Briefing note

Fishing for data

The role of private data platforms in addressing illegal, unreported and unregulated fishing and overfishing

Miren Gutierrez, Alfonso Daniels and Guy Jobbins

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Key messages

- New technologies offer unique opportunities to support fisheries monitoring, control and surveillance, particularly for countries without the means to patrol their waters or enforce legislation against illegal, unreported and unregulated (IUU) fishing and overfishing.
- Developed countries and multilateral organisations have been slow to exploit these opportunities, and have failed to produce a single, effective, public global fisheries information tool.
- Private initiatives tackling overfishing and IUU fishing using satellite and data technologies have emerged in recent years to bridge this gap, but their potential is undermined by the limited size and insufficient quality of their datasets.
- Better data management and closer collaboration between these initiatives is needed, alongside improved fisheries governance and greater efforts to tackle corruption and curtail practices including the use of flags of convenience and secret fisheries agreements.

1. Introduction

Marine fisheries are critical resources for coastal developing countries. They are also difficult to manage sustainably. Almost a third of global fish stocks are degraded from overfishing, and a further 60% are 'fully exploited' (FAO, 2016). Illegal, unreported and unregulated (IUU) fishing accounts for a significant amount of this overfishing. The global IUU catch has been estimated at 11–26 million tonnes each year (Agnew et al., 2009), or between 7% and 17% of the total global catch (FAO, 2016). For fish stocks already exploited at – or beyond – their maximum sustainable yield by legal activities, additional pressure from IUU fishing can be the difference between continuing productivity or collapse.

The degradation of fisheries poses risks to the food security and livelihoods of millions of people, as well as undermining local economies. In coastal West Africa, for instance, up to two-thirds of all the animal protein people eat comes from fish, and around a quarter of jobs are linked to fisheries (Copeland, 2014). According to one recent report, IUU fishing costs just six West African countries a combined $2.3 billion in revenue each year (Doumbouya et al., 2017), almost 15% of their combined gross domestic product.[1]

Global IUU catches are worth an estimated $10–$24 billion each year, and mainly target high-value species (Agnew et al., 2009). The potential profits create strong incentives for illegal behaviour, particularly in areas with weak governance and low enforcement capacity (Standing, 2017). Increasingly effective fisheries monitoring, control and surveillance (MCS) in the global north means that most of the IUU catch is taken by foreign vessels in the domestic waters of developing countries (Annan, 2016). Effective enforcement is made more difficult by the international aspects of the crime; seizing individual vessels does not disable the international criminal networks that finance and coordinate IUU fishing because they are protected by layers of opacity, operating under secret agreements and flags of convenience.[2]

Against this challenging background, technology has the potential to support fisheries MCS. While developing countries may have limited physical assets – such as patrol vessels – for enforcement, satellite imagery and big data infrastructure may offer cost-effective ways to increase the efficiency of MCS and enforcement efforts (Cordes and California Environmental Associates, 2015).

The expansion of commercial satellite services has enabled new remote sensing technologies that support fisheries MCS. Vessels fitted with communications equipment such as vessel management systems (VMS) and automatic identification systems (AIS) broadcast data on their location and movements. In principle, these systems enable new forms of real-time surveillance of fishing fleets and support vessels. Analysis of historic AIS and VMS data may also identify patterns and trends in vessel movements that indicate IUU fishing activities. Coupled with analysis of national and international registries of vessels, this could help identify specific vessels, operators and owners associated with IUU activity. Together, remote sensing and big data techniques can support long-term criminal investigations and real-time MCS and enforcement.

Governments in developed countries and multilateral organisations have been slow to exploit these opportunities, and have failed to produce a single, effective, public global fisheries information tool. The Food and Agriculture Organisation (FAO), for example, maintains the Fishing Vessels Finder register, which as of 2015 contained 238,689 fishing vessels – a fraction of the 4.6 million currently operating in the world, according to FAO's own estimates. Several private and charitable initiatives have set out to bridge this gap, and have attracted significant interest and investment.[3] This briefing note reviews the five main existing initiatives (Table 1). Detailed questionnaires were sent to them and they all replied. The aim of the note is to provide guidance on the private fisheries big data tools available and their strengths and weaknesses for developing

Box 1: What is illegal, unreported and unregulated fishing?

IUU fishing covers a range of illicit activities, including:

- fishing in a country's national waters without permission, or violating its fishing regulations;
- violating regional or international fisheries agreements that the vessel's flag state is signatory to;
- not reporting or misreporting fishing to relevant authorities;
- fishing by vessels without nationality;
- fishing by vessels whose flag state is not party to agreements governing the relevant fishing area or species; and
- fishing on stocks with no applicable conservation or management measures in place.

Adapted by the authors from International MCS Network (2014).

1 The six are Mauritania, Senegal, the Gambia, Guinea Bissau, Guinea and Sierra Leone.

2 A 'flag of convenience' refers to a vessel registered in a different country to that of the ship's owners. Many shipping companies prefer to fly FOC so their ships are registered in countries with less stringent enforcement regulations. Approximately 15% of the world's large-scale fishing fleet is flying FOCs or listed as flag unknown (Gianni and Simpson, 2005).

3 This paper refers to a 'private initiative' as a private for-profit endeavour, a 'charitable organisation' as a private not-for-profit endeavour and a 'public initiative' as a governmental or institutional endeavour.

Table 1: Tools reviewed in this study

Name	Type
Global Fishing Watch	Non-profit partnership between Google, SkyTruth and Oceana
FishSpektrum	For-profit
OceanMind	Non-profit joint venture between Pew Charitable Trusts and the Satellite Applications Catapult
Navama	For-profit, supported by the World Wildlife Fund (WWF)
TM Tracking	For-profit

Source: Developed by the authors

countries whose fisheries are being ravaged by foreign trawlers, but which lack the means to patrol their waters and enforce existing legislation.

We conclude that these big data platforms are complementary, and could potentially be extremely useful in addressing IUU fishing and overfishing in the waters of developing countries. But they have several weaknesses, including the limited size of their databases and their use of algorithms that are incapable of accurately identifying fishing behaviour. Despite their shortcomings, these platforms are seeking to occupy this market space, often offering their services to governments and international and regional organisations in an attempt to crowd out the rest, with insufficient attention given to the robustness of their datasets. Even if these issues were addressed, new technologies cannot substitute for the political will to address institutional and methodological weaknesses in the sector. In short, technology – without cooperation, strategising and the right policies in place – is not going to solve the problem of IUU fishing and overfishing on its own.

2. Different approaches to different challenges

The five initiatives reviewed here focus on different challenges, have different drivers and offer different solutions. Some work on increasing the transparency of the fisheries sector to the public, consumers and others in the supply chain. Global Fishing Watch (GFW) and Navama in particular list greater transparency around fisheries as a major objective. Navama's *transparentsea* tool allows voluntarily registered vessels to demonstrate that their catch is from legitimate fishing stocks and areas by sharing AIS data with the market. GFW focuses on identifying and exposing illegal fishing activity to raise public awareness and mobilise political pressure, using online interactive maps, reports and publicity campaigns.

Long-term investigations and strategic analysis are another major focus area. FishSpektrum regularly collaborates with NGOs and research organisations (including ODI – see Box 3). FishSpektrum's analysis contributed to the World Wildlife Fund (WWF)'s report on the 2012 summer Bluefin tuna season, and identified discrepancies in vessel behaviour suggesting IUU fishing activity (WWF, 2012). TM Tracking (TMT) investigates global fishing operations and the companies associated with IUU fishing, including owners, insurers, agents and charterers. Its claimed successes include a South Korean vessel being denied fishing licences and access to ports in West Africa, and the interdiction and confiscation of tuna vessels in Tanzania and South Africa (FISH-i Africa, 2015). OceanMind's principal focus is support for real-time MCS and enforcement. In Chile, for example, it provides real-time information to naval and aerial units patrolling the country's exclusive economic zone.

While most of these initiatives have capacities in more than one area, and several offer more than one tool to their users, each appears to have a particular comparative advantage (see Table 2). FishSpektrum, for example, may have the most comprehensive database on fishing vessels, but does not offer real-time information. OceanMind and Navama have more limited vessel databases than FishSpektrum, but offer real-time information to their clients.

Of the five initiatives, only GFW makes all its data and findings publicly available. The others either offer services and data in exchange for fees, or limit the distribution of their findings. Although this is understandable given the privileged and confidential nature of the client information that they hold, keeping such data private is a loss to public research and management. As we shall see, data problems are a major barrier to effective MCS and enforcement.

Box 2: What is monitoring, control and surveillance?

Monitoring is the process of observing and analysing fishing activity, such as where fishing is happening, what techniques are employed, how much of which species are caught and where landings are made. *Control* refers to the rules that govern fisheries practices. These may include restrictions on fishing areas, seasons, target species, gear and catch quantities, and may derive from national legislation or international agreements. *Surveillance* is the process of ensuring that fishing practice follows the controls in place, and is generally the most expensive component of MCS. Enforcement is distinct from surveillance, and covers interdiction and prosecution.

Box 3: Big data potential: lessons from ODI's report on transhipments

In 2016, ODI, porCausa and FishSpektrum released a major report on IUU fishing in western Africa, using FishSpektrum's analysis tools and datasets. The report highlighted the importance of illegal transhipments at sea from fishing vessels to large refrigerated containers ('reefers'), and identified suspicious fish transhipments taking place in the Exclusive Economic Zones (EEZs) of Senegal and Côte d'Ivoire, where transhipments are banned. The report showed the significance of containerised fish transport in IUU fishing – a loophole in current European Union (EU) legislation – as well as the potential for analytical tools to raise awareness and influence policy (Daniels et al., 2016: 7).

3. Weaknesses in the data

The effectiveness of these tools depends on the breadth, depth and robustness of the data they use. Broadly speaking, this data falls into two categories. The first is dynamic data on the position and movements of vessels. The second is static data, which includes information about individual vessels, such as the name, class, flag, operator and owner. These can be framed in terms of two questions: where are the vessels at each point in time; and who are they? Answering each of these questions has its own challenges.

3.1. Locating vessels

Automatic identification systems (AIS) were developed to prevent collisions at sea, and equipped vessels broadcast their location, speed and direction. Vessel management systems (VMS), developed specifically for fisheries MCS, also broadcast position and movements, alongside a broad range of functions. Both systems provide dynamic data that allows remote surveillance of vessel movements in real time. Datasets of historic AIS and VMS signals can also be used for long-term analysis. In terms of support to enforcement, this data is most applicable in detecting fishing in restricted waters, such as marine protected areas. In principle, machine-learning from dynamic data could help automate the identification of other behaviours, particularly if combined with situational ecological and oceanographic data. Advanced tools might be able to infer the fishing techniques used or target species being hunted, for example.

However, there are limits to AIS and MVS. International rules require only vessels over 300 gross tonnes to be equipped with AIS, whereas only 2% of the global fishing fleet is over 100 gross tonnes (FAO, 2016). Although national rules vary (European Union (EU) regulations require smaller fishing vessels to have AIS transmitters, for example) and the safety benefits encourage individual owners to install them, many vessels are not equipped with AIS. Another challenge is that AIS broadcasts on line-of-sight VHF radio, with a typical range of up to 20 nautical miles. This leaves unmonitored areas beyond the range of monitoring stations and outside satellite coverage. Finally, crews can manually enter false position data or 'go dark' – turn off the AIS transmitter – if they want to evade surveillance (Clark, 2014). MVS has similar limitations to AIS, and most low-income countries do not require vessels to install it. Some tools use other remote sensing data to address weaknesses in AIS and VMS. In its work in Chile, for example, OceanMind integrates radar data from patrol units to identify vessels that have 'gone dark'. Both OceanMind and GFW also use satellite imagery to observe areas beyond AIS coverage, and to generate photographic evidence.

Table 2: Comparative advantages of the platforms

Name	GFW	FishSpektrum	OceanMind	Navama	TMT
Robust database*		x			x
Specialist knowledge of IUU impacts on biodiversity				x	
Well-resourced and staffed	x				
Algorithm development capacities	x		x		
Extensive sector expertise		x		x	x
Transparency and public affairs	x				
Strategic analysis and research		x	x		x
Real-time information			x	x	

Source: Developed by the authors based on an extensive survey.

* Database information not available for OceanMind and Navama as they declined to answer this question.

3.2. Identifying vessels

Compared to knowing where a ship is and what it is doing at a particular moment in time, the challenge of *identifying* a vessel may seem simple. However, there is no unique global database of fishing vessels; no one is even sure how many fishing vessels there are. Vessel records are scattered across a range of datasets, including class societies (organisations that establish standards for the building and operation of ships), national ship registries, national fisheries licencing bodies, national bodies for registering radios, regional fisheries management organisations and international organisations. The confusion proliferates as vessels change owners and operators, are reflagged and are registered with new authorities. Identifying individual ships and their owners is therefore a significant challenge.

As a result, most of the initiatives reviewed here have developed their own vessel databases to pool and correlate static data from different sources and establish integrated vessel records. They range in size from around 75,000 vessels (GFW) to over 779,000 (FishSpektrum). The other platforms declined to tell us the size of their databases, but the fact that they extract information from similar sources as GFW would suggest that they contain a similar number of fishing vessels in their databases. In any case, it is impossible compare to the actual number of vessels involved in transnational fishing, as no reliable figures exist. As noted, FAO (2016) provides a global estimate of 4.6 million fishing vessels, but most of these are canoes and small vessels incapable of extended voyages, while others are inshore rather than marine vessels.

Additionally, while database size is important, depth and quality matter too. Richer datasets offer greater potential for establishing the histories of individual vessels, and robustly analysing the trends and patterns associated with IUU behaviours. FishSpektrum's database, for example, includes more than 100 pieces of information per vessel, including primary and secondary gear and other physical characteristics, current and former owners, flags, operators, insurers and their addresses and photographs. Most initiatives supplement their vessel database with findings from analysis and investigation, including satellite imagery. TMT's database includes photographs, port logs and human intelligence, as well as entries on organisations and companies, including owners, agents, operators and insurers.

Ensuring data quality is another challenge given the diversity of data sources, the differences between them and the practice of reflagging and reregistering ships. Initiatives take different approaches to quality assurance, and presumably balance issues of quality, database size and the speed with which data can be used in analysis. FishSpektrum has established a large and robust database that includes data on fishing vessels known to pose as other types of vessel, and its database is entirely updated twice a year. Navama uses voluntary registrations and cross-references national registries with AIS identifiers to develop a small but accurate dataset. Rather than reconciling individual vessel records, OceanMind uses algorithms to identify inconsistencies and risk indicators in the data available to it. When we asked GFW how they ensure the reliability of their database, they replied that this is done through random sampling.

Assuring the quality of static data is difficult. Analysis by FishSpektrum of a report on transhipment published in 2017 by GFW indicated that GFW's database of 75,000 vessels contained at the time over 23,500 entries that were either duplicates, or vessels no longer engaged in fishing (FishSpektrum, 2017). FishSpektrum provided ample evidence of duplicates and errors, such as tankers and bulk carriers identified in the GFW report as fishing vessels (ibid.). The problems with the GFW report seem to derive from approaching dynamic data as a source of static data, via faulty algorithms unable to correctly identify fishing vessels from their behaviour. Similar analysis has been done in the case of FishSpektrum (ODI confirmed the robustness of its static database in its 2016 report on IUU fishing based on

Box 4: Identifying transhipments at sea

Recent efforts to identify transhipments at sea* provide an example of the difficulties involved in identifying complex IUU behaviours. GFW (2017) identified 794 'reefers' – refrigerated cargo vessels – and detected 5,065 'likely transhipments' between 2012 and 2016. However, analysis by FishSpektrum (2017) excluded 327 of these 794 reefers for reasons including not having the technical or logistical capacity to conduct transhipments. Of the 327 vessels excluded, 34 had been decommissioned or lost and one was a recreational yacht. FishSpektrum's analysis also considered the criteria for identifying suspected transhipments. GFW's criteria were 'interactions between two vessels remaining within 500 metres of each other for longer than 3 hours while travelling at less than two knots' (Global Fishing Watch, 2017). There are multiple possible explanations for such encounters, and distinguishing between legitimate and illegitimate reasons may require direct or satellite observations, and extensive experience of maritime and fishing practices. While it is not clear how GFW's criteria for 'likely transhipments' were developed, the results are indicative of a particular problem with big data techniques, namely their tendency to prioritise correlations, even spurious correlations (false positive results). Spurious correlations become more likely when using fragmented datasets that collectively have many data fields (variables), but with little data per field. Spurious correlation could be reduced by using an informatically rich database with consistent data fields for each vessel over time. However, as discussed above there is no such database in the public domain (FishSpektrum may be the closest thing we have to this ideal).

*Transhipment at sea is a practice whereby catches are unloaded at sea from fishing vessels onto large refrigerated ships or reefers.

the FishSpektrum registry (Daniels et al., 2016; see Box 3)). Parallel analysis is not available for the other three initiatives. But all five initiatives draw on similar data sources and could be exposed to similar errors. Only constant scrutiny and revision can remove errors from datasets.

4. Identifying illegal behaviour

IUU fishing can involve a wide range of illicit behaviours. Fishing controls are complex, and contravening any of them might constitute IUU fishing. Common rules include total or licenced restrictions on fishing areas, seasons, gear, techniques and target species, limits on the number of days at sea, limits on the quantities of fish that can be landed, designated landing sites and requirements to report activities and catches. Remote sensing and big data techniques can identify some of these elements and activities.

Remote surveillance of a restricted area is relatively straightforward. GFW, for example, claims that its satellite-based evidence has shown that fishing has effectively ceased in the large and remote Phoenix Islands Protected Area (Kiribati) (Global Fishing Watch, 2017a). The integration of other data – such as relating the boat detected to a dataset of licences and permissions – allows more sophisticated surveillance of restricted zones where some vessels may fish but others may not. OceanMind's work in Chile and elsewhere integrates this type of data with real-time observations of vessel movements, analysis of where a vessel's AIS signals are turned off and other functions (OceanMind, 2017).

Detecting other IUU activities can be more difficult. AIS signals may show that a vessel is in a specific area, travelling at a certain speed and making a certain series of directional changes. Does that allow inference of the gear and techniques in use, the species being hunted or how much is caught? In principle, big data techniques applied to large datasets do enable machine-learning to identify such patterns and behaviours. However, none of the five initiatives reviewed claimed that this was a current capability.

5. Using data platforms for enforcement

Problems in underlying data and means of identifying and verifying IUU behaviours mean that there are risks in using these tools for MCS and enforcement. One risk is that false positives and spurious correlations waste enforcement resources. Another is that overconfidence in these tools unduly focuses enforcement efforts on the issues they can detect, and reduces the focus on crimes and behaviours they cannot. Evidence-led enforcement is only as good as the evidence, and effective enforcement will balance inputs from these tools alongside traditional approaches. Technology also needs political will for MCS and enforcement in order to be effective; not all governments in low-income countries are committed to improving MCS and the governance of their fisheries, and in contexts where political will is lacking the application of tools such as OceanMind to address IUU fishing is inevitably limited. Effecting change requires both detailed investigations to unravel international criminal networks, and campaigning strategies to mobilise citizen awareness and advocate for reform. Money can also be a barrier: while OceanMind, FishSpektrum, Navama and TMT all contract with advanced and middle-income economies willing to pay for their services, most engagement in low-income economies is supported by international donors. TMT, for example, has provided technical services to the West African Task Force, funded by Norway.

The lack of a comprehensive global database on fishing vessels is another limitation. A universal vessel identification system has been a long-term proposal, but there are technical, institutional and political obstacles to agreeing a set of standards and how they might be implemented. Similar challenges surround extending international requirements for smaller vessels to be equipped with AIS. The expansion of voluntary national and regional schemes will increase the number of AIS- and VMS-equipped vessels, but technical specifications and exemptions under international law provide loopholes that criminals will continue to exploit.

Conclusion

New technologies such as remote sensing and big data approaches are now common in several areas of environmental and natural resource governance. SkyTruth.org, for example, uses satellite imagery to investigate, monitor and expose oil spills, mine failures and major pollution events. Initiatives using these technologies can expose malpractice to enforcement agencies, insurers, investors and the public, and generate pressure to hold someone accountable. The fight against IUU fishing and the unsustainable exploitation of fisheries resources could benefit greatly from data activism and support to fisheries MCS and enforcement. Increasing datafication and the expansion of data infrastructure offer new resources for fisheries management.

While governments and multilateral organisations have been slow to capitalise on these opportunities, private initiatives such as the ones described in this briefing note are filling the gap. These initiatives have different strengths and abilities. FishSpektrum's capacity to analyse and identify individual vessels, OceanMind's real-time analytic focus, GFW's computational capacities, Navama's supply-chain mapping and TMT's focus on the organisational aspects of international fisheries crimes all address different, critical parts of the challenge. In principle, collaboration and coordination between these initiatives could create a powerful data platform much more useful than any one individual component. How such collaboration can be incentivised between private organisations who are in effect competitors, and under what framework it might be conducted, remains an open question.

Whatever route private operators take, NGOs should demand action from governments and international agencies to improve transparency. A global, centralised database of vessels known or suspected of involvement in IUU fishing would be a good first step. The creation of a worldwide unique vessel identification scheme for and database of fishing vessels has been on the international agenda for too long and with too little progress. In the absence of such resources, the ability of enforcement agencies to address these international environmental crimes is seriously curtailed.

Ultimately, big data solutions alone will not tackle overfishing or end IUU fishing. Greater political will, improved governance and policy action, anti-corruption efforts, enhanced port measures and improved international coordination are all necessary to tackle these crimes. However, these new technologies can be an important tool in the fight against overfishing and IUU fishing, if they can be effectively harnessed.

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Overseas Development Institute
203 Blackfriars Road
London SE1 8NJ

Tel: +44 (0) 20 7922 0300
Fax: +44 (0) 20 7922 0399
Email: info@odi.org.uk

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