



Indonesia Marine Fellows  
Program - MFP

# CALCULATION MODEL OF ECONOMIC LOSSES DUE TO ILLEGAL FISHING ACTIVITIES IN INDONESIAN TERRITORIAL WATERS

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**Indonesia Marine Fellows Program - MFP**  
Applied Economic Research on Fisheries Management  
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## 1. INTRODUCTION

### 1.1 Background

The concept of Illegal Unreported Unregulated (IUU) Fishing was first presented in 1997 in Conservation of Antarctic Marine Living Resources (CCAMLR), which highlighted IUU fishing practices in conservation areas. The Food and Agriculture Organization (FAO) defined IUU fishing in paragraph 3 of their 2001 FAO International Plan of Action to Prevent, Deter, and Eliminate IUU Fishing. IUU fishing is a persistent challenge because the impacts threaten the sustainability of fisheries and the health of marine environments which, in turn, lead to undisputable impacts on global food security (Lindley and Techera, 2017; Miller et al., 2014; Peterson et al., 2017; Petrossian, 2014; Pramod et al., 2014; Sumaila et al., 2006). The drivers of IUU fishing are widely acknowledged, ranging from overfishing to socioeconomic reasons, which has led many to violate fisheries and conservation laws.

Indonesia, as an archipelagic state, has placed IUU fishing as a top priority to be addressed since the establishment of the Ministry of Marine Affairs and Fisheries (MMAF) in 2001. Indonesia also supports the FAO Conduct of Fisheries and FAO international Plan of Action on IUU Fishing. MMAF's first action was mandating that all fishing vessels with capacity greater than 30 gross tons (GT) to must install Vessel Monitoring System (VMS) Transmitters in order to receive a fishing license for Indonesian waters. The second action was the establishment of law enforcement centers in fishing ports and deployment of patrol vessels within marine protected areas. The third set of actions was to combat illegal fishing in the Indonesia Economic Exclusive Zone (EEZ) in coordination with the Indonesian Navy. The major challenges for Indonesia in combating IUU Fishing are its vast area and lack of technology and tools. For example, there are not currently enough patrol vessels to effectively combat illegal fishing from Thailand, Vietnam, and China that occur within/up to 40 nautical miles inside the Indonesia EEZ.

Combating IUU fishing in Indonesia has become an important part of the Indonesian government's activities since 2014. The Indonesian President has claimed that 300 trillion rupiah, or US\$23 billion, are lost annually due to IUU fishing, and in a bold move, authorized the Navy to sink illegal vessels (The Jakarta Post, 18 November 2014). To date, more than 363 illegal fishing vessels have been sunk. Unfortunately, the Indonesian government has claimed that the economic losses and impacts from this illegal fishing activity have yet to be assessed (Lucile and Packard, 2015). The FAO has stated that IUU fishing impact in Indonesia is US\$10 - US\$23 billion annually, but over US\$80 billion annually were lost because of poor fisheries management.

In 2015, an Indonesian presidential task force on illegal fishing was established, and a moratorium on foreign-owned and/or foreign manufactured fishing vessels was put in place. These initiatives represent a new era in combating illegal fishing in Indonesia. Indeed, several cases of sinking illegal foreign fishing vessels, such as the Hai Fa and F.V. Viking cases, have garnered national and international media attention.

Despite these extensive efforts, and the millions of US dollars spent by the Ministry of Marine Affairs and Fisheries, some illegal fishing vessels still make their way to Indonesia.

### 1.2 Objective

The aims of this study are to assess the economic loss incurred by illegal fishing activities by foreign vessels in Indonesian waters, and evaluate the actions of the Indonesian government to mitigate these losses. The specific objectives of this study will be as follows:

1. An economic analysis in terms of law enforcement against IUU fishing
2. An understanding of shifting law enforcement expenditures and their effectiveness
3. An economic strategy for law enforcement combating illegal fishing at sea

## **2. ILLEGAL UNREGULATED AND UNREPORTED (IUU) FISHING**

### **2.1. International Framework on IUU Fishing**

Economics are a major driver of IUU Fishing, and it will always exist as long as the profits can be gained (Gallic and Cox, 2006; Ovetz, 2006). The two most common violations are license violations (Miller and Sumaila, 2014) and destructive/multi fishing gear usage/fishing techniques violations (Gilman, 2015). At the global level, the legal standing to combat IUU fishing was established by:

1. The United Nation Convention Law of The Sea (UNCLOS), known as the “constitution of the ocean” (Lindley and Techera, 2017) which recognizes each country's sovereignty to explore and exploit fisheries resources within their EEZ, with the obligation to protect and preserve their marine environment. For highly migratory species such as tuna, UNCLOS recommends direct regional collaboration or coordination through an international organization. In 1995, the UNCLOS established Regional Fishery Management Organizations (RFMOs) in which member states would collect and share information and create agreements to address IUU Fishing practices for highly migratory species.
2. The FAO has a mandate to ensure the sustainable management of marine resources for food security, and has committed to combat IUU Fishing. The FAO International Plan of Action on IUU Fishing (IPOA-IUU), which was followed by The FAO Agreement on Port State Measures (PSMA) to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing, is an international, legally binding agreement which provides a set of regulations.
3. The United Nation Office on Drugs and Crime (UNODC) stated in the UN Convention on Transnational Organized Crime in 2000 that maritime routes are often used for human trafficking and smuggling, mostly done using IUU fishing vessels.
4. The International Labor Organization (ILO) has regulated working standards aboard fishing vessels since 2013, but this notably does not include Chinese and Thai fishing vessels (Lindley and Techera, 2017).
5. The International Maritime Organization (IMO) set regulations for commercial vessels (greater than 24m length) following the International Convention for the Safety of Life at Sea (SOLAS) in 1974, but efforts to include fishing vessels in this regulation have thus far failed (Lindley and Techera, 2017).

### **2.2. Indonesia Framework on IUU Fishing**

A number of regulations and policies addressing fishing management, including IUU Fishing, have been established in Indonesia. A comprehensive list:

1. Act no. 5/1983, on the Indonesia Exclusive Economic Zone
2. Act no. 6/1996, on Indonesian Waters;
3. Act no. 31/2004, as amended by Act no 45/2009 on Fisheries;
4. Act no. 27/2007, on Coastal and Small Islands Management;
5. Act no. 32/2014, on Marine Affairs;
6. Government Regulation no. 15/1984, on Natural Resource Management in the Indonesia Exclusive Economic Zone;
7. Government Regulation No. 54/2002, on Fisheries Business;
8. Government Regulation no. 60/2007, on Fisheries Resources Conservation;
9. MMAF Decree no. 58/2001, on the Procedures of conducting the Surveillance Based Community System in Marine and Fisheries Resources Management;
10. MMAF Decree no. 45/2014, on the Indonesia Fishing Port Master Plan;
11. MMAF Regulation no. 05/2007, on the Fishing Vessel Monitoring System;
12. MMAF Regulation no. 01/2009, on the Fishery Management Area of The Republic of Indonesia;
13. MMAF Regulation no. 18/2010, on Fishing Logbook;
14. MMAF Regulation no. 02/2011, amended by MMAF Regulation no 05/2012, on Fishing Zones and Placement of Fishing Gears and Auxiliary Fishing Gears in The Fishery Management Area of The Republic of Indonesia;
15. MMAF Regulation no. 08/2012, on Fishing Port;
16. MMAF Regulation no. 12/2012, on High Seas Fishing Business;

17. MMAF Regulation no. 13/2012, on Catch Certificate;
18. MMAF Regulation no. 01/2017, on Operation Licenses of Fisheries Vessel.

In accordance with the international agreement on highly migratory fish and the Port State Measurement Agreement (PSMA), Indonesia has enacted specific regulations as follows:

1. Act no 17/1985, on the Ratification of UNCLOS;
2. Act no 21/ 2009, on the Ratification of the FSA;
3. Presidential Regulation no 9/2007 on Ratification of the Agreement for the Establishment of the Indian Ocean Tuna Commission;
4. Presidential Regulation no 109/2007 on Ratification of the Convention for the Conservation of Southern Bluefin Tuna;
5. Presidential Regulation no 61/ 2013 on Ratification of the Convention On The Conservation And Management Of Highly Migratory Fish Stocks in the Western And Central Pacific Ocean;
6. Presidential Regulation 43/2016, on the Ratification of the PSMA.

### **3. VULNERABILITY ASSESSMENT ON ILLEGAL FISHING AND ITS POLICY**

#### **3.1. Fishing Vessel and Gear License**

One of the Indonesian government's tools to prevent, deter and eliminate IUU fishing is the requirement of licenses for every fisheries activity and related business. Fishers must have a license to operate a vessel and declare their fishing gear. With these regulations in place, the government can gather data and information on the number of ships, types of fishing gear used, and fisheries businesses in Indonesia.

Article 34 Paragraph 1 of Law no. 31/2004 provides categories for fishing vessels based on their purpose and functions: capturing, carrying, processing, training, researching/exploring, and supporting fishing operations and fish cultivation. MMAF Regulation no. 30/2012 Article 11 (2) divides the permits for fishery businesses into three categories: Fisheries Business License (SIUP), License for Fishing (SIPI), and License for Fish Transporting Vessel (SIKPI). In this regulation, the Minister delegates the authority to issue a fishery business permit to the Director General (DG) of MMAF, Governors, and Regents/Mayors. Generally, the distribution of this authority is based on ship size with the DG authorized to issue permits to businesses using ships over 30 GT, Governors in charge of ships 10-30 GT, and Regents/Mayors handling ships less than 10 GT. Alongside a business license, the vessel's owner must register their vessel(s) and will be given identification for each boat. An Operation License (SLO) is also required, stating that the fishing vessel has fulfilled administrative requirements and technical feasibility to conduct fishery activities. A Fisheries Inspector at the port of base or port of loading issues these one-time-use SLOs.

In 2014, the Minister released MMAF Regulation no. 56/2014 on Moratorium of Capture Fishery Business Licenses, which suspended access to foreign fishing vessels over 30 GT. This moratorium was enacted to prevent foreign fishing vessels from catching fish and transporting them out of Indonesian waters directly, and also to discourage the practice of exchanging ship flags when passing through the border areas. During the moratorium, the government planned to analyze and evaluate which foreign fishing vessels have SIPI and SIKPI licenses. In article 37 of MMAF Regulation no. 30/2012, it is stated that every vessel that has been registered is given permission to fish in a specific area in one of the Fisheries Management Area of the Republic of Indonesia (WPP-NRI) or two adjacent WPP-NRI. Each fishing vessel is also assigned to one port of base and one port of call. For the high seas fisheries, every fishing vessel is registered with the three RFMOs that Indonesia has joined. Any fishing vessel operating in the high seas may land its catch in Indonesia or in another member country of the same RFMO, as long as the vessel provides a report to the port of base. If the fishing vessel lands in another country, they must notify the head of the base port in Indonesia through electronic media of ship identity, amount of catch, catching area, and destination countries.

MMAF Regulation no. 71/2016 governs the use and placement of fishing gear and supporting tools on fishing lanes and in WPP-NRI. Article 21 deals with fishing gear, such as seine nets, trawls, and aerals, that compromise the long-term sustainability of the fishery. More specifically, the MMAF issued Regulation no. 2/2015 on the Prohibition of the Use of Trawl and Seine Nets forbidding these gear types specifically. The use of trawlers and seine nets affects marine biodiversity, especially coral reefs. This type of gear is also a threat to seafood security because they are not selective and tend to have huge catch capacity, increasing the bycatch rate and causing overfishing.

### **3.2. Fisheries Monitoring, Control and Surveillance**

The Food Agriculture Organization (FAO) introduced Monitoring Controlling and Surveillance (MCS) in 1981 and the concept has been escalating since 2001 under the International Plan of Action to prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-UU). Principally, MCS provides guidelines for sustainable fisheries management with optimal economic and welfare outcomes, implemented with each country's specific characteristics and needs in mind. A common mistake in implementation of MCS, as outlined by a FAO report, was an overemphasis on the surveillance component. Some countries were exclusively strengthening their law enforcement at sea, while disregarding the monitoring and control components.

One of the keys to success in combating IUU Fishing is effective monitoring through VMS, logbooks, on-board observers, and inspections at sea and in ports. Technology plays an important role in efforts to observe, monitor, and control fisheries, especially in overseeing the fishing fleet. VMS technology uses communication satellite-based equipment to enable MMAF to monitor the movement of fishing vessels and detect, track, and prosecute fishers that are operating in closed waters or other illegal activities on commercial fishing vessels. In addition, VMS can be used to accurately track offshore and near shore fishing activities that might be technically legal, but are unregulated and/or unreported.

In Indonesia, VMS is regulated by MMAF Regulation no. 42/2015, where Article 12 mandates every vessel over 30 GT, operating in WPP-NRI and on the high seas, must install VMS transmitters. This rule also established working units to collect, process, evaluate, analyze, and display monitoring data. Every fishing vessel is obliged to activate their VMS transmitters and is prohibited from transferring the transmitters to other fishing vessels. Based on 2016 data from the Directorate General of Capture Fisheries (DGCF), there were 3,950 licensed fishing vessels operating, of which 2,870 had VMS transmitters installed. Analysis of transmitter data from that year found that as many as 633 fishing vessels committed violations, and that, on average, only half of the vessels that were required to have VMS transmitters actually did.

To conduct monitoring on fishing activities at sea, MMAF applies two mechanisms: logbooks and on-board observers. According to article 2 of MMAF Regulation no. 48/2014, all Indonesian-flagged vessels over 5 GT that operate in WPP-NRI or on the high seas are obliged to fill out fishery logbooks. Prior to landing their catch at the port, the vessel master is obliged to submit the logbook to the port master or logbook officer. This also applies to fishing vessels that receive transshipment from other boats. Logbook data is guaranteed to be confidential by all parties involved.

Appointed inspection officers also conduct supervision and monitoring directly on the ship for vessels over 30 GT operating in WPP-NRI and on the high seas. Observers are placed on boats that use purse seine nets and long lines on the high seas, and boats in WPP-NRI that use hooks and lines, surrounding nets, lift nets, gill nets, seine nets, and trawls. Monitoring reports made by observers are verified, validated, and analyzed with logbook data, and in cases where these obligations are not fulfilled, the fishing vessel shall not be granted a license.

According to Act no 45/2009 article 69 in conducting surveillance, inspection vessels can stop, inspect, carry, and arrest fishing vessels that are suspected of committing a violation in the WPP-NRI, taking them to the nearest port for processing. At present, the MMAF has 35 patrol vessels, with 17 vessels operating in western Indonesia fisheries such as Natuna, Anambas, and Karimata, while 10 others are in eastern Indonesian fisheries such Sulawesi and Arufuru. The DG also establishes the port of base for

these patrol vessels with seven locations in the west and five locations in the east. Those locations were chosen based on strategic positions, close to areas prone to illegal fishing with easy access to supplies, refueling and mooring facilities. MMAF carries out independent patrols and also joins operations with the Navy and Marine Police.

### 3.3. Fishing Port

Ports have an important role in licensing and monitoring, as they are one of the considerations for fishing business permits for a ship, and can issue an SLO for a fishing vessel to sail. The port also serves to verify and validate monitoring results. Therefore, in order to combat IUU fishing, the role of the port should not be underestimated. Integration of pre-production, catch, post-harvest, and marketing can help ports become full-service fisheries centers, with connectivity between upstream and downstream activities that create multiplier effects in the regional economy. This approach can also boost efficiency, reduce the cost of production, and make fishing businesses more competitive.

According to MMAF Regulation 08/2012 articles 5, 6, 7 and 8, fishing ports are classified into 4 groups, namely:

- a) Class A fishery ports, hereinafter referred to as Ocean Fishery Ports (PPS), serve vessels that conduct fisheries activities in Indonesian waters, the Indonesian EEZ, and on the high seas. PPS have partially landed fish for export purposes, fish loading and unloading activities, marketing of fishery products averaging 50 tons per day, and fish processing industries and other supporting industries on site.
- b) Class B fishery ports, hereinafter referred to as Archipelagic Fishery Ports (PPN), serve fishing vessels that conduct fishery activities in Indonesian waters and EEZ and have the operational criteria of: fish loading and unloading activities, marketing of fishery products averaging 30 tons per day, and there are fish processing industries and other supporting industries on site.
- c) Class C fishery ports, hereinafter referred to as Coastal Fishery Ports (PPP), serve fishing vessels that conduct fishery activities in Indonesian waters and host loading and unloading activities, and marketing of fishery products averaging 5 tons per day.
- d) Class D fishery ports, hereinafter referred to as Fish Landing Bases (PPI), serve fishing vessels that conduct fishery activities in Indonesian waters and support loading and unloading, and marketing products averaging 2 tons per day.

Institutions such as Immigration, Customs, Sea Transportation, Monitoring and Control of Marine and Fishery Resources, Processing and Marketing of Fishery Products, and Fish Quarantine must support the port authority to eradicate IUU Fishing and apply the PSMA. For instance, Immigration has an essential role in cases involving illegal human trafficking, which often occurs on fishing vessels that are involved in IUU Fishing. Every port must also have a Fisheries Port Information Centre, which is charged with collecting, managing, analyzing, storage, presenting, and disseminating port data including: frequent ship visits, production and prices of fish, fishing gear, logistics, marketing, and labor. However, synchronization between institutions is still difficult for some ports in Indonesia. Furthermore, data held by the Port Information Centre remains outdated.

In order to reduce IUU Fishing and provide added value for Indonesian fishery products, all vessels have an obligation to certify their catches. Article 6 of MMAF Regulation no 13/2012 entitles two authorities to issue the Certification of Fish Catch (SHTI): the Head of Fishery Port attached to the Ministry and the Head of Fishery Port that is part of a regional institution. The purpose of catch certification is to facilitate trade with the European Union (EU) as well as assist national and international efforts to prevent, deter, and eliminate IUU Fishing activities.

As part of port development in Indonesia, the government has created a Port Master Plan, which is regulated by MMAF Decree no 45/2014. This master plan is closely linked to the implementation plan of the PSMA, especially in appointing designated ports to combat IUU fishing activities by both domestic and foreign ships. One focus of the Port Master Plan is sustainable fisheries, approached through improving the catch certification and fish landing recording systems. The government takes the following factors into consideration in the development of ports:



1. Zoning Plan for Coastal Areas and Small Islands, General Plan for Provincial/Regency/City, and spatial planning;
2. Fishery Management Area of the Republic of Indonesia and potential of fish resources;
3. Capacity of human resources;
4. Supporting regional infrastructure;
5. Geographical area and water conditions;
6. Socio-economic conditions of the surrounding community.

Based on those factors, the general picture of port development over the next 20 years is outlined below:

Period	CLASS					Total
	Ocean Fishery Port (Class A, PPS)	Archipelagic Fishery Port (Class B, PPN)	Coastal Fishery Port (Class C, PPP)	Fish Landing Base (Class D, PPI)	Status Not Available	
2015-2019	6	15	45	936	137	1139
2020-2024	6	15	51	969	98	1139
2025-2029	9	16	51	1063	-	1139
2030-2034	15	18	49	1057	-	1130

Source: Ministerial Marine Affairs and Fisheries decree no. 45, 2014.

### 3.4. Indonesia National Plan of Action to Prevent and to Combat IUU fishing

In 2007, 11 countries in the Southeast Asian region (Indonesia, Australia, Brunei Darussalam, Cambodia, Malaysia, Papua New Guinea, The Philippines, Singapore, Thailand, Timor-Leste, and Vietnam) agreed to establish the Regional Plan of Action (RPOA) to Promote Responsible Fishing Practices, including combating IUU Fishing. The RPOA is designed to enable effective implementation of the IPOA-IUU, and has been translated into a National Plan of Action (NPOA) with specific adjustments to the conditions of every member country. Since 2011, Indonesia has played an active role in the IUU-RPOA forum, supported by MMAF Decree no 50/2012 which offers guidance for every organizational unit within the MMAF on preventing and tackling IUU Fishing and coordinating with other related agencies.

In relation to the PSMA, the NPOA suggests that Indonesia should:

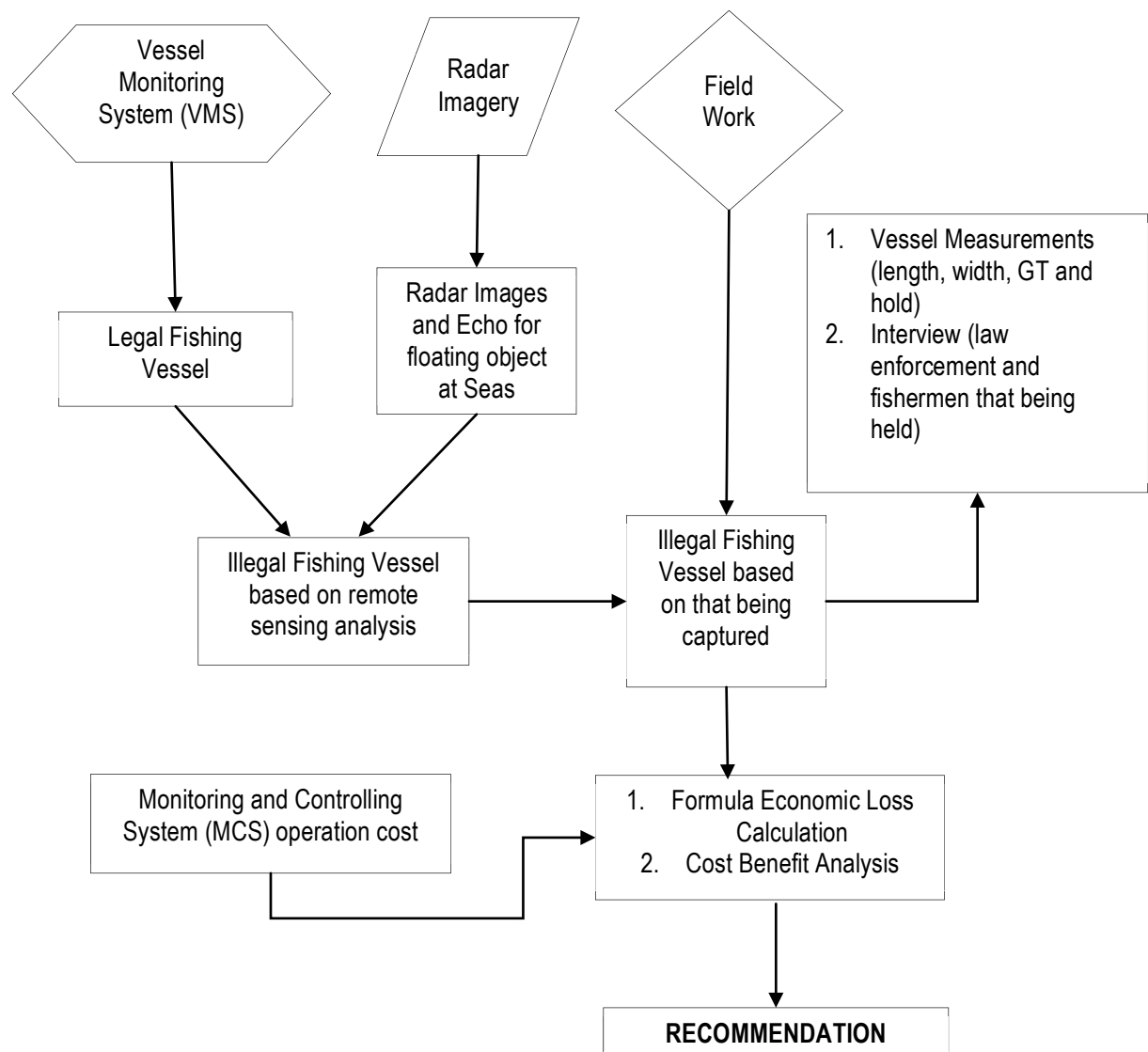
1. Accelerate the ratification process of the FAO Port State Measures Agreement;
2. Improve surveillance of fishing vessels and fish-carrier vessels;
3. Increase the capacity and capability of human resources;
4. Complete the port infrastructure and facilities;
5. Improve communication with the RFMOs.

These actions could prevent foreign vessels - suspected of IUU fishing in the RFMO's convention area - from entering ports in Indonesia. So far, five ports have been designated as PSMA implementation stations: Nizam Zachman (Jakarta), Belawan (North Sumatra), Bitung (North Sulawesi), Pelabuhan Ratu (West Java), and Ambon (Maluku). However, a lack of infrastructure and human resources still prevent these ports from being able to implement the PSMA.

## 4. METHODOLOGY

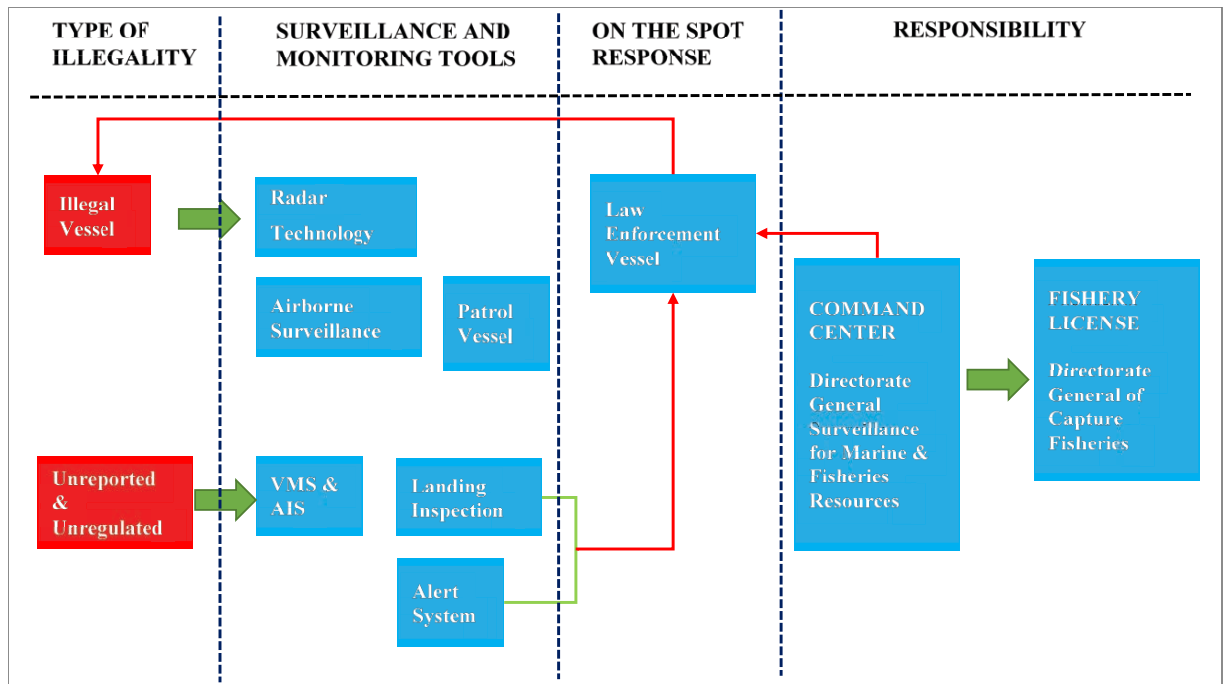
We will use both quantitative and qualitative methods to define the economic impact of illegal fishing.

Geographic Information System (GIS) data based on Radar Satellite Imagery (RSI) and VMS inputs will be used to determine which vessels are legal and which illegal, and determine the indicators of illegal fishing based on the policy definitions in place. In the second phase of the analysis, we will include captured vessel information to calculate economic losses from IUU Fishing. Finally, we will conduct a Cost Benefit Analysis and make recommendations.



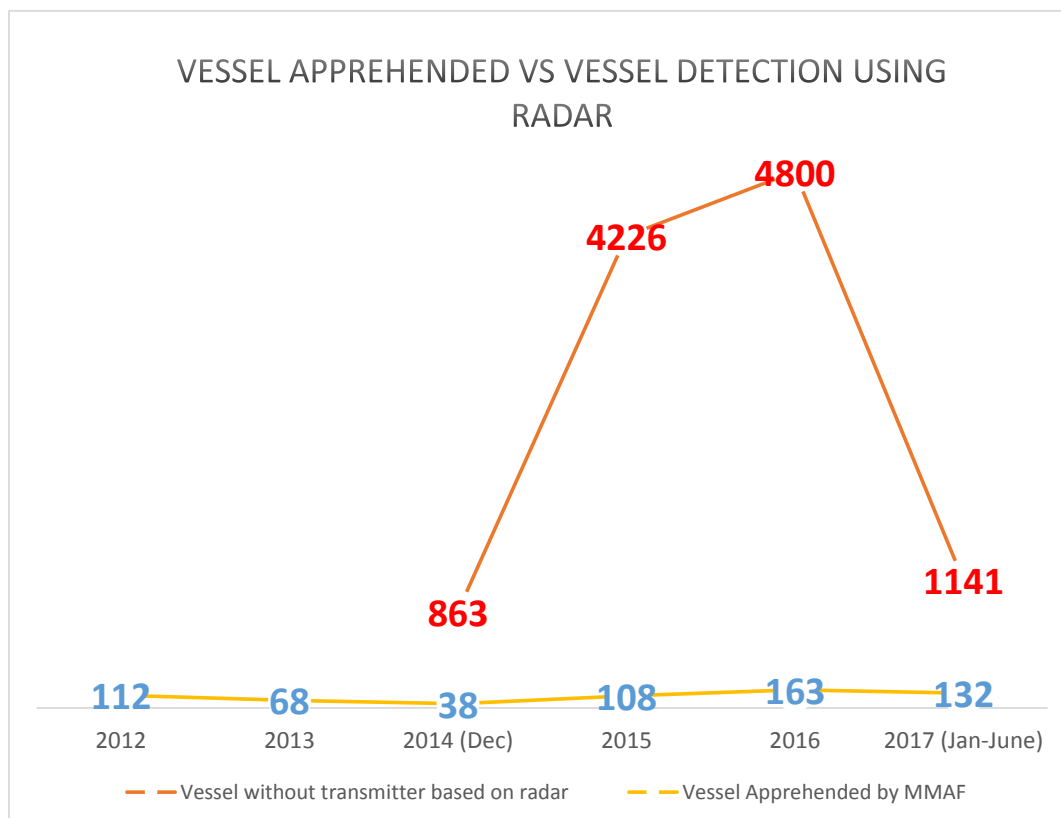
## 5. RESULTS

The Standard Operating Procedures (SOP) for combating IUU Fishing are surveillance and monitoring tools, and on-the-spot or at-sea responses (see figure below).



Before utilizing radar satellite technology (2012-2014), MMAF successfully captured 218 illegal fishing boats, and most of them were apprehended based on patrol experiences and intelligence information from fishermen that operated near the border.

Since 2014, using radar satellite technology at a facility located in Perancak (Bali), there has been a nearly 30% increase in apprehension of illegal fishing vessels. However, radar imagery showed that 11,030 illegal vessels were detected, while only 363 were apprehended from 2014-2017, representing only 3.3% of the total. This indicates significant room for improvement.



Based on an the investigative report by the Directorate General for Surveillance of Marine and Fisheries Resources, the majority of the seized illegal fishing vessels had fishing licenses from their home country, and most of them were equipped with fish finder, radio, and satellite phone technology, but did not have AIS or VMS transmitters on board. Of the 363 fishing vessels apprehended from 2014-2017, only five vessels were equipped with AIS.

Focus group discussions held in August 2017 with captains and crews of illegal fishing boats from Thailand and Vietnam yielded the following information:

#### *Vietnamese Illegal Fishers*

To avoid detection by Indonesian patrols, the captains change the name of their vessel to an Indonesian name and enter Indonesian waters without any transmitters on board. They come to Indonesia an average of 4 times per year, equipped with GPS-fish finder and satellite phone technology. Their fishing locations changed from visit to visit, but were usually 20-40 nautical miles inside the Indonesia EEZ. All of these vessels had official Vietnamese licenses, and the owner had an Indonesian contact that would provide information about when and where to enter Indonesian territory.

They reported earnings of roughly 3 billion VDN (\$129,313 USD) for one year of operation. Capital expenditures were around 3 billion VDN (\$132,029 USD) every 3 months, with a catch of around 100 tons of fish in the same period. They sold that catch to their owner for 7000 VDN (\$0.3 USD), which the owner would then sell for 7 billion VDN (\$308,069 USD). They transported fish at least once per month to the mother ship. No including the transshipment effort, the potential economic losses for Indonesia are at minimum are  $\$308,069 \times 4$  (12 months fishing season) = \$1,232,276 USD per trawl, and the maximum price of the illegal fish is \$3 USD/kg.

#### *Thai Illegal Fishers*

Like the Vietnamese, Thai illegal fishers also operate four times annually, but conduct a transshipment to their mother ship, about 5 nautical miles outside the Indonesian EEZ, every 10 days. Their vessels have official Thai licenses and GPS-fish finder and AIS transmitters, but the AIS transmitters are switched-off during transshipment.

From our discussion, we learned that the owner has 35 pairs of trawl ships and 5 mother ships. Every 10 days the trawl ships transport 2200-tons of fish to the mother ship. Thai fishermen usually get 50,000 Baht (\$1543 USD) per crew and sell at a rate of \$1 million Baht (\$30,877 USD) for 280 tons. Therefore, the total sale of illegal fish per month is worth \$90,699 USD, potential economic losses for Indonesia are  $\$90,699 \times 12$  months (fishing season) = \$1,088,388 USD annually, and the maximum price of the illegal fish is \$1 USD/kg.

## **6. ECONOMIC ASSESSMENT ON ILLEGAL VESSELS**

Based on an data from an investigative report by the Directorate General of Surveillance at MMAF from 2014-2017, our estimate of the economic impact of illegal fishing vessel per month is measured based on gross tonnage (GT). As stated by (Aanes et al., 2011), net tonnage = 60% of gross tonnage, and the average stowed factor = 60% of net tonnage. We follow these calculations to find the average stowed factor with the conversion factor for fish species, i.e. cod 1.5, cod fillet 3.25. Unfortunately, the report did not include pictures of the fish, only the variety, so we chose a conversion factor of 2.

The minimum amount of fish carried by illegal fishing vessels (modified from Aanes et al., 2011):

- Net Tonnage (NT):  $GT - (GT \times 60\%)$
- Payload:  $NT - (NT \times 60\%) \times 2$
- Value of illegal fish is \$3 USD/kg
- Minimum number of transshipments = once a month

- The final calculation: Payload \* illegal fish price \* 24 (12 month fishing season, with transshipment twice per month)

In order to calculate the total annual savings to the Indonesian economy, or benefits, we first calculated the transshipment cost per month. Based on focus group discussions, we assume transshipment twice per month, the minimum tonnage, and based on the highest illegal fishing price, the minimum economic value is \$3 USD/kg.

Based on the aforementioned calculation the benefit to Indonesia of combating illegal fishing is as follows:

Year	Minimum saved	Including transshipment
2014	USD 67,334,400	USD 134,668,800
2015	USD 83,547,418	USD 167,094,836
2016	USD 95,058,317	USD 190,116,634
2017	USD 97,322,342	USD 194,644,684

Expenditures for combating illegal fishing were divided into 5 categories: technology expenditure for radar satellite, patrol vessel operation expenditure, airborne patrol expenditure, IUU Fishing Task Force (SATGAS 115) expenditure, and sinking vessel expenditure. The cost to Indonesia of combating illegal fishing as follows:

Year	Technology	Vessel Operation	Airborne Surveillance	IUU Task Force	Sinking vessel	Total
2014	USD 469,979	USD 28,148,148	-	-	-	USD 28,618,127
2015	USD 908,189	USD 26,814,815	USD 1,407,407	USD 1,481,481	USD 156,602	USD 30,768,494
2016	USD 1,168,952	USD 21,037,037	USD 1,925,926	USD 3,259,259	USD 521,032	USD 27,912,206
2017	USD 154,047	USD 20,444,444	USD 1,777,778	USD 4,666,667	USD 619,769	USD 27,662,705

The cost analysis shows that technology was used extensively from 2014 - 2016 and then dropped significantly by 2017. Vessel operation expenditures also gradually declined over the period of analysis. The expenditures that increased over time were airborne surveillance, IUU Fishing Task Force, and sinking ships. This shows that MMAF decreased their use of technology to detect IUU Fishing, and also reduced patrols, which have the ability to quickly respond and are responsible for intercepting and capturing illegal boats. Without the ability to detect illegal boats, patrols and airborne surveillance will be less effective and consume more fuel, leading to even greater losses.

Between years 2015-2017, radar technology successfully detected more than 11,000 suspected illegal fishing vessels that were not using VMS or AIS transmitters. During 2016-2017, radar technology supported the capture of 163 illegal fishing vessels, nearly 50% of the total vessel apprehended by MMAF between 2015 and 2017. On average, each radar scan can capture 9.6 illegal fishing vessels. We find that the economic savings to Indonesia of capturing one illegal trawl boat are \$1 million USD/annually, which means that one radar scan can save nearly \$10 Million USD/annually. The cost of 500 radar scans is \$1.67 million USD. To find the annual total losses, we conducted the following calculations:

- 1% \* \$1.67 million USD = \$16,700 USD in reduced budget

- One radar scan = \$2500 USD; \$16,700 USD / \$2500 USD = 6.68 fewer scans; 6.68 scans \* 9.6 illegal vessels = 64.13 fewer illegal vessels detected
- 64.13 illegal vessels \* \$1 million USD = \$64.13 million USD in foregone savings

Therefore a reduction of the annual budget by 1% would mean 64.13 fewer illegal fishing vessels detected, and a loss of \$64.13 million USD.

Year	Benefits	Technology expenditure	Vessel Patrol expenditure	Airborne surveillance	IUU Task Force Expenditure	Sinking Vessel Expenditure
2014	USD 67,334,400	USD 469,979	USD 28,148,148	None	None	None
2015	USD 83,547,418	USD 908,189	USD 26,814,815	USD 1,407,407	USD 1,481,481	USD 156,602
2016	USD 95,058,317	USD 1,168,952	USD 21,037,037	USD 1,925,926	USD 3,259,259	USD 521,032
2017	USD 97,322,342	USD 154,047	USD 20,444,444	USD 1,1777,778	USD 4,666,667	USD 619,769
Growth Rate	0.12	-0.37	-0.11	0.08	0.38	0.46

## 7. CONCLUSION & RECOMMENDATIONS

Indonesian Monitoring Controlling Surveillance (MCS) is focused almost entirely on surveillance and enforcement of illegal foreign vessels, missing some major components with the potential to improve fisheries management. In order to achieve optimal economic opportunities and welfare, and have healthy fisheries in the long term, it will be important for the government to establish a more comprehensive MCS strategy for the sustainable use of all marine resources within the Indonesian maritime region.

We found that one illegal trawl fishing vessel can lead to economic losses of \$1.2 million USD annually in Indonesia. We also learned that illegal fishers in Indonesia share a common practice - only small fishing boats come into Indonesian territory and larger boats stay outside the borders. The smaller boats then periodically deliver their catch to the larger boats, and they usually stay to fish for about 3 months.

Radar satellite technology is very helpful for detecting illegal fishing vessels, the majority of which are not equipped with VMS or AIS transmitters. This technology can help guide patrols and airborne surveillance so that MMAF can detect illegal vessels and intervene. A one percent reduction of expenditure on radar technology can result in an increase in illegal fishing equal to a loss of \$64 million USD for the Indonesian economy annually.

IUU Fishing practices will persist due to population pressure, and in order to combat illegal fishing, countries must work together, especially on prosecuting illegal fishers. The PSMA is one part of the solution, if implementation issues can be resolved and ports across the ASEAN region can be developed.

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