FISHERIES ECONOMICS RESEARCH UNIT

Assessing the spatial burden of harmful fisheries subsidies

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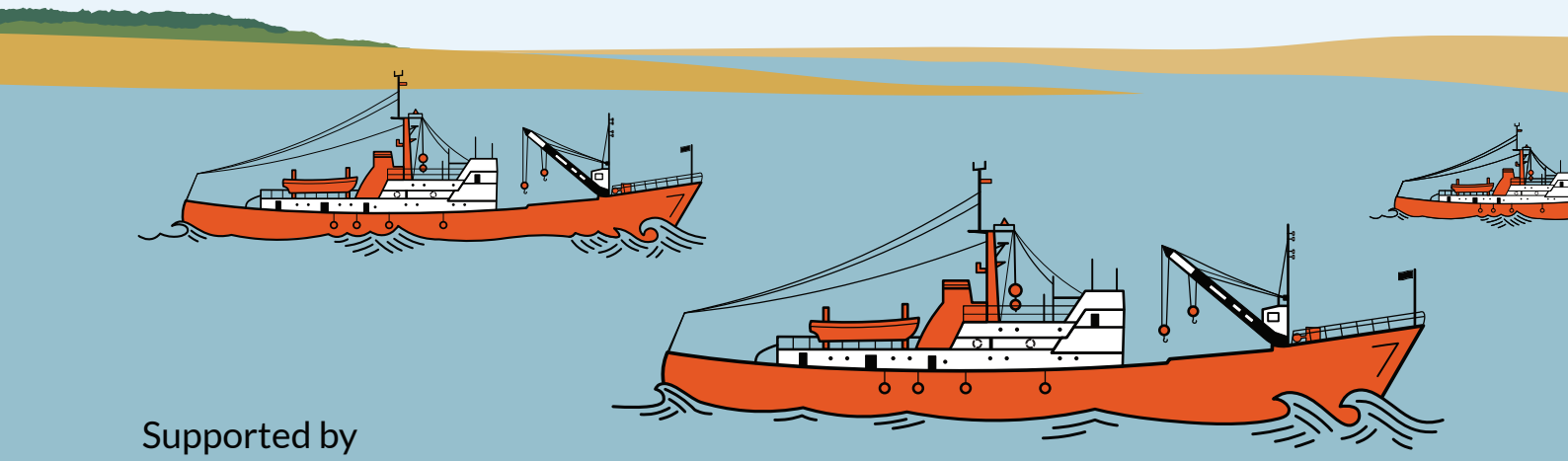

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List of abbreviations

ABNJ	Areas Beyond National Jurisdiction
DWF	Distant Water Fishing
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
FERU	Fisheries Economics Research Unit
HDI	Human Development Index
HSF	High Seas Fishing
IUU	Illegal, Unreported and Unregulated
LSF	Large Scale Fishing
NM	Nautical Miles
OECD	Organization for Economic Co-operation and Development
SAU	Sea Around Us
SCM	Subsidies and Countervailing Measures
SDG	Sustainable Development Goals of the United Nations
SSF	Small Scale Fishing
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
USD	United States Dollar
WTO	World Trade Organization

1 Introduction

It is generally understood that subsidies provided to the fisheries sector that artificially increase profits or reduce costs—so called 'harmful fisheries subsidies'—result in overcapacity and contribute to overfishing. In 2001, the World Trade Organization (WTO) began negotiations to "*strengthen disciplines on subsidies in the fisheries sector, including through the prohibition of certain forms of fisheries subsidies*" (WTO, 2005). Subsequently, in 2010, 193 countries agreed to eliminate, phase out or reform harmful subsidies by 2020 via the Aichi Biodiversity Targets[1]. This position was strengthened in 2015 by the Sustainable Development Goals of the United Nations (SDGs); Target 14.6 called for the WTO to agree on a prohibition on harmful fisheries subsidies, understood as those which contribute to overcapacity, overfishing, and illegal, unreported and unregulated (IUU) fishing, by the end of 2019 (United Nations, 2015). However, despite almost two decades of negotiations and numerous delayed deadlines, member countries are yet to reach consensus on the rules for fisheries subsidies. Further delay jeopardizes the progress needed to achieve sustainable oceans and equitable fisheries worldwide, which are of heightened importance as they underpin our ability to achieve interconnected SDG targets such as reducing poverty, providing nutritious food, and securing livelihoods for current and future generations (Singh et al., 2018).

Several roadblocks reportedly exist; one is the perception that the impact of the provision of harmful subsidies is localized and only affects national interests, as such multilateral prohibition is unnecessary (Cisneros-Montemayor and Sumaila, 2019). However, many fish inhabit and move between multiple nations' waters and the high seas, thus international cooperation is essential for their management (Miller et al., 2013; Pinsky et al., 2018).

Fishing itself is becoming increasingly transboundary too—the world's fishing fleets have been moving progressively further offshore and now operate across multiple jurisdictions (Clarke and Munro, 1991) including areas beyond national jurisdiction (Hannesson, 1995). Furthermore, the majority of harmful fisheries subsidies have been shown to be directed towards large, industrialized fishing fleets that are more likely to operate outside of national waters—a fisher involved in large-scale fishing (LSF), on average, benefits from three and a half times more subsidies than a fisher involved in small-scale fishing (SSF) (Schuhbauer et al., 2020). As such, understanding the subsidies provided to these LSF fleets capable of operating across numerous regions is of international concern.

This study therefore focuses on the degree to which harmful fisheries subsidies are contributing to distant water fishing (DWF) including high-seas fishing (HSF). The study combines existing global datasets in order to estimate the extent to which host countries and large marine ecosystems are affected by the largest subsidizing nations, and in doing so maps the spatial distribution of the impact of fisheries subsidies throughout the ocean. The study aims to answer the following research questions:

1. What is the link, if any, between the provision of harmful subsidies and the prevalence of distant-water and high-seas fishing? and;
2. What is the spatial distribution of the impact of harmful subsidies and which parts of the ocean suffer the consequences of the top-ten highest subsidizing countries?

[1] https://www.cbd.int/sp/targets/rationale/target-3/

1.1 Objectives

The objective of this research is to reveal to the public and policy makers the connection between the provision of harmful fisheries subsidies and the over-exploitation of shared fish stocks by DWF and HSF fleets. The outputs are intended to serve as a tool for effecting policy change, particularly multilateral agreement at the international level. This will be achieved using a series of global datasets compiled over the last two decades by the Fisheries Economic Research Unit (FERU) and the Sea Around Us (SAU).

Specifically, this will be achieved via the following sequential steps:

1. Conduct a literature review of DWF and HSF activities;
2. Identify the top-ten countries that provide the highest amounts of harmful subsidies;
3. To the extent possible, determine the degree to which subsidies support DWF and HSF;
4. Estimate the proportion of harmful subsidies that goes to SSF, DWF and HSF fleets;
5. Determine where the DWF and HSF of these top subsidizers operate;
6. Estimate the spatial distribution of the potential damage due to overfishing that harmful subsidies cause; and
7. Discuss the implications of the findings of the study.

2 Approach

The study draws on a number of existing datasets in order to re-analyze the provision of fisheries subsidies and the potential role subsidies play in driving DWF and HSF fishing. The study uses the following public datasets:

- Data published by FERU on the absolute amount of fisheries subsidies provided by maritime countries in 2018 (Sumaila et al., 2019b);
- Data published by FERU on the division of subsidies provided to SSF and LSF by maritime countries in 2018 (Schuhbauer et al., 2020); and
- Data published by SAU on the location, volume and value of catches from SSF and LSF by maritime countries in 2016 (Pauly and Zeller, 2015; Tai et al., 2017).

2.1 Defining fisheries subsidies

There are a number of different but closely related definitions of fishery subsidies (e.g. (Martini and Innes, 2018; OECD, 2005; U. Rashid Sumaila et al., 2010)). However, there is a common thread throughout that is outlined in Article 1.1 of the WTOs Agreement on Subsidies and Countervailing Measures (SCM Agreement)[2], which defines a subsidy as a financial contribution by a government or any public body that confers some kind of benefit. The SCM Agreement contains a list of measures that are considered a “financial contribution”, including; grants and loans to equity infusions, loan guarantees, fiscal incentives, the provision of goods or services and the purchase of goods. The SCM Agreement, however, fails to provide clear guidance on what constitutes a “benefit”. This is where some of the definitions of fisheries subsidies differ.

[2] https://www.wto.org/english/tratop_e/scm_e/subs_e.htm

For the purpose of this study we follow Sumaila et al. (2010), in which fisheries subsidies include all direct or indirect financial payments from public entities to the private fisheries sector, and further categorizes fisheries subsidies as either 'harmful', 'beneficial', or 'ambiguous' in their nature, based on the subsidy's possible impact on fish stock sustainability over time. Due to the focus of the WTO negotiations on the prohibition of harmful fisheries subsidies, we necessarily focus on these throughout the present study. Harmful subsidies are broadly defined as any subsidy that artificially increases revenue or reduces the costs of fishing and include support for vessel construction, renovation and modernization, tax exemptions, fuel subsidies, and investment in marketing and processing infrastructure (Sumaila and Schuhbauer, 2018).

2.2 Defining fishing fleets

For the purpose of this study each country's fishing fleet is divided into two broad sub-sectors—the SSF fleet, including subsistence and artisanal fisheries and the LSF fleet, including industrial and semi-industrial fisheries. The LSF fleet is further broken down into Domestic LSF, DWF and HSF fleets. Currently there exists no single definition of what is regarded as SSF and LSF that is applicable across all countries (Gibson and Sumaila, 2017). We therefore apply the definitions used by Schuhbauer et al. (2020). We also provide our own definitions of DWF and HSF, based on the form and limitations of the available datasets.

2.2.1 Small-scale fishing

This includes artisanal, subsistence, and small-scale commercial and non-commercial fisheries. They usually consist of small vessels using fixed fishing gears and are assumed to only operate within domestic waters (i.e., in their country's EEZ, <200NM from shore). Within their EEZ they are further usually limited to the inshore areas, to a maximum of 50 km from shore or to a depth of 200 m, whichever comes first (Pauly and Zeller, 2016). Some maritime countries provide their own definition of SSF, and these are used where available (see Schuhbauer et al. 2020 for further detail).

2.2.2 Large-scale fishing

This essentially includes all other fishing activities that are not included within the SSF definition. This usually consists of large vessels with fixed and/ or mobile fishing gears fishing within a countries EEZ, and also includes all fishing taking place outside of a country's own EEZ. Essentially all LSF fleet are assumed to engage in commercial fishing activities.

For the purpose of this study, the LSF fleet is divided into the following three sub-sectors:

- *Domestic large-scale fishing*. This sub-sector of the LSF fleet includes the catch of any vessel that is not considered to be SSF made from within the EEZ of the maritime country under which the vessel is flagged;
- *Distant-water fishing within EEZs*. This sub-sector of the LSF fleet includes the catch of any vessel that is made from the EEZ of any other maritime country other than the maritime country under which the vessel is flagged; and
- *Distant-water fishing within the high-seas*. This sub-sector of the LSF fleet includes the catch of any vessel that is taken from either the high seas or any area beyond national jurisdiction (ABNJ, >200NM from shore).

2.3 Analysis

From the global subsidies dataset provided by Sumaila et al. (2019a), we first identified the top ten countries in terms of the absolute amount of fisheries subsidies provided in 2018. The countries that made the list were: China, Japan, South Korea, Russia, USA, Thailand, Taiwan, Spain, Indonesia and Norway (Figure 1). The location, volume and landed value of all marine catches (including reported and unreported, but excluding discards) made by the ten selected countries fishing fleets (including industrial, artisanal and subsistence, but excluding recreational) in 2016 were extracted from the Sea Around Us dataset (Figure 2). We then used these data to estimate the proportion of the amount of harmful fisheries subsidies provided by each selected country to their DWF (i.e. LSF catch taken from other country EEZs) and the HSF (i.e. LSF catch taken from the high-seas or ABNJ) fleets, as explained below.

First, we used estimates for the proportion of total harmful fisheries subsidies provided to the SSF and LSF for each selected country to split total subsidy amounts into the two fisheries sub-sectors (Schuhbauer et al. (2020))[3]. Second, we took the total LSF catch volume from each selected country from: a) within their own EEZ; b) another countries EEZ (DWF); and c) the high seas (HSF), from the Sea Around Us database. Using these two sets of data, we divided the amount of harmful subsidies provided to the LSF for each country proportionally by the volume of landed catch taken by a) Domestic LSF fleet (i.e. LSF catch from taken within their own EEZ); b) DWF (i.e. LSF catch taken from other country EEZs); and c) HSF (i.e. LSF catch taken from the high-seas or ABNJ). This step assumes that harmful fisheries subsidies are provided to the LSF proportionally to the volume of catch taken (by a, b or c) – a strong but reasonable assumption given the data limitations at the scale we are studying.

As the catches made by LSF from another country's EEZ (i.e. DWF catches) are provided at the level of individual EEZs (i.e. the volume of landed catch from each individual country's EEZ is available), we are also able to present the estimated amount of harmful subsidies impacting each individual foreign EEZ.

All monetary values are presented in USD ($), unless otherwise stated and all volumes and of catch are presented in tonnes. All data used are publicly available, and all data and analyses will be made available upon project completion.

3 Literature review

Since the 1950s the world's marine fishing fleet has rapidly grown in scale and has become increasingly industrialized (Watson et al., 2013). This growth culminated in peak global catches in 1996 estimated to be around 130 million tonnes (Pauly and Zeller, 2016). However, in achieving these high catches the global fishing fleet has overfished many target fish species, leading to huge reductions in global fish stock abundance (Myers and Worm, 2003). Furthermore, growing popularity of fish in countries with developed or rapidly developing economies created a demand that could not be met with fish from their own waters. As such, global fishing fleets hit a major dilemma—in order to support the huge fleets that were developing and to meet the growing demand for seafood, they needed to achieve large revenues and large catches, despite dwindling resources (Milazzo, 1998; Swartz et al., 2010).

[3] This study is an extension of the global subsidies dataset provided by Sumaila *et al.* (2019a).

Simply, the solution was further expansion and subsidization. Heavily subsidized industrial fishing fleets began fishing for less desirable fish species and began expanding their range into less exploited waters of other coastal nations (Bonfil et al., 1998; Sumaila and Vasconcellos, 2000; Swartz et al., 2010) and, as technology advanced, they also began fishing in deeper waters and further offshore in to the high seas (Pauly, 2013). This taxonomic and geographic expansion, as well as the support and security that fisheries subsidies provide, ensured that global fish catches were able to fluctuate around the global peak of 1996 despite the ever decreasing resource base. Below, we provide a brief overview of the two key components within this; distant water fishing and high-seas fishing.

3.1 Distant water fishing

Although distant-water fishing existed well before the 1950s—Europeans first fished the Grand Banks in the late 15th century (Roberts, 2007)—the practice expanded rapidly following the advent of more powerful vessels and improved on-board storage facilities. Since then heavily subsidized fishing fleets have steadily expanded the fished area of the ocean from 60% to more than 90%, doubling the average distance traveled to and from home ports during this time (Tickler et al., 2018). The globalization of fisheries is also evident in trade data—over 70% of EU seafood now originates from outside EU waters, mostly from the global South (Paquotte and Lem, 2008; Pauly et al., 2002; U. Rashid Sumaila et al., 2010), and a similar situation is occurring in Japan (Swartz et al., 2010) and China (Pauly et al., 2014).

However, the tendency to fish further from home is not homogenous but has been dominated by a small number of fishing nations, namely Taiwan, South Korea, Spain and China (Bonfil et al., 1998; Swartz et al., 2010). Indeed, the majority of countries continue to fish within their own waters (Tickler et al., 2018). Other nations, including Japan and Russia, also began to expand their fishing activities post-war but retreated somewhat as access to other countries' waters became increasingly restricted (Tickler et al., 2018). Growing competition between domestic and foreign fleets instigated a series of international negotiations that ultimately led to the United Nations Convention on the Law of the Sea (UNCLOS) in 1982, and the introduction of EEZs (Smith, 2017). Although EEZs restricted freedom to fish, DWF remains prevalent. China's DWF fleet is the largest in the world, estimated to consist of between 1,600 and 3,400 vessels, however, data on the true size and scale is sparse and a recent report suggested that the fleet is probably five to eight times larger—12,490 Chinese vessels were observed outside Chinese waters between 2017 and 2018 (Gutierrez et al., 2021).

Much of the DWF occurs in the EEZs of low-income and developing nations. Recent analysis found that 84% of industrialized fishing effort in the EEZs of low-income countries was by foreign DWF fleets (McCauley et al., 2018). Few developing nations fully exploit the fish within their EEZ due to a lack of technical, financial and governance infrastructure (but see, (Atta-Mills et al., 2004)). As such, developing nations tend to grant access to the fish that their domestic fleets do not supposedly exploit (Chen, 2010). In fact, UNCLOS encourages countries to provide access to this 'surplus' via fishing access agreements (Schatz, 2017). While the host country may choose to prioritize local needs before granting access to DWF fleets, this rarely occurs for economically weak countries struggling to obtain foreign currency and service their external debts[4]. Furthermore, short-term financial benefits are invariably

[4] Vidal J (2012) Seven steps to prevent the collapse of west Africa's fishing grounds. The Guardian. Available: http://www.theguardian.com/global-development/poverty-matters/2012/apr/02/stepsprevent-collapse-west-africa-fishing

seen as preferential to long-term sustained local use of the resource, even if the terms are less favorable. It is estimated that China, for example, provide fees equivalent to only 4% of the ex-vessel value of the catch taken by Chinese DWF from West African waters, while the EU pays 8% (Belhabib et al., 2015). In addition to the financial incentives, DWF nations may also provide aid in exchange for access to fisheries resources, this is particularly the case for tuna fisheries (Petersen, 2003). The inclusion of aid as an indirect payment decreases the transparency of fishing access agreements, decreases the flexibility of government spending and exposes certain host nations to large financial risks associated with possible aid withdrawal. Furthermore, these arrangements can stifle the region's own efforts to develop domestic fisheries and broaden their economic activities. There is also evidence that host nations fail to allocate fishing access sustainably. As well as competing against the interests of local people (Toppe et al., 2017), DWF in low-income countries is often associated with unsustainable levels of extraction and with high risks of IUU fishing activities. The lack of adequate financial and technical resources within the host nation often limits proper monitoring, control and enforcement of foreign DWF, resulting in further overfishing (Belhabib et al., 2012; Iheduru, 1995; Kaczynski and Fluharty, 2002; Porter, 1997). Catch data by DWF fleets are regularly under reported and rarely reliable (Kaczynski, 1989; Pauly, 2013). Bottom-up re-estimations of DWF catches in West Africa revealed that the EU and China reported only 29% and 8%, respectively, of their estimated total catches between 2000 and 2010 (Belhabib et al., 2015). The catch from such IUU fishing ends up being traded illegally with significant food security and economic losses to countries in the global South (Sumaila, 2018; Sumaila et al., 2020).

Moreover, governments often underestimate the importance of domestic activities such as processing and marketing which further limits local development. Access to fisheries resources are often very important for local populations in terms of income and livelihoods, but also in terms of the food security they provide. The expansion of DWF fleets, along with other factors such as weak governance and management (Belhabib et al., 2015), have impacted the viability of the fishing operations within some coastal states, where DWF nations operate (e.g. (Atta-Mills et al., 2004)). Traditional, more responsible fishing fleets have been displaced by less responsible DWF fleets and that the most vulnerable host nations are small coastal states with large EEZs that lack the ability to benefit from value adding processes associated with fishing (Gagern and van den Bergh, 2013).

Clearly, DWF raises several social, economic and ecological concerns. That they are also supported by large government subsidies only worsens this situation. Although empirical estimates of the subsidies provided to DWF fleets are lacking, the provision of subsidies in the case of shared access to a fish stock where each country has incentive to provide subsidies has been studied theoretically (Ruseski, 1998). Indeed, a country able to create a cost advantage may provide harmful subsidies to their fleets so that it is not profitable for other fleets to enter the fishery (Quinn and Ruseski, 2001). This suggests that the provision of harmful subsidies to DWF may make it increasingly difficult for host nations to fully benefit from their own fisheries resource now and in the future.

3.2 High Seas Fishing

As well as industrialized fishing expanding into other territories, fishing has also been extending out into the deep ocean and high seas (Morato et al., 2006b). In contrast to DWF

fleets that operate within the (albeit weak) jurisdiction of host nations, the high seas are international waters and the resources they support are ‘owned’ by all citizens of the world, yet are hardly managed at all. Until very recently the composition of the global HSF fleet was largely unknown, however, it is clear that fishing in the high-seas is dominated by a small number of fishing countries (Sumaila et al., 2015)—five countries, China, Taiwan, Japan, South Korea and Spain, account for 64% of all HSF revenue (Sala et al., 2018) and within that most of the activity is conducted by a handful of consolidated organizations, with 100 companies representing 36% of all HSF effort (Carmine et al., 2020).

As well as suffering from similar issues to DWF, such as lack of transparency and increased likelihood of overfishing and IUU fishing, the increased prevalence of HSF poses a number of unique challenges. Firstly, the life spans of many deep-sea fish are often long and their potential growth rates low, leading to them being biologically much more vulnerable to overfishing than coastal counterparts (Froese and Sampang, 2004; Koslow et al., 2000; Morato et al., 2006a; Norse et al., 2012). Secondly, inadequate or lacking management and enforcement has led many important high seas fish stocks to become overfished (Cullis-Suzuki and Pauly, 2010). Thirdly, due to the transboundary nature of many commercial fish species, the efforts made to control fishing activity within EEZs can be swiftly undone as those fish stocks move in and out of the lightly regulated high seas. The ecological vulnerability of these fish and the current dearth of regulation make it profitable for fishing firms to ‘mine’ these resources rather than sustainably exploit them over time (Norse et al., 2012). In the absence of effective regulation, fleets compete to catch as much as they can before others (and before the resource disappears) (Gordon, 1954)—the so called “race to fish” (Hilborn et al., 2003).

Although the ecological impacts of fishing on the high seas are well studied, the lack of transparent data has largely precluded reliable estimates of the costs and benefits of HSF (Sala et al., 2018). However, what is clear is that harmful fisheries subsidies exacerbate the dire ecological situation by keeping HSF fleets at sea beyond the time when fishing remains profitable (Clark et al., 2005) and in order to ensure that fleets can hold a competitive advantage in the race to fish these shared resources (Quinn and Ruseski, 2001). The provision of subsidies to HSF not only provides economic incentives to run down fish stocks as quickly as possible (Clark, 1973; Sumaila and Walters, 2005), but it is also widely believed that HSF is only possible because of the provision of such subsidies (Gianni, 2004; Sala et al., 2018). Indeed, a recent study revealed that HSF in its current state and scale without government subsidies would result in as much as 54% of the present HSF grounds being unprofitable (Sala et al., 2018). Furthermore, Sumaila et al. (2010) estimated that annual subsidies to bottom trawl HSF fleets totaled about $152 million, or some 25% of the total landed value of the catch. The profit achieved by this particular fleet segment is not more than 10% of the landed value, as such, without subsidies the world's bottom trawl HSF fleet would be operating at a loss and would be unable to fish (Ussif Rashid Sumaila et al., 2010). The economic inefficiency of HSF is magnified by the revelation that they contribute such small percentages of global marine fish catches (Gianni, 2004; Schiller et al., 2018; Ussif Rashid Sumaila et al., 2010). Sumaila et al. (2015) showed that less than 0.01% of the quantity and value of commercial fish are from fish that spend all their lives in the high seas (Sumaila et al., 2015).

These economic and ecological concerns have led some to argue for the complete closure of the high seas to fishing. Sumaila et al. (2007) estimated that such a bold policy could be catch-neutral, that is it would result in no loss to fish supply, while inequality in the distribution of

global fisheries benefits could be reduced by 50% simultaneously (Sumaila et al., 2007). The increasing exploitation pressure on high sea resources makes the elimination of subsidies that impact these shared resources crucial (Jacquet and Jackson, 2018).

3.3 Summary

From reviewing the literature it is increasingly clear that globally we are reaching (or have reached) the physical and biological limits of the expansion of wild capture marine fisheries (Tickler et al., 2018). Indeed, there are fewer and fewer 'underexploited' fish stocks left for our fishing fleets to chase (FAO, 2020) and scarcely any regions of the ocean that are unexploited. Therefore, the geographic and taxonomic expansion that historically supported the growth and maintenance of increasingly high global fish catches are now ineffective. Furthermore, the effect such expansion had on masking the underlying decline of global fish abundances have been revealed (Pauly and Zeller, 2017). However, these (largely) inefficient and economically unviable DWF and HSF fleets continue to be supported by unknown levels of government subsidization (but see, (Ussif Rashid Sumaila et al., 2010)). Indeed, in some cases they are estimated to be only viable because of the provision of subsidies.

Evidence shows that activity and subsidization of DWF and HSF is almost exclusively conducted by the industrialized fishing fleets of a handful of high-HDI countries (Schuhbauer et al., 2020; Sumaila et al., 2019a). However, the ecological burden of these activities are clearly shared and concentrated in developing country waters. Estimates of the provision of harmful fisheries subsidies by all maritime coastal states now exist (Sumaila et al., 2019b), and extensions to this work have begun to try to understand how these subsidies are distributed within the different fleet segments (Sala et al., 2018; Schuhbauer et al., 2020; Ussif Rashid Sumaila et al., 2010), however, having a better understanding of the spatial distribution of the harm that these fisheries subsidies cause and in particular the specific EEZs and marine ecosystems that are being impacted has, until now, not been studied.

4 Results

The following section reports the findings from the study, including the identification of the top-ten subsidizing countries and the estimation of the proportion of their harmful subsidies that go to the SSF, DWF and HSF fleets of those identified countries. Finally, we will estimate the spatial burden of harmful fisheries subsidies provided by the top subsidizing countries.

4.1 Provision of subsidies

It was estimated that in 2018 approximately $35.4 billion of fisheries subsidies were provided to the global fishing sector via public sources (Sumaila et al., 2019a). Harmful fisheries subsidies accounted for about 63% of that total, some $22.2 billion, with 'fuel subsidies' being the largest single subsidy type.

Figure 1 shows the estimated amount of harmful, beneficial and ambiguous subsidies provided in 2018 by the ten largest providers of harmful fisheries subsidies. The 'top-ten' countries are largely from Asia (China, Japan, Korea Rep, Thailand, Taiwan, Indonesia), but also include countries from Europe (Russia, Spain, Norway) and North America (USA). No country from Africa, Oceania, or Central and South America and the Caribbean are included in the 'top-ten'.

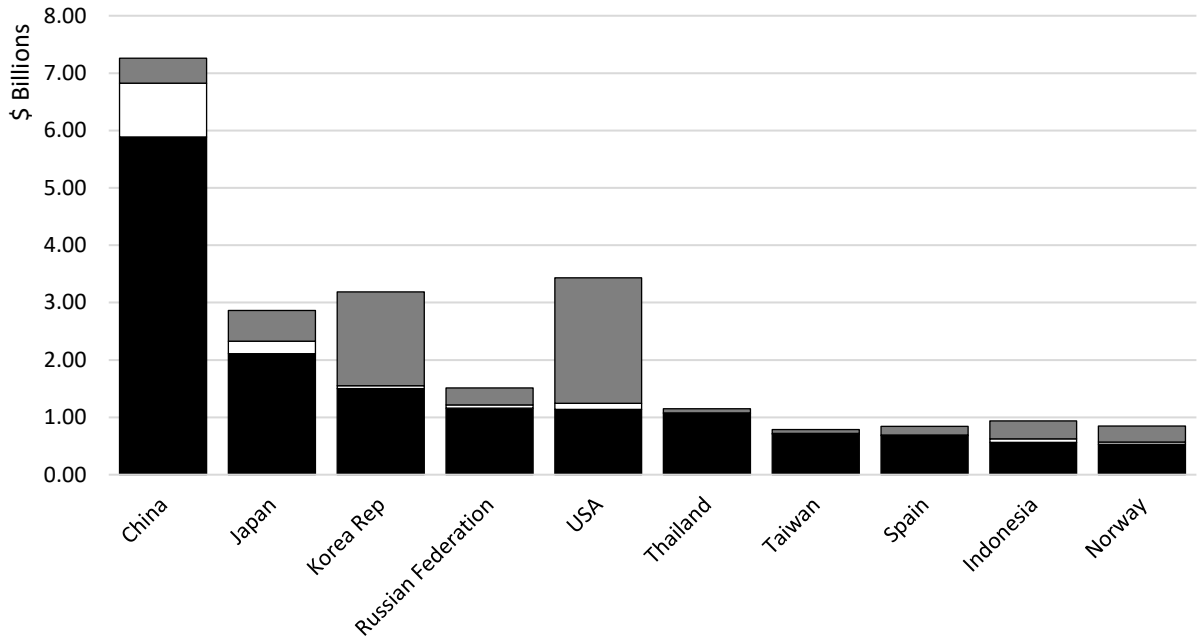

Figure 1: Estimated subsides provided in 2018 by the ten largest providers of harmful subsidies (Sumaila et al. 2019), ranked in order of the provision of harmful subsidies (left to right). Harmful, ambiguous and beneficial subsidies are shown in black, white and grey, respectively.

In total, the 'top-ten' provided more than $22.8 billion of subsidies, some 64% of the global total. More than 67% of the subsidies collectively provided were in the form of harmful fisheries subsidies, over $15.3 billion, and as reflected by the global situation 'fuel subsidies' are the largest single subsidy type provided by the 'top-ten', representing 26% of the total, the third largest subsidy type are 'Tax exemptions' (18%).

However, within the top-ten there is a great deal of variation in the levels of subsidisation. China, for example, provides more than twice as many harmful subsidies as any other country. The estimated $5.9 billion of harmful subsidies provided by China represents over 38% of all the harmful subsidies that the top-ten provides and largely consists of fuel subsidies ($3.4 billion) and tax exemptions ($11.0 billion). Conversely, USA and South Korea provide significant sums of beneficial subsidies, providing 37% ($2.2 billion) and 27% ($1.6 billion) of all the beneficial subsidies that the top-ten provide, respectively.

The amount of fuel subsidies provided were significant for all of the top-ten countries—ranging from $1.1 billion provided to China, to $194.5 million, provided by Norway—and represented the greatest single harmful subsidy type for four of the top-ten. Other significant harmful subsidy types were 'Fishing port developments', 'Market and storage infrastructure', and 'Tax exemptions', the latter was the greatest single harmful subsidy type for five of the top-ten countries.

Using Schuhbauer et al. (2020), we are able to report how the $15.3 billion of harmful subsidies that are collectively provided by the top-ten is estimated to be divided between the SSF and LSF fleets (Table 1). On average, the top-ten provide more than 83% of their harmful subsidies to their LSF fleets, some $13.2 billion of harmful subsidies, compared to only 16% to the SSF fleet ($2.2 billion). The proportion of harmful subsidies allocated to LSF ranges from 59% to 64% for Japan and Indonesia, respectively, up to 98% for Spain and Russia whose fishing fleets are dominated by large-scale vessels.

In terms of the proportion of certain subsidy types going to the LSF fleets, the majority of all harmful subsidy types go to the LSF fleets; it is estimated that 100%, 100%, 97% and 93% of 'Fishing access agreements', 'Vessel buyback', 'Fuel subsidies', and 'Vessel construction & renovation', are provided to the LSF fleets, respectively.

Table 1: Estimated provision of harmful fisheries subsides to the SSF and LSF fleets in 2018 by the ten largest providers of harmful subsidies (Schuhbauer et al. 2020).

Country	Harmful subsidies to SSF (USD millions)	Harmful subsidies to LSF (USD millions)	Proportion harmful subsidies to LSF (%)
China	270.2	5,615.5	95.4
Japan	868.5	1,242.0	58.9
Korea Rep	294.5	1,205.1	80.4
Russian Federation	19.5	1,142.5	98.3
USA	218.7	917.5	80.8
Thailand	110.9	958.0	89.6
Taiwan	46.9	661.6	93.4
Spain	15.7	667.1	97.7
Indonesia	202.9	363.1	64.2
Norway	116.8	410.4	77.8
Total (Average %)	**2,164.6**	**13,182.8**	**83.6**

4.2 Extent and distribution of fishing fleet activity

In 2016, it was estimated that the top-ten subsidizing countries collectively caught around 47.4 million tonnes of seafood, 38.6 million tonnes was officially reported while the remaining 8.8 million tonnes was 'unreported'. The artisanal, recreational and subsistence fleet segments caught approximately, 8.4, 0.6 and 0.3 million tonnes, respectively—meaning that the SSF fleet (artisanal and subsistence, combined) of the top-ten caught approximately 8.8 million tonnes in 2016, valued at around $21.0 billion. The LSF fleet, on the other hand, landed approximately 38.1 million tonnes that is estimated to have had a value of almost $64.5 billion. The LSF fleet of the top-ten therefore represents 80% of all landings in 2016.

It is also possible to report the location of the origin of the 47.4 million tonnes of seafood collectively caught by the top-ten in 2016. We first present the origin as either domestic, distant-water or high-seas—that is whether it came from a county's own EEZ, another country's EEZ, or from the high seas or areas beyond national jurisdiction. On average across the top-ten, the majority of catch was domestic (68%), while almost a third was from distant-waters (29%) and only 3% came from the high-seas (Figure 2).

There is again a high degree of variation between the individual countries of the top-ten (Figure 2). For example, 94% of the catches made by Indonesia and Russia were domestic, representing some 5.4 million and 5.6 million tonnes, respectively. While Spain and Thailand sourced only 28% (0.3 million tonnes) and 35% (1.7 million tonnes) of their catches domestically and both sourced 65% of their catches from the EEZs of other countries, representing some 0.8 million and 3.2 million tonnes, respectively. Taiwan and Korea Rep, sourced 35% and 15% of their catches from the high-seas catches, respectively, the highest percentages of all the top-ten. All of the top-ten countries have a relatively substantial DWF fleet, catching in excess of 0.1 million tonnes each, and up to 6.6 million, 3.2 million and 1.2

million tonnes in the cases of China, Thailand and Russia, respectively. Indonesia has a small DWF fleet, estimated to have caught less than 7 thousand tonnes from other countries' EEZ.

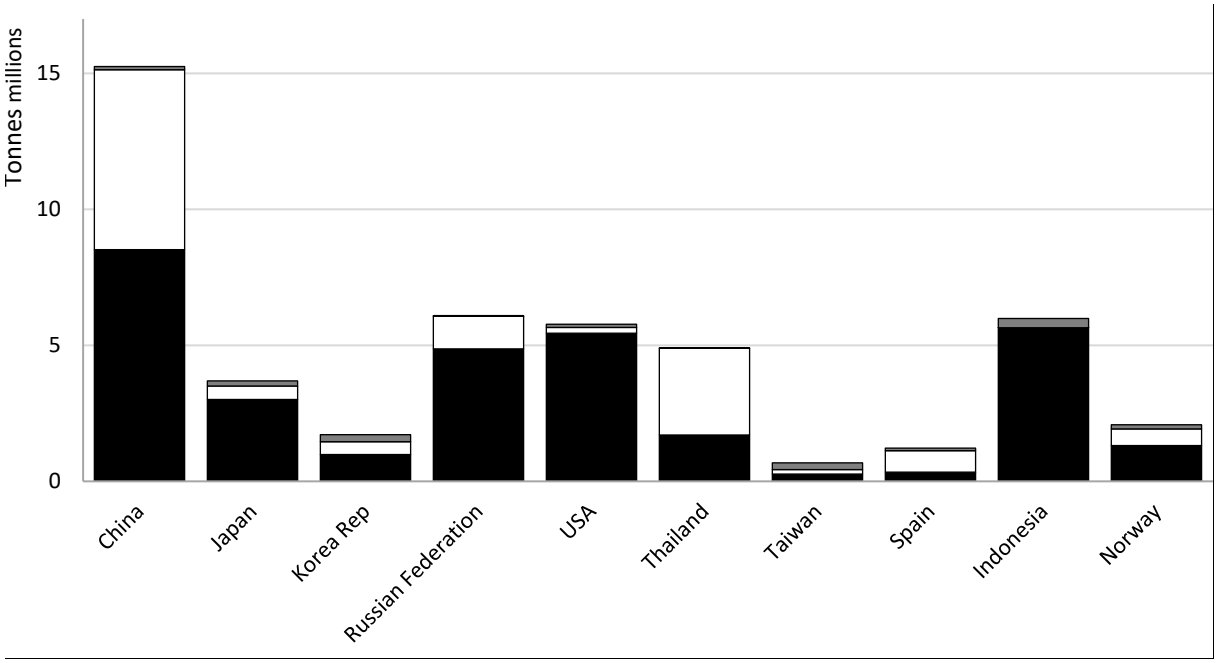

Figure 2: The volume of catch in millions of tonnes that the top-ten providers of harmful subsidies took from domestic, distant-water and high-seas locations in 2016 (Pauly and Zeller 2016). Domestic, distant-water and high-seas shown in black, white and grey, respectively.

The origin of distant-water catches can be reported to the individual EEZ from which it came. In total, the top-ten countries were active in 117 EEZs, excluding their own but including the high-seas, catching 15.2 million tonnes with an estimated value of $25.6 billion. Here, we present the thirty EEZs with the greatest cumulative amount of DWF catch taken by the top-ten (Table 4), this excludes domestic catch from a top-ten country within its own EEZ.

A notable finding is that four of the top-five locations for DWF are within the top-ten themselves (Japan, Indonesia, Russia and Korea Rep; Table 4). Indeed, more catch from DWF was taken from the EEZs of Japan and South Korea than are made by their own domestic fleets—Japan and South Korea are estimated to have taken 3.0 million and 1.0 million tonnes from their own EEZs, respectively, while 3.1 million and 1.1 million tonnes were taken by other top-ten countries in the same year. The majority of both of these DWF catches taken from Japan and South Korea EEZs are taken by Chinese DWF vessels. In fact, only China, Thailand and Taiwan, do not appear in the list of 117 EEZs that the top-ten are active within. USA and Spain also do not appear, although a number of their overseas territories, such as Johnston Atoll and the Howland & Baker Islands (USA), and the Canary and Balearic Islands (Spain), do appear. The EEZs with the greatest catch taken from them by the top-ten, which are not within the top-ten themselves, are Morocco, Malaysia and Cambodia, where approximately 1.0 million, 0.7 million and 0.5 million tonnes were caught by the top-ten in 2016.

The high-seas also appears in the top thirty locations of the top-ten's DWF fleet catches with just over 1.5 million tonnes ($4.2 billion) being taken (Table 4). All of the top-ten were active to some degree within the high-seas, although some more than others. Thailand and Russia were the least active, estimated to have caught 12.5 thousand and 25.9 thousand tonnes, respectively. While, Indonesia, South Korea, Taiwan and Japan were most active, catching

approximately 334.5 thousand, 258.7 thousand, 236.0 thousand and 184.9 thousand tonnes, respectively. While Norway is estimated to have caught 160.1 thousand tonnes from the high-seas it had the greatest value of catch, estimated at around $884.4 million.

4.3 Degree to which harmful subsidies drive distant-water and high seas fishing

While it is not possible to know precisely the degree to which the provision of harmful fisheries subsidies drives the prevalence of LSF, DWF and HSF, it is possible to describe the correlation between them and the degree to which subsidies support those activities. Table 2, shows the absolute amount of harmful subsidies provided to the LSF of each of the top-ten countries alongside the amount of catch made by the LSF fleet as a whole, and the domestic LSF, DWF and HSF fleets, respectively.

Conducting a simple regression analysis between the provision of harmful fisheries subsidies to the LSF fleet and the three components of LSF catches in turn; domestic, DWF, and HSF, reveals that there is a strong correlation between the provision of harmful subsidies and the amount of DWF catches ($R^2 = 0.81$)[5]. Whereas the provision of harmful subsidies to the LSF fleets is less well correlated with the amount of catch made from Domestic LSF and HSF ($R^2 = 0.42$ and 0.04, respectively). Although this approach is perhaps not robust, it suggests that there could be a link between the provision of harmful fisheries subsidies and the prevalence of DWF in these top-ten countries—the more harmful subsidies being provided the greater the amount of catch and/ or vice versa. However, it is not possible to understand the degree to which subsidies support these different components of the LSF fleets, as we do not currently have estimates of how the subsidies are further divided between the different sub-sectors.

Table 2: Estimated provision of harmful fisheries subsides by the top ten providers of harmful subsidies to their LSF fleets in 2018 (Schuhbauer et al. 2020), and the estimated catches from their Domestic LSF, DWF and HSF fleets in 2016 (Pauly and Zeller 2016).

Country	Harmful subsidies to LSF (USD millions)	Domestic LSF catches (thousand tonnes)	Distant-water catches (thousand tonnes)	High seas catches (thousand tonnes)
China	5,616	5,963	6,611	117
Japan	1,242	1,978	494	185
Korea Rep	1,205	613	468	259
Russia	1,143	3,937	1,198	26
USA	918	4,064	218	119
Thailand	958	1,049	3,198	13
Taiwan	662	214	169	236
Spain	667	175	793	92
Indonesia	363	3,692	7	335
Norway	410	1,063	612	160
Total	**13,183**	**22,750**	**13,767**	**1,541**

[5] R^2, representing the goodness-of-fit for the linear regression models from 0, no correlation, to 1, perfect correlation.

4.4 Distribution of harmful subsidies to each sub-sector of the fleet

This section of the report estimates, to the extent possible, the proportion of harmful subsidies that go to three sub-sectors of the top-ten subsidizing countries'; the domestic fleet (SSF and domestic LSF), DWF fleets and HSF fleets. In order to do that, we first make a key assumption that harmful subsidies are provided proportionally to the amount of catch made by the different sub-sectors of the LSF fleets. In reality governments may allocate subsidies in various ways, perhaps in order to expand a certain sub-sector that is presently small in catch volume, or perhaps they want more fishing in a specific geographic location independent of the amount of current catch, or there are specific interests to support constituents occupying a certain sub sector. Here, however, the portion of harmful subsidies provided to SSF and LSF fleets, as reported by Schuhbauer et al. (2020), is divided proportionally to the location of catches made by the LSF fleet as reported by Pauly & Zeller (2015).

Table 3 shows, for the first time, an estimate of the provision of harmful fisheries subsides made by each of the top-ten countries to the three sub-sectors in 2018. Of the $15.3 billion of harmful subsidies collectively provided by the top-ten in 2018, $9.2 billion (60%) were estimated to go to domestic fishing fleets, $5.4 billion (35%) to DWF fleets and $0.8 billion (5.%) to HSF fleets. While China is estimated to remain the greatest provider of harmful fisheries subsidies to domestic and DWF fleets, Taiwan, closely followed by South Korea provide the greatest amount of subsidies to their HSF fleet, estimated to be around $252.2 million and $232.7 million, respectively. In the case of Taiwan it is estimated to be providing almost as much harmful subsidies to its HSF fleet as it is to its own domestic fishing fleet. There are a number of other notable findings, for example, while Spain is the eighth greatest provider of harmful fisheries subsidies overall, it only provides an estimated $180.4 million to its domestic fleets, with more than twice that amount being provided to its DWF fleet thereby impacting other nation's EEZ, mostly in developing countries.

Table 3: Estimated provision of harmful fisheries subsides to the three fishing fleet sub-sectors of the top ten providers of harmful subsidies in 2018.

Country	Domestic Subsidies (USD millions)	Distant Water Subsidies (USD millions)	High Seas subsidies (USD millions)
China	2,909	2,925	52
Japan	1,793	231	86
Korea Rep	846	421	233
Russian Federation	891	265	6
USA	1,071	41	25
Thailand	347	719	3
Taiwan	276	181	252
Spain	180	444	58
Indonesia	535	1	30
Norway	355	137	36
Total	**9,202**	**5,365**	**780**

We can also present these findings in terms of the proportion of the harmful subsidies provided to each sub-sector (Figure 3). Looking at the distribution of harmful subsidies in this way results in different countries coming out 'on top'. For example, Indonesia and USA provided an estimated $535.3 million and $1.1 billion in harmful subsidies to their domestic fleets, respectively, in terms of the proportion of harmful subsidies to their domestic fleets, it is 95% and 94% of all harmful subsidies, making them ranked first and second highest proportion, respectively. Notably, Taiwan may be providing just over a third (35%) of their harmful subsidies to the HSF fleet, and Thailand and Spain are estimated to provide 67% and 65% of their harmful subsidies to their DWF fleets, respectively.

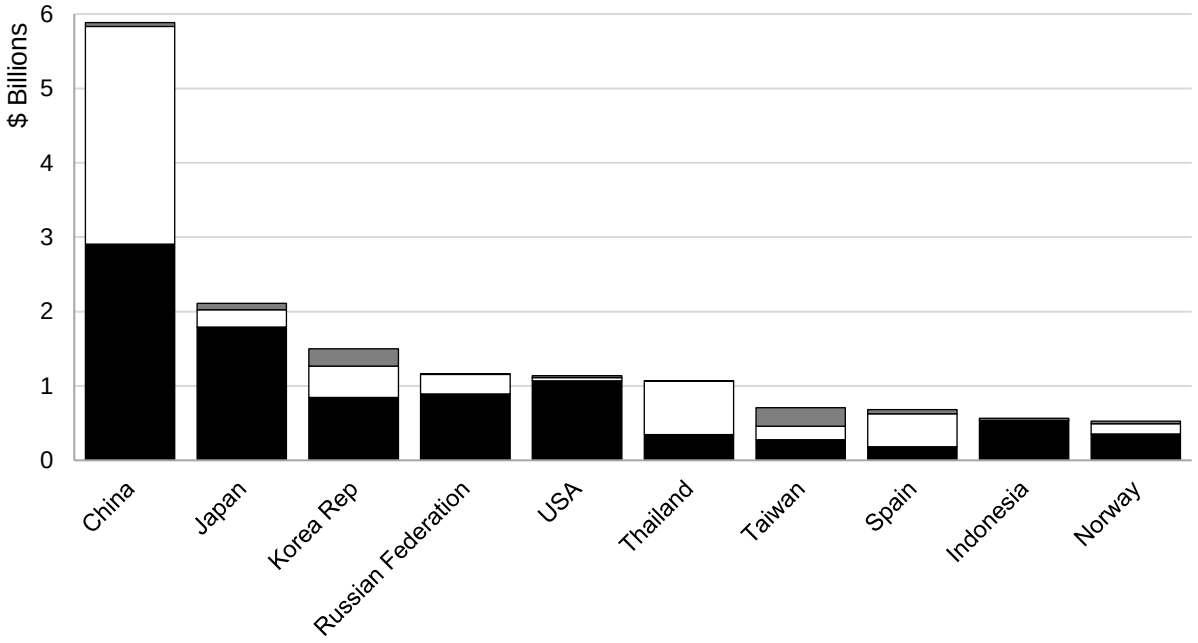

Figure 3: Estimated amount of harmful fisheries subsidies provided by the top ten providers (to their domestic, distant-water and high-seas fishing fleets, in 2018. Domestic, DWF and HSF fleets shown in black, white and grey, respectively.

4.5 Distribution of the potential impact of LSF harmful subsidies

It is also possible to disaggregate the amount of subsidies provided to the top-ten's DWF and HSF fleets to the level of individual EEZ (including the high seas). Using the same list of host EEZs presented in Table 4**Error! Reference source not found.**, here, we present the twenty locations with the greatest cumulative amount of foreign catch taken by the top-ten countries and estimate the cumulative amount of foreign harmful fisheries subsidies that the top-ten are providing to the fleets operating within them, excluding domestic subsidies from a top-ten country within its own EEZ (Table 4). However, it should be noted that this does not represent the top-twenty host-EEZ in terms of the amount of foreign harmful subsides being provided to the fleets that operate within them, as it only includes data for the top ten providers of harmful subsidies.

Japan is top of the list, with more than $1.4 billion of harmful subsidies being provided to foreign vessels of top ten countries fishing in its waters, some 67% of the sum of harmful subsidies being provided to its own fishing fleet. The vast majority ($1.3 billion) of that sum is from China, while $77.8 million and $10.3 million comes from South Korea and Russia, respectively. Interestingly, while Indonesia ranks second in terms of the overall amount of

foreign catches taken from within its EEZ, it ranks sixth in terms of the absolute amount of foreign harmful subsidies being provided to foreign fleets within its waters. This could be due to the fact that while many of the top-ten operate within its waters, the majority of the landings (1.5 million tonnes) are made by Thailand, which is an interesting case study, as while it provides a large amount of harmful subsidies to its DWF fleet ($719.2 million), due the huge amounts of DWF landings that it makes, this large sum is spread across multiple EEZs, and $345.1 million of harmful subsidies is provided to DWF fleets operating within Indonesia's EEZ.

We can also present the amount of foreign harmful subsidies as a proportion of the cumulative value of foreign catch made by the top-ten countries. If we take as our starting point the figures presented in Sumaila et al. (2010) that described the profitability of deep-sea trawl fishing, where the profit achieved was not more than 10% of the landed value. We can begin to use this benchmark to understand the potential profitability of these DWF fleets and the role that harmful subsidies may play in allowing those fisheries to persist. Given that the present study estimates that in Peru, Russia and Guinea-Bissau, the DWF fleets of the top-ten subsidizing countries benefit from 54%, 44% and 42% of the total value of catch in the form of fisheries subsidies, it could suggest that these fleets would be operating at a loss and would be unable to fish in the absence of harmful fisheries subsidies.

5 Discussion

The present study shows that the provision of harmful fisheries subsidies and the activities of distant-water and high-seas fishing are both conducted by a small group of nations. It reveals that the ten largest providers of harmful subsidies direct the majority of their harmful subsidies to their large-scale and industrial fleets (Table 1). While these large-scale fishing fleets operate both domestically, in the territorial waters of other nations and in the high seas, we show that majority of their activity is in the EEZs of other host nations (Figure 2). The DWF fleets of the top-ten subsidizing countries operate in hundreds of EEZs, but much of their activity is perhaps surprisingly within the EEZs of other top-ten country's (Table 4). While the findings here cannot definitively say that the provision of harmful subsidies drives DWF and HSF fleets, it does suggest that the more harmful subsidies being provided the greater the amount of catch their DWF fleets land and/or vice versa.

What this study is able to do, for the first time, is to provide empirical estimates of the spatial distribution of the potential harm that harmful subsidies cause, i.e. the proportion of harmful subsidies that affect domestic and foreign waters, and the high seas (Figure 3). It reveals that the majority of harmful subsidies provided by the top-ten countries are likely to be impacting the waters of other nations, rather than their domestic waters. This is an important finding as it underlines the importance of striving for multilateral consensus in the development of new rules on the provision of harmful fisheries subsidies, as clearly, the impact that they have on natural resources is not a domestic issue.

The present study also begins to try to understand the potential impact that these distribution estimates may have on the economic viability of DWF activities. It shows that, based on the present estimates, harmful subsidies provided to the DWF fleets of the top-ten countries in many of the key host EEZ constitute a large proportion of the total landed value of catch that those fleets take. In some cases, harmful subsidies may be as much as 50% the landed value

of catch. This calls into question whether these activities are viable without the provision of such levels of harmful fisheries subsidies

Clearly, this study represents a crucial first step towards bettering our understanding of the relationship between harmful subsidies; the spatial operation of DWF and HSF globally; and the burden this imposes in waters other than those of the countries that own these operations. The method we present here represents our best attempt at elucidating this relationship, but increased transparency and data availability is necessary for these estimates to become increasingly robust.

Table 4: Location of the collective DWF catches made in 2016 by the top ten providers of harmful subsidies (Pauly and Zeller 2016) and the amount of foreign harmful subsidies estimated to have impacted those EEZ in 2018. Locations are ranked in order of the sum of volume of foreign catches, the top twenty are presented.

Location	Sum of foreign catches (thousand tonnes)	Sum of foreign catch (USD millions 2016)	Sum of foreign harmful subsidies (USD millions 2018)	Amount foreign subsidy as a proportion of catch value (%)
Japan	3,106	5,035	1,404	28
Indonesia	1,617	2,297	417	18
High Seas	1,541	4,165	780	19
Russia	1,392	1,524	664	44
Korea Rep.	1,118	2,060	495	24
Morocco	952	1,579	456	29
Malaysia	696	964	157	16
Cambodia	543	744	122	16
Norway	407	496	90	18
Namibia	326	363	148	41
Myanmar	326	507	73	14
Svalbard Isl. (Norway)	262	700	58	8
Guinea	230	316	111	35
Ireland	227	244	62	25
United Kingdom	203	232	47	20
Guinea-Bissau	200	257	107	42
Angola	170	197	67	34
Falkland Isl. (UK)	159	249	101	41
Kiribati	148	383	106	28
Peru	142	116	63	54
Sierra Leone	124	321	88	27

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Annex 1 Terms of reference

Fisheries subsidies Driving distant water and IUU fishing

Principal investigator: Rashid Sumaila

Project objective and description

The objective of this project is to explore how fisheries subsidies may be fueling the depletion of global common-pool marine resources by serving as a catalyst to distant water fishing (DWF) and illegal, unreported and unregulated (IUU) fishing activities. DWF includes both high seas fishing (in areas beyond national jurisdiction) as well as fishing in the EEZs of host countries on the basis of bilateral fisheries access agreements, which are not necessarily included in the scope of the WTO negotiations on the removal of fisheries subsidies. The goal of this research is to reveal to the public and policy makers the connection between fisheries subsidies and the depletion of shared fish stocks.

Data Sources

The Fisheries Economic Research Unit (FERU) is uniquely positioned to carry out this research because FERU and the *Sea Around Us* (SAU) have been compiling data and building ecological and economic databases for global fisheries over two decades that would come handy for the current project. These global databases include (i) catch (Pauly and Zeller, 2016); (ii) fisheries subsidies (Sumaila et al. 2019); (iii) distant water fishing data and information (Swartz et al. 2010), and (iv) IUU catch and illicitly traded fish catch (Sumaila 2019; Sumaila et al. 2020). The data and analyses contained in these publications would come handy in this new research.

Tasks

1. Conduct a literature search on DWF and IUU capture and trade; including relevant academic grey literature, major magazines and newspaper articles that may contain data on subsidies to DWF and IUU capture and trade;
2. Identify the top 10 countries (political entities) that provide the highest amounts of harmful subsidies;
3. Since fishing vessels that engage in DWF and IUU/illicit fishing are usually large industrial fleets, we will determine the proportion of total harmful subsidies provided nationally that goes to this segment of the total national fleet (Schuhbauer et al. 2016 – Or updated dataset, if published by then);
4. Determine the degree of DWF, IUU fishing and illicit trade in fish catch (in terms of weight and dollars) of the identified top 10 subsidizing countries, respectively;
5. Use the information gathered in (2– 5) to calculate indicators of the degree to which subsidies drive DWF and IUU/illicit fishing;
6. Discuss the policy implications of the findings of the study.

Deliverables

1. Submit a report documenting the findings of the study;
2. Produce a manuscript for submission to a peer-reviewed journal;
3. Present at conferences and at concerned institutions.