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BACKGROUND PAPER

GLOBAL INITIATIVE
AGAINST TRANSNATIONAL ORGANIZED CRIME

MEASURING THE SCOPE AND SCALE OF ILLEGAL, UNREPORTED AND UNREGULATED FISHING

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ABOUT THE SERIES

In the run-up to the launch of the second iteration of the Global Organized Crime Index in September 2023, we are publishing a series of 13 discussion papers. These cover each illicit market considered during the development of the Index. The papers, written by international experts, have been commissioned to help move forward the debate around definitions and measurements used in analyzing transnational organized crime markets, and thus support responses to organized crime.

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FISHERIES AND THE PROBLEM OF ILLEGAL, UNREPORTED AND UNREGULATED FISHING

Annual global production from capture fisheries declined from 96.5 million tonnes in 2018 to 90.3 million tonnes in 2020 (most probably owing to both the disruption of fishing operations because of the COVID-19 pandemic and the reduction in China's catches). Longer trends show that capture fisheries production has been stable at around 90 million tonnes a year for the past 25 years, with annual variability driven most strongly by fluctuations in catches of anchoveta (*Engraulis ringens*).[1] Marine fisheries account for around 87% of capture fisheries production and inland fisheries around 13%.[2] More than 38 million people were employed in capture fishing in 2020,[3] plus many millions more in upstream businesses supplying inputs and downstream marketing and processing. Activities range from single-person entrepreneurs operating small unmotorized dug-out canoes (mainly for subsistence or local sales) to large, vertically integrated fishing companies with single vessels worth millions moving between the fishing zones of different countries, considerable investment in processing plants and trading products around the world.

Indeed, fish is a highly traded commodity and one of the most traded segments of the world food sector. World exports of aquatic products (excluding algae) were valued at US$151 billion in 2020.[4] Different fish species have very different values, with some individual tuna selling for tens of thousands of dollars to sashimi markets, whereas small pelagic species such as sardine and mackerel destined for canneries may be sold for as little as US$100–US$200 per tonne. But even for low-value species, the large volumes caught in a single fishing trip can bring in hundreds of thousands of dollars.

The incentives for non-compliance and crime in the sector are considerable given the possible financial benefits and exist across all scales of fishing operations. For large, industrial-scale vessels, the ability to catch large volumes of fish with a high first-sale value and the need to cover high investment and operational costs provide a motivation to engage in illegal activity. Motivations for illegal practices are equally prevalent in small-scale fisheries, given weak management and enforcement of regulations in many countries, the relative financial benefits of illegal activity for those working in small-scale fisheries with low incomes and increasing levels of trade from small-scale fisheries to high-value overseas markets. In addition, the sector often serves as a 'last resort', with people entering it when income-earning activities and ways to ensure food security from other sectors are limited.

As recognized in the Sustainable Development Goals (SDGs),[5] sustainable management of the world's marine resources is vital in ensuring long-term benefits from the sector for food security, poverty alleviation and economic growth. However, the UN's Food and Agriculture Organization (FAO) estimates that the proportion of the world's fisheries stocks that are within biologically sustainable levels has decreased from 90% in 1974 to 64.6% in 2019.[6]

As the lead UN agency with a global fisheries mandate, the FAO has played a key part in combating illegal, unreported and unregulated (IUU) fishing at the international level in recent years. The FAO's actions have resulted in a number of agreements and guidelines aimed at reducing IUU fishing, including:

- UN Fish Stocks Agreement[7]
- Code of Conduct for Responsible Fisheries[8]
- FAO Compliance Agreement[9]
- International Plan of Action on IUU fishing (IPOA-IUU)[10]
- Port States Measures Agreement[11]
- Voluntary Guidelines on Flag State Performance[12]
- Global Record of Fishing Vessels, Refrigerated Transport Vessels and Support Vessels,[13] linked to unique vessel identifiers

In addition, the International Monitoring, Control and Surveillance Network was established in 2001 to link fisheries enforcement agencies and monitoring, control and surveillance practitioners from around the world, and to facilitate increased communication and information sharing to prevent, deter and eliminate IUU fishing.[14]

At the regional level, the FAO and other international organizations have also been working to combat IUU fishing. For example, regional fisheries management organizations (RFMOs) have adopted several management measures aimed specifically at reducing IUU fishing, such as introducing catch documentation schemes to increase traceability of product; establishing lists of IUU fishing vessels; reporting on transhipments; and appointing compliance committees to ensure that their contracting parties adhere to accepted standards. Such regional organizations are also engaging more collaboratively than ever before with other organizations (such as INTERPOL's Environmental Security Unit) to combat IUU fishing, and countries are increasingly sharing intelligence data about vessels exhibiting illegal activity in a region. Furthermore, the EU adopted a regulation that requires all states exporting to the union to ensure that fisheries products are from legal sources.[15]

The increasingly robust international and regional framework aimed at combating IUU fishing has been supported by considerable efforts at national levels, for example, through increased financial and human resources for monitoring, control and surveillance; improved regulations, such as sanctions and requiring the use of vessel monitoring systems; more risk-based enforcement strategies; and increased interagency collaboration, such as between coastguards, navies, police and fisheries departments.

These efforts primarily reflect recognition of the importance of combating IUU fishing to ensure the sustainable management of resources that underpin the economic and social benefits flowing from the sector. However, despite all these positive developments, IUU fishing remains a serious problem.

There is an increasing trend towards considering IUU fishing as crime[16] and in recognizing its linkages with other sorts of crime, such as smuggling of goods and forced labour.[17] This recognition is gaining traction both in the academic world and in enforcement circles (as evidenced by the work of INTERPOL in combating IUU fishing).

DEFINING ILLEGAL, UNREPORTED AND UNREGULATED FISHING

The term 'IUU fishing' has been a central part of international fisheries policy since it was formally adopted by the FAO at the 23rd session of the Committee on Fisheries in February 1999, following a call from Australia that an international plan of action was needed to combat this kind of fishing. The FAO Council adopted the text of the IPOA-IUU in June 2001 compiled by an expert consultation in May 2000 and two further sessions of technical consultation.

Since then, the standard convention when considering the definition of IUU fishing has been to distinguish between the three elements (illegal, unreported, and unregulated) as follows, based on the IPOA-IUU definition.

- Illegal fishing (articles 3.1.1–3.1.3) refers to fishing activities:
  - conducted by national or foreign vessels in waters under the jurisdiction of a state, without the permission of that state, or in contravention of its laws and regulations (article 3.1.1);
  - conducted by vessels flying the flag of states that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the states are bound, or relevant provisions of the applicable international law (article 3.1.2); or
  - that are in violation of national laws or international obligations, including those undertaken by cooperating states to a relevant regional fisheries management organization (article 3.1.3).

- Unreported fishing (articles 3.2.1–3.2.2) refers to fishing activities:
  - that have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations (article 3.2.1); or
  - undertaken in the area of competence of a relevant regional fisheries management organization, which have not been reported or have been misreported, in contravention of the reporting procedures of that organization (article 3.2.2).
- Unregulated fishing (article 3.3.1–3.3.2) refers to fishing activities:
  - in the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a state not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization (article 3.3.1); or
  - in areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with state responsibilities for the conservation of living marine resources under international law (article 3.3.2).

Recent international instruments, such as the Port States Measures Agreement and the FAO Voluntary Guidelines on Flag State Performance essentially adopt or assume these IPOA-IUU definitions.

However, as noted by Tsamenyi et al[18] and a review of studies to estimate IUU catch in 2016,[19] there are a number of problems, grey areas, overlapping situations and omissions associated with the IPOA-IUU definition. For example:

- In establishing lists of IUU fishing vessels, RFMOs contribute to the definitions of the concept with binding measures being associated with vessel listing and delisting criteria. These listing criteria are not necessarily fully aligned with the IPOA-IUU definitions in practice nor are they uniform across all RFMOs. For example, the definitions may not be similar for contracting parties and cooperating non-contracting parties, on the one hand, and non-contracting non-cooperating parties, on the other hand. The specific definitions of IUU fishing used in the legislation of different countries can also vary, with definitions included directly in states' legislation, indirectly through references to a binding measure of a RFMO or through a combination of the two. As a result, these definitions may be based on a combination of the definitions in the IPOA-IUU, those adopted in practice by RFMOs, or a state's own interpretation.
- 'Illegal' fishing activities may span a wide range of offences with different levels of egregiousness. For example, unlicensed fishing by large industrial vessels in state waters off West Africa may be considered more serious than small infringements over gear marking by domestic small-scale fishing vessels, but both are labelled 'illegal'. Furthermore, national legislation may specify serious and less serious offences or imply a distinction based on different levels of sanctions, which may differ between countries.
- Differences between countries in how the seriousness of offences are viewed extend to variations in the definitions and interpretations of 'fishing' (and therefore 'illegal fishing') contained in national legislation.[20]

- The IPOA-IUU's definition of 'unreported fishing' under article 3.2 attempts to be specific about the loss of information on catch quantity arising from non-compliance with reporting requirements, but it does not cover the non-reporting or misreporting of catch where reporting is not required. Many countries do not have regulations requiring discards, subsistence or recreational fishing catches to be reported, and in some cases quota-based regulations encourage discarding without reporting; while not illegal or a 'crime', such catches are important and often included in studies that attempt to determine 'missing catch' for the purposes of improved stock assessments.
- The concept of 'unreported fishing' may be confusing and overlap with 'illegal fishing' and 'unregulated fishing'. For example, either failing to report or misreporting fishing activities contrary to national laws would deem the fishing activities 'illegal' according to article 3.1.1 of the IPOA-IUU definition. Similarly, information on any fishing activities undertaken by vessels of contracting parties and cooperating non-contracting parties in areas of competence of an RFMO and which has not been reported or has been misreported in contravention of the RFMO's reporting procedures will render the activities 'illegal' under paragraph 3.1.2 of the IPOA-IUU. In addition, in high-seas areas not governed by an RFMO, unreported fishing activities by vessels of states contrary to their wider international obligations may constitute either 'illegal fishing' or 'unregulated fishing'.
- The concept of 'unregulated fishing' was originally centred on international concerns in the 1990s about fishing on the high seas, including indiscriminate high-seas fishing activities of states and fishing entities that did not belong to relevant RFMOs. This type of high-seas 'unregulated fishing' has largely been controlled through a number of more recent international agreements. What remains a grey area in terms of the IPOA-IUU definition is whether unregulated fisheries under the jurisdiction of states (i.e. within their maritime exclusive economic zones[21] or in inland areas) should be considered 'unregulated'. For example, should small-scale inland fisheries of a subsistence nature and that are not regulated be considered as falling within a definition of 'unregulated fishing' or not?

These examples highlight that the concept's definition in the IPOA-IUU is less than ideal. However, there does not appear to be any international appetite to open discussions about revising the definition, and so it is considered to be the best one available at present.

MEASURING ILLEGAL, UNREPORTED AND UNREGULATED FISHING

A summary of studies between 2009 and 2016 to estimate illegal, unreported and unregulated catches

In 2016, researchers reviewed 44 studies from around the world that estimated levels of IUU catch between 2009 and 2016 and categorized the methodologies used.[22] Although the review is now somewhat outdated and does not cover more recent studies,[23] its findings are still of interest and are discussed in the remainder of this section.

Geographical area, scale and scope

The geographical scope of studies to estimate IUU catches spanned local (i.e. subnational), national, regional and global levels; however, most focused on IUU fishing at regional and national levels, rather than on global or local estimates (also see Figure 5, Appendix). A large number of studies dealt with fishing in the Pacific Ocean (or parts of it). Approximately 16% of the studies (seven out of 44) considered fishing in the Antarctic, despite catches in this region accounting for less than 0.5% of global volumes.

Very few studies (only two of the 44) examined IUU fishing in inland freshwater fisheries (in rivers or lakes), although inland fisheries account for around 13% of total global capture fisheries production each year, and even higher proportions of total catches for some countries or regions (e.g. in Cambodia and East Africa).[24]

The review of the studies also found that many studies provide only a partial picture of IUU catch in the geographic area they consider, by focusing on only selected species (see Figure 6, Appendix) or fleet types and gears (see Figure 7, Appendix).

Objectives of studies

The objectives of the studies influenced both the methodologies used to estimate IUU fishing and the focus on different elements of IUU fishing.

More than a quarter of the 44 studies sought a truer picture of the impacts of catches on sustainability, focusing on 'total removals' in order to 'reconstruct' catches. These studies were less concerned about the cause of unreported or misreported catches than their magnitude, and as such did not consider the 'criminal' element of IUU fishing in depth. In fact, studies to reconstruct catch statistics included some activities that are not explicitly considered by the IPOA-IUU at all (see earlier discussion), because they do not infringe existing laws or regulations on reporting. Catches discarded legally at sea or any other sources of unmeasured catches (such as subsistence catches, bait usage or recreational catches) were often included, with the difference between reconstructed catches and official catches being labelled as illegal, unreported or unregulated. These studies estimated total reconstructed catch times series by combining officially reported catches and interpolated, country-wide expanded missing data series.

The objective of some studies was to focus on IUU catches of a particular species, which therefore determined the specific methodology. For example, trade data was used in four studies of IUU catches of shark, salmon, tuna and orange roughy, abalone and sea cucumber.

Some studies did aim to identify the causes and perpetrators of IUU fishing, especially with regard to 'illegal fishing', and to use derived estimates to make recommendations about necessary management actions that would reduce IUU fishing. In these cases, the objective often influenced the geographical scale and species of the study so as to match the scope of analysis to the management competencies of different organizations and institutions, and to focus on species or fleets deemed to be 'high risk' for IUU fishing activity.

Although all the studies generally stated the IUU behaviour they sought to estimate, they did not consistently specify the types of IUU activity in respect of the IPOA-IUU definition, and for some studies, definitions were overlapping. For example, estimates of unreported catches by licensed vessels in contravention of legal reporting requirements (thus mostly IOPA-IUU definition 3.2.1) did not identify whether underreported catches were obtained in compliance with or in breach of existing technical regulations (gear specifications, closed seasons, closed areas), and being illegal under IPOA-IUU article 3.1.1. Other studies did not clearly separate estimates of underreporting by legal vessels from underreporting by vessels operating illegally. Therefore, most studies aiming to estimate real catches from a given set of fisheries focused on a grouping of illegal and unreported components, some explicitly excluding the unregulated component. The difficulties encountered by the different studies in providing consistent definitions of IUU fishing that were unambiguously aligned with those of the IPOA-IUU can be explained by the IPOA-IUU itself not being clear and the definitions not clearly aligning to the types of activity and quantities (e.g. catch or economic loss) estimated in the studies.

Nonetheless, some studies did align well with the IPOA-IUU definitions, such as those exclusively estimating unregulated catches of non-party vessels in areas managed by regional organizations (in line with IPOA-IUU definition 3.3.1), and not including behaviour falling under other IPOA-IUU definitions.

Methodologies used

As already apparent from the preceding discussion, various methodologies can be used to estimate IUU catches, all relying on different sources of data. Rarely did one study use a method identical to another, and a combination of methods was also often used. This variability reflects the availability of data; in addition, the very nature of the problem of investigating IUU fishing, studies try to estimate unknown quantities and so researchers usually use methods that are tailored to their specific situations. Principal methods and sources of data used in the 44 studies reviewed are summarized in Figure 1.

WHAT IS ESTIMATED	IPOA-IUU ELEMENTS	METHOD	DATA SOURCES
Activity of unseen or unknown IUU vessels or fishers	Quantity of unknown catch for unlicensed fishing (definition 3.1.1) or unregulated fishing (definition 3.3.1)	Estimated number of vessels/fishers operating without a licence or in an unregulated way multiplied by the estimated catch per vessel/fisher.	• Unseen fishing effort from surveillance overflight data; vessel location data; MCS and arrest data; expert judgement; identification of specific IUU vessels and knowledge of their whereabouts; surveys of active or discarded fishing gear. • Estimated catch per vessel/fisher/gear unit often assumed to be the same as legal fishing with like gear, target and area.
Unknown IUU catch from known vessels	Illegal behaviour, misreporting or discarding (definitions 3.1.2, 3.2.1, 3.2.2)	Estimated number of fishing vessels displaying the behaviour multiplied by the estimated discard or unreported catch per illegally behaving vessel.	• Estimated number of vessels from known licence data expected to be undertaking transgressions, usually obtained from a combination of licence records and surveillance data. • Estimated unreported or misreported catch, usually obtained from logbook or observer data from vessels that are known to be behaving legally (e.g. when they have an observer/camera on board) and then comparative analysis between expected and reported catch.
Generally unknown catch	Not known whether illegal or not, or which aspects of IUU	• Estimates of total catch compared with declared catch to provide an estimate of undeclared catch (which may not be illegal if it is estimated as discarded or unreported). • Comparison of declared catch with other statistics to provide estimates of undeclared catch. Catches may or may not be illegal.	• Stock assessment for estimates of total catch; catch records for declared catches. • Other statistics may include landings, catches and imports, exports and transhipments to estimate total catch or traded volumes.
Global/regional IUU catches	Potentially all	Use some confirmed estimates of IUU/underreporting for specific years ('anchor points'), and extrapolating/interpolating estimates to other species, years and fleets based on logical argument or anecdotal or interview-based information.	Analyses or reviews of large amounts of secondary data and other studies completed at smaller geographical scales.

FIGURE 1 Methodologies and data used to estimate different aspects of IUU catch in studies carried out between 2009 and 2016.

NOTE: IUU = illegal, unreported and unregulated; MCS = monitoring, control and surveillance.
SOURCE: Based on G Macfadyen, B Caillart and D Agnew, Review of studies estimating levels of IUU fishing and the methodologies utilized, Poseidon Aquatic Resource Management, 2016.

Inherent strengths and weaknesses of the different methods and data sources used in the 44 studies reviewed are summarized in Figure 2. Most methodologies have limitations. For example, a method may be good at estimating the unreported catch of a particular species, but weaker at identifying where it came from or what types of IUU were involved. Similarly, a method may be good at identifying specific violation types, but poor at estimating quantities, or it could be well suited to estimating IUU catch for target species but have no way to estimate the impact of IUU fishing on other species also being caught.

DATA SOURCE	POTENTIAL IUU ELEMENTS BEING ESTIMATED	STRENGTHS	WEAKNESSES
MCS inspection data, from at-sea, aerial or landing site inspections	Accurate recording of individual violations (IUU or non-IUU)	• High-resolution data attributing IUU catches to actual fishing activity and violation type. • Large sample sizes from fishery surveys may be statistically unbiased. • Possible information on damage to non-target species and habitats.	• Underlying statistical framework unlikely to be appropriate when arising from targeted MCS activities (i.e. this produces over-sampling of high IUU problems). • Catches from different IUU activities may not be recordable by different inspection means, i.e. at-sea inspection is better at detecting some types of infringements than landing inspections, and vice versa.
Remote sensing, including satellite, ship and air surveys using vessel tracking, on-board camera monitoring	Number of vessels fishing without licences or in areas that are prohibited	• Possibility of repeat synoptic surveys, generating high-quality statistical data. • Possibility of matching various data sources – anecdotal and objective. • Can detect and track individual vessels globally, not just in area of study.	• Computationally and electronically intensive, which could drive up costs. • Identification of actual fishing activity is lacking. • Cannot detect non-positional violations (e.g. gear, misreporting, discarding). • Must be matched with other estimates of catch rate, species, etc. from legal vessels.
Stock assessments deriving estimates of missing catches	• Total unreported catches of target fish (the subject of the stock assessment) • IUU type if input data allows	• Offers statistically robust estimates. • Good spatial and temporal coverage: coverage of the whole of the stock, across all years. • Potentially applicable to all species caught by the fleet if they are assessed.	• Usually unable to identify violation type, e.g. to separate illegal from legal unreported. • Should be used in conjunction with other information on relative levels of IUU activity to anchor estimates. • Best to estimate significant periodic IUU, rather than long-term IUU. • No information on collateral damage by IUU fishing to non-target species and habitats.

continued

DATA SOURCE	POTENTIAL IUU ELEMENTS BEING ESTIMATED	STRENGTHS	WEAKNESSES
Trade data analysis, including data captured by catch and statistical documentation schemes	Total unreported catch by species and sometimes by country	• Easy access to global data. • Accurate data if declared on catch/ import documents by all countries importing, or if all countries subscribe to the scheme.	• Misdeclared products not captured. • Usually limited to iconic species, which are declared on customs documents. • Trade data not linked to catch documentation (which tracks catches through the entire supply chain) may suffer from low temporal resolution (product often stays in storage for months or years), meaning that cross-checking with declared catch data is inaccurate. • Where fish can be caught and landed in several jurisdictions, identification of IUU location is difficult. • Specific violations (except import violations) cannot be detected. • Relies on exporting – cannot detect IUU where fish are consumed locally.
Expert judgement	Individual point estimates of IUU or trends over time	Integrates knowledge from practitioners, often fishers with direct knowledge of IUU activities or MCS professionals.	• Difficult to validate or understand in the context of any objective, comprehensive and statistical analysis. • May suffer from oversampling, i.e. only those observing high IUU levels will be interviewed.
Interpolation from multiple sources	Resolution depends on resolution of source data	• Use of many different sources allows cross-checks. • Generates time series and allows reasonable extrapolations/ interpolations to unobserved fleets. • Different data sources can be given different quality markings and assigned confidence.	• Difficult to consistently separate different types of IUU fishing. • Establishing quality and overlap of individual contributing studies is difficult. • As the scale increases, the potential for double counting increases. • Anchor points can be sparse and the rationale for using management changes to infer interpolations results in estimates with considerable uncertainty.[25]

FIGURE 2 Strengths and weaknesses of common approaches to estimate IUU fishing.

NOTE: IUU = illegal, unreported and unregulated; MCS = monitoring, control and surveillance.
SOURCE: Adapted from D Agnew, Background paper 3 in the report of the Expert Workshop to estimate the magnitude of illegal, unreported and unregulated fishing globally, FAO, February 2015.

Reviewing the strengths and weaknesses of the studies between 2009 and 2016 showed that they generally specify their objectives, scope (with regard to area, fleets, species and gear) and methodological approach well. However, in addition to inherent weaknesses in the different methodologies and data sources used, many of the studies were also weak in the following aspects:

- The definition of IUU fishing as set out in the IPOA-IUU was not consistently applied (partly because of its inherent ambiguities). There was considerable confusion about what constitutes illegal, unreported and unregulated. In addition, a number of global and regional studies estimated and included 'missing or unknown catch' rather than catch that is specifically IUU in terms of the IPOA-IUU definition.
- A large number of assumptions were made, which raises questions about the accuracy of the estimates produced, especially with studies that fail to provide ranges of estimates.
- Details of source information were limited; more detailed information would allow for replicability of the study and scrutiny of the workings to derive IUU estimates. However, the lack of detail is understandable for studies reported in peer-reviewed journal articles owing to extent limitations, but less justifiable in project reports.
- Authors often failed to state the weaknesses and limitations of their work.
- There was a lack of transparency or robustness about statistical methods used to produce confidence intervals.

The 2016 review also concluded that subglobal estimates cannot be combined to generate a global estimate, nor can national estimates be used to generate regional ones, as they do not cover all ocean areas; tend to focus on selected fleet types, gears or species; in some cases, overlap in geographical coverage (but with different estimates of IUU catch being produced); and use different methodologies, which are not comparable. The limited number of studies available and their associated country coverage also precluded comparison of IUU fishing between countries.

DISCUSSION

The IUU Fishing Index

The IUU Fishing Index[26] was established in 2019 given concerns over levels of IUU fishing and its negative impacts, and because no reliable estimates of IUU fishing covering all countries and using a standardized methodology existed at the time.

Despite many recent actions taken at international, regional and national levels to reduce IUU fishing, malpractice remains a serious concern. The target to eliminate IUU fishing by 2020 associated with indicator 14.6.1 of SDG 14 was not achieved. The relevance of the index is that it provides an up-to-date and robust assessment that tracks the risk of IUU fishing,[27] and how the level of risk is changing over time.[28]

The IUU Fishing Index measures and maps the vulnerability, perceived prevalence and response to IUU fishing in 152 coastal states. It also compares IUU fishing risks for four key 'responsibility' domains: coastal, flag, port and general. The index uses 40 indicators, with each indicator applied to the 152 countries. The suite of indicators provides the basis for assigning scores to countries. The scores, in turn, provide the basis for a comparison between countries, regions and ocean basins.

The index scores do not provide a measure of the volume or value of the IUU fish catch (and should not be used as a proxy), but they nevertheless provide a standardized measure of the degree to which states are vulnerable to and effectively combat IUU fishing, thus providing a measure of the risk that IUU fishing may be occurring.

Each country is scored between 1 and 5 (1 = good/strong; 5 = bad/weak), with the score consisting of weighted indicators belonging to different groups. Indicator groups relate to:

- Responsibilities:
  - Coastal indicators refer to states' obligations in relation to IUU fishing that are specific to managing their exclusive economic zone.
  - Flag indicators refer to states' obligations in relation to IUU fishing that are specific to vessels they flag (i.e. that are on their vessel register).
  - Port indicators refer to states' obligations in relation to IUU fishing that are specific to managing their ports.
  - General indicators are those not specific to flag, coastal or port state responsibilities.
- Types:
  - Vulnerability indicators refer to risks for IUU fishing.
  - Prevalence indicators refer to known or suspected IUU incidents.
  - Response indicators refer to actions that aim to reduce IUU fishing.

Scores for 2021

The index scores for 2021 (see Figure 3) show that Asia and the Western Pacific are the two regions of most concern when indicators are aggregated. However, these overall scores hide important differences in performance when considering 'type' or 'responsibility'. While Asia and the Western Pacific are also of most concern with regard to prevalence scores, North America and the Eastern Pacific are especially vulnerable, and the Middle East and the West Atlantic are of most concern when considering their responses. Asia and the Western Pacific also score poorly for flag state scores and Asia is of most concern for scores related to general indicators, but Africa is of most concern when coastal indicators are considered, and the Middle East when port indicators are taken into account.

RESPONSIBILITY	TYPE			
	VULNERABILITY	PREVALENCE	RESPONSE	OVERALL
COASTAL STATE	Oceania/ Western Pacific	Africa/ Eastern Pacific	Caribbean and Central America/West Atlantic	Africa/ West Indian Ocean
FLAG STATE	North America/ Eastern Pacific	Asia/ Western Pacific	Middle East/ West Indian Ocean	Asia/ Western Pacific
PORT STATE	North America/ Eastern Pacific	Asia/ Western Pacific	Middle East/ West Indian Ocean	Middle East/ Western Pacific
GENERAL	Asia/ East Indian Ocean	North America/ Eastern Pacific	Middle East/ West Atlantic	Asia/ East Indian Ocean
OVERALL	North America/ Eastern Pacific	Asia/ Western Pacific	Middle East/ West Atlantic	Asia/ Western Pacific

FIGURE 3 Worst-performing regions and ocean basins by indicator group in 2021.

SOURCE: IUU Fishing Index, https://www.iuufishingindex.net/.

The aggregated scores for all countries in a region or ocean basin do not reveal the risk of IUU fishing in specific countries, nor the need for action in such countries. Figure 4 shows the countries that had the worst scores for different indicator groups in 2021. The maps, ranking tables and country profiles on the IUU Fishing Index website provide indicator scores for all individual countries for different combinations of indicator groups.

RESPONSIBILITY	TYPE			
	VULNERABILITY	PREVALENCE	RESPONSE	OVERALL
COASTAL	Japan China France	Seychelles Ecuador Guinea-Bissau (and four others)	Congo, R. Argentina Jamaica (and two others)	Congo, R. Seychelles Equatorial Guinea (and three others)
FLAG	China France Japan (and four others)	China South Korea Taiwan	Russia Libya Guinea-Bissau	China Taiwan Russia
PORT	Canada China France (and nine others)	China Thailand Uruguay	Bahrain Brunei Darussalam China (and six others)	China South Africa Singapore
GENERAL	Vietnam India Indonesia	Mexico China Ecuador	Singapore Eritrea Israel	Somalia Eritrea China (and one other)
OVERALL	China Japan USA	China South Korea Taiwan	Eritrea Singapore Yemen	China Russia South Korea

FIGURE 4 Three worst-performing countries by indicator group in 2021.

NOTE: Countries with the same ranking are listed alphabetically. Where more countries than shown in the table have the same score, the number of additional countries is noted in parentheses.

China, Russia, South Korea, Somalia, Yemen, Taiwan, Ukraine, Eritrea, Egypt and Libya were the ten worst-performing countries in 2021 when all indicators were combined. However, other countries were also of concern when individual indicators were considered:

- for coastal indicators – the Republic of Congo, Seychelles and Equatorial Guinea
- for port indicators – South Africa and Singapore
- for vulnerability indicators – Japan and the USA

Developing countries are often especially vulnerable to IUU fishing, and also often lack the resources to fully respond to the challenges of combating the practice. This means that mechanisms need to be established that support developing countries in their drive to combat IUU fishing across applicable state responsibilities.

Nations operating distant-water fishing fleets that yield poor scores for both prevalence and response indicators may be considered as particularly problematic. Solving their poor performance would go a long way to eliminate IUU fishing globally, and there is a pressing need to hold these countries to account in taking the necessary remedial actions.

Changes in performance between 2019 and 2021

The first update of the index in 2021 underlined that IUU fishing is a dynamic issue and that regular updates can help to track these dynamics in a meaningful way at the global scale.

The global score across all state responsibilities and types of indicator in 2021 was 2.24, down from 2.29 in 2019. Given that scores closer to 1 indicate better performance, the change represents a slight improvement. Upon interrogation, 93 countries improved their scores between 2019 and 2021, two had the same score and 57 countries had a worse score. Countries with the largest improvements in their scores were Vietnam, Cambodia, Sudan, Cameroon and Sierra Leone. Those with the largest negative changes were Eritrea, South Korea, Mauritania, Costa Rica and Equatorial Guinea.

A key finding from comparing the 2021 scores with those from 2019 is that countries can reduce the potential risk of IUU fishing. Although index scores can improve when countries sign up to international agreements,[29] real-world reductions in the levels of IUU fishing also require the actual and practical implementation of such agreements and the fulfilment of obligations incumbent upon countries committing to them.

CONCLUSION

This paper has highlighted the economic incentives for illegal activity in the fisheries sector and the serious consequences of IUU fishing, which can prevent the sector from realizing its potential contribution to sustainable economic, social and environmental development. Many national and international efforts to combat IUU fishing, such as international regulatory instruments and the use of technology such as satellites and onboard cameras, make it increasingly hard for operators of fishing vessels to engage in IUU activities, yet limited government budgets and the offshore nature of fishing mean that IUU fishing is likely to remain a problem for many years to come. No comparable estimates for the volume and value of fish from IUU sources are available at the country level, and comparable estimates of this type are not expected to become available soon given the challenges in agreeing to and adopting standardized methodologies. The IUU Fishing Index thus provides a useful way to compare risk between countries and regions, which is likely to remain relevant in the future. Although the index does not provide a measure of criminality in the fishing sector per se, and country scores should therefore not be mapped directly onto the Global Organized Crime Index when the fishing sector is considered, it certainly contributes to informing country scores for organized crime as related to the fishing sector.

APPENDIX: DATA ON SCOPE AND COVERAGE OF REVIEWED STUDIES

Data is drawn from G Macfadyen, B Caillart and D Agnew, Review of studies estimating levels of IUU fishing and the methodologies utilized, Poseidon Aquatic Resource Management, 2016.

OCEAN AREAS	SCALE				TOTAL	PROPORTION
	GLOBAL	LOCAL/ SUB-NATIONAL	NATIONAL	REGIONAL		
All	6			2	**8**	18%
Antarctic/ Southern Ocean				7	**7**	16%
Arctic				1	**1**	2%
Baltic			1	1	**2**	5%
East Atlantic Ocean		2	3	2	**7**	16%
Indian Ocean			3	3	**6**	14%
Inland rivers/ lakes		1		1	**2**	5%
Mediterranean		1		1	**2**	5%
Pacific Ocean		4	3	1	**8**	18%
West Atlantic Ocean			1		**1**	2%
Total	**6**	**8**	**11**	**19**		
Proportion	14%	18%	25%	43%		

FIGURE 5 Geographical scale and ocean coverage of studies between 2009 and 2016 (N=44) to estimate IUU catch.

NOTES: (i) Not all global studies provided estimates of total global IUU catch, as some estimates were for a particular species or particular fishing fleets. (ii) Studies with a regional geographical scale but that covered all ocean areas are those using a number of regional case studies in different oceans.

TYPE OF SPECIES	TOTAL	PROPORTION OF TOTAL
All (in the area of study)	17	39%
Anadromous	2	5%
Crustacea	1	2%
Demersal	9	20%
Freshwater	1	2%
Mollusc	1	2%
Multiple	6	14%
Pelagic	7	16%
Total	**44**	

FIGURE 6 Types of species included in studies between 2009 and 2016 (N=44) to estimate IUU catch.

NOTE: The two studies focusing on anadromous species both concerned salmon. The study related to molluscs estimated IUU fishing for abalone.

FLEET TYPE	GEAR TYPE					TOTAL	PROPORTION
	GILLNET	LONGLINE	MULTIPLE GEARS	POTS/ TRAPS/ DIVERS	TRAWLING		
Commercial, recreational and subsistence fisheries			11			**11**	25%
Commercial and recreational fisheries			5	1		**6**	14%
All commercial fleets		1	9	1		**11**	25%
Foreign fleets only			2			**2**	5%
Large-scale fleets only	2	3	4		3	**12**	27%
Small-scale fleets only	1		1			**2**	5%
Total	**3**	**4**	**32**	**2**	**3**		
Proportion	7%	9%	73%	5%	7%		

FIGURE 7 Types of fishing fleets and fishing gear included in studies between 2009 and 2016 (N=44) to estimate IUU catch.

NOTES

1 FAO, The state of world fisheries and aquaculture 2022: Towards blue transformation, Rome, 2022.

2 This paper focuses only on definitions and measurements of IUU fishing in capture fisheries. In 2020, the aquaculture sector produced an additional 88 million tonnes.

3 Africa accounts for 15% of total employment and for 15% of the world's fleet of 4.6 million fishing vessels.

4 FAO, The state of world fisheries and aquaculture 2022: Towards blue transformation, Rome, 2022.

5 SDG 14 is to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development'. See: https://sustainabledevelopment.un.org/sdg14.

6 FAO, The state of world fisheries and aquaculture 2022: Towards blue transformation, Rome, 2022.

7 United Nations, Agreement for the implementation of the provisions of the United Nations convention on the law of the sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks, 1995.

8 FAO, Code of Conduct for Responsible Fisheries, Rome, 1995.

9 FAO, Agreement to promote compliance with international conservation and management measures by fishing vessels on the high seas, Rome, 1995.

10 FAO, International Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing, Rome, 2001.

11 FAO, Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, 2016.

12 FAO, Voluntary Guidelines for Flag State Performance, Rome, 2015.

13 FAO, Global record of fishing vessels, refrigerated transport vessels and supply vessels, https://www.fao.org/global-record/en/.

14 The network is a voluntary organization acting informally. Although its members participate in an individual capacity rather than formally representing their international, regional or member state organizations, it serves to share experiences, methods and tools for combating IUU fishing.

15 Council Regulation (EC) No 1005/2008 of 29 September 2008 establishing a community system to prevent, deter and eliminate illegal, unreported and unregulated fishing (IUU Regulation), 2008.

16 Not all IUU fishing activities are necessarily considered 'criminal' in national fisheries legislation, and legislation in different countries varies as to whether infringements are dealt with through administrative penalties or criminal sanctions. However, as far as the definition of illegal fishing in the IPOA-IUU is concerned, whether a contravention or violation constitutes a crime per se (attracts a criminal liability or sanctions) or attracts civil or administrative sanctions is irrelevant to characterizing it as an illegal fishing activity.

17 A specific International Labour Organization convention (C188) addresses the issue of work standards in the fishing sector, including forced labour.

18 M Tsamenyi, B Kuemlangan and M Camilleri, Defining illegal, unreported and unregulated (IUU) fishing: Background paper 2 in the report of the Expert Workshop to estimate the magnitude of illegal, unreported and unregulated fishing globally, FAO, February 2015.

19 G Macfadyen, B Caillart and D Agnew, Review of studies estimating levels of IUU fishing and the methodologies utilized, Poseidon Aquatic Resource Management, 2016.

20 The definition of the term 'fishing' in the Port States Measures Agreement (the most recent binding international fisheries instrument) is given as 'searching for, attracting, locating, catching, taking or harvesting fish or any activity which can reasonably be expected to result in the attracting, locating, catching, taking or harvesting of fish'.

21 Typically zones extending 200 nautical miles from the shore, subject to proximity to other countries' zones.

22 G Macfadyen, B Caillart and D Agnew, Review of studies estimating levels of IUU fishing and the methodologies utilized, Poseidon Aquatic Resource Management, 2016. The review did not include reports of specific IUU fishing events, the volumes of IUU fish resulting from those events as documented by national or regional management agencies

or studies (or national/regional data) that reported on compliance or incentives for IUU fishing rather than those trying to make an estimate of IUU fish catch.

23 See, for example, MRAG Asia Pacific, The quantification of illegal, unreported and unregulated (IUU) fishing in the Pacific Islands Region – a 2020 update, 2021; as reviewed in MRAG, The financial costs of UK IUU fisheries: A systematic review of evidence and proposed future agenda, Department for Environment, Food and Rural Affairs 31444, 2021; I Tessnow-Von Wysocki et al, Undercurrents: Illegal fishing and European Union markets, Research Gate, 2022.

24 For example, Lake Victoria has one of the largest freshwater fisheries in the world, producing around 800 000 tonnes of fish. These fisheries support almost 2 million people with household incomes and provide for the annual fish consumption needs of almost 22 million people in the region.

25 Perhaps the most widely quoted global study is D Agnew et al, Estimating the worldwide extent of illegal fishing, *PLoS ONE*, 4, 2 (2009). This study estimated that IUU-caught fish in 2003 was 11%–19% of reported catches, representing 10–26 million tonnes of fish, valued at US$10–US$23 billion.

26 See IUU Fishing Index, https://www.iuufishingindex.net/.

27 The database underpinning the IUU fishing scores in 2021 contains 5 681 separate data entries, based on both publicly available data and expert opinion, with a high (98%) completion rate across all indicators and countries.

28 An update of the index in 2021 allowed not just for an assessment of the situation in 2021 but also for changes in global IUU fishing risk dynamics over the two years.

29 For example, through ratification of the Port States Measures Agreement.

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