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TECHNICAL GUIDELINES FOR
RESPONSIBLE FISHERIES

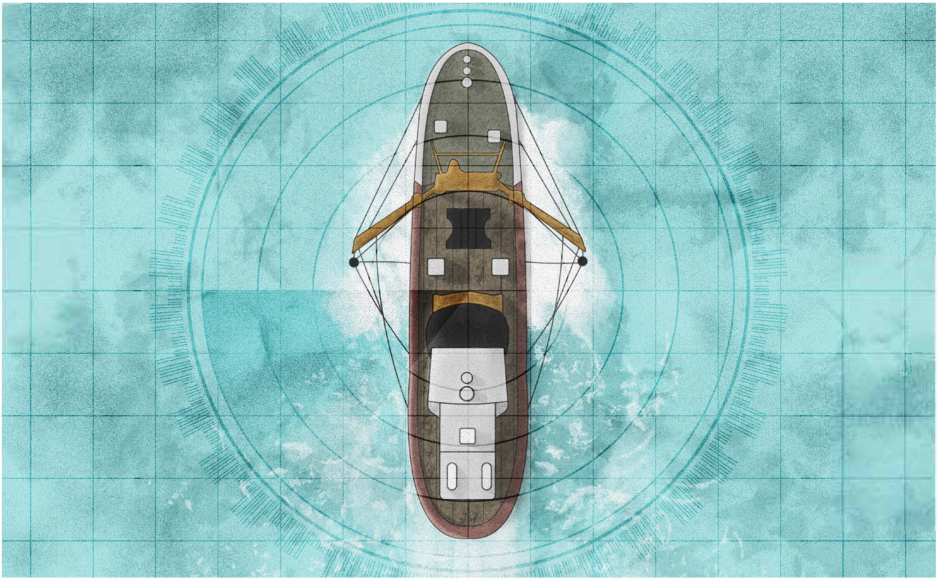
9

Suppl. 1 Vol. 1

IMPLEMENTATION OF THE INTERNATIONAL PLAN OF ACTION TO PREVENT, DETER AND ELIMINATE ILLEGAL, UNREPORTED AND UNREGULATED FISHING

1. Methodologies and indicators for the estimation of the magnitude and impact of illegal, unreported and unregulated fishing

1.1 Principles and approaches



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PREPARATION OF THIS DOCUMENT

This document is a product of the Food and Agriculture Organization of the United Nation's (FAO) global programme to support the implementation of the Agreement on Port State Measures (PSMA), complementary international instruments, and regional mechanisms and tools to combat illegal, unreported and unregulated (IUU) fishing. The guidance in this first volume, along with the other two volumes in this series of technical guidelines on methodologies and indicators for estimating the magnitude and impact of IUU fishing, is designed to meet the specific, practical needs of State authorities.

This volume is published under the Technical Guidelines for Responsible Fisheries series to support the principles of the Code of Conduct for Responsible Fisheries (CCRF), which call for effective fisheries management. Article 7.3.1 of the CCRF specifically refers to managing fish stocks to account for all removals and Article 7.4.4 notes the importance of complete and reliable statistics on catch and fishing efforts. Understanding the full extent of fishing mortality, from both legal and IUU fishing, is critical for ensuring that the level of fishing permitted is commensurate with the state of fisheries resources as called for in Article 7.6.1. Furthermore, knowledge of the type and amount of IUU fishing can be critical in assessing the effectiveness of monitoring, control and surveillance (MCS) systems (Article 7.7.4).

This document was prepared by the Fisheries Global and Regional Processes Team of FAO's Fisheries and Aquaculture Division. It was written by Duncan Souter with contributions from David Agnew and technical backstopping provided by Matthew Camilleri and Alicia Mosteiro.

ABSTRACT

The Food and Agriculture Organization of the United Nations (FAO) can play an important role in encouraging consistent and sound practices for estimating illegal, unreported and unregulated (IUU) fishing activities around the world. This first volume in a series of guidance documents on this topic outlines guiding principles and approaches applicable to a broad range of IUU fishing estimation scenarios. It begins by defining which components of IUU fishing to estimate depending on the specific objectives of the exercise. It then helps to set boundaries for the estimation exercise based on the fishery, species, area and timeframe of interest. Top-down and bottom-up methodological approaches are introduced, with examples, as ways of partitioning an overall IUU fishing amount into component activities, or compiling estimates of IUU fishing at a granular scale to form an overall composite figure, respectively. Ideas for presenting results to maximize the uptake by stakeholders and decision-makers are also presented.

CONTENTS

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ABBREVIATIONS AND ACRONYMS

BOBLME	Bay of Bengal Large Marine Ecosystem
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CCRF	Code of Conduct for Responsible Fisheries
COFI	FAO Committee on Fisheries
EEZ	exclusive economic zone
ETP	endangered, threatened and protected (species)
FAD	fish aggregation device
FAO	Food and Agriculture Organization of the United Nations
FFA	Forum Fisheries Agency
FOB	free on board
IPOA-IUU	International Plan of Action for Illegal, Unreported and Unregulated (fishing)
IUU	illegal, unreported and unregulated (fishing)
MCS	monitoring, control and surveillance
NPOA-IUU	National Plan of Action for Illegal, Unreported and Unregulated (fishing)
PSMA	Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing
RFMO	regional fisheries management organization
SDG	Sustainable Development Goals
SOFIA	State of World Fisheries and Aquaculture (report)
UNCLOS	United Nations Convention on the Law of the Sea
VMS	vessel monitoring system

SUMMARY

The Food and Agriculture Organization of the United Nation's (FAO) work toward fostering reliable worldwide estimates of illegal, unreported and unregulated (IUU) fishing began in 2015 when a workshop was convened to discuss priorities and approaches. Following this workshop, a review of existing studies was undertaken and it was suggested that estimates of IUU fishing at the subnational, national or regional level would be most useful for improving fisheries management and monitoring, control and surveillance. It was also suggested that FAO could usefully support the development of technical guidelines. FAO's Committee on Fisheries (COFI) 32nd session subsequently supported this proposal and the work that has led to the development of this series of guidelines. This first volume in the series aims to strengthen the quality and consistency of IUU fishing estimation studies, irrespective of the methodology chosen or the nature and scope of the study.

This document begins with a brief background to the concept of IUU fishing and sets out some of the main challenges in defining IUU fishing for the purposes of estimation. What is and isn't considered I, U, and U can have a large bearing on the magnitude of IUU fishing estimates, therefore it is important to follow a practical pathway for defining IUU fishing at a relevant scale. The benefits to be gained from having robust estimates of IUU fishing activity are outlined as an additional means of staying focused on practical outputs.

A range of guiding principles for IUU fishing estimation study design and implementation that have been distilled from more than 40 existing studies are highlighted in section 3. These guiding principles can be applied irrespective of the methodological approach used.

Many commonly faced issues by estimation studies are presented in section 4. These include avoiding and mitigating double counting and estimating the value of IUU fish from estimates of volume and species composition.

As the aim of IUU fishing estimation studies is usually to prompt improved fisheries management, section 5 provides advice on how best to present results to stakeholders in a logical and transparent manner. Suggestions for encouraging uptake both before and during the study, as well as after its completion, are also provided.

BACKGROUND

1 From ancient times, fishing from oceans, seas, lakes and rivers has been a major source of food and a provider of employment and other economic benefits for humanity. Living aquatic resources, an essential part of the aquatic ecosystem, are finite and their use, like that of other renewable natural resources, needs to be properly managed if their contribution to the nutri-tional, economic and social well-being of the growing world's population is to be sustained.

2. The adoption of the United Nations Convention on the Law of the Sea (UNCLOS) in 1982 was instrumental in the protection of living marine resources in the sea. The legal regime of the oceans gave coastal States rights and responsibilities for the management and use of fish-ery resources within the areas of their national jurisdiction.

3. After a long period of growth, capture fisheries landings began to level off from the end of the 1980s, due to sustainability issues, including overfishing, marking the end of the contin-ued development paradigm of global fisheries. Overfishing has negative implications for food and nutrition security and for economic development, whilst also reducing social welfare in countries worldwide. This is especially the case for small-scale fishers and fish workers in de-veloping countries who depend upon fish as their main source of essential nutrients, animal protein and income, while other fishers and fish workers employed in the medium and indus-trial sectors are reliant on these fisheries for income and livelihoods. The exploitation and use of living aquatic resources need to be properly managed and overfished and depleted stocks need to recover, ensuring that they can continue to benefit society.

4. Following rapid development, aquaculture started to play an increasing role in supply-ing fish for human consumption in the 1990s.

5. The 19th Session of the FAO Committee on Fisheries (COFI), held in March 1991, recom-mended the development of new approaches to fisheries and aquaculture management, em-bracing conservation and environment, as well as social and economic considerations. FAO was asked to develop the concept of responsible fisheries and elaborate a code of conduct to dis-seminate its principles and foster its application.

6. The Declaration of Cancun, endorsed at the International Conference on Responsible Fish-ing in Cancun in May 1992, and the United Nations Conference on Environment and Develop-ment Summit in Rio de Janeiro in June 1992, reinforced the concept of responsible fisheries and supported the preparation of a code of conduct for responsible fisheries. The FAO Technical Consultation on High Seas Fishing held in September 1992 further recommended the elaboration of a code to address the issues regarding high seas fisheries.

7. In November 1992, the FAO Council formally approved the preparation of a draft of this code. The formulation was carried out through a participatory process involving FAO Members and designed so as to be interpreted and applied in conformity with the relevant rules of inter-national law, as reflected in the 10 December 1982 United Nations Convention on the Law of the Sea. It was also formulated in line with the Agreement for the Implementation of the Pro-visions of the 1995 Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks and, *inter alia*, the 1992 Declaration of Cancun and the 1992 Rio Declaration on Environment and Development, in particular Chapter 17 of Agenda 21.

8. At its 27th Session in November 1993, the FAO Conference adopted the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which, as stated within the FAO Conference Resolution 15/93, should form an integral part of the code of conduct for responsible fisheries.

9. The Code of Conduct for Responsible Fisheries (the Code) was adopted on 31 October 1995 during the 28th Session of the FAO Conference through Resolution 4/95. The same Reso-lution requested FAO *inter alia* to elaborate appropriate technical guidelines in support of the implementation of the Code in collaboration with FAO Members and interested relevant organ-izations. This document is one of a series produced in response to this request.

10. The Code is voluntary. However, certain parts of it are based on relevant rules of international law, and it also contains provisions that have already been given binding effect by means of other obligatory legal instruments amongst the Parties.

11. On the implementation of the provisions of the Code, the application of the Ecosystem Approach to Fisheries, as reinforced in the Reykjavik Declaration (2001), provide strategies for the actual implementation of the Code, contributing to the further development and manage-ment of sustainable capture fisheries in the marine and freshwater environments and of the interaction between capture fisheries and aquaculture for sustainability, thereby supporting the technical, ecological, economic and social sustainability of the sectors.

12. Despite significant progress in places where capture fisheries management is imple-mented, the continued prevalence of illegal, unreported and unregulated (IUU) fishing and the ongoing use of ineffective management measures, means that the global percentage of fish stocks that are classified as overfished has not declined.

13. Since its adoption in 1995, the Code has been supplemented, within its framework, by other internationally negotiated instruments addressing specific provisions of the Code and other related matters on responsible fisheries and aquaculture, in the form of International Plans of Action, Voluntary Guidelines and Strategies. In addition, in 2009, the 36th Session of the FAO Conference adopted the Agreement on Port State Measures to Prevent, Deter and Eliminate IUU Fishing which later came into force in June 2016.

14. Whilst contributing smaller volumes to the global fish catch than marine fisheries, inland fisheries contributes fundamentally to food and nutrition security, livelihoods and rural econo-mies, especially in many developing countries. The existence of a broad range of interests out-side the inland fisheries sector emphasizes the need for States to establish negotiation mech-anisms to protect inland fisheries under multi-purpose use regimes. The importance and the challenges of ensuring the sustainable and responsible use of inland fisheries are clearly acknowledged in the Rome Declaration which emerged from the Global Conference on Inland Fisheries in 2015: The ‘Ten Steps to Responsible Inland Fisheries’ emphasize cross-sectoral ap-proaches to sustain livelihoods, food and nutrition security, and aquatic ecosystems.

15. The role of aquaculture in supplying fish for human consumption has continued to in-crease, reaching approximately 50 percent of global fish available for human consumption in 2018. This has allowed fish to contribute to the transition to more healthy and nutritious diets while not increasing the pressure on capture fisheries. However, aquaculture development, when inadequately managed, has also shown the potential to cause environmentally or socially adverse impacts. The outstanding issue in aquaculture is that, unlike in capture fisheries, the existing applicable principles of international law and treaty provisions provide little guidance on the conduct of aquaculture operations. The importance of sustainable aquaculture develop-ment and management for securing food and nutrition security, alleviating poverty and main-taining the integrity and sustainability of aquatic resources and environments was reinforced in the Bangkok declaration (2000) and the Phuket consensus (2010).

16. Elements of the Code and the subsequent framework of international instruments were reinforced through the United Nations Conference on Sustainable Development held in Rio de Janeiro in 2012, which launched a process to develop a set of Sustainable Development Goals (SDGs). The 2030 Agenda for Sustainable Development was adopted with 17 SDGs at the United Nations Sustainable Development Summit in 2015. In particular, SDG 14 "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" includes targets, *inter alia*, for sustainable management of fisheries and aquaculture, ensuring access to resources and markets for small-scale fishers, ending of overfishing, destructive fishing practices, IUU fishing and the implementation of science-based plans to restore fish stocks.

17. FAO produces Technical Guidelines for Responsible Fisheries to assist the international community in taking the necessary practical steps to implement the provisions foreseen in the Code.

1. INTRODUCTION

Illegal, unreported and unregulated (IUU) fishing is a recognized global problem that undermines the integrity of responsible fisheries management arrangements, results in lost value to coastal States and can threaten food security (e.g. Agnew *et al*., 2009). Previous studies have shown that the effects of IUU fishing are often hardest felt in developing coastal States heavily reliant on fishing for income (e.g. MRAG, 2005). Quantifying the nature and extent of IUU fishing is important in gauging potential losses suffered by coastal States, addressing uncertainties in stock assessments and planning effective monitoring, control and surveillance (MCS) investments. However, by its very nature IUU fishing is secretive and difficult to estimate with accuracy (FAO, 2002; Le Gallic and Cox, 2006).

In February 2015, the Food and Agriculture Organization of the United Nations (FAO) convened a workshop in Rome, Italy to consider methodologies for estimating IUU fishing at the global level. The workshop suggested that FAO could:

- coordinate a review of IUU fishing studies to compile the different methodologies being used to estimate IUU fishing;
- lead a process to develop technical guidelines for future studies so they could be conducted in a way that would allow for estimates to be combined to contribute to a global estimate; and
- consider indicators of IUU fishing for inclusion in FAO's biennial publication on The State of World Fisheries and Aquaculture (SOFIA).

A review of IUU fishing studies was conducted in 2016 (FAO 2016), and it found that:

- there are many different methodologies being used to estimate IUU catch but many estimates are not robust and are insufficiently transparent about the sources of information used;
- estimates of total removals made in some studies include catch that is not necessarily IUU in terms of the descriptions in the International Plan of Action for IUU fishing (IPOA-IUU);

- developing an updated global estimate of IUU catch may have limited benefit due to wide confidence intervals, a strong reliance on assumptions in the process of scaling up estimates and a lack of clarity in the IUU fishing behaviours included;
- efforts are more likely to be usefully focused on generating estimates at subnational, national or regional levels as a basis for practical targeting of fisheries management and MCS;
- indicators to monitor progress in combatting IUU fishing need not necessarily include global estimates of volumes of IUU fish, and could focus on other aspects such as numbers of vessels on IUU fishing vessel lists, the number of countries on the European Union IUU fishing yellow and red card lists, and selected regional or local estimates of IUU fish catch based on repeatable and robust methodologies; and
- FAO might play a role in supporting the development of technical guidelines, both on methodologies for estimating IUU catch, and on how to conduct risk-based assessments of IUU fishing.

The outcomes of the review were considered by the FAO Committee on Fisheries (COFI) at its 32nd Session in July 2016. COFI supported developing technical guidelines on methodologies and indicators by FAO for estimating the magnitude and impact of IUU fishing. It also called for reliable periodic estimates of IUU fishing, including at the regional level.

This series of guidance volumes has been developed in line with the second action agreed on during the 2015 workshop and COFI32 guidance. The overarching objective is to strengthen the quality and consistency of IUU fishing estimation studies, irrespective of the methodology chosen or the nature and scope of the study. It is not the aim of the guidelines to channel people towards a single best practice methodology – given the wide variability in the objectives of IUU fishing estimation studies, the very different types of IUU fishing that may be estimated, and the highly variable availability of information from which to estimate them, all methodologies will need to be bespoke to some extent and innovative approaches are continually being developed.

Rather, Volume 1 of these guidelines sets out a number of guiding principles, which should be incorporated into study design and implementation irrespective of the specific methodology used, while Volume 2 provides practical advice on the process of undertaking an IUU fishing estimation study.

Volume 3 then provides a catalogue of examples of IUU fishing estimation studies to assist researchers to develop an appropriate methodology for their own study based on the experience of others. Planned volumes on IUU fishing indicators and impacts (including valuation) will complete the set.

2. WHAT IS ILLEGAL, UNREPORTED AND UNREGULATED FISHING AND WHY ESTIMATE IT?

2.1 Illegal, unreported and unregulated fishing – what's in a name?

The notion of IUU fishing first emerged during the 1990s in reaction to perceived inadequacies of the extant international legal and policy framework governing the exploitation of living marine resources (Tsamenyi, Kuemlangan and Camilleri, 2015). At the regional level, efforts to fill the gaps in the 1982 United Nations Convention on the Law of the Sea (UNCLOS) were championed by international organizations responsible for the high seas management of straddling and highly migratory stocks in an attempt to identify and reduce the impact of fishing by parties that were not subject to or complying with their management measures. One of the first organizations to act, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), developed a suite of measures to address the increasingly uncontrolled fishing activities of several non-members and members alike in the Southern Ocean, which were undermining CCAMLR conservation and management measures. At the international level, the term "IUU fishing" was formally adopted by FAO and became a central part of the Organization's international fisheries policy at the 23rd Session of COFI in February 1999, based on a paper submitted by Australia urging FAO to develop an international plan of action to combat IUU fishing. Tsamenyi, Kuemlangan and Camilleri (2015) note that a series of rapid developments after the 23rd Session of COFI between 1999 and 2000 concretized the IUU fishing notion, which ultimately led to the adoption by the FAO Council of the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU) at its 120th Session in June 2001.

The text of the IPOA-IUU includes the most commonly accepted working description of IUU fishing (FAO, 2001), which has subsequently been adopted in a range of instruments including the FAO Agreement on Port State Measures (PSMA). Rather than providing a prescriptive definition, the IPOA-IUU describes a number of illustrative activities under each of the IUU fishing components (see Box 1).

Box 1
International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing description of illegal, unreported and unregulated fishing

(para 3.1) Illegal fishing refers to fishing activities:

- (para. 3.1.1) 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;
- (para 3.1.2) 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; or
- (para 3.1.3) in violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization.

(para. 3.2) Unreported fishing refers to fishing activities:

- (para 3.2.1) which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or
- (para 3.2.2) 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.

(para. 3.3) Unregulated fishing refers to fishing activities:

- (para 3.3.1) 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; or
- (para 3.3.2) 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.

While the range of national and international instruments directed at combating IUU fishing has evolved considerably since the IPOA-IUU was adopted, Tsamenyi, Kuemlangan and Camilleri (2015) note that a number of definitional challenges remain. In particular, in the context of attempts to estimate IUU fishing activity, they note that the IUU fishing term is broad and, due to the diversity in governance frameworks, national legislation and fishing operations throughout the globe, there are a number of grey areas and overlapping situations among the three components of IUU fishing (e.g. much of that which is unreported is also illegal). In addition, while the IPOA-IUU describes a number of illustrative activities under each of the IUU fishing components, it does not completely cover all possible scenarios and does not address the issue of overlap among the three IUU fishing components.

Perhaps partly because of these uncertainties and overlaps, some States have increasingly sought to treat IUU fishing as a single concept (e.g. the European Union IUU fishing regulation simply provides a list of activities that are considered to be IUU fishing, without attempting to categorize them into "I", "U" and "U"), or alternatively redefine the concept in national legislation.

In order to resolve some of the uncertainty and provide consistency to interpretation and estimates of IUU fishing activity, Tsamenyi, Kuemlangan and Camilleri (2015) proposed redefining the IUU fishing concept to the effect that: a) illegal fishing could cover fishing activities by all vessels (national and foreign) in areas under national jurisdiction, including inland fisheries, in contravention of national laws or regional fisheries management organization (RFMO) conservation and management measures; b) unreported fishing should be recast as "non-reporting, underreporting or misreporting of any information related to the fishing activity"; and c) unregulated fishing should be recast as largely an issue of governance failure, which would cover other types of activities that are not regulated or that are taking place in areas without a fisheries governance framework.

COFI and other groups have not yet formally considered these changes, and the text in section 3 of the IPOA-IUU remains the most widely accepted definition of IUU fishing internationally. Nevertheless, some of the concepts raised by Tsamenyi, Kuemlangan and Camilleri (2015), particularly consideration of any non-reporting whether or not it is required by regulation or law, are commonly considered IUU fishing in the literature. We include them here because they are subject to the same sorts of considerations for estimation, and may legitimately

be included in IUU fishing studies, whether or not they are formally considered to fall into the international (FAO) description of IUU fishing.

Noting that it is often difficult to categorize the different activities that are commonly referred to as IUU fishing purely in terms of the formal FAO description, FAO's 2015 workshop identified a number of different types of activity that could be, or have been, commonly identified in IUU fishing studies (FAO, 2015 (Annex 7)). Table 1 presents these organized into groups and roughly indicating the IPOA-IUU description to which they relate.

Table 1. Example categorization of common types of illegal, unreported and unregulated activity relevant to estimation studies

Group	Category	#	Types of activity	Notes
Fishing outside regulations	Encroachment (IPOA-IUU description categories 3.1.1, 3.1.3, 3.3.1)	1	• Fishing in the waters of a country without a valid licence, authorization or permit by the relevant national authority, where required • Fishing in the waters of an RFMO without a valid licence, authorization or permit	Note if this is within a country or by an RFMO contracting party flag State it is illegal; if in an RFMO area by a non-party it is unregulated. Where there is activity within an exclusive economic zone (EEZ) that is not required to be licensed, this is often referred to by IUU fishing analyses as unregulated but strictly speaking it is not according to the FAO definition – see below category 3.
	Absence of authentic documentation (3.1.3)	2	• Fishing in the waters of a country or an RFMO with false documentation • Fishing as a stateless vessel (not registered with a national registry, or registered simultaneously on more than one)	
	Legal non-reporting of activity	3	• Lack of reporting of fishing activities where this is **not** required either by national law or in international waters by RFMO and/or flag State regulations	Examples include fisheries that are often unregulated such as artisanal, subsistence and recreational fisheries. As above, note that this is not necessarily unregulated according to the IUU fishing definition.

Group	Category	#	Types of activity	Notes

Fishing in contravention of regulations	Non-compliance with technical measures (3.1.3)	4	• Vessels may be licensed and have authentic documentation, but are:
			  ▸ fishing in an area and/or season in contravention of management measures
			  ▸ engaging in directed fishing for a stock or species which is subject to a moratorium or for which fishing is prohibited
			  ▸ using fishing gear which is prohibited or non-compliant with applicable laws and conservation and management measures
			• Non-compliance with, or contravention of, technical requirements relating to a fishing access contract/agreement
			• Unauthorized transshipment of fish and fishery products without authorization from the coastal or flag State or in contravention of the requirements of an RFMO, and/or without a designated and accredited observer to witness and record the transshipment operation if required	

Group	Category	#	Types of activity	Notes
Fishing in contravention of regulations	Illegal non-reporting and misreporting (3.2.1, 3.2.2)	5	• Lack of reporting of fishing activities where required either by national law or in international waters by RFMO and/or flag State regulations • Lack of reporting of catches, discards, and other incidental impacts of the use of fishing gear, where required by regulations • Over-reporting of catch (for example, to load logbooks in advance of allocations based on catch history)	A distinction is made between legal and illegal non-reporting. Normally IUU fishing studies restrict themselves to estimating retained catch and discards, but some have gone further to estimate mortality from ghost fishing.
	Legal non-reporting of catches and discards	6	• Lack of reporting of catches and discards where this is **not** required either by national law or in international waters by RFMO and/or flag State regulations	If not required in law, non-reporting discards is not unreported according to the IUU fishing definition. Despite not being *sensu stricto* IUU fishing, estimating these volumes is often one of the primary objectives of IUU fishing studies, and should be considered in any future IUU fishing studies.

2.2 Why estimate it?

Irrespective of the definitional challenges involved in interpreting the IUU fishing concept and the patchy and incomplete nature of available information, where IUU fishing is likely to be even a moderate problem, there can be very substantial benefits in attempting to quantify the nature and scale of it.

Each fishery and area likely has its own unique reasons for wanting to estimate IUU fishing activity, but some of the most common benefits are set out below:

- **Improving stock assessments and scientific/policy advice** – one of the earliest motivations for fisheries researchers to estimate IUU fishing activity was to improve the accuracy of stock assessments. Unaccounted for catch, particularly in fisheries where IUU fishing activity is thought to be a substantial problem, has the potential to bias assessment outcomes. This can lead to scientific recommendations that are unable to maintain the target stock at biologically sustainable levels (maximum sustainable yield or above) and result in overfishing. IUU fishing impacts on habitats, bycatch and the incidental mortality of endangered and threatened species also needs to be understood if managers are to deliver sustainable ecosystem-based fishery management. Lack of knowledge on the level of IUU fishing, and the inaccurate estimates of stock status that result, may also lead to overly conservative assessment outcomes and unnecessary restrictions on legitimate fishing opportunities. To that end, producing credible estimates of IUU fishing activity (or total unaccounted for catch, which may or may not all be IUU fishing) are important in strengthening the scientific certainty of stock assessments and the appropriateness of resulting policy advice.
- **Improving socio-economic conditions of legitimate fishers** – understanding the economic impact of different types of IUU fishing activity, either directly through impacts on legitimate fishers (e.g. by increased competition), or indirectly through damage to stocks or ecosystem services, allows managers to identify the measures necessary to mitigate these economic impacts.
- **Information to allow better targeting of MCS activities** – a key benefit of those studies that aim to assess the full scope of the IUU fishing problem in a particular fishery and/or area is that they provide information on the relative contribution of different types of IUU fishing activity (e.g. unlicensed fishing, under-reporting, illegal transshipping)

to overall IUU fishing volume and value. Such information is typically highly valuable, both from an operational and financial point of view, because different types of IUU fishing activity can require very different types of MCS responses to detect and mitigate. For example, where the main IUU fishing activity is unlicensed fishing by pirate vessels, which are essentially dark from a monitoring point of view, substantial investments in assets and infrastructure (e.g. aerial and surface surveillance, satellite images) may be required to address the problem. However, where the main form of IUU fishing activity is under-reporting by licensed vessels, comparatively modest investments in additional monitoring (e.g. observers, dockside inspection, electronic monitoring, catch documentation schemes) may be all that's required. Understanding the relative importance of each type of IUU fishing activity can help prioritize limited MCS resources and help optimize compliance activity.

- **Monitoring changes in IUU fishing activity in space and time** – even where the nature and extent of IUU fishing activity has been robustly estimated within a particular fishery, the reality is that the picture will change over time. The nature of IUU fishing is highly dynamic, with the extent of activity changing as the mix of incentives, disincentives and the regulatory environment evolve. Fishers are often quick to respond to changes where economic opportunities arise, and squeezing the regulatory and enforcement balloon in one area may result in bulges in others. To that end, a key benefit of IUU fishing estimation studies that produce reproducible models of activity is the capacity to track changes over time and space as the nature of the operating environment changes. Tracking changes over time also allows us to evaluate the effectiveness of previous MCS activity, as well as to ensure that current MCS plans and approaches are most appropriately targeted at the current configuration of IUU fishing activity.
- **Evaluating MCS cost effectiveness and helping calibrate sanctions** – as with most forms of resource management, the benefits received from addressing a particular challenge should ideally outweigh the investment put into tackling it. Having a robust estimate of the value and costs associated with different forms of IUU fishing activity can help fisheries managers and MCS practitioners evaluate the relative cost effectiveness of MCS investments (i.e. if I invest USD 5 million in a new surveillance asset, how much am I likely to save in income that would otherwise be lost to IUU fishing operators?). Having a good

understanding of the volume of IUU fishing, particularly the economic benefits to IUU fishers, can also help calibrate sanctions to ensure they sufficiently exceed the benefits to act as an effective deterrent.

- **Advocacy** – there's little doubt that actions taken by FAO and others through initiatives such as the IPOA-IUU and more recently the PSMA have considerably raised awareness of the perils of IUU fishing internationally. However, producing credible estimates of IUU fishing volume and value can still have substantial advocacy benefits in highlighting the issues and mobilizing resources. Estimates of pirate fishing are often quick to be picked up by global media, helping to galvanize public support for action, while for policy makers and treasury officials having a credible estimate of the lost value to local economies is typically more effective in justifying spending than qualitative information and anecdotes.
- **2030 Agenda for Sustainable Development and IUU fishing** – while there are multiple reasons to carry out IUU fishing studies, in the context of FAO, IUU fishing activities are considered primarily as activities undermining the achievement of the Sustainable Development Goals (SDGs) agreed to by the international community. Against this background, COFI would like to be regularly informed of the magnitude and impact of IUU fishing activities and of progress in combatting IUU fishing globally. With this in mind, COFI requested that information on the magnitude and impact of IUU fishing be included in the biennial SOFIA report.

2.3 Which parts of illegal, unreported and unregulated fishing should I estimate?

In the absence of a formal definition of IUU fishing, stakeholders involved in IUU fishing estimation studies are left to make a judgement about which of the possible components of IUU fishing should be estimated and which, if any, should be excluded. The answer will largely be informed by the objectives of the exercise.

In many cases, stakeholders will simply be interested in estimating the volume and species composition of fish harvested or transferred through the supply chain illegally – that is, outside of, or in contravention of, relevant fisheries management frameworks operating in the fishery/area of interest. In this case, illegal fishing would include all forms of unlicensed activity, all forms

of contravention of fisheries regulations and license conditions and all forms of non-reporting or misreporting of fish where there was a legal requirement to do so. It would also include fishing by Stateless vessels in contravention of international law, and fishing in an RFMO area by vessels flagged to a non-party State. It would not include, for example, other elements raised by Tsamenyi, Kuemlangan and Camilleri (2015) such as non-reporting of discarded fish where there was no legal requirement to do so, or unregulated fishing (Box 2) to the extent that there was no law in place prohibiting the activity (for example, where a lack of regulation in a particular area allowed fishing to take place in a manner inconsistent with internationally recognized biodiversity conservation and stock management principles).

In other cases, stakeholders may be interested in estimating the volume and species composition of one particular type of IUU fishing activity only.

In practice, the nature of activities that are IUU will vary from fishery to fishery, State to State and region to region according to which legal framework/s are in place since what is perfectly legal in one area may be considered an egregious offence in another. Accordingly, attempting to provide a prescriptive top-down list of IUU fishing activities that should be considered in estimation studies runs the risk of missing important forms of IUU fishing activity at the local level and therefore biasing results.

With that in mind, these guidelines take the view that the nature of IUU fishing activities to be estimated is best defined by interested stakeholders taking into account the objective of the study (e.g. is the objective to estimate total IUU or just a specific component?), the legal frameworks in place and the use that will be made of the results (see section 2.4). The advantages of this approach are that stakeholders (e.g. fisheries managers, MCS practitioners, RFMO contracting parties) are able to ensure that efforts are focused on the issues considered most important while avoiding devoting limited time and resources to issues of lesser interest. For instance, if the objective is to identify and then act to stop a particular illegal activity affecting a single sensitive species, it may not be necessary to estimate other illegal activities on that or other species in order to identify the scale of the problem and the most appropriate actions that should be taken to prevent it.

Box 2
A note on unregulated fishing

Of the three components of IUU fishing, unregulated fishing is perhaps the hardest to define in clear terms and is, therefore, the hardest to estimate with any precision. While there are certainly examples of unregulated fishing that are relatively clear (fishing by stateless vessels on the high seas, fishing in the area of an RFMO by a vessel flagged to a non-party in contravention of conservation and management measures), the IPOA-IUU description also arguably encompasses circumstances that are harder to define (see Tsamenyi, Kuemlangan and Camilleri, 2015 for discussion). These include, for example, fishing activities in areas under national jurisdiction, which are not prohibited or regulated by national legislation or conservation and management measures of an RFMO but which are contrary to the general international obligations of States (e.g. failure to collect relevant scientific data, failure to declare a total allowable catch under Art. 61 of the UNCLOS). These latter circumstances are largely issues of governance failure and are likely to be opaque, difficult to estimate in practice and potentially sensitive for a range of interested stakeholders. Given the potential for the inclusion of such activities to substantially influence overall estimates of IUU fishing activity, and the potential for controversy surrounding their inclusion to overshadow the benefits for any study, our view is that unless there is a very clear guidance around what is considered unregulated fishing within a relevant jurisdiction (e.g. through a national plan of action (NPOA)-IUU), these more opaque forms of unregulated fishing should not be included in IUU estimates. This is consistent with the historical development of the concept of unregulated fishing, which focused largely on indiscriminate fishing activity by vessels flagged to States and fishing entities that were not members of RFMOs.

Note: **Tsamenyi, M., Kuemlangan, B. & Camilleri, M.** 2015. *Defining illegal, unreported and unregulated (IUU) fishing*. FAO Expert Workshop to estimate the Magnitude of Illegal, Unreported and Unregulated Fishing Globally (Background Paper 2).

Local stakeholders are usually well placed to advise both on local laws and their interpretation in practice, and those activities likely to make the largest contribution to the overall IUU fishing problem.

The exception to this approach is where a study is part of a broader coordinated effort to estimate IUU fishing across multiple fisheries/areas, for example, a coordinated effort to produce an updated estimate of global IUU fishing. In this case, coordinators of the study should provide broad policy guidance on some of the key areas of uncertainty (for example, should discards which are not legally required to be reported be included in estimates?) to ensure apples vs apples estimates between regions.

2.4 Why interpretation matters

In the context of studies estimating the nature and scale of IUU fishing activity, debates around the definition of IUU fishing are more than academic arguments. What is and is not considered IUU fishing can have a substantial influence on the overall outcomes. For example, including estimates of unreported discards as IUU fishing even where there is no legal requirement to report could lead to a several-fold increase in overall IUU fishing estimates for some fisheries.

Moreover, even where the illegality of the activity is clear, how particular circumstances are interpreted for estimation purposes can have a large bearing on overall estimates. For example:

- If a fishing vessel accurately reported its catch in a compulsory logbook, but submitted the logbook after the legal deadline for submission, should these catches be considered IUU fishing?
- Within a single trip, if a vessel fishes within its licensed area for 80 percent of the time, but also fishes for 20 percent of the time in an area in which it has no licence, is all the catch on the trip considered IUU fishing? Or just the catch taken in the unlicensed 20 percent?
- If a vessel fishes with three lines, but only one uses illegal gear, is all the catch from that vessel IUU fishing or just the catch taken from the illegal line?
- If a fishing vessel is required to continuously operate a vessel monitoring system (VMS), but the VMS is non-operational for a proportion of the trip and the vessel fails to manually report, should the catch taken during the trip be considered IUU? If so, should all of it be considered IUU fishing or just an amount equivalent to the proportion of the trip for which the VMS was inactive?

The point here is that, in practice, most studies will come across a range of situations in which some form of a judgement call needs to be made about how illegal activities will be interpreted for the purposes of quantification. These calls can have a substantial influence over the final results and should be given careful consideration. Our view is that such calls are best made with the active participation of interested stakeholders in the context of the objectives of the study. Irrespective of the agreed upon interpretation, all such calls should be carefully documented in study outputs so that readers have a clear picture of how estimates were made.

3. GUIDING PRINCIPLES FOR ILLEGAL, UNREPORTED AND UNREGULATED FISHING ESTIMATION STUDIES

The different objectives motivating IUU fishing estimation studies and the highly variable nature of data and information sources available mean that all estimation methodologies will be bespoke to some extent. Nevertheless, many of the best studies have several features in common that serve to strengthen their overall credibility, defensibility and practical usefulness to interested stakeholders.

This section sets out a number of principles (or features) common to studies that could be considered best practice in estimating IUU fishing. Principles have been categorized as relevant to either the study design or study implementation and have been distilled from the review of methodologies (FAO, 2016), as well as the authors' own experience in estimating IUU fishing.

To that end, while the actual estimation methodology is expected to be tailored to the circumstances of the study in question, incorporating the following principles/features into the overall approach is likely to better position the study to produce credible, informative outcomes that will be useful to the intended audience.

3.1 Study designs

3.1.1 Clear objectives

The first step in the design and implementation of an IUU fishing estimation study is to be clear about why you're doing it. What are the objectives of the exercise and what are you hoping to achieve? The answer to these questions can have a substantial influence on the design of the study and the methodology chosen.

For example, where the objective is simply to understand the total IUU fishing activity or unaccounted for catch to reduce uncertainty in stock assessments, or to produce a total estimate for advocacy purposes, a top-down approach (see section 4.1) that doesn't discriminate between the relative contribution of different types of IUU fishing activity may be appropriate. However, if the objective is to get a more granular understanding of the relative contributions of different activities to the overall IUU fishing problem (for example, for MCS

planning purposes or to address specific elements of impact on stakeholder/fisher livelihoods), a more detailed, bottom-up approach may be required.

Wherever possible, the objectives of the study should be developed with the active participation of interested stakeholders (e.g. fisheries managers, MCS practitioners, senior policy makers).

As well as helping to ensure the methodology chosen is fit for purpose, ensuring clarity around the objectives of the exercise at the outset can also help save costs. For example, if all that's required from an operational point of view is a picture of the relative level of risk between different IUU fishing activities (for example, to help prioritize the deployment of MCS resources), a relatively simple qualitative or semi-quantitative risk assessment may be a cost effective way to provide the level of information required. However, if more detailed information on likely volumes, species compositions and economic costs associated with IUU fishing activity is required (for example, to assess the cost effectiveness of new MCS investments, or calibrate sanctions), a more detailed and costly quantitative assessment may be necessary.

3.1.2 Clear scope

Once the objectives have been agreed upon, the next main step is to define the scope of the study. As a general rule, this will be a combination of answers to the following questions, many of which are inter-related to some extent:

- Which fisheries/sectors?
- Which species?
- Which area/region?
- Which timeframe?
- Which parts of IUU fishing?

These questions should be answered in the context of the objectives agreed upon, and with a clear eye towards practicality, feasibility and the resources available. Given the intention to quantify IUU fishing activity with as much precision as possible, every attempt should be made to limit ambiguity. The boundaries around each component of the scope should be clearly defined (we are including these species, but not these species; the geographical boundaries of the study will be X/Y/Z, etc.) and structured to minimize the potential for overlaps and double counting, or alternatively to exclude key areas of IUU fishing activity.

As with the study objectives, the scope of the project should ideally be agreed to with the participation of interested stakeholders.

Some of the key considerations in choosing an appropriate scope are set out below:

Fisheries/sectors – the choice of which fisheries to include in a study will be driven by the objectives and in most cases will involve decisions that can have a substantial impact on the overall outcomes. For example, if the objective is to estimate total IUU fishing activity within a geographic/geopolitical region (e.g. EEZ, RFMO area), are all sectors (e.g. industrial, artisanal, subsistence, recreational) included? If only industrial fishing is included within the scope, are all fleets included or just foreign fleets? Are all gear types included, or just some?

Even where the choice of fishery is relatively clear, some components may be considered more important to include than others based on risk and practicality. For example, in their studies of Western Pacific tuna fisheries, MRAG Asia Pacific (2016; 2021) included the purse seine and longline sectors within the scope, but excluded the pole and line sector on the basis that overall IUU fishing activity in this sector was likely to be small in comparison to the other two.

Often the choice of fisheries/sectors will be a judgement call considering the extent to which the sector is likely to contribute to overall IUU fishing activity and the nature and type of information available.

Species/stocks – the choice of target species (or stock) to include in the study should be relatively straightforward based on the focus of the study, although there may be decisions to be made about whether to include other lesser value byproduct and bycatch species in scope. These decisions may be influenced to some extent by the types of IUU fishing activity to be estimated (for example, whether unreported discarding of bycatch species is considered unreported and therefore within the scope). The choice of species may also be influenced by the legal frameworks in place at the local level (for example, in one area a species may be subject to a moratorium and included within the scope, whereas in other areas the species is not regulated and is therefore out of the scope).

A clear decision should also be made about whether to include endangered, threatened and protected (ETP), or otherwise potentially vulnerable species (e.g. shark bycatch). Where ETP species are included within the scope and overall estimates of IUU fishing value are provided, a clear rationale will be needed for how these species have been valued (e.g. market value, non-market value).

Area/region – the choice of area/region should again be relatively straightforward based on the focus of the study (e.g. RFMO area, EEZ, inland lake) and the interests of stakeholders. Irrespective of the geographic boundaries chosen, these should be described clearly to avoid ambiguity. Where independent estimates from multiple regions are to be combined into an overall IUU estimate, care should be taken to avoid the potential for overlap and double counting.

Timeframe – as with other components of scope, the choice of timeframe will be influenced by the study objectives. For the many studies wanting to estimate the current IUU fishing activity (for MCS planning, for example), the most recent period for which sufficient data are available should be used (recognizing that in most fisheries, data, such as logbook records, may take some time to filter into official sources). Other studies (those wanting to estimate IUU fishing activity within an uncertain period in a stock assessment model, for example) may limit analysis to a defined period. The results of the IUU fishing estimation studies may be expressed in terms of the total volume of IUU fishing activity within the relevant period or averaged to form a typical annual estimate of IUU fishing.

Which parts of IUU fishing? – as described above, defining which parts of IUU fishing are to be included in estimates is one of the most important choices to be made in defining a scope and can have a substantial impact on overall outcomes. Decisions must be made on which activities are considered IUU fishing for the purposes of the study and, for each of those activities, how they will be interpreted for estimation purposes.

The nature of activities considered in the scope will be influenced by the objectives of the study – for example, are we attempting to estimate only one form of IUU fishing (say illegal foreign fishing) or all forms of IUU fishing within a fishery/area – and by the legal frameworks in place in the study area. Ideally, the nature of IUU fishing activities considered in the scope, and how

they're interpreted for the purposes of estimation, should be discussed and agreed upon by interested stakeholders and experts. Where multiple IUU fishing activities are estimated within a particular fishery/area, clear definitions of each IUU fishing activity should be provided to limit ambiguity and opportunities for double counting.

Irrespective of how the above questions are answered, the final scope should be set out in sufficient detail to leave the reader in no doubt about exactly what is being estimated.

3.1.3 Clear, reproducible methodology

As discussed above, the substantial variation in the objectives of IUU fishing estimation studies and the nature of information available means that all methodologies will be bespoke to some extent. Irrespective of the methodology adopted, it is essential that it be described in sufficient detail to ensure the reader has a clear understanding about how the estimates were arrived at and can make an informed judgement as to its appropriateness. As with all scientific studies, the description of the methodology should be sufficient to allow an independent group to carry out the methodology in the same way using the same inputs and achieve the same results.

The other key benefit to ensuring reproducibility is to allow for changes in the nature and extent of IUU fishing to be tracked over time. Being able to repeat the same basic methodology at periodic intervals allows us to track the evolution of IUU within the study area, to continually optimize and refine MCS targeting and to assess the effectiveness of previous MCS investments and activities. A robust, repeatable basic methodology also allows us to continually improve the estimates of IUU fishing activity as better information and monitoring becomes available.

3.1.4 Data-driven and transparent

While the nature of IUU fishing activity means that information is frequently patchy and uncertain, the best IUU fishing estimation studies will prioritize the use of empirical data sources where available. Although they can be subject to their own uncertainties and biases, which need to be accounted for, the use of empirical data (i.e. that derived from observation or experiment) offers a more objective starting point than other forms of evidence (e.g. logical argument, expert judgement), which can be subject to a range of conscious and unconscious biases.

Where empirical data are not available or are incomplete, the use of expert judgement and other more subjective sources of information may be required to fill in the blanks. Where expert judgement is used, every effort should be made to standardize the process of collection to maximize objectivity. This is particularly the case where estimates are expected to be repeated over time and it is essential that the methodology be reproducible.

Irrespective of the final configuration of data and information used, all sources of data and information should be set out in sufficient detail to allow the reader to make an informed judgement of their credibility and reasonableness. The implications of any important data gaps should be discussed.

Three types of data sources often used in IUU fishing studies need special mention:

- **Confidential MCS data** – these data can rarely be scrutinized by a third party, so the level of trust in the correct collation and analysis of data needs to be high. We would recommend that in order to deliver this level of confidence, studies using such data should include participation by relevant government MCS professionals responsible for the data (e.g. as a member of the study team or on a study steering committee).
- **Confidential informants** – these sources, which are different from named experts, can never be effectively verified by a third party. Where possible, these sources should be used sparingly and only for the purposes of corroboration/triangulation (i.e. they should not be the primary sources of information used to estimate IUU fishing activity).
- **Grey literature** – without access to the literature a third party cannot verify them, nor identify whether the methods used in those studies were robust (or even whether the specific estimates cited in those studies were actually made by the authors themselves or were also simply cited from non-robust sources). We recommend that either all grey literature is made publicly available, or it is only used for the purposes of corroboration/triangulation.

3.1.5 Use of multiple data sources/triangulation

The nature of IUU fishing activity means that most sources of data and lines of evidence will be patchy, uncertain and incomplete. With that in mind, the best IUU fishing estimation studies will use multiple data sources to triangulate

estimates in order to reduce the impacts of uncertainties inherent within individual datasets or approaches. For example, Plagányi, Butterworth and Burgener (2011) used stock assessment, police/surveillance and trade data to estimate illegal catches of abalone in South Africa, while MRAG Asia Pacific (2016; 2021) used VMS, licensing, aerial and surface surveillance data and expert judgement to inform the estimates of unlicensed fishing in Western Pacific tuna fisheries.

While the use of triangulation is encouraged, multiple independent sources of data or information may not always available. In these cases, it is essential that any increase in uncertainty associated with the use of a single data source (and any data gaps) be reflected in estimates of statistical confidence, and the implications discussed.

3.1.6 Clarity around assumptions

The uncertain nature of estimating IUU fishing activity means that most studies will need to make a number of assumptions. The nature of these assumptions can often have a substantial influence on the overall estimates. For example, in their study of Southeast Asian IUU fishing hotspots Funge-Smith, Lee and Leete (2015) assumed that all catch taken by all fleets implicated in IUU fishing hotspots was taken illegally. This is neither right nor wrong, but an alternate set of assumptions – for example, that only catch from vessels for which there was direct evidence of IUU fishing activity are counted in estimates – would have yielded an alternative result.

While it is not possible to completely avoid using assumptions even in comparatively data rich circumstances, it is important that all assumptions are clearly spelled out in sufficient detail to allow the reader to make an informed judgement about their reasonableness and the extent to which they may have influenced the overall results.

Ideally, all assumptions (but particularly those that are likely to have substantial bearing on outcomes) should be checked against any available data and refined where necessary with informed stakeholders during the course of the study to provide some confidence in their reasonableness.

For all assumptions likely to have a large bearing on overall results, the implications of alternative assumptions should be discussed. Where practical, this should be done in quantitative terms (e.g. our results assume X. If we

assumed Y, our results would be different by Z, with Z being some quantitative figure) and ideally through some form of appropriate statistical sensitivity testing.

3.1.7 Mechanisms to account for uncertainty, estimates of confidence

The estimation of IUU fishing activity is, except in the most isolated of circumstances, an inherently uncertain enterprise. Information is often weak and patchy, sometimes of uncertain provenance and frequently hard to verify except in the most anecdotal manner. To that end, the best IUU fishing estimation studies will incorporate mechanisms to account for uncertainty in the information base and provide the reader with an estimate of confidence in the outcomes, sufficient to allow an informed judgement as to their credibility.

At their most simple, mechanisms may be as straightforward as providing a minimum and maximum range to estimates, with a discussion of the main sources of uncertainty and a justification of the upper and lower bounds of estimates. More sophisticated studies will make use of quantitative analytical techniques to account for uncertainty such as Bayesian analysis, bootstrapping and Monte Carlo simulation. These approaches typically produce probabilistic estimates of IUU fishing activity (e.g. there is a 90 percent chance that the actual level of IUU fishing activity is within the range X to Y) or best estimates with a range of statistical confidence.

As a general rule, the more uncertain the underlying information the wider the estimated range of IUU fishing should be or alternatively the wider the estimates of statistical confidence. IUU fishing estimation studies that produce single point estimates with no statistically based confidence intervals, or very narrow ranges without a clear justification, should be viewed with strong scepticism.

All studies should be clear about the sources of data they use, be explicit about any weaknesses and uncertainties and discuss the implications in the context of the results.

3.1.8 Statistical rigour

Most IUU fishing estimation studies will require some form of statistical analysis to account for uncertainty in the underlying information and to provide quantitative estimates of confidence in the final results. Depending on

the nature of the study, a range of statistical challenges may be encountered including the need to combine estimates of IUU fishing activities with varying levels of confidence or the need to account for non-randomness and bias within available datasets (e.g. the need to account for non-randomness in aerial surveillance targeting where sightings data are used to estimate the extent of unlicensed fishing).

Given the variability in IUU fishing estimation approaches and datasets, there is no one best practice statistical approach to dealing with uncertainty. Nevertheless, the best studies will ensure that mechanisms are in place to ensure statistical rigour in project design and outcomes. This could be including a person with relevant high level statistical training on the study team or seeking advice from an external statistical expert on project design and interpreting results.

3.2 Study methods

3.2.1 Stakeholder participation

The active participation of stakeholders in the design and conduct of IUU fishing estimation studies can be highly valuable for a number of reasons. These include:

- **Defining objectives and scope** – particularly where the outcomes of the study are intended to be used in practice by interested stakeholders (e.g. in prioritizing future MCS activities/investments), the involvement of stakeholders in the definition of study objectives and scope can help ensure the study is focused on the right things. The ownership engendered by giving stakeholders a say in study design will also, in most cases, mean the outcomes have a better chance of being accepted and acted upon.
- **Identifying risks** – within the objectives and scope agreed upon, informed stakeholders will often be a valuable source of advice on the types of IUU fishing activities operating in the area of interest (based on their knowledge of local legal frameworks and the operation of relevant fisheries), as well as their likely relative importance to the overall IUU fishing problem.
- **Providing information/data** – stakeholders who have worked in and around the relevant fishery/area being studied will often be well placed to advise on the types of information and data that exist to help support IUU fishing estimation. Those holding official positions may also be

well placed to facilitate access to information that would otherwise not be publicly available. Industry and MCS practitioners may also be able to provide advice on some of the key input parameters underlying estimation (e.g. average hold size for IUU fleets, average trip length and fishing strategy for IUU vessels based on previous prosecutions, etc.).

- **Use of expert judgement** – given the frequently patchy nature of information available on IUU fishing, the judgement of persons considered experts in the issue at hand can often be used to fill in the blanks in available information. Expert judgement can also be used to provide a secondary or tertiary source of data to help triangulate IUU fishing estimates.
- **Checking draft outputs** – presenting and discussing draft outputs with informed stakeholders, and refining inputs and outputs where necessary, can be a valuable exercise, leading to more accurate and plausible estimates. In addition to involving stakeholders in study design, it can help build stakeholder confidence in the outcomes and better position the results to be picked up in practice.

With that in mind, the best IUU fishing estimation studies will incorporate mechanisms to allow for meaningful stakeholder participation. This could be arranged, for example, through a series of workshops, establishing a study steering committee or advisory committee, involving stakeholders on study teams where appropriate or formal processes to check draft outcomes to ensure practicality.

Studies completed in isolation from interested stakeholders run the risk of focusing on the wrong things, missing important IUU fishing activity and arriving at conclusions that may not be plausible. There is also a higher chance that project outputs will be viewed with suspicion and provoke a negative response upon publication.

3.2.2 Risk identification/assessment

3.2.2.1 Risk identification

Where the objective of the study is to assess the total IUU fishing within a defined fishery unit, a formal process of IUU fishing risk identification and/or risk assessment can assist in ensuring that the full scope of IUU fishing activities are captured and appropriate distinctions/definitions are made between each.

Although the two terms are sometimes used interchangeably, it is worth noting that they are not the same thing. As the name suggests, in the context of IUU fishing estimation risk identification is the process of identifying and defining IUU fishing risks within a fishery unit (unlicensed fishing, under-reporting target species, non-reporting of bycatch, illegal transshipping, etc.). The nature of the risks will be influenced by the legal frameworks in place for the relevant area. The process of clearly defining IUU fishing risks/activities through a formal risk identification exercise can help ensure comprehensiveness and minimize the opportunities for double counting.

3.2.2.2 Risk assessment

By contrast, risk assessment builds on risk identification by applying some form of qualitative or quantitative judgement as to the relative importance of each risk to the overall IUU fishing problem based on the information available. The process of risk assessment can help IUU fishing estimation studies focus on activities likely to comprise the greatest component of overall IUU fishing and thereby make the best use of limited resources. Nevertheless, it should be recognized that studies that only incorporate IUU fishing activities considered highest risk may lose the quantitative picture of relativity between higher and lower risks, which can be important in MCS planning.

The process of risk identification/assessment is best undertaken in a participatory manner with stakeholders and can often be done as part of an integrated exercise that involves the definition of study objectives and scope, risk identification/assessment, and identification of possible data sources to support estimation.

3.2.3 Checking/peer review

3.2.3.1 Checking

As described above, the process of checking preliminary study outputs with informed stakeholders/experts can add significant value to overall study outcomes. This can provide an important filter to ensure relevance and credibility to study outputs and any conclusions drawn, can help detect and correct at an early stage implausible outputs that would otherwise undermine the overall credibility of the study and can help build stakeholder support and improve the chances of the outcomes of the study being used in practice.

Depending on the nature of the study, checking could be done through a formal workshop, or alternatively by allowing stakeholders and independent experts to review draft reports prior to publication.

3.2.3.2 Peer review

Formal peer review is arguably a slightly different process involving the critical examination of study methodology and the reasonableness of the interpretation of results by a relevant expert/s not involved in the study team. A formal peer-review process may not be required for many studies (particularly those not published in the scientific literature); however, the exercise can help strengthen the robustness and defensibility of outcomes. The best studies may undertake both the process of checking and peer-review. However, where some form of checking is not carried out, every effort should be made to ensure at least one peer-reviewer has a strong familiarity with the fisheries in question.

4. OTHER KEY ISSUES

In addition to the guiding principles provided above, this section highlights several issues commonly faced by IUU fishing estimation studies and provides guidance to encourage consistency across studies.

4.1 Double counting

Double counting occurs when a single unit of IUU fishing activity (e.g. a tonne of unaccounted for fish) is counted twice or more in estimates. It is a particular challenge when estimating IUU fishing across multiple IUU fishing activities, fisheries or areas.

For example, a single tonne of IUU fish that is harvested in a closed area, not reported in logbooks and then transshipped illegally may be counted up to three times in overall estimates of IUU fishing activity if each of these values are estimated independently. To that end, if not identified and accounted for, double counting has the potential to bias overall outcomes.

The opportunities for double counting will be largely dependent on the scope of the study and the nature of the IUU fishing activities being estimated. Broadly, the opportunities are of two types:

- In the context of a single IUU fishing study, double counting may occur if individual units of IUU fish are included in estimates of multiple IUU fishing activities. For example, MRAG Asia Pacific (2016) identified the potential for double counting in their study of Pacific tuna fisheries, which estimated the volume and value of IUU fishing activities across different parts of the supply chain (e.g. catching, reporting, transshipping). In this case, there was potential for double counting if the same IUU fish were involved in multiple activities (e.g. fish taken in EEZ to which the vessel had no licence, not reported in logbooks and then illegally transshipped). The potential for double counting is arguably highest in bottom-up approaches that estimate IUU across multiple IUU fishing activities separately, although the scope for double counting also exists in top-down methodologies (e.g. Lack and Sant, 2001).

- In the context of attempting to combine estimates of IUU fishing activity from multiple studies into a single overall estimate for a fishery or region, potential for double counting exists where there is overlap in the scope of different studies (e.g. where estimates of IUU fishing activity are made for the same fishery/geographic area across multiple studies). Recognizing and accounting for this type of double counting is a particularly important consideration in any attempt to produce an updated global/regional estimate of IUU fishing activity from multiple pre-existing studies, or alternatively in the design of any new coordinated effort to estimate global IUU fishing from multiple discrete fishery units.

While the potential for double counting is a common challenge for all studies attempting to estimate IUU fishing volume and value across multiple IUU fishing activity types and/or geographic regions, its impacts can be minimized through a series of hierarchical steps:

- **Eliminate the potential for double counting in study design** – first and foremost, potential areas of double counting should be identified and eliminated where possible in the design phase of the study. This could be through a series of justified assumptions where multiple forms of IUU fishing activity are being estimated (e.g. all catch taken by unlicensed vessels is also likely to be unreported, therefore catches from these vessels are only included in unlicensed catch estimates), or by carefully designing the scope of discrete units to avoid overlap where IUU fishing activity is being estimated across multiple fisheries and/or geographic areas.
- **Provide quantitative estimates of double counting if possible** – where the potential for double counting cannot be entirely eliminated in the study design but capacity exists to quantify the extent of double counting (e.g. where there is evidence of the proportion of overlap in IUU fishing estimates between two studies or individual IUU fishing activities for which estimates are being combined), quantitative estimates should be provided with justification and overall figures adjusted as required.
- **Where quantification is not possible, explicitly recognize the possibility of double counting and discuss the implications** – where potential for double counting cannot be eliminated at the design stage, and the extent cannot be accurately quantified, the potential for double

counting should be explicitly recognized and its implications on overall estimates discussed. For example, is residual double counting likely to substantially bias results? If so, how? Across which activities/fisheries/areas is it likely to be most prevalent? If it's not likely to bias results, why not? This discussion should be provided in sufficient detail to allow the reader to make an informed judgement about the reasonableness of the conclusions reached.

4.2 Combining estimates from different studies

Within a single study, where the project team has a good understanding of how each individual IUU fishing estimate was derived, of their likely statistical properties and of their limitations, estimates of multiple activities may be combined with some confidence.

Regional studies usually attempt to combine such estimates to derive estimates of total IUU fishing (e.g. total unreported catch of species X = estimated unlicensed vessel catch of species X + estimated unreported retained quantity of species by licensed vessels + estimated unreported discarded quantity of species X by licensed vessels). Generally, confidence intervals estimated for the different types of IUU fishing are of quite different forms and robustness, and the only practical way of deriving combined estimates of confidence around the total is through analytical techniques such as bootstrapping or Monte Carlo simulation.

It is more difficult to combine estimates from different studies, although there may be an interest and need to do this. For instance, there may be some interest in combining an estimate of unreported catch of species Y with a separate estimate of unlicensed fishing on the same stock to achieve an estimate of overall unreported mortality. In some circumstances this would be possible, particularly where the general principles outlined in this paper have been followed, such that the statistical properties of the various estimates are known.

Global estimates have, in the past, been based on combining studies from the literature. This practice suffers from the difficulty of being able to use studies that are temporally coincident and that are fully transparent in their methodology and statistical properties. We would advise against IUU fishing projects that attempt to combine data/sources from widely differing studies. If large scale combined estimates are attempted, wherever possible reference

should be made to the original authors, and to the fact that data are limited to a narrow temporal window. In any case, these approaches will likely only produce a reliable top-down estimate with quite wide confidence intervals, although they may also be able to make use of metadata relationships (such as the relationship between IUU fishing and governance identified by Agnew *et al*., 2009).

4.3 Estimating economic consequences

Once the volume and species composition of IUU fishing activity have been estimated, many studies will seek to provide an indication of the economic consequences of the problem. This has most frequently been done through an estimate of the value of the IUU fishing products (e.g. Agnew *et al*., 2009), or sometimes through an estimate of the loss to coastal States (e.g. MRAG Asia Pacific, 2016; 2021). Having an accurate picture of the economic impacts arising from IUU fishing activity can be valuable for advocacy purposes, as well as in evaluating the cost effectiveness of potential MCS solutions.

This section provides some high-level advice on the most common approaches for estimating value from volume and introduces some of the differences between value and loss. The intent is not to provide a detailed treatise on economic valuation methods, but to encourage consistency in the presentation and discussion of the economic consequences in IUU fishing estimation studies.

4.3.1 Estimating value from volume

Once IUU fishing volume and species composition have been estimated, assigning a value to the IUU catch is usually undertaken through a relatively straightforward multiplication of volume and the associated price, according to the following formula:

$$TR = Q \times P \qquad \textit{(Equation 1)}$$

Where TR is the total revenue (or value) of IUU catch, Q is the estimated IUU fishing volume and P is the associated value per unit volume. For example, if it was estimated that 5 000 tonnes of catch was illegally taken and it was determined the value per tonne was USD 3 500, then the total value of IUU fishing product would be 5 000 T x USD 3 500 = USD 17.5 million.

There are two options most commonly used for assigning a price per unit volume: ex-vessel price and market price.

Ex-vessel price is the price per unit a vessel operator receives when selling the product to the next point in the supply chain (e.g. a seafood trader). The ex-vessel price is also sometimes referred to as the free on board (FOB) price. Unless the vessel operator is part of a vertically integrated company, the ex-vessel price can be assumed to be a reasonable reflection of the value of the IUU fishing product received by the fisher.

By contrast, market value is typically estimated based on a market price found at a commonly accepted marketplace for a given fishery (albeit market value is often ill-defined and technically could be the price at any point in the supply chain where goods are traded). For example, sashimi grade tuna will often use Japanese auction markets as a price guide and canning grade tuna may use Thai customs import prices.

Given that fisheries products often go through multiple links in the supply chain, each with their own overhead, market value will almost always be higher than ex-vessel value.

There is no standard metric to assign value to estimated IUU fishing volumes and each of the two approaches have pros and cons. For example, market prices were used to calculate estimated values of IUU fishing product in a study of IUU fishing in the Bay of Bengal Large Marine Ecosystem (BOBLME, 2015), while ex-vessel values were used to calculate the value of IUU fishing product in Western Pacific tuna fisheries (MRAG Asia Pacific, 2016; 2021).

Ex-vessel value is arguably a better reflection of the price (and is, therefore, a component of the incentives) available to fishers from IUU fishing; however, such figures may not always be readily available. To calculate ex-vessel value from market price, the analyst will need to discount all supply chain costs up to the point of vessel landing. However, this information is typically not available to the public so obtaining it usually requires industry access, knowledge, and/or experience. The use of ex-vessel value will also produce a lower overall estimate of IUU fishing value than market value, so may dilute the value of studies that aim to produce a big number for advocacy purposes.

Market values are often easier to obtain than ex-vessel price (for example, through trade data services such as United Nations Comtrade [UN Comtrade, 2022] or GLOBEFISH [GLOBEFISH, 2022]), although differences in value adding along the supply chain may obscure incentives for IUU fishing at the fisher level. Nevertheless, the consistent and widespread availability of market values means they are relatively easy to apply across multiple species and product types and allows for straightforward apples vs apples comparisons of impact across different fisheries/jurisdictions.

Irrespective of which value is ultimately chosen, it is essential that the approach and data sources are set out explicitly such that studies can be repeated over time and meaningful comparisons can be made.

4.3.2 Accounting for multiple species and illegal, unreported and unregulated activities

The discussion above provides a very basic formula for estimating total revenue *TR* for a single species of fish taken through IUU fishing means. However, in many cases IUU fishing activity will result in several species being taken, all of which may be sold. Moreover, if the objective of a study is to estimate the total value of IUU fishing activity in a particular fishery/area, the estimated value of multiple IUU fishing activities may need to be calculated.

If the IUU catch estimate includes multiple species, the different species will almost certainly have different quantities Q and prices P. This can be accounted for with a slight amendment to Equation 1) which is:

$$TR = \sum_s (Q_s \times P_s) \qquad \textit{(Equation 2)}$$

where Q_s is a value of IUU catch for each species and P_s is the associated price for each of those species. The product of quantity and price for each species is calculated and each are then added together to estimate the total revenue.

Where multiple IUU fishing activities occur within a fishery, it is possible that both catch composition and the value per unit volume will vary between activities. For example, an unlicensed free school purse seine set could result in 20 tonnes of skipjack tuna only, while a set on a fish aggregation device (FAD) during a moratorium period could result in 20 tonnes of catch that consists of 15 tonnes of skipjack, 4 tonnes of yellowfin tuna, and 1 tonne of bigeye tuna. While these two examples result in the same overall IUU fishing volume (20

tonnes), the catch composition and therefore value of IUU product is different. Moreover, it is possible that some forms of IUU fishing activity will target the same fish species at different stages in their life cycle, resulting in different values (for example, one IUU fishing activity may harvest juveniles, whereas another IUU fishing activity may target higher priced adults).

It is possible to factor in differences in prices received across different IUU fishing activities with a further amendment to the total revenue equation, which is:

$$TR = \sum_a \sum_s (Q_{sa} \times P_{sa}) \qquad \textit{(Equation 3)}$$

where Q_{sa} is the IUU catch quantity of a species through a certain activity and P_{sa} is the price of that species taken by that activity. The product of quantity and price is calculated for each species under one IUU fishing activity and is then summed up. This step is repeated for each of the different activities and then these are all summed to provide a total revenue estimate.

Where double counting is likely across different IUU fishing activities, a value of zero can be assigned to P_{sa} for each instance in which the estimate is likely to be a repeat of the original quantity of fish.

4.3.3 Value versus loss

A key concern of many IUU fishing studies is to estimate the losses to various stakeholders from IUU fishing, and in particular to coastal States. Where only the ex-vessel or market values of IUU fishing are presented, there is often an implicit assumption that these values represent the revenue lost to coastal States. However, value may not equal loss in many cases (e.g. because the full value of fishing revenue may not flow to coastal States under normal circumstances).

Consider the following fairly common scenario in which a developing coastal State collects revenue by licensing foreign fishing vessels to access its waters: In the relevant fishery, the average annual revenue per vessel (i.e. the total ex-vessel value of the catch) is USD 1 million. If the coastal State set the access fees at the full ex-vessel value of the catch (USD 1 million), the fishing vessel would be unviable because there would be no money to pay for the costs of fishing (e.g. fuel, crew wages, maintenance). To that end, assuming the coastal State wants licensed fishers to remain viable, they can only expect

to recover a proportion of the value of the catch. While the nature of access fee arrangements vary markedly around the world, many States aim to set fees at a level roughly equivalent to rent from the catch. In economic terms, rent is the residual left over after production costs, capital provisions and normal profits are deducted from the revenue generated from the sale of the fish. In this scenario, if we assume a rent value of 5 percent, the revenue that would flow to the coastal State through access fees would be USD 50 000.

Using the same logic, the coastal State could not expect to receive the full value of any catch taken through IUU fishing activity. Looking at it another way, if MCS was strengthened such that IUU fishing was reduced by USD 1 million and the coastal State could sustainably license one additional foreign vessel, the revenue received would not be the full USD 1 million – it would be USD 50 000.

It is also worth noting that the types of mechanisms in place to collect revenue from the fishery can have a substantial influence over the extent of actual losses in a fishery. Consider the following two fisheries: 1) Fishery A is charged a flat fee of 5 percent of the value of its catch as an access fee and has no observers or other measures in place to independently validate catch. 2) Fishery B is subject to a competitive process in which fishing companies bid for access to the fishery (in terms of fishing effort or quota) annually and is also subject to 100 percent observer coverage, cost-recovered from industry. In Fishery A, under-reporting of catch is likely to result in direct losses in revenue because arrangements to collect rent are inefficient and there are no mechanisms to detect under-reporting. In Fishery B, under-reporting can be picked up and corrected by observers and the competitive nature of the bidding process will mean that fishing companies will take into account both reported and unreported catches in their calculations of how much to bid for access. To that end, efficient mechanisms to collect rent from licensed vessels together with strong MCS arrangements can limit the extent of losses from IUU fishing in practice.

In practice, calculating the actual losses to coastal States (and other stakeholders) from IUU fishing will in most case be a complex exercise and require a detailed understanding of the economics of the sector and associated value chains, the mechanisms available to collect rent and the potential direct costs (e.g. lost rents, MCS) and indirect costs (e.g. reduced stock productivity, foregone taxes, opportunities lost) involved. In the context of these guidelines,

the important point is that the value doesn't necessarily equate to loss and care should be taken by the authors of IUU fishing estimation studies to avoid conflating the two when discussing study outcomes.

FAO's intention is to develop a dedicated volume on estimating impacts from IUU fishing as part of this series.

4.4 Other illegal, unreported and unregulated fishing impacts

In addition to estimating volume and value of IUU fishing, study authors should discuss the main consequential impacts arising from such fishing. These should be considered in the context of fishery/management system/economy being assessed, although they may include:

- **Broader ecosystem impacts** – IUU fishing is often undertaken with fishing gear that is destructive to the aquatic environment. Impacts may be felt by ETP species (e.g. through the non-use of impact mitigating gear types), habitats (e.g. through the illegal use of bottom trawl apparatus) and the broader ecosystem (e.g. through trophic cascades associated with the illegal harvest of keystone species or unsustainable volumes of biomass from a particular trophic level).
- **Socio-economic impacts** – the impacts of IUU fishing on communities and economies dependent on fish stocks can be myriad and complex. Although there may be some short-term benefit to some stakeholders (the IUU fishers and associated supply chains), experience indicates that the impacts are overwhelmingly negative, particularly in the long term. Impacts may be felt on local employment (e.g. where IUU fishers are competing for catches with legitimate fishers) as well as on local supply chains (e.g. where IUU fish is diverted away from local supply chains into export supply chains). Impacts may also be felt disproportionately by women (e.g. where the supply of legal fish to post harvest processing facilities is reduced) and may mean a deterioration of labour standards (e.g. where IUU vessels are associated with slavery and other labour and human rights abuses). Considerable impacts may also be felt at the coastal State government level through loss of foreign or domestic fishing access revenues and the need to fund additional MCS resources (or reallocate limited resources to MCS, which could otherwise be invested in productive sectors of the economy).
- **Food security** – IUU fishing can have an impact on food security at the local level by depleting key food fish stocks by IUU fishers and by

redirecting IUU caught fish to alternative markets. Where food security is likely to be impacted by IUU fishing, studies should identify the stakeholders and sectors most affected.

- **Data integrity/management capacity** – given its largely hidden nature, a key impact of IUU fishing activity is that it undermines official data sets used for stock assessment and other fisheries management purposes. Weakening the integrity of official datasets in turn weakens the capacity of fisheries agencies to manage stocks and impacts effectively. Where available data is likely to be compromised by IUU fishing (bearing in mind that unaccounted for catch may be either positive or negative – in some cases there may be incentives to over-report catch in the lead up to allocation exercises), the main impacts and implications should be discussed.
- **Geopolitical impacts** – IUU fishing, particularly that undertaken by vessels flagged to one country fishing in another's waters, can result in heightened geopolitical tensions between countries and regions. While this is perhaps most obvious in the case of unlicensed foreign fishing, there are numerous examples of sensitive political situations arising from licensed foreign fishers breaching license conditions. Moreover, where stocks are shared, IUU fishing by domestic fishers in one State may have impacts on other States, leading to political tensions.
- **Food safety** – Although much of the fish taken through IUU fishing means may ultimately find its way into legal supply chains, there is a risk that fish taken illegally may not be subject to the same food safety standards and inspection regime as legally produced fish.

Studies should identify and discuss other key impacts where appropriate.

Impacts should be discussed at least qualitatively, or quantitatively if data is available to support estimates.

5. PRESENTATION OF RESULTS

5.1 Technical considerations

The best format for presenting study outcomes will be influenced to some extent by the nature and objectives of the exercise, the target audience and the medium in which the results are presented (e.g. academic paper, technical report, policy brief). Space restrictions for academic journals may mean there is less latitude to go into detail around the methodology and key results, while policy briefs will want to go straight to the point.

Nevertheless, there are common elements for presenting the methodology and outcomes of IUU fishing estimation studies that will help improve their understandability and allow the reader to make an informed judgement about the reasonableness of the methodology used and the credibility of the outcomes. Many of these are discussed in some length in section 3. Rather than repeat these here, Table 2 provides a brief checklist that study authors may wish to use as a guide to ensure that key content and formatting considerations are incorporated into study outputs.

Table 2. Checklist of key considerations in the presentation of illegal, unreported and unregulated fishing estimation studies

Yes/No?	Presentation element
	Are the objectives of the study clearly stated?
	Is the scope of the study clearly outlined, i.e. which fisheries, which species, which geographic area, which timeframe and which components of IUU fishing?
	Are all important interpretations of IUU fishing at the level relevant to the study explicitly stated? Are the implications of alternative interpretations discussed?
	Is the methodology set out in sufficient detail to allow a reader to make a judgement as to its reasonableness, and allow an independent group to reproduce the methodology if required?

	Is the reasoning for choosing the methodology used made clear?
	Are all data sources used clearly set out, together with any information gaps? Are the main implications of any data gaps discussed?
	Are all key assumptions explicitly spelled out in sufficient detail to allow a reader to make a judgement as to their reasonableness, with the implications of alternative plausible assumptions spelled out?
	Are estimates of statistical confidence provided around all estimates?
	Where economic value has been estimated from volume and species composition, is the approach to valuation (e.g. ex-vessel vs market price) clearly spelled out, together with data sources? Where loss to coastal States or other stakeholders has been estimated, is it clear how the estimates were arrived at?
	Are the main implications of the study outcomes (e.g. extent and types of IUU fishing, estimated volumes, species composition and value of IUU product) discussed in the context of fisheries management, science and compliance?

5.2 Encouraging uptake

For IUU fishing estimation studies to have more than academic value, the outcomes need to be picked up and applied by relevant stakeholders. This could be politicians considering future spending priorities, MCS practitioners planning deployment of resources or scientists refining stock assessment models, among others.

While encouraging uptake is often thought of as something that happens after a study is completed, the reality is that much of the work to ensure that outcomes are adopted needs to be completed in the study design and early implementation phases.

This section sets out a (non-exhaustive) range of practical measures that study authors and funders can take to improve the uptake of study results. Broadly, these are broken down into actions occurring before the study commences (before study), while the study is being undertaken (during study), and after the study is completed (post study).

5.2.1 Before the study

Arguably the most important period for encouraging the uptake of an IUU fishing estimation study is not after the study is completed, but before it has begun. Involving the key stakeholders at the early stages of the study design will mean the questions being asked are the ones of most relevance, while allowing participants to contribute to and refine the methodology where necessary means the study is more likely to proceed in a way that gives them confidence in the outcomes.

The rapport established in these early stages, through collaboratively setting the direction of the study and dealing with any methodological challenges, can often be invaluable in laying the groundwork for the uptake of the study outcomes during later stages.

The process of involving stakeholders in the study design and the definition of objectives can take a number of forms including study design workshops or one-on-one meetings with key stakeholders.

5.2.2 During the study

As discussed in section 3.2, there are a range of mechanisms that can be used to encourage a participatory study process, and therefore better ensure credibility and relevance of outcomes and ultimately the uptake of results. These include the use of stakeholder-inclusive project steering committees to help guide study implementation, assist with interpretation and facilitate access to information, and the process of checking results with stakeholders to ensure project outcomes are plausible based on collective experience.

For longer running studies, written study updates or presentations on progress to key stakeholders may be undertaken.

5.2.3 Post study

Following the completion of the study, there are a range of mechanisms available to raise awareness and encourage uptake, which can be tailored to the target audience. These include:

- **Media event/study launch** – media events to launch project reports have been used successfully to promote awareness for a range of different IUU fishing studies. The issue of illegal fishing often attracts media attention, particularly where big numbers are involved, and widespread media coverage can play a strong role in influencing decision-makers to take action to address IUU fishing. While there is often limited control over how the outcomes of reports are presented by media outlets, care should be taken in written materials to ensure all results are presented accurately and in context. Press releases should be drafted by trained media professionals where possible, but with the involvement of the study authors to ensure accuracy in the presentation of outcomes. Media launches tend to work best when interested stakeholders are involved and are supportive of the outcomes of the study, this is more likely where stakeholders have been actively engaged at all stages (rather than simply asked to turn up at the concluding media event).
- **Meetings with key decision makers/influencers** – where the objective of a study is to influence government (or other) decision-makers (e.g. to invest in new MCS assets, to establish new bilateral/multi-lateral instruments to tackle IUU fishing), there can be considerable value in arranging for face-to-face meetings with key decision-makers (e.g. senior politicians) and influencers (other parties with capacity to influence decision-makers (e.g. non-governmental organizations, public thought leaders). Arranging for in-person meetings allows for the key results and implications of the study outcomes to be transmitted directly to the key decision-makers and allows them to ask questions and receive answers that would assist them in directing future policy.
- **Policy briefings** – policy briefings summarize the main outcomes of the study and focus mainly on what those results mean (e.g. in the context of fisheries management, MCS planning, science or economics). Policy briefings can be concise written summaries highlighting the key issues or delivered in person to groups of key stakeholders (e.g. to a relevant government standing committee).
- **Social media/web presence** – the increasing use of social media in recent years and the widespread access to the internet within most

countries offers study authors a range of novel means to raise awareness of study outcomes. In particular, the nature of social media networking means that key study outcomes can be distributed among large numbers of people virtually instantaneously. Social media strategies can be tailored to particular audiences, with information available through a central website for those seeking further details. While social media users may not be decision-makers in their own right, politicians and others with the capacity to influence the operating environment for IUU fishers are often highly attuned to social media activity. To that end, a strong social media reaction to study outcomes can play an important role in creating the right conditions for positive change.

6. CONCLUDING REMARKS

Almost two decades after adopting the IPOA-IUU, IUU fishing in its various guises remains one of the most important challenges facing world fisheries. Despite the impressive progress made in combatting the problem by FAO and its members, IUU fishing continues to undermine responsible fisheries management regimes with varying degrees of severity in many parts of the world. Moreover, there is evidence that as our efforts to combat existing forms of IUU fishing have borne fruit, new forms of IUU fishing activity have developed. To that end, it is important to have an accurate contemporary picture of IUU fishing activity both to understand its ecological and socio-economic consequences and to best target future mitigation efforts.

Methodologies to estimate IUU fishing activity have evolved considerably over the past 20 years and are likely to continue to develop as new information and technologies become available and new groups of smart people apply innovative thinking to the problem. In particular, continuing advances in data analytics and the increasing availability of information from remote sensing technologies appear to offer exciting possibilities in the detection and estimation of some forms of IUU fishing. As a result, the methodologies provided here and in Volume 3 of this series should be seen as a starting point only, with the development of innovative new approaches both welcomed and encouraged.

Nevertheless, while the specific techniques used to estimate IUU fishing may change over time, the general approaches to ensuring quality and consistency in estimation studies should remain relatively constant. To that end, the framework of best practices set out in these guidelines should serve as a useful frame of reference for all groups involved in undertaking, commissioning or evaluating IUU fishing estimation studies. Incorporating these approaches into the study design and implementation will help strengthen the credibility and robustness of the estimates, as well as ensuring outputs are both relevant and informative for stakeholders.

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Illegal, unreported and unregulated (IUU) fishing is a recognized global problem that undermines the integrity of responsible fisheries management arrangements. This can result in loss of revenue and threats to food security, which are often hardest felt in developing coastal States that rely heavily on fishing for income.

One way of combatting these threats is to estimate the amounts taken as a first step toward quantifying losses and planning effective countermeasures. Since the magnitude of IUU fishing estimates can vary widely based on the definitions used, the methodologies selected and the assumptions applied, it is critical to invest time in developing case-specific objectives and study designs.

While there is no single best practice methodology, this document sets out a number of guiding principles that should always be incorporated into study design and implementation. As estimation approaches continue to evolve, the lasting value of these guidelines lies in providing a framework to help ensure that the results are credible, robust and relevant regardless of the methodology selected.

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