An analysis of sustainability issues in eastern Indonesian pole-and-line tuna fisheries

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Submitted for the degree of Doctor of Philosophy
May 2019

Abstract

Sustaining healthy tuna fisheries is crucial to Indonesia's national income from the fisheries sector and to securing the fishers' livelihoods. Yet sustainability issues in the small-scale pole-and-line tuna fisheries have been little analysed, and this study helps to fill some gaps in the literature. Data were collected from ten sites across eastern Indonesia (Sorong, Ternate, Pulau Bacan, Larantuka, Kupang, Bali, Surabaya, Bandung, Bogor and Jakarta) by four methods: review of academic and other publications; quantitative questionnaire surveys; qualitative interviews with key informants; and personal observations. The thesis investigates potential short-term effects of a government moratorium on foreign fishing vessel on small-scale tuna pole-and-line fishing (Chapter 2); trends in landings and effort (Chapter 3); the relationships between fishing effort and oceanographic variables at fish aggregating devices (FADs) sites (Chapter 4); and market supply strategies (Chapter 5).

The findings of the study are: (1) the moratorium had little effect on the tuna pole-and-line fishery, yet fishers claimed it helped them to fish more freely. (2) Landings trends varied between locations but in general from 2012 the landings volumes declined. (3) Stakeholders perceived that the government's published fisheries data were inaccurate because they were not collected using established scientific principles. (4) There were positive relationships between catch per unit of effort (CPUE) and both sea surface temperature (SST) and chlorophyll-a (chl-a) concentration but these were relatively weak. (5) On market supply, only Sorong seemed to demonstrate the initiative to access export markets by partnering with international private companies and preparing for Marine Stewardship Council (MSC) certification, an essential strategy if the fisheries are to achieve their full potential in the global tuna market. Tuna pole-and-line fisheries in eastern Indonesia are in moderately good shape, but they face significant challenges including diminishing tuna stocks, illegal, unreported and unregulated fishing practices; competition from industrial vessels, and restricted marketing options.

To my GOD, parents, Yessi, Humaira and Zaidan

For their invaluable love and support

Acknowledgements

First of all I would like to thank my supervisors, Professor Nicholas Polunin, Professor Tim Gray and Dr Aileen Mill for their tireless and constant support and guidance during my Ph.D study in Newcastle University. Professor Nick has always encouraged me to take on the challenge of an independent researcher and has provided guidance, feedback and support throughout both academically and non-academically. Professor Tim Gray always believed in me to understand and perform analysis independently and to be academically critical so as to be a better thinker in science and academic matters. Dr Aileen Mill has always provided me with valuable inputs on data analysis which greatly improved this research. I would like to give a special mention to Dr Aileen Mill for her constant help and patience which helped me understand the statistical analysis in this research.

I also would like to thank the Indonesian Government through the Directorate General of Research and Higher Education Resources, the Ministry of Research and Higher Education (formerly the Ministry of Education and Culture) for providing me with Ph.D funding at Newcastle University. My gratitude goes particularly to the Rector of Padjadjaran University, Bandung–Indonesia for allowing me to study here in Newcastle University. My thanks also goes to the fishers in Sorong, Ternate, Pulau Bacan, Larantuka, Kupang and Bali and to the tuna processing companies in Sorong, Larantuka and Surabaya, and to everyone who participated during the research survey and key informant interviews. I would like to give a special mention to Dr Budy Wiryawan, Dr Roza Yusfiandayani, John Garside, Muhammad Irfan bin Abdul Jalal, Lantun Paradhita Dewanti, Anta Maulana Nasution, Georgina Hunt and my academic panel team for their significant contributions to this research during my study time. I am also grateful to my brothers and sisters, colleagues, friends and all the staff of the School of Natural and Environmental Science (formerly the School of Marine Science and Technology), Newcastle University for their encouragement and assistance.

Last but not least, I would like to give my special thanks to my parents, my wife and my children who tirelessly and unconditionally support me. Thank you GOD for giving me the mercy and the easiness to complete one of my life chapters, all the praises be to my GOD.

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Chapter 1. Introduction

This thesis is a study of aspects of the pole-and-line tuna fisheries in eastern Indonesia in order to better understand its current status and future sustainability. This introductory chapter explains the rationale of the research, the literature that supports it, research questions that have been posed, a problem statement, the theoretical framework informing the analysis, and the methodology employed. It then outlines the main body of the thesis.

1.1 Thesis rationale

Tuna pole-and-line fisheries in Indonesia have reached a critical point in development, and their future viability depends on a choice between either scaling-up activities in order to become a world player with a corresponding potential global market, or remaining as a small-scale industry with a mainly domestic market. The core objective of this study is to explore aspects of the plausibility of each of these options and to help identify which is the more likely to secure the long-term sustainability of the fisheries.

1.2 Literature review

This thesis has adopted predominantly an integrated literature review approach rather than a single stand-alone literature review. The integrated approach uses literature throughout the thesis at the times when it is immediately relevant to the subject matter and discussion. Using this approach, each chapter effectively contains within it a mini-literature review. The mini-literature review for the current chapter consists of a critical account of the publications that are closest to the rationale of the thesis.

1.2.1 Tuna fisheries globally and in Indonesia

The largest part of the global tuna catch is caught in the Pacific Ocean, whilst the Indian Ocean provides the second highest catch, followed by the Atlantic Ocean (Garrett and Brown, 2009). The six main tuna catching nations are Japan, the EU, Taiwan, Indonesia, Philippines and South Korea (Schiffman and MacPhee, 2014). Globally, skipjack tuna (*Katsuwonus pelamis*) provides the great volume of all tuna fish caught (FAO, 2017). For example, in 2006 the volume of skipjack caught was twice that of any other individual tuna species, and skipjack is the most important tuna in the Pacific Ocean constituting 50.7% of the total global tuna catch (Miyake et al., 2010). However, in the Indian Ocean, bigeye tuna (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) stocks support the largest catches (Zhang et al., 2013), followed by skipjack tuna and tuna-like species (Sunoko and Huang, 2014, MMAF, 2013b). The stocks of key species for fresh tuna production have remained relatively constant over time with yellowfin traded in the largest volumes followed by bigeye, bluefin (*Thunnus sp*) and albacore (*Thunnus alalunga*) (Garrett and Brown, 2009). Squires et al. (2013) found that continuing the current level of fishing effort on most tuna stocks will probably lead to there being reduced catches in the long term, although skipjack tuna is not currently considered to be overfished in any ocean (Davies et al., 2014).

In an archipelagic nation such as Indonesia, the ocean is both a dominating physical reality and a potential source of wealth. From the capture fisheries viewpoint, it can and does provide an important contribution to the national economy. The Indonesian government classifies pelagic fish resources into large pelagic fishes and small pelagic fishes (Table 1.1).

Table 1.1 Indonesia marine fishes' classification (MMAF, 2006).

Small pelagic	Large pelagic
Needle fish	Common dolphin fish
Trevallies	Indo-pacific sailfish
Scad	Black marlin
Rainbow runner	Indopacific blue marlin
Torpedo Scad	Striped marlin
Black pomfret	Swordfish
Queen fish	Bullet tuna
Oxeye scad/ Bigeye scad	Frigate tuna
Chacunda gizard shad	Kawa kawa/ Eastern little tuna
Spotted sardinella	Skipjack tuna
Rainbow sardine	Narrow-barred spanish mackerel
Fringescale sardinella/Deepbody sardinella/Goldstrip sardinella	Indo-pacific king mackerel
Bali sardinella	Albacore tuna
Hilsa shad	Yellowfin tuna
Anchovies	Southern bluefin tuna
Flying fish	Bigeye tuna
Garfish and Halfbeaks	Longtail tuna
Mangrove mullet/ Blue-spot mullet/Blue-tail mullet	Sharks
Short-body mackerel	Sharpnose sharks
Indian mackerel	Mackerel sharks
Striped bonito	Makos/ White sharks
Spotted chub mackerel	

The long and well-established tuna fisheries in Indonesia are one of the most valuable of the country's fishing activities. Both the traditional and industrial levels of fishing depend on tuna availability from the wild (Fernández-Polanco, 2016, FAO, 2016b, MMAF, 2015c). The traditional fishing of tuna in many islands of eastern Indonesia is shown by the artisanal fishing techniques that are employed (Harsono et al., 2014). The local skipjack tuna stock in eastern Indonesia is supplemented periodically by large migrations from the western tropical Pacific Ocean stocks (McElroy and Uktolseja, 1992). The tuna resources in Indonesian waters are currently considered, however, to be under pressure and most species have become fully exploited or are potentially over-exploited. Only skipjack is perceived to have been maintained at a moderate level (Sunoko and Huang, 2014). Yellowfin tuna has been fully exploited except in the Makassar Strait waters, Bone Bay, Flores Sea, Bali Sea, Aru Sea, Arafura Sea and the Eastern Timor Sea areas (Sunoko and Huang, 2014, MMAF, 2013b).

The live-bait fisheries associated with longlining are very important for supplying and maintaining pole-and-line tuna fishing operations (Dahle, 1981). In most Indonesian pole-and-line tuna fisheries, the bait is usually composed of small-size pelagic fish (Conand, 2003, Gilman et al., 2014, Soegiri and Budiman, 2010), mostly anchovies (*Stolephorus* spp.) (IPNLF, 2012), the natural food of the larger fish in the food chain. Other live baits that are used in Indonesia include round scad (*Decapterus* spp.) for hand-line tuna fisheries (Linting et al., 1994), trevallies (*Selaroides spp.*), sardines (*Sardinella* spp.), chub mackerel (*Rastrelliger* spp.) and fusiliers (*Caesionidae*) (Linting et al., 1994, IPNLF, 2012, Rumahrupute et al., 1987, Gafa and Subani, 1987). Live bait is supplied directly to the tuna fishing vessel by local small-scale fishers (Conand, 2003) where the dominant species are caught by floating lift nets, rounded haul nets and beach seine nets (Gafa and Subani, 1987) and "bait-boats" support the pole-and-line vessels (Hall and Roman, 2013).

Indonesia's marine fisheries resources are at the present time unevenly exploited, since most of the fishing pressure occurs inshore (Setiyowati et al., 2016); the shallow water are heavily exploited, and with the exception of coastal waters surrounding some of the more sparsely populated islands, offer distinctly limited potential for any expanded production (Bailey et al., 1987). Because skipjack reproduction is continuous over the year in tropical areas (Andrade and Teixeira

Santos, 2004), tuna pole-and-line fishing targets skipjack actively throughout the year.

Indonesia's small-scale tuna fisheries fishing grounds are located mostly in the coastal areas, largely because of the small size of the fishing vessels, a lack of on-board refrigeration thus limiting trip time, and the high cost of petrol. Small-scale tuna fishing is generally confined to within 20 to 30 km from the nearest fish markets (Jackson et al., 2014). By a ministerial decree in 2009 (Ministry of Marine Affairs and Fisheries (MMAF) Republic of Indonesia number: Per.01/MEN/2009), Indonesian waters are divided into eleven fisheries management areas and these are designed for fishing monitoring, fish stock assessment, total allowable catch calculations, and fishing licensing (Sunoko and Huang, 2014). These eleven areas are listed below (Table 1.2. and Figure 1.1.).

Table 1.2 Indonesia's fisheries management areas [*Wilayah Pengelolaan Perikanan Republik Indonesia/ WPP-RI*] (MMAF, 2013b).

Fisheries Management Areas	**Location**
WPP-RI 571	Malacca Straits and the Andaman Sea
WPP-RI 572	Western Sumatera of the Indian Ocean, and the Sunda Straits
WPP-RI 573	Southern Java to Nusa Tenggara of the Indian Ocean, the Sawu Sea and the Western Timor Sea
WPP-RI 711	Karimata Straits, the Natuna Sea and the South China Sea
WPP-RI 712	Java Sea
WPP-RI 713	Makassar Straits, Bone Straits, Flores Sea and Bali Sea
WPP-RI 714	Tolo Straits and Banda Sea
WPP-RI 715	Tomini Bay, Berau Bay, Maluku Sea, Halmahera Sea and Seram Sea
WPP-RI 716	Sulawesi Sea and Northern Halmahera Island
WPP-RI 717	Cenderawasih Bay and the Pacific Ocean
WPP-RI 718	Aru Bay, Arafuru Sea and Eastern Timor Sea

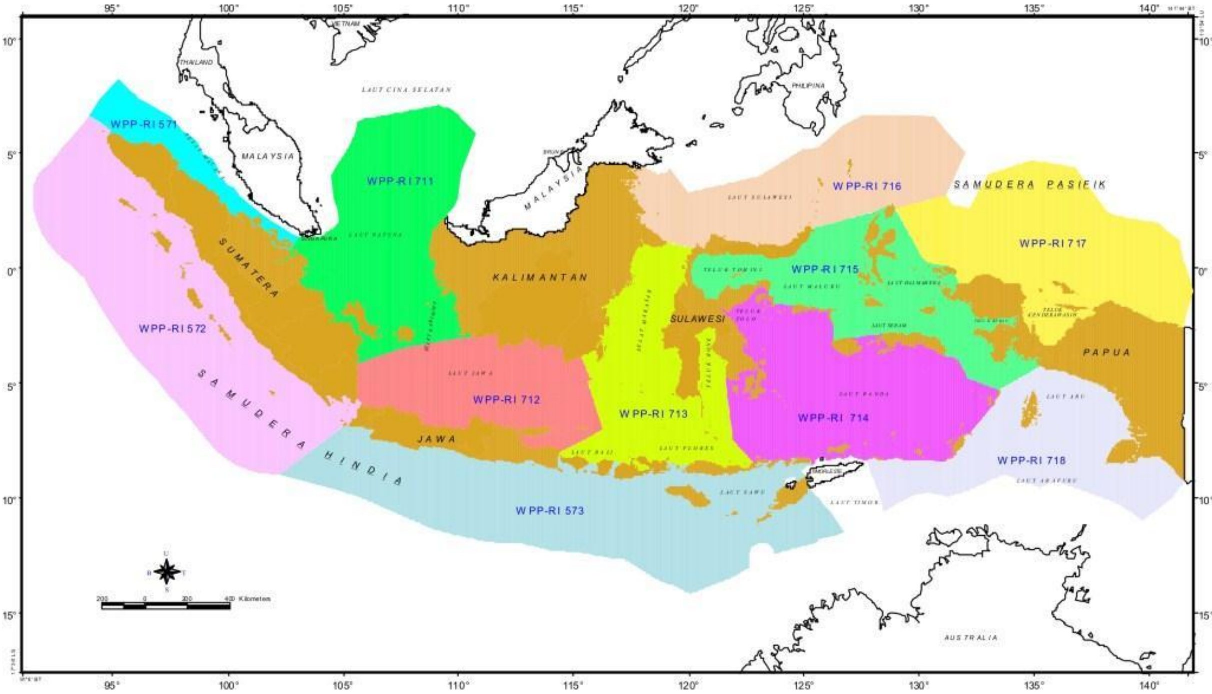

Figure 1.1 Indonesia fisheries management areas (MMAF, 2013b).

In East Indonesia skipjack tuna are generally caught by local small-scale fishers throughout the year but especially during the fishing seasons which are April to May and September to December (Harsono et al., 2014). This behaviour is not universal, and some skipjack exhibit an alternative strategy of exploiting any floating object habitat instead (Wang et al., 2014). Indonesian tuna fisheries are usually engaged with the employment of fish aggregation devices (FADs), such as quite simple floating objects or *rumpon* around which fish tend to congregate. FADs are likely to play a role in the interactions between the skipjack and their local environment, including numbers of small fish, their food thus altering the natural grouping state of the local population (Wang et al., 2014, FAO, 2014b).

1.2.2 Trade in tuna both globally and in Indonesia

The global trade in all tuna materials and developed products has increased in the last 30 years. In 1976, just over 425,000 tonnes of tuna were caught, with a value of US$391 million globally. By 2006, these figures had grown to over 1.8 million tonnes of tuna with a value in excess of US$3.6 billion (Majkowski, 2007). The international trade in fresh tuna has increased considerably since 1976: but while the export trade statistics show a consistent increase in the volume traded over this time period, the global export trade statistics for fresh tuna indicated a peak in 2002 before a period of decline when the key exporter of fresh tuna in 2006 was Indonesia followed by

Thailand, Cape Verde, Spain and Mexico (Garrett and Brown, 2009). In Indonesia, the tuna export volume was 122,450 tonnes in 2010, almost doubled in 2014 to 206,553 tonnes with an average increase of 10% per year (MMAF, 2015c). The proportion of frozen forms of tuna in the total amount of fish traded for human consumption increased from 3% in the 1960s to 11% in the 1980s and 25% in 2014 (FAO, 2016b). Tuna exports from Indonesia to Thailand in 2012 were 61,422 tonnes; this was the largest single tuna export destination from Indonesia (MMAF, 2013c), The second largest Indonesian tuna export destination by volume in 2012 was to Japan of 38,526 tonnes, then to the European Union of 27,803 tonnes including to the United Kingdom where the volume was 6,450 tonnes (MMAF, 2013a).

Tuna products can be separated into three groups, namely fresh tuna, frozen tuna, and prepared and preserved tuna (Gillett, 2015). Different species of tuna are typically destined for different markets; yellowfin, bigeye and bluefin are primarily exported as fresh, frozen and prepared products, however albacore and skipjack are used primarily to supply the canned tuna industry and for export (IPNLF, 2016). *Tongkol* (*Euthynnus affinis*) is sold mainly in the domestic markets as both fresh and prepared products (Sunoko and Huang, 2014).

One of the problems of trading in tuna is in how to deal with illegally caught tuna entering into the market place. Illegally caught tuna comes from the illegal, unreported and unregulated (IUU) fishing practices (Young, 2016, Petrossian, 2015). Pramod et al. (2014a) reported a growing concern in how to clearly identify not only where IUU fishing takes place but also where and how illegal products with unknown sources enter the markets. Certification systems have arisen in order to address this concern, but these systems largely depend on the market's interpretation of what are sustainable practices (Leroy et al., 2016a). These eco-labelling schemes are aimed at differentiating products based on resource sustainability and environmental impact, and allowing consumers to then make informed purchasing decisions (Kirby et al., 2014). 'A certification system's credibility, and of the claims that are made, grant them the requisite level of authority to govern those that are involved in the process of capture, production and trade' (Miller and Bush, 2014). However, eco-labelling schemes are only good if they are credible and become trusted (Bailey, 2017). One of the most widely recognised of fisheries certification systems is that of the Marine Stewardship Council (MSC) which is deemed to be credible because: (1) it is a transparent system of assessment and it has a well-defined internal governance structure; (2) it promotes traceability of fishing operations through the progressive chain of custody certification; and (3) certification is awarded based on rigorous scientific assessments from a third party of independent auditors (Agnew et al., 2014, MSC, 2017). The MSC certification remains problematic for developing countries fisheries (Bush et al., 2013) due to the lack of fisheries management and budget for certification process for small-scale fisheries (Gulbrandsen, 2009, Jacquet and Pauly, 2008). By comparison, the Earth Island Institute (EII) has showed that the Dolphin Safe Label (DSL) is more comprehensive in term of certification cost than MSC (Miller and Bush, 2014).

1.2.3 Lack of data on tuna fisheries both globally and in Indonesia

One of the most obvious requirements for fisheries management is to obtain reliable data on current and predicted stock levels. Estimating levels of fishing effort is crucial to fisheries scientists, because it can provide information for calculating catch volume per unit of effort (CPUE) which is a standardised index, providing an indirect measure, of relative stock abundance (Matsuzaki and Kadoya, 2015). When utilizing effort data, its spatial component deserves proper attention because the spatial distributions of fleets both locally and regionally may change over time, and non-randomly distributed fishing efforts may falsely lead to the extremes of both hyper-stability or hyper-depletion and/or unreliable abundance indices (Rose and Kulka, 1999, Bordalo-Machado, 2006, Chang and Yuan, 2014). The requirement to provide science-based advice for stock size allowing for their migratory nature in data-poor situations has forced analysts to be creative in using available data to infer catch rates, fish biology, and socio-economic interactions (NOAA, 2014, Staples et al., 2014). Trends in landings and fishing effort can be derived from the formal fisheries annual data statistics that are published by the government or from field surveys (Sims and Simpson, 2015), however, it is a challenging task even to estimate the actual level of fishing effort (Froese et al., 2012) as biological features such as primary productivity change with time (FAO, 1997). Differences in fisheries classifications and definitions among nations also make international comparisons difficult (de Graaf et al., 2015, NOAA, 2014, Staples et al., 2014).

1.2.4 Government action to protect tuna stocks both globally and in Indonesia

Indonesia, as an archipelago that is situated between two of the major tuna producing areas in the world, is particularly vulnerable to IUU fishing (Bondaroff, 2015). Illegal fishing practices include activities that contravene the laws and regulations relating to fisheries conservation and to resources sustainability that legal fishers obey (Bondaroff, 2015, Arias and Pressey, 2016, Miller and Sumaila, 2014). Unreported fishing practices mostly relate to a form of administrative crime that is knowingly conducted by foreign fishing fleets (Bondaroff, 2015, Washington and Ababouch, 2011). Unregulated fishing refers to fishing activities without any definite nationality being involved (Meaden and Aguilar-Manjarrez, 2013, Bondaroff, 2015, Arias and Pressey, 2016). Unreported fishing refers to fishers who do not keep formal accurate logs of their catches or landings. There is only a limited amount that governments can do in order to combat IUU tuna fishing, and Indonesia's government is particularly constrained by a lack of resources. However, one initiative it did take was to impose a moratorium, a temporary ban, on foreign and ex-foreign vessels in 2014-2015 from operating in Indonesian waters aimed to protect their resources from such irresponsible fishers (Tamindael, 2015). This initiative was in line with the FAO agreement to address the problem of IUU fishing world-wide (FAO, 2016b) in order to ensure the sustainability of security obtained from fisheries resources (de Graaf et al., 2015).

1.3 Problem statement

From the above account of the situation of tuna fishing in Indonesia waters, and from the researcher's personal observation, the following problem statement has emerged. The tuna pole-and-line fishery in Indonesia is facing an existential threat from four directions. First, IUU fishing removes considerable quantities of tuna in the country's waters. Second, there is a lack of reliable and comprehensive data on tuna stocks, which makes management decision-making very difficult. Third, pole-and-line fishing is acutely sensitive to climatic conditions which are changing because of global warming. Fourth, the pole-and-line fishery finds it hard to market its products abroad, where prices are highest.

1.4 Research objectives

The over-arching aim of this research is to investigate the future prospects of the Indonesian pole-and-line fishery in the light of these four threats. This investigation is therefore divided into the following four tasks: (1) to examine the extent of IUU tuna fishing and the steps taken by the government to deal with it by imposing a moratorium; (2) to study the government's statistical data on pole-and-line tuna landings, stakeholders' perceptions of its reliability, and the potential of fishers to provide additional data if fishers relationships with middlemen were altered; (3) to look at the evidence for a relationship between tuna pole-and-line catch per unit of effort (CPUE) and oceanographic factors such as the levels of surface sea temperature (SSF) and chlorophyll-a (chl-a) at fish aggregation device (FADs) sites; and (4) to look into the way the pole-and-line tuna fishery currently markets its products for sale both at home and abroad, and how it might improve its performance by changing client-patron relationships.

1.5 Theoretical framework

A theoretical framework is the organizing principle of the thesis, or the cognitive lens through which the project has been conceived and developed. Every researcher approaches their topic with some prior perceptions or understandings of the specific topic and its complexities in mind. These prior perceptions may be described as being world views or value systems which affect the way that the researcher approaches a topic. No matter how objective and value-neutral researchers strive to be, there will inevitably be some preconceptions driving, or initially driving, their research strategies. The very choice of the topic and the appropriate research methods that are selected to study that topic will reflect the researcher's view of what they believe in their experience is important. In the case of fisheries, researchers may approach their topic from a long list of possible theoretical perspectives, including ecological conservation; ecosystem-based management; sustainable development; economic modernisation; poverty reduction; rural empowerment; community well-being; adaptive management; or participative governance. The theoretical framework that has been chosen for this thesis is that of sustainable development, because this thesis attempts to evaluate the present pole-and-line tuna fisheries condition from eco-social perspectives and the recommendations that are likely to be made for improving the long-term sustainability of the tuna pole-and-line fisheries in eastern Indonesia.

Fisheries management designed to achieve sustainable development requires the active engagement of all directly affected stakeholders, including the fishers themselves, government workers at every level of administration, non-government agencies, academics, and other fisheries dependent groups (such as traders, fish processing companies, and boat owners). Researchers must seek to understand and accommodate the sometimes conflicting interests and needs of each of these stakeholders (FAO, 2001, Hartoto et al., 2009). Moreover, fisheries management's effectiveness depends on considering not only the targeted species, but also the local ecology, economy and society affected, including the equitable distribution of benefits across the range of affected stakeholders (FAO, 2014a).

1.6 Methodology

Quantitative data sources include skipjack and yellowfin tuna landings. The landed value statistics, unless stated otherwise, were extracted from the Ministry of Marine Affairs and Fisheries, Republic of Indonesia, statistical fisheries annual reports, and companies' landings data. Other relevant published fisheries data were obtained from journals or books which include inventories on catches, fishers, fishing effort, types of fishing gears, fishing ground locations, by-catch species, tuna processing companies, production data and stakeholders and field visit surveys. The qualitative data were obtained from semi-structured interviews with key informants from both fishery and non-fishery government agencies at both national and local levels, law-enforcement agencies, NGOs, fishers and fisher groups, tuna processing companies, and other relevant agencies. This study focuses on selected pole-and-line tuna landing sites in eastern Indonesia: Sorong (Papua Barat Province), Pulau Bacan (Maluku Utara Province) and Larantuka (Nusa Tenggara Timur Province). Additional sites including processing-plants of tuna canning and frozen tuna in Surabaya (Jawa Timur Province) and tuna landing sites in Benoa (Bali Province), Jakarta, Bogor, Bandung and Ternate (Maluku Utara Province), were visited to obtain further data. These particular locations were chosen for data analysis as being representative fishing bases for small-scale tuna pole-and-line operations and markets in eastern Indonesia. Each location had data available related to their tuna pole-and-line supply lines and marketing chains. According to Yuniarta et al. (2017) and Sunoko and Huang (2014), eastern Indonesia has traditionally been recognised as the centre of tuna fishing in the country for many years.

1.7 Thesis outline

This thesis empirically investigates the ecological and social drivers of tuna pole-and-line tuna fishery in eastern Indonesia using a number of primary and secondary data sources to help address the various research questions mentioned above (Figure

1.2). The rationale and remainder of this thesis is organised into five sequential chapters as set out below.

Chapter 2 explains the moratorium policy that was issued by the government of Indonesia during 2014–2015 and which was aimed to protect the countriy's fisheries resources from IUU fishing practices. The fishing moratorium was imposed in order to protect tuna stocks by reducing the overall level of fishing effort (Wang et al., 2015) and providing an opportunity for the government to evaluate the fishing level within their territorial waters (Schrank and Roy, 2013). Chapter 2 is to evaluate the impact of the moratorium by comparing the levels of tuna production both years before the moratorium was introduced and 12 months during the moratorium. The collected production data are those that have been derived from government and companies' statistics and also from interviews with fishers and others with reliable knowledge of the fisheries involved. Part of the data and analysis has been published in the *Marine Policy* journal (https://doi.org/10.1016/j.marpol.2018.05.014). The principle objective of this chapter is on government policy that affected the small-scale fishery.

Chapter 3 investigates the information on tuna fisheries in eastern Indonesia. Owing to practicality, these data are very limited in terms of academic quality, accuracy and validity to be used as a basis for scientific studies. As reported by Banks and Lewis (2011), the Indonesian government tried to develop a tuna fisheries improvement programme with support from international agencies, and found that there was a dire need to strengthen the performance of the fisheries data collection system in Indonesia's tuna fisheries. Most of the information gathered on these species comes from exploited fisheries data, which may be biased, inaccurate or lacking in quality (Pillai and Satheeshkumar, 2012). The systematic development of rigorous data collection and formalised reporting using 'standard operating procedures' would thus go a long way towards improving the reliability of the fisheries statistics system in Indonesia (Noye and Mfodwo, 2012). Chapter 3 contains data on landings and fishing effort from available formal government fisheries statistical data and supported by results from face-to-face interviews with selected stakeholders including fishers, government employees, private companies, NGOs, traders and tuna processing plants. This chapter assesses the trends in the data from the tuna fisheries in eastern Indonesia and compares them with stakeholders' perceptions about the quality of the compiled data and of the data collection and publication processes themselves.

Chapter 4 examines the relationships between tuna catches and the concurrent nature of the ocean environment. The oceanographic characteristics that have been found to be most correlated with tuna abundance are sea surface temperature (SST) and the levels of chlorophyll-a (chl-a). Many studies have revealed that SST and chl-a influence tuna abundance (Klemas, 2013, Xue et al., 2016, Nieto and Mélin, 2017). In Indonesia, for example in Bone Bay (Flores Sea), the highest skipjack tuna catches occur in the SST range of 28.5–30^{0}C (Zainuddin et al., 2013) and the highest catches of bigeye tuna in Java and Bali, occur when chl-a levels are in the range 0.05–0.12 mg/m^{3} (Setiawati et al., 2015). Chapter 4 is aimed at achieving a better understanding the relationships between tuna pole-and-line fishing effort and oceanographic characteristics at the fishing grounds.

Chapter 5 addresses the tuna marketing supply lines in Indonesia, using both quantitative and qualitative data collected during the field surveys to investigate the various pole-and-line tuna market supply lines in eastern Indonesia. Based on documentary records, information from interviews and direct observation, the chapter compares the marketing supply lines at each of the three landing sites by an analysis of their respective supply chains and modes of selling the fish. Each stakeholder's perception of the market and of the associated local supply lines was also surveyed. Part of the questionnaire that was employed in this procedure focused on the stakeholders' perceptions of their local market supply lines and of the traceability of their products, which is highly important to consumers.

Chapter 6 synthesises the findings from the above data chapters to build up a fuller understanding of the tuna and live-bait fisheries in eastern Indonesia (Chapters 2-5). The implications of the findings for the fishers, fisheries management and spatial management of the tuna and live-bait fisheries are discussed. Specific implications of the findings are framed in the context of the aim of sustainable development of the tuna fisheries in eastern Indonesia. While a local case study approach is adopted, this chapter also highlights the generic lessons of the research with a view to informing the objective of sustainable development of fisheries on the broader scale for Indonesia as a whole.

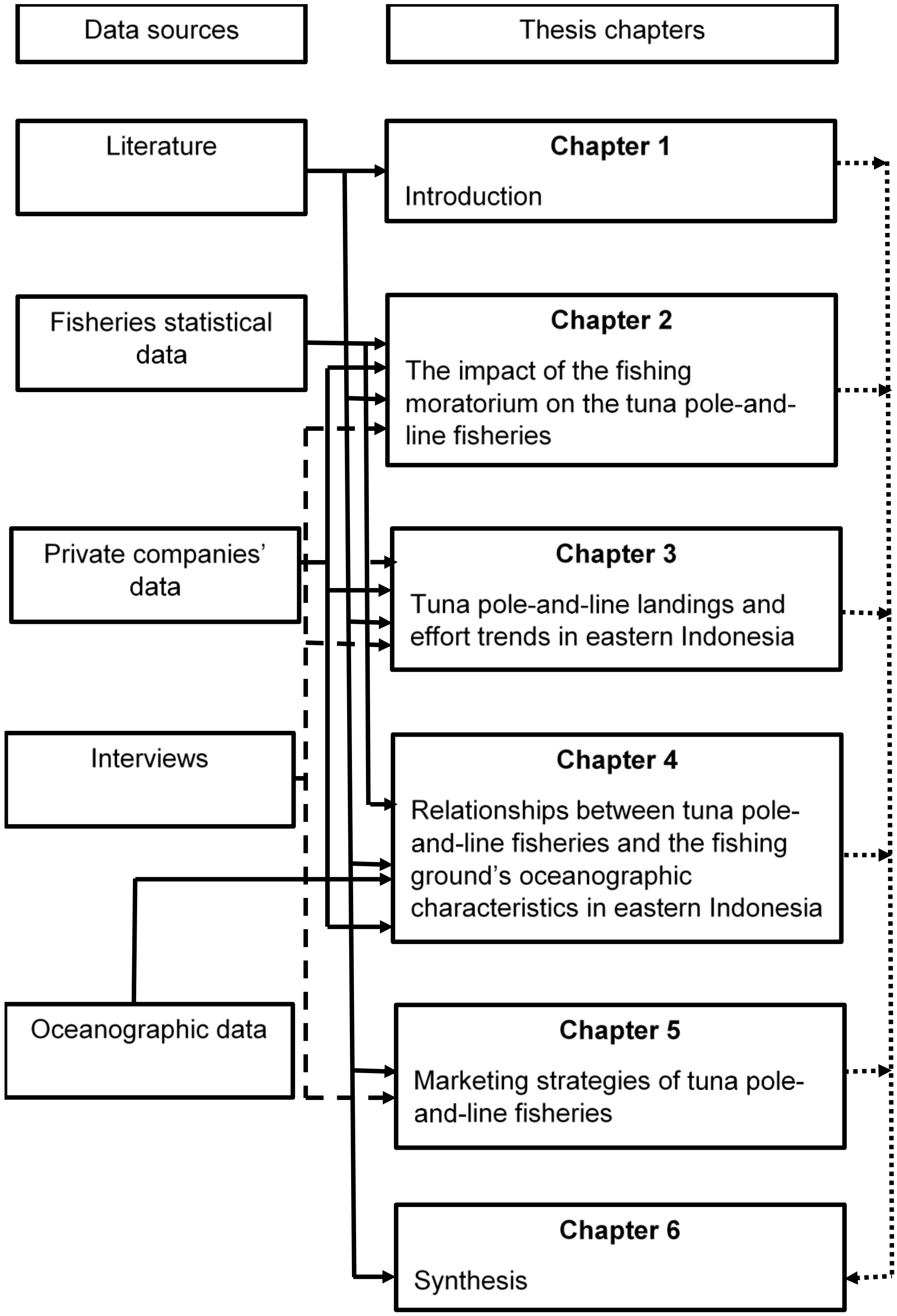

Figure 1.2 Thesis structure.

Legend: summary of primary (dashed lines) and secondary (continuous lines) data sources used in this thesis and the chapters in which they are used (boxes). Additional lines (dotted lines) represent the outputs of Chapter 1, 2, 3, 4 and 5 which feed into the synthesis in Chapter 6.

Chapter 2. The impact of the fishing moratorium on tuna pole-and-line fisheries in eastern Indonesia

Abstract

Indonesia's fisheries sector is contributing significantly to the strategy of national sustainable development, not least because regulations have been developed by the government in order to manage and maintain its tuna resources. One of these governmental regulations was a moratorium: the Indonesian government established a moratorium on fishing licences for foreign and ex-foreign fishing vessels in the Indonesian fisheries management area effective from 3rd November 2014 to 31st October 2015 in order to combat illegal, unreported and unregulated (IUU) fishing activities. However, the effectiveness of this moratorium has not been assessed. In particular, its impact on small-scale coastal tuna fisheries, such as pole-and-line, has not been investigated. This research is aimed to explore the moratorium's impact on pole-and-line tuna production via an analysis of data related to tuna landings and the fishers' perceptions at specific sites. The data regarding landings revealed that during the moratorium, pole-and-line fishing increased in Pulau Bacan and Sorong though total tuna landings in Larantuka and longline tuna landings in Benoa declined. Sorong and Pulau Bacan are relatively small-scale fishery landing bases, whereas Larantuka and Benoa are medium to large-scale bases. The effects of the Indonesian fishing moratorium, therefore, seems to have been variable - moderately increasing pole-and-line tuna landings in one areas, but reducing pole-and-line tuna landings in other areas. Consequently, the verdict on the moratorium on foreign and ex-foreign fishing vessels in Indonesia remains uncertain.

2.1 Introduction

It appears that tuna catches worldwide have begun to deteriorate and that the stocks of the more popular species have now been either fully exploited or are well below historical achievable levels (Beddington et al., 2007, FAO, 2013, ISSF, 2015). This stock depletion has been caused by several factors, including excessive fishing by illegal, unreported and unregulated (IUU) vessels; unintentional by-catch from industrial-scale fisheries; ecosystem degradation; climate changes; marine pollution; and destructive fishing practices (Zhang et al., 2013). As a result, the current tuna fisheries resources can no longer sustain the rapid and repeatedly uncontrolled increases in exploitation and development that took place in the past (de Bruyn et al., 2013). Moreover, this decline of tuna stocks is having a serious social and economic impact on several fisheries-dependent communities and regions around the world (Pillai and Satheeshkumar, 2012), including Indonesia. Several countries have taken steps to tackle national overcapacity of their fishing fleets, such as imposing restrictions on larger vessels and particular gear types (FAO, 2014b).

Illegal fishing is commonly associated with several factors, including fishing without a licence, fishing in marine closed and protected areas, fishing with banned gears, fishing above quota levels, and fishing for protected species (Bondaroff, 2015). Unreported fishing practices often include keeping two fishing logbooks, under-reporting the size of catches, incorrectly recording the vessel's fishing location, or unloading fish at ports having low regulatory and inspection standards (Bondaroff, 2015). Unregulated fishing practices are defined as practices that are undertaken by vessels without a defined nationality, or that are flying the flag of a country that is not part of a regional fisheries management organisation (RFMO) within the jurisdiction of that RFMO, or that are conducting any fishing activity that violates national or international laws (Bondaroff, 2015).

IUU fishing threatens fisheries resources biologically, financially and socially, and has a major negative impact on the yield of the world's oceans (Petrossian, 2015). During the past 20 years, as global marine stocks have diminished, the level of IUU fishing has increased (FAO, 2013). IUU fishing may catch from 11 to 26 million tonnes of fish each year, with an estimated value of between US$ 10 and 23 billion (FAO, 2014b, MRAG, 2008). Intentional IUU fishing practices are categorised as fishing crimes, often conducted by way of organised gangs via systematic and highly coordinated efforts around the world (Bondaroff, 2015) thus threatening ecosystem stability, food security and coastal livelihoods (Pramod et al., 2014b). The vessels that are blacklisted by the eight RFMOs and the International Criminal Police Organisation (INTERPOL) pursuing IUU fishing (Miller and Sumaila, 2014) are also the focus of serious attention from the Indonesia government by means of its moratorium policy.

Sustaining and maximising Indonesia's income from its tuna fisheries is particularly crucial for the reason that tuna are high-valued commodities in the market (Barclay and Cartwright, 2007b), and play a critical economic role in coastal and small island areas (Aranda et al., 2012). Indonesia has a significant role in the global tuna fisheries sector, given that its average annual production of tuna in 2005–2012 was 1.035 million tonnes. This is more than 16% of global tuna production and contributed in 2014 approximately 20% of total production to national capture fisheries (MMAF, 2014), making it the largest tuna exporter in the world (Sunoko and Huang, 2014).

Two significant problems have hampered the efforts made by island nations such as Indonesia, in managing their exclusive economic zones (EEZs): First, the lack of co-operation of the distant water fishing nations (DWFNs), who perform more than 90% of their fishing effort within the EEZs of states such as Indonesia; and second, the pressure applied on island governments from the DWFNs to not impose conditions of access (Tarte, 1999). As a result, Indonesia's tuna resources are under threat, with the majority of tuna species, including bluefin, yellowfin, bigeye, and albacore, being completely or heavily exploited, and with only the skipjack tuna being at a relatively moderate level of exploitation (Sunoko and Huang, 2014, FAO, 2014b). Additional research by Karman et al. (2014) notes that skipjack is one of the most valuable types of tuna, for both export and the domestic markets in Indonesia. For decades, Indonesia's geographically extensive waters have experienced illegal fishing practices, mostly from neighbouring countries, such as Thailand, Taiwan, China, Malaysia and the Philippines, in addition to pressure from the legal artisanal sector in the region of eastern Indonesia (Pauly and Budimartono, 2015). As reported by Sunoko and Huang (2014), 90% of tuna fisheries in Indonesian waters is considered as small-scale fishing fleets, including by the use of pole-and-line, trolling line and handline.

Indonesia faces a particulary serious challenge because of IUU fisheries practices in its EEZ. The government's moratorium was introduced in order to meet this challenge. A moratorium is a top-down policy measure, intended to discontinue a specified form of conduct which is currently practised by some. The standard definition of a moratorium is 'a temporary prohibition on some behaviour, ostensibly imposed in order to allow further investigation to take place before a resumption of that behaviour can be considered' (Lieberman et al., 2012). The difference between a moratorium and a ban is that a moratorium is temporary, whereas a ban is permanent. A fisheries moratorium on industrial fishing would not prevent over fishing; however, it is occasionally essential to help threatened fish stocks to recover by reducing the level of fishing. Additionally, it will provide access in order to evaluate the overall status of marine resources, including both single and shared stocks (Telesetsky, 2013). According to Telesetsky (2013) fisheries resources moratoria are generally imposed for a given period of time in order to protect stocks and to enable the government to monitor stock levels.

In Indonesia, the moratorium was imposed as part of a global fight against IUU fishing. Whether this message of deterrence was the most important aim of the moratorium is unclear, although we may note that the moratorium was not explicitly linked to any supporting research to be conducted in order to determine the conditions required for it to be lifted, nor was it imposed in order to offer a temporary relief to fish stocks to enable them to recover. During the period of the moratorium, the government checked 1,132 banned foreign vessels and discovered that 769 vessels had committed serious violations and 363 vessels had committed minor violations (Amindoni, 2015, MMAF, 2015a). As a consequence, the government resolved to increase surveillance and to strengthen law enforcement activities (Amindoni, 2015). This rather suggests that the moratorium was primarily designed to convey a strong signal to others that Indonesia was no longer willing to tolerate illegal fishing in its waters by foreign and ex-foreign fishing vessels and this signal thus marked its response to international pressures to take firm action against IUU fishing.

Reflecting on international community experiences and the lessons learned with regards to fishing moratoria, research undertaken by Telesetsky (2013) revealed that in the Gambia, a moratorium was first implemented in 1991 and then continued in a revised form until 1997, with the aim of restricting the total allowable catch (TAC) and allowable fishing effort related to fish stocks. Sierra Leone issued a moratorium in 1994, while Liberia did so in 2010 (Telesetsky, 2013). In Canada, a fishing moratorium was introduced for cod fisheries in 1994 and extended in 1996 and 2003 (Khan and Chuenpagdee, 2014), and after twenty years of the moratorium, the northern cod stock is no longer at its lowest level and historical migration patterns have been restored, even though the stock still remains at a very low level (Schrank and Roy, 2013). Telesetsky (2013), argues that any moratorium in fisheries resources should preferably be applied regionally because numerous marine stocks are shared between countries and regional moratoria should be harmonised with domestic fishing laws to prevent havens for destructive fishing practices from occurring. Wang et al. (2015) claimed that a temporary moratorium on entire fishing operations has an insignificant effect on the long-term recovery of fish stocks that have suffered from over-exploitation.

The moratorium introduced by the Indonesian government in 2014 to combat IUU fishing was to ban fishing by foreign and ex-foreign fishing vessels, in order to protect the country's fish stocks. The estimated financial loss incurred by its fisheries industry from IUU fishing practices in Indonesia exceeds US$ 1 billion per year (Hutton, 2014). Tamindael (2015) claimed that "Indonesia remains committed to completely eradicating IUU fishing activities" by controlling over-fishing throughout the period of the moratorium. The moratorium regulations issued by ministerial decree were also designed to assist Indonesia to meet the requirements of the international fisheries agreements that it had signed up to (Bailey et al., 2015).

In October 2014, the Minister of Fisheries and Marine Affairs proposed a fishing moratorium (Susetyo, 2015). On 3rd November 2014, the minister issued Ministerial Decree No. 56/Permen-KP/2014 for a six month period followed on 23rd April 2015 by another Ministerial Decree No. 10/Permen-KP/2015 declaring a moratorium, again for six months on fishing licences for fishing vessels built overseas (Salim, 2015). The rationale for the extension of the first moratorium for a second six-month period was to provide more time for the completion of the evaluation process on foreign and ex-foreign fishing vessels in operation (Budy Wiryawan, personal communication, 12 May 2015). The two decrees stipulated that for these vessels:

a. There would be no new licences issued by the Ministry for fishing operations (*surat izin usaha penangkapan/ SIUP*), for fishery landings (*surat izin* *penangkapan ikan/ SIPI*), or for catch transport vessels *(surat izin kapal pengangkut ikan/ SIKPI*).

b. There would be no extensions for expired SIUP, SIPI and SIKPI licences.

c. An analysis and evaluation would be conducted into the activities of existing SIUP, SIPI and SIKPI licence holders, particularly in relation to their landings of fish at designated landing sites rather than transhipping them to carrier vessels.

d. Any violation of regulations by existing licence holders would mean the imposition of administrative penalties.

To date, however, there has been no in-depth analysis of the impact of this moratorium on the fisheries involved, nor of the underpinning motivations for it, or for its subsequent cessation. One retired high-level policy maker in Indonesia, as a key source of information in relation to this research, stated that *"At this moment, a fishing moratorium related to the effectiveness of regulations on foreign and ex-foreign vessels in Indonesia has not yet been studied …" (key informant (KI)-03, 28 July 2015).*

This chapter aims to fill this gap, focusing on representative tuna pole-and-line fisheries in Sorong, Pulau Bacan and Larantuka in eastern Indonesia and using the tuna longline fishery in Benoa as a comparative case. The principal question addressed in the chapter is how the government's moratorium on foreign and ex-foreign fishing vessel licences during 2014–2015 affected the pole-and-line tuna fisheries. The chapter attempts to answer this question by comparing the levels of tuna production prior to and during the period of the moratorium. The production data are those derived from government and local company statistics and from interviews with fishers and others with knowledge of the fisheries involved. The study uses both quantitative and qualitative data to address the following questions:

1. Were there any differences between pole-and-line tuna landings prior to and during the moratorium?
2. What do pole-and-line fishers perceive as being the effect of the moratorium on the levels of their fishing effort? Do pole-and-line fishers perceive that their fishing effort during the moratorium had changed relative to that before the moratorium?
3. Have pole-and-line fishers noticed a change in the size of fish caught during the moratorium compared to fish caught prior to the moratorium?

2.2 Methods

2.2.1 Study sites

Sorong City (West Papua Province, Figure 2.1) is a coastal city that is dependent on marine resources. Landings data and interviews with pole-and-line fishers and workers at local tuna canning and frozen processing companies. Skipjack and yellowfin tuna (Khan, 2012, Karman et al., 2014, Alimina et al., 2015) are processed at the tuna canning company, supplied from the tuna pole-and-line fishing fleets under a fishers-private partnership system. Ternate (Maluku Utara Province, Figure 2.1) which is located next to Pulau Bacan and most of the tuna pole-and-line fishers consider Ternate as their landing base. However some of the fishers move to Pulau Bacan on a seasonal basis with the intention of landing their catches there. No landing data were available from the fisheries authority in Ternate to be analysed; however, during the research, 20 fishers who landed their tuna catches at Ternate participated in the survey.

Pulau Bacan (Halmahera Selatan Regency, Maluku Utara Province, Figure 2.1) is Indonesia's most active skipjack tuna fishing area for the principal reason that the Halmahera Eddy flows through it (Harsono et al., 2014). Pulau Bacan does not have a local tuna processing company, although there is a small tuna trader known as a *Dibo-dibo* who operates out of the landing site located in the area. The *Dibo-dibo* organisation occasionally provides logistics for pole-and-line fishing operations, such as fuel, live-bait, snacks and beverages for crews. Additionally, the *Dibo-dibo* can support several pole-and-line fishing vessels. After a fishing operation ends, the captain of the individual pole-and-line fishing vessel will negotiate the tuna prices with the *Dibo-dibo*. As soon as the price has been agreed, the crew will subsequently unload the catches from the boat to be taken away by the *Dibo-dibo*. The share between the *Dibo-dibo* and the crew of the fishing vessel is calculated after the cost of the logistics provided by *Dibo-dibo* have been deducted and the remainder is divided among them. The landing site divides tuna catches into two categories: skipjack and other types.

Larantuka (Flores Timur Regency, Nusa Tenggara Timur Province, Figure 2.1) is on Flores Island and has two adjacent small islands, Solor and Adonara. There are four tuna processing companies operating in Larantuka, under the fishers-private partnership system. The companies also provide fishing logistics and support, for instance fuel, cash lump sums and live-bait (Khan, 2012). There are no canning industry operators in this area and frozen tuna is the primary processing activity. At Benoa fishing port (Bali Province, Figure 2.1), most of the tuna fisheries involved are longline and handline fishing vessels. Benoa serves not only as a fishing port, but also as a port for ferries, tankers and other commercial vessels.

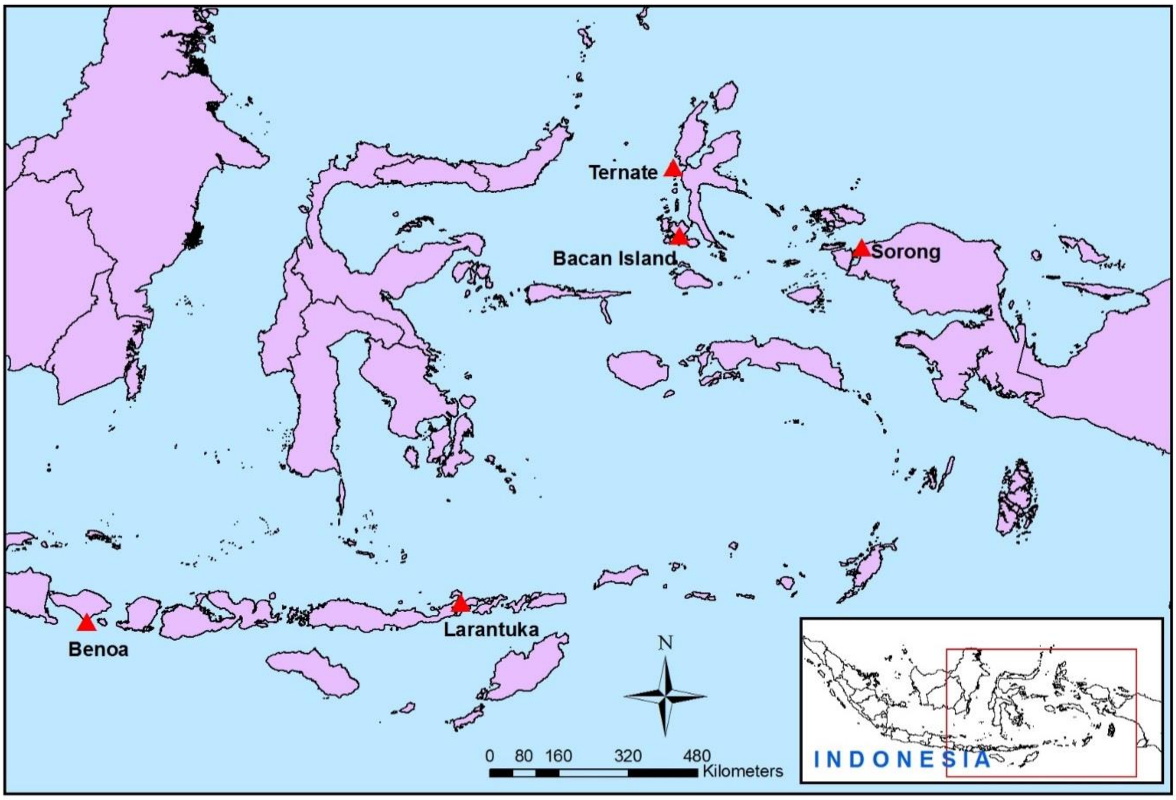

Figure 2.1 Study sites

2.2.2 Sources of data

2.2.2.1 Production data

Monthly tuna production, data were obtained for the period 2007–2015 from landing site managers, government fishery offices and tuna processing companies. Production data collection, which followed the methods of Cook (2013) and Cope (2013), at each landing site are generally divided into different tuna species as each type of fishing gear is specific to a particular species. However, although pole-and-line fishing gear targets certain various tuna species, including skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) (Khan, 2012, Karman et al., 2014, Alimina et al., 2015), they cannot be identified at several of the landing sites because the recorders do not identify the species in the compiled production data. Similarly, longline fishing gear predominantly targets four tuna species: southern bluefin (*Thunnus maccoyii*), albacore (*Thunnus alalunga*), bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) (Miyake *et al.*, 2010; Bush *et al.*, 2013; Kirby *et al.*, 2014), but landing data is aggregated, so particular species cannot be identified. Moreover, landings data collected during the field survey were not available in the same format by year for each location. For example, the landings data collection system was not the same for each location regarding the private companies landing data and that from government sources (Table 2.1).

Table 2.1 Landings data used in the analyse

Location	Data source	Year range used
Sorong	Private company	2012–2015
Pulau Bacan	Government port landing	2007–2015
Larantuka	Government port landing	2015
	Private company	2010–2014
Benoa	Government port landing	2013–2015

2.2.2.2 Questionnaires

Information concerning the individual fishers' perceptions of the moratorium and of its consequences was gathered directly from the fishers themselves based on prepared questionnaires comprising both open-ended and closed questions (Gubrium & Koro-Ljungberg, 2005). The target population for the questionnaires were the tuna fishers (captains and crew) and the live-bait fishers (captains and crew) (Table 2.2).

Table 2.2 Research sites, respondents and their fleet characteristics

Respondents' characteristics	Research site				
	Sorong	Ternate	Bacan	Larantuka	Benoa
Tuna fisher respondents	202	20	235	198	69
Handline fishers	71	0	0	0	10
Longline fishers	0	0	0	0	59
Pole and line fishers	131	20	235	198	0
Mean age (years)	33	41	30	31	33
Mean fishing experience (years)	12	18	10	10	11
Mean engine power (PK)	200	200	223	141	357
Mean boat capacity (GT)	49	20	30	17	40
Mean crew number	16	19	18	13	12
% tuna fishers own boat	35	0	25	0	14
% tuna fishers rent boat	65	100	75	100	86
% tuna fishers as captain	17	5	6	12	9
% tuna fishers as crew	83	95	94	88	91
Live-bait fisher respondents	5	37	80	32	0
Boat liftnet	0	37	0	32	0
Floating liftnet	5	0	80	0	0
Mean age (years)	31	27	29	28	0

Mean fishing experience (years)	11	7	9	7	0
Mean engine power (PK)	40	28	0	26	0
Mean crew number	6	4	5	5	0
% live-bait fishers own boat	20	8	10	25	0
% live-bait fishers rent boat	80	92	90	75	0
% live-bait fishers as captain	40	19	17.5	15.6	0
% live-bait fishers as crew	60	81	82.5	84.4	0

Part of the questionnaire focused on the fisher's perceptions of changes in their fishing experience both prior to and during the moratorium. The field survey was conducted by the researcher with some additional support from two or three field assistants in each location, who were inducted into the research project and received training related to conducting the field survey (Lavides, 2009). In order to maximise the use of time, the research questionnaire was translated into *Bahasa Indonesia* (the Indonesian national language) and the responses from respondents were translated back into English for subsequent analysis. An initial contact with several fishers was made through introductions made by local company staff, fishery office staff, landing site staff and fishers' group leaders. Further potential respondents were contacted by means of the snowball method, whereby participants suggested other possible participants (Gubrium and Koro-Ljungberg, 2005), or by visiting fishers at the landing sites, as suggested by Turner (2010). Up to 17% of the fishers who participated in the survey were captains, while the remainder were crew members. The captains were targeted because they were the ones most likely to make important decisions concerning fishing activities. The survey questionnaires were designed to obtain data pertaining to respondents' demographics, details of their fishing vessels and fishing gears, fishing grounds, typical catches, fisheries management practices and their fishing experience both prior to and during the moratorium.

2.2.3 Data analysis

2.2.3.1 Differences analysis on tuna landings before and during moratorium

A frozen tuna processing company based in Sorong provided landings data from 2012 to 2015, while regarding Pulau Bacan, landings data from 2007 to 2015 were provided by the landing site authority. Additionally, landings data from 2010 to 2015 pertaining to Larantuka were provided by both the landing site authority and a frozen tuna processing company. Landings data from 2013 to 2015 relating to Benoa were acquired from the landing site authority.

To determine if the moratorium influenced the tuna landings was analysed the available monthly landings time series data from each of the three areas using wavelet analysis and harmonic general least squares models (GLS). Wavelet analysis (R package WaveletComp) (Tian and Cazelles, 2012, Nason, 2008) was used to identify the periodicity in landings and guide the selection of the appropriate harmonic period for the GLS analyses. Monthly catch data were log transformed prior to analysis and a categorical variable was used to account for the moratorium period (0/1) in the GLS model. Analysis was undertaken in R (R Core Team, 2013) using the package nlme (Pinheiro et al., 2018).

2.2.3.2 Fishers' perception analysis

Of the 878 respondents who participated from 27 July until 25 September 2015, 724 were tuna fishers and 154 were live-bait fishers from the five landing sites. Differences in fishers' perceptions concerning fishing characteristics between locations were analysed using Chi-square tests.

2.3 Results

2.3.1 The analysis results of tuna landings data

All landings data (Figure 2.2) showed a seasonal trend with the largest catches in Larantuka (from 2010–2015 with total landings = 19,058,119 kg) and lowest catches between Pulau Bacan (from 2007–2015 with total landings = 17,265,557 kg) and Sorong (for 2012–2015 with total landings = 5,668,462 kg). Annual tuna landings in Sorong had an overall increase from 822,899 kg in 2012 to 1,714,169 kg in 2015. However June, July and August 2012 in Sorong had no reported landings, while maximum monthly landings were 259,068 kg in October 2013. The monthly landings variability was low in 2012 but great in 2015 (Figure 2.2). In Sorong, the wavelet analysis revealed significant periodicity to the landings of 6.1 months (Figure 2.3) and subsequently with a significant harmonic GLS regression (cos t = -4.34, p = 0.0001; sin t = -1.78, p = 0.083) (Table 2.3). There was no significant difference in tuna pole-and-line landings data between prior to the moratorium (mean monthly production = 108,490 kg ± 67,053 s.d.) and during the moratorium (mean monthly production = 135,208 kg ± 65,459 s.d.) (GLS, t = 0.13; p = 0.896).

Pulau Bacan's annual landings increased from 2007 (total tuna production = 509,729 kg) to 2015 (total tuna production = 3,158,457 kg). Monthly landings were reported to be zero in January, February, March and December 2007, and the maximum of 615,682 kg was in March 2013; landings were low in 2007–2010 and rose steadily in 2011 to 2015 (Figure 2.2). The wavelet analysis demonstrated no significant periodicity to the landings data (Figure 2.3) and similarly with the harmonic GLS regression (cos t = -0.89, p =0.372; sin t = 0.71, p = 0.477) (Table 2.3). There was an evidence an increase in landings in Pulau Bacan during the moratorium (mean monthly landings before moratorium: 143,894 kg ± 133,366 s.d.compared to mean monthly production during moratorium: 269,737.5 kg ± 66,363 s.d.) (GLS, t = 0.37; p = 0.712).

Tuna production data in Larantuka revealed that annual landings declined between 2010 (total tuna production = 5,010,765 kg) and 2015 (total tuna production = 1,890,731 kg). The monthly data showed a minimum production of 4,142 kg in January 2015 and a maximum of 970,400 kg in October 2010. The monthly landings were high in 2010 – 2012, then decreased constantly from 2013–2015 (Figure 2.2; Table 2.3). The wavelet analysis showed significant periodicity to the landings of 5.9 months (Figure 2.3) and subsequently supported with a significant harmonic GLS regression (cos t = 2.57, p = 0.012; sin t = -5.45, p < 0.001). There was an evidence of decrease in landings during the moratorium period at Larantuka (mean monthly production during moratorium: 164,479 kg ± 120,181 s.d. compared to mean monthly production prior to moratorium: 284,739 kg ± 198,321 s.d.; GLS, t = -1.79; p = 0.078).

Tuna production data from Benoa between 2013 (total tuna production = 25,340,360 kg) and 2015 (total tuna production = 13,906,579 kg) revealed a large decrease. During the field survey, the tuna species landed at Benoa port were bigeye, bluefin, albacore and yellowfin. Landings data from 2013 to 2015 as reported by the fishers demonstrated a decrease, with a minimum production at 774,919 kg in June 2015 and a maximum production at 3,332,765 kg in July 2014. The wavelet analysis demonstrated significant periodicity to the landings data of 3.6 months (Figure 2.3) and similarly with the harmonic GLS regression (cos t = -2.05, p =0.048; sin t = 1.0, p = 0.325) (Table 2.3). In Benoa, there was a significant difference in landings, in the form of a large reduction, during the moratorium period (mean monthly production = 1,211,052 kg ± 380,570 s.d.) in comparison to the preceding period before the moratorium (mean monthly production = 2,106,249 kg ± 623,229 s.d.) (GLS, t = -2.84, p = 0.008).

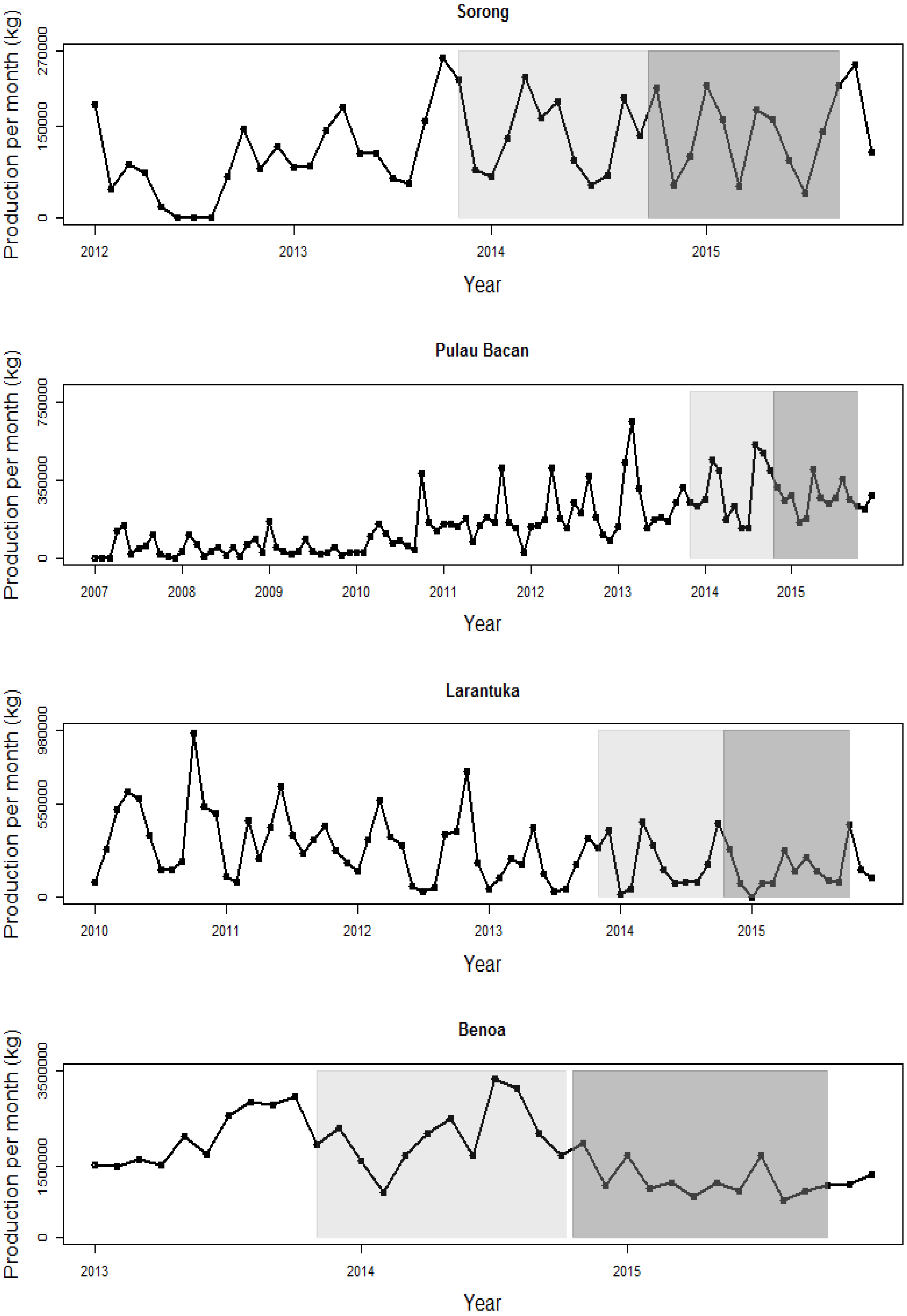

Figure 2.2 Monthly production data from the research sites, differing durations of data were available for each location. For each locations the moratorium period is highlighted in dark grey and the 12 months period prior to the moratorium is in light grey.

Table 2.3 Predictor, slope, standard error (SE), t-value and p-value of log-production tuna pole-and-line obtained via GLS.

Location		slope	SE	t-value	*p*-value
1.	**Sorong**				
	Intercept	11.7	0.08	145.68	0.0000
	Cos	-0.41	0.94	-4.34	0.0001
	Sin	-0.17	0.92	-1.78	0.083
	Moratorium	0.02	0.14	0.13	0.896
2.	**Pulau Bacan**				
	Intercept	10.8	0.72	14.95	0.0000
	Cos	-0.18	0.19	-0.89	0.372
	Sin	0.14	0.19	0.71	0.477
	Moratorium	0.47	1.26	0.37	0.712
3.	**Larantuka**				
	Intercept	12.26	0.13	92.7	0.0000
	Cos	0.34	0.13	2.57	0.012
	Sin	-0.71	0.13	-5.45	0.0000
	Moratorium	-0.55	0.31	-1.79	0.078
4.	**Benoa**				
	Intercept	14.44	0.09	155.2	0.0000
	Cos	-0.13	0.06	-2.05	0.048
	Sin	0.06	0.06	1.0	0.325
	Moratorium	-0.43	0.15	-2.84	0.008

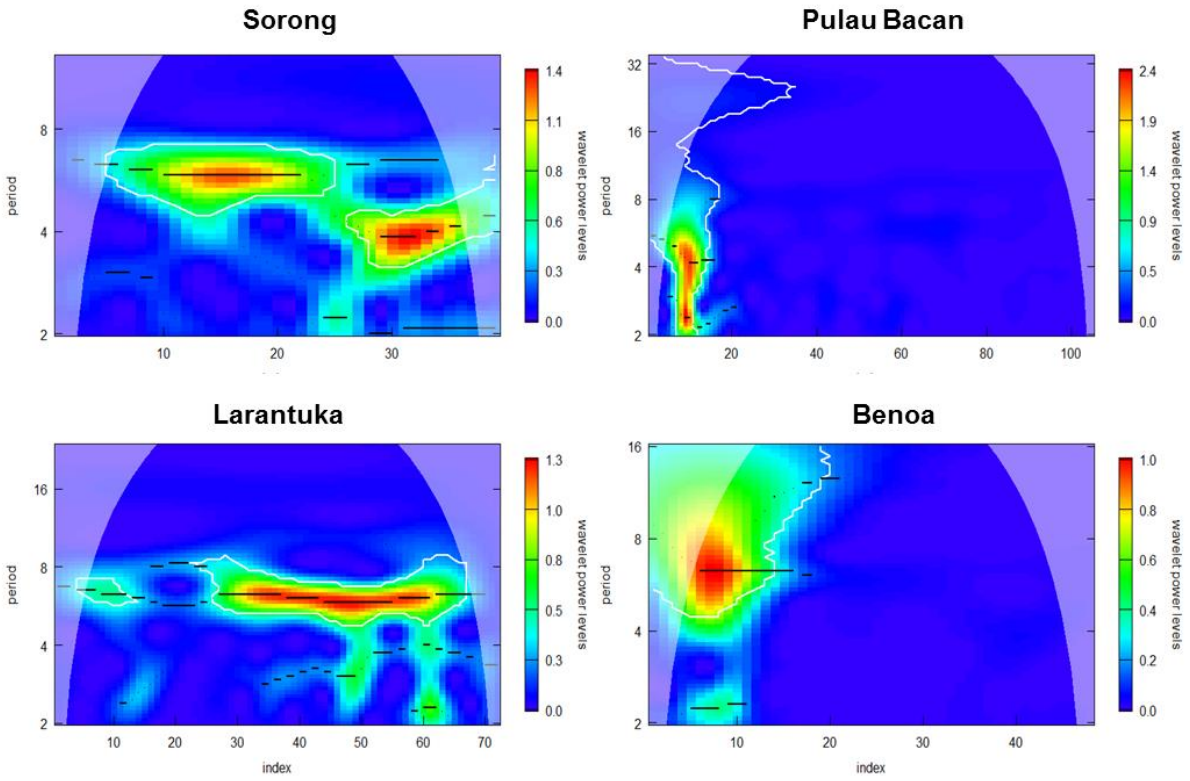

Figure 2.3 Wavelet heatplots of periodicity of landings. The red areas indicate the period (y axis) at which periodicity is detected

2.3.2 Fishers' perceptions

2.3.2.1 Effects on fishing effort

It should be noted that most of the fishers agreed that their fishing effort changed during the duration of the moratorium (Table 2.4). In fact, 701 tuna fishers (96.8%) and 143 of live-bait fishers (92.9%) reported that there was a change in their fishing effort, whereas 23 tuna fishers (3.2%) and 11 (7.1%) stated that there was no change in their fishing effort. Nevertheless, there was a significantly different response from each of the locations in relation to tuna (Pearson, $\chi^2 = 16.4$, $p < 0.05$) and live-bait fishers (Pearson, $\chi^2 = 45.16$, $p < 0.05$).

Table 2.4 Participants' responses to the question: 'With regards to all the research sites, has your fishing effort changed?'.

Location	**Participant's responses**									
	Tuna fishers					**Live-bait fishers**				
	Yes		**No**		**Total**	**Yes**		**No**		**Total**
	n	**%**	**n**	**%**		**n**	**%**	**n**	**%**	
Sorong	193	96	9	4	202	5	100	0	0	5
Ternate	20	100	0	0	20	37	100	0	0	37
Pulau Bacan	221	94	14	6	235	80	100	0	0	80
Larantuka	198	100	0	0	198	21	66	11	32	32
Benoa	69	100	0	0	69	0	0	0	0	0
Total	**701**	**96.8%**	**23**	**3.2%**	**724**	**143**	**92.9%**	**11**	**7.1%**	**154**

Most respondents at the five researched sites agreed that their fishing effort had been affected during the moratorium imposed on tuna and live-bait fishers (Table 2.4). With regards to Benoa (Bali), no live-bait fishers contributed to the research questionnaire because the local longline tuna fishers do not use live-bait during their operations.

Several fishers spoke of the effects of the moratorium on their fishing effort. They assumed that the moratorium had changed the fishing effort of all other fishing gear operations within their fishing grounds. One hand-line fisher for example commented: *"…, purse seine fishing vessels made our catches decline but since the moratorium policy has been implemented those fishing gears do not operate anymore within our fishing ground and our own fishing effort and production have increased" (KI-24, 9 August 2015).*

2.3.2.2 Changes in fishing effort

Most fishers reported changes in level of fishing effort occurring during the last 5 years (Table 2.5). Over the past five years, there was a small decline in fishing effort for 447 tuna fishers (61.7%) and 89 live-bait fishers (57.8%); a considerable decline in fishing effort for 114 tuna fishers (15.7 %) and 15 live-bait fishers (9.7%); a small increase in fishing effort for 80 tuna fishers (11.0%) and six live-bait fishers (3.9%); no change in fishing effort for 32 tuna fishers (4.4%) and 17 live-bait fishers (11%); a small increase in fishing effort during the moratorium for 51 tuna fishers (7.0%); and one fisher (0.1%) said he did not know if there had been any changes in fishing effort. There was a significantly different response for both tuna fishers (Pearson Chi-square, $\chi^2 = 263.63$, $p < 0.05$) and live-bait fishers (Pearson, $\chi^2 = 102.04$, $p < 0.05$) in their perceive on change of fishing effort for all research sites. Disaggregating these figures, the tuna pole-and-line fishers who stated that fishing effort had declined slightly, were 49% at Benoa and 74% at Larantuka. The percentage responses of the live-bait fishers at Ternate and Sorong who reported their catches to have declined slightly were 43% and 100% respectively (Table 2.5).

The fishers said there had been a degree of fishing ground overlap with large-industrial fishing vessels in the past. The principal focus of the overlap discussed by participants at all of the five sites were concerning purse seining by vessels from other locations. All respondents in these locations highlighted a spatial overlap related to themselves and the tuna purse seine fishing vessels prior to the moratorium. The fishers reported that this had happened for many years and that they preferred to avoid open conflict.

Table 2.5 Participants' responses to the question: 'To what level has your fishing effort changed?'.

Fishers' responses	Locations									
	Sorong		Ternate		Pulau Bacan		Larantuka		Benoa	
	n	%	n	%	n	%	n	%	n	%
Tuna fishers										
Declined slightly	102	50.5	0	0	165	70	146	74	34	49
Declined considerably	18	9	20	100	15	6	39	20	22	32
Did not know	1	0.5	0	0	0	0	0	0	0	0
Increased slightly	54	27	0	0	0	0	13	6	13	19
Increased significantly	19	9	0	0	32	14	0	0	0	0
Stayed the same	8	4	0	0	24	10	0	0	0	0
Live-bait fishers										
Declined slightly	5	100	16	43	53	66	15	47	0	0
Declined considerably	0	0	15	40	0	0	0	0	0	0
Did not know	0	0	0	0	0	0	0	0	0	0
Increased slightly	0	0	6	17	0	0	0	0	0	0

Increased significantly	0	0	0	0	27	34	0	0	0	0
Stayed the same	0	0	0	0	0	0	17	53	0	0
Total	**207**		**57**		**316**		**230**		**69**	

2.3.2.3 Factors influencing changes in fishing effort

The tuna and live-bait fishers mentioned several factors to confirm that their fishing effort had changed over the past 5 years (Table 2.6). The most frequent factor was in the total number of gears at all sites operating for 429 tuna fishers (59.2%) and 77 live-bait fishers (50%). The second factor was seasonal weather for 174 tuna fishers (24%) and 42 live-bait fishers (27.3%). The third factor influencing their fishing effort was the destructive practice of fish bombing conducted by 15 tuna fishers (2.1%) and 35 live-bait fishers (22.7%). The fourth factor was a reduction in tuna production for 76 tuna fishers (10.5%). The fifth factor was the availability of FAD (fish aggregating devices) for 28 tuna fishers (3.9%). The final factor identified by the tuna fishers as influencing their fishing effort was the ready availability of live-bait reported by two tuna fishers (0.3%). There was a significant difference for both tuna fishers (Pearson, $\chi^2 = 195.5$, $p < 0.001$) and live-bait fishers (Pearson, $\chi^2 = 44.7$, $p < 0.05$) perceive in factors that are influencing changes in fishing practice for all of the researched sites collectively.

Table 2.6 Participants' responses to the question: 'In what way has your fishing effort changed?'.

Fishers' responses	**Locations**									
	Sorong		**Ternate**		**Pulau Bacan**		**Larantuka**		**Benoa**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Tuna fishers										
Total gear operating	148	73	20	100	102	43	113	57	46	67
Seasonal weather	38	19	0	0	54	23	72	36	10	14
Destructive fishing practices	2	1	0	0	0	0	13	7	0	0
Decline in tuna production	12	6	0	0	51	22	0	0	13	19
FAD availability	0	0	0	0	28	12	0	0	0	0
Live-bait availability	2	1	0	0	0	0	0	0	0	0
Live-bait fishers										
Total gear operating	0	0	11	30	45	56	21	66	0	0
Seasonal weather	5	100	6	16	20	25	11	34	0	0
Destructive fishing practices	0	0	20	54	15	19	0	0	0	0
Total	**207**		**57**		**315**		**230**		**69**	

The greatest factor influencing changes in fishing effort was the total amount of gear operating within their fishing effort for 148 tuna fishers (73%) in Sorong and 45 live-bait fishers (56%) in Pulau Bacan. The lowest factor identified was the damaging practice of fish bombing performed that was reported by two tuna fishers (1%) in Sorong and 15 live-bait fishers (19%) in Pulau Bacan (Table 2.6).

2.3.2.4 Changes in fish size

Some of the tuna and live bait fishers stated that they had observed changes in the size of fish that they had caught (Table 2.7). However, most of the fishers, 691 tuna (95.4%) and 149 live bait fishers (96.8%) collectively from all of the sites stated that there were no noticeable changes in the size of the fish that they had captured, whereas a small increase in size was reported by 21 tuna fishers (2.9%) and five live-bait fishers (3.2%). Large reductions in the size of fish caught were reported by seven tuna fishers (1%), whilst a slight reduction in the size of fish caught were reported by four tuna fishers (0.6%). However, one tuna fisher (0.1%) stated that he had not noticed any changes in the size of fish that he had captured. There was a significant difference for both tuna (Pearson, $\chi^2 = 89.35$, $p<0.05$) and live-bait fishers (Pearson, $\chi^2 = 154$, $p<0.05$) in relation to the size of fish caught for all research locations.

All tuna longline, pole-and-line and live-bait fishers from Ternate, Pulau Bacan, Larantuka and Benoa stated that the tuna they had caught had remained the same size, while in relation to Sorong, 21 tuna fishers (10%) stated that the size had increased slightly. Additionally, seven tuna fishers (3%) claimed that they had witnessed a considerable decline; four tuna fishers (2%) stated that there had been a slight decline; one tuna fisher mentioned that he was not aware of any changes in the size of the tuna he had captured; and five live bait fishers (100%) stated that the size of the fish they had caught had increased slightly (Table 2.7).

Table 2.7 Participants' responses to the questions: 'In comparison to the last 5 years, has the size of the fish caught changed?'.

Fishers' responses	Locations									
	Sorong		Ternate		Pulau Bacan		Larantuka		Benoa	
	n	%	n	%	n	%	n	%	n	%
Tuna fishers										
Declined slightly	4	2	0	0	0	0	0	0	0	0
Declined considerably	7	3	0	0	0	0	0	0	0	0
Didn't know	1	0.5	0	0	0	0	0	0	0	0
Increased slightly	21	10	0	0	0	0	0	0	0	0
Stayed the same	169	84.5	20	100	235	100	198	100	69	100
Live-bait fishers										
Increased slightly	5	100	0	0	0	0	0	0	0	0
Stayed the same	0	0	37	100	80	100	32	100	0	0
Total	**207**		**57**		**315**		**230**		**69**	

Fish sizes were not reported formally by the government in their published statistical data, due to funding limitations. One of the respondents remarked: *"Fish biology data* *is very important for scientific analysis with additional effort, but due to budget limitations this data cannot be obtained from the government" (KI-12, 11 September 2015).*

2.4 Discussion

The moratorium on fishing licences specifically targeted foreign and ex-foreign fishing vessels that were built overseas, and which were operating in Indonesia's traditional fishing grounds. Before the moratorium was introduced in Indonesia, there were 1,132 foreign and ex-foreign fishing vessels operating in Indonesian waters (both territorial and EEZ); however, after the moratorium was issued, there were only 666 foreign and ex-foreign fishing vessels in operation – a decline of 42% (MMAF, 2015a). The moratorium period was initially for six months and which was subsequently extended for another six months. Prior to this current study, there had been no research into the effects of the Indonesian moratorium. This study has investigated the impact of the moratorium on foreign and ex-foreign fishing vessels in the tuna pole-and-line fisheries in eastern Indonesia by way of an analysis on tuna production and specially collected the data related to the fishers' perceptions both previous to and during the moratorium. The results suggest many factors have driven conditions before and during the moratorium in both tuna and live-bait fishing. The factors are discussed in the following three subsections. Firstly, the production analysis is discussed in the context of the relevant literature. Secondly, evidence of changes in fishing effort as perceived by fishers is discussed. Thirdly, perceptions of the fishers regarding possible changes in the size of fish being caught are discussed. As Sharma et al. (2014) and Maunder and Punt (2013) note, there are a number of limitations pertaining to the landings data collected.

The different sources of landings data that were collected from each selected location (Table 2.1) make a comparative analysis by year, both before and during the moratorium, extremely challenging. Landings data clearly play a highly significant role in fisheries management, and most landings data published by some countries may result in underestimates (Anticamara et al., 2011) and can lead to a misinterpretation of the landings data during analysis. Nevertheless, this research provides an illustrative snap-shot of the tuna landing conditions before and during the moratorium.

2.4.1 Tuna landings before and during the moratorium

The landings data revealed no significant difference overall in the tuna pole-and-line fisheries in Sorong, Pulau Bacan and Larantuka while, in contrast, the longline fishery in Benoa demonstrated a significant difference (Table 2.3). These results can vary in every location particularly when the data reported by companies may be biased and misreported. As Pet-Soede et al. (1999) observed, the accuracy and validity of Indonesian production data is debatable. The lack of sound fisheries data was one of the problems that was faced by the US government related to creating sustainability in fisheries development (Benson et al., 2016). However, regarding a fishing moratorium, Wang et al. (2015) identified a successful example in the context of controlling a fishing effort. Their research reported that in relation to the Pearl River estuary in China, reducing fishing effort by 50% led to a 28% increase in fish stocks and a 43% rise in total landings.

The Sorong landings data demonstrated no significant difference in relation to the year before and during the moratorium. However, employees of the processing company commented that no fishing took place during three months in 2012, due to maintenance of the pole-and-line fishing fleet. Moreover, the landings data may not truly reflect the actual fishing pressure within the location, because, as Muallil et al. (2014b) has argued, some of the fishers may not have been fishing within the designated fishing grounds. The increased landings in Sorong prior to and during the moratorium may be related to the decline in the numbers of fishing vessels that operated due to the moratorium, suggesting that in this case, the moratorium may have been effective at reducing IUU practices (MMAF, 2015a) and reducing up to 25% of fishing effort in Indonesia (Cabral et al., 2018). Landings data from small-scale fishing ports in Indonesia displayed an increase in volume of 100% after the moratorium was issued to cover from September until December 2014 (MMAF, 2015a). Moreover, the large distant water fleets (DWFs) that were undertaking illegal fishing were displacing the fishing capability of the traditional small-scale local fleets and thus reducing small-scale landings (Mallory, 2013).

A key informant (KI) from a tuna processing company in Sorong stated:

"As a small-scale pole-and-line fisher, I am glad and happy with the moratorium policy that banned the large-industrial scale fishing vessel operations, such as purse-seines in this area. The moratorium policy has increased our production relatively, we

feel secure and it reduces competition on fishing grounds between those two fishing methods. From my own experience, before the moratorium, we usually only got on average between three to five tonnes per fishing trip respectively. Since the moratorium policy was issued, we can get between five and 10 tonnes per fishing trip (KI-01, 06 August 2015).”

At Pulau Bacan, there was also no significant difference in landings before, and during the moratorium, which is consistent with the observations from other similar moratorium impact studies conducted elsewhere (Lin et al., 2013, Larmande and Ponssard, 2014, Mohamed, 2014). Similarly, no difference was observed in tuna landings in Larantuka, before and during the moratorium. In addition, Larantuka faced a similar situation to the one that had confronted India, where the moratorium demonstrated no significant difference in landings (Mohamed, 2014). Landings data declined in Larantuka from 2010 and 2014, and the introduction of the moratorium confirmed an even greater decline. The government reported that over the course of the moratorium, the landings revealed a 20% decrease in oceanic fishing ports in Indonesia (MMAF, 2015a). Such a decline experienced over four decades, from the 1950s to 1990s, is consistent with other studies (Anticamara et al., 2011, Watson and Pauly, 2013).

At Benoa, the landings data tended to decline from 2013 until 2015, the year when the moratorium was introduced. Fishing gear operations in Benoa pertaining to tuna fisheries are longline, and Benoa is one of the largest tuna export ports in Indonesia (MMAF, 2014). Moreover, in contrast with the other research locations, there was a significant difference between during and before the moratorium. According to the longline tuna fishers and fishery officers, the moratorium had a significant impact on this fishing port because many oceanic industrial fishing vessels were subject to the moratorium. This finding of this study is consistent with research findings by Woodrow (1998), which claimed that as a fisheries management tool, a moratorium can reduce the number of full-time and part-time fishers and lead to a decline in landings.

Government compiled landings data in relation to the small-scale fishing ports in Indonesia reveals that landings volumes doubled during the period from before the moratorium (landings in Sept 2014 = 7,310,458 kg) to three months after the moratorium was issued (landings for December 2014 = 14,599,564 kg) (MMAF, 2015a). In contrast, the decline in landings was calculated to be 19.66% during the moratorium in the oceanic fishing ports in Indonesia, which took effect from September 2014 until December 2014 (MMAF, 2015a). Since 2006, there has been a general decline in longline tuna catches in the Indian Ocean, as tuna stocks have been poorly managed (Satheeshkumar and Pillai, 2013). The decline in tuna landings at this study's research sites support other research findings, which suggest that estimates of total and spawning stock of tuna biomass will continue to decrease because of overexploitation in the Indian Ocean (Satheeshkumar and Pillai, 2013). Moreover, environmental and climate change has contributed to the drop in actual tuna fishing operations and the production catch rate (Lehodey et al., 2013).

Compared to other fisheries moratoria, the depiction of the more selective moratoria in Indonesia is complex because it was only apllied for one year. One study undertaken by Garza-Gil et al. (2011) appeared to reveal the failure of a fisheries moratorium: in the Bay of Biscay the profitability of the Spanish purse seine fisheries, was higher before the implementation of a moratorium in 2005 than after. In India, a fishing moratorium made no significant difference in catch trends before and after the introduction of the moratorium in 1988 (Mohamed, 2014). It is worth noting that several people have described the implementation of the moratorium policy in Indonesia as being strictly enforced. For example, one research respondent stated that the *"Moratorium on foreign and ex-foreign fishing vessel was implemented relatively effectively in Indonesia due to strict enforcement by the government during their implementation periods"* (KI-03, interview, 28 July 2015). Furthermore, a study by Cabral et al. (2018) revealed that the moratoria policy in Indonesia have simplified enforcement. However, if the Indonesia's fishing moratoria is still in place and local fishing effort is well regulated accordance to their maximum sustainable yield, it was projected that Indonesia's skipjack landings could increase by 14% by 2035 compared to current levels (Cabral et al., 2018).

2.4.2 Fishers' perceptions of change in effort

Numerous fishers stated that their fishing effort had changed during the past five years. This perception is consistent with global conditions in tuna fisheries in the Indian Ocean (Moreno and Herrera, 2013). Both field surveys and questionnaire analysis of tuna and live-bait fishers showed that the average boat capacity of tuna fishers was 49 GT in Sorong, 20 GT in Ternate, 30 GT in Pulau Bacan, 17 GT in Larantuka and 40 GT in Benoa, which are all relatively small-scale vessel. Sunoko and Huang (2014) commented that the tuna fishing fleet in Indonesia was considered to be small-scale. The live-bait fisher's boat capacities were not recorded in this study. The small-scale character of the tuna fishing fleet can be determined from the size of the fishing crews working on the vessels. The average fishing crew involved in tuna fishing is 15 fishers, and five fishers for the smaller live-bait vessels. Alternatively, Engler-Palma (2011) suggest the level of capacity of fishing activity can be indexed by the vessel size (carrying capacity) and measured by the potential output (harvesting capacity).

Most of the fishers (both tuna and live-bait) agreed that their level of fishing effort had decreased considerably during the previous five years, however during the same period tuna landings had increased in Sorong and Pulau Bacan, although not so in Larantuka or in Benoa. The primary cause of the reduction in fishing effort, according to both tuna fishers and live-bait fishers, was the increased number of different fishing gears operating within the same fishing grounds. This fishers' statement is consistent with research by Leroy et al. (2016b), which claims that industrial-sized fishing fleets may reduce artisanal fishers catchability. Additional time spent searching for other alternative fishing grounds was also a factor reducing fishing effort, as fishers attempted to adapt to a perceived decline in tuna stocks. In the Gulf of Carpentaria, (Australia), changes in catchability have heavily depended on the number of available fish aggregation devices, in addition to the fishers' acquired expertise and knowledge (Ellis and Wang, 2007). In the Philippines, an unavoidable change of gear in order to undertake less efficient operations has been one of the primary causes of the decline in local tuna catches (Muallil et al., 2014a). Moreover, the fishers indicated that the climatic changes in the fishing seasons was an additional factor that had adversely influenced the fishing effort during the last five years. Destructive fishing practices, especially blast fishing (i.e. the use of explosives) were reported by fishers in Larantuka, though it does not seem to happen in Sorong, Ternate, Pulau Bacan or Bali. The use of destructive fishing practices refered to in this research are consistent with research performed on Karanrang Island (Spermonde Archipelago, Indonesia), where destructive fishing practices involve both blast fishing and the use of cyanide (Grydehøj and Nurdin, 2015).

Fish aggregation devices (FADs) are often deployed in fishing grounds in order to provide 'shelter' for tuna. Tuna fishers stated that the availability of FADs had played a significant part in affecting their ability to catch tuna over the last five years. This study's results are also consistent with the findings of Staples et al. (2014), who report that the installation of FADs in offshore areas was done in order to improve small-scale tuna fishing catchability in the Pacific Islands. FADs have now become the mainstream method for pelagic fishing both with respect to artisanal and industrial fishers in order to improve fishing catch rates (Leroy et al., 2016b). The FADs' impact on localised tuna schooling in the wild, to potentially increase tuna catchability, is considerable, and they can play a crucial role in the interaction between skipjack tuna and their natural environment (Wang et al., 2014), given that many types of pelagic species naturally associate with floating objects (Sharma et al., 2014). Before the extensive deployment of FADs, log-associated bigeye tuna were already in a poorer condition than are fish in free swimming schools in the Indian Ocean (Sharma et al., 2014). However, an increase in the use of FADs would not mean a uniform increase in fishing effort (Davies et al., 2014). There are two types of FADs that are used in Indonesian waters: deep sea and shallow water, with differences generally observed in material, shape and structure (Yusfiandayani, 2013). Most of the pole-and-line tuna fishers remarked that their FADs are of the deep-sea type. Moreover, the use of FADs needs to be optimally managed in order to ensure sustainability of the stocks and undertaken by means of research planning, resource allocation and law enforcement (Yusfiandayani, 2013).

Numerous fishers reported that the physical size of the fish that they caught had remained unchanged for the previous five years. In Indonesia, the average tuna size determines its price at local markets. For example, in Maluku Utara, including Pulau Bacan and Ternate, the mean skipjack tuna length was 42.9 cm with a maximum fork-length (FL) of 75.5 cm (Karman et al., 2014). However, the fishers' estimates of fish size may be somewhat inaccurate. In the Indian Ocean inconsistencies in the length have been pointed out by Sharma et al. (2014), so the estimates provided by Indonesian fishers may also be unreliable. It is important to mention that a moratorium can be imposed to improve the biology (size, weight, condition, etc.) of the targeted fish, for example to increase the mean length of fish (Sundelöf et al., 2015).

2.5 Conclusion

Eastern Indonesian both pole-and-line and longline tuna fisheries experiences suggest that there is no significant effect that has been observed with regards to the year before and the year during the moratorium. The moratorium may have increased pole-and-line tuna landings in Sorong and Pulau Bacan; however, the landings declined in both Larantuka and longline tuna landings in Benoa. The perceptions of both the tuna and the live-bait fishers agreed that any changes in their fishing effort during the past five years were caused by changes in the total amount of gear and in the numbers of vessels operating within their fishing grounds. Other causes that were stated by the fishers, included destructive IUU fishing practices, for instance blast fishing; the availability of FADs; and changes in seasonal weather conditions. Some fishers stated that a decrease in the production of actual live-bait in conjunction with the moratorium was also one of the causes of the change in their fishing effort. It seems possible that the moratorium may have been more effective politically in demonstrating to the wider international community that Indonesia was taking its commitment to counter IUU fishing seriously.

Chapter 3. Tuna pole-and-line landings and effort trends in eastern Indonesia

Abstract

This chapter examines tuna pole-and-line landings data, focusing on trends, effort levels, and stakeholders' perceptions. On trends, landings and other fisheries data can reflect trends that may be developing in resource abundance and conditions, and thus help to inform fisheries monitoring and management. On effort levels, can reflect trends that may inform level of utilization. On stakeholders' perceptions, the views that users express about the accuracy of governmental data reveal the level of trust that they can place in management decisions based on these data. The findings of this chapter are (1) that tuna and live bait stocks have declined; (2) that there was no significant correlation between landings and effort; and (3) that stakeholders perceived the government data to be inaccurate and unreliable.

3.1 Introduction

Tuna is a food commodity that has a relatively high economic value in the global market. Tuna species are exceedingly migratory in the high seas and found in the Exclusive Economic Zones (EEZs) of many countries across the world (Bailey et al., 2012, Miyake et al., 2004). Statistical fisheries data on tuna caught is obtained from both primary and secondary sources: primary data comes from field observations, surveys, compiled records, and interviews with selected stakeholders (Froese et al., 2012, NOAA, 2012b, NOAA, 2012a, FAO, 2013, Cadima, 2003, MMAF, 2015b, Francis, 2011); while secondary data is derived from desk study, literature reviews and relevant research reports (Froese et al., 2012, NOAA, 2012a, NOAA, 2012b, FAO, 2013, MMAF, 2015b, Francis, 2011). Catch per unit effort (CPUE, e.g. catch per fisher, per hour or per day) data is commonly acquired from government statistics and research surveys (Sims and Simpson, 2015) and are the principal means by which changes in the relative natural stock size are perceived (Shono, 2014). However, there are difficult issues involved in estimating actual capture and effort values (Froese et al., 2012). There is an increasing requirement to meet international requirements in terms of clear definitions, classifications, statistical stratifications and other standards on fisheries statistics related to: (1) data collection; (2) sampling and design of data collection schemes; (3) data analyses and projections and (4) data storage and dissemination (de Graaf et al., 2015).

Indonesia has been developing tuna fisheries statistical data for many years. The Indonesian Ministry of Marine Affairs and Fisheries (MMAF) is the compiler and provider of annual fisheries data and aims to provide: (1) complete, accurate and reliable statistical data; (2) reference material to support decision making, and (3) performance indicators regarding marine and fisheries development in Indonesia (MMAF, 2015b). National data for fisheries statistics are collected monthly at a local level by *pencacah* (enumerators) in the *Dinas Kabupaten/Kota* (fisheries authority at the district level) from *tempat pendaratan ikan* (fish landing sites) and *desa sampel* (sample villages). The data is validated by the *Dinas Kabupaten/Kota* and is reported quarterly to the *Dinas Provinsi* (fisheries authority at the provincial level). The validated data is subsequently transferred from the *Dinas Provinsi* level to *Kementerian Kelautan dan Perikanan* (the Indonesian Ministry of Marine Affairs and Fisheries). *Kementerian Kelautan dan Perikanan* registers, re-validates and analyses the collected data from all provinces before publishing it annually as a comprehensive set of national fisheries statistics. This process of transferring information from district to national levels complies with the MMAF Ministerial Decree (Figure 3.1) that data at the national level should be derived from the subsidiary levels (provincial and district levels). However, although MMAF continues to improve its standards of fisheries data management, data collection and processing, analyses and dissemination (MMAF, 2015b), separate set of fisheries data are not usually available for the small-scale fisheries (Muallil et al., 2014a).

The most recent data obtained from MMAF reveals that the largest annual tuna catches were of eastern little tuna (520,460 tonnes), followed by skipjack (507,510 tonnes) and other varieties of tunas (319,950 tonnes) (MMAF, 2015c). Tuna are traditionally caught across several areas in Indonesia by fishers with simple fishing gear, such as handlines. Other fishing gears such as pole-and-line, purse seines, longlines and trolling lines were introduced more than four decades ago (Sunoko and Huang, 2014, Bailey et al., 2012). The most common fishing gears used to catch tuna are: purse seine and pole-and-line for skipjack tuna, and purse seine, handline, longline and pole-and-line for yellowfin and bigeye tuna (Bailey et al., 2012, Zhou et al., 2015). Pole-and-line gear consists of a flexible rod 2-3 metres in length made from bamboo and a strong short line at the end of which hangs a feathered jig mounted on a barbless hook (Majkowski, 2003). This fishing method generally employs water spray and manually disbursed live-bait to attract the tuna (Cruz et al., 2016). Small-scale tuna fisheries in Indonesia commonly consist of modest fishing gears such as handlines and pole-and-line (Khan, 2012, Alimina et al., 2015, Karman et al., 2014); in Southeast Sulawesi, small-scale tuna fisheries use trolling lines and pole-and-line (Alimina et al., 2015). At other locations such as Ternate, Larantuka and Sorong (Karman et al., 2014, Khan, 2012) most fishers use pole-and-line. In 2012 in Indonesia there were 12,714 longline units, 7,338 pole-and-line units, 86,523 troll line units, 96,780 handline units and 27,706 purse seine units (MMAF, 2013c). It should be noted that a fishing unit is a combination of the fishing vessel and its chosen gear (MMAF, 2015c).

This chapter is aimed to analyse the timeseries of the tuna pole-and-line statistical data and invstigate the perceptions of the various stakeholders on the quality of the national fisheries data from eastern Indonesia. The following questions are addressed: what are the trends in tuna pole-and-line landings, trips and gears; what are the relationships between tuna pole-and-line landings, trips and gears and what factors are driving these; what are stakeholders' perceptions of trends in tuna stocks; and what are the perceptions of stakeholders regarding the official fisheries data and how they are compiled; and what affects all these perceptions?

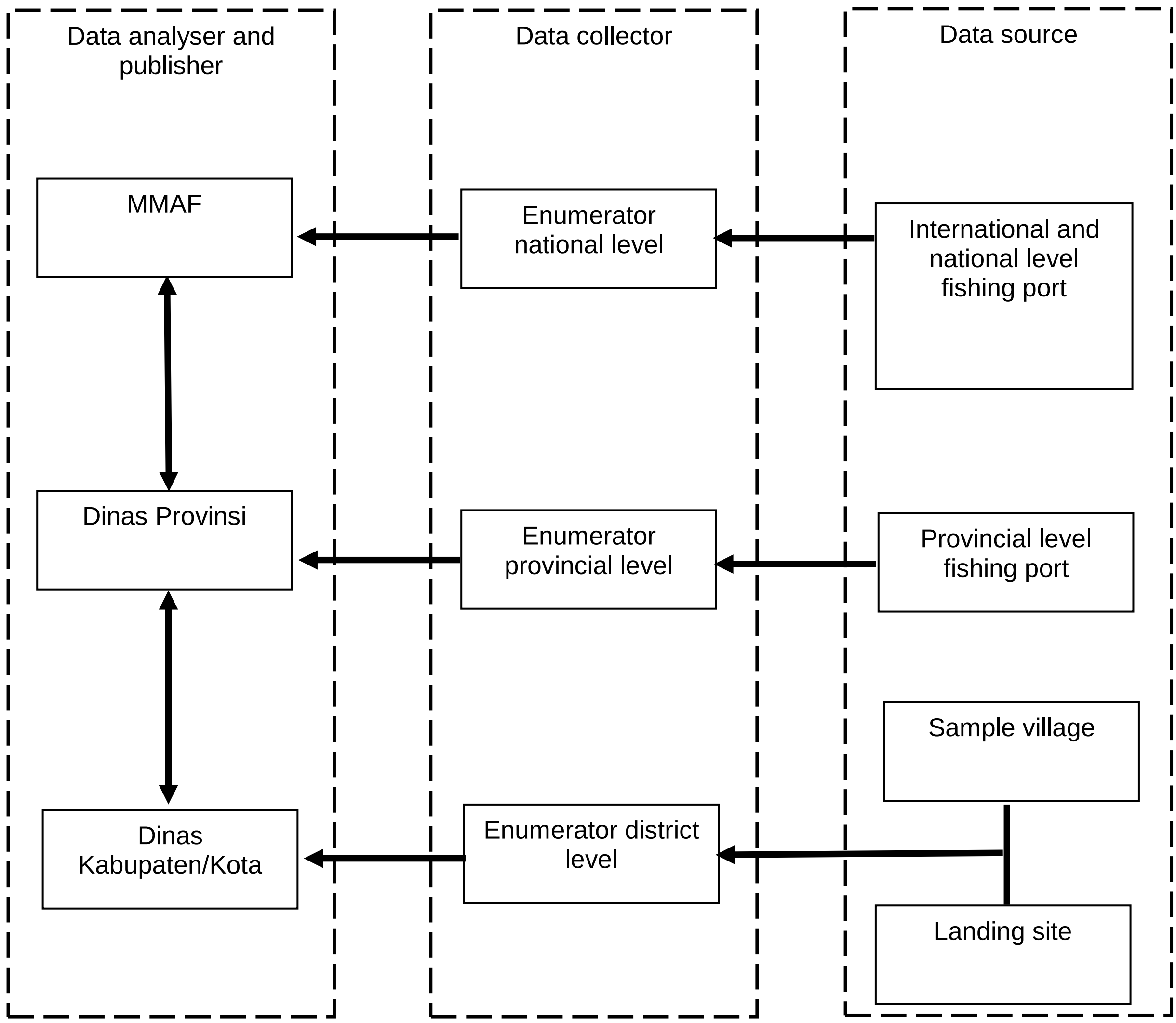

Figure 3.1 Fisheries statistic data compilation flowchart for Indonesia, according to the Ministerial Decree Number: 35/PERMEN-KP/2014.

3.2 Methods

3.2.1 Study sites

The selected study sites for the full scope of this research were located at Jakarta, Bogor, Bandung, Surabaya, Benoa, Larantuka, Ternate, Pulau Bacan and Sorong (Figure 3.2). For a closer study, particular attention was also paid to two particular districts. The Halmahera Selatan district is located in the Maluku Utara province with Pulau Bacan as its capital. The district of Flores Timur is located in the Nusa

Tenggara Timur province with the capital based in Larantuka. According to Yuniarta et al. (2017), eastern Indonesia has traditionally been recognised as the centre of tuna fishing in the country for many years. These two locations in eastern Indonesia were chosen for this chapter's analysis as they have the most extensive temporal records of tuna fisheries data of data.

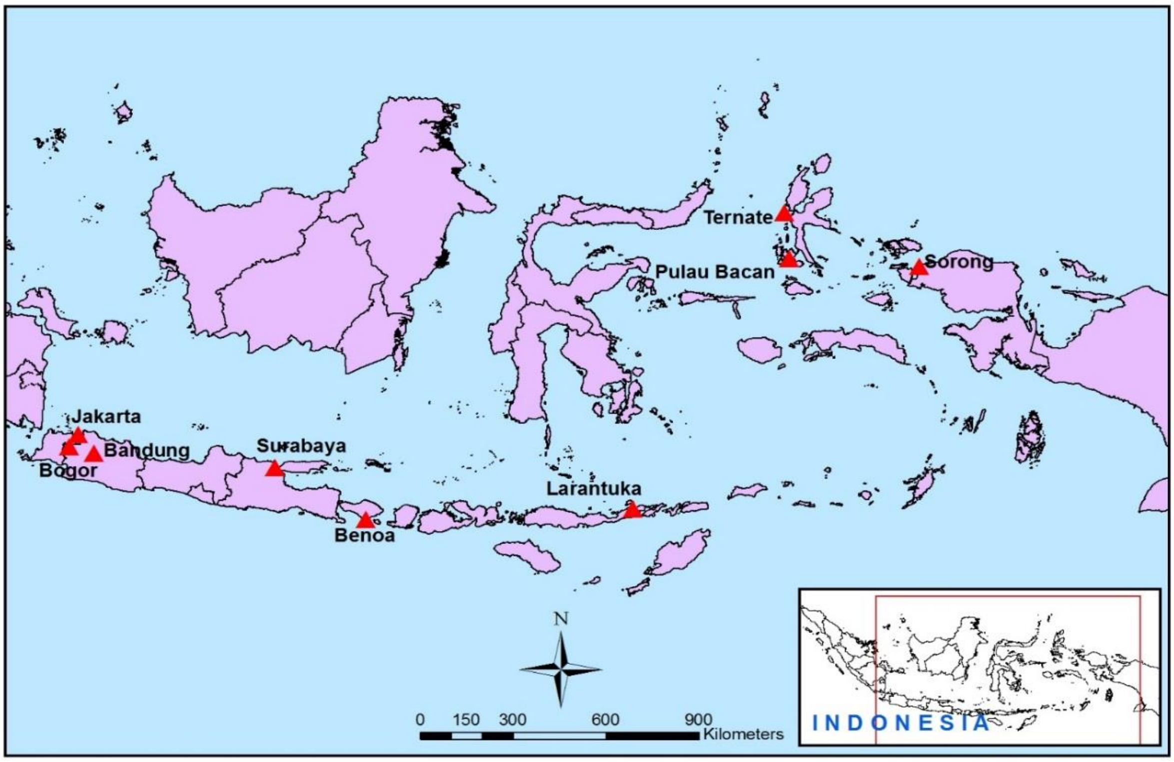

Figure 3.2 Research sites

3.2.2 Sources of data

3.2.2.1 Landings, trips and gears data

Landings, trip and gear data on the tuna pole-and-line fisheries for the period 2005-2014 were obtained from the fisheries authority in the districts of Halmahera Selatan and Flores Timur; from a desk study; and from a field survey.

3.2.2.2 Questionnaires

Individual perceptions of the quality of the officially compiled statistical data were solicited among selected stakeholders at each of the nine sites using prepared questionnaires (see appendix 5: interview schedule) combined with both open-ended and closed persontoperson question sessions, based on methods suggested by Gubrium and Koro-Ljungberg (2005). Respondents were visited at their work locations (Turner et al., 2014) and were contacted by means of the so-called “snowball” technique, whereby initial participants suggested, with some encouragement, other potential participants (Gubrium and Koro-Ljungberg, 2005). Table 3.1 reveals the relevant details of the respondents who participated at each of the nine locations.

Table 3.1 Respondents’ mean characteristics

Respondent’s characteristics	**Research sites**									**Total**
	Sorong	**Ternate**	**Bacan**	**Larantuka**	**Benoa**	**Surabaya**	**Bandung**	**Bogor**	**Jakarta**	
Tuna fishers	**202**	**20**	**235**	**198**	**69**	**0**	**0**	**0**	**0**	**724**
Age (years)	33	41	30	31	33	0	0	0	0	
Fishing experience (years)	12	18	10	10	11	0	0	0	0	
Fishers as captain (%)	4.6	0.1	1.9	3.3	0.8	0	0	0	0	
Fishers as crew (%)	23.2	2.6	30.5	24.0	8.7	0	0	0	0	
Live-bait fishers	**5**	**37**	**80**	**32**	**0**	**0**	**0**	**0**	**0**	**154**
Age (years)	31	27	29	28	0	0	0	0	0	
Fishing experience (years)	11	7	9	7	0	0	0	0	0	
Fishers as captain (%)	1.3	4.5	9	3.2	0	0	0	0	0	
Fishers as crew (%)	19.5	1.9	42.8	17.5	0	0	0	0	0	
Policy makers	**1**	**2**	**3**	**4**	**5**	**0**	**0**	**0**	**1**	**16**
Age (years)	34	38	44	40	33	0	0	0	35	
Working experience (years)	7	11	11	8	8	0	0	0	12	
Public sector	**4**	**1**	**1**	**0**	**4**	**0**	**1**	**3**	**2**	**16**
Age (years)	37	46	24	0	30	0	43	47	46	
Working experience (years)	8	11	2	0	5	0	23	22	3	
Private sector	**3**	**0**	**1**	**4**	**2**	**1**	**0**	**0**	**0**	**11**
Age (years)	42	0	25	38	38	47	0	0	0	
Working experience (years)	13	0	4	7	8	23	0	0	0	
Total	**215**	**60**	**320**	**238**	**80**	**1**	**1**	**3**	**3**	**921**

The carefully prepared survey questionnaires focused on the stakeholders’ perceptions about tuna statistics data, especially about the quality of the data, the data collection, and the publication processes. The questionnaires were distributed during the field survey with additional support being provided by two to three field assistants at each location who had been inducted into the aims of the research and had received some basic training related to conducting the field survey (Lavides, 2009). The questionnaires were translated into *Bahasa Indonesia* (the Indonesian national language) and the responses that were obtained from the respondents were translated into English for subsequent analysis. Policy makers and public-sector workers were asked for their opinions on the probable conditions of both the tuna and the live-bait stock and of what factors they thought influenced the stock abundance of both (regulation section; see appendix 5: interview schedule). Fishers and individuals in the private sector were asked a combination of both closed and open-ended questions that were designed to elicit information and views on the fisheries data recording system (Fisheries Data Section; see appendix). Additional information was sought on stakeholders’ views of the accuracy of the officiallycompiled statistical data, the collection process, compilation and subsequent interpretation of the statistical data, and the data analysis conducted within the hierarchical process (Government Fisheries Data Section, see appendix). The questionnaires were distributed and the respondents were encouraged to complete them at their own time and convenience. The reasons for these questions, and the intended use of the answers, were discussed with the respondents in advance (Turner, 2010). Private sector respondents were the processing company employees; public-sector workers were NGO staff, academics and researchers. Other respondents included tuna and live-bait fishers, government staff and landing site managers. All responses were stored in a Microsoft Excel spread-sheet.

3.2.3 Data analysis

3.2.3.1 Tuna pole-and-line fishery trends

Data was analysed for the districts of Halmahera Selatan and Flores Timur. Landings, trips and gears data for the ten years from 2005 until 2014 inclusive were presented using simple plots in order to capture the trends from each of the two research sites. The term ‘trends’, in this chapter, means any observable periodic changes within the specific 10 years period (Staples et al., 2014, Hall and Roman, 2013).

3.2.3.2 Relationships between tuna pole-and-line landings, trip and gears in eastern Indonesia

Generalised least squares (GLS) regression models were employed in order to determine the significant factors that are associated with tuna landings. Tuna landings were handled as being a response variable, whilst the numbers of both the trips and gears employed were considered as being independent covariates with the assumptions that the residuals were linear and the residuals were normally distributed.

The final predictive regression model that was used was:

$$Y \text{ (tuna landings)} = \beta_0 + \beta_1 \text{ (trips)} + \beta_2 \text{ (gears)} + \varepsilon \ \ldots \ (1)$$

Where β_0, β_n and ε are the intercept, the regression coefficient and the error terms respectively. All tests and plots were performed in the R software environment (Version 3.0.2; R Core Team, 2013).

3.2.3.3 Stakeholders' perceptions

The questionnaires were used in order to acquire information on the respondents' perceptions of the statistical data related to the tuna fisheries, including how they were collected, interpreted, analysed and subsequently published in Indonesia. The associations between types of stakeholders and their perceptions of the condition of tuna and live-bait stocks; ,the relative fish abundance; the fisheries data management and reporting system, including the probable level of accuracy of the compiled government fisheries data; the government statistics data process (collection, compilation and interpretation); and the hierarchical process, were all analysed using Chi-square tests.

3.3 Results

3.3.1 Trends in the tuna pole-and-line fishery

3.3.1.1 Tuna pole-and-line landings trends

The pole-and-line tuna landings clearly tended to increase appreciably in the districts of Halmahera Selatan and Flores Timur from 2005-2014 (Figure 3.3).

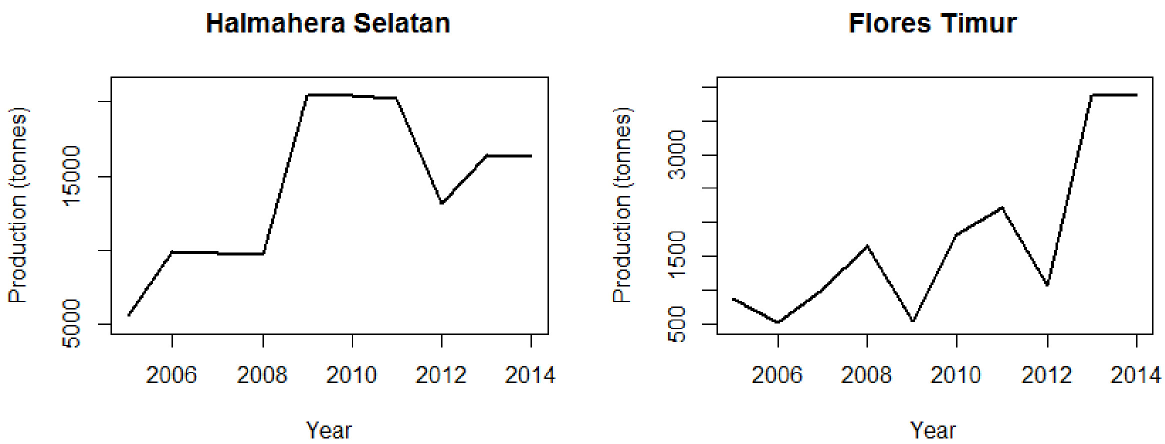

Figure 3.3 Trends in annual landings in each research district, 2005-2014.

3.3.1.2 Tuna pole-and-line fishing gears trends

The data for each research district was annual data obtained from 2005-2014. It should be noted that the number of gears in the district of Flores Timur had decreased appreciably since 2007. Conversely, in the district of Halmahera Selatan, the number of gears increased significantly over the same time period (Figure 3.4).

3.3.1.3 Tuna pole-and-line fishing trip trends

The reported annual pole-and-line fishing trips fluctuated from 2005-2014. The number of trips tended to increase in the district of Halmahera Selatan, while they declined considerably in Flores Timur (Figure 3.5).

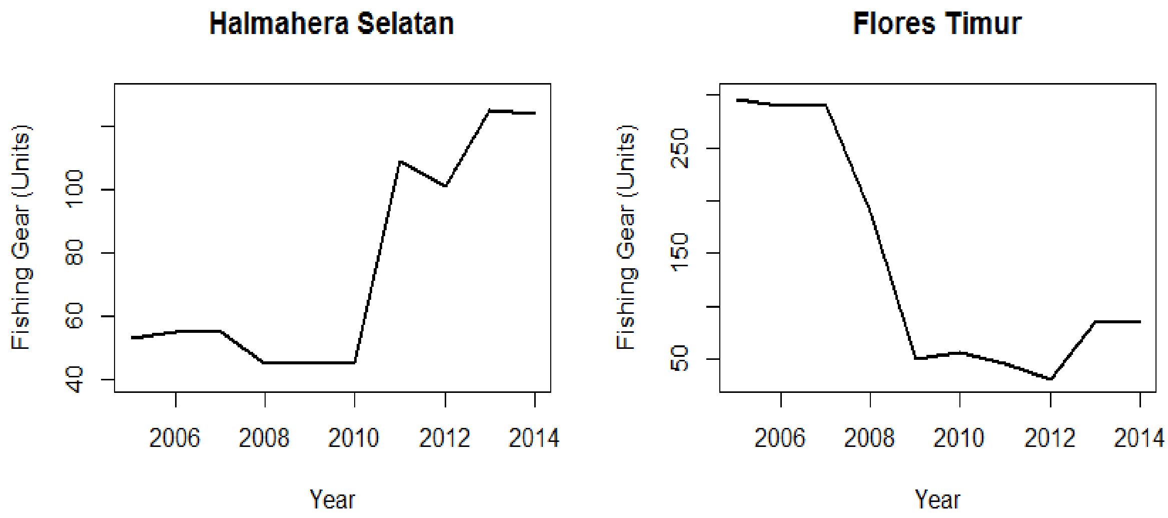

Figure 3.4 Trends in annual pole-and-line gears in each research district, 2005-2014.

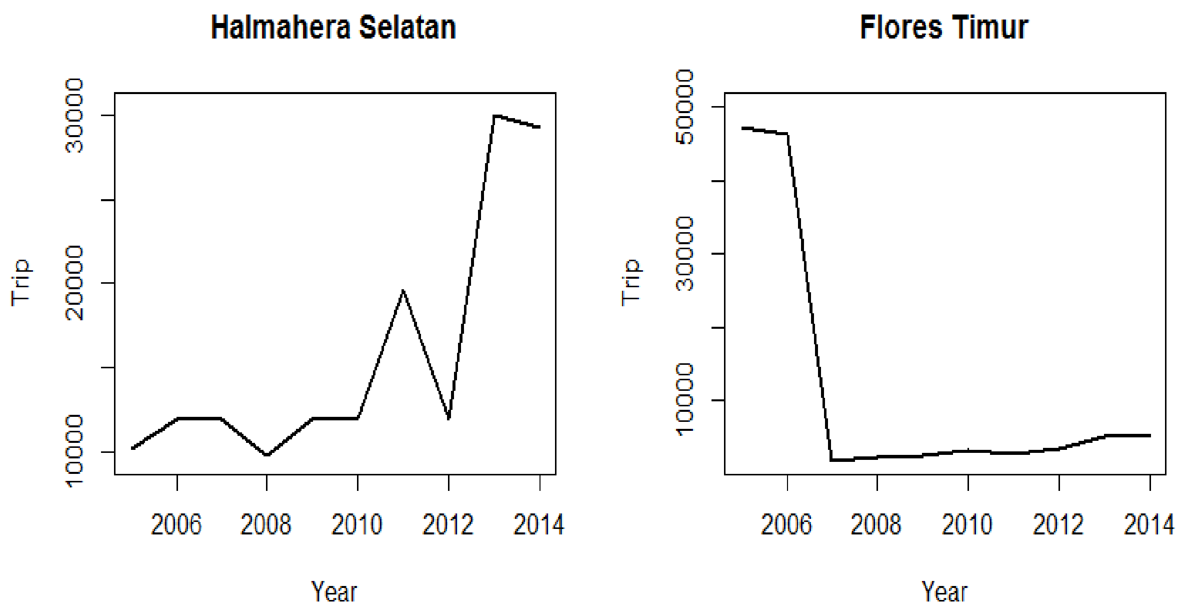

Figure 3.5 Trends in annual pole-and-line fishing trips at each research district, 2005-2014.

3.3.2 Relationships between landings and efforts

The best fit GLS model regarding the landings data included the effects of both tuna pole-and-line trips and gears (Table 3.2). The relationships between landings to trips (slope = 0.471; *p*-value = 0.1483) and gears (slope = -66.224; *p*-value = 0.4753) in the district of Halmahera Selatan can be interpreted as a one unit increase in the number of trips tending to be associated with an increase of 0.471 tonnes in landings. Conversely, a unit increase in gears was connected with a decrease of 66.224 tonnes in landings. Similarly, in the district of Flores Timur, the relationship between landings to trips (slope = -0.0087; *p*-value = 0.7639) and gears (slope = 8.1285; *p*-value = 0.2715) can be interpreted as being a unit increase in number of trips, which tended to be linked with a decrease of 0.0087 tonnes in landings. In contrast, a unit increase in gears tended to be associated with an increase of 8.1285 tonnes in landings. There were no statistically significant relationships between landings, numbers of both fishing gears and trips in the districts between Halmahera Selatan and Flores Timur.

Table 3.2 Generalised least squares regression model on landings

District	Predictor	Slope	SE	t	p-value
Halmahera Selatan	Intercept	9373.579	8287.627	1.1310329	0.2953
	Trips	0.471	0.290	1.6245737	0.1483
	Gears	-66.224	87.796	-0.7542904	0.4753
Flores Timur	Intercept	1048.0772	10698428	0.0000980	0.9999
	Trips	-0.0087	0	-0.3122519	0.7639
	Gears	8.1285	7	1.1936406	0.2715

3.3.3 Stakeholders' perception of tuna and live-bait in Indonesia

Of 921 respondents participating at the nine research sites, 724 were tuna fishers, 154 were live-bait fishers, 16 were policy makers, 16 were public sector workers and 11 were private individuals. The age range was from 25 to 47, with years of working experience ranging from 2 to 23 years (Table 3.1).

3.3.3.1 Public and policy perceptions of the condition of tuna and live bait stocks

The majority of the respondents from both the policy makers and the public sector workers agreed that tuna and live-bait stocks had declined, though two public sector workers (6.25%) and one policy maker (3.13%) stated that it had increased (Figure 3.6). There is seen to be a significant difference in this response between the policy and public sectors ($\chi^2 = 6.024$, $p < 0.05$).

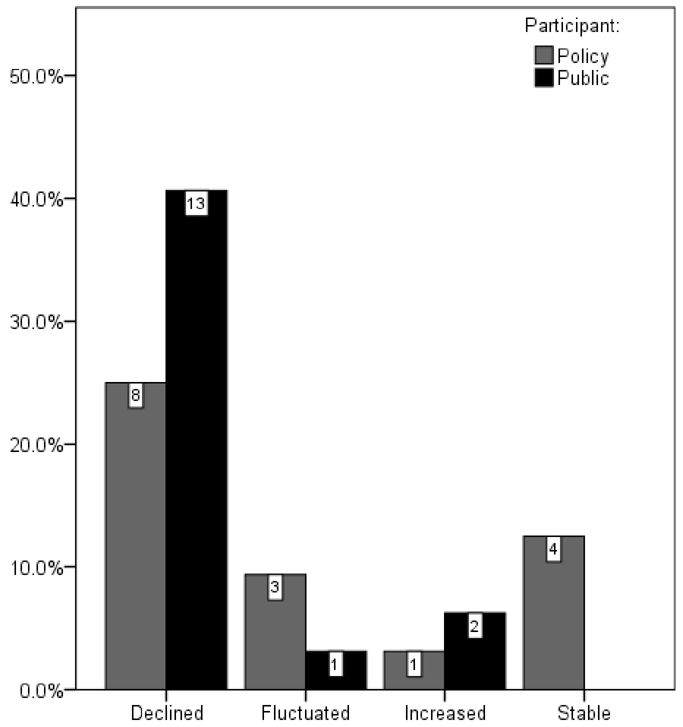

Figure 3.6 Participants' views concerning the current status of the tuna and live-bait stocks at the research sites, as perceived by policy makers and public-sector workers.

The majority of the respondents agreed that the abundance or otherwise of tuna and live-bait stocks was influenced by the effects of limitations on fishing activities, although the respondents also stated that they considered that new recruitment, illegal fishing, fishing ground use and the closed season also influenced stocks (Figure 3.7). However there was no significant difference in the perceived influential factors regarding the relative abundance of tuna and live-bait stocks between the policy makers and public-sector workers (χ^2 = 10.8; p > 0.05).

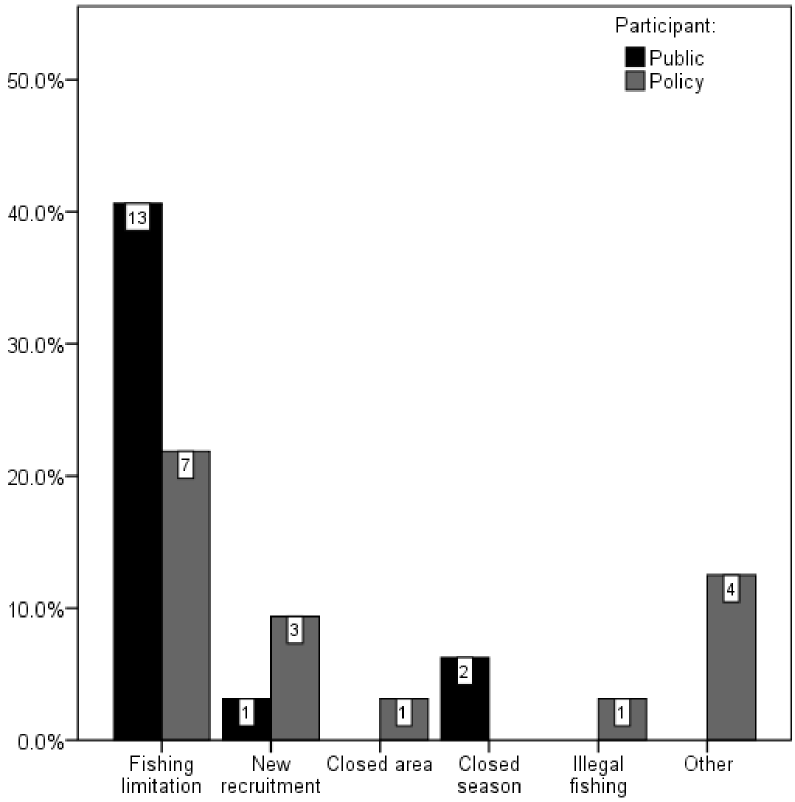

Figure 3.7 Factors potentially affecting the abundance of tuna and live-bait stocks, as perceived by public and policysector perceptions of fisheries data

3.3.3.2 Fisher and private sector perceptions of fisheries data

Most fishers (84%, n = 747) stated that they recorded their catch landings, although 131 fishers (15%) reported that they did not keep any formal records as such. All private sector workers (n = 11) asserted that they maintained records pertaining to their tuna level of production (Figure 3.8). There was no significant difference in data recording attitudes between the fishers and the private sector individuals (χ^2 = 1.925 p > 0.05).

Most of the fishers and private sector workers stated that according to government regulations they were obliged to report their landings to the fisheries authority agency at the local level (Table 3.3). There was no difference between the stakeholder groups (χ^2 = 404.02; p < 0.05).

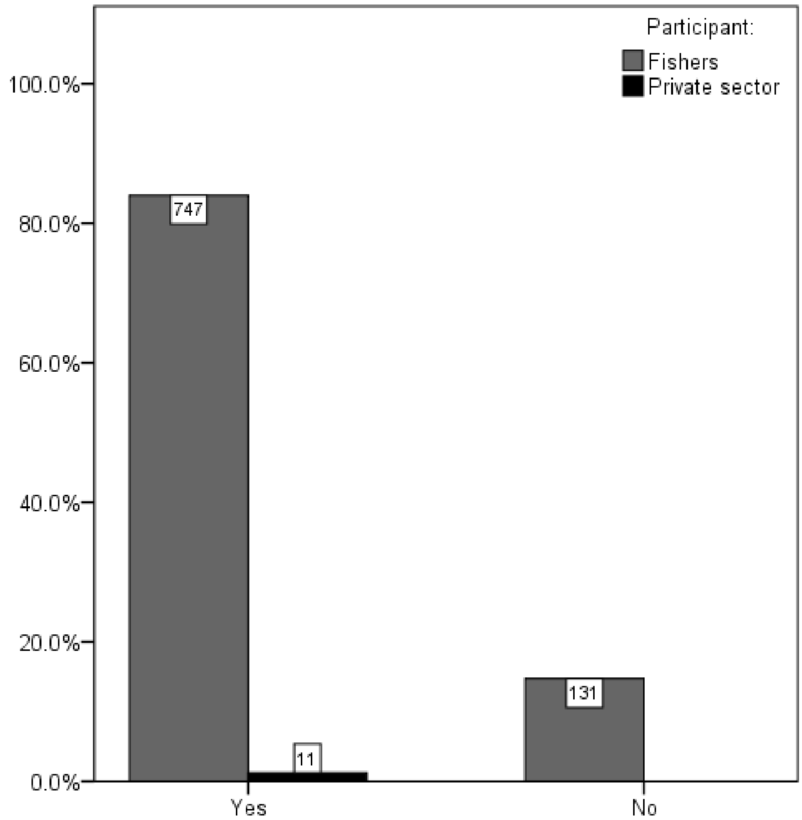

Figure 3.8 Responses to the question: ‘do you keep a record of your landings?’ For all research sites combined.

Table 3.3 Responses to the question: 'To whom do you report your landings data?' results for all research sites combined.

Data report to	**Participants**			
	Fishers		**Private sector**	
	n	**%**	**n**	**%**
Company	158	18	-	-
District fisheries office	45	5	-	-
Government	485	55	6	55
No data reported	153	17	-	-
Fishing vessel’s owner	37	5	-	-
Government and buyer	-	-	1	9
Government and internal company	-	-	2	18
Government, internal company and NGOs	-	-	2	18
Total	878	100	11	100

3.3.3.3 Policy makers and public-sector workers perceptions regarding the accuracy of published government fisheries data

Most public-sector workers (n = 12.75%) and several policy sector individuals (n = 7; 43.8%) stated that the government’s statistical data was not accurate (Figure 3.9). No difference was observed among the groups in these responses concerning government statistical accuracy ($\chi^2 = 4.134$; $p > 0.05$).

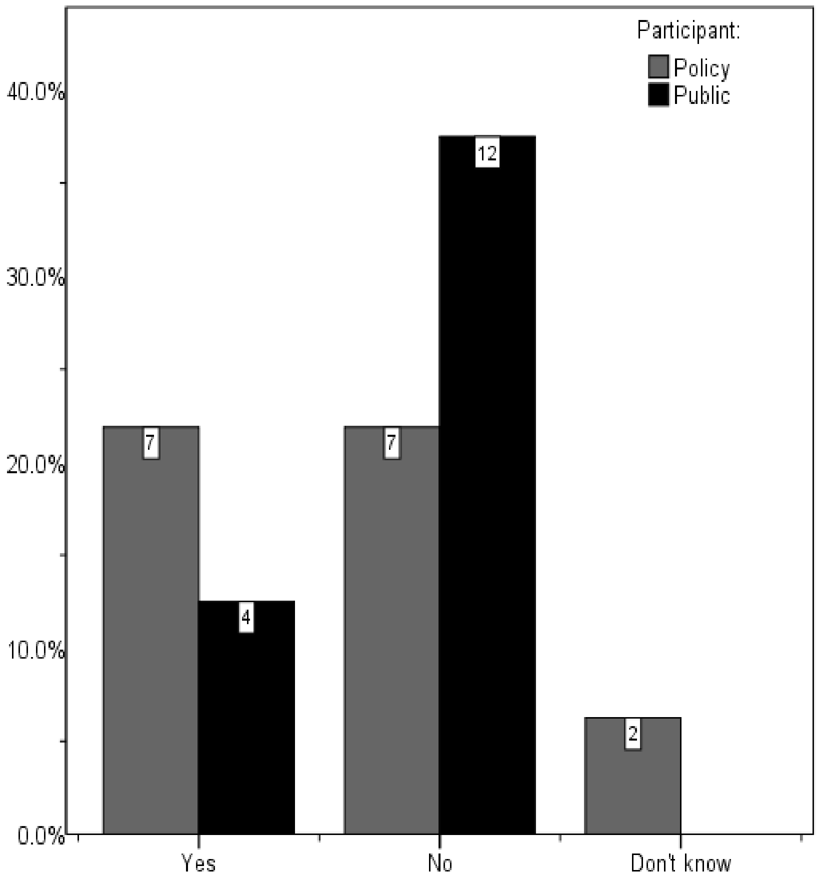

Figure 3.9 Responses to the question: ‘do you think the published government statistics are sufficient to accurately quantify the condition of the Indonesian tuna fisheries?’ (All research sites).

3.3.3.4 Policy makers and public-sector workers perception of the government’s statistics process pertaining to data collection, its compilation and its interpretation

With regards to policy makers, 56.3% (n = 9) remarked that the government had accurately collated statistical data, while 68.8% (n = 11) of public-sector workers stated the opposite (Figure 3.10). There was no significant difference between these groups of respondents ($\chi^2 = 4.5$; $p > 0.05$).

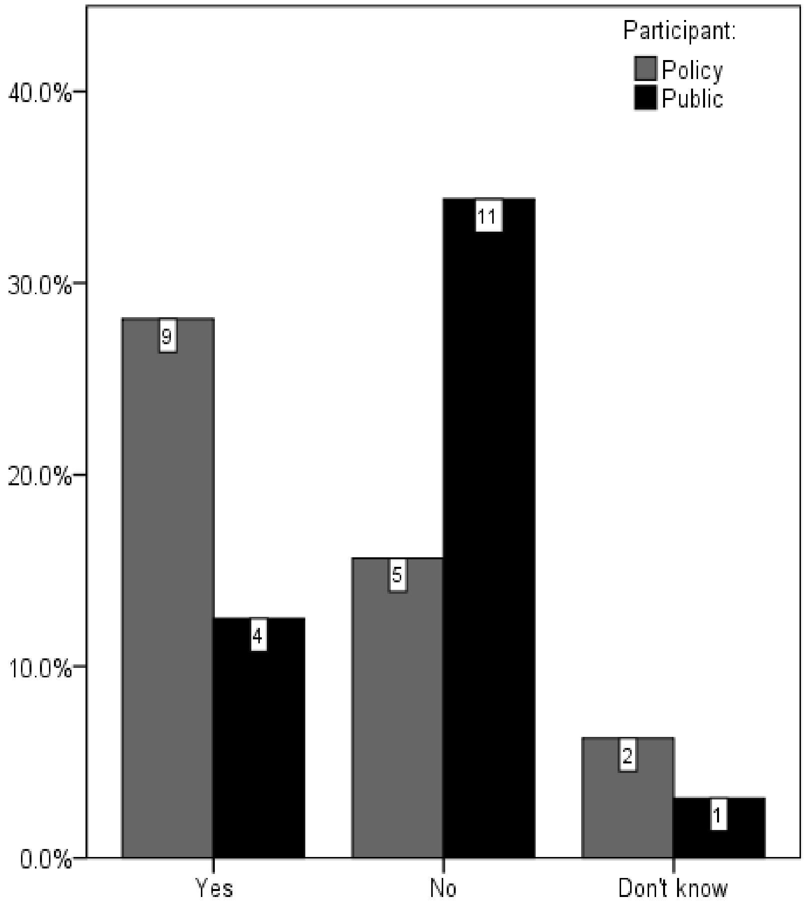

Figure 3.10 Responses to the question: ‘do you think the published government statistics are properly collected?’.

The respondents did not have different perceptions related to whether or not the field data were accurately collected by the responsible agency (Table 3.4). The respondents did not have a significant difference in their perceptions regarding this ($\chi^2 = 16.5$; $p > 0.05$).

The public and policy stakeholders had different perceptions about which government agencies were responsible for the collection, compilation and interpretation of fisheries data (Table 3.5). There was a significant difference between the groups of research respondents and their perceptions of the government agencies responsible for data compilation, and interpretations at all of the nine research locations ($\chi^2 = 19.47$, $p < 0.05$).

Table 3.4 Responses to the question: "Who is responsible for data collecting in the field for fisheries statistics information?".

Responsible for data collection	**Participants**			
	Policy		**Public**	
	n	**%**	**n**	**%**
Central government	3	18.8	0	0
Local government	3	18.8	1	6.3
Enumerator	1	6.3	0	0
Landing site authority	4	25	3	18.8
Independent institution	0	0	1	6.3
Central and local government	1	6.3	2	12.5
Central, local government and landing site authority	1	6.3	3	18.8
Central, local, landing site authority and independent institution	3	18.8	0	0
Local government and industry	0	0	1	6.3
Local government, landing site authority and independent institution	0	0	3	18.8
Other	0	0	2	12.5
Total	**16**		**16**	

Table 3.5 Responses to the question: "Who is responsible for data compilation and interpretation of statistical data from the fisheries sector?".

Responsible for data compilation and interpretation	**Participants**			
	Policy		**Public**	
	N	**%**	**n**	**%**
Central government	3	18.8	1	6.3
Local government	3	18.8	4	25
Landing site authority	4	25	0	0
Independent institution	0	0	1	6.3
Central government and independent institution	1	6.3	2	12.5
Central and local government	1	6.3	1	6.3
Central government and landing site authority	2	12.5	0	0
Central government and statistic office	0	0	2	12.5
Central, local gov, landing site authority and independent institution	2	12.5	0	0
Central, local government and fishers	0	0	1	6.3
Central, local government and landing site authority	0	0	1	6.3
Local government and landing site authority	0	0	1	6.3
Local government and landing site authority and independent institution	0	0	1	6.3
Other	0	0	1	6.3
Total	**16**		**16**	

3.3.3.5 Policy and public-sector workers' perceptions of statistics analysis and the data hierarchy process

It should be noted that 62.5% (n = 10) of policy sector workers correctly identified the hierarchy that is involved in the data gathering processes, whilst only 50% of public-sector respondents (n = 8) were correct (Figure 3.11). However, responses of the respondents within these groups did not differ significantly ($\chi^2 = 0.5$; $p > 0.05$).

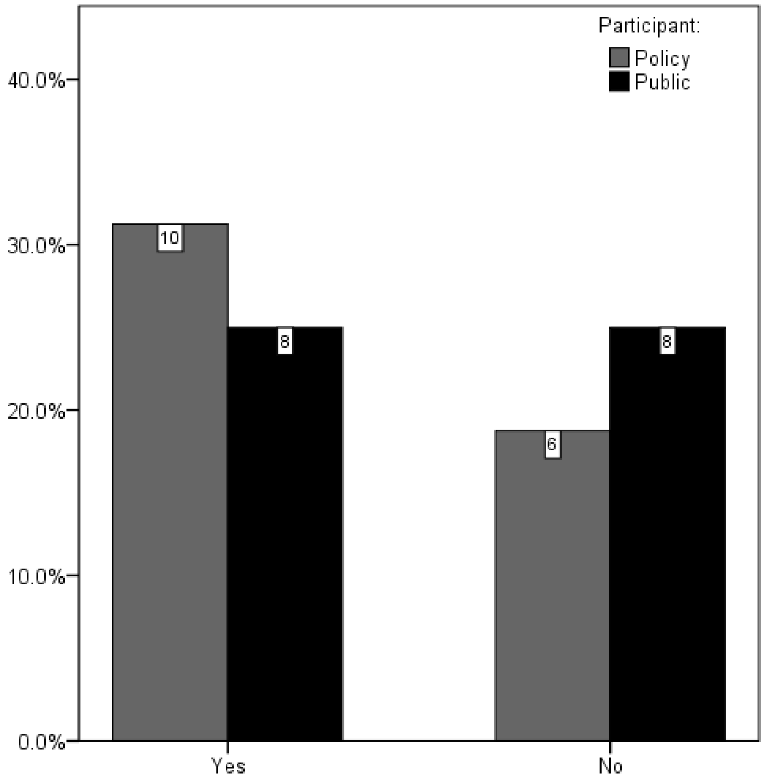

Figure 3.11 Responses to the question: “Do you know the hierarchical process related to statistical data collection?”.

3.4 Discussion

3.4.1 Trends in the tuna pole-and-line fisheries

Overall, tuna landings data from 2005-2014 have demonstrated increases in eastern Indonesia. These findings are consistent with the observations of previous studies. For instance, Miyake et al. (2004) reported a rapid growth in tuna catches from the 1980s, resulting in Indonesia being the largest global producer of yellowfin tuna in 1997. Additionally, Sunoko and Huang (2014) stated that Indonesian tuna landings had increased between 2004 and 2014, to then supplying more than 16% of tuna catches globally by 2014 (MMAF, 2014). However, the FAO reported that a global decline in tuna catches had developed since 2004 (FAO, 2016a, FAO, 2016b) which was mirrored by a declining trend in tuna catches in the Indian Ocean since 2006 (Satheeshkumar and Pillai, 2013). For example, in Hawaii since the 1940s, Ecuador in the 1950s, Senegal in the early 1960s, the Basque region of Spain in the early 1970s, Japan in the late 1970s, Brazil in 1985, the Canary Islands in 1994, the Azores in the1990s, the Maldives in 2006 and Indonesia in the late 1990s (Gillett, 2015), all reported declines in tuna catches. Other studies revealed that fishing limitations, including those regarding fishing rights (Caballero-Miguez et al., 2014); quotas (Squires et al., 2013) for cod fishing in Newfoundland, Canada (Schrank and

Roy, 2013); illegal fishing for sturgeon in the Caspian Sea (Ye and Valbo-Jørgensen, 2012); areas closed for purse-seine fleets fishing for tuna in the eastern tropical Atlantic (Torres-Irineo et al., 2011); and the closed season in the Pearl River Estuary (Wang et al., 2015), were all factors pertaining directly and indirectly to the abundance or otherwise of tuna and live-bait stocks. One reason for the poor correlation between landings and effort data is that landings are subject to a landings tax, which fishers are under pressure from middlemen and companies to reduce or avoid altogether.

3.4.2 Relationships between tuna pole-and-line landings and fishing effort

The use of pole-and-line fishing gear declined in the district of Flores Timur of eastern Indonesia between 2005 and 2014, though the use of pole-and-line fishing gear increased in the district of Halmahera Selatan. In Indonesia as a whole however, before 2012, the use of pole-and-line fishing gear had increased. Sunoko and Huang (2014) revealed that there were 513 pole-and-line fishing gears in Indonesia in 1979, whereas three decades later, this figure had increased to 12,727. But from 2012-2015, pole-and-line fishing declined both globally including in Indonesia (Gillett, 2015). Fishing trip durations varied among locations. For the district of Flores Timur, fishing trip duration was typically between 7 and 14 days, whilst in the district of Halmahera Selatan it was regularly only for a single day. This difference is due to several factors, including fishing season, engine type and boat size (Buchary, 1999), distance to fishing grounds (McElroy, 1991, Pet-Soede et al., 2001, Russo et al., 2016), the availability of live-bait, which is crucial for pole-and-line fishing (McElroy and Uktolseja, 1992), and government regulations (for example, when the government of Indonesia increased the fuel subsidy in 2010 (Alfian, 2010) it led to an increase in the number of fishing trips at a national level that year). Before 1990, Indonesian pole-and-line fishing vessels had capacities of 7–15 GT for one day trips, 20–30 GT for one to five day trips, and 100–300 GT for 15 to 30 day trips (McElroy, 1989, Buchary, 1999). Havice (2013) found that the catch rate and the number of trips influenced landings (Chan et al., 2014).

It is worth noting that the numbers of fishing gears and fishing trips were not in themselves significant indicators, or predictors, of tuna landings. This may be because of (1) errors in data input, such as missing entries and errors in typing (Yuniarta et al., 2017); (2) data submitted by enumerators being improperly collected and analysed due to diverse geographical conditions (Gillett, 2011); (3) vessel capacity (tonnage) and engine power all varying in each location (Yuniarta et al., 2017), (4) different levels of economic and infra-structure development in each location, and/or (5) changes in surrounding areas (FAO, 2016b). Other factors may be more significant predictors of tuna landings. For example, the number of fishing vessels, days spent at sea per trip, and the complex characteristics of the fishing grounds and associated FADs, may affect the number of tuna landings (Murray et al., 2013, Cardinale et al., 2009, Quirijns et al., 2008). Casini et al. (2005) found that the spatial distribution of demersal species in the Kattegat and Skagerrak Sea channel areas (Sweden) was associated with the landings. Walsh and Brodziak (2015) held that tuna landings were connected to CPUE. Additionally, fishing technologies such as vessel size and engine power (Parente, 2004), in addition to local gear modifications (Pradervand et al., 2007) may influence landings. Another factor is seasonal variation: one of the major limitations of this study is that the data only represent the annual variation, so the critical monthly variations were not taken into consideration. Zainuddin et al. (2013) revealed that the highest landings and efforts for skipjack tuna in Bone Bay-Flores Sea, Indonesia, occurred from June to August. Other potential factors associated with tuna landings include natural disasters, including climate change and tsunamis. Lehodey et al. (2013) demonstrated that skipjack tuna in the Western Central Pacific Ocean was associated with climate changes. A further predictive factor that may influence tuna landings trends is the total number of fishers who are operating at the same fishing ground (Purcell et al., 2016). According to Williams and Terawasi (2011) in the Pacific Ocean, the decline in landings was attributed to an increase in the number of operating vessels. Finally, tuna pole-and-line landings are heavily reliant on the availability of live-bait to serve fish aggregating devices (FADs), fluctuations in the availability of which is a primary factor in landings trends (McElroy and Uktolseja, 1992, Monintja and Mathews, 2000, Govinden et al., 2013).

It is important to note that the reliability of these findings might be diminished by poor source data (Mace et al., 2011). The current study uses data published by the government, which might not have been collected accurately (Costello et al., 2012). It is a poorly managed fisheries information system (Hobday and Evans, 2013), with weak data handling and questionable fishery analysis (Ramírez-Rodríguez, 2011). As previous researchers say, it is imperative to ensure the reliability of the data that is collected so that the sustainability goals of fisheries management can be assured

(Bardach and Matsuda, 1980, Polacheck, 1989, Miyake et al., 2004). This leads us to the question of stakeholders' perceptions about the fisheries data quality in Indonesia. According to respondents, another reason for poor data published by the government is the patron-client relationships between fishers and middlemen or companies who tend to provide incorrect information regarding their landings to avoid the retribution or tax payments. Yuniarta et al. (2017) noted that poor tuna fisheries CPUE data may come from misleading on-board and home consumption figures, unreported catch, tuna transhipments between catch and carrier vessels, lack of logbook entries, and patchy landings data verification by government agencies. Tuna pole-and-line fishers and their processors often report low levels of landings, and this means that tuna landings Indonesia are likely to be 30 to 40% higher than reported (Yuniarta et al., 2017).

3.4.3 Stakeholders' perceptions about data on tuna pole-and-line and live-bait in Indonesia

Indonesian fisheries management necessitates that basic information such as landings data be available in a reliable form, which is a colossal task given the country's large size and geographical complexity (Pauly and Budimartono, 2015). But it is a task which many stakeholders feel is not being adequately carried out. There are three elements in stakeholders' perceptions about tuna fisheries data: the raw data on the level of the stocks; the government' statistical analysis of that raw data; and the government's interpretation of that statistical analysis.

3.4.3.1 Stakeholders' perceptions about the raw data on the level of tuna and live bait stocks

The opinions of most respondents indicated that they considered the stocks to be declining. They held that the abundance of tuna and live-bait stocks was influenced by fishing limitations, new recruitment, illegal fishing, closed areas and seasonal factors. The government claimed that its raw data was reliable because it was systematically recorded and collected. Numerous fishers and public-sector individuals reported that they recorded their tuna landings. Based on the Ministry of Marine Affairs and Fisheries' Ministerial Decree No. 35/PERMEN-KP/2014, landings data by fishers and private sector individuals were obtained from logbooks and questionnaires using direct interviews**.** The logbooks and questionnaires were obtained from respondents at fish landing sites, fishing ports and sample villages. In addition, MAFF stated that landings data were reported to *Dinas Kelautan dan*

Perikanan Kabupaten atau Kota (district fishery authority) every month, and at each quarter then to the fisheries data centre at the ministry level. Subsequently, the landings data are compiled by the ministry annually. Several KIs also testified to the veracity of the data collection process. For instance, according to one of the canning companies (private sector) employee; "*data regularly-reported to the government were productions, production processes, quality controls and certificates of origin for our products"* (KI-05, 08 September 2015). Another key informant, who was a tuna fisher stated that; "*the type of data that is regularly reported to the company were productions, species and fish size"* (KI-23, 06 September 2015).

However, according to another fisher, landings data were not regularly reported by the fishers: "*landings data was reported to the government, although this was not done regularly, nor considered as an obligation for reporting"* (KI-36, 20 August 2015). Another key informant from the public sector, who had retired from his managerial position at MMAF, said that: *"the data did not accurately describe the current and actual condition of the Indonesian fisheries, for three reasons: (1) Dinas Perikanan dan Kelautan Kabupaten/Kota (district fishery authority) regards the collection of fisheries data as irrelevant and not a critical priority; (2) MMAF were unable to conduct a proper data collection exercise because of an insufficient budget; and (3) lack of awareness on the part of the fisheries sector of the importance of data in the process of fisheries planning and management"* (KI-03, 28 July 2015). Another reason is that it is unclear where the responsibility lies for collecting the data. According to the ministerial decree, enumerators are responsible for data collection at the field level - that is, from landing sites and sample villages - but both policy makers and public-sector participants have different perceptions of which government agencies are responsible for the collection, compilation and interpretation of the fisheries data. According to the FAO (2016b), Indonesia is one of its member countries that did not regularly report annual catch statistics and whose fisheries data were not entirely reliable.

3.4.3.2 Stakeholders' perceptions about the government's statistical analysis of tuna fisheries data

The accurate, complete and up-to-date marine and fisheries national data collection is the principal responsibility of the MMAF and it is regarded as being one of the government's performances indicators (MMAF, 2015b). Several policy makers have stated that the government's statistical data is consistent with scientific standards.

For example, one key informant from the public sector who worked as a scientist, stated that "*starting from 2004, Indonesia attempted to follow FAO's guidelines on the collection of fisheries data at several landing sites*" and that this information is used as the source of officially published government data (although "*not because of its inherent quality and reliability*" (KI-12, 11 September 2015). According to a government officer, *"the data collection process appears to adhere to the ministerial decree concerning the collection of marine and fisheries data"* (KI-25, 20 August 2015). Moreover, by means of the Indonesian Philippines Data Collection Project (IPDCP) in 2004 and the Western Pacific East Asian Fisheries Project (WPEAFP) in 2010, the Indonesian MMAF had been involved in rectifying the paucity of catch data related to the landing of highly migratory species in Bitung and Kendari, Indonesia (FAO, 2014c). By collaborating with regional fisheries management organisations (RFMOs), several improvements had been observed with respect to the data collection processes, including the strengthening of data collection and reporting procedures by the introduction of formal logbooks (IPNLF, 2014).

Nevertheless, the evolution of the Indonesian tuna fisheries has made the monitoring and reporting of catches and efforts challenging (WWF, 2013). Although the quality and accuracy of fisheries data in Indonesia has improved markedly over the past twenty years, and it has not been affected by natural disasters such as the tsunami in 2004 and Cyclone Nargis in May 2008 (FAO, 2016b), most public-sector workers perceived that the government's statistical analysis of its fisheries data lacked accuracy. The principal reasons for the inaccuracy of the government's statistics, according to public-sector workers, are lack of manpower available to collect all the data at a field level given that not every landing site in Indonesia has enumerators to systematically gather the data; the complexity of the archipelagic geography of Indonesia which makes the data collection process expensive; and the lack of technical competence and dedication of the enumerators. Also the data collection process is not always consistent with established scientific principles (Miyake et al., 2010, FAO, 2014c, Cadima, 2003). In contrast to the claims of MMAF Ministerial Decree No. 35/PERMEN-KP/2014, most public-sector participants stated that the government data was inappropriately collected. For instance, according to a key informant who worked at an NGO, "*the deficiencies in government fisheries statistics were due to the enumerators' poor skills that needed to be improved technically, an insufficient budget for proper data collection, and lack of a data validation process*"

(KI-13, 03 September 2015)”. Another public-sector participant stated that: “*Indonesian fisheries statistics were incorrectly collected as the collecting process was not conducted in accordance with the acceptable scientific principles*” (KI-07, 17 September 2015). According to Kusumastanto and Jolly (1997), Pet et al. (1997), Pet-Soede et al. (1999), Polacheck (2012), and Lehodey et al. (2013), the difficulties encountered regarding the management of fishing data in Indonesia were predominantly due to leadership and management failues; bureaucratic and organisational deficiencies; and poor technical data management systems.

3.4.3.3 Stakeholders’ perceptions about the government’s interpretation of its statistical analysis

The Indonesian government has mandated that the MMAF is responsible for the official interpretation of the fisheries data at the national level. This is in line with one of the government’s objectives in relation to the development of the Indonesian fisheries – that the country should be the world leader in providing accurate, complete, and up-to-date publication of fisheries data and expert interpretation (MMAF, 2015b). Several policy makers expressed the view that data have been interpreted in an appropriate way. For example, a government officer at provincial level stated that: “*fisheries data statistics have been collected, compiled and accurately interpreted by the enumerators using multi-tiered processes beginning from the landing sites and sample villages. The data were subsequently submitted to the fisheries district office, and subsequently transferred from the fisheries provincial office to the Ministry of Marine Affairs and Fisheries at the national level for official statistical data compilation, analyses and eventually, publication*” (KI-25, 20 August 2015). In the parts of Indonesia where there were fisheries projects that strictly followed the FAO guidelines, the positive impact on data and fisheries management was confirmed by the major stakeholders (i.e. fishers and government officials) (Pauly and Budimartono (2015). However, other respondents were far from convinced by MMAF’s interpretation of the tuna data. For example, a respondent from the public sector who worked as a scientist stated that: “*the statistical data cannot be used for fisheries management due to data bias from small-scale fisheries in Indonesia... sometimes... unreported catches landed in the small-scale landing sites were not properly completely collected by the enumerators*…” (KI-19, 11 September 2015).

3.5 Conclusion

This chapter has focused on three issues about the tuna fisheries in eastern Indonesia. On trends in landings, it has shown that although experience varies in different locations, overall landings increased up to 2012, but have declined since then because of many factors, including chronic over-fishing. On the relation between landings and effort, the chapter has shown that there is no significant correlation between them, probably because of the different fishing technologies and fishing efforts across the various research sites. On the stakeholders' perceptions about fisheries data, the study has found that stakeholders believe that official data is inaccurate, partly because the data is not gathered in accordance with scientific principles, partly because some agencies do not regard statistics as being vital and therefore do not see data collection as a priority, and partly because there is inadequate budgeting provided for data collection.

Chapter 4. Relationships between tuna pole-and-line fisheries and fishing ground oceanographic characteristics in eastern Indonesia

Abstract

Fish aggregating devices (FADs) deployed at fishing grounds for tuna pole-and-line fisheries in eastern Indonesia, and trends in landings, trips, and catch per unit effort (CPUE) at three locations were investigated. The FADs' locations, mean sea surface temperature (SST), and chlorophyll-a (chl-a) concentration, were examined using a geographic information system (GIS). Annual trends in landings, trips, CPUE, SST and chl-a concentrations were analysed using time series plots, and relationships of CPUE with SST and chl-a were analysed using generalised linear models (GLMs) constructed from generalised additive models (GAMs). GAM plots indicated that positive association was observed between CPUE and SST from approximately 26.5-29.5^{o}C in Sorong, <28.7^{o}C and >30^{o}C in Pulau Bacan and >29^{o}C for Larantuka. Furthermore, positive effects between CPUE and chl-a from GAM plots occurred where chl-a <0.4 mg/m^{3} in Sorong, >0.22 mg/m^{3} in Pulau Bacan and <0.35 mg/m^{3} in Larantuka. The GAM models showed that SST explains up to 20%, whereas chl-a explains up to 3.8 %, of the deviances in skipjack CPUE, and the addition of predictor variables resulted in an increase in the deviance explained. A seasonality factor was added in by incorporating time of year as one of the variables to the model to explain the seasonality relationships between CPUE and the covariates. This research provides evidence that skipjack and yellowfin tuna CPUE have relationships with SST and chl-a.

4.1 Introduction

Skipjack (*Katsuwonus pelamis*) and yellowfin (*Thunnus albacares*) are regularly caught by tuna pole-and-line fisheries in Indonesian waters. Oceanographic conditions, including sea surface temperature (SST) and chlorophyll-a (chl-a) (Andrade and Garcia, 1999, Harsono et al., 2014, Zainuddin et al., 2013) are expected to affect their abundances. For example, the local oceanographic environment greatly affects tuna natural migration patterns and the corresponding catch per unit effort (CPUE) (McElroy and Uktolseja, 1992, Proctor et al., 1995). Moreover, potential new skipjack tuna fishing grounds in the Flores Sea could be predicted based on SST and chl-a variabilities (Zainuddin et al., 2013). SST is related to the southern bluefin tuna (*Thunnus maccoyii*) CPUE in the Central Indian Ocean (Lu et al., 2010), the bigeye tuna (*Thunnus obesus*) catches in the eastern Indian Ocean off Java (Syamsuddin et al., 2013) and potential skipjack tuna fishing grounds in the Bone Bay-Flores Sea (Zainuddin et al., 2013). It has been suggested that chl-a can be used as an indicator of tuna distribution and abundance. For example, yellowfin tuna distribution and abundance in the equatorial Atlantic was correlated with chl-a abundance (Zagaglia et al., 2004); high chl-a concentration corresponded with high catches of mackerel (*Scomber scombrus*) in the Indian Ocean (Solanki et al., 2015) and high catches of bigeye tuna occurred when chl-a concentration was at low to moderate levels off Java and Bali (Setiawati et al., 2015).

Recent developments in remote sensing technologies have helped increase understanding of relationships between tuna and climate. For instance, Lehodey et al. (1997) found that El Niño Southern Oscillation (ENSO) events can be used to predict probable regions of high skipjack abundance within fishing grounds that are extended over 6,000 km along the equator. Atmospheric phenomena like El Niño have also been found to have a positive influence on bigeye tuna catch rates in the central Pacific Ocean (Howell and Kobayashi, 2006) and skipjack tuna migration in the southern California Bight (Fiedler and Bernard, 1987). Moreover, peak bigeye tuna catches in the eastern Indian Ocean off Java coincided with an El Niño event between 1997 and 2000 (Syamsuddin et al., 2013). In 2010, the cool water mass during the La Niña event in the eastern Pacific Ocean, resulting in a decrease in skipjack landings (Ormaza-Gonzalez et al., 2016). Interestingly, the La Niña event resulted in an increase in bigeye tuna catches off Java and Bali (Setiawati et al., 2015). Syamsuddin et al. (2013) found that ENSO had significant effects on influencing bigeye tuna catches in the eastern Indian Ocean off Java.

Tuna frequently associate with floating objects, both natural (eg. branches, logs) and man-made (Girard et al., 2004, Scott and Lopez, 2014, Yusfiandayani, 2013). This behaviour is partly attributed to greater abundances of small fish prey (Girard et al. (2004) associated with the floating objects. Globally, fish aggregating devices (FADs) are used for over 40% of tropical tuna catches (Taquet, 2013) with both anchored and drifting FADs being extensively employed in both small-scale and industrial fisheries that are targeting skipjack and yellowfin tuna (Jaquemet et al., 2011). The use of FADs to attract schooling fish in eastern Indonesia dates back to 1985 (Yusfiandayani, 2013, Dempster, 2004, Girard et al., 2004). The presence of FADs has been found to strongly influence density and movements of tuna species. In areas where FADs are located, relationships between tuna CPUE and SST and chl-a are most likely to be detected, which in turn provides a unique opportunity to understand these relationships in more detail.

In eastern Indonesia, tuna pole-and-line fishers deploy FADs in order to create an artificial shelter for skipjack and yellowfin tuna, as well as to create a more effective method of targeting tuna (Kim, 2015; Rodriguez-Tress et al. (2017). In eastern Indonesia, tuna pole-and-line fishers deploy FADs in order to create an artificial shelter for commercially exploited tuna species, as well as to create more efficient fishing methods (Scott and Lopez, 2014). Guillotreau et al. (2011) showed that during 1980–2007, the majority of tuna were caught using FADs rather than from free swimming schools in the Indian Ocean (Morgan, 2011). Taquet (2013) estimated that 40% of tuna catches worldwide were from the use of FADs, and concluded that tuna fishing grounds are highly dependent on their deployment (Madjid et al., 2012, Robert et al., 2014, Wang et al., 2014). Furthermore, Scott and Lopez (2014) reported that more than 90% of the world's tropical tuna catches, which are dominated by skipjack tuna, come from fisheries that deploy FADs. In relation to fishing vessel location, the position of FADs is important in minimising search time and associated operation costs (Davies et al., 2014).

There is a great need to observe how SST and chl-a variations affect tuna pole-and-line catches in eastern Indonesia, and more specifically, relationships between tuna pole-and-line CPUE and oceanographic characteristics at FAD sites in order to manage the FAD deployment for resource sustainability. A previous study undertaken by McElroy and Uktolseja (1992), revealed that FAD deployment in eastern Indonesia increased average skipjack catches. In this region, biophysical characteristics (e.g. SST and chl-a) are likely to be an important driver of tuna abundance as the majority of Indonesia's tuna are sourced here (Yuniarta et al., 2017). The present study aimed to examine relationships between tuna pole-and-line CPUE and oceanographic variables (chl-a and SST) at three FAD fishing grounds in eastern Indonesia. Specifically, this chapter addresses the following questions: (1) what are the temporal patterns of CPUE data at FAD sites? (2) What temporal oceanographic characteristics of these sites can help to explain these patterns?

4.2 Method

4.2.1 Study sites

Sorong, Pulau Bacan and Larantuka were chosen as representative locations for fishery operations known to use FAD sites (Figure 4.1). At each site, the number of fishing trips undertaken and catches over a period of time were documented in relation to their associated tuna pole-and-line fishing grounds. Information about the fishing grounds was obtained from questionnaires at Sorong and Larantuka and by observation of typical pole-and-line fishing operations of the fishers during a fishing trip from Pulau Bacan.

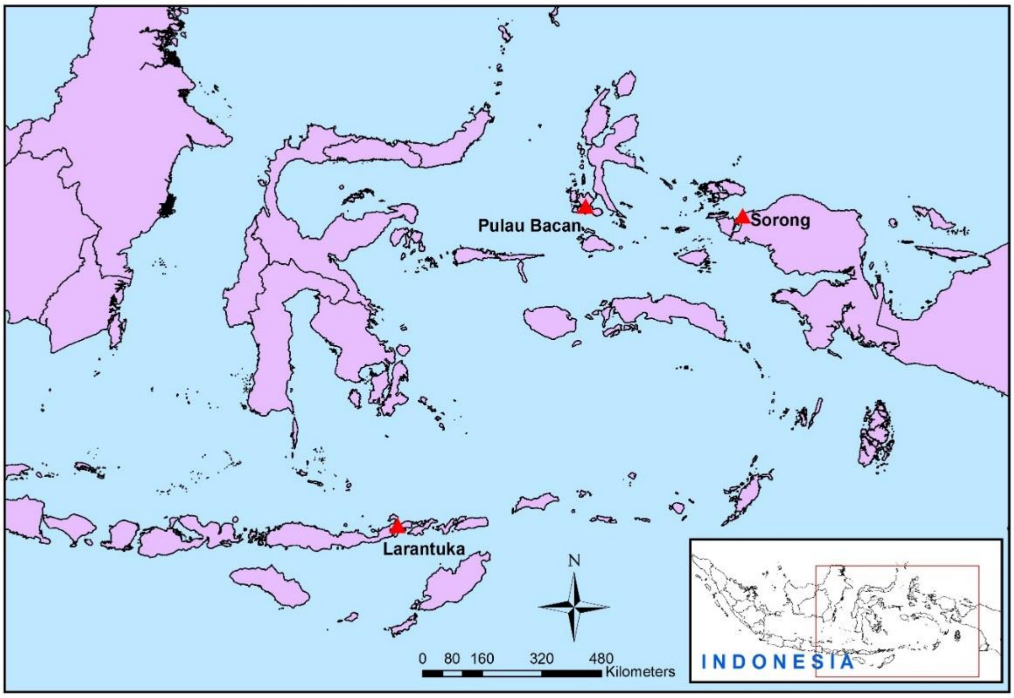

Figure 4.1 Locations of research sites (Sorong, Pulau Bacan and Larantuka) in eastern Indonesia

4.2.2 Data Sources

4.2.2.1 Landings, trips and CPUE

Fisheries data, including all tuna landings and trips (separate individual fishing vessel journeys to the FAD) undertaken during the study period were collected from landing site managers, government fisheries officers, and tuna processing companies at each location (Table 4.1).

Table 4.1 Sources of landings and trips data at the three study sites.

Location	Data source	Years
Sorong	Private company	2012–2015
Pulau Bacan	Government port landings	2007–2015
Larantuka	Government port landings	2015
	Private company	2010–2014

Landings and trips data in Sorong for the period 2012-2015 were obtained from a field survey conducted by a private company. There was no fish processing company in operation in Pulau Bacan, so landings and trips data for 2007-2015 were collected from the Government of Maluku Utara Province port landings records. Landings and trips data for Larantuka were collected from two sources; those for 2010–2014 were derived from the private company during the field survey and those for the year 2015 were obtained from the landings port official's office. Tuna CPUE data were derived from landings and trips data.

4.2.2.2 Oceanographic data

Monthly SST and chl-a data for relevant time periods and sites were estimated from the Advanced Very High Resolution Radiometer (AVHRR) Pathfinder Version 4+ Global Area Coverage (GAC) with a geographic resolution of 8 km, and also from the Aqua moderate resolution imaging spectroradiometer (Modis) with a spatial resolution of 4 km. The data were downloaded from the US National Oceanic and Atmospheric Administration (NOAA) data base at geographic points corresponding to the three specific locations and months during the period of interest (Tables 4.1 and 4.2).

Table 4.2 Sources of the oceanographic data.

Data Set		Spatial resolution
1.	Ocean Watch – monthly sea-surface temperature, AVHRR Pathfinder v4.1 + GAC	0.1^{o} (8 km)
2.	Ocean Watch – monthly chlorophyll-a concentration, Aqua MODIS	0.05^{o} (4 km)

4.2.3 Data analysis

4.2.3.1 Global Information System (GIS)

SST and chl-a data were mapped for each location using ArcGIS 10.2.1 and a graphic visualisation of these oceanic variables was undertaken in order to understand the distribution of the specific biophysical conditions.

4.2.3.2 Landings, trips, CPUE and oceanography trends

Landings, trips, CPUE, SST and chl-a variations were described using simple plots in order to differentiate between and within year trends from each site. This was further compiled and presented to illustrate: (1) variability over the years inclusively and, (2) monthly variability based on the summated data for each calendar month over all the combined years.

4.2.3.3 Relationships between CPUE and oceanographic factors

Correlation analysis was used in order to determine how strongly pairs of variables were related to one another, and generalised additive models (GAMs) were used in order to model relationships between CPUE (response variable) and the two oceanographic variables SST and chl-a (predictor variables). Explanatory model terms were treated as continuous variables, and splines were fitted to each term in the model (Zuur et al., 2009). Initially, the GAM was performed in order to determine the spline model best fitting the data prior to application of the final GAM for all of the data sets. The Akaike information criterion (AIC) and deviance were used to understand and qualify the optimum set of explanatory variables (Zuur et al., 2009, Zuur et al., 2007).

The GAM was tested based on the following formula:

$$g\ (\mu\iota) = \alpha 0 + s_1\ (x_{1i}) + s_2(x_{2i}) + s_n(x_{ni})\ \ldots \text{(1)}$$

Where *g* is the link function, $\mu\iota$ is the expected value of the dependent variable, $\alpha 0$ is the model constant, and s_n is a smoothing function for each of the model covariates x_n, respectively.

The associations between $_{log}$CPUE and the covariates SST, chl-a and year were represented by constructing both generalised linear models (GLMs) and GAMs. Subsequently, a seasonality factor was added in by incorporating year as one of the variables to the model. This was further modelled using the smoothing spline function in the GAM framework (Zagaglia et al., 2004), and as an ordinary covariate for the GLM. Finally, Fourier (harmonic) series, represented by sine and cosine terms, were used in order to capture relationships between CPUE, SST and chl-a in the GLM. To avoid any possible over-parameterisation issues, the number of sine and cosine terms did not exceed five harmonics. The final model was then selected based on the lowest AIC (Zuur et al., 2007, Zuur et al., 2009, Wood, 2017), and residual deviance was (Guisan and Zimmermann, 2000, Guisan et al., 2006) given by the following equation:

$$Yi = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \varepsilon \ldots(2),$$

Where *Yi* is the CPUE, $\beta 0$ is the constant, $\beta 1$, $\beta 2$, $\beta 3$ are the predictor variables, and ε is the error term.

The GAM and GLM were constructed in an R software environment (version 3.0.2; R Development Core Team) with the function of the mgcv package for the GAM (Everitt and Hothorn, Martínez-Rincón et al., 2012) and the nlme package used for the linear model.

4.3 Results

4.3.1 Fish aggregating device locations and oceanographic conditions

In Sorong, the associated FAD is located 166 nautical miles (nm) in a straight-line and in a south-eastern direction from the fishing base, and is adjacent to the Kabupaten Fakfak District of Papua Barat Province (Figure 4.2A). This location was confirmed by one of the fishers who stated, "*our FAD location is in Fakfak in the Seram Sea. It is approximately 28 hours' cruise time and more than 120 nm in a straight line from the fishing base in Sorong to the FAD location*" (KI-02, 08 August 2015). The mean chl-a around the FAD during 2012–2015 ranged from 0.06 mg/m^3 to 15.1 mg/m^3 (Figure 4.2B), whilst the mean SST ranged from 23.8 to 30.9^{o}C (Figure 4.2C).

Pulau Bacan’s FAD is located 22.5 nm in a straight-line and in a south-western direction from the fishing base (Figure 4.2D) in the Maluku Sea, Kabupaten Halmahera Selatan District (Maluku Utara Province). One of the fishers stated that “*our fishing ground is where the FAD was deployed and is approximately four hours’ cruise and around 55 nm in a straight line from the fishing base in Pulau Bacan*” (KI-40, 16 August 2015). The mean chl-a concentration around the FAD ranged from 0.04 mg/m^3 to 3.04 mg/m^3 between 2007 and 2015 (Figure 4.2E), whilst the SST ranged from 28.1^{o}C to 30.9^{o}C (Figure 4.2F).

In Larantuka, the FAD is located in the Sawu Sea, which is approximately 44 nm in a straight-line and in a southern direction from the fishing base (Figure 4.2G). A key informant fisher confirmed this by stating that, *“the fishing ground is where the FAD was deployed and located in the Sawu Sea and approximately eight hours’ cruise and 20 nm from the fishing base in Larantuka”* (KI-33, 25 August 2015). The mean chl-a at the FAD (and in the surrounding waters) during 2010–2015 ranged from 0.05 mg/m^3 to 2.7 mg/m^3 (Figure 4.2H), and the mean SST varied from 28.1°C to 30.9°C (Figure 4.2I).

4.3.2 Landings, trips, CPUE and oceanographic trends at the FAD sites

Overall, landings, trips, and CPUE of tuna in Sorong fluctuated considerably between and across years (2012-2015) (Figure 4.3A, 4.3B and 4.3C). Monthly landings ranged from 17,775 kg in May 2012 to 259,068 kg in October 2013 (mean 119,049 kg; median 105,410.5 kg). The total number of monthly trips ranged between two trips in December 2014 to 11 trips in January 2012 (mean 6.275; median 6). CPUE ranged from 5,925 kg/trip in May 2012 to 35,670 kg/trip in November 2015 (mean 19,046 kg/trip; median 17,547 kg/trip). Variability of the landings data during 2012–2015 was low in June–August when landings tended to be low. Conversely, there was greater variability between October and March when landings were high (Figure 4.4). These findings were concurrent with trips (Figure 4.4) and CPUE (Figure 4.4).

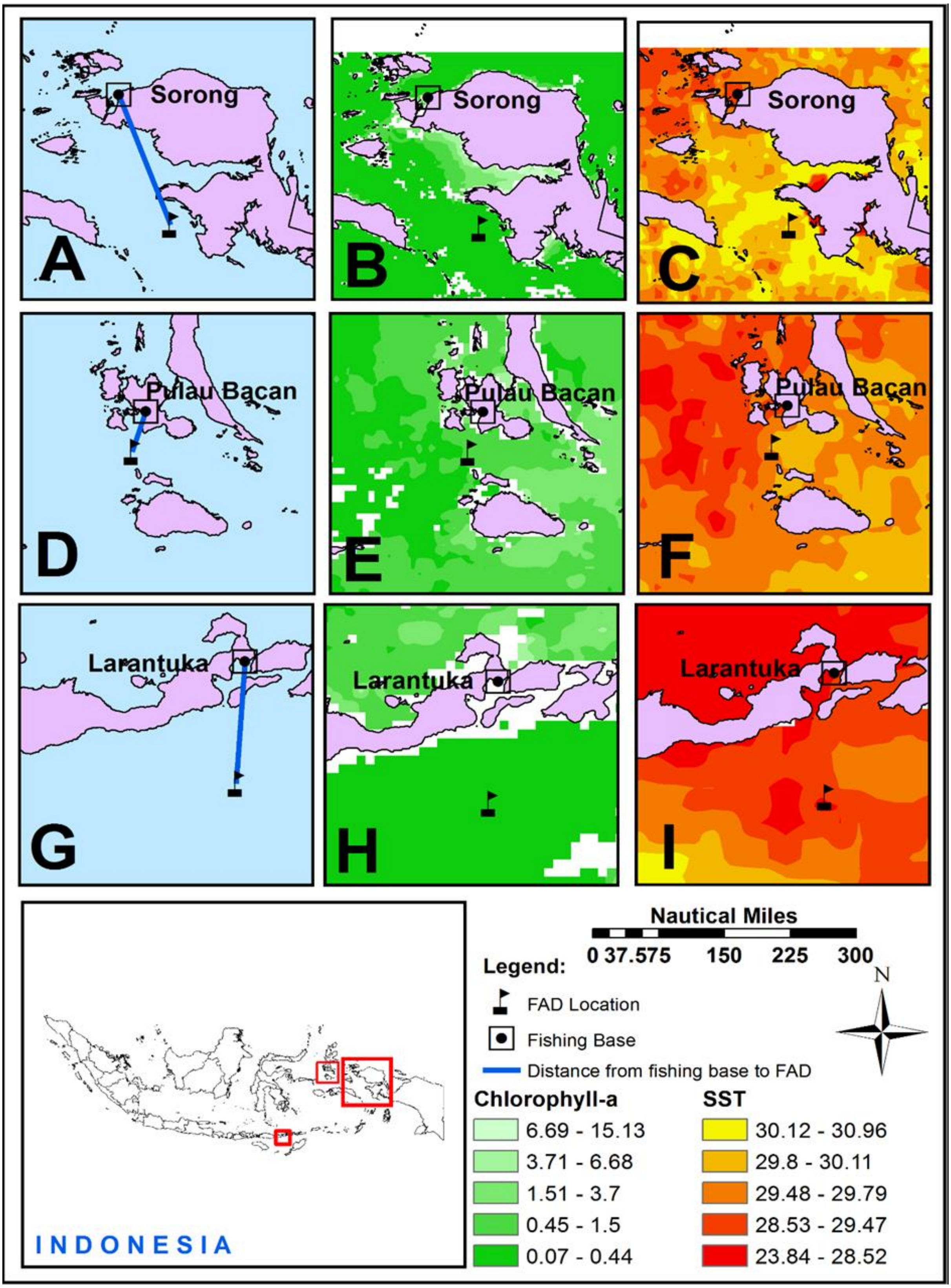

Figure 4.2 FAD locations, fishing bases and oceanographic characteristics at the three locations. The blue line indicates the straight-line distance on a given bearing from the fishing base to the FAD location in Sorong (A), Pulau Bacan (D), and Larantuka (G). (B) Mean chlorophyll-a from 2012–2015 at the FAD and surrounding waters in Sorong. (C) Mean SST from 2012–2015 at the FAD and surrounding waters in Sorong. (E) Mean chlorophyll-a from 2007–2015 at the FAD and surrounding waters in Pulau Bacan. (F) Mean SST from 2007–2015 at the FAD and surrounding waters in Pulau Bacan. (H) Mean chlorophyll-a over the period 2010–2015 at the FAD and surrounding waters in Larantuka. (I) Mean SST from 2010–2015 at the FAD and surrounding waters in Larantuka.

The SST ranged from 25.57°C in August 2015 to 30.55°C in December 2013 (mean 28.95°C; median 29.46°C). Chl-a concentration ranged from 0.13 mg/m^3 in April 2014 to 1.58 mg/m^3 in August 2015 (mean 0.38 mg/m^3; median 0.28 mg/m^3). SST and chl-a data over the period 2012–2015 at the Sorong FAD are set out in Figures 4.3D and 4.3E. The overall variability in SST data over the four years was low between January and May, corresponding with higher SST values. However, there was greater variability between June and October when SST tended to be lower (Figure 4.4). In contrast, the monthly variability in chl-a data across all months was higher in June to August, when chl-a level tended to be higher. There was reduced variability between October and May, when chl-a level was lower (Figure 4.4).

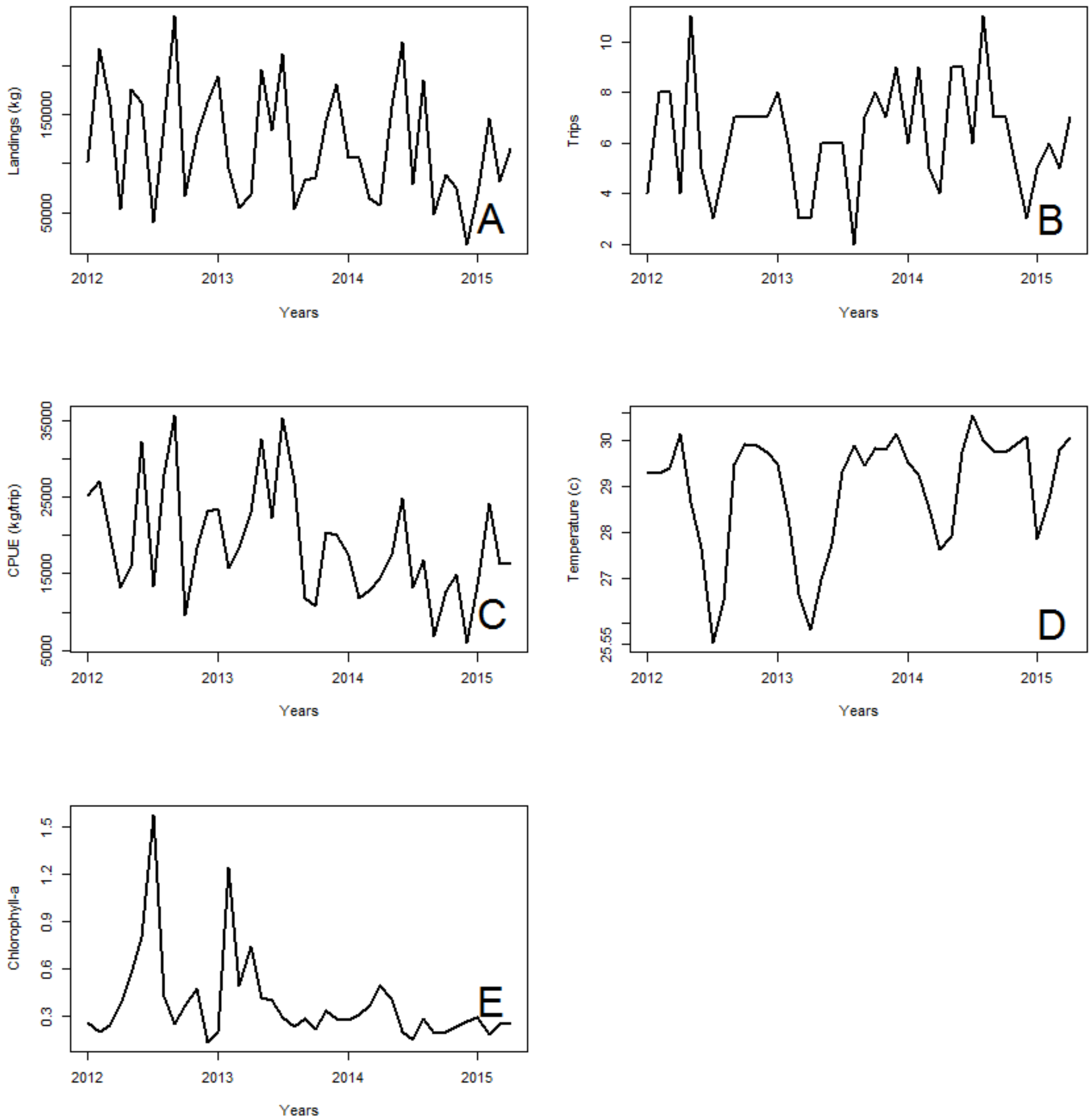

Figure 4.3 Plots of monthly landings (A), trips (B), CPUE (C), SST (D) and chlorophyll-a (E) in Sorong from 2012 to 2015

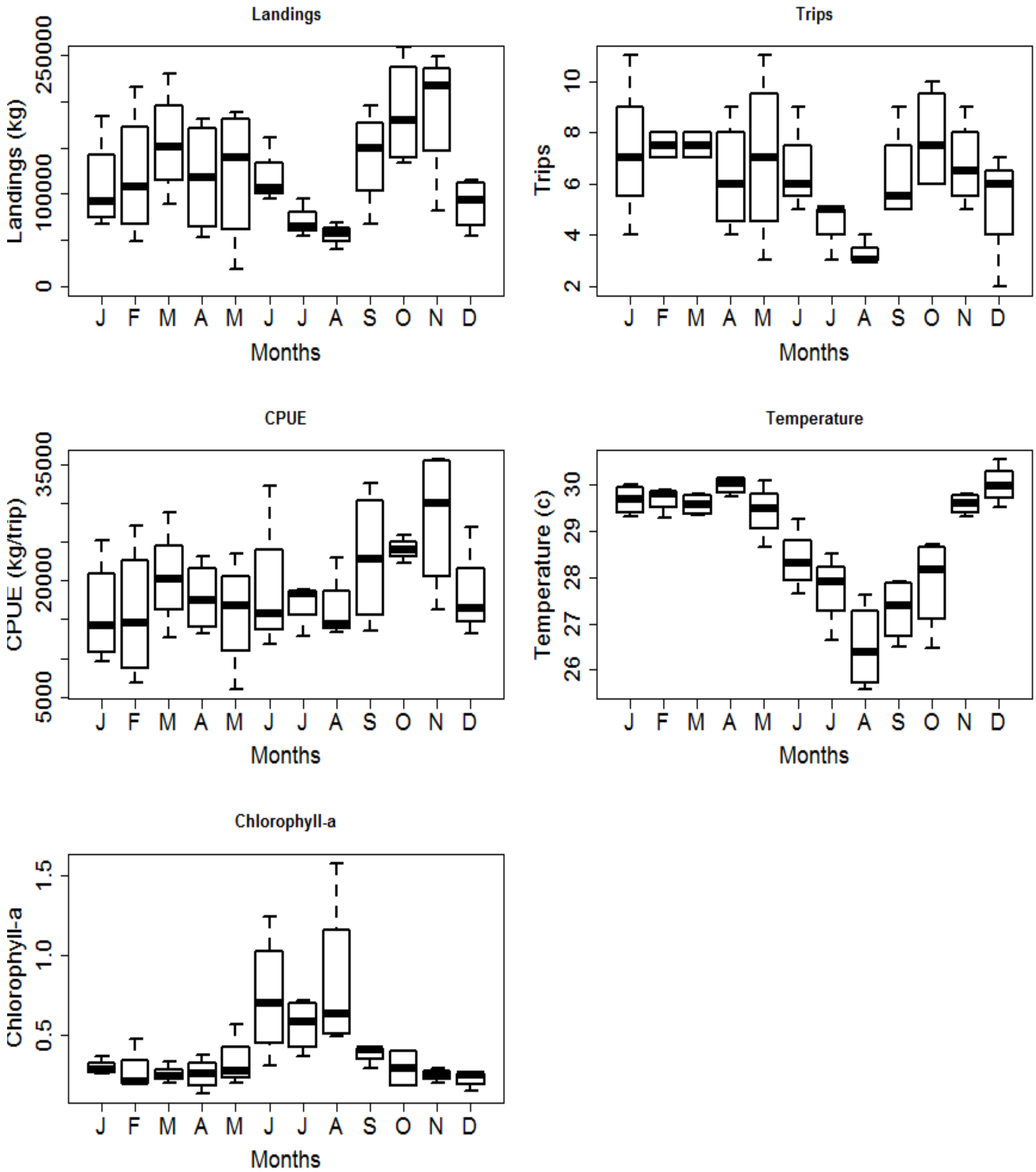

Figure 4.4 The summated monthly data for Sorong showing the range of variability within each month over the years 2012–2015 for landings, trips, CPUE, SST and chl-a. The solid band inside each bar represents the median, the middle “box” represents the inter-quartile range, while the lines outside the box (“whiskers”) represent the lower and upper quartiles.

In Pulau Bacan, tuna pole-and-line landings, trips, CPUE, SST and chl-a varied considerably between 2007 and 2015 (Figure 4.5). Monthly landings ranged from 4,074 kg in November 2007 to 615,682 kg in March 2013 (mean 151,539.7 kg; median 136,031 kg). The total number of monthly trips ranged from 25 trips in August 2007 to 322 trips in October 2011 (mean 131.5; median 129). Monthly CPUE in Pulau Bacan varied from 43.3 kg/trip in November 2007 to 3,731.4 kg/trip in March

2013 (mean 1,134.9 kg/trip; median 944.2 kg/trip). The landings data variability for the period 2007–2015 in Pulau Bacan was low in May to July, when landings were low, and was much greater in September to March (Figure 4.6). This was also the case for the number of trips (Figure 4.6) and CPUE (Figure 4.6).

SST data for Pulau Bacan ranged from 28.05^{o}C in August 2014 to 30.55^{o}C in November 2010 (mean 29.3^{o}C; median 29.4^{o}C), whilst chl-a ranged from 0.12 mg/m^{3} in March 2009 to 0.39 mg/m^{3} in July 2009 (mean 0.21 mg/m^{3}; median 0.19 mg/m^{3}). SST variability between years was low in August, when SST tended to be low, and greater between October to April when SST was high (Figure 4.6). In contrast, chl-a variability was low in February to April, when chl-a also tended to be lower, and greater in June to August when the chl-a was high (Figure 4.6).

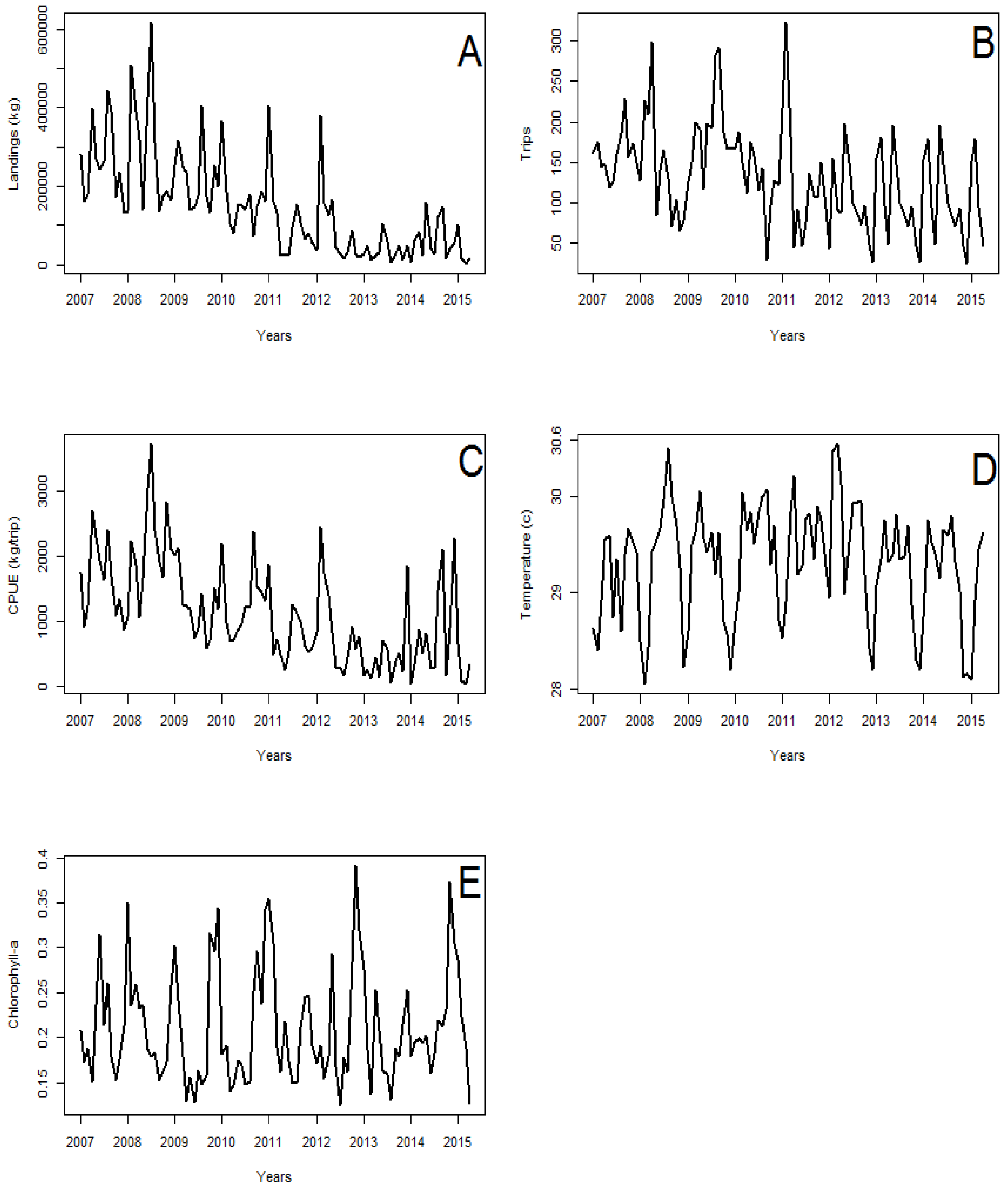

Figure 4.5 Annual trends of monthly landings (A), trips (B), CPUE (C), SST (D) and chlorophyll-a (E) over the years in Pulau Bacan from 2007 to 2015.

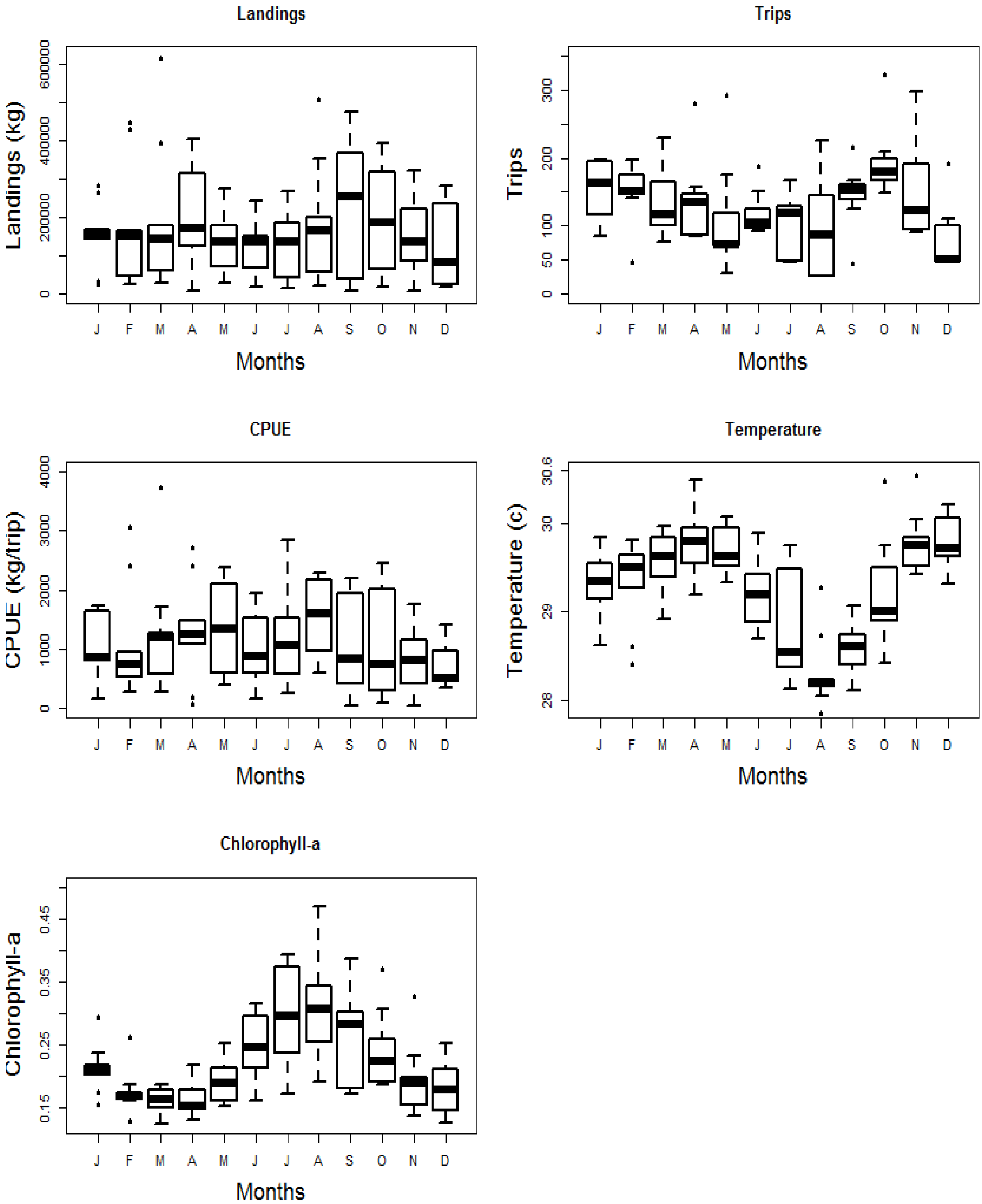

Figure 4.6 The summed monthly data for the years 2007–2015 for Pulau Bacan landings, trips, CPUE, SST and chlorophyll-a. The solid band inside the box is the median, the middle "box" represents the inter-quartile range, the lines outside the box ("whiskers") represent the lower and upper data, and the black dots signify any outliers in the dataset.

In Larantuka, tuna pole-and-line landings, trips, CPUE, SST and chl-a data during 2010–2015 showed cyclic variability (Figure 4.7). Monthly landings varied between 4,142 kg in January 2015 and 970,435 kg in October 2010 (mean 266,268.5 kg; median 225,642 kg), whilst the total number of monthly trips from the port ranged from 10 trips in January 2015 to 558 trips in April 2011 (mean 200.1; median 176). The monthly CPUE ranged from 404.4 kg/trip in April 2011 and 4,755.9 kg/trip in February 2013 (mean 1,508.5 kg/trip; median 1,282.5 kg/trip). the variability in landings was low in January and August when landings were low, and greater between September to December when landings tended to be high (Figure 4.8). The variability of trips between years was low in October when trips was frequent, conversely here was greater variability in July when trips was low (Figure 4.8). Additionally, CPUE variability was low in January when CPUE tended to be low, whereas the variability was greater in September when CPUE tended to be high (Figure 4.8).

SST in Larantuka from 2010 to 2015 ranged from 26.35^{o}C in August 2014 to 31.27^{o}C in March 2013 (mean 28.98^{o}C; median 29.27^{o}C). Chl-a data varied from 0.11 mg/m^3 in March 2013 to 1.03 mg/m^3 in August 2011 (mean 0.32 mg/m^3; median 0.23 mg/m^3). These Larantuka oceanographic data showed yearly variability over the months (Figure 4.7D and 4.7E). SST variability was low in July to September when SST tended to be low, and it was greater in October to May when SST tended to be high (Figure 4.8). In contrast, chl-a variability was large in July to September when chl-a was high, and there was greater variability between November to April when chl-a was low (Figure 4.8).

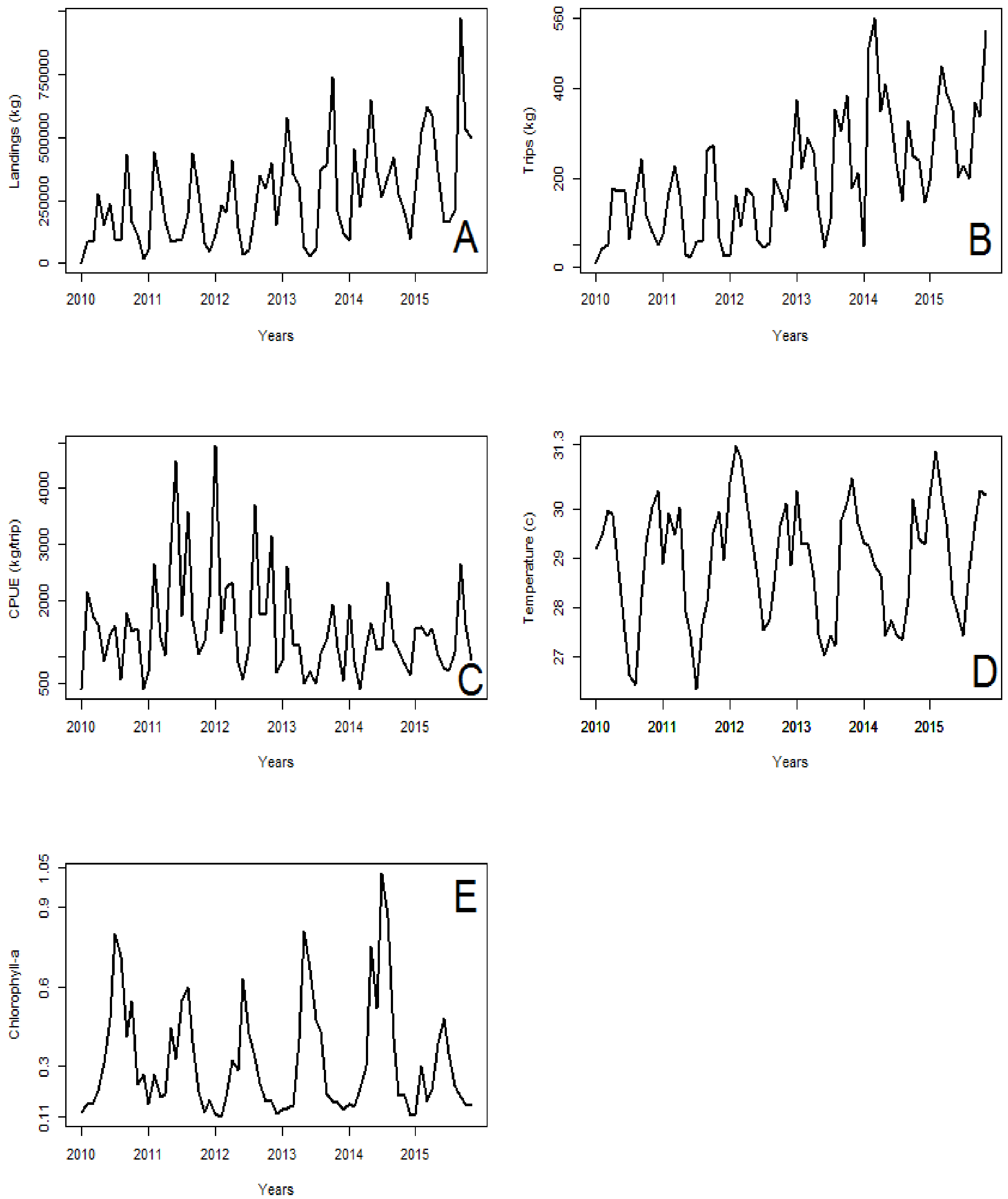

Figure 4.7 Annual trends of monthly landings (A), trips (B), CPUE (C), SST (D) and chlorophyll-a (E) over the years in Larantuka from 2010 to 2015.

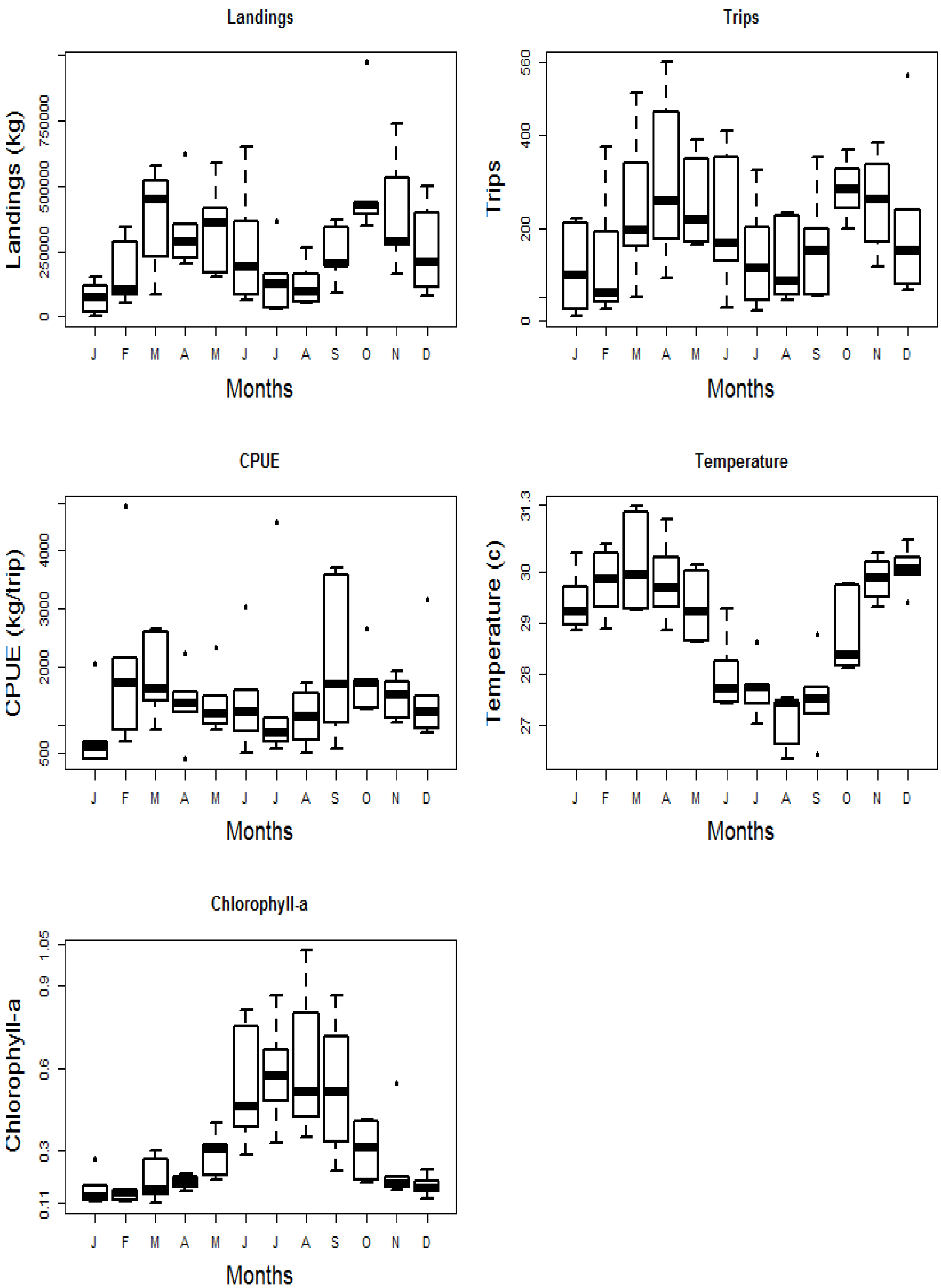

Figure 4.8 The summated monthly data variability over the period 2010 to 2015 collectively in Larantuka for landings, trips, CPUE, SST and chl-a. The solid band inside the box is the median, the middle “box” represents the inter-quartile range, while the lines outside the box (“whiskers”) signify the lower and upper data, whereas the black dots denote any outliers in the dataset.

4.3.3 Relationships between CPUE and oceanographic factors

The predictor variables (SST and chl-a) were not significantly correlated with CPUE. However, a significantly high negative correlation was found among the predictor variables (SST and chl-a) for all sites (Table 4.3). Moreover, the lowest correlation between CPUE and SST was found in Pulau Bacan (r = -0.0124; p = 0.9027); that between CPUE and chl-a was in Sorong (r = -0.0372; p = 0.8174); and the highest correlation was between SST and chl-a in Larantuka (r = -0.7647; p < 0.001).

Table 4.3 Results of correlation analysis between CPUE and the oceanographic factors

	CPUE	Temperature (^{o}C)	Chlorophyll-a
Sorong			
CPUE	1	-0.2357 (p = 0.1281)	-0.0372 (p = 0.8174)
Temperature (^{o}C)		1	-0.6652 (p < 0.001)
Chlorophyll-a			1
Pulau Bacan			
CPUE	1	-0.0124 (p = 0.9027)	0.1613 (p = 0.1071)
Temperature (^{o}C)		1	-0.6978 (p < 0.001)
Chlorophyll-a			1
Larantuka			
CPUE	1	0.0548 (p = 0.6501)	-0.0798 (p = 0.5049)
Temperature (^{o}C)		1	-0.7647 (p < 0.001)
Chlorophyll-a			1

The GAM plots indicated that both SST and chl-a had negative and positive effects on CPUE (Figure 4.8). Positive association was observed between CPUE and SST in the ranges from 26.5 to 29.5^{o}C in Sorong, <28.75^{o}C and >30^{o}C in Pulau Bacan, and >29^{o}C for Larantuka. There were also positive effects on CPUE where chl-a was approximately <0.4 mg/m^3 in Sorong, >0.22 mg/m^3 in Pulau Bacan, and <0.35 mg/m^3 in Larantuka.

SST explained the highest deviances (20.4% in Sorong, 7.66% for Pulau Bacan and 1.63% in Larantuka), whereas chl-a explained the lowest deviances (0.31% for Sorong, 3.8% in Pulau Bacan and 0.79% for Larantuka) in CPUE. Year as a predictor variable was found to be the most significant variable in explaining CPUE (24.5% in Sorong, 28.4% for Pulau Bacan and 2.37% for Larantuka) (Table 4.4). The addition of predictor variables resulted in an increase in the deviance explained. The final model derived from the GAM demonstrated that SST+year (30.3% in Sorong, 45.3% for Pulau Bacan and 11.7% in Larantuka) and chl-a+year (30.3% for Sorong, 41.3% in Pulau Bacan and 1.13% for Larantuka) explained seasonality trends between CPUE and covariates.

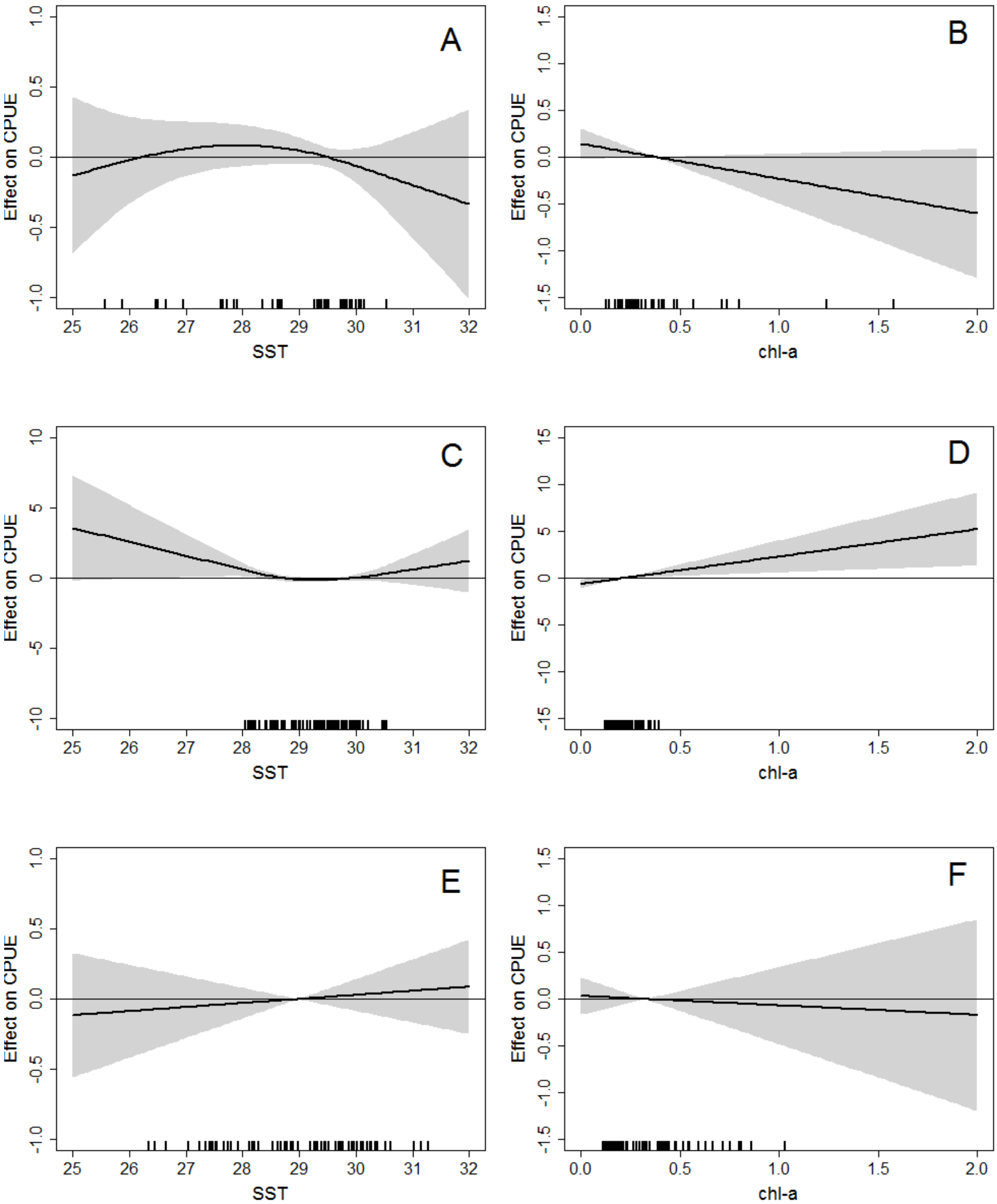

Figure 4.9 GAM plots derived effect of SST and chl-a on monthly tuna pole-and-line CPUE for Sorong (A and B), Pulau Bacan (C and D) and Larantuka (E and F). The x-axis represents the values of predictor variables and the y-axis shows the results of smoothing the fitted values. The tick marks on the *x*-axis represents the values of the observed data points; the solid line indicates the fitted function. The grey area shows 95% confidence bands. The horizontal line at zero represents no effect and positive effect on CPUE with predictor variables above the zero point line.

Table 4.4 Results of GAM on tuna pole-and-line logCPUE: adjusted R2, p value, deviance explained and the Akaike's information criterion (AIC).

Model		Explanatory variable	R^2 adjusted	*p*-value	Deviance explained	AIC
Sorong						
1.	SST	SST	0.128	0.177	20.4%	48.4
2.	chl-a	chl-a	-0.024	0.949	0.31%	48.1
3.	year	Year	0.227	0.000632	24.5%	38.7
4.	SST+year	SST year	0.254	0.447 0.00234	30.3%	40.0
5.	chl-a+year	chl-a year	0.267	0.0995 0.000230	30.3%	36.0
Pulau Bacan						
1.	SST	SST	0.0558	0.0913	7.66%	266.9
2.	chl-a	chl-a	0.029	0.0486	3.8%	271.2
3.	year	year	0.377	5.02×10^{-12}	38.4%	226.3
4.	SST+year	SSt year	0.433	0.0195 2.21 x 10-12	45.3%	217.5
5.	chl-a+year	Chl-a year	0.401	0.03 4.14×10^{-12}	41.3%	223.6
Larantuka						
1.	SST	SST	-0.00023	0.381	1.63%	123.0
2.	chl-a	chl-a	-0.00639	0.461	0.78%	124.4
3.	year	year	0.00971	0.197	2.37%	123.2
4.	SST+year	SST year	0.0558	0.338 0.0887	11.7%	125.3
5.	chl-a+year	chl-a year	-0.00283	0.454 2×10^{-16}	1.13%	123.3

The final linear models which best explained the CPUE data included chl-a and year in Sorong, and SST and year in Pulau Bacan and Larantuka (Table 4.4). The addition of the Fourier (harmonics) series to the GLM analysis resulted in a further decrease in the residual deviance (Table 4.5).

Table 4.5 Results of GLM on tuna pole-and-line logCPUE: estimate, confidence interval, standard error (SE), residual deviance, p value and AIC.

Model		Explanatory variable	Estimate	95% Confidence interval		SE	Residual deviance	*p*-value	AIC
				2.5%	97.5%				
Sorong									
1.	SST	SST	-0.0833	-0.1774	0.0109	0.0481	6.6004	0.0906	47.4
2.	chl-a	chl-a	-0.00027	-0.0452	0.4463	0.2291	6.6391	0.991	47.7
3.	Year	Year	0.1849	0.0868	0.2831	0.0501	5.3483	0.000632	38.1
4.	SST+year	SST	-0.0254	-0.1176	0.0668	0.0470	5.2572	0.59296	39.7
		year	0.1799	0.0696	0.2903	0.0563		0.00271	
5.	chl-a+year	chl-a	-0.3588	-0.7753	0.0578	0.2125	4.6247	0.099614	34.9
		year	0.2244	0.1163	0.3324	0.0551		0.00023	
With harmonics									
6.	SST+year+sin+cos	SST	0.0639	-0.0916	0.2195	0.0794	4.3655	0.425094	35.7
		year	0.2219	0.1094	0.3346	0.0575		0.000422	
		sin	-0.2246	-0.4659	0.0168	0.1232		0.076178	
		cos	0.0907	-0.0859	0.2674	0.0902		0.32061	
7.	chl-a+year+sin+cos	chl-a	-0.5002	-0.9466	-0.0539	0.2278	3.5997	0.03458	28.6
		year	0.2384	0.1399	0.3368	0.0502		3.23×10^{-5}	
		sin	-0.2218	-0.3703	-0.0732	0.0758		0.00591	
		cos	0.0607	-0.0939	0.2152	0.0788		0.44673	
Pulau Bacan									
1.	SST	SST	-0.0349	-0.3406	0.2707	0.1559	83.739	0.8232	272.04
2.	chl-a	chl-a	2.8098	0.0512	5.5684	1.4075	81.508	0.0486	270.97
3.	year	year	0.2299	0.1725	0.2873	0.0293	52.259	5.02×10^{-12}	226.08
4.	SST+year	SST	-0.0263	-0.2689	0.2163	0.1238	52.234	0.832	226.84
		year	0.2297	0.1709	0.2886	0.0300		1.48×10^{-11}	
5.	chl-a+year	chl-a	2.4365	0.2674	4.6056	1.1067	49.796	0.03	223.20
		year	0.2272	0.1409	0.2836	0.0288		4.14×10^{-12}	
With harmonics									
6.	SST+year+sin+cos	SST	0.0431	-0.2365	0.3227	0.1426	50.395	0.7632	227.26
		year	0.2283	0.1694	0.2873	0.0301		2.16×10^{-11}	
		sin	-0.0305	-0.2609	0.1999	0.1175		0.7957	
		cos	-0.1982	-0.4069	0.0105	0.1065		0.0658	
7.	chl-a+year+sin+cos	chl-a	2.6184	-0.0941	5.3310	1.3840	48.648	0.0615	224.84
		year	0.2220	0.1652	0.2789	0.0290		1.51×10^{-11}	
		sin	0.1073	-0.1263	0.3409	0.1192		0.3702	
		cos	-0.1101	-0.3225	0.1023	0.1084		0.3124	
Larantuka									
1.	SST	SST	0.0497	-0.0585	0.1579	0.0552	21.5	0.3711	122.67
2.	chl-a	chl-a	-0.2235	-0.8143	0.3674	0.3015	21.7	0.461	124
3.	year	year	0.0497	-0.0251	0.1244	0.0381	21.4	0.197	122.84
4.	SST+year	SST	0.0589	-0.0488	0.1668	0.0549	20.8	0.287	122.23
		year	0.0601	-0.0162	0.1365	0.0389		0.127	
5.	chl-a+year	chl-a	-0.2746	-0.8658	0.3166	0.3016	21.1	0.366	123.98
		year	0.0539	-0.0215	0.1292	0.0384		0.166	
With harmonics									
6.	SST+year+sin+cos	SST	0.1743	1.1×10^{-3}	0.3474	0.0884	19.9	0.0528	123.18
		year	0.0717	-5.4×10^{-3}	0.1489	0.0394		0.0729	
		sin	-0.2189	-4.76×10^{-1}	0.0388	0.1315		0.1007	
		cos	-0.1224	-3.5×10^{-1}	0.1061	0.1166		0.2975	
7.	chl-a+year+sin+cos	chl-a	-0.6469	-1.5599	0.2661	0.4659	20.7	0.170	126.6
		year	0.0596	-0.0168	0.1361	0.0390		0.131	
		sin	-0.1375	-0.3773	0.1023	0.1222		0.265	
		year	-0.0716	-0.3025	0.1593	0.1178		0.545	

4.4 Discussion

4.4.1 FAD location and oceanographic conditions

Tuna pole-and line fishing grounds associated with the deployment of FADs in the present study are located more than 20 nm from their fishing base. In other areas of Indonesia, such as in South and North Sulawesi, and in other countries including, Papua New Guinea, Malaysia, and Tahiti, FADs have been found to be located at similiar distances relative to their fishing base (Scott and Lopez, 2014, Ibrahim et al., 1996, Bach et al., 1998). The total number of FADs deployed could alter the movement and schooling behaviour of tuna (Moreno et al., 2007, Matsumoto et al., 2016, Rodriguez-Tress et al., 2017). From the current study, it was observed that the pole-and-line fishery targeted only skipjack and yellowfin tuna around the FAD sites. These findings are consistent with evidence from other studies. For instance, skipjack tuna have a strong tendency to associated with anchored floating objects (Matsumoto et al., 1984) and yellowfin tuna were found to orientate themselves towards a FAD within a radius of approximately 10 km (Girard et al., 2004). Furthermore, yellowfin tuna had longer FAD residence times than skipjack (Rodriguez-Tress et al., 2017) and it can be assumed that skipjack have greater mobility than yellowfin (Matsumoto et al., 2016).

Aside from the the presence of FADs, oceanographic factors such as SST and chl-a were also found to relate to tuna abundance in the region. In this study, SST varied from 23.8^{o}C to 30.9^{o}C at the FADs and in the surrounding waters. This finding is unsurprising considering that the oceanographic factor most widely considered likely to affect tuna schooling behaviour is SST (Lehodey et al., 1997, Santos, 2000, Matsumoto et al., 2016). For example, in the Flores Sea, eastern Indonesia, high catches of skipjack and yellowfin tuna were found to be influenced by SST during a monsoon that occurred between April and August 2012, with SSTs varying between 28.5^{o}C and 30^{o}C (Zainuddin et al., 2013). These findings are concurrent for yellowfin tuna catches in the Pacific Ocean which occurred when SST ranged from 20^{o}C to 30^{o}C between 2006 and 2010 (Kuo-Wei et al., 2017). Matsumoto et al. (1984) found that skipjack can select their optimal themal habitat.

Chl-a variation between 0.04 and 1.58 mg/m^3 found here across FAD sites is consistent with other studies within the region by Zainuddin et al. (2013) and Syamsuddin et al. (2013) which found that levels of chl-a abundance affected the distribution of skipjack and yellowfin tuna. For example, from 1995-2010 chl-a concentration in the west-central Pacific Ocean ranged from 0.0 to 2.0 mg/m^3 and corresponded to specific ranges of skipjack tuna concentration (Wang et al., 2016). Additionally, skipjack tuna CPUE data from January to December 2013 on the west coast of Sumatra occurred when chl-a ranged between 0.1 mg/m^3 and 0.29 mg/m^3 (Usman et al., 2017).

Other factors that affected the success of FAD deployment at fishing grounds included fishers' experiences. Fishers' selection of productive fishing grounds reflected fishers' knowledge of the migration paths of the tuna (Roza Yusfiandayani, *personal communication*, 20 July 2017) and of suitable ocean sea bed contours related to the installation of the FADs (Pradipta, 2014). Furthermore, socio-economic factors are considered in the deployment of FADs. For example, the distances between FADs deployment and fishing bases for the Philippines FAD fishery are based on the fishers' financial resources (Macusi et al., 2017b), the cost and efficiency of fishing operations (Cayre, 1991) including fuel cost considerations (Macusi et al., 2017a) and the need to maintain catch freshness (Macusi et al., 2015).

4.4.2 Landings, trips, CPUE and oceanography trends

Strong seasonal trends in landings, trips, CPUE, SST, and chl-a were observed in eastern Indonesia. This is consistent with similar findings elsewhere of seasonality in tuna landings (FAO, 2017, Pauly and Budimartono, 2015, McElroy and Uktolseja, 1992, Pet-Soede et al., 1999). The study's results were characterised by low levels of landings, trips, CPUE, and SST between June and August, when high levels of chl-a occurred. Other studies have made similar observation. For example, yellowfin tuna landings from the longline fishery in the Tasman Sea displayed a seasonal trend which could have resulted from an increase in cold water mass during winter and warm water during the summer that may promote fluctuation in SST (Kawamoto and Nakamae, 2017, Dell et al., 2015). Zainuddin et al. (2013) used lower SST and greater chl-a over June-August as evidence of seasonal upwelling events.

CPUE patterns in this research showed variability over the years in each location. These patterns are attributable to variations in fishing pressure (Casini et al., 2005) and in the marine environment, including effects of wind strength, rainfall, land runoff, river discharge and upwelling which may influence nutrient enchancement (Yu et al., 2014). In addition, changes in vessel capacity and fishing power are likely to have contributed to changes in the number of trips and CPUE over time (Respondek et al., 2014, Fulanda and Ohtomi, 2011). Other factors that may affect the variability of CPUE are climate events, such as the El Niño (Syamsuddin et al., 2013) and La Niña (Ormaza-Gonzalez et al., 2016) phenomena, , sea currents such as the Halmahera Eddy (Harsono et al., 2014), and tuna movement and migration behaviours affected by these environmental changes (Xu et al., 2017).

The ranges in the SST at the research locations fluctuated between 2.5 and 4.9^{o}C while the chl-a range varied between 0.27 and 1.45 mg/m^{3}. These observations accord with other work in these tropical waters, where although there is significant seasonal variation, there is low inter-annual variation in both SST (Matear et al., 2015) and sea-surface chl-a concentration (Messié and Radenac, 2006). For example, Karman et al. (2016) found that inter-annual variation of SST in Pulau Bacan from 2008-2012 was low, ranging between 1.8 and 2.6^{o}C, whilst the chl-a difference was 0.2 mg/m^{3}. Setiawati et al. (2015) reported that in the southern Java and Bali waters, small differences in SST (1.2-1.3^{o}C) and chl-a data (0.05-0.06 mg/m^{3}) occurred from January 2006 to December 2010.

4.4.3 Relationships between CPUE and oceanographic factors

Although SST and chl-a were not significantly correlated with CPUE, significant high negative correlation was found between SST and chl-a in this research. This is consistent with other studies within the region and elsewhere (Kuo-Wei et al., 2017, Kanaji et al., 2012). For instance, there was no significant correlation between skipjack tuna CPUE with SST in Brazilian waters (Andrade and Garcia, 1999, Andrade, 2003). Skipjack CPUE variations were probably more highly correlated with seasonal variability of other environmental conditions than just SST alone, such as depth, fronts, and abundance of prey (Andrade and Garcia, 1999). In contrast to this study, strong correlations were shown between tuna CPUE with SST and chl-a within the region (Syamsuddin et al., 2013, Zainuddin et al., 2013, Usman et al., 2017). The reasons for this difference in findings are unclear at this time.

Here relationships between CPUE and SST or chl-a might be affected by other factors that are not included in the analysis, such as sea surface height and prevailing currents (Syamsuddin et al., 2013, Harsono et al., 2014). Andrade and Garcia (1999) found that other biotic and abiotic factors are more important in the relationships between skipjack tuna CPUE and SST (Andrade, 2003), as this species is better adapted to coping with temperature variations in equatorial waters (Zainuddin et al., 2013).

There may be a correlation between tuna biological life history and SST and chl-a, which would support the idea that skipjack tuna have little tolerance of low SST (Boyce et al., 2008). Moreover, this may have varied according to the progressive biological stages of the tuna from larval, juvenile and adult stages, where adult tuna had more tolerance of the temperature ranges (Boyce et al., 2008). The distribution and prevalence of their natural prey (e.g. anchovies, sardines) may have masked any relationship between CPUE and SST or chl-a, which are associated with thermal fronts (Klemas, 2013).

The model results from the GAM and the GLM analyses in this study showed that SST+year and chl-a+year best explained variations in CPUE. Similarly Lu et al. (2010) demonstrated a relationship between year and SST with bluefin tuna CPUE in the central Indian Ocean. Strong relationships between CPUE and SST for skipjack and yellowfin tuna, have also been found in Peru, Colombia and Ecuador (Ormaza-Gonzalez et al., 2016), and relationships between bluefin tuna fishing grounds and chl-a revealed strong correlation in the Mediterranean Sea (Druon, 2010).

4.5 Conclusion

This study has illustrated the relationships of SST and chl-a on CPUE at representative FAD sites in Sorong, Pulau Bacan and Larantuka, eastern Indonesia. Tuna pole-and-line fishing grounds in eastern Indonesia are heavily dependent on the deployment of FADs. The CPUE was not significantly correlated with the predictor variables, SST and chl-a, whilst a strong negative correlation was found only between SST and chl-a. Moreover, the models from the CPUE with the year, SST and chl-a can explain only up to 45% of their relationships. The relationships between skipjack tuna CPUE, SST and chl-a in eastern Indonesia may be explained by the following reasons: (1) the biological life-cycle stages of skipjack tuna may have different relationships with SST and chl-a; (2) the correlation between CPUE with SST and chl-a may be due to abiotic and other biotic factors that affected these relationships, such as sea surface height, sea current and winds; (3) variations in live-bait abundance may have contributed to the weakness of relationships, and (4) climate phenomena , such as La Niña and El Niña may have also affected the relationships between tuna CPUE with SST and chl-a. Future studies must investigate the relationships between CPUE and other biotic and abiotic factors that are not included in this research, such as sea currents heights and winds for more comprehensive analysis.

Chapter 5. Marketing strategies of the pole-and-line tuna fisheries

Abstract

This chapter is a study of the way the small-scale pole-and-line tuna fisheries in three locations in Indonesia (Sorong, Pulau Bacan, and Larantuka) have attempted to adapt to the challenges facing them by developing new marketing strategies. It makes use of resilience theory to inform the concept of adaptation, and it investigates three marketing strategies by examining three sources of data: official records of supply chains; key informant and fishers' perceptions of marketing; and personal observations of landings and selling. The findings are that market supply strategies vary widely between the three sites, but that the most successful fishery is in Sorong, where vigorous attempts have been made to obtain certification of sustainable production from the Marine Stewardship Council (MSC). In Pulau Bacan and Larantuka, constraining factors posed by the patron-client relationship made it hard to develop such marketing strategies to achieve a more sustainable fishery. In Sorong, where fishers were more independent of middlemen and company constraints, they could make use of certification and traceability as tools to ensure greater transparency and therefore bypass the patron-client relationship to facilitate more sustainable practices, Certification and traceability therefore became adaptive strategies enabling fishers in Sorong to overcome market obstacles.

5.1 Introduction

Indonesia lies between two major tuna producing regions, the Pacific and Indian Oceans. The eastern Indian Ocean contributes up to 20%, whilst the Pacific Ocean contributes approximately 80%, of Indonesia's total tuna landings (Investment, 2016, Bailey et al., 2013). Given the nature of its strategic geo-positioning, Indonesia plays a significant role in the supply of tuna to the global market. In 2015, 48% of total global tuna production from both wild and farming sources consisted of skipjack; followed by yellowfin (23%); several other less common tuna species supplied the remainder (FAO, 2017). In Indonesia, the skipjack is also the most important tuna (van Duijn et al. (2012). The Indonesian Ministry of Marine Affairs and Fisheries (MMAF) reported that total Indonesian exports of tuna, including skipjack and eastern little tuna, increased from 122,450 tonnes in 2010 to 206,553 tonnes in 2014 (MMAF, 2015c). In the 1980s, Indonesia was the seventh largest tuna producer in the world: by the 1990s it had become the third largest tuna producer; and by 2004, it had become the principal producer of tuna worldwide (Sunoko and Huang, 2014).

The global tuna market is supplied with a range of products, including canned tuna, fresh and frozen sashimi, other fresh and frozen value-added products and *katsuobushi* (Hamilton et al., 2011). The leading market destinations for Indonesia's tuna are for sashimi and fresh and deep frozen tuna to Japan; for canned tuna to the USA and Europe; and to domestic markets for fresh, salt-boiled or smoked forms of tuna (McElroy, 1989). Globally, 84% of total world fisheries catch is derived from small-scale fisheries (de Graaf et al., 2015) and these provide work for 90% (109 out of 119 million people) of the people employed in capture fisheries (FAO, 2016b). In the case of Indonesian tuna fisheries, to understand differences in market orientation between small-scale and large scale fishers, it is essential to note that the small-scale tuna fisheries fulfil local, national and international niche markets, as well as fishers' own household consumption, whilst the large-scale tuna fisheries primarily sell their catches into organised large mass markets (Bjorndal et al., 2014).

Since the 1970s, the Indonesian government has promoted tuna fisheries development throughout the country with the aim of creating livelihoods and income for families and generating revenue for the nation (MMAF, 2014). However, small-scale pole-and-line tuna fisheries in Indonesia are at risk from several threats to their survival. One threat is overfishing by illegal, unreported, and unregulated (IUU) industrial fisheries, mostly foreign, which derive substantial tuna catches from within

Indonesia's exclusive economic zones (EEZs). This theme was introduced in chapter 2 which looked at the moratorium, which was evidently introduced in part to protect the pole-and-line tuna fishery. Another threat is legal large-scale fisheries which benefit from economies of scale and out-compete small-scale fisheries on price. This threat is addressed in the present chapter by examining the attempts by local pole-and-line fisheries to develop marketing strategies that give them a competitive edge over large-scale fisheries on the quality of fish and environmentally friendly modes of fishing.

Market demand from developed countries for tuna products has risen due to their increasing human populations. At the same time, markets in developed countries have increasingly required responsibly operated and sustainably maintained sources of tuna to meet their current and future needs. Certification of tuna sources and their traceability from fishing ground to final consumers is convincing evidence that tuna products have come from sustainable and responsible sources (Stratoudakis et al., 2016, Stemle et al., 2016, Parenreng et al., 2016, Hadjimichael and Hegland, 2016). A lesson learned from the members of Parties of the Nauru Agreement (PNA) was that the fisheries certification of tuna fisheries such as that by the Marine Stewardship Council (MSC) has brought new changes especially in tuna negotiation, agreements and outcomes amongst parties (Yeeting et al., 2016). Indonesia, as one of the largest tuna producers in the world, has been striving to fulfil the requirements of the international community in relation to tuna certification and the traceability process (Duggan and Kochen, 2016, Adhuri et al., 2016). The certification scheme required by developed countries intended for fish products entering their market could also influence the price of tuna, even at the fishing port dockside level (Stemle et al., 2016, Stratoudakis et al., 2016, Adolf et al., 2016). Traceability plays a particularly key role in promoting pole-and-line fisheries since they involve very little discarding or by-catch, and have a negligible impact on the benthic system. The MSC certification label means that the product comes from sustainable fisheries in accordance with the MSC fisheries standards (MSC, 2017), which include three criteria: (1) sustainable fish stock; (2) minimal environmental impact and (3) effective management.

In fisheries resilience theory, there is a distinction drawn between two strategies: transformation and adaptation (Chandler, 2014, Chandler and Reid, 2016, Boyd and Folke, 2012). Transformation means changing the external parameters of the circumstances in which the fishery works. In the case of the Indonesian pole-and-line fishery, the moratorium imposed by the government in 2014 was transformative in that it was a change in the external parameters within which the pole-and-line fishery worked, protecting it from illegal competition by foreign fishing vessels. Adaptation means changing the internal workings of a fishery to respond to the external situation in which it finds itself. In the case of the Indonesian pole-and-line fishery, attempts by the fishery to respond to its external situation are examples of adaptation, and they include marketing strategies of various kinds. In chapter 2, the transformative strategy of resilience in the shape of the moratorium was elaborated, while this chapter is focused on the adaptive strategy of resilience in the shape of marketing techniques. The aim here is to examine the systems of marketing in place in the small-scale pole-and-line tuna fishery in eastern Indonesia, paying particular attention to three fishing areas - Sorong, Pulau Bacan, and Larantuka. The objective is to find out whether there are stages in the supply chain which impede the success of local pole-and-line tuna fisheries, and if so, how these impediments might be removed or diminished.

5.2 Methods

5.2.1 Study sites

The field survey was conducted at three sites in Indonesia (Sorong, Pulau Bacan, and Larantuka) between July–September 2015. The sites surveyed during the study have been described in detail in the previous chapters (Figure 5.1.).These locations were chosen as being representative fishing bases for small-scale tuna pole-and-line operations and markets in eastern Indonesia. Each location had data available related to their tuna pole-and-line supply lines, marketing chains and recorded companies data. Information on the supply and marketing system was obtained by questionnaires at Sorong and Larantuka and by witnessing the typical pole-and-line fishing operations of the fishers during a fishing trip from Pulau Bacan.

5.2.2 Data Sources

5.2.2.1 Documentary sources

The market supply lines and selling data for the study were gathered from landing site managers; government fisheries offices; tuna processing companies at the three sites; a desk study; and a field survey.

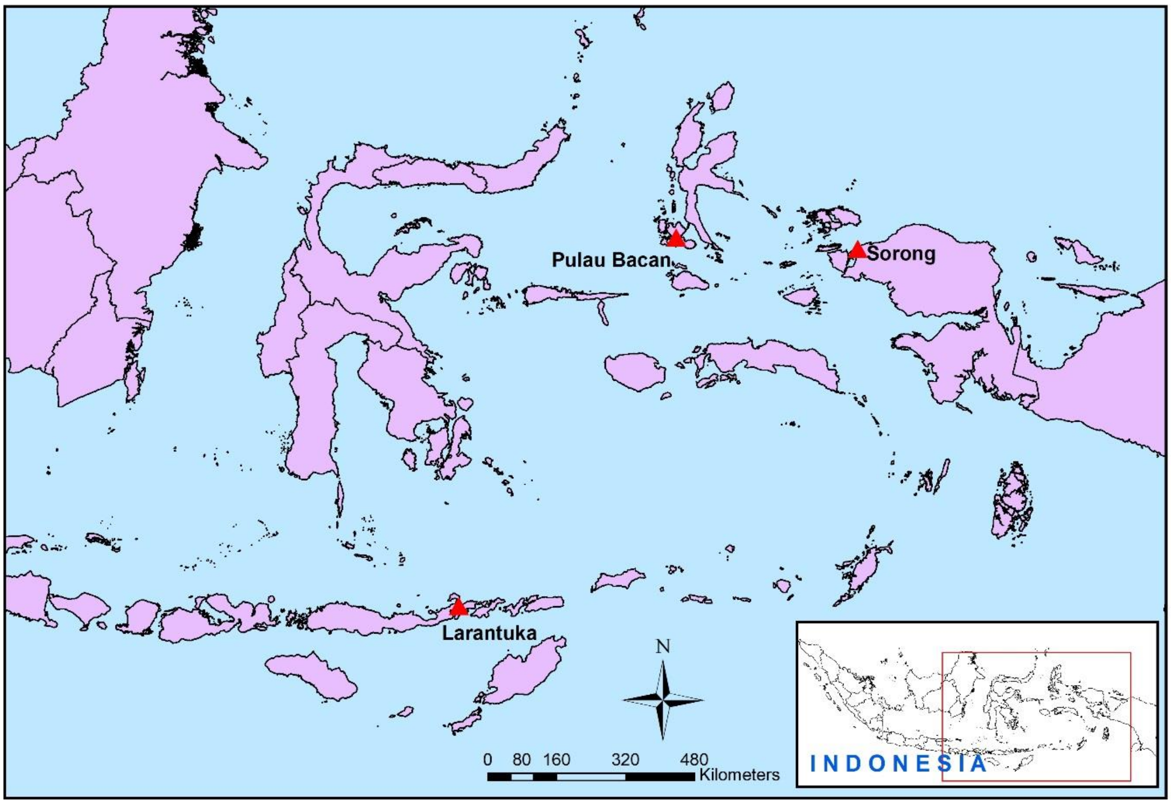

Figure 5.1. Research sites

5.2.2.2 Questionnaires

Two separate exercises of questioning stakeholders were carried out. First, 40 key informants (KIs) were interviewed face-to-face at length by the researcher to ascertain their perceptions of the market from the research sites based on prepared questionnaires consisting of both open-ended and closed questions, following the study of Gubrium and Koro-Ljungberg (2005). The 40 KIs interviewed were chosen for their expert knowledge and working experience of tuna pole-and-line fisheries at the research sites. Part of the KI questionnaire focused on the KIs' perceptions of their market supply lines and the traceability of their products. Initial contact was made with several potential KIs by way of interactions and introductions made by local tuna processing company staff, fishery office staff, landing site staff, fishers' group leaders, captains, community leaders, scientists, and policy makers from local and national levels, and their responses to the interviewer generated mainly qualitative data. Additionally, further contacts were made by using the 'snowball sampling' method, whereby participants suggested other possible participants (Gubrium and Koro-Ljungberg, 2005), or by visiting other stakeholders at the research sites in the manner suggested by Turner (2010). Second, 560 fishers were questioned in a field survey by the researcher with additional support from two local field assistants who received training related to the conduct and aims of the research (Lavides, 2009). This survey questionnaire (SQ) contained closed questions and generated quantitative data.

5.2.2.3 Observations of tuna pole-and-line market activities

Tuna pole-and-line landings activity beginning with fishers transferring fish to market and subsequently to the processing company was observed during the field survey at the three selected sites (Sorong, Pulau Bacan and Larantuka). The researcher joined typical fishing trips undertaken by the pole-and-line vessels from their fishing bases to the fishing ground and back, and observed the unloading of the catches. From the fishing base, the catches were transported to market and then to the tuna processing company and occasionally outside the fishing base. This entire market process was observed in order to better understand the flows of the catches.

5.2.3 Data analysis

The information obtained from the KI questionnaires on respondents' perceptions of the supply lines and market chains was collected, interpreted, and analysed descriptively. Descriptive analysis was used to obtain relevant information regarding the current conditions of the tuna pole-and-line supply lines and marketing system to describe the existing supply lines and market chain situations. From the SQ questions, the associations between types of stakeholders and their perceptions of the supply chains and the approaches to traceability were compared and differences were determined using Chi-square tests.

5.3 Results

5.3.1 Supply chains and traceability in the Indonesian small-scale tuna fisheries

The historical tuna supply chain originated with the fishers simply selling their catches to local consumers directly, but as time passed, this tradition changed into fishers selling to traders, who sold the fish on to processors and retailers, and then finally it reached consumers. The majority of the respondents from both the policy makers and public-sector workers (62.5%; n= 20) stated that they were aware of the overall tuna supply chain, although nine of the policy makers and public-sector workers (28.1%) said they were unaware, and three said they did not know (Figure 5.2). Taken as a whole, there was no significant difference in the stakeholders' perceptions of the tuna supply chain, between the policy makers and the public-sector workers (χ^2 = 2.133; p > 0.05). The fact that the tuna supply lines differ between the research sites was confirmed by a public-sector worker who stated: "*there are many types in terms of tuna supply lines, such as: (1) direct selling by the fishers into the local market; (2) fishers to the middle-man prior to the local market, and (3) fishers-private partnership on export market orientation"* (KI-03, 28 July 2015).

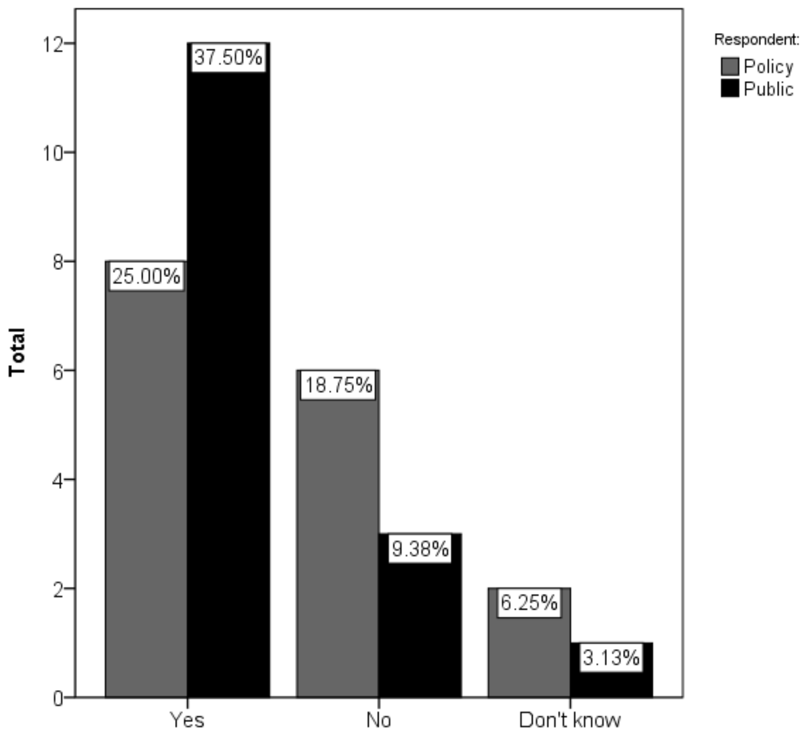

Figure 5.2. Respondents' responses to the research questions: "are you aware of the tuna supply lines?"

The traceability process in the supply of tuna pole-and-line products consists of several processes, according to one of the policy makers. One government officer stated that: *"the tuna traceability process in Indonesia generally follows these simple processes: (1) the tuna canning company's traceability system; (2) the catch origin certificate, which is issued by the fish landing manager; and (3) the fishing licence, which is issued by the government"* (KI-04, 15 September 2015). Another key informant, said that his company has its own traceability system: *"the processing company has its own barcode system that it employs in its canned operations, which enables the end buyers or consumers to trace back any product to its point of origin"*

(KI-05, 08 September 2015). Most of the KIs, both policy makers and public-sector workers (62.5%; n= 20), declared that they were aware of the tuna traceability process, although three (15.6%) said they were unaware, and nine (21.8%) said they did not know (Figure 5.3). There was no significant difference in respondents' perceptions of the tuna traceability process between the policy makers and public-sector workers ($\chi^2 = 2.8$; $p > 0.05$).

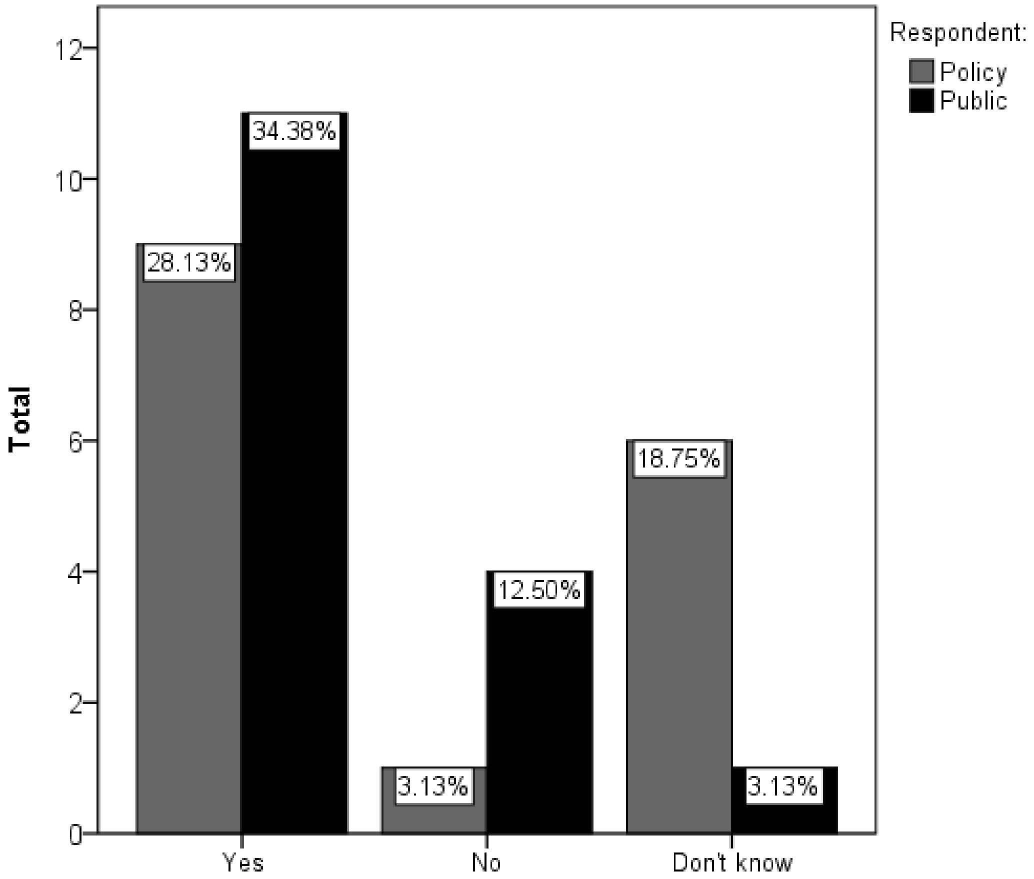

Figure 5.3. Respondents' responses to the research question: "are you aware of the tuna traceability process?"

5.3.2 Supply chains and traceability in Sorong, Pulau Bacan, and Larantuka

5.3.2.1 Sorong

All the fresh tuna catches from the Sorong fishing grounds are landed by the fishers at two locations. If the fishers are contracted by a canning company, the catches are landed at the canning company's port. Similarly, if the fishers obtain fishing operation logistical support from a frozen fish company, the tuna will be landed at that company's landing site. There is therefore no way for a fisher to enter the canned market if he is not contracted by a company. The tuna canning company in Sorong targets national and international markets, while the frozen fish companies predominantly supply whole frozen tuna to the export market and the national market, with a small amount being distributed locally in Sorong (Figure 5.4.).

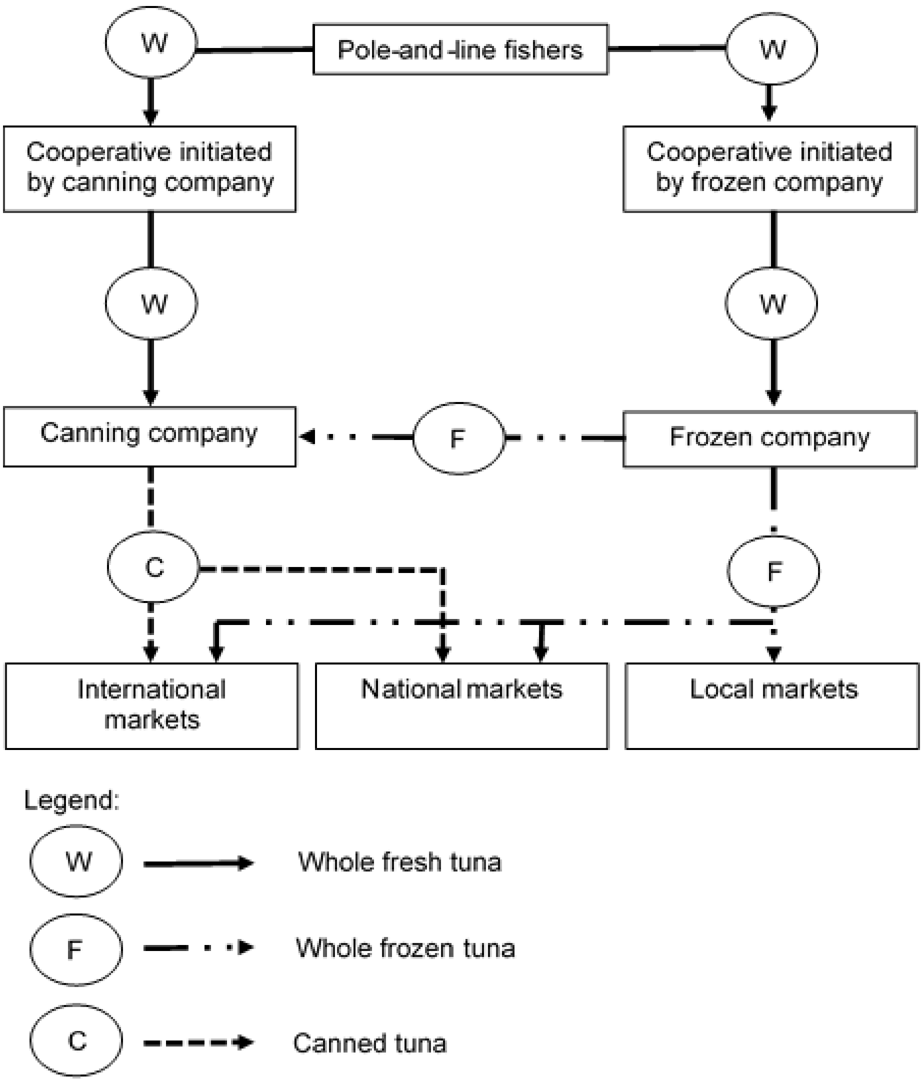

Figure 5.4. Pole-and-line tuna market distribution supply lines in Sorong. The arrows illustrate the market flow of the tuna

One of the employees at the frozen tuna company in Sorong, stated: *"our frozen tuna product is supplied to the local markets within this location and within the province ... sometimes it is distributed inter-island, while the export of our tuna is typically to the market in the US"* (KI-01, 06 August 2015). The supply lines both from the canning and frozen companies in Sorong (Fig. 5.4) show that the traceability system was an important element in their marketing strategy since they are oriented towards the export and national markets. The traceability system used by one of the processing companies in Sorong was confirmed by a tuna canning processing company employee in Surabaya who said: *"list of documents to confirm the tuna origin* *provided by our suppliers is one of the requirements that must be met"* (KI-05, 08 September 2015). However, unlike the other two sites, the tuna pole-and-line fishery in Sorong was pursuing Marine Stewardship Council (MSC) certification for its skipjack and yellowfin tuna.

5.3.2.2 Pulau Bacan

There was no processing company, either for canning or frozen operations, at the landing site in Pulau Bacan. The fishers were landing their catches at the government-operated landing port in Pulau Bacan where contracted and non-contracted middlemen (*known as dibo-dobo*) were waiting for the landings. The whole fresh tuna was then distributed to another location either within or outside Pulau Bacan by the middlemen, who were supplying the frozen and canning companies. The closest canning company is located in Bitung (North Sulawesi), whilst the closest frozen-fish company is in Ternate (North Maluku). From the canning and frozen companies, the tuna subsequently enters national and international markets (Figure 5.5). The tuna distribution market lines in Pulau Bacan have traditionally been dependent on middlemen because they manage the local market in Pulau Bacan, control the tuna prices, and provide financial support for fishing operations. A public sector worker stated that: "*the tuna supply line in Pulau Bacan starts from the fishers at the landing site, is transported to a middleman who is traditionally known as a dibo-dibo, and subsequently onto the local and inter-island markets"* (KI-09, 21 August 2015).

No traceability system was found in the supply lines in Pulau Bacan because the market was monopolised by traditional local middlemen rather than by national or international players.

5.3.2.3 Larantuka

During the field survey, there was only one processing company (*Katsuobushi*) and two frozen tuna companies operating in Larantuka. The *Katsuobushi* processing company was directly exporting to markets in Japan, whereas products such as frozen tuna were going to both national and international markets. The tuna pole-and-line fishers were also directly marketing their catches to the market in Larantuka (Figure 5.6). A staff member at the processing company in Larantuka confirmed that: "*our market orientations are for export and national markets with destinations predominantly in Japan, which is our international market and to a tuna canning* *company in Pasuruan, East Java, as the destination for our national market"* (KI-10, 24 August 2015).

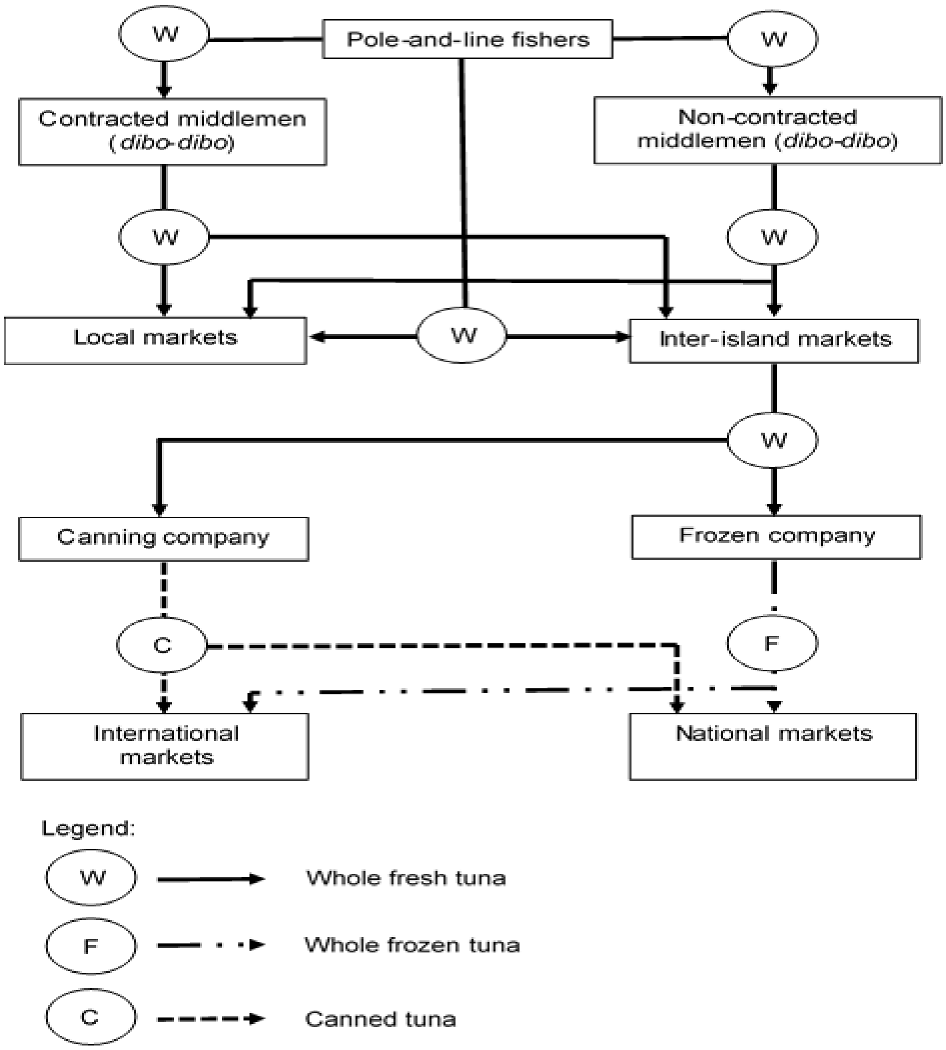

Figure 5.5. Pole-and-line tuna distribution supply lines in Pulau Bacan. The arrows reveal the market flow with regards to the tuna.

In Larantuka, tuna supply lines from both the processing and frozen companies showed that the traceability system was applied in their marketing strategy for both export and national markets. The traceability system found at Larantuka was confirmed by a tuna processing company worker who stated that: "*our product uses our own internal production code as the product traceability system"* (KI-11, 25 August 2015).

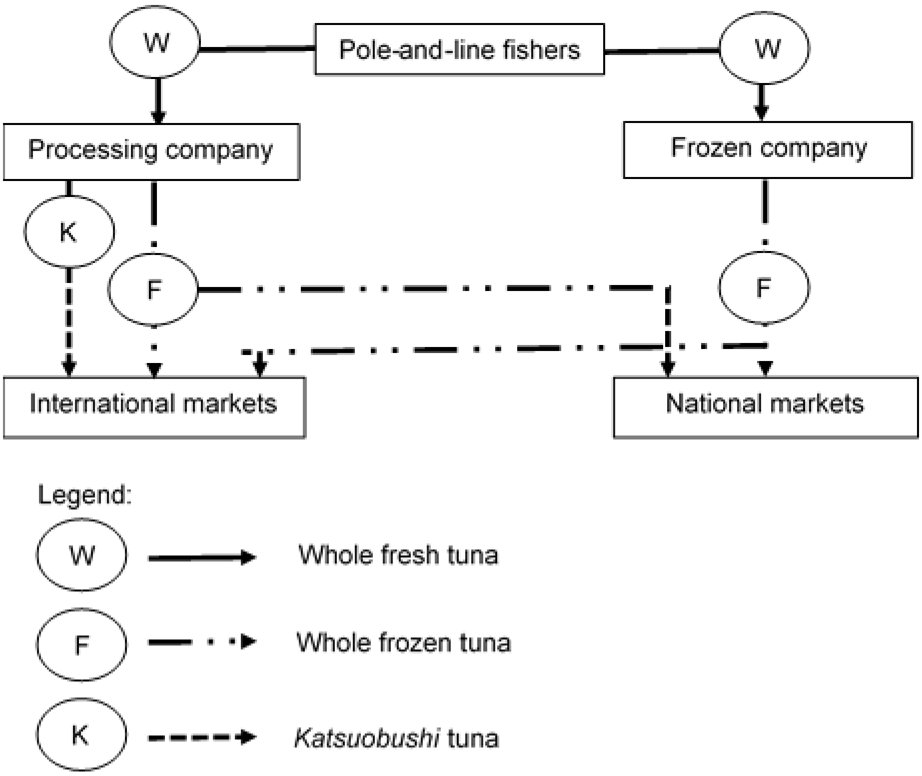

Figure 5.6. Pole-and-line tuna distribution supply lines in Larantuka. The arrows display the market flow with regards to the tuna.

5.4 Discussion

5.4.1 Restricted range of marketing choices faced by fishers

The traditional tuna supply activities can still be found in several places in developing countries, including Indonesia, where, as Alimina et al. (2015) notes, the small-scale tuna pole-and-line supply line in Southeast Sulawesi, eastern Indonesia consists mainly of fishers to middleman or to retailers and subsequently into some form of processing or cold storage, and also sold on to consumers locally. In all three study sites, the range of choice of marketing strategies is constrained by either or both contractual or traditional arrangements. In Sorong, the pole-and-line fishers are constrained by the fact that they must land their whole fresh tuna catches in the cooperative unit which is initiated by the processing companies. Data from Sorong fishery office showed that from 375 units of pole-and-line, 133 units were tied to processing companies in 2014 (Dinas Perikanan Kota Sorong, 2015). This is because the fishers receive both logistical and financial support for conducting their fishing operations from the companies with whom they are affiliated and contracted. The catches could not be landed elsewhere and this relationship is more like an employee-employer arrangement than a partnership arrangement. The fishers thus do not have the freedom to land their catches at other places, even though the prices could be higher, because of their commitment to the contracts that they have agreed.

The fishers affiliated and contracted with both the canning and frozen companies thus are highly dependent on their "bosses" and have no control over the market. Similarly, in Larantuka, the pole-and-line fishers have a limited choice between sending their fish directly to the local market or selling it to the tuna processing companies.

Traditional arrangements restrict marketing opportunities in Pulau Bacan also because non-contracted or contracted middlemen control the landing process, manage the local market, control tuna prices, and provide financial support for fishing operations. Effectively, the fishers are locked into a marketing system which is completely monopolised by middlemen. These marketing choices in Sorong and Larantuka are clearly contrary to the FAO's Blue Growth Initiative, which supports fair access to market by small-scale fisheries (FAO, 2016b). Furthermore a study undertaken by Watson et al. (2017) revealed that open market access between developed and developing countries may lead to poverty reduction, greater food security and strengthened small-scale fisheries resilience. For example, open market access for tuna products from Regional Fisheries Management Organisations (RFMOs) members such as Indonesia to markets in Europe, USA, Japan and other developed countries led to more fairness in setting tuna prices (Yongil et al., 2008, Huang and Leung, 2011, Fernández-Polanco, 2016).

5.4.2 Profits going mostly to processors rather than fishers

In all three sites, the profits from tuna fishing go mostly to processors and middlemen rather than to fishers. The fishers have very limited direct interface with retailers and are therefore price-takers rather than price-makers (Figs 5.4-5.6). For example, in Sorong the added value profit from the tuna is primarily enjoyed by the financiers (the processing companies, both canning and frozen) rather than by the tuna pole-and-line fishers. Both canning and frozen processing companies in Sorong export to international markets, mostly to the USA and the EU, which are high quality markets requiring strict standards to be met. Washington and Ababouch (2011) reported that since 1973 the food control authorities in the USA have imposed on imported tuna products the code of good manufacturing practices (GMP) and incorporated both hazard analysis and critical control point (HACCP) systems as a condition of entering their markets. An observer might think that these certification requirements would benefit local fishers by sharing in the high prices obtained for their high quality products (Adolf et al., 2016). But in fact, most of the added value goes to processors not local fishers; Stratoudakis et al. (2016) found that fisheries certification has potentially negative socio-economics consequences particularly for small-scale fishers.

Moreover, this situation is unlikely to change in the future. In mid-2017 one of the tuna processing companies in Sorong which is supplied by local pole-and-line fishers committed to apply for internationally recognised MSC certification for its fishing practice in eastern Indonesia (White, 2017). This certification process is one of the adaptation processes mentioned by Boyd and Folke (2012) to deal with the complexity and uncertainty of globalisation of fish markets, especially for small-scale fisheries such as tuna pole-and-line which are vital to food security, livelihoods and economic development of local communities (Longo et al., 2017). But while MSC accreditation might help to maintain demand for Sorong pole-and-line tuna fish and therefore safeguard jobs, it is unlikely to make the fishers richer, because most of the premium for MSC tuna will be absorbed by processors. In Pulau Bacan, most catches are taken by the "*dibo-dibo*" (traditional middlemen), who provide logistical support for fishing operations and thereby form an association with fishers with an implied obligation for fishers to hand over their catches. There are, however, some fishers who have direct access to local and inter-island markets if they receive no logistical support from a middleman, and this can increase their income because no middleman is involved in the supply line. This finding is consistent with research carried out on fishers' incomes in Kenya, Ghana, Namibia, Sri Lanka, Thailand, the Philippines, Nicaragua, Brazil, Chile, Senegal and Fiji by Bene (2006), which suggested that where the fishers were actively involved in the selling of export-orientated products, this tended to increase their income. However, this benefit could be eroded by government policies that seek to increase the cost of business activities (Barclay and Cartwright, 2007a).

It is true that in Larantuka, fishers can sell their fish direct to local markets, but local consumers cannot afford to pay high prices, since there is a strong correlation between tuna quality and price in local markets (Suhana et al., 2016). In this respect, the tuna pole-and-line supply lines and market chains in Larantuka are similar to those in Sorong. Tuna processing companies supplied by small-scale pole-and-line fishers can adopt international private sector certification and government certification schemes (Gulbrandsen, 2014). An example of the latter is in Greenland, where the implementation of Sustainable Small-scale Fisheries (SFF) Guidelines increased the bargaining power of small-scale fishers and large-scale buyers (Jentoft et al., 2017). Furthermore, many governments consider eco-labelling certification schemes as a helpful additional tool for fisheries management (Gulbrandsen, 2014).

5.4.3 Problems with traceability schemes

Traceability can be defined as being able to track a product through every stage of the overall production and handling process from fishing ground to plate (Popper, 2007). The traceability scheme of tuna pole-and-line in this study consists of two types: manual and electronic schemes. These findings are consistent with a study undertaken by Leal et al. (2015) which reported that tuna traceability may consist of manually or electronic recordings. In Sorong and Larantuka, the tuna processing companies use both manual and electronic schemes to track their tuna products as part of their product traceability. Other studies found that in Bitung, Indonesia, a manual traceability scheme has been adopted by tuna processing companies (Parenreng et al., 2016) and an electronic scheme for tuna pole-and-line (Seminar et al., 2016). Three lessons can be learned from these traceability schemes. The first lesson is that the active involvement of all stakeholders including fishers, processing companies, government, retailers and end-consumers is important to their success (Bush et al., 2017). The second lesson is that the traceability process must be robust and firmly secured all the way from the fishing grounds to the consumers (Seminar et al., 2016). Third, the basis of the traceability process is food safety (Leal et al., 2015).

There are however, many obstacles faced by tuna pole-and-line fisheries in eastern Indonesia in adopting the traceability schemes. Traceability implementation in the seafood market can be costly, and it requires coordination with all actors involved in the fisheries (Bailey et al., 2016). Traceability schemes also require valid and reliable data, which has been difficult to obtain in Indonesia due to lack of authorities' capabilities, and so uncertainty of data on tuna is commonplace in Indonesia (Yuniarta et al., 2017). As a result, the traceability systems that are in place for these pole-and-line tuna fisheries are variable in their reliability. Finally, even when reliable, traceability schemes invariably bring premium prices to processors rather than fishers. To deal with such problems, in 2017 a collaborative partnership between the US government and a non-governmental organisation (NGO) called the International Pole-and-Line Foundation (IPNLF) embarked on establishing a tuna pole-and-line traceability system throughout Indonesia with the purpose of gaining a niche advantage of sustainable fisheries management and supply chain procedures (IPNLF, 2017). This partnership promises to bypass the patron-client relationship and ensure that the financial benefits of certification and traceability accrue to fishers rather than to middlemen and processors.

5.5 Conclusion

This chapter has examined the market supply system in place for small-scale pole-and-line tuna fisheries in three sites in eastern Indonesia, and has found that the supply chains are tightly controlled by middlemen and processors who provide financial and other operational help to fishers to enable them to continue fishing, in return for which fishers are required to deliver their fish at prices set by the middlemen and/or processors. This means that apart from the few fishers who can fund their fishing without help from middlemen or processors, most fishers have little or no control over the terms on which they deliver their fish for sale. Three kinds of adaptability strategy potentially available to the small-scale pole-and-line tuna fisheries – direct selling to processors; eco-labelling certification; and traceability – were investigated, but all of them seemed to provide more benefit to other players in the supply chain (especially processors) than to fishers, though they may help to keep up demand for the fishery and thereby maintain the employment of pole-and-line fishers. However, the 2017 partnership between the US government and IPNLF to set up a country-wide traceability scheme for the pole-and-line tuna fishery in Indonesia may prove to be a game-changer in re-balancing the power ratio in the export market between fishers and middlemen/processors.

Chapter 6. Synthesis

6.1 Introduction

This final chapter has two objectives. First it draws the diverse parts of the thesis together by showing how the four preceding data chapters (2, 3, 4 and 5) form a coherent analysis of the issues set out in Chapter 1. In doing so, it demonstrates that what the four data chapters have in common is that they are all addressing the issue of the viability of the pole-and-line tuna fishery in eastern Indonesia. Second, the chapter considers how small-scale pole-and-line fisheries in eastern Indonesia could become more sustainable, focusing particularly on what further steps the government might consider taking in order to make its future more secure.

6.2 Aim of the research

Given its strategic location between two major tuna fishing grounds, the Pacific and the Indian Ocean, Indonesia has a unique opportunity to maintain its leading role as a tuna producer into the future (Sunoko and Huang, 2014, FAO, 2017). However, it faces three main challenges. First, tuna stocks are not inexhaustible, and there is evidence that some tuna species are declining in numbers, whether by over-fishing or climatic change or both (Fernandez-Polanco and Llorente, 2016, FAO, 2016b, Adhuri et al., 2016, Bush et al., 2017). This decline mirrors a global decline in marine fisheries resources: in 2017, over 32% of fish stocks were classified as being depleted or recovering (Sunoko and Huang, 2014, FAO, 2017). Second, foreign vessels (sometimes illegal, unreported and unregulated (IUU)) on the high seas often pursue tuna inside Indonesia's EEZ. This is despite the fact that during the past 20 years, steps have been taken to combat the IUU to control fishing capacity and to implement plans for conservation (FAO, 2016b). Third, consumers in developed countries are increasingly demanding that their tuna products are designated by international certification organisations as being sustainably produced. These three challenges affect different parts of the Indonesian tuna fishery in different ways. For example, the seine netters face all three challenges, but the long-liners and pole-and-line fishers face only the first two challenges, this is because the third challenge (eco-certification) is actually an opportunity for them to demonstrate their superior environmental credentials when compared to purse-seine. The demand for certified seafood is increasing and it will eventually become a requirement for operating in mass markets through the retail chains (Clarke et al., 2014, Benetti et al., 2016, Nichols et al., 2015, Bush et al., 2017). In this thesis, the research concentrates exclusively on the situation of the pole-and-line fishers because it is a small-scale, artisanal fishery which has a light environmental footprint; it causes no physical damage to the marine environment except associated with the use of fuel; it has virtually nil by-catch or discards; and it provides much-needed employment for local coastal populations. The main research questions are about the current and future viability of the pole-and-line fishery in eastern Indonesia, where it plays a crucial role in the well-being of local communities.

6.3 Contributions made by the data chapters to this aim

6.3.1 Effects of the moratorium (Chapter 2)

Every policy that is issued by a government has implications with both positive and negative effects. The general purposes of the measures that are issued by the government in the field of fisheries resources in Indonesia are aimed to protect the fisheries resources from any potentially ruinous activities such as IUU fishing practices and seek to maintain their sustainability for the next generations of fishers by avoiding over-fishing. Chapter 2 examined the moratorium on foreign fishing vessels that was issued by the Indonesian government in 2014-2015 and assesses its subsequent impact on tuna pole-and-line fishing in eastern Indonesia by comparing landings years before and 12 months during (2015) the moratorium and by studying the fishers' perceptions of the impact of the moratorium on their fishing activity. Comparison of the landings before and then during the moratorium period suggested that there were overall no detectable effects of the ban. However the fishers' perceptions told another story, in that they perceived that the moratorium had had a positive effect on their fishery because they were able to fish more freely. The apparent lack of any increased catches may have been due to poor record keeping, the usage of different gears, a reduction in the number of vessels at sea operating, the unavailability of local FADs, fluctuating seasonal weather conditions, or the time period of the moratorium being too short (it was in force for only 12 months) to have had an impact. It has been argued that the moratorium was not designed specifically to benefit the country's pole-and-line tuna fishery directly through increased catches but it was more of a political statement directed to the international community by signifying that Indonesia was strongly committed to the global fight against IUU fishing practices (Chapter 2). If the government had wanted to protect the indigenous pole-and-line fishery, perhaps it should have extended the moratorium for a further twelve months after which the impact on the pole-and-line fishery might have been more discernible. An example of a more extended fishing moratorium exists in the Pearl Estuary, in the southern Chinese province of Guangdong, China, of which Wang et al. (2015) reported that after 12 months of moratorium, catch rates increased by 30% while after 15 consecutive years of the moratorium in place, catch rates doubled. This study also found that the fishing moratorium improved fishers awareness of the important of environmental protection and restoration (Wang et al., 2015). Thus a moratorium may have some effect in the short-term, but a much greater effect over a longer period.

6.3.2 Long-term trends from tuna landings and efforts data (Chapter 3)

Understanding the long-term trends from tuna landings and effort data is crucial in order to provide a better picture, or assessment, of the overall condition of tuna stocks and of any changes taking place in them for the management of this resource (Kawamoto and Nakamae, 2017, Miyake et al., 2004, Arrizabalaga et al., 2012, Pet-Soede et al., 1999) and from this to establish an approach which will achieve an secure level of sustainability (FAO, 1997). Chapter 3 found that the landings trends varied at different locations but in general from 2012 onwards the trends are indicative of some decline. At first sight this appears to suggest over-fishing, but the study investigated the relationship between the landings and the amount of effort made by pole-and-line fishers to achieve these and found that there was no significant correlation between them. However, Pauly and Budimartono (2015) reported that the real trends in both landings and effort were estimated to be around 57% higher than those that were actually reported from the western, central and eastern regions of Indonesia from 1950–2010 due to both the estimated levels of illegal fishing and misreported components of the industrial fishery. Likewise, Yuniarta et al. (2017) suggested that the actual landings by active small to medium scale fishing vessels in eastern Indonesia were around 33–38% higher than those formally reported due to unintended reporting failures by fishers and imperfections in the data collection and management procedures by the local fishery authorities. Findings from this study revealed that lack of human resources and budgeting by the government at both local and national levels for data collection and analysis leads to poor data quality.

These findings also have been supported by the research that was conducted by the FAO which indicated that the tuna catches may have been misreported due to the lack of comprehensive landings data availability (Arrizabalaga et al., 2012). Stakeholders' perceptions about the purpose and value of fisheries data concluded that the published fisheries data by the government were inaccurate (Chapter 3). A possible explanation for this believed inaccuracy is that the data were not collected in accordance with established scientific principles and that some otherwise responsible agencies in eastern Indonesia do not appear to regard the statistics as being important and thus data collection recording and its integrity were not a priority for them. Also, the inaccuracy may be caused in part by inadequate budgeting and human resources for data collection being provided by the government. For more than two decades, international agencies, with help from the FAO, have tried to improve the reliability of the recording of catch data in Indonesia, especially for tuna and shark stocks, by data being cross-checked and complemented with reliable input from other sources (FAO, 2016b), but shortcomings evidently remain.

6.3.3 Oceanographic conditions and pole-and-line fishing methods (Chapter 4)

The relationships between pole-and-line fishing and local oceanographic conditions have been studied for many years in order to fully understand the yield potential of local fishing grounds for safely maximizing tuna fishing efficiency and effectiveness (Polovina et al., 2017, Abhisek and Shreyashi Santra, 2017, Trygonis et al., 2016, Pennington et al., 2006, Lehodey et al., 1997, Fiedler and Bernard, 1987). However, this thesis is one of only a few studies that have been undertaken in order to definitively set out the relationships between tuna pole-and-line CPUE and prevailing local oceanographic characteristics at the fish aggregation devices (FADs) in eastern Indonesia.

The findings suggested that a marine cold water upwelling event occurs from June to August, and is characterised with a higher level of chl-a and a relatively modest level of SST which results in decreases in landings and fishing effort for tuna pole-and-line operations in eastern Indonesia. These research findings are, however, the opposite of the results of a study in the Bone Bay (Flores Sea) area of eastern Indonesia by Zainuddin et al. (2013) which suggested that a high intensity of the upwelling corresponded to a high potential of skipjack tuna CPUE (Andrade and Garcia, 1999, Andrade, 2003, Andrade and Teixeira Santos, 2004). These research findings are probably related to the effects of the seabed topography features and the fact that upwelling events might be more convenient for smaller fish species in the ocean which are not a targeted prey for skipjack (Andrade and Garcia, 1999, Andrade, 2003, Andrade and Teixeira Santos, 2004). The analysis of CPUE, SST and chl-a data suggested that there were positive effects and such a relationship might be explained with the following rationale: (1) the biological life-cycle stages of skipjack tuna may have different relationships with SST and chl-a; (2) the weak correlation between CPUE and SST and chl-a may be due to abiotic and other biotic factors that affected these relationships, such as sea surface height, current speed and wind; (3) variations in live-bait abundance may have contributed to the weakening of the relationships, and (4) climate phenomena, such as La Niña and El Niña, may have also affected the relationships between tuna CPUE with SST and chl-a. These research findings on the relationships between CPUE, SST and chl-a appear to support other studies made elsewhere. For example, Xu et al. (2017) suggested that albacore tuna biotic factors such as food availability in the Northeast Pacific influenced CPUE, while Syamsuddin et al. (2013) found that skipjack CPUE fluctuation was affected by water productivity of which chl-a is a proxy.

6.3.4 Marketing (Chapter 5)

The fourth data chapter studied the supply chains of three tuna pole-and-line fisheries in order to assess whether their marketing strategies were fit for purpose. Most of the information for this chapter was obtained from the stakeholders' perceptions of the formation of their local market supply lines and of the tuna traceability within their fisheries. From the questionnaires it was found that the tuna pole-and-line market supply lines consist of either (1) direct selling by the fishers to their local markets; (2) fishers selling to middlemen; or (3) fishers' partnerships with the private sector (which are mostly for export and/or larger national markets). The traceability systems employed at the three sites were generally found to consist of either internal company traceability systems, typically with a barcode system, or the use of government documents such as fishing licences and catch origin documents in order to enable the end buyers or consumers to trace almost back to the product's origin. In two of the three sites, fishers were locked into a system of selling to their local markets or to middlemen, neither of which required rigorous traceability, but nor did they provide high prices to the fisher's benefit. Only Sorong seemed to demonstrate the initiative to access export markets by partnering with international private companies and preparing for the marine stewardship council (MSC) certification. Such a strategy is probably essential if the pole-and-line tuna fishery in eastern Indonesia is to achieve its full potential as a niche producer in the world tuna market. The specific market orientation needed for exporting from a developing country to a developed country is to export the high valued seafood to the developed country and retain relatively low-value seafood for local consumption (Watson et al., 2017, Gillett et al., 2001).

6.4 Fisheries management

At the end of 2014, MMAF initiated a national plan of action for the development of tuna management for the whole of Indonesia (MMAF, 2014). This management plan was aimed to enable tuna management policies to achieve the following objectives (MMAF, 2014): to ensure the sustainable use of tuna resources; to increase the competitiveness of Indonesian products in the global tuna market; and to ensure a sufficient supply of fish to domestic tuna processing industries. This plan is dependent on accurate and reliable data collection systems being put in place. This thesis has examined the relationship between fisheries data collection and the sustainability of the pole-and-line tuna fishery. As stated by the FAO, fisheries management is an *'integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives*" (Cochrane and Garcia, 2009). The results of the thesis support this statement that the data in landings in crucial to the fisheries management process. However, the weaknesses of the fisheries data collection system currently operating in the Indonesian pole-and-line tuna fishery threaten to undermine the national plan of action to promote tuna sustainability. Moreover, these weaknesses indicate that Indonesia is failing to fulfil its obligations under UN rules to obtain reliable and accurate data to be used in identifying the status of fish stocks within its EEZ (FAO, 1995, Agnew et al., 2013)

There are several reasons for the inadequacies of the tuna data collection system in Indonesia. First, there is a lack of government resources to fund the large number of enumerators required to check landings at the hundreds of different landing sites. Second, fishers and processing companies are reluctant to provide accurate landings data because they risk incurring additional taxes: in other words, there is a financial incentive for them to underestimate the quantity of landings in order to avoid heavier taxes. Third, mistakes in species identification were common at landing sites, undermining the reliability of the statistics that were compiled (Sims and Simpson, 2015). Fourth, these identification errors were compounded at the data processing stage wherer there were further errors (Yuniarta et al., 2017). Fifth, the patron-client relationship inhibits data collection. On this last point, there is a close relationship between patrons and clients in the pole-and-line fishery in Indonesia based on a system of mutual benefit. Most patron-client relationships in Indonesian fisheries are driven by profit opportunities, formalised though contractual engagements (Satria and Li, 2017). This research confirms that the processing company provides logistical support, including fuel, live-baits, foodstuffs and even personal loans for fishers in need. This makes the relationship between the client and patron one-sided: fishers have a greater dependence on companies than vice-versa. In some respects, this dependence has benign consequences – for example, some patrons put pressure on fishers to use environmentally-friendly gears (Ferrol-Schulte et al., 2013, Ferrol-Schulte et al., 2015). However, in other respects, the dependence has malign consequences – for example, some patrons put pressure on fishers to withhold some catch landings from their reports. Co-management arrangements were recommended by Ferse et al. (2012) to rebalance the relationship between patron and client, in order to eliminate this obstacle to accurate data reporting.

In an attempt to overcome these data collection obstacles, in 2015 Indonesia launched a programme called “the before fishing, while fishing, during landing and post landing program”, which was designed to control and monitor tuna fishing activities as well as improve the data collection system (MMAF, 2015a). But there is little evidence that this programme has produced more accurate tuna landing figures. There is a need for greater government commitment at both national and district levels to make fishers and companies more aware of the importance of providing reliable landings data in the future (Allen, 2010). Also, the government must provide more resources at the landing site level to facilitate the collection of landings data, and at the national level to ensure that the collected data is adequately processed.

6.5 Conclusion

The tuna pole-and-line fishery in eastern Indonesia faces significant challenges including potentially diminishing tuna stocks, unregulated fishing practices, increasing competition from industrial vessels, and restricted marketing options. In meeting these challenges, the fishery needs the support of the government in combatting IUU fishing and in protecting quotas from being monopolised by the industrial sector. But the fishery also needs to help itself by more strenuous efforts in order to establish a niche market internationally for its uniquely environmentally-friendly and high quality product. These issues are part of a wider debate about the sustainability of small-scale fisheries (SSF) which focuses on the arguments for and against fisheries modernisation. The argument in favour of modernization is that large-scale fishing (LSF) or industrial fishing as more efficient than SSF because it takes advantage of the economies of scale (Gordon, 1991). Three assumptions lie behind this argument. First, is TH Huxley's assertion in the 19th century that the sea provided an unlimited supply of fish, and no matter how much fishing took place, fisheries resources would never be exhausted. Second, vast resources of fish existed in the high seas beyond the reach of SSF vessels (Bailey, 1988). Third, artisanal fisheries were backward, in urgent need of modernization.

> ”Modernisation has been seen as the key to developing small-scale fisheries into engines of rural and even national economic growth.The typical technological fisheries modernisation narrative was that many developing countries were rich in fish stocks but were unable to utilise them because the local fishers were stuck in underdeveloped traditions and the recently independent states neither had the technology nor the funds to promote industrial fisheries. Therefore, the fishers remained poor and the potential of the fisheries to stimulate national industrialisation was underutilised. As a solution, Western countries should transfer modern technology, capital and knowledge to 'force the pace of development in fisheries'” (Overa, 2011).

The argument against modernisation is that artisanal fishers have an important part to play in the contemporary fishing sector. There are five strands in this argument. First, evidence of global, regional, and local over-fishing by LSFs began to emerge in the 1970s (Johnson, 2001). Second, during the 1980s and 1990s, the tide turned away from the idea of inexhaustible natural resources, and the 'limits of growth' hypothesis debate began to take root, manifesting itself in the Brundtland Report of 1987 which inspired the Rio Earth Summit in 1990 to enunciate the seminal concept of sustainable development. Although the emphasis at this time was on terrestrial resources, the focus soon embraced marine resources (Bailey, 1988, McGoodwin, 1990). The industrial model of maximising economic yield (MEY) was being challenged by the environmental model of maximum sustainable yield (MSY), and the role artisanal fishers play in providing employment and food security to coastal communities with a light marine footprint was increasingly being recognised (Cycon, 1986). Third, some economists argued that SSF was more efficient than LSF. For example, (Bailey, 1988) rejected the claim that LSFs are more efficient than SSFs. LSFs require huge amounts of capital investment; they are heavy consumers of oil; they emit considerable volumes of CO^2; and they depend on “subsidised credit, subsidised fuel, and preferential taxes’. According to (Bailey, 1988), the growth of large-scale fishing has more to do with institutional mind-sets and class interests than with economies of scale. Fourth, artisanal fisheries provide a livelihood and way of life for millions of people. They are important to maintain for food security, to benefit local communities, and to sustain cultural identity. “Small-scale fisheries, as opposed to industrial fisheries, in term of fishing capacity contribute about one half to two thirds of the global food-fish catch (the harvest used to feed people directly rather than as feed for other animals), and employ about 80-90% of the world’s fishermen and fish workers” (FAO, 2016a). Fifth, according to Bailey and Jentoft (1990), the development of large-scale fisheries inevitably means fewer jobs: “there is a trade-off between letting some fishermen adopt more powerful technologies and letting more people become fishermen”

Overa (2011) claims that a backlash against the modernization discourse is now taking place in the literature: “A growing body of literature contests the received wisdom by empirically documenting the importance of small-scale fisheries for welfare in poor countries. This literature shows that because of their technological simplicity, facilitating easy entry, small-scale fisheries can be of great importance as safety valves...for poor people who experience economic, political or environmental shocks and as labour buffers in periods of unemployment. These functions play a vital role in ensuring food security and poverty alleviation”. As Cycon (1986) remarks, this is not to say that all fisheries should be artisanal, but that LSFs should not wipe out SSFs.

Applying this argument to the pole-an-line fishery in Indonesia leads us to the conclusion that the government should take steps to protect this valuable SSF from the existential threat to its future posed by industrial tuna fishing, especially by IUU vessels.

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Appendix - Interview Schedule

Appendix 1. Tuna fisher's questionnaire

A. GENERAL INFORMATION

A.1 Date/*tanggal* : ____________________ 2015

A.2 Interviewee/*nama* : ____

A.3 Age/*usia* : __________ Years/*tahun*

A.4 Location/*lokasi* : ____

A.5 Experience as fishers/*pengalaman nelayan* : ___________ Years/*tahun*

A.6 Boat ownership/*kepemilikan kapal* : ☐ Own/*milik sendiri* ☐ Rent/*sewa*

A.7 Fisher status/ *status nelayan* : ☐ Captain/fishing master/ *Kaptain/tekong* ☐ Crew/ *ABK*

B. FISHING BOAT

B.1 Boat name/*nama kapal* : ____

B.2 Boat engine power/*kekuatan mesin* : __________ HP/PK

B.3 Boat capacity (total)/*kapasitas kapal* : __________ GT

B.4 Total number of crew/ *jumlah ABK* : _____________ Person (s)/ *orang*

C. FISHING GEAR

C.1 Type of fishing gear/ *jenis alat tangkap* : ☐ Pole-and-line *Go to C2* ☐ Handline ☐ Longline ☐ Purse seine *Go to C4*

C.2 Number of hook (s)/ *jumlah mata pancing* : __________ Unit (s)

C.3 Hook (s) size/*nomor pancing* : __________

C.4 Mesh-size/*ukuran mata jaring* : __________ mm/inch

C.5 Net depth/ *dalam jaring* : __________ m

C.6 Net length/ *panjang jaring* : __________ m

C.7 Any fish aggregating devices (FAD)/ *rumpon?* : ☐ Yes ☐ No

C.8 If yes, type of FAD/ Jika iya, tipe rumpon : ☐ Fixed/*tetap* ☐ Mobile/ *berpindah*

C.9 How many FAD (s)/ banyaknya rumpon? : ____________ Unit (s)

C.10 Is there any licence for your fishing gear/ *apakah ada izin menggunakan alat tangkap?* :

☐ Yes/ada ☐ No/tidak

C.11 Is there any licence for your FAD/ *apakah ada izin menggunakan rumpon?* : ☐ Yes/ada ☐ No/tidak

D. FISHING GROUND

D.1 Main fishing ground location/ *lokasi penangkapan utama* : ____________________

[show map/*lihat peta*]

	Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season/ *musim paceklik*	Transition season II/ *musim peralihan II*
D.2 Fishing ground location/ *lokasi penangkapan* :	________	________	________	________
D.3 Duration of sailing to fishing ground/ *lama perjalanan* :	Hour(s)/*jam* ________	Hour(s)/*jam* ________	Hour(s)/*jam* ________	Hour(s)/*jam* ________
D.4 Fuel needed for one trip operation/ *BBM yang dibutuhkan satu trip* :	Litre(s)/*liter* ________	Litre(s)/*liter* ________	Litre(s)/*liter* ________	Litre(s)/*liter* ________
D.5 Days per trip/ *jumlah hari per trip* :	Day(s)/*hari* ________	Day(s)/*hari* ________	Day(s)/*hari* ________	Day(s)/*hari* ________
D.6 How far is the nearest land? *Berapa jauh dari daratan?* :	NM ________	NM ________	NM ________	NM ________

D.7 Is any licence required to enter the fishing ground/ *apakah ada izin memasuki dearah penangkapan?*

☐ Yes/ ada ☐ No/tidak

D.8 If yes, who issued the licence/ j*ika ada, siapa yang keluarkan izin?* :

____

____

E CATCHES

E.1 Which tuna species do you target / *hasil tangkapan tuna utama?* :

____

____

____

____

	Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season / *musim paceklk*	Transition season II/ *musim peralihan II*
E.2 Average tuna catch per trip/ *rata-rata hasil tangkapan per trip:*	________ Kg	________ Kg	________ Kg	________ Kg

E.3 Are you going fishing with bait/*apakah anda menggunakan umpan?* :

☐ Yes/*ya* ☐ No/*tidak*

E.4 If yes, is that live-bait /*jika ya, apakah umpan hidup?* : ☐ Yes/*ya* ☐ No/*tidak*

E.5 What is the main live-bait species/jenis ikan umpan utama yang digunakan? :

	Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season / *musim paceklk*	Transition season II/ *musim peralihan II*
E.6 Live-bait source location/*lokasi sumber umpan:*	______	______	______	______
E.7 Average live-bait needed per trip/ *rata-rata kebutuhan umpan per trip:*	______ Kg	______ Kg	______ Kg	______ Kg

E.8 List your by-catch species/ *ikan sampingan* : ______

	Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season/ *musim paceklik*	Transition season II/ *musim peralihan II*
E.9 Average by-catch collected per trip/ rata-rata *jumlah ikan sampingan per trip:*	______ Kg	______ Kg	______ Kg	______ Kg

E.10 By-catch handling for each species/ *penanganan hasil sampingan setiap spesies* :

☐ Discard at sea/ *Buang ke laut* ______

☐ Sell it at the port/*jual di pelabuhan* ______

☐ Other, specify/ *lainnya, sebutkan*
a ______
b ______

E.11 In comparison with the last 5 years, has your fishing effort changed/ dibandingkan lima tahun belakangan, apakah anda mengalami perubahan penangkapan? :

☐ Yes/ya ☐ No/tidak

E.12 To what extent / dalam hal apa perubahannya? :

☐ Increased a lot/ *meningkat banyak*

☐ Increased a bit/ *meningkat sedikit*

☐ Stayed the same/ *masih sama*

☐ Decreased a lot/ *Menurun banyak*

☐ Decreased a bit/ *menurun sedikit*

☐ Don't know/ *tidak tahu*

E.13 In what way/dalam hal bagaimana perubahannya? :

☐ More / less gear / *peningkatan atau penurunan jumlah alat tangkap*

☐ More or less days at sea/ *peningkatan atau penurunan jumlah hari menangkap*

☐ Larger / smaller vessel/ *ukuran kapal lebih besar atau lebih kecil kapal*

☐ Other, specify/ lainnya, sebutkan:

____

____

E.14 Has the size of fish caught changed in comparison to the last 5 years years/ *apakah ada perubahan ukuran ikan yang tertangkap dalam 5 tahun belakangan ini?:*

☐ Increased a lot/ meningkat banyak ☐ Increased a bit/ meningkat sedikit ☐ Stayed the same/ masih sama

☐ Decreased a lot/ Menurun banyak ☐ Decreased a bit/ menurun sedikit ☐ Don't know/ tidak tahu

E.1 If changed, , why*/ jika berbeda, kenapa*?:

____

____

F. FISHERIES DATA

F.1 Is there any record of production data/ *apakah ada catatan hasill tangkapan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.2 If yes, who keeps the record / *jika ada, siapa yang pegang*? : ☐ Myself/*sendiri*

☐ Company/ *perusahaan* ☐ Cooperative/ *koperasi* ☐ Other, specify/ lainnya, sebutkan

____

____

F.3 What kind of data is collected/*data apa saja yang dikumpulkan?* :

____

____

F.4 Is there any obligation to report your catches*/ apakah ada kewajiban untuk melaporkan hasil tangkapan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.5 If yes, is the data regularly reported/ jika ya, *apakah datanya dilaporkan rutin*? :

☐ Yes/ ya ☐ No/ tidak

F.6 To whom do you report / *kepada siapa dilaporkan?* : ☐ Government officer/ *petugas*

☐ Company/ *perusahaan* ☐ Cooperative/ koperasi ☐ Other, specify/ lainnya, sebutkan

____

____

G FISHERIES MANAGEMENT

G.1 Is there any management regulation of the fisheries/ *apakah ada aturan pengelolaan dalam menangkap ikan* :

☐ Yes/*ya* ☐ No/*tidak*

G.2 If yes, what do the management regulations cover/ *jika iya, dalam bentuk apa pengelolaan penangkapannya?*

☐ Allowable catch/ *izin menangkap* ☐ Landing size/ *ukuran tangkap*

☐ Allowable gear/ *alat tangkap yg diperbolehkan* ☐ Closed area/ *penutupan lokasi tangkap*

☐ Closed season/ *penutupan musim tangkap* ☐ Other, specify/ *lainnya, sebutkan*

____

G.3 Is there any fishers' associations that you are involved with/ *apakah anda bergabung dalam organisasi nelayan?* :

☐ Yes/*ya* ☐ No/*tidak*

G.4 If yes, what is the form or name of your organisation/ *jika iya, sebutkan bentuk atau nama organisasinya?* :

☐ Cooperative/ *koperasi* ☐ Association / *asosiasi* ☐ Company/ *perusahaan*

☐ Local fishers group/ *kelompok nelayan* ☐ Other, specify/ *lainnya, sebutkan*

G.5 Do you think the fisheries resources need to be managed?/ *apakah menurut anda sumberdaya ikan perlu di kelola* :

☐ Yes/*ya* ☐ No/*tidak*

G.6 If yes, why/ jika *iya, kenapa harus dikelola?* :

☐ To control the number and size of fishing boats *untuk keberlanjutan penangkapan*

☐ To limit catches/ *pembatasan penangkapan*

☐ To restrict fishing gear / *meningkatakan hasil tangkapan*

☐ Other, specify*/ lainnya, sebutkan:*

G.7 Who should manage the fish resources/ *siapa yang harus mengelola sumberdaya ikan?* :

☐ Government/ *pemerintah* ☐ Company/ *pengusaha* ☐ local community/ *masyarakat sekitar*

☐ Fishers themselves, individually, or collectively/ *nelayan sendiri* ☐ Other, specify*/ lainnya, sebutkan*

H. OTHERS

H.1 Are there any issues you would like to add/ *apakah ada permasalahan dan saran yang ingin anda berikan?* :

☐ Yes/*ya* ☐ No/*tidak*

H.2 If yes, please state them here/ *Jika iya. sebutkan* :

Thank you for sharing your views with me: I really appreciate your contribution to my project/ *terima kasih banyak atas masukan yang anda berikan; saya sangat menghargai kontribusi anda dalam kegiatan ini.*

/ /2015

(signature and name of interviewee/ *Ttd dan Nama Yang Mengisi*)

Appendix 2. Live-bait fisher's questionnaire

A. GENERAL INFORMATION

A.1 Date/*tanggal* : ____________ 2015

A.2 Interviewee/*nama* : ____________

A.3 Age/*usia* : ________ Years/*tahun*

A.4 Location/*lokasi* : ____________

A.5 Experience as fishers/*pengalaman nelayan* : ________ Years/*tahun*

A.6 Boat ownership/*kepemilikan kapal* : ☐ Own/*milik sendiri* ☐ Rent/*sewa*

A.7 Fishers status/ *status nelayan* : ☐ Captain/fishing master/ *captain/tekong* ☐ Crew/ *ABK*

B. FISHING BOAT

B.1 Boat name/*nama kapal* : ____________

B.2 Boat engine power/*kekuatan mesin* : ________ HP/PK

B.3 Boat capacity (total)/*kapasitas kapal* : ________ GT

B.4 Total number of crew/ *jumlah ABK* : ________ Person (s)/ *orang*

C. FISHING GEAR

C.1 Type of fishing gear/ *jenis alat tangkap* : ☐ Floating liftnet/ bagan apung

☐ Fixed liftnet/ bagan tancap ☐ Boat liftnet/ bagan perahu

C.2 Mesh size/ *ukuran mata jaring* : ________ Inch/mm

C.3 Total depth/*dalamnya jaring* : ________ m

C.4 Total length/*panjang jaring* : ________ m

C.5 Are you using light fishing/ apakah anda menggunakan lampu untuk menarik ikan? :

☐ Yes/ *ya* ☐ No/ *tidak*

C.6 Is there any licence for your fishing gear/ *apakah ada izin menggunakan alat tangkap?* :

☐ Yes/ada ☐ No/tidak

D. FISHING GROUND

D.1 Main fishing ground location/ *lokasi penangkapan utama* : ____________
[show map/*lihat peta*]

		Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season/ *musim paceklik*	Transition season II/ *musim peralihan II*
D.2	Seasonal fishing ground location/ *lokasi penangkapan* :	________	________	________	________
D.3	Duration of sailing to fishing ground/ *lama perjalanan* :	Hour(s)/*jam* ________	Hour(s)/*jam* ________	Hour(s)/*jam* ________	Hour(s)/*jam* ________
D.4	Fuel needed for one trip :	________	________	________	________

	operation/ *BBM yang dibutuhkan satu trip*	Litre(s)/*liter*	Litre(s)/*liter*	Litre(s)/*liter*	Litre(s)/*liter*
D.5	Days per trip/ *jumlah hari per trip* :	Day(s)/*hari*	Day(s)/*hari*	Day(s)/*hari*	Day(s)/*hari*
D.6	How far is the nearest land? *Berapa jauh dari daratan?* :	NM	NM	NM	NM

D.7 Is any licence needed to enter fishing ground/ *apakah ada izin memasuki dearah penangkapan?* :

☐ Yes/ ada ☐ No/tidak

D.8 If yes, who issued the licence/ j*ika ada, siapa yang keluarkan izin?* :

____

____

E CATCHES

E.1 Targeted species / *Ikan tangkapan utama* :

____

____

____

____

		Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season/ *musim paceklik*	Transition season II/ *musim peralihan II*
E.2	Average production per trip/ *rata-rata hasil tangkapan per trip* :	Kg	Kg	Kg	Kg

E.4 By-catch species/ *ikan sampingan* :

____

____

____

		Peak season/*musim tangkap*	Transition season I/ *musim peralihan I*	Low season/ *musim paceklik*	Transition season II/ *musim peralihan II*
E.5	Average by-catch collected per trip/ rata-rata *jumlah ikan sampingan per trip* :	Kg	Kg	Kg	Kg

E.6 By-catch handling for each species/ *penanganan hasil sampingan per spesies* :

☐ Discard at sea/ *Buang ke laut* :	☐ Sell it at the port/*jual di pelabuhan* :	☐ Other, specify/ *lainnya, sebutkan* :
______	______	a ______
______	______	______
______	______	______
		______
		b ______
		______
		______
		______

E.7 In comparison with the last 5 years, has your fishing effort changed/ dibandingkan lima tahun :

belakangan, apakah anda mengalami perubahan penangkapan?

☐ Yes/ya ☐ No/tidak

E.8 If yes, to what extent / *dalam hal apa perubahannya?* : ☐ Increased a lot/ *meningkat banyak*

☐ Increased a bit/ *meningkat sedikit* ☐ Stayed the same/ masih sama ☐ Don't know/ tidak tahu

☐ Decreased a lot/ Menurun banyak ☐ Decreased a bit/ menurut sedikit

E.9 In what way has it changed /dalam hal bagaimana perubahannya? :

☐ More / less gear / peningkatan atau penurunan jumlah alat tangkap

☐ More or less days at sea/ peningkatan atau penurunan jumlah hari menangkap

☐ Larger / smaller vessel/ ukuran kapal lebih besar atau lebih kecil

☐ Other, specify/ lainnya, sebutkan:

____

____

____

E.10 Has the size of fish caught changed in comparison to the last 5 years / *apakah ada perubahan ukuran ikan yang tertangkap dalam 5 tahun belakangan ini?* :

☐ Increased a lot/ *meningkat banyak* ☐ Increased a bit/ meningkat sedikit ☐ Stayed the same/ masih sama

☐ Decreased a lot/ Menurun banyak ☐ Decreased a bit/ menurun sedikit ☐ Don't know/ tidak tahu

E.13 If different, why/ *jika berbeda, kenapa*? :

____

____

____

F. FISHERIES DATA

F.1 Is there any record of production data/ *apakah ada catatan hasill tangkapan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.2 If yes, who keeps it/ *jika ada, siapa yang pegang*? : ☐ Myself/*sendiri*

☐ Company/ *perusahaan* ☐ Cooperative/ *koperasi* ☐ Other, specify/ lainnya, sebutkan

____

____

____

F.3 What kind of data is collected/*data apa saja yang dikumpulkan?* :

____

____

____

F.4 Is there any obligation to report your catches/ *apakah ada kewajiban untuk melaporkan hasil tangkapan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.5 If yes, is the data regularly reported/ jika ya, *apakah datanya dilaporkan rutin*? :

☐ Yes/ ya ☐ No/ tidak

F.6 To whom do you report / *kepada siapa dilaporkan?* : ☐ Government officer/ *petugas*

☐ Company/ *perusahan* ☐ Cooperative/ koperasi ☐ Other, specify/ lainnya, sebutkan

____
____

G FISHERIES MANAGEMENT

G.1 Is there any management regulation of the fisheries/ *apakah ada aturan pengelolaan dalam menangkap ikan* :

☐ Yes/*ya* ☐ No/*tidak*

G.2 If yes, what do the management regulations cover/ *jika iya, dalam bentuk apa pengelolaan penangkapannya?*

☐ Allowable catch/ *izin menangkap* ☐ Landing size/ *ukuran tangkap*

☐ Allowable gear/ *alat tangkap yg diperbolehkan* ☐ Closed area/ *penutupan lokasi tangkap*

☐ Closed season/ *penutupan musim tangkap* ☐ Other, specify/ *lainnya, sebutkan*

____
____
____

G.3 Is there any fishers' associations that you are involved with/ *apakah anda bergabung dalam organisasi nelayan?* :

☐ Yes/*ya* ☐ No/*tidak*

G.4 If yes, what is the form or name of your organisation/ *jika iya, sebutkan bentuk atau nama organisasinya?* :

☐ Cooperative/ *koperasi* ☐ Association / *asosiasi* ☐ Company/ *perusahaan*

____________________ ____________________ ____________________
____________________ ____________________ ____________________

☐ Local fishers group/ *kelompok nelayan* ☐ Other, specify/ *lainnya, sebutkan*

____________________ ____________________
____________________ ____________________

G.5 Do you think the fisheries resources need to be managed?/ *apakah menurut anda sumberdaya ikan perlu di kelola* :

☐ Yes/*ya* ☐ No/*tidak*

G.6 If yes, why/ jika *iya, kenapa harus dikelola?* :

☐ Fishing gear needs to be restricted / *untuk keberlanjutan penangkapan*

☐ Catches need to be limited/ *pembatasan penangkapan*

☐ Boats need to be reduced in size and number/ *meningkatakan hasil tangkapan*

☐ Other, specify*/ lainnya, sebutkan:*

____
____
____

G.7 Who should manage the fish resources/ *siapa yang harus mengelola sumberdaya ikan?* :

☐ Government/ *pemerintah* ☐ Company/ *pengusaha* ☐ local community/ *masyarakat sekitar*

☐ Fishers themselves, individually/ *nelayan sendiri* ☐ Other, specify*/ lainnya, sebutkan*

____
____
____

H. OTHERS

H.1 Are there any issues you would like to add/ *apakah ada permasalahan dan saran yang ingin anda berikan?* :

☐ Yes/*ya* ☐ No/*tidak*

H.2 If yes, please state them here/ *Jika iya. sebutkan* :

____
____
____
____
____
____

Thank you for sharing your views with me: I really appreciate your contribution to my project/ *terima kasih banyak atas masukan yang anda berikan; saya sangat menghargai kontribusi anda dalam kegiatan ini.*

____________________________, / /2015

(signature and name of interviewee/ *Ttd dan Nama Yang Mengisi*)

Appendix 3. Private sector's questionnaire

A. GENERAL INFORMATION

A.1 Date/*tanggal* : ________________ 2015

A.2 Interviewee/*nama* : ____________________________________

A.3 Age/*usia* : ________________ Years/*tahun*

A.4 Business name/ *nama perusahan* : ____________________________________

A.5 Business address/ alamat perusahaan : ____________________________________
____

A.6 Year of first production/ *pertama kali mulai berproduksi tahun* : ____________

A.7 Type of Business/ *jenis usaha* : ☐ Tuna canning processing/ *pengolahan tuna kaleng*

☐ Tuna capture, frozen *processing and marketing* ☐ Tuna trading/ *perdagangan tuna*

☐ Other, specify/ *lainnya, sebutkan*
____
____
____

A.9 Your position at this business : ☐ CEO/ *direktur utama* ☐ Commissioner/ komisaris

☐ Company's staff/ staf perusahaan ☐ Other, specifiy/ lainnya sebutkan
____
____

A.10 Length of working experience/ pengalaman kerja : ____________ Year(s)/ *tahun*

A.11 Marketing orientation/ orientasi pasar : ☐ Local within location/ *di sekitar lokasi*

☐ Within province/ *dalam propinsi* ☐ National/ *nasional*

☐ Export/ *ekspor* ☐ Other, specify , *lainnya, sebutkan*
____
____

.

A.12 Main marketing destination/tujuan utama pasar :
____
____
____

B. INPUTS

B.1 Tuna source came from where/ *sumber ikan berasal dari?* : ☐ Contracted suppliers/ *supplier tetap*
Continue to B.4 / lanjut ke B. 4

☐ Contracted fishers/ *nelayan binaan*
Continue to B.2 / lanjut ke B.2

☐ Own fleet/ *armada sendiri*
Continue to B.2/lanjut ke B.2

☐ Other, specify/ *lainnya, sebutkan,*
____
____
____

B.2 Total of unit fleet(s)/ Berapa unit total armada? : ____________ Unit(s)

B.3 Details of fleets :

		Total number		Total capacity	
a.	Carriers/ *pengangkut* :	______________	Unit (s)	______________	tonnes
b.	Pole-and-line :	______________	Unit (s)	______________	tonnes
c.	Longline :	______________	Unit (s)	______________	tonnes
d.	Purse seine :	______________	Unit (s)	______________	tonnes

B.4 Do you select the species/*apakah anda menseleksi jenis ikannya?* :

☐ Yes/ *ya* ☐ No/*tidak*

B.5 Tuna species accepted/ S*pesies tuna yang diterima* :

____
____
____

B.6 Do you select the tuna size/*apakah anda menseleksi ukuran tuna?* :

☐ Yes/ *ya* ☐ No/*tidak*

B.7 If yes, details of fish size accepted/ *jika ya, ukuran ikan yg diterima* : (minimum)

Total length/ *panjang total* : __________ mm
Total weight/ *berat total* : __________ Kg

B.8 Do you select the quality of tuna/ *apakah anda menseleksi mutu tuna?* :

☐ Yes/ *ya* ☐ No/*tidak*

B.9 If yes, what are your quality standard requirements?/ *jika iya, sebutkan standar kualitas anda* :

____
____
____

B.10 Do you select the tuna fishing grounds/ *Apakah anda menseleksi sumber daerah penangkapan tuna?* :

☐ Yes/ *ya* ☐ No/*tidak*

B.11 If yes, where are the tuna fishing grounds / *jika ya, dari mana asal fishing ground tuna tersebut?* :

____
____
____

B.12 Do you require a certificate for tuna from your supplier/ *Apakah anda membutuhkan sertifikat dari pemasok tuna?*

☐ Yes/ *ya* ☐ No/*tidak*

B.13 If yes, what is the certificate requirement and by whom is it issued/ *jika ya, sertifikat apa dan siapa yang mengeluarkan?* :

Certificate:	Issued by:
______________________	______________________
______________________	______________________
______________________	______________________

C. PROCESSES

C.1 What is your installed processing capacity/ *berapakah kapasitas prosessing terpasang?* :

Species	Per day (tonnes)	Per week (tonens)	Per month (tonnes)	Per year (tonnes)

C.2 Do you have certification for each product/ apakah anda memiliki sertifikat untuk setiap produk?:

☐ Yes/*ya* ☐ No/*tidak*

C.3 If yes, what certification do you have and issued by whom/ *jika ya, sertfikat apa dan siapa yang mengeluarkan?:*

Certificate:	Issued by:

D. OUTPUTS

D.1 What is your marketing system/ *apakah system pemasaran yang digunakan?* :

____

____

____

D.2 Has your marketing system been certified/ *Apakah system pemasaran memiliki sertifikat?* :

☐ Yes/ ya ☐ No/ tidak

D.3 If yes, what is your marketing certification, and by whom is it issued / *jika sertifikat pemasaran yang dimiliki dan dikeluarkan oleh siapa?* :

Product	Marketing certification	Issued by

D.4 Can the end buyer or consumer trace back the origin of the product/ *apakah pembeli atau konsumen akhir dapat men-trace-back sumber asal ikan?:*

☐ Yes/ *ya* ☐ No/ *tidak*

D.5

If yes, how/ *jika ya, bagaimana*	If no, why/ *jka tidak,kenapa?*

E. GOVERNMENT FISHERIES DATA

E.1 Is there any record kept of company data/ *apakah ada data perusahaan?:*

☐ Yes/*ya* ☐ No/*tidak*

E.2 If yes, who keeps it/ *jika ada, siapa yang pegang*? :

☐ buyer/ *pembeli* ☐ Company/ *perusahaan* ☐ government/ *pemerintah*

☐ Other, specify/ *lainnya, sebutkan:*

____

____

____

E.3 What kind of data is collected/*data apa saja yang dikumpulkan?* :

____

____

____

E.4 Is there any obligation to report the company data*/ apakah ada kewajiban untuk melaporkan data* *perusahan?:*

☐ Yes/*ya* ☐ No/*tidak*

E.5 If yes, is the data regularly reported/ *jika ya, apakah datanya dilaporkan rutin?*

☐ Yes/ ya ☐ No/ tidak

E.6 To whom and what data do you report/ *kepada siapa dan data apa yang dilaporkan?* :

☐ Government/ *pemerintah* ☐ Internal company/ *internal perusahaan* ☐ Other, specify, lainnya

________________ ________________________ ______________

________________ ________________________ ______________

________________ ________________________ ______________

E.7 Can researchers access and copy that data/ *Apakah peneliti bisa mengakses dan mendapatkan copy data tersebut?:*

☐ Yes/ *ya* ☐ No/ *tidak*

F FISHERIES MANAGEMENT

F.1 Are you aware of fisheries management regulations/ *apakah ada megetahui aturan pengelolaan dalam menangkap ikan:*

☐ Yes/*ya* ☐ No/*tidak*

F.2 If yes, what do the management regulations cover/ *jika iya, dalam bentuk apa pengelolaan penangkapannya?:*

☐ Allowable catch/ *izin menangkap*

☐ Landing size/ *ukuran tangkap*

☐ Other, specify/ *lainnya, sebutkan*

____

____

____

____

☐ Closed season/ *penutupan musim tangkap*

☐ Allowable gear/ *alat tangkap yg diperbolehkan*

☐ Closed area/ *penutupan lokasi tangkap*

F.3 Do you think the fisheries resources need to be managed/ *apakah menurut anda sumberdaya ikan perlu di kelola?:*

☐ Yes/*ya* ☐ No/*tidak*

F.4 If yes, why jika *iya, kenapa harus dikelola?:*

☐ To restrict the size and number of boats / *untuk keberlanjutan penangkapan*

☐ To limit catches/ *pembatasan penangkapan*

☐ To control fishing gear *meningkatakan hasil tangkapan*

☐ Other, specify/ *lainnya, sebutkan:*

____

____

____

F.5 Who should manage the fish resources/ *siapa yang harus mengelola sumberdaya ikan?* :

☐ Government/ *pemerintah* ☐ Company/ *perusahaan* ☐ Fishers themself/ *nelayan sendiri*

☐ Traditional local community/ *masyarakat sekitar* ☐ Other, specify/ *lainnya, sebutkan*

____

____

____

G. OTHERS

G.1 Is there any issue or suggestion you would like to add?/ *apakah ada permasalahan dan saran yang ingin anda berikan?*

☐ Yes/*ya* ☐ No/*tidak*

G.2 If yes, please state it here/ *Jika iya. sebutkan* :

____

Thank you for sharing your views with me: I really appreciate your contribution to my project/ *terima kasih banyak atas masukan yang anda berikan; saya sangat menghargai kontribusi anda dalam kegiatan ini.*

__________________________, / /2015

____

(signature and name of interviewee/ *Ttd dan Nama Yang Mengisi*)

Appendix 4. Public sector's questionnaire

A. GENERAL INFORMATION

A.1 Date/*tanggal* : ________________ 2015

A.2 Interviewee/*nama* : ________________

A.3 Age/*usia* : ________________ Years/*tahun*

A.4 Institution name/ *nama Institusi* : ________________________________

A.5 Institution address/ alamat institusi : ________________________________

____

A.6 Type of activity/ *jenis kegiatan* : ☐ Academic / *pendidikan:* ☐ NGO/LSM:

☐ Research/ *penelitian:* ☐ Public ☐ local

☐ Government/ pemerintah ☐ Private ☐ National

☐ Private/*swasta* ☐ International

A.7 Your position / *jabatan anda* : ☐ Lecturer/ *dosen* ☐ Scientist/ *peneliti*

☐ Management staff/ *pengelola* ☐ Other, specifiy

____

____

A.8 Length of working experience/ *pengalaman kerja* : ________________ Year(s)/ *tahun*

A.9 Institution's main focus/ focus utama institusi : ☐ Conservation/ *konservasi*

☐ Fishery/ *perikanan* ☐ Marine/ *kelautan* ☐ Social/ *sosial* ☐ Pollution/ *polusi*

☐ Other, specify/ lainnya. sebutkan

____

____

B. REGULATION

B.1 What do you think is the condition of tuna and live bait stock right now/ *bagaimana kondisi stok perikanan tuna dan umpan saat ini?* :

☐ Stable/ *stabil* ☐ Increasing/ *meningkat* ☐ Declining / *menurun*

☐ Don't know/ tidak tahu ☐ Other, specify/ lainnya, sebutkan:

____

____

B.2 In your opinion, what are the main factors that determine the abundance of tuna and live bait/ *menurut pendapat anda, factor apakan yang menentukan kelimpahan tuna dan umpan?* :

☐ New recruitment/ *pengerahan baru* ☐ Protected area/ *wilayah perlindungan*

☐ Fishing limitation/ *pembatasan penangkapan* ☐ Closed seasons/ *penutupan musim*

☐ Other, specify/ *lainnya sebutkan:*

____

____

B.3 Are there any rules and regulations that manage the tuna and live bait fisheries/ *apakah ada aturan regulasi yang mengatur pengelolaan perikanan tuna dan umpan?* :

☐ Yes/ *Ya* ☐ No/ *Tidak*

B.4 If yes, which rules and regulation do you think are the most effective for managing tuna and live bait/ *jika ya, peraturan mana yang efektif mengatur perikanan tuna dan umpan?* :

____
____
____

B.5 For these rules and regulations please rate the level of compliance by fishers/ *untuk setiap aturan dan regulasi mohon tentukan tingkat kepatuhan nelayan* :

☐ 1 (very low/ *sangat rendah*) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (very high*/ sangat tinggi*)

B.6 Why do you think fishers comply / do not comply with these rules and regulations /*Menurut anda, mengapa nelayan patuh/tidak patuh dengan aturan ini?* :

____
____
____

B.7 Are there any unwritten rules, or norms or conventions that you think are, or would be, effective in managing the tuna and live baits fisheries/ *menurut anda, apakah ada aturan atau regulasi (tidak tertulis) lainnya yang bisa efektif mengelola perikanan tuna dan umpan?* :

☐ Yes/ *ya* ☐ No/ *tidak*

B.8 If yes, what are the unwritten rules or norms or conventions that are, or might be, effective in managing tuna and live bait fisheries jika *iya, sebutkan peraturan dan regulasi tidak terlulis yang dapat mengatur perikana tuna dan umpan?* :

____
____
____

C. GOVERNMENT FISHERIES DATA

C.1 Do you think the statistical data collected by the government is sufficient to accurately measure the condition of Indonesia's fisheries / *bagaimana pendapat anda mengenai data statistic perikanan yang dibuat oleh pemerintah, apakah sudah cukup menggabarkan kondisi perikanan di Indonesia?* :

☐ Yes/*ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

Please give a short explanation/ *Mohon dapat berikan penjelasan:*

____
____
____
____
____

C.2 Do you think anything needs to be added to, or deleted from, current statistical data/ *menurut anda, apakah ada yang perlu di tambahkan atau dikurangi dalam data statisitik yang ada saat ini?* :

☐ Yes/ ya ☐ No/ tidak ☐ Don't know/ tidak tahu

C.3 If yes, what data need to be revised*/ jika iya, data apakah yang perlu di revisi?* :

Data to be deleted/ *data yang perlu dihapus*	Data to be added/ *data yang perlu ditambah*

C.4 Do you think, Indonesia fisheries statistical data are properly collected/ *apakah menurut anda data statistic perikanan Indonesia telah dibuat secara tepat?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tau*

If yes, why/ *jika iya, kenapa?:*

If no, why not/ *jika tidak, kenapa?:*

C.5 Who do you think is responsible for collecting the statistical data from the field/ *manurut anda, siapakah yang bertanggungjawab mengumpulkan data statistic perikanan di lapangan?* :

☐ Central government/ *pemerintah pusat*
☐ Local government/ *pemerintah daerah*
☐ Landing site authority/ *otoritas lokasi pendararan ikan*
☐ Statistical office/ *BPS*
☐ Independent institution/ *lembaga independent*
☐ Other, specify/ *lainnya sebutkan:*

C.6 Who do you think is responsible for compiling and interpreting the statistical data from the field/ *menurut anda, siapakah yang bertanggungjawab mengkompilasi data statistic perikanan di lapangan?* :

☐ Central government/ *pemerintah pusat*
☐ Local government/ *pemerintah daerah*
☐ Landing site authority/ *otoritas lokasi pendararan ikan*
☐ Statistical office/ *BPS*
☐ Independent institution/ *lembaga independent*
☐ Other, specify/ *lainnya sebutkan:*

C.7 Do you know how the data have been collected, compiled and interpreted?/ *apakah anda mengetahui bagaimana data tersebut di kumpulkan, kompilasi dan disajikan?* :

☐ Yes/ *ya*
☐ No/ *tidak*
☐ Don't know/ *tidak tahu*

C.8 If yes, please explain/ *jika ya, mohon dijelaskan* :

C.9 Do you know if there is an inherent limitation in Indonesian fisheries statistical data/ *apakah anda mengetahui kekurangan yang terdapat dalam data statistic perikanan Indonesia?* :

☐ Yes/ *ya*
☐ No/ *tidak*
☐ Don't know/ *tidak tahu*

C.10 If yes, please explain/ jika ya, mohon dijelaskan :

C.11 Do you know what data or information fishers and landing site officials hold/ *apakah anda mengetahui data atau informasi yang dimiliki oleh nelayan dan petugas pangkalan pendaratan ikan?* :

☐ Yes/ *ya*
☐ No/ *tidak*
☐ Don't know/ *tidak*

☐ ☐ ☐ *tahu*

C.12 If yes, would you please explain it/ *jika ya, mohon jelaskan?:*

____

____

C.13 Do you understand the methodology of the Indonesian fisheries data collection/ *apakah anda memahami metode pengumpulan data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.14 If yes, would you please explain it/ *jika ya, maukah anda menjelaskannya?:*

____

____

C.15 Do you understand the analysis of the Indonesian fisheries data/ *apakah anda memahami analysis yang digunakan pada data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.16 If yes, would you please explain it?/ *jika ya, maukah anda menjelaskannya?:*

____

____

C.17 Do you know the hierarchy process of the statistical data collection process in Indonesian fisheries / *apakah anda memahami proses tahapan pengumpulan data untuk data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.18 If yes, could you please describe it / *jika ya, maukah anda menjelaskannya secara berurutan?*

Data collector/ *pengkoleksi data:*	Data analyser/ penganalisis data:
__________	__________
__________	__________
__________	__________
__________	__________
__________	__________

C.19 Is there anything you'd like to add regarding Indonesian fisheries statistical data/ apakah ada hal lainnya yang ingin anda tambahkan atau komentari mengenai data statistic perikanan Indonesia? :

____

____

____

____

____

D FISHERIES MANAGEMENT

D.1 Are you aware of fisheries management regulations/ *apakah ada menggetahui aturan pengelolaan dalam menangkap ikan?* :

☐ Yes/*ya* ☐ No/*tidak* ☐ Don't know/ *tidak tahu*

D.2 If yes, what do the management regulations cover/ *jika iya, dalam bentuk apa pengelolaan penangkapannya?* :

☐ Allowable catch/ *izin menangkap* ☐ Landing size/ *ukuran tangkap*

☐ Other, specify/ *lainnya, sebutkan* ☐ Closed season/ *penutupan musim tangkap*

__________ ☐ Allowable gear/ *alat tangkap yg diperbolehkan*

____

☐ Closed area/ *penutupan lokasi tangkap*

D.3 Do you know that if any of the above regulations have been implemented in Indonesia/ *apakah anda tahu bahwa peraturan tersebut dijalankan di Indonesia?* :

☐ Yes/*ya* ☐ No/*tidak* ☐ Don't know/ *tidak tahu*

D.4 If yes, what regulations, and where have they been implemented in Indonesia*/ jika ya, aturan mana dan dimana di jalankan di Indonesia?* :

Regulation/ *aturan*: Location/ *lokasi:*

D.5 Based on your experience, are the implemented regulations doing well or not? Please explain/ *berdasarkan pengalaman anda, bagaimana implementasinya, apakah berjalan dengan baik atau tidak? Mohon jelaskan* :

D.6 Do you think the fisheries resources need to be managed/ *apakah menurut anda sumberdaya ikan perlu di kelola?* :

☐ Yes/*ya* ☐ No/*tidak* ☐ Don't know/ *tidak tahu*

D.7 If yes, why *jika iya, kenapa harus dikelola?* :

☐ To control fishing gear / *untuk keberlanjutan penangkapan*

☐ To limit catches/ *pembatasan penangkapan*

☐ To restrict the number and size of fishing boats *meningkatakan hasil tangkapan*

☐ Other, specify/ *lainnya, sebutkan:*

D.8 Who should manage and control the fish resources/ *siapa yang harus mengelola dan mengkontrol sumberdaya ikan?* :

☐ Government/ *pemerintah* ☐ Company/ *perusahaan* ☐ Fishers themself/ *nelayan sendiri*

☐ Traditional local community/ *masyarakat sekitar* ☐ Other, specify*/ lainnya, sebutkan*

E. MARKETING

E.1 Are you aware of the tuna and live bait marketing systems/ *apakah anda paham dengan system penjualan tuna dan umpan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

E.2 If yes, would you please explain them / *jika iya, dapatkah anda menjelaskannya?* :

Tuna marketing system/ *system penjualan tuna:*

Live bait marketing system/ *system penjualan umpan:*

E.3 Are you aware of the tuna and live bait supply chains/ *apakah anda paham dengan rantai pasokan tuna dan umpan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tau*

E.4 If yes, would you please explain them / *jika iya, dapatkah anda menjelaskannya?* :

Tuna supply chain/ *rantai pasokan tuna:*

Live bait supply chain/ *rantai pasokan umpan:*

E.5 Are you aware of the tuna and live bait traceability process/ *apakah anda paham dengan penelusuran asal-muasal sumber tuna?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

E.6 If yes, would you please explain it/ *jika iya, dapatkah anda menjelaskannya?* :

E.7 Do you think that market demand for these tuna and live bait fisheries threatens the sustainability of marine resources / *apakah menurut anda permintaan pasar akan perikanan tuna dan umpan mempengaruhi keberlanjutan sumberdaya dan lingkungan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

E.8 If yes, how/ *jika iya, bagaimana?:*

If no, why not / *jika tidak, kenapa?*

F. OTHERS

F.1 Are there any issues you would like to add/ *apakah ada permasalahan dan saran yang ingin anda berikan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.2 If yes, stated them here/ *Jika iya. sebutkan* :

Thank you for sharing your views with me: I really appreciate your contribution to my project/ *terima kasih banyak atas masukan yang anda berikan; saya sangat menghargai kontribusi anda dalam kegiatan ini.*

, / /2015

(signature and name of interviewee/ *Ttd dan Nama Yang Mengisi*)

Appendix 5. Policy maker's questionnaire

A. GENERAL INFORMATION

A.1 Date/*tanggal* : ________________ 2015
A.2 Interviewee/*nama* : ________________
A.3 Age/*usia* : ________________ Years/*tahun*
A.4 Institution name/ *nama Institusi* : ________________________________
A.5 Institution address/ alamat institusi : ________________________________
____

A.6 Type of agency/ *jenis instansi* :

- ☐ Government / *pemerintah*
  - ☐ Central/*pusat*
  - ☐ Province/ *propinsi*
  - ☐ District/ *kabupaten*
- ☐ Non-government/ *bukan pemerintah*
  - ☐ RFMO/ *Organisasi pengelolan*
  - ☐ Tuna commission/ *komisi tuna*
- ☐ Other, specify/ lainnya, sebutkan
  ____
  ____

A.7 Your position / *jabatan anda* : ☐ Head of/ *Kepala* ☐ Scientist/ *peneliti*

☐ Staff/ staf ☐ Field staff/ *staff lapangan* ☐ Other, specify/ lainnya sebutkan:
____
____

A.8 Working experience/ *pengalaman kerja* : ______________ Year(s)/ *tahun*

A.9 Institution main focus/ focus utama institusi : ☐ Policy making/ *pembuat kebijakan*

☐ Research/ *penelitian* ☐ Law enforcement/ *penegak hukum* ☐ Licensing/ *pemberi izin*

☐ Other, specify/ lainnya. sebutkan
____
____

.

B. REGULATION

B.1 What do you think is the condition of tuna and live bait stock right now/ *bagaimana kondisi stok perikanan tuna dan umpan saat ini?* :

☐ Stable/ *stabil* ☐ Increasing/ *meningkat* ☐ Declining / *menurun*

☐ Don't know/ tidak tahu ☐ Other, specify/ lainnya, sebutkan:
____
____

B.2 In your opinion, what are the main factors that determine the abundance of tuna and live bait/ *menurut pendapat anda, factor apakan yang menentukan kelimpahan tuna dan umpan?* :

☐ New recruitment/ *pengerahan baru* ☐ Protected area/ *wilayah perlindungan*

☐ Fishing limitation/ *pembatasan penangkapan* ☐ Closed seasons/ *penutupan musim*

☐ Other, specify/ *lainnya sebutkan:*

B.3 Are there any rules and regulations that manage the tuna and live bait fisheries/ *apakah ada aturan regulasi yang mengatur pengelolaan perikanan tuna dan umpan?* :

☐ Yes/ *Ya* ☐ No/ *Tidak*

B.4 If yes, which rules and regulations do you think are the most effective for managing tuna and live bait/ *jika ya, peraturan mana yang efektif mengatur perikanan tuna dan umpan?* :

B.5 For these rules and regulations please rate the level of compliance by fishers/ *untuk setiap aturan dan regulasi mohon tentukan tingkat kepatuhan nelayan* :

☐ 1 (very low/ *sangat rendah*) ☐ 2 ☐ 3 ☐ 4 ☐ 5 (very high/ *sangat tinggi*)

B.6 Why do you think fishers comply / do not comply with these rules - *Menurut anda, mengapa nelayan patuh/tidak patuh dengan aturan ini?* :

B.7 Are there any unwritten rules, or norms or conventions that you think would be effective in managing the tuna and live baits fisheries/ *menurut anda, apakah ada aturan atau regulasi (tidak tertulis) lainnya yang bisa efektif mengelola perikanan tuna dan umpan?* :

☐ Yes/ *ya* ☐ No/ *tidak*

B.8 If yes, what are the unwritten rules or norms or conventions that might be effective in managing tuna and live bait fisheries jika *iya, sebutkan peraturan dan regulasi tidak terlulis yang dapat mengatur perikana tuna dan umpan?* :

C. GOVERNMENT FISHERIES DATA

C.1 Do you think the statistical data collected by the government is sufficient to accurately measure the condition of Indonesia's fisheries / *bagaimana pendapat anda mengenai data statistic perikanan yang dibuat oleh pemerintah, apakah sudah cukup menggabarkan kondisi perikanan di Indonesia?* :

☐ Yes/*ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

Please give a short explanation/ *Mohon dapat berikan penjelasan:*

C.2 Do you think anything needs to be added to, or deleted from, current statistical data/ *menurut anda, apakah ada yang perlu di tambahkan atau dikurangi dalam data statisitik yang ada saat ini?* :

☐ Yes/ ya ☐ No/ tidak ☐ Don't know/ tidak tahu

C.3 If yes, what data need to be revised/ *jika iya, data apakah yang perlu di revisi?* :

Data to be deleted/ *data yang perlu dihapus* Data to be added/ *data yang perlu ditambah*

C.4 Do you think, Indonesia fisheries statistical data is properly collected/ *apakah menurut anda data statistic perikanan Indonesia telah dibuat secara tepat?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tau*

If yes, why/ *jika iya, kenapa?:*

If no, why not/ *jika tidak, kenapa?:*

C.5 Who do you think is responsible for collecting the statistical data from the field/ *manurut anda, siapakah yang bertanggungjawab mengumpulkan data statistic perikanan di lapangan?* :

☐ Central government/ *pemerintah pusat* ☐ Local government/ *pemerintah daerah*

☐ Landing site authority/ *otoritas lokasi pendararan ikan* ☐ Statistical office/ *BPS*

☐ Independent institution/ *lembaga independent* ☐ Other, specify/ *lainnya sebutkan:*

C.6 Who do you think is responsible for compiling and interpreting the statistical data from the field/ *menurut anda, siapakah yang bertanggungjawab mengkompilasi data statistic perikanan di lapangan?* :

☐ Central government/ *pemerintah pusat* ☐ Local government/ *pemerintah daerah*

☐ Landing site authority/ *otoritas lokasi pendararan ikan* ☐ Statistical office/ *BPS*

☐ Independent institution/ *lembaga independent* ☐ Other, specify/ *lainnya sebutkan:*

C.7 Do you know how the data have been collected, compiled and interpreted?/ *apakah anda mengetahui bagaimana data tersebut di kumpulkan, kompilasi dan disajikan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.8 If yes, please explain/ *jika ya, mohon dijelaskan* :

C.9 Do you know if there is an inherent limitation in Indonesia on fisheries statistical data/ *apakah anda mengetahui kekurangan yang terdapat dalam data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.10 If yes, please explain/ jika ya, mohon dijelaskan :

C.11 Do you know what data or information fishers and landing site officials hold/ *apakah anda mengetahui data atau informasi yang dimiliki oleh nelayan dan petugas pangkalan pendaratan ikan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.12 If yes, would you please explain it/ *jika ya, mohon jelaskan?:*

C.13 Do you understand the methodology of the Indonesian fisheries data collection/ *apakah anda memahami metode pengumpulan data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.14 If yes, would you please explain it/ *jika ya, maukah anda menjelaskannya?:*

C.15 Do you understand the analysis of the Indonesian fisheries data/ *apakah anda memahami analysis yang digunakan pada data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.16 If yes, would you please explain it?/ *jika ya, maukah anda menjelaskannya?:*

C.17 Do you know the hierarchy process of the statistical data collection process in Indonesian fisheries / *apakah anda memahami proses tahapan pengumpulan data untuk data statistic perikanan Indonesia?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

C.18 If yes, could you please describe it in order/ *jika ya, maukah anda menjelaskannya secara berurutan?*

Data collector/ *pengkoleksi data:*

Data analyser/ penganalisis data:

C.19 Is there anything you'd like to add regarding Indonesian fisheries statistical data/ apakah ada hal lainnya yang ingin anda tambahkan atau komentari mengenai data statistic perikanan Indonesia? :

D FISHERIES MANAGEMENT

D.1 Are you aware of fisheries management regulations/ *apakah ada menggetahui aturan pengelolaan dalam menangkap ikan?* :

☐ Yes/*ya* ☐ No/*tidak* ☐ Don't know/ *tidak tahu*

D.2 If yes, what do the management regulations cover/ *jika iya, dalam bentuk apa pengelolaan penangkapannya?* :

- [ ] Allowable catches/ *izin menangkap*
- [ ] Landing sizes/ *ukuran tangkap*
- [ ] Other, specify/ *lainnya, sebutkan* ______________________
- [ ] Closed seasons/ *penutupan musim tangkap*
- [ ] Allowable gears/ *alat tangkap yg diperbolehkan*
- [ ] Closed area/ *penutupan lokasi tangkap*

D.3 Do you know whether any of the above regulations have been implemented in Indonesia/ *apakah anda tahu bahwa peraturan tersebut dijalankan di Indonesia?* :

- [ ] Yes/*ya*
- [ ] No/*tidak*
- [ ] Don't know/ *tidak tahu*

D.4 If yes, what regulations, and where have they been implemented in Indonesia*/ jika ya, aturan mana dan dimana di jalankan di Indonesia?* :

Regulation/ *aturan*: ______________________

Location/ *lokasi:* ______________________

D.5 Based on your experience, are the implemented regulations doing well or not. Please explain/ *berdasarkan pengalaman anda, bagaimana implementasinya, apakah berjalan dengan baik atau tidak? Mohon jelaskan* :

____

D.6 Do you think the fisheries resources need to be managed/ *apakah menurut anda sumberdaya ikan perlu di kelola?* :

- [ ] Yes/*ya*
- [ ] No/*tidak*
- [ ] Don't know/ *tidak tahu*

D.7 If yes, why *jika iya, kenapa harus dikelola?* :

- [ ] To reduce the number and size of boats / *untuk keberlanjutan penangkapan*
- [ ] Other, specify*/ lainnya, sebutkan:* ______________________
- [ ] To limit catches/ *pembatasan penangkapan*
- [ ] To restrict fishing gear *meningkatakan hasil tangkapan*

D.8 Who should manage and control the fish resources/ *siapa yang harus mengelola dan mengkontrol sumberdaya ikan?* :

- [ ] Government/ *pemerintah*
- [ ] Company/ *perusahaan*
- [ ] Fishers themself/ *nelayan sendiri*
- [ ] Traditional local community/ *masyarakat sekitar*
- [ ] Other, specify*/ lainnya, sebutkan* ______________________

E. MARKETING

E.1 Are you aware of the tuna and live bait marketing system/ *apakah anda paham dengan system penjualan tuna dan umpan?* :

- [ ] Yes/ *ya*
- [ ] No/ *tidak*
- [ ] Don't know/ *tidak tahu*

E.2 If yes, would you please explain it/ *jika iya, dapatkah anda menjelaskannya?* :

Tuna marketing system/ *system penjualan tuna:*

Live bait marketing system/ *system penjualan umpan:*

E.3 Are you aware of the tuna and live bait supply chain/ *apakah anda paham dengan rantai pasokan tuna dan umpan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tau*

E.4 If yes, would you please explain it/ *jika iya, dapatkah anda menjelaskannya?* :

Tuna supply chain/ *rantai pasokan tuna:*

Live bait supply chain/ *rantai pasokan umpan:*

E.5 Are you aware of the tuna and live bait traceability process/ *apakah anda paham dengan penelusuran asal-muasal sumber tuna?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

E.6 If yes, would you please explain it/ *jika iya, dapatkah anda menjelaskannya?* :

E.7 Do you think that market demand for these tuna and live bait fisheries threatens the sustainability of marine resources / *apakah menurut anda permintaan pasar akan perikanan tuna dan umpan mempengaruhi keberlanjutan sumberdaya dan lingkungan?* :

☐ Yes/ *ya* ☐ No/ *tidak* ☐ Don't know/ *tidak tahu*

E.8 If yes, how/ *jika iya, bagaimana?:*

If no, why not / *jika tidak, kenapa?*

F. OTHERS

F.1 Are there any issues you would like to add/ *apakah ada permasalahan dan saran yang ingin anda berikan?* :

☐ Yes/*ya* ☐ No/*tidak*

F.2 If yes, stated them here/ *Jika iya. sebutkan* :

Thank you for sharing your views with me: I really appreciate your contribution to my project/ *terima kasih banyak atas masukan yang anda berikan; saya sangat menghargai kontribusi anda dalam kegiatan ini.*

, / /2015

(signature and name of interviewee/ *Ttd dan Nama Yang Mengisi*)