks and ranges are set to alter patterns of IUU fishing globally. This stands to occur as climate change hastens a variety of disruptive changes that serve, in a range of cases, to reduce fish stocks and displace key species from unfavourable habitats.

These changes are linked to the oceans' role in climate dynamics. In 2013, the Intergovernmental Panel on Climate Change (IPCC) found the world's oceans to have absorbed over 93% of excess heat from greenhouse gas emissions between 1971 and 2010.²⁶ Over the past 100 years, US National Oceanic and Atmospheric Administration data shows that the average global sea surface temperature has risen by around 0.13°C per decade. This warming trend is set to continue, with ocean temperatures predicted to rise by 1–4°C by 2100.²⁷ Meanwhile, marine heatwaves are estimated to have increased by more than 50% in the past 30 years, emerging as 'forceful agents of disturbance with the capacity to restructure entire ecosystems'.²⁸

Rising greenhouse emission concentrations are also contributing to ocean acidification and deoxygenation. Notably, uptake of anthropogenic CO2 is altering the chemical balance of seawater, with the IPCC identifying a global mean drop in surface water pH of 0.08 from 1765 to 1994, disrupting the development and survival rates of larval fish, among other impacts on marine life.²⁹ Meanwhile, since the 1950s, the oceans' oxygen content has dropped by around 2%, with the volume of ocean waters completely depleted of oxygen quadrupling since the 1960s.³⁰ By 2100, in a 'business as usual' scenario, ocean oxygen levels are expected to decline by 3–4%,³¹ with localised hypoxic areas – or 'dead zones' – expected to spread.³²

- Monika Rhein et al., 'Observations: Ocean', in Thomas F Stocker et al. (eds), Climate Change 2013: The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press, 2013), pp. 255–315.
- 27. Marine Stewardship Council (MSC), 'Climate Change and Fishing', <https://www.msc.org/what-weare-doing/oceans-at-risk/climate-change-and-fishing>, accessed 13 November 2022.
- 28. Dan A Smale et al., 'Marine Heatwaves Threaten Global Biodiversity and the Provision of Ecosystem Services', *Nature Climate Change* (Vol. 9, 2019), pp. 306–12.
- 29. Rhein et al., 'Observations'.
- 30. International Union for Conservation of Nature (IUCN), 'Ocean Deoxygenation', IUCN Issues Brief, December 2019.
- 31. *Ibid*.
- 32. Matthew O Berger, 'Another Threat to the Ocean: Deoxygenation', *New Humanitarian*, 5 July 2017, https://deeply.thenewhumanitarian.org/oceans/articles/2017/07/05/another-threat-to-the-ocean-deoxygenation, accessed 2 February 2023.

Combined with the effects of melting sea ice, rising sea levels and changing weather patterns, the impact on aquatic ecosystems is destabilising. This has the potential to amplify the impact of stressors such as overfishing, with 35% of assessed marine fishery stocks overfished as of 2019, up from 10% in 1974.³³ In terms of climate change, recent research shows differential regional impacts, with reductions in fishery size of up to 34% in the worst-affected region studied – the Sea of Japan.³⁴ Looking ahead, global fish biomass is expected to decline by 5% for every 1°C of warming.³⁵ While not a universal trend, there is also evidence that a number of marine species are responding by shifting poleward and to deeper waters, with declines in marine catch potential of up to 40% expected in parts of the tropics and average increases of 30–70% in high-latitude regions.³⁶

Thus, both fish stocks and the locations in which fish feed, migrate and spawn are changing. This situation could present opportunities; for example, poleward distribution shifts could see key species move closer to market states with stronger monitoring and enforcement frameworks. In other ways, however, challenges could emerge, where IUU fishing operators shift their fishing grounds or use alternative methods, requiring adaptation by enforcement actors and regulators.

Against this backdrop, the scan singled out six priority emerging issues related to the implications of shifting fish ranges and stocks for patterns of IUU fishing. Some are global in nature, while others pertain to particular geographies – including the poles and key fishing states in the tropics. These six trends are presented in the remainder of this chapter.

^{33.} FAO, The State of World Fisheries and Aquaculture 2022.

Christopher M Free et al., 'Impacts of Historical Warming on Marine Fisheries Production', Science (Vol. 363, No. 6430, 2019), pp. 979–83; Arthur Neslen, 'East China Sea Fish Stocks Hit Hard by Global Warming', China Dialogue Ocean, 5 March 2019.

^{35.} Heike K Lotze et al., 'Global Ensemble Projections Reveal Trophic Amplification of Ocean Biomass Declines with Climate Change', *PNAS* (Vol. 116, No. 26, May 2019), pp. 12907–12.

^{36.} Poloczanska et al., 'Responses of Marine Organisms to Climate Change Across Oceans'; William W L Cheung et al., 'Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change', *Global Change Biology* (Vol. 16, No. 1, 2010), pp. 24–35; Vicky W Y Lam et al., 'Climate Change Impacts on Fisheries in West Africa: Implications for Economic, Food and Nutritional Security', *African Journal of Marine Science* (Vol. 34, No. 1, 2012), pp. 103–17; Vicky W Y Lam et al., 'Climate Change, Tropical Fisheries and Prospects for Sustainable Development', *Nature Reviews Earth & Environment* (Vol. 1, No. 9, 2020), pp. 440–54.

Trends

Global fish redistributions with oceanic warming

Rank: 1

As the world's oceans warm, multiple studies anticipate a large-scale redistribution of global marine catch potential. Although exceptions exist, a number of studies anticipate overall increases in high-latitude regions and decreases in the tropics.³⁷ Projected range shifts could see some species cross national boundaries as they leave waters that are too warm, incentivising a 'race to fish'.³⁸ Tropical countries are expected to see the greatest losses, furthering inequities between Global South and North.³⁹ By 2050, for example, research suggests that the Pacific Islands could see a 20% decline in purse-seine catch in their waters,⁴⁰ with implications for licensing revenue, port taxes and employment.⁴¹ This could have a range of implications, for example, compensation may be demanded between countries losing and gaining fish.⁴² Meanwhile, poleward distribution shifts could see key species shift closer to leading market states with more capable monitoring, control and surveillance (MCS) arrangements. In parallel, however, as fish enter new jurisdictions, unregulated fisheries could form, with management and enforcement frameworks requiring adaptation.⁴³ In the case of Atlantic mackerel, warming waters have expanded ranges as far north as Svalbard, challenging mechanisms for negotiating fishing rights.⁴⁴ Such cases highlight the issues emerging where species move with rising temperatures, with potential governance lags arising where regulatory and enforcement systems - and the content of multilateral agreements - fail to keep pace with environmental change.

- Cheung et al., 'Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change'; Kimberly L Oremus et al., 'Governance Challenges for Tropical Nations Losing Fish Species Due to Climate Change', *Nature Sustainability* (Vol. 3, 2020), pp. 277–80; Jorge García Molinos et al., 'Climate Velocity and the Future Global Redistribution of Marine Biodiversity', *Nature Climate Change* (Vol. 6, No. 1, 2016), pp. 83–88.
- U Rashid Sumaila et al., 'Climate Change Impacts on the Biophysics and Economics of World Fisheries', Nature Climate Change (Vol. 1, No. 9, 2011), pp. 449–56.
- 39. Oremus et al., 'Governance Challenges for Tropical Nations Losing Fish Species Due to Climate Change'.
- 40. A purse seine is a large wall of netting deployed around an entire area or school of fish.
- 41. Johann D Bell et al., 'Pathways to Sustaining Tuna-Dependent Pacific Island Economies During Climate Change', *Nature Sustainability* (Vol. 4, 2021), pp. 900–10.
- 42. Oremus et al., 'Governance Challenges for Tropical Nations Losing Fish Species Due to Climate Change'.
- 43. Malin L Pinsky et al., 'Preparing Ocean Governance for Species on the Move', *Science* (Vol. 360, No. 6394, 2018), pp. 1189–91.
- 44. Regin Winther Poulsen, 'An Ever-Moving, Unloved Fish is Stirring Chaos in the North Atlantic', *The Atlantic*, 13 February 2021; Miller et al., 'Governing Marine Fisheries in a Changing Climate'.

'Race to fish' expanding stocks in the Arctic

Rank: 3

Rank: 6

In the Arctic, surface air temperatures are rising two to four times faster than the global average.⁴⁵ Here, reductions in Arctic sea-ice coverage and the opening of new shipping lanes are raising concerns over the potential for a growing 'race to fish' in previously inaccessible waters.⁴⁶ In parallel, warming waters risk causing some of the most significant shifts in fish stocks globally, with marine catch potential in the Arctic increasing as the anticipated ranges of some species extend poleward.⁴⁷ This risks raising tensions, as seen in the northward shift and expansion of mackerel stock in key locations, spurring disputes over quota setting.⁴⁸ Moving forward, a key challenge could be that stocks shift from the sub-Arctic (encompassing littoral EEZs) to the Central Arctic (the high seas of the Arctic Ocean). With melting ice creating new fishing grounds over the long term, stocks could face future exploitation by a wider range of actors – despite the signature by 10 parties of an international agreement in 2021 temporarily prohibiting commercial fishing in the Central Arctic.⁴⁹ These changes – combined with high demand for key species and ongoing infrastructural development – could create new issues in relation to unregulated fisheries in areas beyond national jurisdiction.

Ice loss and surging demand for krill in the Antarctic

Antarctic marine ecosystems are changing rapidly, with unprecedented ice loss and surging demand for key species⁵⁰ increasing concerns over IUU fishing. Notably, the market for Antarctic krill oil is expected to grow from \$740.3 million in 2021 to \$2.25 billion by 2031.⁵¹ Key states are investing in krill fishing infrastructure; in 2019, China's Jiangsu Shen Lan Distant Water Fishing

45. Intergovernmental Panel on Climate Change (IPCC), 'Climate Change Widespread, Rapid, and Intensifying – IPCC', 9 August 2021, <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809pr/>, accessed 2 February 2023; Arctic Monitoring and Assessment Programme, 'Arctic Climate Change Update 2021: Key Trends and Impacts', 2021, <https://www.amap.no/documents/doc/ arctic-climate-change-update-2021-key-trends-and-impacts.-summary-for-policy-makers/3508>, accessed 2 February 2023; Mika Rantanen et al., 'The Arctic has Warmed Nearly Four Times Faster than the Globe Since 1979', *Communications Earth & Environment* (Vol. 3, 2022), pp. 1–10.

- 46. Jen Evans and Andreas Østhagen, 'Fisheries Disputes: The Real Potential for Arctic Conflict', Arctic Institute, 3 June 2021, https://www.thearcticinstitute.org/fisheries-disputes-real-potential-arctic-conflict/, accessed 3 February 2023.
- 47. Ed Struzik, 'Welcome to the Arctic Ocean, Mysterious Fish', New Humanitarian, 12 May 2017.
- 48. Poulsen, 'An Ever-Moving, Unloved Fish is Stirring Chaos in the North Atlantic'.
- 49. Arctic Council, 'An Introduction to: The International Agreement to Prevent Unregulated Fishing in the High Seas of the Central Arctic Ocean', 25 June 2021.
- 50. Cassandra M Brooks et al., 'Challenging the "Right to Fish" in a Fast-Changing Ocean', *Stanford Environmental Law Journal* (Vol. 33, No. 289, 2013), pp. 289–324.
- 51. Future Market Insights, 'Krill Oil Market', <https://www.futuremarketinsights.com/reports/krill-oilmarket>, accessed 1 October 2022.

Company launched the world's largest purpose-built Antarctic krill fishing vessel.⁵² In 2019–20, in key areas, quota limits set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) were reached after 69 days, significantly faster than the average of 130 days over the previous five years.⁵³ Growing demand and more distant-water fishing operations risk fuelling a rise in instances of IUU fishing, increasing pressure on management and policing mechanisms.⁵⁴ Proactive preventative actions are required.⁵⁵ Yet, at times these come with challenges: at CCAMLR's 39th meeting in 2020, members could not agree to protect waters exposed by the receding Pine Island Glacier, or to add the Russian *F/V Palmer* to the IUU vessel list, despite suspicion of IUU fishing.⁵⁶ Ongoing strong commitment is needed from all CCAMLR members in the face of accelerating climate-driven changes to the Antarctic marine ecosystem.

Potential climate-driven current system shifts in Peru and Chile

Rank: 14

In a changing climate, redistribution of global seafood catch potential could see declines in catch in the tropics of up to 40% by 2050.⁵⁷ Peru and Chile are among the top fishing states globally due to the Humboldt Current System, a wind-driven coastal upwelling system that constitutes the world's most productive marine ecosystem.⁵⁸ Climate change could shift this system out of its present state of productivity, exacerbating existing pressures on Peru's and Chile's fishing sectors.⁵⁹ From 2005 to 2015, on average, 9.35 million tonnes of fish, molluscs and crustaceans were landed annually in Peru and Chile, with a decreasing trend witnessed over

- 52. Mark Godfrey, 'Shen Lan Launches Antarctic Krill Fishing Vessel', *SeafoodSource*, 20 May 2019.
- 53. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), 'Report of the Thirty-Ninth Meeting of the Commission', 2020, p. 18, <https://www.ccamlr.org/en/system/files/e-cc-39-rep.pdf>, accessed 1 October 2022.
- 54. Sea Shepherd, 'Operation Icefish: Shutting Down an Illegal Toothfish Poaching Fleet', <https:// www.seashepherdglobal.org/our-campaigns/icefish/>, accessed 1 October 2022.
- 55. Jeffrey McGee, Bruno Arpi and Andrew Jackson, "Logrolling" in Antarctic Governance: Limits and Opportunities', *Polar Record* (Vol. 56, 2020).
- 56. Antarctica 2020, 'CCAMLR: Leaders Miss Another Opportunity to Protect the Seas of Antarctica', 30 October 2020; Liz Allen, 'Russian Vessel Suspected of Illegal Fishing in Antarctic Waters Will Face No Consequences', *Forbes*, 31 October 2020.
- 57. Cheung et al., 'Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change'; MSC, 'Climate Change and Fishing'.
- 58. Arnaud Bertrand, Omar Defeo and Rodolfo E Vögler Santos, 'Climate Change Impacts, Vulnerabilities and Adaptations: Southwest Atlantic and Southeast Pacific Marine Fisheries', in Manuel Barange et al. (eds), 'Impacts of Climate Change on Fisheries and Aquaculture: Synthesis of Current Knowledge, Adaptation and Mitigation Options', FAO Fisheries Technical Paper 627, July 2018, pp. 325–46.
- 59. Science Daily, 'Tipping Point in Humboldt Current off Peru Leads to Species Shift', 7 January 2022.

time.⁶⁰ Peruvian fisheries are focused on marine pelagic resources⁶¹ such as anchoveta, with climate change and other key stressors such as overfishing already reducing stocks, affecting fishmeal production and potentially incentivising IUU activity.⁶² The future impacts of climate change on the dynamics of El Niño–Southern Oscillation events could alter current levels of productivity further.⁶³ Previous studies have shown sharp differences in levels of socio-ecological vulnerability among different fishing communities sharing the same fishing grounds in areas highly sensitive to changes associated with El Niño; in this context, the potential impacts of the aforementioned environmental shifts must be anticipated.⁶⁴

Novel interactions between industrial fleets and small-scale vessels

Rank: 12

The displacement of key fish stocks in warming conditions could potentially result in greater spatial movement of vessels seeking to follow moving species or target new stocks.⁶⁵ This is a particular possibility for vessels targeting highly migratory species, such as tuna. The result is a potential scenario in which industrial vessels and distant-water fleets exhibit greater flexibility in their operational adaptations to climate change, whereas smaller vessels are spatially constrained. This may lead to novel interactions between small-scale and mobile industrial fleets – with implications for IUU fishing. First, new conflicts may arise as distant-water vessels encroach on local fishing resources.⁶⁶ Second, new symbiotic relationships may form between small-scale and industrial fleets, altering incentives for IUU activity. An example is visible in Ghana, where climate change could increase local fishers' dependence on 'saiko' fishing – the

- 62. UN Economic Commission for Latin America and the Caribbean, 'La Economía del Cambio Climático en el Perú ['The Economics of Climate Change in Peru'], 2014, https://repositorio.cepal.org/handle/11362/37419, accessed 16 February 2023.
- 63. The El Niño–Southern Oscillation is a normally temporary period of above-average surface water temperatures in the equatorial Pacific. See Miguel Ñiquen and Marilú Bouchon, 'Impact of El Niño Events on Pelagic Fisheries in Peruvian Waters', *Deep Sea Research Part II: Topical Studies in Oceanography* (Vol. 51, Nos. 6–9, March–May 2004), pp. 563–74; Michael J McPhaden, Agus Santoso and Wenju Cai (eds), *El Niño Southern Oscillation in a Changing Climate* (Washington, DC: American Geophysical Union, 2021).
- 64. Hans J Jara et al., 'Current and Future Socio-Ecological Vulnerability and Adaptation of Artisanal Fisheries Communities in Peru: The Case of the Huaura Province', *Marine Policy* (Vol. 119, 2020).
- 65. David Tickler et al., 'Far from Home: Distance Patterns of Global Fishing Fleets', *Science Advances* (Vol. 4, No. 8, 2018).
- 66. Jessica Spijkers et al., 'Identifying Predictors of International Fisheries Conflict', *Fish and Fisheries* (Vol. 22, No. 4, 2021).

^{60.} FAO, 'FAO Warns of Climate Change Impact on World's Most Productive Marine Ecosystem: The Humboldt Current System', 6 August 2018.

^{61.} Pelagic resources inhabit the open water column, neither close to the bottom nor near the shore, of coasts, open oceans and lakes.

illegal transhipment of catch from industrial vessels.⁶⁷ Third, displacement of small-scale fleets by industrial fleets could push artisanal fishers into IUU activity in order to maintain marginal livelihoods. The ecological and social impacts of all three scenarios must be considered in fisheries management and broader social and economic policy.

Variations in supply chain lengths and transparency and control measures Rank: 7

Consumer concern over sustainability has seen an expansion in seafood supply chain transparency and control measures, through government regulation, international agreements and private initiatives.⁶⁸ Trade-related measures to combat IUU fishing include trade-restrictive measures and catch certification schemes operated unilaterally and multilaterally. While positive results have been achieved in some areas, gaps remain in others. In 2016, for example, the US established the Seafood Import Monitoring Program (SIMP), a federal traceability initiative covering 13 species groups at risk of illegal fishing and seafood fraud.⁶⁹ SIMP currently screens up to 47% of US imports of fish products and only 10% of fish products imported globally.⁷⁰ According to the US National Marine Fisheries Service, of 4,977 US importers holding International Fisheries Trade Permits in 2020, 47% imported SIMP products, with 472 undergoing a SIMP audit. Of these audits, 43% were non-compliant.⁷¹ In 2019, Oceana tested popular seafood consumed in the US that was not covered by SIMP and found one in every five fish to be mislabelled.⁷² The impact of these gaps could grow as fish move to cooler, deeper waters. As they do, domestic fishery closures could alter the length of existing supply chains, affecting the options available for fish laundering.⁷³ Globally, a key challenge in terms of trade-related measures will be that of designing a single platform to cover any species decided on unilaterally or multilaterally – with such a platform immune to the impacts of future stock displacements.⁷⁴

74. Hosch, 'Trade Measures to Combat IUU Fishing'.

^{67.} Environmental Justice Foundation, 'Stolen at Sea: How Illegal "Saiko" Fishing is Fuelling the Collapse of Ghana's Fisheries', 2019.

Gilles Hosch, 'Trade Measures to Combat IUU Fishing: Comparative Analysis of Unilateral and Multilateral Approaches', International Centre for Trade and Sustainable Development, 2016; Gilles Hosch and Francisco Blaha, 'Seafood Traceability for Fisheries Compliance: Country-Level Support for Catch Documentation Schemes', Technical Paper 619, FAO Fisheries and Aquaculture, 2017.

US National Oceanic and Atmospheric Administration (NOAA), 'Seafood Import Monitoring Program', <https://www.fisheries.noaa.gov/international/seafood-import-monitoring-program>, accessed 1 October 2022.

^{70.} NOAA, 'Improving International Fisheries Management: 2021 Report to Congress', August 2021, p. 54.

^{71.} *Ibid.*, p. 55.

^{72.} Kimberly Warner et al., 'Casting a Wider Net: More Action Needed to Stop Seafood Fraud in the United States', Oceana, March 2019.

^{73.} Fish laundering describes the process whereby illegally sourced fish are fed into legal supply chains, either via mislabelling or other means.

Summary

Collectively, these trends begin to illustrate the multifaceted ways in which climate change could alter the parameters of human interactions with aquatic species through IUU fishing. These are some of the highest-ranked trends in the scan – in 1st, 3rd, 6th, 7th, 12th and 14th place – indicating a shared belief that many could be significant factors in the coming decade and beyond. Many act as the foundation from which trends in subsequent chapters emerge, with shifting numbers and distributions of the core commodities sought by IUU operators intersecting with evolving trends in other thematic areas.

III. Contested Maritime Boundaries and Ungoverned Spaces

HE RESULTS OF the horizon scan demonstrate the importance of proactively addressing IUU fishing challenges where these intersect with wider security issues, boundary disputes and ungoverned spaces. Already, insecurity presents opportunities for IUU actors, with significant potential for evolution in this domain in a climate-changed world. Maritime boundaries, for example, are central to the very definition of any instance of fishing activity as illegal, unreported or unregulated, depending on its occurrence relative to recognised jurisdictional borders. Where these borders are disputed, defining and thus responding to IUU fishing activity becomes increasingly complex.

Underpinning the definition of any instance of fishing activity as illegal, unreported or unregulated is the current framework of maritime governance under international law, whereby coastal states enjoy jurisdiction in their own EEZs. A concept defined under the 1982 UN Convention on the Law of the Sea, the EEZ comprises an area extending 200 nautical miles from the coast. The EEZ lies adjacent to the territorial sea, with its limits drawn from the baseline along the coast. Across its EEZ, each coastal state has special rights to exploration and resource use, with the ability to exclude or grant fishing licences to foreign vessels. When fishing activity occurs here – or in areas covered by RFMOs – without permission or in contravention of laws, regulations and management measures, that activity is illegal.

Potential issues arise where EEZ boundaries are disputed. With EEZs measured from the lowwater lines of coastal states, long-term climate change-induced sea-level rise has the potential to feed into contestation in this area. In 2013, the IPCC reported a rise in global mean sea level of 0.19 metres from 1901 to 2010, based on tide gauge records and, more recently, satellite data.⁷⁵ The future impact is pronounced in the case of islands and low-lying states, with potential implications for maritime boundary disputes and patterns of IUU fishing where island states start to sink beneath the waves.

Combined with the shifting fish distributions discussed in Chapter II, the evolution of wider maritime security issues, boundary disputes and the emergence of ungoverned spaces have a range of implications for IUU fishing activity. The scan singled out four trends directly relating to these themes.

Trends

Potential for fisheries conflict and shifting maritime boundaries

Rank: 8

As fish move across boundaries, an emerging issue concerns the propensity of climate change to exacerbate fisheries conflict. First, as oceanic warming causes shifts in fish distributions, key species may cross EEZ borders, incentivising those who have fished them historically to pursue them.⁷⁶ This could create new juxtapositions of marine biomass concentration and (IUU) fishing effort with respect to jurisdictional boundaries, weaving geopolitical stakes into fishing activity in evolving ways. In regions already experiencing related tensions, claimants may send fishing vessels to newly contested areas, stoking fisheries conflict. Over the long term, rising sea levels could play into these dynamics, with rising waters shifting low-water lines and eventually submerging low-lying islands on which EEZ claims are based. In Tuvalu, for example, up to 40% of the capital district is now underwater at high tide, with the entire country forecast to be underwater by the end of the century.⁷⁷ Elsewhere, receding baselines in low-lying countries could potentially see claims lodged by third parties to have the outer limits of their EEZs reassessed. In such a world of shifting coastlines, the very definition of IUU fishing could become more challenging.

Declining fisheries and geopolitical tensions in the South China Sea

Rank: 17

The South China Sea is a flashpoint for international tension over fisheries, inter alia.⁷⁸ As one of the world's hottest geopolitical trouble spots, it sees at-sea confrontations occurring regularly between fishers and coast guards of bordering states, with altercations over fishing just one facet of wider disputes.⁷⁹ Many relate to China's commitment to the 'nine-dash line' – the country's self-declared maritime boundary – with armed fishing militia proving instrumental in enforcing Chinese sovereignty claims.⁸⁰ Ongoing climatic change could play into these tensions. The South China Sea is one of the world's most over-exploited ecosystems, with rising temperatures

- Lucy Craymer, 'Tuvalu Turns to the Metaverse as Rising Seas Threaten Existence', *Reuters*, 15 November 2022; Chris Armstrong and Jack Corbett, 'Climate Change, Sea Level Rise and Maritime Baselines: Responding to the Plight of Low-Lying Atoll States', *Global Environmental Politics* (Vol. 1, No. 1, 2020), pp. 89–107.
- 78. U Rashid R Sumaila and William W L Cheung, 'Boom or Bust: The Future of Fish in the South China Sea', ADM Capital Foundation, 2015, <https://www.admcf.org/wp-content/uploads/2019/11/4-Resource-a_-Boom-or-Bust_-The-Future-of-Fish-in-the-South-China-Sea-English-version-November-2015.pdf>, accessed 27 January 2023.
- 79. John Reed, 'South China Sea: Fishing on the Front Line of Beijing's Ambitions', *Financial Times*, 24 January 2019.
- Derek Grossman and Logan Ma, 'A Short History of China's Fishing Militia and What it May Tell Us', RAND Corporation, 6 April 2020.

^{76.} Eric Schwaab, Rod Fujita and Jacqui Vogel, 'Climate Change is Causing Fishery Problems, But We Can Solve Them', Environmental Defense Fund, 21 April 2022.

and acidification expected to further impact fish stocks.⁸¹ According to ecological modelling, as temperatures exceed tolerable thermal limits for many organisms, the South China Sea could witness the disappearance of key commercial species as these seek refuge in higher latitudes.⁸² The economic and security implications could be exacerbated by further IUU activity: as climate change displaces fish stocks, more incursions across disputed boundaries could occur as fishers chase fewer fish.⁸³ This, in turn, could fuel confrontation between fishing vessels, coastguards and navies of counterclaimants, damaging efforts to build mutual cooperation.

The place of IUU fishing in maritime security discourse Rank: 20

IUU fishing has not always been viewed as a top-tier maritime security threat, with higher priority historically assigned to threats such as piracy.⁸⁴ However, the perceived status of IUU fishing is changing. Notably, growing recognition of the interlocking nature of IUU fishing and other transnational criminal threats has seen the former assume rising importance in maritime security discourse.⁸⁵ Key to this is a growing understanding of IUU fishing for diminishing marine resources as a catalyst for maritime insecurity, with documented instances of fishing (legal and illegal) intersecting with a range of security issues.⁸⁶ In the South China Sea, use of fishing fleets as 'maritime militia' to stake out territorial claims and support geopolitical objectives poses critical challenges.⁸⁷ In 2021, the US Coast Guard stated that IUU fishing had 'replaced piracy as the leading global maritime security threat'.⁸⁸ In a changing climate in which the wider maritime security landscape is set to be impacted in various ways by disruptive environmental change, the role fishing plays in this contested space could evolve further. This could create a range of opportunities to strengthen the resourcing and effectiveness of existing efforts to counter

- 81. Murray Hiebert, 'The Looming Environmental Catastrophe in the South China Sea', *The Diplomat*, 14 January 2022.
- U Rashid Sumaila et al., 'Sink or Swim: The Future of Fisheries in the East and South China Seas', ADM Capital Foundation, 2021, https://www.admcf.org/research-reports/sink-or-swim/, accessed 7 February 2023.
- 83. Louise S L Teh et al., 'What is at Stake? Status and Threats to South China Sea Marine Fisheries', *Ambio* (Vol. 46, No. 1, 2017), pp. 57–72.
- 84. Haenlein, 'Below the Surface'; U Rashid Sumaila and Mahamadu Bawumia, 'Fisheries, Ecosystem Justice and Piracy: A Case Study of Somalia', *Fisheries Research* (Vol. 157, 2014), pp. 154–63.
- Sarah M Glaser et al., 'Foreign Illegal, Unreported, and Unregulated Fishing in Somali Waters Perpetuates Conflict', *Frontiers in Marine Science* (Vol. 6, No. 704, 2019); Alan Cummings, 'The Mumbai Attack: Terrorism from the Sea', Center for International Maritime Security, 29 July 2014.
- 86. Andrew M Song, 'Civilian at Sea: Understanding Fisheries' Entanglement with Maritime Border Security', *Geopolitics*, 12 November 2021.
- 87. Gregory B Poling et al., 'Pulling Back the Curtain on China's Maritime Militia', Center for Strategic and International Studies, November 2021.
- US Coast Guard, 'Illegal, Unreported and Unregulated Fishing Strategic Outlook', September 2020, p. 2.

IUU activity. Alongside this, however, could come intensified debate over what constitutes 'IUU fishing' in this context.

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increasing	IIICUI SIOIIS	mu	IVIFAS	

MPAs globally are under strain. Abundant evidence suggests that they are not as effective as hoped at safeguarding marine biodiversity, with IUU fishing documented in MPAs globally.⁸⁹ Whether by industrial or small-scale fleets, there can be little deterrent to this, given a lack of resources for monitoring and enforcement. Despite this, there is a growing international push to expand MPA cover, as seen in the '30by30' target to protect at least 30% of the global ocean by 2030 (pursued despite the non-achievement of previous targets under UN Sustainable Development Goal 14.5).⁹⁰ In this context, the risk is a proliferation of 'paper MPAs' that exist as, effectively, ungoverned spaces. With fish scarcity rising and demand unlikely to shrink, there is also a risk of increased IUU fishing in these areas and on their borders. Notably, existing pressures stand to increase as sustained high global fish consumption runs in contrast to a push to close off everlarger oceanic spaces. These issues can be seen in the Galapagos, where 60,000 km² was added to existing protected waters in 2022 under a plan by Ecuador, Colombia, Costa Rica and Panama to create a migration corridor between protected areas.⁹¹ However, many doubt authorities' ability to police protected areas, with IUU activity suspected in and around existing reserve borders, including by Chinese fleets.⁹² Globally, these challenges could worsen should climate change cause key fish stocks to move further into MPAs.

Summary

Considered together, these trends illustrate the potential issues that climate change raises for fisheries management in a context of shifting maritime boundaries and other related (and evolving) security issues. With many rooted – in cases such as the South China Sea – in already present dynamics, and with climate change acting as a potential threat multiplier, they stand to emerge as increasingly exigent issues on the global horizon.

Rank: 19

^{89.} Manuel Dureuil et al., 'Elevated Trawling Inside Protected Areas Undermines Conservation Outcomes in a Global Fishing Hot Spot', *Science* (Vol. 362, No. 6421, 2018), pp. 1403–07.

^{90.} UK Government, 'Global Ocean Alliance: 30by30 Initiative', <https://www.gov.uk/government/ topical-events/global-ocean-alliance-30by30-initiative/about>, accessed 4 January 2022; Mialy Andriamahefazafy et al., 'Sustainable Development Goal 14: To What Degree have We Achieved the 2020 Targets for Our Oceans?', Ocean and Coastal Management (Vol. 227, August 2022).

^{91.} Anna Portella, 'Galapagos Fishermen Skeptical of New Marine Reserve Amid Enforcement Challenges', *Reuters*, 10 February 2022.

^{92.} Oceana, 'Oceana Finds 300 Chinese Vessels Pillaging the Galapagos for Squid', September 2020.

IV. Evolving Socioeconomic and Criminological Dynamics

FURTHER GROUP OF issues concerns the impact of climate change on the socioeconomic factors that combine to incentivise individuals to engage – or not engage – in IUU fishing. This applies to both low-intensity, near-shore IUU activity and systematic offending by large-scale transnational operators. Crucially, as the climate changes, so do the conditions in which (potential) perpetrators make decisions around risk, reward and opportunity. Key to this are assessments as to the viability of other livelihood options – many themselves impacted by climate change.

At a community level, the vulnerability of fishery-based livelihoods to climate variability in key locations is well established.⁹³ Where livelihoods based on legal fishing are undermined, the socioeconomic circumstances and alternative options of those affected are highly relevant. Here, differences emerge in line with the varying impacts of climate change from community to community. Often, those most heavily dependent on artisanal fishing exhibit lower adaptive capacities than those with more diversified economies and more of the infrastructure required for adaptation.⁹⁴ These factors – as well as climate impacts on land-based livelihoods such as agriculture – may alter the relative attractiveness of IUU fishing.

Meanwhile, at the level of large-scale IUU fishing activity, the increasingly fragile geophysical and sociopolitical conditions that risk emerging in a climate-changed world stand to alter the operations of organised criminal actors. Notably, research in other areas has shown how organised crime benefits from the instability caused by climate change.⁹⁵ Should the same apply to large-scale IUU fishing, climate change could present a critical enabler. In this context, the scan identified five priority trends linked to evolving socioeconomic and criminological dynamics.

^{93.} Daniel Etongo and Lyn Arrisol, 'Vulnerability of Fishery-Based Livelihoods to Climate Variability and Change in a Tropical Island: Insights from Small-Scale Fishers in Seychelles', *Discover Sustainability* (Vol. 2, No. 1, 2021).

^{94.} Jara et al., 'Current and Future Socio-Ecological Vulnerability and Adaptation of Artisanal Fisheries Communities in Peru'.

^{95.} Climate Diplomacy, 'Insurgency, Terrorism and Organised Crime in a Warming Climate: Analysing the Links Between Climate Change and Non-State Armed Groups', October 2016.

Trends

Climate stress and shifts in socio-ecological systems Rank: 5

Complex interrelationships exist between climate variability, food security, IUU fishing and wildlife poaching, with climatic impacts at sea affecting behaviour on land, and vice versa. In a range of locations, rising sea temperatures and declining fish stocks are disrupting fishing communities' livelihoods, potentially driving adoption of IUU practices. This risk is elevated where communities rely on climate-sensitive ecosystems such as coral reefs. Globally, 275 million people depend directly on reefs for livelihoods and food, but over 75% of reefs are threatened by stressors including overfishing, oceanic warming and acidification.⁹⁶ On land, meanwhile, where fish-eating communities seek alternative protein sources, the meat-production sector may come under growing pressure. In Ghana, research over three decades linked years of poor fish supply with sharp increases in bushmeat hunting in nature reserves and declines in biomass in 41 terrestrial wildlife species.⁹⁷ These impacts are not unidirectional, and climate stress on land also has the potential to drive IUU activity. In Siberia, for example, fishing and reindeer-herding are the main occupations of indigenous people, but elevated temperatures, longer off-season periods, melting ice and tundra fires are harming reindeer populations, threatening food security and presenting future risks in relation to a resort to IUU fishing.⁹⁸

Extreme weather: A 'perfect storm' of risk-taking and vulnerability

Rank: 10

In key locations, climate change has the potential to squeeze fishing-dependent livelihoods, both through changes to aquatic ecosystem structure and through a rise in extreme weather events, raising the risk to fishers at sea.⁹⁹ The IPCC notes that 'even relatively small incremental increases in global warming (+0.5°C) cause statistically significant changes in extremes on the global scale ... (*high confidence*). In particular, this is the case for temperature extremes (*very likely*), [and] the intensification of heavy precipitation (*high confidence*) including that associated with tropical cyclones (*medium confidence*).'¹⁰⁰ In some cases, erratic weather is creating 'boom

- FAO, 'Building Adaptive Capacity to Climate Change: Policies to Sustain Livelihoods and Fisheries', 2007; Lauric Thiault et al., 'Escaping the Perfect Storm of Simultaneous Climate Change Impacts on Agriculture and Marine Fisheries', *Science Advances* (Vol. 5, No. 11, 2019).
- 100. Sonia I Seneviratne, 'Weather and Climate Extreme Events in a Changing Climate', in Valérie Masson-Delmotte et al., 'Climate Change 2021: The Physical Science Basis: Working Group Contribution I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change', IPCC, 2021, p. 1517. Emphasis in original.

^{96.} Environmental Justice Foundation, 'Marine Havens Under Threat: The Impacts of the Climate Crisis on Tropical Coral Reefs and the Communities that Rely on Them', 2020.

^{97.} Justin S Brashares et al., 'Bushmeat Hunting, Wildlife Declines, and Fish Supply in West Africa', *Science* (Vol. 306, No. 5699, 2004), pp. 1180–83.

^{98.} Diana Magnay, 'Climate Change: The Arctic Reindeer Herder Whose Livelihood is Threatened by Warmer Winters', *Sky News*, 25 July 2021.

and bust' years, reducing income security.¹⁰¹ Some bust years can cause harmful algal blooms, Pdisproportionately affecting small-scale fishers.¹⁰² In California, the 2014–16 Northeast Pacific marine heatwave impacted most on small-vessel fishers unable – unlike larger fleets – to mitigate losses by leaving the area.¹⁰³ In Bangladesh, such environmental stressors have been found to push those with insufficient adaptation strategies into IUU fishing.¹⁰⁴ As such, subsistence fishers face a potential scenario in which fish stocks are displaced and competition from large-scale vessels is rising, pushing them into IUU activity in more extreme at-sea conditions. With weather-related dangers to fishers' safety witnessed clearly in locations such as Cambodia,¹⁰⁵ the potential result is a 'perfect storm' of risk-taking and vulnerability.

Climate-related shifts in crime convergence

Systematic collection of data on IUU fishing incidents is key to enabling analysis of shifting offending patterns and devising targeted enforcement solutions. This should cover not only details of IUU activity, but also associated organised criminal activity. Clear evidence of the nexus between IUU fishing and other crimes exists.¹⁰⁶ Most recently, the Interpol/World Customs Organization Operation *Thunder* 2021 saw Mexican authorities arrest three Chinese nationals for smuggling totoaba swim bladders (swim bladders are a sought-after delicacy in China) and sea cucumber alongside methamphetamine and cash.¹⁰⁷ More broadly, the use of fishing vessels in drug transhipment operations has increased, tripling in eight years to 15% of the global retail value of illegal drugs in 2017.¹⁰⁸ Such crime convergence is under-analysed – and set to evolve. As climate change affects the scarcity and distribution of key resources, this may impact their profitability and the attractiveness of other commodities as complements or substitutes. Co-mingled shipments are a hallmark of greater sophistication among IUU offenders, with the makeup of criminal portfolios dictated by risk, reward and opportunity. As fish stocks decline and awareness of the profits available from species such as the European

- 102. Alejandro Clement et al., 'Exceptional Summer Conditions and HABs of Pseudochattonella in Southern Chile Create Record Impacts on Salmon Farms', *Harmful Algae News* (Vol. 53, 2016).
- 103. Sunny L Jardine, 'Inequality in the Economic Impacts from Climate Shocks in Fisheries: The Case of Harmful Algal Blooms', *Ecological Economics* (Vol. 176, 2020).
- 104. Istiakh Ahmed et al., 'Climate Change, Environmental Stress and Loss of Livelihoods Can Push People Towards Illegal Activities: A Case Study from Coastal Bangladesh', *Climate and Development* (Vol. 11, No. 10, 2019), pp. 907–17.
- 105. Sun Narin and Lors Liblib, 'Climate Change Threatens Cambodia's Coastal Fishing Communities', VOA News, 5 November 2021.
- 106. Asia/Pacific Group on Money Laundering, 'APG Yearly Typologies Report 2022'.
- World Customs Organization, 'Global Arrests and Seizures: WCO–INTERPOL Operation Thunder 2021 Strikes Wildlife and Timber Trafficking Networks', 30 November 2021.
- Dyhia Belhabib, Philippe Le Billon and David J Wrathall, 'Narco-Fish: Global Fisheries and Drug Trafficking', Fish and Fisheries (Vol. 21, No. 5, September 2020), pp. 992–1007.

Rank: 11

^{101.} Kimberly L Oremus, 'Climate Variability Reduces Employment in New England Fisheries', *Proceedings of the National Academy of Sciences* (Vol. 116, No. 52, 2019).

eel (*Anguilla anguilla*) grows,¹⁰⁹ criminal actors' calculations could shift. Empirical research is needed to analyse the fluctuating income streams and risk–reward calculations of key actors, identifying common 'nodes' between crimes to maximise disruptive impact.

Strengthening organised criminal dimensions of large-scale IUU fishing Rank: 15

In many states, national legislation fails to criminalise IUU fishing with the minimum criteria – a four-year custodial sentence – for it to qualify as a serious crime per the UN Convention Against Transnational Organized Crime.¹¹⁰ This lenient treatment is problematic: while some forms of IUU fishing are small in scale and opportunistic, others are conducted on an industrial scale, across jurisdictions and by repeat offenders as a form of transnational organised crime.¹¹¹ Climate change is set to exacerbate this disconnect between crime type and response. As fish stocks decline in a range of locations and shift to deeper waters with rising oceanic temperatures, ever-more sophisticated organised criminal operations may be required to access the world's shifting fishing grounds. An ongoing failure to recognise large-scale IUU fishing as transnational organised crime in many states will limit the effectiveness of responses. The result risks leaving fishing communities facing the dual pressures of unchecked criminal extortion on the one hand, and mismatched responses such as tighter regulation on the other.

	Increase in exploit	ative labour practice	s linked to IUU fishing	Rank: 18
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IUU fishing is estimated to represent 14–33% of the value of global marine capture – up to \$36.4 billion annually.¹¹² Human trafficking is estimated to generate around \$150 billion annually, with forced labour in fishing – alongside agriculture and forestry – generating an estimated \$9 billion.¹¹³ The points at which these phenomena intersect are likely to be influenced by ecosystem destruction and climate change, including the use of slave labour on vessels.¹¹⁴

- 109. Hiromi Shiraishi, 'Reviewing the Trade in Glass Eels *Anguilla* spp', *TRAFFIC Bulletin* (Vol. 32, No. 1, 2020), pp. 13–19.
- 110. Haenlein, 'Below the Surface'.
- 111. Teale N Phelps Bondaroff, Wietse van der Werf and Tuesday Raitano, 'The Illegal Fishing and Organized Crime Nexus: Illegal Fishing as Transnational Organized Crime', Global Initiative against Transnational Organized Crime and The Black Fish, April 2015.
- 112. Mavrellis, 'Transnational Crime and the Developing World'.
- 113. *Ibid*.; International Labour Office, 'Profits and Poverty: The Economics of Forced Labour', 2014.
- 114. David Brown et al., 'Modern Slavery, Environmental Degradation and Climate Change: Fisheries, Field, Forests and Factories', Environment and Planning E: Nature and Space (Vol. 4, No. 2, 2021), pp. 191–207; Stimson, 'Shining a Light: The Need for Transparency Across Distant Water Fishing', 2019; Chelsey F Marto, 'Human Rights Violations Consequent to Transshipment Practices in Fisheries', Ocean and Coastal Law Journal (Vol. 24, No. 1, 2019), pp. 32–58; Environmental Justice Foundation, 'Thailand's Seafood Slaves: Human Trafficking, Slavery and Murder in Kantang's Fishing Industry', 2015.

Notably, pressure on profitability due to dwindling fish stocks, climate change and economic downturns risks forcing fishing operators to take more drastic measures to remain viable, including reliance on illegal labour practices.¹¹⁵ This risk is amplified by the lack of deterrent offered by historically inadequate levels of investigation of forced labour cases in the maritime sector.¹¹⁶ Climate impacts on land are also relevant, with farming communities in some locations vulnerable to climate change and thus to entry into debt-bonded labour at sea. Meanwhile, growing numbers of climate refugees could provide unscrupulous fishing operators with a ready pool of labour to exploit. In the Asia-Pacific, for example, there is evidence of climate change inducing high-risk migration, potentially intersecting with a parallel trend witnessed in the exploitation of large numbers of trafficking victims on fishing vessels.¹¹⁷ These intersections are complex, with the bi-directional nature of links between modern slavery, climate change and environmental degradation presenting a range of emerging issues.

Summary

Examined together, these trends speak to the potential for climate change to alter land-based human factors of direct relevance to IUU fishing. Ultimately, IUU fishing is often a maritime manifestation of a range of land-based governance challenges, with complex interactions between levels of resilience to climate change on land and at sea. As such, drivers of IUU fishing activity – from low-level to systematic offending – must be viewed in the wider context of alternative livelihood options, both sea- and land-based. As human patterns of activity in relation to IUU fishing are altered, navigating this landscape holistically will be key to devising effective future responses.

^{115.} David Tickler et al., 'Modern Slavery and the Race to Fish', *Nature Communications* (Vol. 9, No. 1, 2018).

^{116.} Environmental Justice Foundation, 'Thailand's Seafood Slaves'.

^{117.} International Organization for Migration, 'The Climate Change–Human Trafficking Nexus', 2016.

V. Challenges and Opportunities for Monitoring and Enforcement

HE FINAL GROUP of trends arising from the horizon scan relate to emerging challenges and opportunities for monitoring and enforcement. Many of these link to changes in the nature of the threat identified in earlier chapters. Of particular relevance are changing patterns of IUU activity driven by ongoing decline and displacement of fish stocks – as identified in Trends 1 and 12, among others. These environmentally driven evolutions in the threat necessitate adaptation among those charged with responding.

Extensive previous research has highlighted the range of gaps in existing efforts – nationally and internationally – to tackle IUU fishing.¹¹⁸ While some successes have been witnessed, many actors engage in IUU fishing in what remains a low-risk, high-reward environment.¹¹⁹ Indeed, with no single body responsible for setting and enforcing fisheries management policies, and with international fisheries managed through a patchwork of regulations, numerous vulnerabilities persist. These range from gaps in information sharing to the lack of a uniform system for tracking fishing vessels, to insufficiently robust legislative frameworks.

Submitted trends that merely reiterated these well-known challenges without explaining the relevance of climate change did not score sufficiently highly to feature in the final ranked list of 20. By contrast, in the five trends presented in this chapter, climate change is identified as having tangible implications for responses. A number are dualistic in nature, presenting both challenges and potential opportunities. All are global in scope.

Trends

Rising pressure for transparency of ownership and access agreements

Rank: 2

The global fight against IUU fishing has long been hindered by a lack of transparency, across multiple facets of a notoriously opaque fishing industry. Two areas attracting growing attention are ultimate beneficial ownership and foreign fishing access agreements. In terms of ownership, authorities continue to struggle to peel back the layers to identify and hold

^{118.} Charlie de Rivaz et al., 'Turning the Tide? Learning from Responses to Large-Scale Illegal, Unreported and Unregulated Fishing in Five Countries', *Whitehall Report*, 3-19 (November 2019).

^{119.} Haenlein, 'Below the Surface'.

accountable the ultimate beneficial owners of IUU vessels.¹²⁰ In terms of access agreements, the failure of many governments to disclose basic information limits efforts to identify IUU activity by foreign vessels.¹²¹ Public awareness of these issues is mounting, as domestic fishers bring home ever-smaller catches. In Madagascar, media reporting is shining a light on this opacity;¹²² in Ghana, NGO investigations have found that 90% of the industrial trawl fleet is linked to Chinese beneficial owners, despite laws banning foreign ownership in the sector.¹²³ Countries such as Senegal have committed to schemes like the Fisheries Transparency Initiative,¹²⁴ while calls mount for fishing-specific transparency legislation and the expansion of ultimate beneficial ownership registries.¹²⁵ These promising developments reflect growing popular insistence on access to information as a public right – a longer-term trend driven by multiple factors, but further amplified as climate change and IUU fishing shrink livelihood options in key locations.

Technological advances and monitoring of changing vessel activity Rank: 4

Many states are relatively unprepared to detect climate-driven spatiotemporal shifts in IUU activity, due to ongoing gaps in vessel identification and monitoring capabilities. Vessel monitoring requires a combination of remote-sensing capabilities, human capabilities and AI to process raw data. It remains a fragmented activity, with significant differences in capacity between states. Organisations like Global Fishing Watch are working to drive progress in this area, turning big data into actionable information and creating publicly available map visualisations by combining tracking data from the publicly available automatic identification system with information from vessel monitoring systems secured via governmental partnerships.¹²⁶ Despite this, a barrier to understanding IUU fishing patterns and acting on real-time information remains a lack of state-level capacity to analyse unprocessed data. To give one example, recent research in the Republic of the Congo, based on analysis of three years of vessel monitoring system data, has pointed to an urgent need to bolster national and regional capacity to analyse national-level data sets for efforts to combat IUU fishing to

^{120.} Peter Horn and Gina Fiore, 'Better Tracking of Vessel Ownership Needed to Fight Illegal Fishing', The Pew Charitable Trusts, 20 September 2021.

^{121.} André Standing, 'Corruption and Commercial Fisheries in Africa,' U4 Brief No. 23, December 2008.

^{122.} Edward Carver, 'Madagascar: Opaque Foreign Fisheries Deals Leave Empty Nets at Home', Mongabay, 9 October 2019.

^{123.} Environmental Justice Foundation and Hen Mpoano, 'Stolen at Sea: How Illegal "Saiko" Fishing is Fuelling the Collapse of Ghana's Fisheries', 2019, p. 8.

^{124.} Fisheries Transparency Initiative, 'About the FiTI', <https://www.fiti.global/about-the-initiative#>, accessed 1 October 2022.

^{125.} Horn and Fiore, 'Better Tracking of Vessel Ownership Needed to Fight Illegal Fishing'.

^{126.} Global Fishing Watch, 'Our Technology', <https://globalfishingwatch.org/our-technology/>, accessed 27 September 2022.

be effective.¹²⁷ Meanwhile, as different organisations innovate in this space, a fragmenting technological landscape could raise issues around interoperability, with further issues concerning the need to keep up with blocking and mimicking software.¹²⁸

Infrastructural investments and unintended consequer	nces Rank: 9
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Ongoing large-scale infrastructural development across a range of locations presents various potential options for actors engaged in IUU fishing. Key vulnerabilities surround infrastructural investment under China's Belt and Road Initiative, for example, including development of a network of fishing bases across four continents comprising ports, vessels and processing facilities to service China's distant-water fleet.¹²⁹ These vulnerabilities risk arising in a context in which the wider implementation of the 2009 Port State Measures Agreement remains lacking in many cases.¹³⁰ Unintended consequences in terms of enabling IUU fishing could also arise from future infrastructure upgrades designed to enhance access to shifting fish stocks or to improve climate resilience at ports. That said, such potential future investments could help curb future IUU activity by addressing infrastructural needs around monitoring and enforcement, and instituting systems to support transparency across supply chains.¹³¹

Lack of systematic evaluation of interventions to disrupt IUU fishing

In recent years, concern over accelerating environmental destruction has seen the harmful impacts of large-scale IUU fishing attract global attention. A growing number of policy recommendations have sought to address the threat posed, with multiple interventions designed to disrupt IUU fishing implemented at local, national and international levels.¹³² However, rarely are these interventions evaluated,¹³³ with limited attention historically paid to

- 129. Whitley Saumweber, 'Distant-Water Fishing Along China's Maritime Silk Road', Stephenson Ocean Security Project, 31 July 2020.
- 130. Gilles Hosch et al., 'Any Port in a Storm: Vessel Activity and the Risk of IUU-Caught Fish Passing Through the World's Most Important Fishing Ports', *Journal of Ocean and Coastal Economics* (Vol. 6, No. 1, June 2019).
- 131. Sally Yozell, 'Distant-Water Fishing Operations Must Become More Transparent', *China Dialogue Ocean*, 6 December 2019.
- 132. Nerea Marteache, Monique C Sosnowski and Gohar A Petrossian, 'A Review of Responses to IUU Fishing Around the World Through the Lens of Situational Crime Prevention', in Jarrett Blaustein et al. (eds), *The Emerald Handbook of Crime, Justice and Sustainable Development* (Bradford: Emerald Publishing Limited, 2020), pp. 485–512.
- 133. De Rivaz et al., 'Turning the Tide?'.

Rank: 13

^{127.} Philip D Doherty et al., 'Threats of Illegal, Unregulated, and Unreported Fishing to Biodiversity and Food Security in the Republic of the Congo', *Conservation Biology* (Vol. 35, No. 5, 2021), pp. 1463–72.

^{128.} Anatoly Kurmanaev, 'How Fake GPS Coordinates are Leading to Lawlessness on the High Seas', *New York Times*, 3 September 2022.

Rank: 16

the question of how best to judge the efficacy of specific mitigation and deterrence methods. Although a recent global effort – comprising initiatives such as the IUU Fishing Index – has been launched to assess the progress and effectiveness of a range of MCS measures, significant knowledge and evaluation gaps remain.¹³⁴ Without comprehensive evaluation, it is not possible to learn from past initiatives, develop best practice or make smart policy decisions on where to allocate future resources to combat IUU fishing. This lack of systematic evaluation is likely to remain a key issue in a context of climate change, in which IUU fishing operators are likely to exhibit evolving patterns of behaviour, with which interventions must keep pace.

Coordination gaps between intergovernmental organisations

Perpetrators of large-scale IUU fishing are often highly mobile, operating across swathes of ocean, including the EEZs of numerous states and the high seas. The transnational dimension to their actions derives not only from the jurisdictions across which fish are caught, but also from the nationality of fishers, the flags of vessels and the ports at which they dock. Such complex transnational operations require a sophisticated global response,¹³⁵ yet information sharing and cooperation remain inadequate, including between intergovernmental organisations. Currently, a range of intergovernmental organisations aim to support the international community in disrupting IUU fishing, including the UN Office on Drugs and Crime (UNODC), Interpol and the International MCS Network.¹³⁶ Coordination can be limited, with challenges involving overlapping mandates and competition over member-country resources and donor funding. Other challenges arise from the fact that Interpol holds the international law enforcement information-sharing mandate but does not host an overarching global maritime domain awareness capability (despite possessing some of the infrastructure and capabilities required). As climate-driven operational shifts bring into play new patterns of transnational IUU activity, addressing these gaps in the international response will be crucial.

- 135. Interpol, 'International Law Enforcement Cooperation in the Fisheries Sector: A Guide for Law Enforcement Practitioners', February 2018.
- 136. UNODC, 'UNODC Approach to Crimes in the Fisheries Sector', <https://www.unodc.org/res/piracy/ index_html/UNODC_Approach_to_Crimes_in_the_Fisheries_Sector.pdf>, accessed 29 October 2022; Interpol, 'Fisheries Crime', <https://www.interpol.int/en/Crimes/Environmental-crime/ Fisheries-crime>, accessed 29 October 2022; International MCS Network, 'History and Mission', <https://imcsnet.org/about-us/who-we-are/>, accessed 29 October 2022.

^{134.} Graeme Macfadyen and Gilles Hosch, 'The Illegal, Unreported and Unregulated Fishing Index, 2021', Poseidon Aquatic Resource Management Ltd and the Global Initiative Against Transnational Organized Crime, https://globalinitiative.net/wp-content/uploads/2021/12/IUU-Report-2021. pdf>, accessed 9 February 2023.

Summary

These trends point to a range of challenges and opportunities emerging in relation to current and future responses to IUU fishing. All highlight the fact that shifts in IUU fishing operations brought about by climatic change will warrant adaptation among fisheries management and enforcement entities. At 2nd, 4th, 9th, 13th and 16th, these trends are some of the highest-ranked in the scan, indicating a shared belief that many will be of practical importance to efforts to disrupt IUU fishing in the coming decade and beyond.

Conclusion

UU FISHING IS a multifaceted global issue, and one that stands to evolve in a warming world. With climatic change already affecting fish stocks in key locations globally, interactions between humans and the aquatic environment in the form of IUU fishing have the potential to be altered. Among other emerging issues, this paper has shown the potential issues arising where fish move across maritime boundaries, where fishing-dependent livelihoods are threatened, and where existing governance arrangements are required to keep pace with disruptive environmental change. Together, the trends raised by the scan point to the emergence of an array of issues to be navigated over the next decade and beyond.

By focusing on the future, there is an opportunity to prepare for what is to come. Through the horizon scanning process – which prioritised 20 trends from an original pool of 148 submissions – a range of challenges and opportunities to address IUU fishing in a warming world emerged. Many are rooted in trends already underway, which will intensify as the Earth warms.

To ensure progress in disrupting the multidimensional threat likely to be posed, forecasting must be translated into updated policy and practice. The stakeholders involved will be varied, a testament to the patchwork system of ocean governance currently in place. Given the high-level focus of the scan and the specific focus on climate change, this paper does not seek to make tailored, context-specific recommendations for individual sets of actors in individual countries. Instead, it offers a set of broad considerations to those contributing to an overarching global response that must evolve to meet future challenges. With future policy unable to address climate impacts in isolation, these points should be considered in the wider context of other evolving aspects of fisheries management.

- Advance planning is essential. Many of the potential identified impacts of climate change are rooted in already visible trends, allowing a prediction of likely future trajectories of IUU fishing activity. On this basis, advance action is needed, given the time and negotiations required to update multilateral agreements, for example. Notably, proactive efforts are needed to anticipate the potential formation of new fisheries not covered by management frameworks, and the potential destabilisation of existing arrangements. Dedicated monitoring is needed to track changes in fish stocks relative to specific governance arrangements, as are forward-looking fisheries crime assessments.
- Vessel-monitoring capabilities must be bolstered to detect climate-driven changes in IUU fishing activity. IUU vessels could exhibit greater spatial mobility as they pursue shifting and declining stocks of key species, yet numerous gaps persist in vessel identification and monitoring capabilities, with gaps in state-level capacity to analyse unprocessed data acting as a barrier to understanding IUU fishing patterns and acting

on real-time information. In many cases, sustained work is required to build analytical capacity at this level.

- Enforcement must be strengthened and adapted to a climate-changed future. As IUU fishing operators adopt new modi operandi, enforcement efforts must adapt. With perpetrators of large-scale IUU fishing potentially becoming increasingly geographically mobile, persistent gaps in international cooperation must be addressed. Beyond this, to adapt responses to ongoing shifts in IUU fishing patterns, investment is needed in more systematic evaluation of enforcement, mitigation and deterrence methods. Globally, focused attention is needed to address challenges associated with the policing of expanding MPAs.
- Enhanced transparency and traceability must be pursued. Efforts to counter IUU fishing continue to be hindered by a lack of transparency. In this context, fishing-specific transparency legislation should be passed, ultimate beneficial ownership registries expanded, and schemes such as the Fisheries Transparency Initiative supported. In parallel, key gaps remain in seafood supply chain transparency measures. As fish distributions shift and potentially trigger changes in the length of supply chains, effective traceability and trade-related measures to combat IUU fishing will remain crucial.
- Geopolitical stakes woven into fishing activity must be accounted for. The potential of climate change to affect tensions linked to fisheries is increasingly apparent. As stocks of key species decline and their distributions shift, new juxtapositions of marine biomass concentration and fishing effort with regard to jurisdictional boundaries risk altering the geopolitical stakes involved. Where the issue of fishing has the potential to rise more frequently to the level of high geopolitics, a clear focus on fisheries is needed within efforts to build mutual trust and cooperation.
- **Resilience among artisanal fishing communities must be strengthened**. In various locations, climate change could affect the vulnerabilities facing fishing-dependent communities as key species shift to deeper, cooler waters, out of reach of artisanal fishers. Key risks include a rising adoption of IUU practices, increasing risk-taking in unsafe conditions and susceptibility to labour exploitation. With the impact of climate stress on land and at sea interconnected, livelihood options and coping strategies among artisanal fishers must be strengthened. Evidence-based measures must be enacted to enhance resilience to climate change, including long-term 'pro-poor'¹³⁷ strategies to strengthen adaptive capacities.
- **High-volume IUU fishing must be treated with the severity it deserves**. As fish stocks shift, IUU actors may adopt more sophisticated organised criminal fishing operations to access

^{137. &#}x27;Pro-poor' is a term widely used in the development literature to describe policies or strategies that directly target poor people, or that are more generally aimed at reducing poverty. See Paolo de Renzio, 'Understanding Pro-Poor Policy Processes', Overseas Development Institute, <https://odi.org/en/about/our-work/understanding-pro-poor-policy-processes/, accessed 17 February 2023.

shrinking fishing grounds. With IUU fishing often treated as a minor issue, the existing disconnect between crime type and response could therefore grow. National legislation must be updated such that large-scale IUU fishing is criminalised with the minimum criteria – a four-year custodial sentence – to qualify as a serious crime per the UN Convention against Transnational Organized Crime. Meanwhile, enforcement responses must be tailored to address shifting patterns of crime convergence, with concerted investigation of forced labour cases undertaken.

Appendix: Trends 21–40

Proliferation of unilateral trade-based measures to combat IUU fishing Rank 21

In the coming years, unilateral trade-based measures to combat IUU fishing are expected to expand. Prominent examples include those used by the EU and the US, with other fish-importing jurisdictions expected to adopt similar measures.¹³⁸ While many laud their results, the effectiveness and impact of these measures on low-income and small island developing states is subject to debate.¹³⁹ Critics present these measures as an effort by large countries to control the terms and flows of seafood trade, projecting normative ideals while wielding their market power. With exporting countries facing an uncertain future as fish stocks and distributions shift, these questions will likely become more salient.

King crab stocks in the eastern and western Bering Sea Rank 22

King crab is a high-value crustacean whose three species are harvested almost exclusively in the territorial waters of two states: Russia and the US. After the break-up of the Soviet Union, IUU fishing for king crab in Russian waters became a significant threat, persisting into the 2010s, when Russia began targeting offenders.¹⁴⁰ More recently, changing climatic patterns in the North Pacific have left Russian crab stocks in the western Bering Sea thriving, while US king crab stocks in the eastern Bering Sea all but collapsed in 2021. This climate-driven collapse raises uncertainty in terms of prices, demand and future pressure on the two major global king crab suppliers.¹⁴¹

- 140. WWF, 'Case Study on Russian King Crab Sourcing and Traceability Pilot', 4 June 2020; WWF, 'Illegal Russian Crab: An Investigation of Trade Flow', 16 October 2014.
- 141. Hal Bernton, 'Valuable Crab Populations in Alaska's Warming Bering Sea Waters are in a "Very Scary" Decline', Anchorage Daily News, 21 September 2021.

 ^{138.} European Parliament, 'Briefing: Illegal, Unreported and Unregulated (IUU) Fishing', November
 2017, <https://www.europarl.europa.eu/RegData/etudes/BRIE/2017/614598/EPRS_
 BRI(2017)614598_EN.pdf>, accessed 4 October 2022; NOAA, 'Seafood Import Monitoring
 Program'.

^{139.} Environmental Justice Foundation et al., 'The EU IUU Regulation – Analysis: Implementation of EU Seafood Import Controls', March 2017, p. 6.

Implementation of WTO deal to reduce harmful subsidies Rank 23

As the planet warms and the displacement of fish stocks continues, ongoing progress on curbing harmful fishing subsidies is needed.¹⁴² Without subsidies, much fishing on the high seas would be unprofitable, with such subsidies long recognised as a significant factor in enabling long-distance IUU fishing.¹⁴³ The passage of the World Trade Organization Agreement on Fisheries Subsidies in June 2022 represents important progress,¹⁴⁴ but gaps remain. Highly challenging to reach politically, critics see the agreement as falling short, due to 'carve-outs' for key states.¹⁴⁵ Meanwhile, if not addressed directly, practical problems surrounding enforcement will persist, potentially limiting the deal's impact on reducing IUU fishing.

Vulnerability of small-scale fishers and convergence with drug trafficking Rank 24

IUU fishing is known to converge with other crimes, including narcotics trafficking. Notably, the use of fishing vessels in drug transhipment operations has tripled in eight years to 15% of the global retail value of illegal drugs in 2017.¹⁴⁶ These intersections begin at local level and could evolve as key species shift to deeper, cooler waters, out of reach of artisanal fishers. Collapsing stocks – alongside stricter conservation measures – already risk driving small-scale fishers, in certain regions, into drug trafficking, with traffickers pumping money back into fragile fisheries, laundering their profits and securing smuggling routes.¹⁴⁷ This evolving convergence must be met with stronger measures to protect livelihoods.

Role of cultural diasporas in driving increased demand	Rank 25

Shifting patterns of diaspora distribution and broader population movements in a warmer world are likely to influence demand for key products. Examples include *haiwei* (dried seafood), with the expansion of trade connections generating widening demand among Chinese consumers. Other examples include CITES-listed wild-caught European eel (*Anguilla anguilla*),

- 145. Karen McVeigh, 'First WTO Deal on Fishing Subsidies Hailed as Historic Despite "Big Holes", *The Guardian*, 21 June 2022.
- 146. Belhabib, Le Billon and Wrathall, 'Narco-Fish'.
- 147. Ibid.

^{142.} See The Pew Charitable Trusts, 'Reducing Harmful Fishing Subsidies', <https://www.pewtrusts.org/ en/projects/reducing-harmful-fisheries-subsidies>, accessed 17 February 2023.

^{143.} David Vivas-Eugui and Claudia Contreras, 'Too Large to be Missed: How Fleet Size and Harmful Subsidies Undermine Fish Stocks Sustainability', UNCTAD Transport and Trade Facilitation Newsletter, No. 88, 7 December 2020; Bertrand Le Gallic and Anthony Cox, 'An Economic Analysis of Illegal, Unreported and Unregulated (IUU) Fishing: Key Drivers and Possible Solutions', Marine Policy (Vol. 30, No. 6, 2006), pp. 689–95.

^{144.} World Trade Organization, 'Agreement on Fisheries Subsidies', <https://www.wto.org/english/ tratop_e/rulesneg_e/fish_e/fish_e.htm>, accessed 4 October 2022.

supplied worldwide in an enterprise described as 'the greatest wildlife crime on the planet'.¹⁴⁸ Research is needed to anticipate the impact of shifting diasporas on wider IUU fishing trends and consumption, coupled with enhanced traceability (using, for example, environmental DNA, isotopes and blockchain) to provide empirically sound evidence of origin.¹⁴⁹

Managing the emergence of mesopelagic fisheries	Rank 26
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There is growing interest in exploring commercial fisheries in the mesopelagic zone – the twilight zone of the world's oceans, 200–1,000 metres below sea level. However, there is limited understanding of mesopelagic species' population sizes, and governance frameworks are feared to be insufficient.¹⁵⁰ With the current patchwork system of ocean governance a known precondition for IUU fishing, and significant potential gaps around mesopelagic fisheries, this could provide a route for IUU operators to diversify away from species covered by increasingly robust governance and enforcement systems. The potential impact is amplified by mesopelagic species' key role in the global carbon cycle and likely vulnerability to climate change.¹⁵¹

Gaps in human resources available for fisheries management

In many jurisdictions, there is no correlation between the budgets allocated to fisheries' MCS and the value of the fishery itself.¹⁵² Yet more is being asked of fisheries compliance, without a corresponding increase in capacity. Where efforts to counter IUU fishing are expanded in a warmer climate, fisheries compliance risks seeing a piling on of new systems, risk analysis and bigger and better information management systems, without giving those expected to use them (or their institutions) the required resources or tangible incentives to do so.¹⁵³ Financial and technical support will be crucial to manage this situation and adjust current incentive structures.

- 148. The Ecologist, 'The Greatest Wildlife Crime on the Planet', 9 July 2019; Florian Stein, 'Europe's Largest Wildlife Crime: Illegal Trade of the European Eel', Oxford Martin Programme on Wildlife Trade, 27 July 2018; Hiromi Shiraishi and Vicki Crook, 'Eel Market Dynamics: An Analysis of Anguilla Production, Trade and Consumption in East Asia', TRAFFIC, July 2015.
- 149. Marina Cusa et al., 'A Future for Seafood Point-of-Origin Testing Using DNA and Stable Isotope Signatures', *Reviews in Fish Biology and Fisheries* (Vol. 32, 2022), pp. 597–621.
- 150. Glen Wright et al., 'Fishing in the Twilight Zone: Illuminating Governance Challenges at the Next Fisheries Frontier', IDDRI Study No. 6, November 2020.
- 151. Kristina M Gjerde, Glen Wright and Carole Durussel, 'Strengthening High Seas Governance Through Enhanced Environmental Assessment Processes: A Case Study of Mesopelagic Fisheries and Options for a Future BBNJ Treaty', STRONG High Seas Project, 2021, p. 13.
- 152. Paul Wallis and Ola Flaaten, 'Fisheries Management Costs: Concepts and Studies', OECD, <https://www.oecd.org/greengrowth/fisheries/1917868.pdf>, accessed 11 October 2022.
- 153. Brian Pentz and Nicole Klenk, 'The "Responsiveness Gap" in RFMOs: The Critical Role of Decision-Making Policies in the Fisheries Management Response to Climate Change', Ocean and Coastal Management (Vol. 145, 2017), pp. 44–51.

43

Rank 27

IUU fishing for fishmeal and fish oil

Rank 28

In many countries in the tropics, a substantial proportion of local fish catches are processed to generate fishmeal, which is used to feed farmed fish in the aquaculture sector.¹⁵⁴ Increasingly, high demand from the aquaculture sector is driving indiscriminate 'biomass' fishing for small pelagic fish and juveniles for fishmeal and fish oil production. This indiscriminate – often IUU – fishing can have negative impacts on fish stocks, as well as food security.¹⁵⁵ In the face of overexploitation, climate change and other factors, declining fish stocks have led to an expanding aquaculture industry,¹⁵⁶ with associated fishmeal demand likely to continue to act as a driver of IUU fishing.

Expanding civil society engagement in countering IUU fishing	Rank 29
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NGOs such as Sea Shepherd are increasingly engaged to support governments that lack the expertise or capacity to disrupt IUU fishing. They are also key to documenting evidence of IUU activity in international waters.¹⁵⁷ Such NGOs continue to grow their operations to bolster countries' MCS capacities, offering joint at-sea ship-riding agreements (whereby vessels can be utilised by partners) alongside bilateral maritime law-enforcement ship-rider programmes by states such as the US.¹⁵⁸ While achieving a range of positive results, the assumption of such roles by non-governmental actors raises questions around jurisdiction, chain of custody and flag state responsibility. If past success is a predictor of future growth, these issues will become more pressing as more 'deputised' NGOs patrol the seas.

- 156. Lynda Searby, 'FAO: Feed Industry Must Meet Expanding Aquaculture Demand "in a Sustainable Way"', *FeedNavigator*, 2 August 2022; Rosamond L Naylor et al., 'A 20-Year Retrospective Review of Global Aquaculture', *Nature* (Vol. 591, No. 7851, 2021), pp. 551–63.
- 157. Sea Shepherd, 'How Sea Shepherd Helps Combat Illegal Fishing', 15 September 2018, <https:// www.seashepherdglobal.org/latest-news/our-approach-iuu/>, accessed 4 October 2022.
- 158. Michael Buchanan, "Shipriders" Partner with US to Secure Pacific Waters', ShareAmerica,
 30 July 2018; Sea Shepherd, 'Operation Sola Stella: Combatting Illegal Fishing in Liberia, West
 Africa', https://www.seashepherdglobal.org/our-campaigns/operation-sola-stella/learn-more/,
 accessed 4 October 2022.

^{154.} Albert G J Tacon and Marc Metian, 'Global Overview on the Use of Fish Meal and Fish Oil in Industrially Compounded Aquafeeds: Trends and Future Prospects', Aquaculture (Vol. 285, No. 1–4, December 2008), pp. 146–58.

^{155.} Changing Markets Foundation, 'Fishing for Catastrophe: How Global Aquaculture Supply Chains are Leading to the Destruction of Wild Fish Stocks and Depriving People of Food in India, Vietnam and The Gambia', October 2019.

Expansion of electronic catch documentation s	ystems	Rank 30
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The widespread adoption of digital approaches to documenting catch will remain important as fish stocks and ranges shift in response to warming waters. In this context, the need for fisheries management entities globally to move away from paper and adopt electronic catch documentation systems (eCDS) will grow more pressing than ever.¹⁵⁹ Electronic data collection, and use of centrally operated eCDS platforms, will provide opportunities to better follow catch from boat to plate, increasing traceability.¹⁶⁰ The possibility of fast-tracking the adoption of eCDS should be considered in locations likely to be most strongly impacted by climate change from a fisheries perspective.

Long-distance IUU fishing perpetrated by small-scale vessels	Rank 31
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An issue that has received relatively little policy attention to date concerns small and mediumsized vessels engaging in long-distance IUU fishing, involving unauthorised border entries. Such transboundary IUU fishing is conducted by rudimentary vessels, with smaller fleets incentivised to engage in precarious and unauthorised transboundary voyages as distributions of target species shift and resources in local fishing grounds decline.¹⁶¹ Vietnamese 'blue boats', for example, are known to travel to remote Pacific Island waters to catch sea cucumbers and giant clams, in contravention of fishing regulations and immigration requirements.¹⁶² This issue could emerge elsewhere, posing resource, border and human security challenges.

High seas transhipment in the Western and Central Pacific OceanRank 32

In the tuna fishing sector, two main types of transhipment occur in the Western and Central Pacific. One occurs in or near port, usually under the authorisation of the port state. The other (more problematic) occurs at sea – particularly on the high seas – under the responsibility of the vessel's country of registration. Recognising the risks involved, in 2009 the Western and Central Pacific Fisheries Commission stipulated that there should be no high seas transhipment except where a member state determines port transhipment to be impractical – but without defining 'impractical', thus establishing a loophole.¹⁶³ Contrary to the Commission's intentions, high seas

- 162. Andrew M Song et al., "Blue Boats" and "Reef Robbers": A New Maritime Security Threat for the Asia Pacific?', *Asia Pacific Viewpoint* (Vol. 60, No. 3, 2019), pp. 310–24.
- 163. Western and Central Pacific Fisheries Commission, 'Transhipment Regulation Scheme', https://www.wcpfc.int/transhipment-regulation, accessed 4 October 2022; MRAG Asia Pacific, 'The

^{159.} USAID, 'From Bait to Plate: The Power of Electronic Catch Documentation and Traceability', https://www.usaid.gov/biodiversity/stories/from-bait-to-plate, accessed 4 October 2022.

^{160.} FAO, 'Catch Documentation Schemes for Deep-Sea Fisheries in the ABNJ: Their Value, and Options for Implementation', 2018.

^{161.} Jaeyoon Park et al., 'Illuminating Dark Fishing Fleets in North Korea', *Science Advances* (Vol. 6, No. 30, 2020).

transhipments in the Western and Central Pacific Ocean have increased – from 544 operations in 2014 to 1,472 in 2019.¹⁶⁴ Exploitation of this loophole has the potential to increase under changing – potentially less favourable – climatic conditions.

Prioritising fish or fish habitat

Enforcement resources are often focused on perpetrators of IUU fishing over those engaged in destruction of fish habitat, yet the latter can result in permanent reduction in the productive capacity of coastal or inland systems. With fish habitat providing the foundation for productive fisheries, climate change may necessitate a refocusing of resources.¹⁶⁵ Future measures must be assessed for unintended impacts on fish habitat – including calls to ban trade in wild-collected ornamental fish as companion animals. Such bans can have negative effects: the 2018 Indonesian coral export ban forced fishers into other environmentally damaging activities, while reducing capacity for carbon sequestration in aquatic food webs.¹⁶⁶ Promotion of low-yield, high-value, ecologically enhancing industries may be key to helping both ecosystems and communities to adapt to climate change.

Adaptive management: Learning, sharing and cross-sectoral working

Coordinated action by multiple agencies will remain vital in efforts to counter IUU fishing. Key to this will be collaborative cross-sectoral working, bridging divides between NGOs, industry, traceability platform providers and government agencies.¹⁶⁷ This will help reduce the dissipation of energy that occurs as multiple groups pursue parallel approaches to disrupting IUU fishing.¹⁶⁸ Instead, energy must be harnessed across divides, with successful approaches shared and scaled to other locations. In a warming world, multi-sectoral approaches should not exclude displaced

Quantification of Illegal, Unreported and Unregulated (IUU) Fishing in the Pacific Islands Region – a 2020 Update', October 2021.

- 164. Francisco Blaha, 'High Seas Tuna Transhipment: What it is and Why it Should Be Reformed',
 2 September 2021, http://www.franciscoblaha.info/blog/2021/9/2/high-seas-tuna-transshipment-what-it-is-and-why-it-should-be-reformed>, accessed 20 February 2023.
- 165. Marine Conservation Institute, 'Fish Habitat a Safety Net for Ocean Fisheries Needs Stronger Protections', 13 May 2021.
- 166. Ingrid Gercama and Nathalie Bertrams, "After the Coral Ban, I Lost Everything", *BBC News*,
 27 February 2020; Ning Labbish Chao and Gregory Prang, 'Project Piaba Towards a Sustainable Ornamental Fishery in the Amazon', *Aquarium Sciences and Conservation* (Vol. 1, 1997), pp. 105–11.
- 167. De Rivaz et al., 'Turning the Tide?'.
- 168. Lee Willett, 'International Agencies Co-Operate to Tackle Illegal Fishing', *Jane's Intelligence Review*, 13 August 2020.

Rank 33

Rank 34

fishers who can be employed as coastal ocean stewards, restoring ecosystems and rebuilding social and ecological capital where oceans encroach on land.¹⁶⁹

Proliferation of certification schemes and lack of audit ca	pability	Rank 35
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An expanding number of eco-certification schemes purport to assess fisheries (for a fee) and assure consumer confidence that fish are sustainably sourced.¹⁷⁰ With no international audit capability to deliver quality control of these processes, there are fears that eco-certification schemes might be leveraged to legitimise opportunities for industry. The result may offer unwarranted credibility to fishing operations tainted by misconduct, giving a misleading impression of sustainability. Prominently, questions have been raised over whether the Marine Stewardship Council, as the world's biggest fisheries certification scheme, is fit for purpose.¹⁷¹ With fish stocks declining in a warming world, there are fears that this situation could increasingly result in the 'greenwashing' of unsustainable catch, while obscuring IUU fishing.

Climate-induced non-compliance within small-scale fisheries Rank 36

As fish move poleward and to deeper waters,¹⁷² under-resourced small-scale fisheries could struggle to adapt. While providing resources for those fishers to pursue their traditional livelihoods is one option, in many developing countries full adaptation to new conditions looks unfeasible,¹⁷³ potentially incentivising a range of non-compliant behaviours. This could hasten a range of scenarios, including the short-term depletion of the shifting resource; rising pressure on more sedentary species, resulting in potential conflict with other fishing sectors; abandonment of fishing as a livelihood, increasing pressure on other natural resources; and the development of an expanding labour pool for recruitment by IUU actors.

- 172. Cheung et al., 'Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean Under Climate Change'.
- 173. C Pongsri et al., 'Issues and Challenges in Sustainable Fisheries Development of the Southeast Asian Region: Human Resources in Fisheries', in Southeast Asian Fisheries Development Center, 'The Southeast Asian State of Fisheries and Aquaculture', 2012, pp. 96–98.

^{169.} Anthony Langat, 'Meet the Small Fishing Community Regrowing Coral Reefs in Kenya', *New Humanitarian*, 31 May 2018.

^{170.} David J Agnew, 'Who Determines Sustainability?', *Journal of Fish Biology* (Vol. 94, No. 6, 2019), pp. 952–57.

^{171.} Karen McVeigh, 'Blue Ticked Off: The Controversy Over the MSC Fish "Ecolabel", *The Guardian*, 26 July 2021.

Climate-driven mass human migration events and fisheries conflict Rank 37

Climate-driven human migration events have the potential to act as catalysts of fisheries conflict,¹⁷⁴ and with rising temperatures could become more common. Past examples of migration intensifying fisheries conflict can be seen in civil wars in Rwanda, Burundi, Uganda and the Democratic Republic of the Congo in the 1990s, with an influx of migrants to the Lake Victoria and Lake Tanganyika areas¹⁷⁵ in low-employment situations exacerbating pressure on fish stocks. Where migrants travel with few assets, robbery of boats and fishing gear can also be a problem, as can any resort to poison or dynamite fishing.

Differentiating between illegal, unreported and unregulated fishing Rank 38

'IUU fishing' describes a wide range of genres of activity, with different drivers.¹⁷⁶ Yet there is often little nuance in the literature and language used by NGOs accounting for the difference between 'illegal', 'unreported' and 'unregulated' fishing. The terms are commonly lumped together, creating confusion and, at times, a false sense of confidence in the ability of existing governance frameworks to address these (often very different) challenges. As the vicious circle of climate change and unsustainable fishing deepens, the prediction of future trends and mitigating action requires accurate differentiation between these terms.

Cycles of rapid exploitation driven by traditional Chinese medicine Rank 39

Demand for endangered species for use in traditional Chinese medicine and culinary delicacies is driving cycles of rapid illegal exploitation – a trend set to continue under warming conditions. As high-value species decline, short-lived 'booms' see remaining fisheries exploited by roving bandits, outpacing regulation. As populations collapse, perpetrators move on to the next hotspot or species. Examples include sea cucumbers and dried swim bladders. The Chinese bahaba, prized for its swim bladder, has been pushed to commercial extinction, with individual fish selling for over \$450,000.¹⁷⁷ Elsewhere, the swim bladder trade has seen the totoaba and

^{174.} Sarah M Glaser et al., 'Fish Wars: The Causes and Consequences of Fisheries Conflict in Tanzania', One Earth Future Foundation, November 2018, p. 8.

^{175.} Sarah M Glaser et al., 'Armed Conflict and Fisheries in the Lake Victoria Basin', *Ecology and Society* (Vol. 24, No. 1, March 2019); Glaser et al., 'Fish Wars', p. 4.

^{176.} Jens T Theilen, 'What's in a Name? The Illegality of Illegal, Unreported and Unregulated Fishing', International Journal of Marine and Coastal Law (Vol. 28, No. 3, 2013), pp. 533–50.

^{177.} Katie Bindley, 'Bahaba Fish Worth \$473,000 Caught, Sold in China', *Huffington Post*, 21 August 2012.

diminutive vaquita pushed to near-extinction.¹⁷⁸ With attention increasingly turning to the Nile River perch, affected African countries must prepare for a potential rush of exploitation.¹⁷⁹

Growing potential of nanopore DNA sequencing	Rank 40
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As fish stocks decline, illegal substitution or mislabelling of species could become a growing risk, with effective deterrence becoming increasingly important. Prosecution requires robust evidence of species origin, particularly for hard-to-differentiate juvenile specimens or those stripped of distinguishing morphological characteristics before sale. Wealthy states can use DNA testing to prove that a product is derived from protected species, but this requires expensive equipment and skilled operators.¹⁸⁰ Nanopore DNA sequencing is a new approach that uses simpler and smaller DNA sequencers, costing just \$1,000.¹⁸¹ This could allow developing countries to undertake DNA typing, increasing access to crucial forensic evidence.¹⁸²

^{178.} Owen Mulhern, '2021: The Year That Could Save or Kill the Vaquita', *Earth.org*, 22 April 2021.

^{179.} Geoffrey Kamadi, 'Secretive Traders Netting Chinese Delicacy Leave Nile Perch Under Threat', *The Guardian*, 27 May 2019.

^{180.} Cusa et al., 'A Future for Seafood Point-of-Origin Testing Using DNA and Stable Isotope Signatures'.

^{181.} Jonathan K I Ho et al., 'MinION Sequencing of Seafood in Singapore Reveals Creatively Labelled Flatfishes, Confused Roe, Pig DNA in Squid Balls, and Phantom Crustaceans', Food Control (Vol. 112, June 2020); Esmail et al., 'Emerging Illegal Wildlife Trade Issues', p. 8.

^{182.} Jia Jin Marc Chang et al., 'Takeaways from Mobile DNA Barcoding with BentoLab and MinION', *Genes* (Vol. 11, No. 10, 2020); Esmail et al., 'Emerging Illegal Wildlife Trade Issues', p. 8.

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