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GETTING OFF THE HOOK:

Reforming the tuna fisheries of Indonesia

Introduction

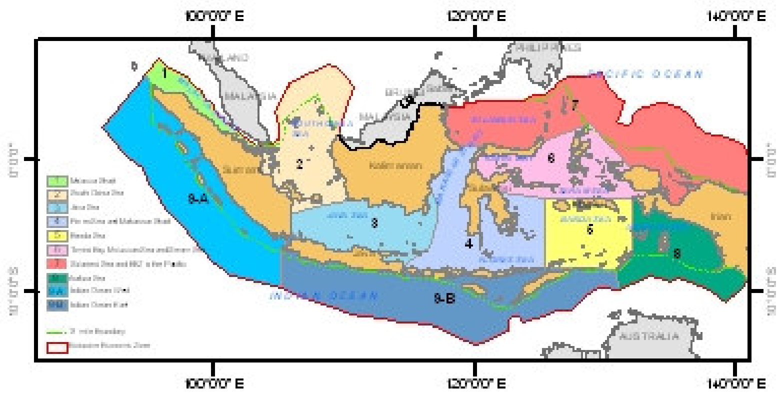


Figure 1.1 Map of Indonesia showing the geographical location of the nine fishery management areas.

Background of the Study

This study on the tuna resources of Indonesia is the first serious effort in 25 years, since the work of Marceille (1984), to understand the tuna fishing sector of a country which produces more tuna (from its waters) than any country in the world. Also, this study is the first serious attempt to analyze the tuna fisheries per fishery management area since its legal establishment as the country's management unit in 1999 (Minister Agriculture Declaration 995 of 1999). The identification of these management units (referred to in this document as FMAs) is a necessary prerequisite to reform tuna management using the ecosystem-based management approach (EBM) which is the main goal of this assessment. Because tagging studies have shown a large amount of interaction between the tuna fisheries in Indonesia and that of the larger Western and Central Pacific Ocean, any improvements made on tuna management in Indonesia would contribute to the overall management of tunas within the region.

The current understanding of information about tunas of Indonesia may be likened to a doughnut, where the tuna fisheries of the countries to the north, south, east, and west of Indonesia are relatively well-studied, while a gaping "black hole" remains in the waters of Indonesia, hindering the flow of knowledge required for effective management. Such lack of accurate understanding of the stocks, fishing capacity and fleet characteristics result to a high degree of uncertainty of stock status in both the Indian and Pacific Oceans. Acquiring those information would be a major contribution to both understanding the pelagic ecosystem, and implementing specific EBM strategies not just for the Indonesian tuna fisheries but for the whole Indian and Pacific Oceans.

Economically, the conservation of tuna and other pelagic resources in Indonesia is critically important, supporting the livelihood of the tens of thousands of fishers and workers, including significant number of women in the processing sector that are dependent on the tuna industry of the country. This study highlights the major management issues as a step in initiating interventions, including those appropriate for EBM.

Objectives

This study has two major components:

1. The first would be a detailed overview on a per fishery management area (FMA) description and characterization of the tuna fisheries that covered the broad topics of fishing areas, fishing gears and crafts, landings and production by gear and species, infrastructure support as well as identification of issues and problems.

2. The second component deals with the ecosystem-based management topics that include the bait fisheries, subsidies, post harvest handling, tuna trade as well as impacts of the fuel price hike to the tuna sector and link these to the identification of major management issues.

Description of the study area

Indonesia, with its 17000 islands, 81,000 km of coastline and water area including its exclusive economic zone of about 5.8 million square kilometers is the biggest archipelago in the world. Its fisheries output in 2005 exceeded 4 million tons and is the 6th largest global fish producer. It is also the number one tuna producer in the world based on the latest published production output of over three quarters of a million tons (790,000 MT)(DKP 2006).

The waters of Indonesia provide the ideal environment for the tunas. This is brought about by its strategic location between two large continents (Asia and Australia) and major oceans (Pacific, Indian and South China Sea) influencing its climate and marine environment. In addition, the enormous number and highly varied ecosystems brought about by the archipelagic pelagic nature of Indonesia bringsabout an ideal environment for high biodiversity and productivity (Tomascik et al, 1997).

The climate regime of Indonesia is governed by ocean-atmosphere interaction in the form of strong seasonal variations at the upper oceanic circulation that is influenced by monsoonal winds. Heating of the Asian and the Australian continent drives these monsoon winds which changes directions depending from which continent the wind blows (Webster et al. 1998). The southeast (SE) monsoon blows from June to September brought about by high pressure over Australia and low pressure over Asia. In the southern hemisphere of the country, this wind blow on a SE direction which becomes a Southwest wind in the northern hemisphere. The northwest (NW) monsoon occurs from December to March brought by higher atmospheric pressure in Asia and lower pressure in Australia. In the northern hemisphere this blows from the northeast and turns to northwest in the southern hemisphere.

The difference between the two monsoon weather is in the amount of rainfall where the NW monsoon is considered the rainy season brought about by moist air as a result of high evaporation rates in the Pacific Ocean. The amount of rainfall generally decreases towards the inter-monsoon period (April-May) leading to the dry season during the SE monsoon.

Tidal fluctuations vary with area where diurnal (once daily) tides occur in Java Sea, semi-diurnal (twice daily) in west Sumatra and mixed tides in eastern Indonesia (Tomascik et al. 1997).

There are three notable oceanic and coastal processes that contribute to the productivity and influence the dynamics of the marine ecosystem. These are upwellings, the Indonesian throughflow (ITF), coastal discharge (Hendiarti, 2003) and the naturally occurring large scale phenomena of ENSO and Pacific Decadal oscillations (PDO). These latter two factors contribute to the global climate.

Upwelling areas are high productivity zones linked with very high fish production. These are reported in waters off Makassar Strait, West Sumatra, South Java, South Bali, Banda Sea and Arafura Sea, Sunda Strait (Wyrtki, 1961, Bray et al., 1996 Susanto et al, 2001, Gordon and Susanto, 2001). The El Nino southern oscillation (ENSO) contributes to development of upwelling events that extend past the normal season in Java and Sumatran southern coasts that triggers high fish yields (Susanto et al., 2001, Gaol et al., 2002). The downside impacts of ENSO however manifest in the low agricultural output due to prolonged dry season (Caviedes, 2001).

High rates of freshwater influx containing nutrients from Kalimantan and Javan tributaries influence both the productivity as well as circulation of Java Sea brought about by mixing of lower with higher saline waters (Tomascik et al., 1997). The Indonesian Throughflow (ITF) that pass through the Indonesian archipelago from the Pacific and exits into the Indian Ocean brings warm, less saline waters and formed part of the global thermohaline circulation. This phenomenon contributes also to the general climatic pattern of the region that result in the difference of sea levels between these oceans (Murray and Arief, 1988; Meyer, 1996; Gordon et al., 1999; Hautala et al., 2001). The melting of the ice caps due to global warming could change the character of the global thermohaline circulation whose impacts to climate and general ecology for Indonesia has yet to be studied.

The waters of Indonesia are divided into 9 fishery management areas or FMAs (Figure 1.1), each unit refer to a particular body of water or fishing ground. This approach is ideal because it takes into consideration resource management based on ecological boundaries or fishing ground scale as opposed to use of political boundaries as management unit. However, as with new landmark laws, implementation and operationalization of large areas entails huge challenge because:

1. fisheries management responsibilities fall on multiple provinces/ regencies, thus necessitating the need for an integrated management approach and guidance for each government unit to shift from using political to ecological boundaries;
2. the recent enactment of the autonomous law that provides direct management control to individual local government units has created management confusion as a result in shift from individual resource management to management of shared resources. The lack of integrative framework between the three levels of governance resulted in a highly fragmented rather than unified management approach to shared resources.

The roles of each units at the sub-district, district, provincial and national levels needs to be clearly defined, its management leadership established and a clear fisheries plan for each FMA developed and implemented.

Places Visited

A total of 45 localities belonging to 17 provinces were visited (Figure 1.2) to conduct interviews and to collect fisheries information and observe the local tuna fisheries. These included visits to 11 major ports (oceanic ports (PPS) =7, Archipelagic ports (PPN) = 2, PPP-2) and coastal fishing ports/ minor landing areas (PPP/ TPI / PPI) to observe trading, and collect information. Likewise, interviews were made in General Santos City, Philippines wherein about 1600 tuna handline boats that fish in Indonesian waters and neighboring areas. The surveyed areas sufficiently cover

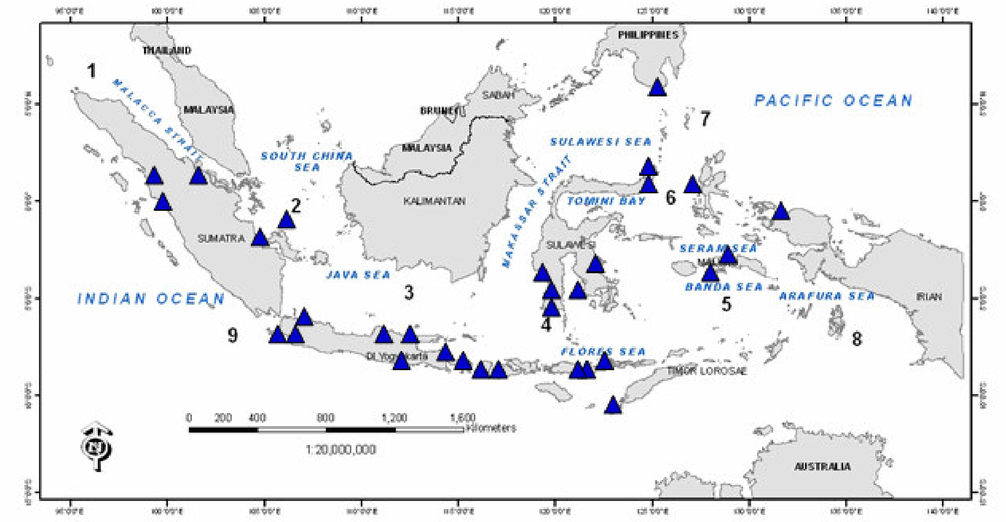


Figure 1.2. Survey sites of this study.

the 9 fishing zones with respect to the tuna fishery. The choices of sites surveyed were based on the following criteria:

1. volume of tunas landed as published in the fisheries statistics;
2. representation of both the small scale and large scale fishers;
3. representation of tuna fishing gears;
4. accessibility of the area
5. cost of travel to the area.

The only provinces not visited include South Kalimantan, East Kalimantan ,West Kalimantan, the newly formed Sulawesi Barat, Sulawesi Tengah and Nangaroe Aceh Darussalam (NAD).

Methods

The sources of data compiled during the study came from three major sources:

1 From existing literature both from published sources (internet-based sources), references and reports of government agencies, from annual statistical data compiled but not published by districts, province and regencies of local government units. A large part of references used were articles published from the two Fisheries Journals.

2 From gray literature, mostly coming from thesis of students of fisheries graduates of Sekolah Tinggi Perikanan (STP), a state-run fisheries school based in Jakarta. Over two hundred reports made by students over four month period as part of their on-the-job training provided valuable data sets on fishing, fishing technology and processing that remained untapped and unutilized but were used here to compare and provide basis for comparison with data provided by the respondents. We also have used post graduate thesis on two occasions.

3 Results of interviews conducted on 78 fishers/ boat owners of various tuna fishing gears, 12 fish buyers (middlemen), 15 large tuna processors and exporters, all the local fisheries agencies of Dinas Kelautan dan Perikanan (DKP), fishing port officials. Also visited and interviewed were representatives from the different directorate general offices of Marine Resources, Aquaculture, Processing Technology, Capture Fisheries (including statistics) at the national level. We also interviewed head of Laboratory Testing facility in Makassar.

Treatment of Data

A newly published statistical yearbook by management area became available in 2006 where summaries of production by species from 2000-2004 were provided. This publication represents a first good attempt to better analyze fisheries into management units. Unfortunately, it is far from complete and important data such as production of each species by gear types, number of fishing vessels of each type were not available. To fill this gap, we have used the provincial fisheries statistics data and separated the data into management units. This proved a very difficult task as the presentation of data between provinces differs. To provide time series analysis, we selected only specific year to represent each decade. We have chosen, due to availability of data sets, the following years: 1976, 1986, 1990, 1995, and years 2000, 2002, 2003, 2004, 2005 to provide the recent trend over the last 5 years. Since such data sets are not available for all provinces, we selected one or two provinces with sufficient data to represent a particular FMA.

We also have included in our analysis, the artisanal or small scale fisheries of Indonesia as well as expanded the coverage of our analysis to include the small tunas belonging to *Auxis thazzard, Auxis rochei, Euthynus affinis*. This is to provide a holistic assessment of the tuna fisheries of the country, setting this study apart from previous studies. There are very few published information on the extent of the small-scale tuna fisheries and how large the small tuna landings relative to the export species.

We did not include swordfish, marlins and sailfishes in the presentation because these species are taken also by a wide variety of fishing gears with a lot of local names and separating them by fishing gear type proved to be very difficult. Detailed methods pertaining to each fishing ground is discussed separately under each chapter.

Presentation of Data

The report is divided into two main parts: Part I consists of 8 sections (Chapters 2-9) that includes the description of the tuna fisheries for the nine fishery management units (FMA) of Indonesia. We did not include Arafura Sea (FMA 8) as the fishery is overwhelmingly demersal trawl fisheries. Each FMA section describes tuna fisheries, its fleet, catches, status of the resources based on historical data, infrastructure support, issues and challenges as well as notes on the economics of fishing.

Part II includes four chapters that deals with various aspects related to ecosystem based fisheries management (EBM) for tunas. These include chapters on the bait fisheries, by-catch issues that include juvenile tuna by-catch, turtles and sharks, the poor quality of tunas, international trade of tunas, subsidies and other issues such as impacts of fuel price increases. The last chapter summarizes the issues and provides a comprehensive list of recommendations for each issue. A roadmap to tuna sustainability is described at the end of the section.

Each section on the different FMA is written as stand alone to allow a more detailed, disucssion of locally-based issues and recommendations

Limitations of the Study

A total of 140 thesis works of students from STP were used as reference material. These data sets covering years from 1995-2000 proved very valuable and were used in many instances in this report. However as the thesis were written in Bahasa Indonesia, accurate interpretation of their results proved challenging and we have sourced local help to translate many of the results. Misinterpretation of results could occur. There are also few instances (e.g. Beliko, 1999) when data were reanalyzed to provide the correct interpretation of results.

Considering the expanse of Indonesian maritime territory, the time allotted for the study was short and the survey alone took us over three months of actual travel time. National events such as the Ramadan (whole month of October in 2006) and Christmas (last half month) added to the challenges of doing surveys.

To complement existing published works on tuna, we have depended many of our assessments on the results of the interviews conducted. To give credence to results of these interviews, we have chosen respondents, whenever possible, with many years of fishing experience. This is reflected on the average age of fisher respondents to be 41.6 years and average fishing experience of $\geq$ 15 years.

We followed a non-structured interview format to allow a more relaxed interview atmosphere. Interviews were conducted on site but actual interviews are done on a one on one basis, avoiding as much as possible for other fishers to join in the discussions. The types of information asked of the respondents include characterization of the fisheries of each gear, capital investments, markets of tuna and tuna products, product disposals, product flow and management issues. A sample of the questions asked is attached in Appendix 1.

Overall, the quality of information for most answers ranged from good to very good and usually are in very good agreement with responses from other respondents from the same area using same gear type. Key information from these interviews were used as proxy for the operational information (catch, catch rates for each season, species composition) to estimate tuna production for each gear type for each fishing ground.

To get an accurate approximation of tuna production, we have separated catch rates between peak and lean seasons and by species if possible. We also collected information on the number of times per month with zero catch, correcting the usual overestimation of catch per effort based on landings where zero catches are never reported or incorporated into the estimates.

One of the challenges encountered during interviews is the way seasonality is understood. To some respondents, understanding of time scale is not based on Julian calendar but on lunar cycle and do not use January as start of the year. What complicates is that the start of the year varies each year by 15 days. We overcame this problem by combining their understanding of lunar periodicity with monsoonal (wind) season in getting the seasons into the Julian calendar.

Instances arise when information provided by the respondents have limited or were not used at all. These were instances when company owners (or supervisors in companies) or when fishery officers were present during the interview, providing the answers instead of our respondents. We have weighed the use of information in such instances with caution as it is in most instances, the supervisors or the fishery officials influence the respondents' answers.

Often, information regarding the capital investments could not be provided by boat captains or fishers working under a company but similar information were freely given by boat captains of owned vessels.

Sourcing and interpreting existing statistical data proved challenging. One of the major challenges in putting together this report is the large discrepancies of the values of statistical tables between agencies. Instances arise when production values were either too similar (two consecutive years repeated with very minor differences) or with extremely large differences between consecutive years. Without any accompanying explanatory notes, these values would be difficult to interpret. Availability of complete set of statistical tables in the provinces or the regencies is another challenge, as making back up either in hard or soft copies (electronic copies) is not part of their standard operating procedures.

To circumvent these two challenges and to be able to present data over a time series for each FMA, we opted to present trends in decadic intervals, each decade represented by a year where data are available for the areas (provinces/ regencies) representing a particular FMA. We are aware on the use of data sets that fall on ENSO years where catch and landings are unusually high.

Data available differ in their presentation and format and in some provinces, data could not be separated from where it was landed or fished. We opted to limit use of such data when we no other data is available. In such circumstances, we provided explanatory notes on its use.

The use of the local terminologies which differ highly between areas, as basis for entries of values for statistical tables added a high degree of uncertainty in the data. The local term "*tongkol*" is a universal local term to mean small tunas which by definition, and depending on the area and probably the ethnic background of the fishery enumerator, could mean the bullet tunas (*Auxis rochei*), frigate tunas (*Auxis thazzard*), bonitos (*Euthynnus affinis, E. yaito*), juvenile and immature individuals of yellow fin (*T. albacares*) and big eye tunas (*T. obsesus*). Because names changes with fishing ground, we have used the local name tongkol how this term was used in the area being described.

We believed that changes in the dominance between these species could have possibly occurred through time but was simply not captured in the statistical yearbooks because of this lumping practice. In the early literature, "tongkol" meant the oceaninc bonitos which were then the most dominant species in the 1980's. During our survey, most of the small tunas we found in the market are bullet and frigate tunas but these unfortunately were continuously classified as E. affinis/ E. yaito. This explains why recent statistical tables have very low record production of bullet and frigate tunas despite their abundance at the markets and landing areas. This issue is discussed in pertinent chapters.

We also have included, whenever data is available, cost of fishing for each tuna gear type. We simply applied a very simple cost benefit analysis, utilizing a 10% depreciation cost on capital and used actual expenses (2006) based on figures given by the respondents.

FMA-I: Malacca Strait

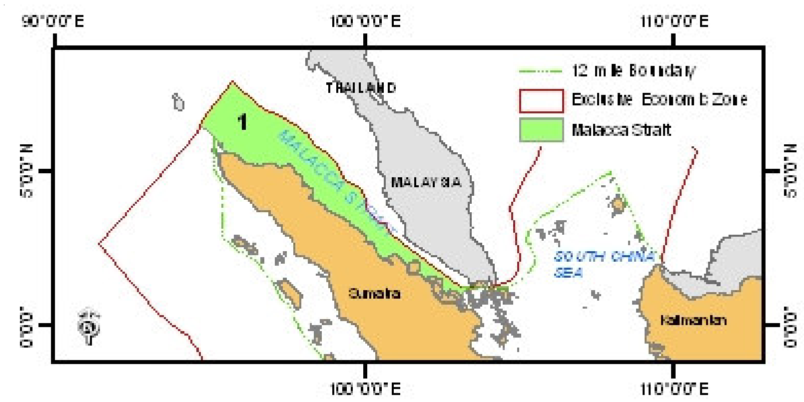


Figure 2.1 Geographic location of Fishery Management I: Malacca Strait.

Geographic Scope

Malacca Strait is a narrow waterway connecting the Andaman Sea (in the west) and South China Sea (in the east) with an area of about 65,000 km^2, length of about 800 km and width of about 65 to 249 km (Britannica Encyclopedia, 2007). The depth of the Strait is shallow (27-37 meters) near South China Sea and gradually deepens towards the Andaman Sea (200 meters). The approximate area of Malacca Strait that belongs to Indonesia is 55,000km^2 (Bailey, 1987). It runs through the entire length of the Sumatra Island of Indonesia (south border), Peninsular Malaysia (northwest border) and Thailand (northeast border). The Strait got its name from the famous trading port "Melaka" in Peninsular Malaysia during the 16th and 17th centuries. Today the Strait has become one of the world's busiest marine transportation lanes because it is the shortest route between the Indian Ocean and the Pacific Ocean (Anugerah, 2004).

In general, the water circulation of Malacca Strait flows a continual southeast stream originating from the Sunda Shelf passing through the Strait into the Indian Ocean (Roy, 1996). During the northeast monsoon, this current carries with it high salinity waters from the South China Sea while during the southeast monsoon, the waters are relatively low saline due to significant mixing with the river runoffs from the Sumatran Island. This current flow and strong tidal fluctuations in the Strait induces constant vertical mixing of the waters that result to the high primary productivity of the area (Roy, 1996 and Nurdjaman, 2006).

Indonesia recently passed a law differentiating its waters into nine fisheries management areas. These fisheries management areas are developed for the purposes of better approach to manage the country's natural resources. For the fisheries sector, Indonesia allocated its jurisdiction on Malacca Strait as Fisheries Management Area One (Figure 1). It covers the Provinces of Nangroe Aceh Darussalam, Sumatera Utara, and four Kabupaten (District) of Riau (Table 2.1).

Table 2.1 Political units that belong to fishery management area one (FMA I)

Provinces	Kabupaten/ Kodya/ Kota
Nanggroe Aceh Darussalam	Pidie Aceh Utara Aceh Timur
North Sumatra	Langkat Deli Serdang Kota Medan Asahan Kota Tanjung Balai Labuhan Batu Serdang Bedagai
Riau	Bengkalis Rokan Hilir Dumai Siak

Sources of Data

The data considered for primary analysis are from the results of interviews of fishers, fisheries-related enterprises, government personnel (working on the fisheries departments) and other stakeholders involved in the tuna fisheries. The interview was conducted, primarily for this study, on February 2007. However, during the data collection, among the three provinces covered by FMA-I only the province of Sumatera Utara was visited. This province was selected as site of interview because it occupies a large portion of the Strait and accounts for the largest share of fish landings.

The collected primary data during this study was supported by the statistics published by the National Dinas Perikanan dan Kelautan (DKP) and Provincial DKP statistics, report of students from the Sekolah Tinggi Perikanan and other papers (published and unpublished) on Malacca Strait fisheries, all of which are listed in the cited references. Because the FMA is a recent development and therefore incomplete, most of the information on trends used in this report made use of the statistics published by the DKP of the provinces of North Sumatra.

Limitations and Assumptions

This study has allocated a short-time for actual survey in FMA-I because of the relatively small volume of tuna landings from Malacca Strait – Indonesia; as was indicated by the landings report. We visited Belawan Fishing Port, a primary fishing port (PPS category) in north Sumatra and interviewed purse seines targeting small pelagics using fish aggregation devices (FADs). This study intentionally did not cover Nanggroe Aceh Darussalam (NAD) as we could disturb fisheries rehabilitation efforts currently being undertaken by the global community. While we never had interviews conducted, the analysis of trends in tuna fishery covering up to 2004 includes data sets from NAD.

Following the newly established Fisheries Management Zoning, the Directorate General of Capture Fisheries published the fisheries production statistics by Fisheries Management Areas (Wilayah Pengeleloan Perikanan or WPP) in 2006. This yearbook's first issue in 2006 covered years from 2000 to 2004. Henceforth there are two sets of statistical report for those years, that by FMA which we refer to as DKP-WPP 2006, and by Provinces and Coastal Areas which we simple refer to as DKP. Comparing these two reports however showed some irreconcilable differences in the production figures presented. In such instances, mention of the inconsistency is made and the probable reasons given.

Prior to 2004, the tuna species were reported into three main categories, the "*tuna*" which clumped the large tuna species (e.g. YFT, BET, etc.), the "*tongkol*" which comprises the small tuna species (e.g. Bullet Tuna, Frigate Tuna, Eastern Little Tuna, juveniles of large tunas) and "*cakalang*" (pronouced "*tsa-ka-lang*") which consists mainly skipjack tuna (*Katsuwonus pelamis*) an a few oceanic bonitos. Based on the annual fisheries yearbook, the most abundant and dominant species of "*tongkol*" in FMA-I is the Eastern Little Tuna or *Tongkol Komo* in Bahasa Indonesia. During the actual surveys, however, this species are rarely observed in the markets and landing areas. In fact the most commonly observed species of small tuna are the Bullet Tunas (*Auxis rochei*) which is known locally as *Lisong*. The eastern Little Tunas represent only a tiny fraction of the tunas sold in the markets and landed in the ports.

Analyzing the reports and published fisheries papers done for Malacca Strait, the Eastern Little Tuna appeared to be the most abundant species. This is not surprising considering that the main source of data and identification stem from the fisheries statistical yearbook, published by the Directorate General of Fisheries or DGF. It appears therefore that either the eastern little tuna used to be abundant in the area before but has disappeared over the years but was not noticed. Or that the misidentification occurred early on but the error has been perpetuated over the years. Both instances could be attributed to the failure at the sampling level to verify the veracity of this species.

Similar to the rest of the country, it proved difficult to get a complete set of fisheries yearbooks. To address this issue, we presented trends for general capture fisheries and tuna production trends at 10-year intervals rather on an annual basis. For this fishing area, we have used 1976 to represent 1970, 1983 yearbook for the 1980's, 1993 yearbook for the 1990's and years 2001, 2004, 2005 to represent year 2000 (DKP 1976, 1983, 1993, DGF 2001, 2002, 2004, 2004, 2005).

Trends of total fish and tuna landings

As an overview it would be helpful to know that Malacca Strait is one of the pioneer fishing grounds of Indonesia. Published papers have described the fisheries' existence since the 1860s (Butcher, 1996). Records show that commercial fishing activities have been export-oriented from the very start. It is not so surprising that the area has apparently been described as already overfished as early as 1904 (Butcher, 1996; Yamamoto, 1973). Fisheries studies done in the seventies showed that during this period, the small pelagic fisheries resources of Malacca Strait are already fully exploited (Bailey, 1987; Sudjastani, 1975). At present, despite being in an overfished state for a long time, Malacca Strait still remains a very important fishing ground for the Indonesians particularly for small pelagic fishes.

Over the last three decades (1970s-2000s), the total fish landings of FMA-I contribute an average of 7.30% to the total fish landings of Indonesia but its importance has waned over the last 40 years (Figure 2.2). In the 1970's, the Strait contributes about 17% to the total national fish landings. However, due to overexploitation of the resources, its contribution significantly decreased to just 12%-13% in the eighties and nineties, and slipped further to just 6% to 7% in more recent times. At present, the major fish species landed in Malacca Strait are small pelagics that include the scads (*layang*), Indian mackerels (*kembung* and *banyar*) and sardines (*tembang*).

Surprisingly, while the general fisheries production is on the decline, nominal tuna landings in FMA-I showed five-fold increase from 1970 to 2001 where it attained it highest catch level of 52,470 tons (Figure 2.3). Since 2001, tuna production has declined in the last four years by 50% to its 2005 level of only 25,719 tons.

Tunas represent about 9.80% of FMA-I's total production from capture fisheries. This figure represents a 45% increase in the share of tunas relative to the total fisheries production in the 1970's. The average contribution of tuna to the total fish landings of FMA-I over three decades (1970s-2000s) is about 7.95 percent.

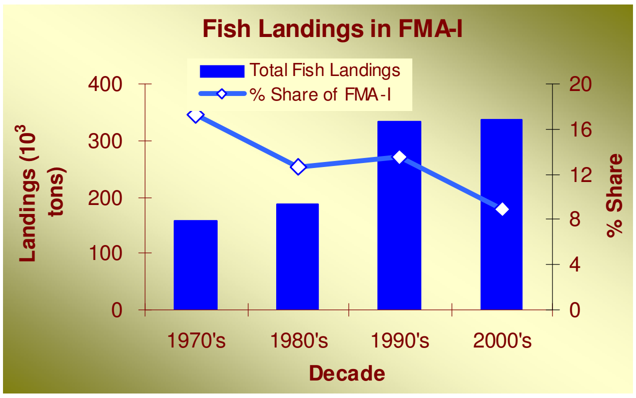


Figure 2.2. Total fishery production and share of tunas for fishery management area One (FMA-I). Source: DKP Statistics (1977, 1984,1994, 2002, 2005,2006).

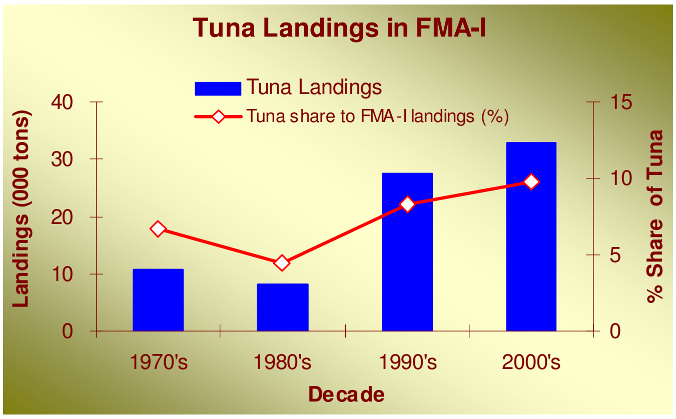


Figure 2.3. Tuna production in FMA-I and share to total fish output. Source: DKP Statistics (1977, 1984,1994, 2002, 2005,2006).

Share of Landings by Province

Three Indonesian provinces share the fisheries resources of Malacca Strait. These are Nanggroe Aceh Darussalam, North Sumatra and Riau.

About three fourths (75.4%) of tuna production in FMA-I are landed in North Sumatra, 28.5% in Nanggroe Aceh Darussalam and the remaining 0.99% in Riau Province. Because of its huge contribution, the trend of tuna landing for the FMA-I follows the trend exhibited by tuna landings in North Sumatra (Figure 2.4). Tuna landings in FMA I increased 10-fold over the period from 1970's to reach 36,000 MT in 2003 and then declined by 29% in 2005.

Trends of Fishing Capacity

There are about 12 types of fishing gears catching tuna in FMA-I (Table 2.2a). These include two types of seines (pelagic Danish seine or boat seine called "*payang*" and purse seine called *pukat cincin*), four gillnets (drift gillnet, encircling gillnet, set gillnet and trammel net) and six hook and line types (tuna handline, simple handline, drift longline, set longline, tuna longline and troll line). Note that all gears listed save for the tuna longline and the tuna handline, target mainly small pelagic fishes.

In 2005, there are about 18,818 units of fishing gears landing tuna in FMA-I. This number of fishing gears represents just 46% of the total recorded in 2001 (Table 2.2a). While such huge decline in gear number may partly be attributed to the tsunami

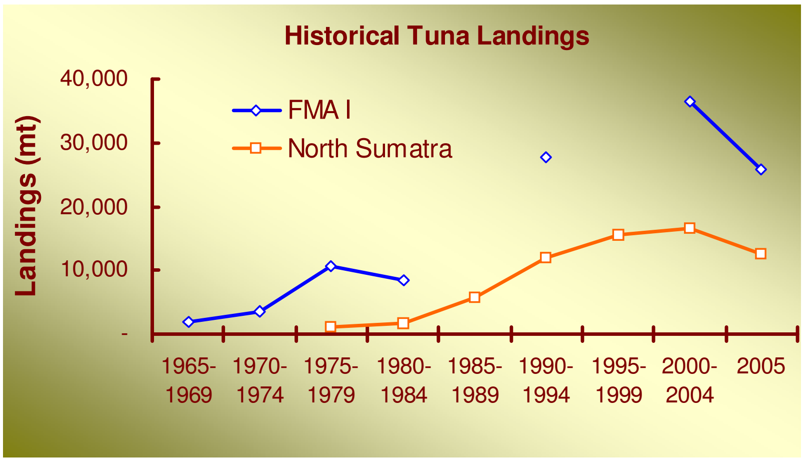


Figure 2.4. Trends of tuna landings in fishery management area One (FMA-I) and in North Sumatra province. Source: DKP Statistics (1977, 1984,1994, 2002, 2005,2006); Sudjastani (1975); Herry, et.al. (1985).

Table 2.2a. Trends in the number of types of fishing gears catching tuna in fishery management area (FMA-I). Source: DKP Statistics (1977, 1984,1994, 2002, 2005,2006).

Gear Type	1976	1983	1993	2001	2004	2005
Danish Seine	794	205	1997	1092	963	855
Drift Gillnet	5754	8479	8879	10072	7797	6797
Drift Longline	1278	597	894	1431	2131	2085
Encircling Gillnets	136	297	628	809	836	800
Hand Line	-	-	-	-	229	236
Hook and Line	8009	8629	9663	10281	3522	1549
Purse Seine	180	540	1310	2198	2262	1519
Set Gillnet	217	1247	3529	5491	2203	2050
Set Longline	110	460	2351	5873	1172	721
Trammel Net		255	3592	2243	1731	1497
Troll Line	766	1190	1471	1418	418	686
Tuna Longline	0	15	127	54	86	23
Total	**17244**	**21914**	**34441**	**40962**	**23350**	**18818**

Table 2.2b. Trends in the number of fishers, boats and fishing gears catching tuna in north Sumatra province. Source: DKP Province Statistics of North Sumatra (1977, 1984,1994, 2002, 2005,2006).

Year	# of fisher	# of boat	# of gears	# of gear for tuna
1980's	75,173	18,253	22,552	8,207
1990's	84,910	20,447	24,828	9,844
2000	89,688	19,581	25,251	9,961
2001				
2002	90,478	19,828	26,575	9,861
2003	93,048	20,214	24,837	10,372
2004	95,981	19,047	18,683	8,639
2005	98,687	19,097	19,237	8,912

that resulted in gear losses at NAD, records from North Sumatra likewise showed similar trend.

The fishing capacity of FMA-I as can be gleaned from North Sumatra fisheries show that the number of fishers continue to increase, the number of boats, gears and tuna gears appear to have fluctuated within a range, probably brought about more by inconsistent reporting (Table 2.b). Beginning 2000 however, a declining trend in number of fishing gears, in particular the number of tuna fishing gears for the period between 2003-2005 is evident. The most probable reason is decline profit in the face of increasing operating costs.

Table 2.3. Total fish and tuna landings in Malacca Strait jurisdiction of North Sumatra (FMA-I). Source: North Sumatra Provincial Statistics (2006).

Gear Type	Total Fish (mt)	Total Tuna (mt)	% Tuna	% Tuna per gear type
Purse Seine	36,162	3,648	28.9	10.1
Drift Gill Net	39,306	6,770	53.7	17.2
Encircling Gillnets	12,456	1,855	14.7	14.9
Drift Hook & Line	6,022	162	1.28	2.69
Troll Line	536	119	0.94	22.2
Hand Line	1,068	23	0.18	2.13
Other Hook & Line	3,724	36	0.29	0.97
Total	99,272	12,612	100	

Landings by fishing gear

In 2005, the 97% of total tuna landings in FMA-I is caught by only three (3) fishing gears, namely the drift gillnet which contributes more than half (53.7%), followed by purse seine (28.9%) and encircling gillnet which contributes 14.7% of the total landed tunas (Table 2.3). Interestingly, these fishing gears target small pelagic species in general and catch tunas during certain seasons. Tunas therefore account between 1-22% of the total fish production of these gears with the troll line showing the biggest share of tunas in its catch with 22% while purse seine, encircling and drift gillnets account for 17.2%, 15% and 10%, respectively (Table 2.3). Purse seines and encircling gillnets target the small tunas while troll line and drift gillnet catch skipjack and also the juvenile individuals of the big tuna species.

Landings by species

Small tunas account for 97% of total tuna catch for FMA-I. Eastern little tunas (*tongkol komo*) dominate the tuna catch with 81.6%, frigate tunas with 15.2% (*tongkol krai*) (Figure 2.5). Large tunas are represented by the longtail tuna (*tongkol abu-abu*) and account for a mere 3.17% of total tuna production with just 400 tons in 2004 (DKP 2005).

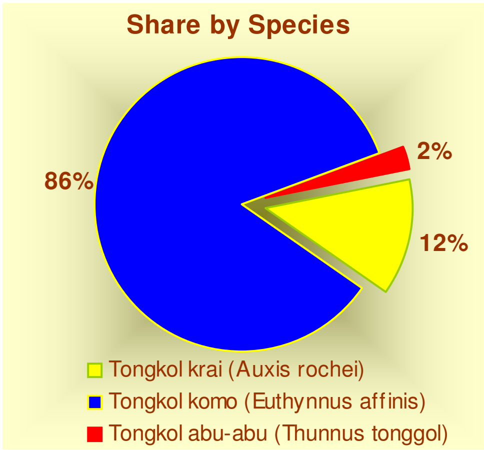


Figure 2.5. Share to tuna production by species for 2004 from FMA I. Source: DKP-WPP 2006.

The contribution of each tuna species to the total production of each gear type is shown in Table 2.4. Eastern little tuna are caught by four gear types (drift gillnet, encircling gillnet and purse seine) while longtail tunas are taken by three gear types. The rest of the tuna gears catch insignificant amount of tunas.

Prior to 2004, reporting of tuna catch was classified into three groups, namely "*tongkol*" (mixture of small tuna species and juveniles of large tuna species), "*cakalang*" (skipjacks), and "*tuna*" (large tuna species i.e. yellow fin, big eye, etc.).

Table 2.4. Tuna landings (mt) by species by gear type in North Sumatra province, Malacca Strait in 2005. Source: DKP North Sumatra Province Statistics 2006.

Gear Type	Tongkol krai (Frigate tuna)	Tongkol komo (Eastern little Tuna?)	Tongkol abu-abu (Longtail tuna)	Total Tuna Landings	Contribution to Total Landings (%)
Purse Seine	1,699	1,764	185	3,648	28.9
Drift Gill Net	16	6,574	179	6,770	53.7
Encircling Gill Nets	-	1,855	-	1,855	14.7
Drift Hook and Line	162	-	-	162	1.28
Troll Line	19	100	-	119	0.94
Hand Line	23	-	-	23	0.18
Other Hook and Line	-	-	36	36	0.29
Total	1,918	10,294	400	12,612	100.0

Table 2.5 Tuna landings by species by fishing gear in 2005, Malacca Strait (FMA-I). Sources: DKP Statistik (1977, 1984,1994, 2002, 2005,2006), Tatang (1975).

Decade	Large tuna	Skipjack tuna	Small tuna	ELT (?)	Frigate tuna	BET	Longtail tuna	Bullet tuna	ALB	YFT
1960's		294	1,676							
1970's		1,594	9,096							
1980's	267	983	7,067							
1990's	1,922	2,028	23,707							
2001	1,500	7,286	43,684							
2004		2,862		14,236	2,083	825	400			
2005		3,303		12,479	3,419	833	3,874	6	2	1,803

Landing of large tunas in Malacca Strait is very small compared to other fishing grounds. Small tunas and skipjack form the bulk of the tuna landings. In the late sixties to seventies, these two groups are the only tunas landed. It was only in the 1980s that the large export species of tuna are landed in the Malacca Strait (Table 2.5), probably as a result of the construction of a first the PPS Belawan fishing port that allowed bigger boats to land with sufficient support faciities. These large tunas landed then are presumably caught from outside the Strait.

Recent initiative to improve quality of fisheries statistics were made that included identification of important fish groups (including tunas) to species level. The *tongkol* in FMA-I is identified and reported by the statistics department as *Tongkol komo* (*Euthynnus affinis*), *Tongkol krai* (*Auxis thazard*), *Tongkol abu-abu* (*Thunnus tonggol*). Among these species of small tunas, the *Tongkol komo* (Eastern Little Tuna ~ *E. affinis*) are the most abundant (Table 2.5).

Verification visits to the local markets and landing places showed that the *Tongkol komo* (Eastern Little Tuna ~ *E. affinis*) are rarely found. The *lisong* (bullet tuna) which is not at all reported in the statistics are the abundant and the common species in the markets. This led us to question the identity of fishes in the statistics. It is highly probable that misidentification of the species occurred as these species are difficult to sort from one another, particularly the very small ones to an untrained enumerator.

It is therefore presumed that *Tongkol krai* would mean a group of small-sized tunas composed of mostly bullet tuna (*Auxis rochei*) mixed with juveniles of skipjacks, frigate tuna, eastern little tuna, and of the large tunas, instead of just the eastern little tuna species. The statistics from DGF according to Fisheries Management Area (WPP) reported that in 2004, 85.2% are bullet tunas and others (*A. rochei* and other baby tunas), 12.5% are frigate tuna (*A.thazard*) and 2.39% are longtail tunas (*T. tonggol*) (Figure 2.5).

The two different published statistics are reporting two conflicting figures, in the original statistical publication (Fisheries Statistics by Provinces and Coastal Areas) large tuna species and skipjacks are landed in Malacca Strait but in the newly published statistical report (Fisheries Statistics according to Fisheries Management Areas) only the small tuna species are landed in FMA-I (Malacca Strait) but the large species of tuna and skipjacks are not (Table 2.4 and Figure 2.4).

Estimate of Tuna Catch

This study provides an independent estimate of the tuna catch of each management area. For FMA-1, we have utilized only two set of fishing gears, the purse seine and the drift gillnet primarily because these two are the major gears that catch tunas and because of availability of operational data from results of interview and from existing publications.

The estimated total tuna production of these two major fishing gears operating in Malacca Strait is about 12,969 tons. Drift gillnet account for three quarters (78%), purse seine, categorized into small (<50 GT) contributed the remaining 21% while

Supply of FAD materials for sale in a sidestreet near Belawan Fishing port. Above, cement anchors, below aredried coconut fronds.

Table 2.6. Estimate of tuna catch in FMA I. See Box 1 for explanation

Gear Type	Ref. Year	No. of gear	Total fishing days	CPUE (kg/boat day)	Total fish production (ton)	% share of tuna	Total tuna Production (ton)
Drift Gillnet	1992-2002	6797	150	20	20,391	1	12,235
Purse Seine (50-100 GT)	2006	100	90	122.2	1,100	0	110
Purse Seine (5-50 GT)	1984; 2006	1,419	75	61	6,449	0	645
Total					27,940		12,989

Box 1: Explanatory Notes on Table 2.6

The tuna production estimate for FMA I is based on just two gear types, the purse seine and the drift gillnet. The gear number for purse seine used (n=1519) was taken from the 2005 estimate of DGF in the number of purse seines operating in Malacca Strait. Of these, about 100 units belong to the 50-100 GT class and the remaining units (~1,419) are vessels <50 GT and are considered mini-purse seines (Table 1). For drift gillnet, the total fleet number used is the one isted in the statistics and is less than the estimate provided by our respondents.

The operational data used in the computation were based from results of interview as follows:

Purse seine (>50 GT) : number of vessels - 100; 90 annual fishing days; mean catch of 122.2 kg per day; the catch composed of sardines (50%), mackerels (20%), small tunas (20%), and other fishes (10%). We have used 10% instead of 20% for the share of small tunas in the purse seine catch.

Purse seine (<50 GT) : number of vessels - 1419, 75 annual fishing days, mean catch of 61 kg per day; same catch composition as above.

Drift Gillnet: number of vessels - 6797, 150 annual fishing days, mean catch of 20 kg per day; share of tunas in catch is 60%.

We did not get to interview mini purse seine but used as catch rates half of the catch of the bigger vessels. This assumption is valid given the fact that both purse seines operate in the same fishing ground, use the same technique (using FADs and lights) and fish at the same time of the year. The bigger ones are just better and catching more because of their faster mobility and bigger nets thereby higher fishing efficiency. Note that in the mid 1980's, the catch rates of mini purse seines is 559 kg per day or 310 kg per set (PRPL 1984)

We used the 2005 figures given by the provincial statistics for drift gillnet as this has been confirmed by our respondent. For the catch rates, we have used data of PRPT (2006) that gave a range of catch between 2-5 tons per year. Given that average annual fishing days is about 150, the catch rate amounts to 20 kg per fishing day which is very conservative.

the large purse seine boats numbering about 100 units account for less than 1% (0.7%) of the total tuna catch. The details of data used in the estimate of tuna production are presented in Table 6.

The estimate of tuna production is incomplete because of lack of sufficient operational data to allow tuna output of the remaining 10000 other gears reported to be catching tuna as by catch. Troll fishing experiments conducted in the seventies (1972-1976) showed catch rates of 100 kg per day with half of the catch are skipjack (Venema, 1996).

It is likely that the mean catch rates are far higher that the ones used in Table 2. 6. This is due to the use of FADs and lights which are very effective in herding the fish and translate to higher fish yields. The recent oil price hike has trigger the use of FADs in order to save on fuel that would otherwise go to searching of schools. As a consequence, businesses around Belawan PPS port are established that provide the materials used in FADs (Figure 2.6)

Description of Fishing Techniques

Purse Seine

Purse Seines were first introduced to Indonesia in Malacca Strait, particularly in Bagan Siapi-api, in the early 1960's along with trawl fisheries but were not as popular as the trawl fisheries. But with the trawl ban in the early 1980's, many trawl units were converted to purse seine that resulted in the three-fold increase of purse seine units between 1976 and 1983 (Table 2.2) (Yamamoto, 1987; Morgan and Staples, 2006).

Purse Seines mostly target surface shoaling fishes. The net is designed like a wall of curtain buoyed at the surface and weighted at the bottom. The longitudinal view of the net is akin to the letter V of the English Alphabet with the float line longer than the lead line. The lead lines are also outfitted with ringed-line which serves as the closing mechanism of the net. The net operates by surrounding a school of fish. Once the school of fish is surrounded, the ringed-line is pulled up so that the bottom of the net closes first and then the net is pulled up. When the fish are concentrated and near the surface, these are taken through dip-nets or are pumped out of the net.

There are two classes of purse seine operating in Malacca Strait, those onboard the fishing vessels of 50-100 Gross Tonnages (GT) which are also using larger nets and those onboard the fishing vessels of <50 GT which are also using smaller nets. The surface length of the large purse seine's net is about 1 km while the depth is about 60 m. The mesh size is 20 cm and the selvage is 40 cm. There are about 100 units of this size category of purse seines operating in FMA-I, based in Belawan. For a detailed description of the Purse Seine please go the chapter discussing Fisheries Management Area Seven (FMA-VII).

In the large purse seines there are about 35 crews manning the operation. Traveling time to the fishing ground usually take nine hours. Fishing is usually in FADs at day-time but sometimes fished at night when the weather condition is good. When fishing at night, they used 26 mercury lights of about 1000 watts each to aide in concentrating the fish. They usually stay at the fishing ground for 5 days before going back to the port to unload their catch and renew their food provisions. Conservative estimate of the total number of days fishing in One year is about 90 days with a mean catch of 122.2 kg per day which amounts to about 11 tons per year. There are about 100 fishing gears of this size operating in the area. It was assumed that the catch rate of the mini-purse seines is half that of the big purse seines. In comparison with the purse seines in 1984, there was a significant decrease of about 450% in catch rate but with a significant increase in the gross tonnages of fishing vessels (Table 2.5)

Infrastructure Support

Despite the relatively small contribution of FMA-I to the tuna industry Indonesia, there is a first level fishing port here, the Pelabuhan Perikanan Samudera (PPS) – Belawan. This may be because of the rich and productive fisheries history of Malacca Strait. However, the facilities in the port are not at par with the other PPS in the country. The landing facilities are built of bamboo material, and there are very few storage warehouses and ice-making facilities.

A typical large purse seine docked at PPS Belawan, Medan. Note FAD materials on board ready for deployment.

Post harvest handling of fish needs a lot of improvement too. Though the fish are put in baskets for the whole duration of the unloading and sorting operation until the auction is done, the quality of the fish is very poor. About 45% of the landed fishes, despite being fresh, are smash due to overstuffing of the fishhold or fish containers while in the fishing boats; this stage together with the stale and decaying fishes are usually classified under Class C. The relatively good quality (Class B), which is characterized by fishes with fresh and intact body and are moderately fresh but are candidates of putrefaction, is about 45 percent. Only 10% are said to be really fresh and of very good quality (Class A). The Class C fishes mostly go to fishmeal factories, the Class B fishes are marketed locally and the Class A fishes are mostly exported to Singapore and Malaysia. The exported fishes are mostly fresh or frozen scads and mackerels

Most of the fishing vessels landing in the port are Pukat Ikan (modified Trawl ~ 39%), Lampara Dasar (demersal Danish Seine ~ 11.5%), Pukat Cincin (Purse Seine ~ 46.8%), Jaring Insang (Gillnets ~ 2.5%) and Pancing (Hook and Line ~ 0.3%) (PPS-Belawan, 2005).

The road leading to the port exhibits several depots of materials for payao which may indicate that the use of FADs is very rampant in the area.

FMA-II: South China Sea

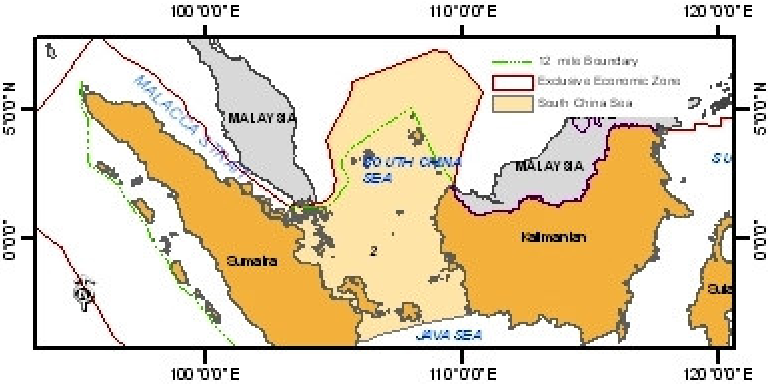


Figure 3.1. Geographic location of the South China Sea fishery management area two (FMA-II).

Geographic Scope

South China Sea is the southernmost arm of the China Sea and is also connected to the Pacific Ocean. It is bounded by Sumatra (south), Borneo (southeast), Philippines (east), islands of Taiwan (northeast), and the Southeast Asian and Malay Peninsula (north through west). The Sea's total area is about 3.7 million km^2, extending for about 2,900 km from south to north and 950 km from east to west (Britannica, 2007). The area of Indonesian jurisdiction within South China Sea is about 595,000 km^2 (PRPT, 2006).

The South China Sea, along with other seas such as Java, Flores and Banda which are aligned on the main axis of wind flux exhibit strong surface current circulation (Roy, 1996). This particular characteristic together with the relatively shallow depth of the water column (within the Indonesian jurisdiction) enhances vertical mixing of waters thereby enhancing primary productivity.

The Indonesian jurisdiction of South China Sea is in the southernmost edge of the Sea and was designated as Fisheries Management Area Two (FMA-II), the designation is for statistical and management purposes. Also included as part of FMA-II are Karimata Strait and Natuna Sea (Figure 3.1). There are six Provinces covered within FMA-II namely: Riau, Jambi, Sumatera Selatan, Kepulauan Bangka Belitung, Lampung, and Kalimantan Barat (Table 3.1).

Drift gillnet boats docked at the coastal fish port of Pangkal Pinang, Bangka Belitung

Sources of Data for Analysis

Data processed and analyzed are primarily from the results of interviews and actual scoping of the landing places in FMA-II. This is supplemented by the statistics published by the Departemen Kelautan Perikanan (DKP ~ formerly Department General of Fisheries) and the Provinces' Dinas Perikanan, term papers of the students of Sekolah Tinggi Perikanan, and other research papers and reports done in the area (published or unpublished). The internet was also thoroughly searched for data and publications published through the web.

Table 3.1. Political units within the South China Sea (FMA-II). Source: DKP 2006.

Province	Kabupaten/ Kodya/Kota	Province	Kabupaten/ Kodya/Kota
Riau	Pelalawan,	**Kalimantan Barat**	Ketapang
	Indragiri Hilir		Pontianak
	Karimun		Sambas
	Batam		Bengkayang
	Kep. Riau		Kota Singkawang
	Natuna		Kota Pontianak
	Tanjung Pinang	**Lampung**	Lampung Utara
Jambi	Tanjung Jabung Barat		Lampung Tengah
	Tanjung Jabung Timur		Lampung Selatan
Kep. Bangka Belitung	Bangka		Kota Teluk Bitung
	Kota Pangkal Pinang		Tanjung Karang
	Belitung	**Sumatera Selatan**	Musi Banyuasin
			Ogan Komering Ilir

Most of the data used for trend analysis of tuna landings in FMA-II was from the statistical data published by the Province of south Sumatra (Sumatera Selatan) and the DKP Annual Statistic Reports.

Limitations and Assumptions

It was assumed at the start of the study that FMA-II was one of those areas which tuna landings were not quiet significantly high to the country's total tuna landings. This assumption was further confirmed by the national fisheries statistics reports published by DKP. This assumption and the limited time and logistics, the time spent for the actual survey in the area is lesser compare to other areas where tuna landings were significant.

For the determination of trends, the national statistics of the tuna fisheries in FMA-II, is complemented by the statistics of the Provinces of Sumatera Selatan and Kepulauan Bangka Belitung.

Similar to the other FMAs, tongkol komo (eastern little tuna ~ *Euthynnus affinis*) is reported in the available statistics to be the main small tuna species caught but actual surveys of markets and landing places show that another species, the bullet tuna (*Auxis thazard*) or lisong in Bahasa Indonesia, is the most common and abundant. In order to settle this confusion, we have decided to use the local generic term small tunas or tongkol as a collective term that includes bullet tuna, frigate tuna and juveniles of skipjacks, and the large tunas.

Trends of Total Fish and Tuna Landings

The total capture fisheries output of FMA-II in 2004 is 433.6 thousand metric tons. This represents about 11.3% of the total fish landings of Indonesia (Table 3.2). The share of FMA-II relative to the total Indonesian fish production for the period 2000-2004 show 15% decline. The fishery of FMA-II consists of the demersal, reef and pelagic fisheries, the major pelagic fisheries are mainly small pelagic fishes such as small tunas, sardines, scads and anchovies. The most current assessment of the fisheries in 2005 showed that exploitation rate of pelagic fishery resources within FMA-II is already very high though not yet classified as fully exploited (PRPT, 2006).

Trends of tuna landings, based on two available statistical records; from DKP statistics presented on per provinces and coastal areas and the other presented on per FMA, show an upward trend since the 1970's where production from 10,000 MT has quadrupled at the start of the millennium (Figure 3.2). It is apparent that tuna landings has peaked in 2003-2004 wherein it amounted to over 50,000 MT and then showed a 50% drop landings in 2005 with only 23.6 thousand MT (Figure 3.3). The reason for such significant decline can not be ascertained although fishers interviewed reported scarcity of fish even during the season.

Table 3.2. Share of FMA-II fish landings to the total Indonesian landings. Source: DKP-SPP 2006.

Year	Total fish landings Indonesia (103 MT)	Total fish landings of FMA-II (103 MT)	% share of FMA-II
2000	3350.475	444.04	13.3
2001	3446.389	476.73	13.8
2002	3507.86	452.59	12.9
2003	3785.356	463.49	12.2
2004	3832.733	433.60	11.3

While the general trend of tuna landings between the two statistical yearbooks show similar trend, there are significant differences between the landing figures given; the statistics presented on the per provinces and coastal areas consistently report higher landings as compared to the landings presented by the statistics according to fisheries management areas (Figure 3.3). This is partly because the province of Sumatera Selatan contained landings from the Indian Ocean that falls under FMA-IX and partly from the inconsistencies in data reporting system inherent within the system used in the country.

We analyzed the fisheries statistics of Sumatera Selatan and Bangka Belitung provinces to represent tuna from the South China Sea portion of the country. Tuna landings from these two provinces account for a fifth (20.5%) of the total tuna production from FMA-II (Table 3.3). The remaining 79.5% was assumed to be landed from the other five provinces of Riau, Jambi, Lampung and Kalimantan Barat. The share of tuna landings in these two provinces relative to the total tuna landings of FMA-II is increasing from 14% in 2000 to 25% in 2005 (Table 3.3).

The contribution of Sumatera Selatan to the total tuna landings of FMA-II represents only 1.25%. Tuna landings for the Province range between 300-1,000 metric tons since

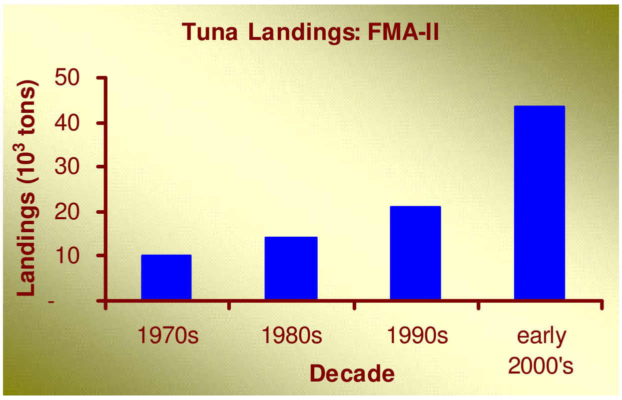


Figure 3.2. Historical trend of tuna landings in FMA-II to include South China Sea, Karimata Strait and Natuna Sea. Sources: DKP National Statistics, various years.

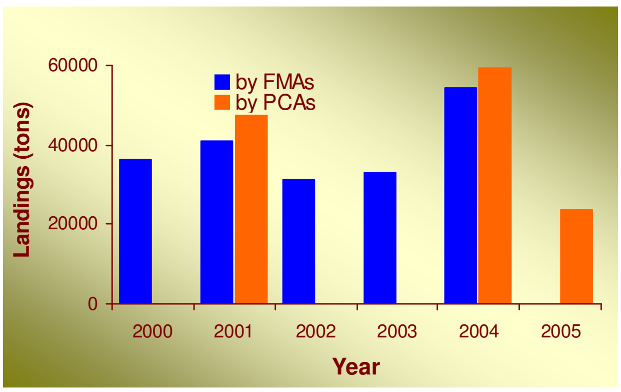


Figure 3.3. Comparison of tuna landings in FMA-II from two official statistical yearbooks. Sources: DKP-PCA and DKP-WPP.

1970. It probably reached its highest level of landings in the mid-1990's with recorded landings of 2,858 MT. The lack of time series data for tuna from this province precludes any worthwhile trend analysis.

Tuna landings from the province of Bangka Belitung is more significant in terms of volume with 19% share. It is worthy to note that despite just being a newly established province, the fisheries statistics over the last five years are complete and readily available for public use. Tuna landings in Bangka Belitung Province between 2000 and 2002 leveled off at around 5,000 tons, and more than doubled in 2004 and 2005 with over 13,000 tons (Figure 3.4).

Table 3.3.Share of tuna landings in the Provinces of Sumatera Selatan and Bangka Belitung to the total tuna landings in FMA-II. Sources: DKP-WPP 2006.

Year	South Sumatra	Bangka Belitung	Total of FMA II	% Share South Sumatra	% share Bangka Belitung
2000	396	5212	36305	1.09	14.4
2001	431	5563	41010	1.05	13.6
2002	514	5831	31115	1.65	18.7
2003	504	8031	33034	1.52	24.3
2004	517	13673	54344	0.95	25.2
2005	266	13673	-		

Trends of Tuna Landings by Species

Species identification and reporting of the tuna species prior to 2004 has been grouped into three major categories namely, "tuna" (large tuna species), "cakalang" (skipjacks) and "tongkol" (small tuna species). The statistics gleaned from the annual reports according to provinces and coastal areas (PCA) showed that in the 1970's the "tongkol" group (96% ~ 9,694 tons) dominated the landings of tuna in FMA-II, followed by the large tuna species "tuna" (3.3%) and "cakalang" with only 0.66% (Figure 3.5). In the 1980's, the entire tuna fishery is practically "tongkol" (99.2%), the large "tunas" still coming next but the contribution has decreased to only 0.67% (94 tons) while cakalang comprises 0.10% (14 tons) only. In the decade of the nineties, the "tongkol" still dominates with about 93.4% (19,587 tons), but lost 7% of its share to the the "large tuna" comprised about 4.3% (900 tons) and cakalang which share increased significantly into 490 tons (2.3%).

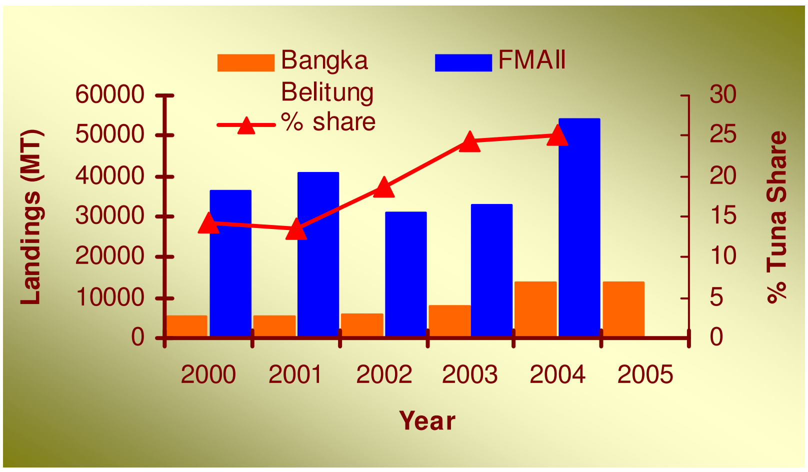


Figure 3.4. Trend of tuna landings in the newly created Province of Bangka Belitung and its share to the tuna landings in South China Sea (FMA-II). Source: DKP Propinsi Bangka Belitung 2000-2005.

Starting in the 2000s, there have been major changes in the landings of tuna. For instance, share of "tongkol" fell to just 82.5%, while landings of both the "tuna" and cakalang markedly increased their share to 5% and 12%, respectively. In 2004, the landings of cakalang were back to its pre 2000 levels at just 85 tons. In 2005, the share of the "tuna" account to almost half at 49.5%, and is at the same level as that of the "tongkol" with 49.5%) while the skipjack (cakalang) account for the remaining 1.1%.

Clearly, large fluctuations (as shown by recent data on skipjack) may probably be due to shortcomings in data recording rather than on the status of the resources. However, the apparent changes in share of small tunas being replaced by large tuna species may be partly a result of probable shift in fishing techniques, from drift gillnets to handline and the growing use of FADs in the fishing operations. The shift could have been triggered by declining availability of small tunas.

In the last three years, improvements in the data collection system are visible. The publication of the statistics presented on a per management area and the identification of tunas to species level are two key improvements in recent years. The first release of statistics according to fisheries management areas (FMAs) showed frigate tunas *Auxis thazzard*, as the dominant species under the category of "tongkol", a category in previous statistical yearbooks identified as eastern little tuna, *Euthynnus affinis* and *E. yaito*. Whether there was a shift of species composition from eastern little tuna to the frigate tunas could not be ascertained.

In 2005, longtail tuna (*T. tongkol*) and eastern little tunas (*E. affinis*) account for 97.6% of total tuna production and the remaining 2.55% are shared by big eye, frigate and skipjack tunas (Figure 3.5).

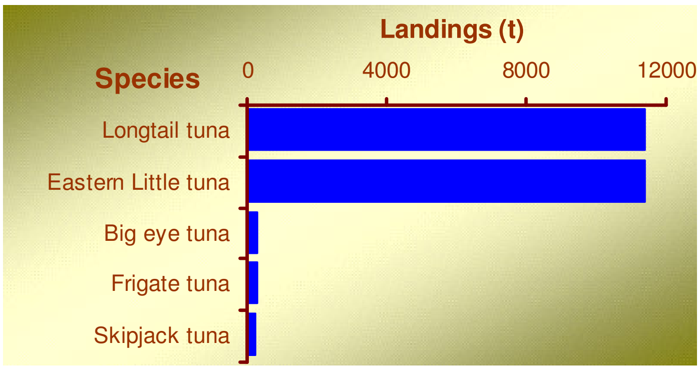


Figure 3.5. Tuna landings (tons) by species in FMA-II in 2005.
Source: DKP-PCA 2006

Trends of Tuna Landings by Fishing Gear

Because there is no clear data on the national fisheries statistics on tuna landings by fishing gear in different fisheries management areas, the fisheries statistics of the province of Sumatera Selatan was used here to represent FMA-II. Since Sumatera Selatan Province covers two fishery management areas, the statistics are first sorted to get landings belonging to South China Sea (Table 3.2).

There are five types of fishing gears catching tuna in the FMA-II jurisdiction of the province of Sumatera Selatan. Unfortunately one of the categories, "pancing lainnya" (other hook & line) lumped all the different types of the hook and line fishing gears (Figure 3.6). In 1995, jaring insang hanyut (drift gillnet) and pancing lainnya (other hook and line) were the only fishing gears catching tuna. Starting 2000, trammel net started to catch tuna. In 2003, jaring insang tetap (set gillnet) and bagan tancap (stationary liftnet) recorded tuna catch as well (Figure 3.6).

In 1995, drift gillnet contributes 7.35% to the total tuna landings in FMA-II while the group of hook and line contributes 2.66% (Figure 3.7). Starting 2000 however, the

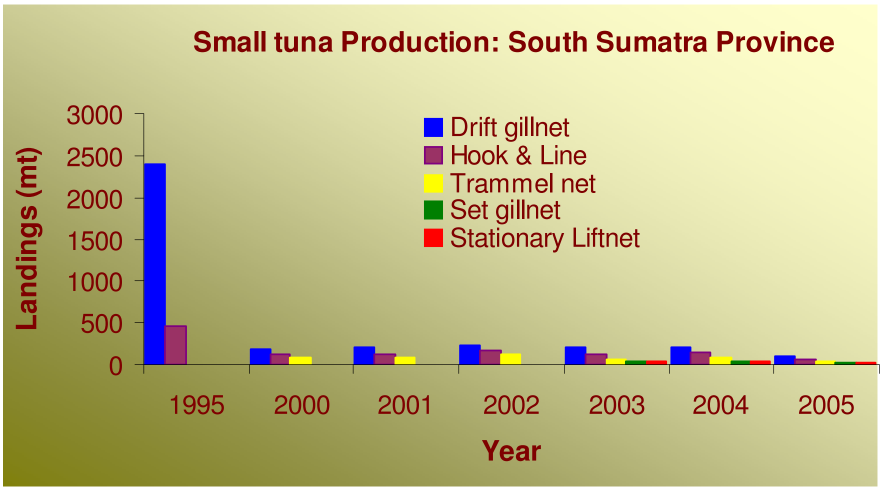


Figure 3.6. Tuna landings by gear types operating in FMA-II and based in Sumatera Selatan Province. Source: DKP Propinsi Sumatera Selatan, various years.

contribution of drift gillnet significantly decreased while other fishing gears are starting to catch a share in the tuna resources. The group of unidentified type of hook and line maintain the same share but has become the major contributor to the tuna landings.

It is apparent that because of the usual practice of lumping fishing gears according to major type, loss a lot of information very necessary in the analysis of the condition of a certain resources.

Trends of Fishing Capacity

Fishing Gears

Because of the universal practice of lumping data, there is not much we can make use of the effort data reported by in the fisheries statistics, including data set of the provinces. However just to have an idea of what is happening to the whole fisheries, a short description is presented below to show what is happening to the tuna fisheries by making use of the data from the fisheries provincial statistics of Sumatera Selatan and Bangka Belitung Provinces (Table 3.4 and Table 3.5).

There is an anomaly observed for the records of Sumatera Selatan Province which indicates an all-time high on the number of fishing gears which was discounted in the analysis (Table 3.4).

In Sumatera Selatan, the group of hook and line is the most widely used among the tuna gears. Its numbers have fluctuated from a level of over 2,000 units in the mid 1970's to 1980's, reached its peak in 1995 with 3,800 units and has since declined to just over 1,000 units since the turn of the millennium (Table 3.4). The number of troll lines, attaining its highest number in 1979 (n=744 units) has been used in the 1970-1980's but has not been absent from statistical records since 1995. The reason for its absence is not known.

Drift gillnets is likewise popular and its numbers have fluctuated significantly over the years with the general trend of decreasing numbers. The number of units of drift gillnet was below 1,000 units from 1976-1980, reached its highest number in 1995 with 2,400 units and has since declined by as much as 75% wherein only 389 units remained in 2005. Its demersal counterpart, the set gillnet showed an increasing trend whose numbers have increased from less than 100 units in the mid 1970's to over 800 units in 2003-2004. Similarly, trammel net, which was first introduced the mid 90's has remained popular whose numbers fluctuated from 600-850 units. Liftnets, which catch tunas only a seasonal basis remained one of the popular gears mainly because it supplies anchovies, a favorite fish of the locals (Table 3.4).

In Bangka Belitung Province, available record in 2005 show hook and line with (13,846 units) followed by a demersal gear, the set gillnet with about 10,298 registered units. The trammel net (6,735), drift gillnet (5,944), troll line (3,435) and Danish seine (1,160) are also significantly used in the area (Table 3.5). The number of lift net is almost as abundant as that in Sumatera Selatan within the FMA-II which was 586 units. The registered purse seines number about 40 units. The popularity of hook and line is expected due to its low capital requirement and high return on investment. This group also exhibit the most number of varieties.

Fishing crafts

Again the fisheries provincial statistics of Sumatera Selatan Province was used to represent trend in fishing crafts. Only the number of motorized fishing boats is presented here as non-motorized fishing boats are not used in tuna fishing. There seems to be an unexplained very high number in 1995 that it was deemed appropriate not to include them in the analysis (Figure 3.7). The graphical presentation of all the motorized boats registered within the coverage of FMA-II in Sumatera Selatan Province (and assumed to be fishing within the FMA-II) showed generally increasing trend since 1970 until 2005, which is the latest statistical publication as of this study period.

Table 3.4. Number of fishing gears for the province of Sumatera Selatan. Source: DKP Propinsi Sumatera Selatan various years.

Gear Type	1976	1977	1978	1979	1980	1995	2000	2001	2002	2003	2004	2005
Danish Seine	558	476	500	146	542	861		98	102	179	179	205
Drift Gillnet	927	862	850	727	886	2414	502	513	549	408	422	389
Set Gillnet	47	64	152	167	187	492	210	196	202	825	854	681
Trammel Net						600	615	696	712	856	870	707
Lift Net	588	698	973	864	389	1440	781	570	580	648	717	630
Other Hook & Line	2394	2084	1919	2038	2345	3872	724	777	751	1042	1064	1126
Troll Line	864	152	653	744	658							
Total	5378	4336	5047	4686	5007	9679	2832	2850	2896	3958	4106	3738

Table 3.5. Number of fishing gears for the Province of Bangka Belitung for 2005. Source: DKP Propinsi Bangka Belitung.

Tuna Gear Type	No of Gears (2005)
Other Hook and Line	13846
Set Gillnet	10298
Trammel Net	6735
Drift Gillnet	5944
Troll Line	3435
Danish Seine	1160
Lift Net	586
Purse Seine	40

A closer look in Table 3.6 show marked increases in the number of fishing vessels, particularly for small ones with in-board engines; while a marked decline in the large boats of 20-30 gross tons. This may indicate more small scale fishers are joining the fishing sector, a truly disturbing development that will have severe consequences in the years to come.

Estimate of tuna catches

Tuna catches from South China Sea based on Table 3.8 is almost 50 thousand tons (49,745 MT). This estimate is very near the recorded values of 54,344 metric tons for

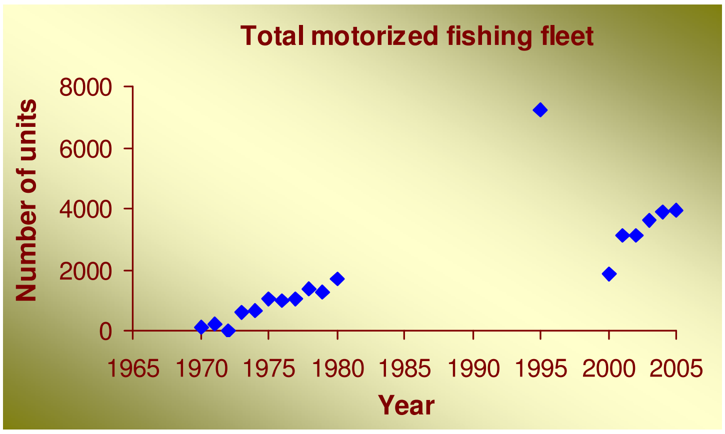


Figure 3.7. Trend in the increase of motorized fishing fleet of Sumatra Selatan Province. Note the high entry for 1995. Source: DKP Propinsi Sumatera Selatan (various years).

2004. However, our estimate is based on very conservative figures and we believe that the actual production of tunas from South China Sea is much higher for the following reasons:

1. The number of gears used to estimate total production is on the low side as we have used only 60% of actual number of fishing gears listed in the official statistical records of each province.

2. For Drift gillnet and the pelagic Danish seine, we have used the lower limits of the figures fisher our respondents gave.

3. Similarly for the catch rates, we have used operational data for drift gillnet and pelagic Danish seines pertaining to early 2007, the time when we conducted our interview.

4. There is so much shift in use of fishing vessels, particularly in Bangka Belitung where some boats were converted into service boats for the nickel mining industry.

5. We did not include the possibility of fleets from other areas near the South China Sea but were not officially included in the list of provinces and districts covered by FMA-II which may be fishing in Sea during certain seasons.

6. For lack of sufficient data, the tuna landings in the provinces of Kalimantan Barat, Riau, Jambi and Lampung were not included in the computation.

7. An e-research on the website of SPC on tuna fishing revealed that there are tuna long liners operating in South China Sea – Indonesia territory from time to time. The fishing ground coverage is within 0° to 5° North Latitude and 120° to 125° East Longitude. The data show that

Table 3.6. Trends of fishing capacity (number of boats) in Sumatra Selatan for different vessel types. Source:DKP Propinsi Sumatera Selatan (various years).

Year	Outboard (25-40 hp)	Inboard <5 GT	Inboard 5-10 GT	Inboard 10-20 GT	Inboard 20-30 GT	Inboard 30-50 GT
2000	nd	1587	224	27	nd	nd
2001	100	2439	410	46	132	nd
2002	86	2412	417	52	135	nd
2003	221	2662	410	232	68	12
2004	225	2885	441	248	60	12
2005	231	2955	452	254	62	13

the catch composition of long lines in South China Sea is about 50% tuna species and 50% other fishes which are considered by-catch. Catch of tunas, though fluctuating between years from the lowest of 246.71 tons in 2000 and the highest of 352.82 tons in 2001, the average catch is about 282.81 tons for the years 2000 to 2003 (Figure 3.8).

With the foregoing limitations, our estimate of 50 thousand tons coming from just two provinces (Sumatera Selatan and Kepulauan Bangka Belitung), but with tuna catches approximating official records for the whole South China Sea portion of Indonesia, suggest that the total tuna catches will be in the vicinity of three times of the current estimates.

Description of Fishing Technique

In this section, only those fishing gears sampled will be described and only the intricacies and modifications pertaining to these fishing gears and this fishing ground are described.

Drift Gillnet

The drift gillnet is a curtain of netting hanging horizontally at sea. Buoyed at the surface by a series of floats attached to float-line at the upper end of the nets and weighted at the lower end with leads attached to the lead-line. The netting material is made of multi-filament polyethylene twine of 50 mm mesh size. The total length of the net is about 1,500 to 3,000 meters and the depth is about 10 meters.

The other end of the net is attached to the boat while the other end is left at sea with a float. The engine of the boat is generally idle and just drifting at sea with the net for at most 3 hours. Fishing is usually at night. The boats commonly stay at the fishing ground for 3 to 4 days per trip to save on fuel and time during the East Monsoon but during the West Monsoon, the fishers usually go home everyday. This is because sea condition during the west monsoon is a bit harsh and staying longer at sea is risky.

In Sumatera Selatan Province, drift gillnets are using boats powered with outboard motors (kapal motor temple) and inboard motor boats (kapal motor) of <5 to 30 gross tonnages (Table 3.6). In Bangka Belitung, the drift gillnets are using boats of about 3 and more gross tons. The minimum number of fisher onboard is three and more depending on the scale of the fishing operation.

Table 3.8. Estimate of tuna landings in the provinces of Sumatera Selatan and Bangka Belitung Provinces including some distant water fleets from Java Island. See text for details. Note: footnotes refer to numbers stated on rows and columns.

Gear Type	No of fishing gears[2]	No of fishing gears used [1,3]	Annual fishing days [3] or trips/yr [4]	Est. annual prod. /unit (t)	total fleet prod. (t)	% share of tunas	Est. Tuna Production (t)
Drift Gillnet[1]	20807	15000	210	8.22	123300	0.286	35,264
Pelagic Danish Seine[1]	3180	2500	150	55.5	138750	0.100	13,875
Hooks and Lines[2]	1590	1590	240	2.4	3816	0.03	114
Trammel Net[2]	210	126	150	3.0	378	0.05	19
Set Gillnet[2]	4623	2774	150	3.0	8321	0.01	83
Stationary Liftnet[2]	1216	730	200	10.0	7296	0.005	36
Purse Seine (>30GT)[2,4,5]		30	24	168.0	5040	0.07	353
Purse Seine (<30GT) [3]	180	90	200	16.0	1440	0.07	101
Troll line[2]	4623	2774	200	10.0	27738	0.05	1,387
TOTAL							**49,745**

[1]/ based on operational data from interview results
[2]/ based on aggregate number of gears from provinces within South China Sea
[3]/ annual fishing days (sum of peak and lean months)
[4]/ number of fishing trips per year
[5]/ purse seine fleet from Java fishing in South China Sea (PRPT 2006)

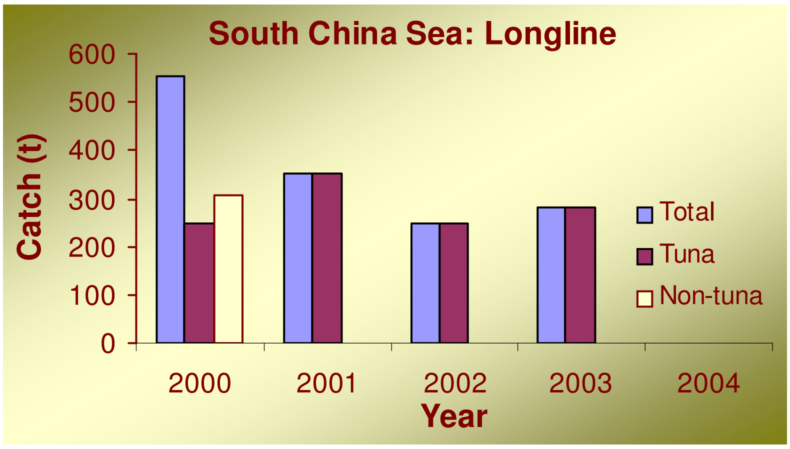


Figure 3.8. Records of tuna longline catch by Indonesian fleet operating in South China Sea for years 2000-2003.Source: Secretariat of the Pacific Commission (SPC) database.

Danish Seine

Danish Seine is a type of seine which originated in Denmark. The gear is with a net that looks like the trawl but with a larger bunt and longer wings connected to long towing ropes. Danish Seines operating in South China Sea, Indonesia has a net opening of about 7 meters and each of the towing ropes is 45 meters long.

The pelagic Danish seines in FMA-II mostly operate in FADs. One of the towing ropes is tied to the boat while the other is anchored bouy. The anchored bouy is set first and the vessel moves in a wide circle (effectively surrounding a school of fish), returning to the bouy. The ropes act to keep the net open and concentrate the fish towards the bag. The ropes are hauled together until all the net is onboard.

There are about five to six fishers onboard but could be more depending on the size of the gear and boat. The Danish Seine boats leaves port at night and settings of net is usually at daytime. The stay at the fishing ground for 3-4 days during the East Monsoon and during the West Monsoon, the boats go back to port everyday.

Infrastructure Support

The highest level of fish landings infrastructures in FMA-II is the Pelabuhan Perikanan Nusantara (PPN) Tanjungpandan which is located in the Island Province of Bangka Belitung. A PPN or archipelagic fishing port is categorized as Type or Class B fishing port in Indonesia wherein the port facilities caters for 15 to 60 gross tonner fishing boats with a maximum limit of 75 units or 3,000 gross tons (Proctor, 2003). The fish landing capacity of PPNs ranges from 40 to 50 tons of fish per day and it caters mostly for the local market and secondarily for the export industries.

The second highest level of fishing port in FMA-II is the Pelabuhan Perikanan Pantai (PPP) which is Class C on the classification of ports in Indonesia. A Type C Fishing Port (PPP) is a coastal fishing port which caters to about 5-15 GT boats fishing just within the archipelagic waters and with landings of about 15-20 tons of fish per day (Proctor, 2003). The port facilities are definitely small-scale that it only caters to local and domestic markets. There are two PPPs (Type C fishing ports) in FMA-II namely, PPP Sungailiat in the Island Province (Kepulauan) of Bangka Belitung and PPP Lempasing in Lampung.

Early morning scene at the fish market. Note the less than ideal hygenic conditions.

There are also locally managed fish landing centers or Tempat Pelelangan Ikan (TPI's) distributed in almost all the coastal communities in the area. Almost half of these places however are ill-maintained especially those in the cities. What is quiet amazing is that those maintained by the communities are better kept as compared by those under a government institution – a situation that is observed all throughout the country.

Notes on the Economics of Fishing

As discussed above during this study we were able to gather first hand data only for two fishing gears operating in FMA-II, these are the pelagic Danish Seine and the drift gillnet. The fishing business sector is a function of investments and revenues. Investment comes in terms of the costs of the fishing vessel and its motor or engine, and operational expenses which mostly include fuel, ice, food and other government fees. The revenue is highly dependent on local prices as dictated by the owner of the fishing boat which in most cases are fish traders in the area.

For the pelagic Danish seine fisheries in FMA-II, the initial investment for a 3 gross tons fishing vessel powered with an inboard motor of 26 HP invests about 40 million Rupiah which when converted into US$ using the exchange rate of 9,750.00 Rupiah per US$ (IMA Asia, 2006) which amounts to about US$4,102.56 in 2005. A complete set of the Danish seine fishing gear costs about 3 million Rupiah (US$307.69). The annual depreciation costs is determined by the number of years the fishing boat, engine and gear are expected to last which becomes the divisor of the total investment, the quotient would be a part of the yearly fixed costs. In most cases the owners assign ten years of lifetime to the vessel and engine while three years for the fishing gear. Thus the annual depreciation cost (fixed cost) of the fishing vessel and the engine is about US$410.36 (4 million Rupiah) while for the fishing gear it is about US$102.56 (Rp1 million).

A unit of FAD (used by the Danish Seines) costs, for the year 2006, about 300,000 Rupiah which amount to US$28.85, this is making use of the 2006 average exchange rate of Rp10,400.00 per US$1.00 (IMA Asia, 2006). In most cases the costs of FADs is not part of the costings of the fishing operation but rather, the FAD gets a certain share from the gross sales or even from the gross catch in the form of fish if the FAD owner has a means of selling it for a better price; a better business technique more advantageous to the owner of the FAD which in most cases are also the owner of the fishing vessel.

The operational expenses which is accounted for every fishing trip is about 2.18 million Rupiah (US$209.76). If a boat operates about 48 trips a year the total estimated annual expenses reaches about Rp104.71 billion (US$10,086.46). Knowing how the fisheries business industry works in most developing countries, there are other costs incurred such as license fees, bribes and docking fees that are seldom reported by the fishers, which is estimated in this report as 10% of the total operational expenses which amounts to about Rp10.47 million (US$1,006.85).

The estimated revenue per year based on the results of the interview is about Rp322.509 billion. From this simplified calculations, the pelagic Danish seine is earning a gross profit of about 202.33 billion Rupiah. This is where the shares of all the active workers including the FAD would be based from.

The Danish seine though different from the other fishing gears, most of the situations presented are true to the other fishing gears.

Issues and Recommendation

The general fisheries condition particularly for the tuna industry is not so much known as very few studies were made. Even governments efforts, if such exist, are not well-coordinated within the area. Maybe because the attention of the government is focused in the fishing grounds of eastern Indonesia and Indian Ocean. However its location is strategic and its resources is promising not just for capture fisheries but also as seeding area for the famous Malacca Strait fisheries.

It is therefore suggested here that:

1. Comprehensive study on the capture fisheries of the entire FMA-II giving focus on the pelagic resources and other parameters that may affect the said resources.


Typical scenes at a market place in Pangkal pinang, Bangka Belitung.

2. The location of FMA-II is also ideal because it is very near the two main islands of Indonesia and its neighboring countries. A good port facility here could encourage fisheries development and other fisheries-related business ventures.

3. Visits to the markets indicate relatively good condition of the fisheries resources. Moreover, very good small entrepreneurial industries are all over the place, making use of the fish resources as raw materials. Time will come that these enterprises upon learning the value of their products would definitely expand and consequently put a strain to the resources – it is a must now that a comprehensive plan integrating the business sector and the fish resources would be put into place. An appropriate resource management would definitely sustainably support the probable expansion of the business enterprises in the area.

4. Infrastructure development of the fishing ports and landing areas would definitely increase the value of the marine resources landed and sold in those places. As of now most of the landing places are in sorry state and is way down below the health standard provided by the international community.

FMA-III: Java Sea

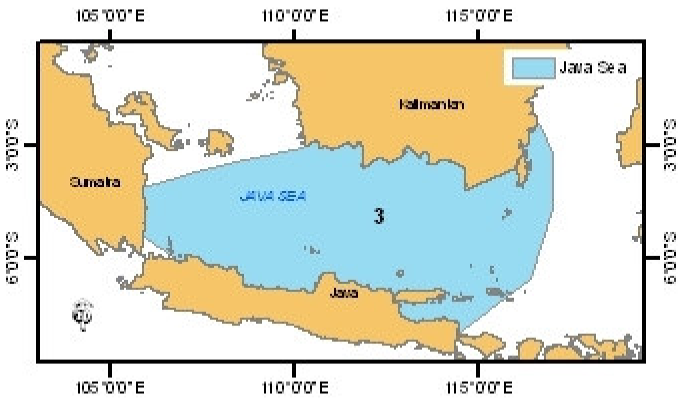


Figure 4.1. Geographic location of Java Sea.

Geographic Scope

The Fisheries Management Area Three (FMA-III) covers the entire Java Sea. It is bordered by Java Island in the south and by the island of Borneo in the north. It connects with Makassar Strait and Flores Sea to the east and with South China Sea through Karimata Strait in the south (Figure 4.1). The sea is about 420 km long on the north-south border and 1,450 km east-west with an approximate area of 1,790,000 km^2 (Britannica, 2007). It is a shallow sea with a mean depth of 46 meters and a relatively flat bottom.

The Java Sea is less saline compared to the adjacent bodies of water because of the large inflow of freshwater from big rivers in the islands adjoining it, in particular those coming from south Kalimantan. During the northwest monsoon, water surface current flows west from Flores Sea and Makassar Strait with a velocity of 25-38 cm/sec, bringing with it cold waters which helps in the productivity enrichment of the Sea particularly at the eastern part. During the southeast monsoon, surface currents from South China Sea and Sunda Strait flow east at a velocity of 12-25 cm/sec (Ilahude 1979, Bailey 1987, Sharp 1996 and Pasaribu 2004). This process of homogenous mixing the high nutrient load waters contributes to the high productivity of Java Sea.

The provinces covered by FMA-III are DKI Jakarta, northern coastal parts of Jawa Barat, Banten, northern coasts of Jawa Tengah, northern coasts of Jawa Timur, Kalimantan Tengah and Kalimantan Selatan (Table 4.1).

Sources of Data for Analysis

To estimate the tuna catches, the actual data collected in this study are used primarily. These are the interviews conducted from August 2006 to May 2007 of direct stakeholders (fishers, traders and processors, scientists, and government personnel) of the tuna

Table 4.1. Political units falling under fishery management of Java Sea (FMA-III). Source: DKP 2006.

Provinces	Kabupaten/Kota/Kodya	Provinces	Kabupaten/Kota/Kodya
DKI Jakarta	Kota Jakarta Utara	Jawa Timur	Tuban
	Kep. Seribu		Lamongan
Jawa Barat	Bekasi		Gresik
	Karawang		Kota Surabaya
	Subang		Bangkalan
	Indramayu		Sampang
	Cirebon		Pamekasan
	Kota Cirebon		sebagian Sumenep
Banten	Serang		Sidoarjo
	Tangerang		Pasuruan
	Kota Cilegon		Kota Pasuruan
Jawa Tengah	Brebes		Probolinggo
	Tegal		Kota Probolinggo
	Kota Tegal		Situbondo
	Pemalang	Kalimantan Tengah	Kapuas
	Pekalongan		Kota Katingan
	Kota Pekalongan		Kotawaringin Timur
	Batang		Seruyan
	Kendal		Kotawaringin Barat
	Kota Semarang		Pulang Pisau
	Demak		Sukamara
	Jepara	Kalimantan Selatan	Tanah Laut
	Pati		Kota Banjarmasin
	Rembang		Banjar
			Barito Kuala

fisheries industry. The data collected during this study are supported and supplemented by other studies and the published statistics of the central DKP and the provincial DKP Offices, literatures (published and unpublished) and the term papers of some of the students from Sekolah Tinggi Perikanan (STP) in Jakarta.

Limitations and Assumptions

Just like that of FMA-I and FMA-II, the statistical reports in FMA-III also considered tongkol komo (eastern little tuna) as the most abundant species within the once “tongkol” (small tunas) species grouping prior to the year 2004.

Among the provinces covered within FMA-III, only Jawa Timur and Jawa Tengah have good compilation of fisheries statistics. These two provinces also covered about more than half of the coastal areas of FMA-III; therefore it was assumed that the data provided by these provinces are good representation of this fisheries management area.

Also the resident fleets in the coastal waters of Java Sea do not always operate just within the area but would sometimes go out to South China Sea and even Flores Sea and Makassar Strait, making the segregation of statistics a bit difficult. This is true with the mini purse seines and purse seines fleets landing in PPN-Pekalongan and PPP-Juwana and Tegal (Jaya & Ghofar 2006).

Total Landings and Trends

The shallow and flat terrain characteristics that made Java Sea ideal for demersal trawl fishing, a gear famous for its contribution to the collapse of demersal fisheries in the 1980’s. The collapse of large number of fish populations forced the government in 1982 to close Java Sea for trawl fisheries. This closure led to the birth of pelagic fisheries.

Over the last four decades starting in the seventies, the volume of total fish landings in Java Sea has increased three fold but its share relative to the Indonesian total fish output has declined (Figure 4.2). Java Sea (FMA-III) contributes significantly to the total fish landings of the country, maintaining its overall contribution of over 20%. In fact, in the seventies about 27% were coming from Java Sea, steadily decreasing over the decades and in the early 2000s the average annual fish landings in FMA-III is about 21.82% of the total fish landings of the country. The rise in the volume of landings in the

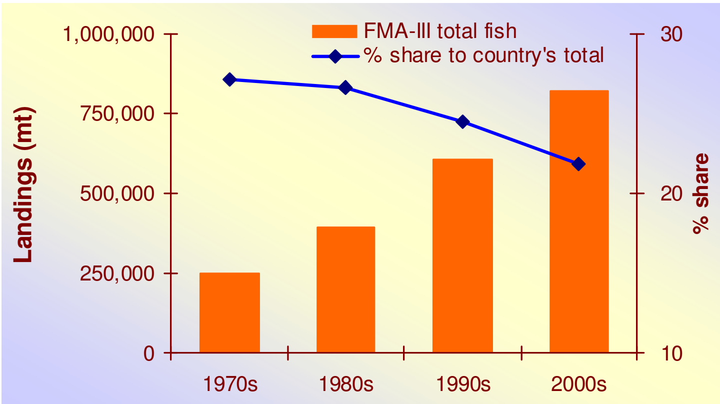


Figure 4.2. Trends in fish landings of FMA-III (Java Sea) and its share relative to the total landings of Indonesia based on the DKP statistics by province and coastal area annual yearbooks of 1976, 1983, 1993, 2001, 2004 and 2005.

1980's to the present could be attributed to the increased landings of small pelagics following the introduction of purse seine and drift gillnet, as replacement of the trawl gear.

Tuna landings in Java Sea (FMA-III) based from the DKP Statistics according to provinces and coastal areas is on a steady rise, with annual average landings of 10,506 tons in the 1970s, rose to 33,516 tons in the 1980s, and to 54,512 tons in the 1990s. By the turn of the millennium, tuna landings reached 91,660 tons about tenfold increased from 1970 levels (Figure 4.3). The trends also show that the contribution of FMA-III to the total tuna landings of Indonesia have levelled off at about 12% despite the seemingly increasing trend in the volume of tuna landings (Figure 4.3).

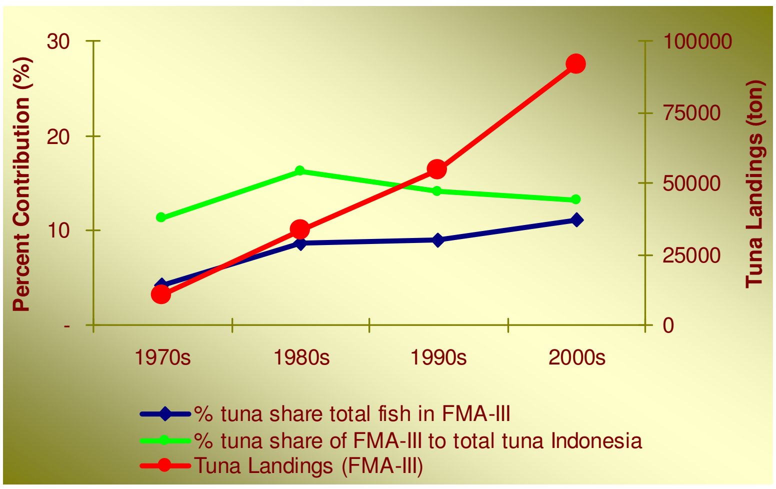


Figure 4.3. Trends of tuna landings from Java Sea and its share relative to the total landings (fish and tuna) of Indonesia based on the DKP statistics by province and coastal area annual yearbooks of 1976, 1983, 1993, 2001, 2004 and 2005.

Looking closely at the recent tuna landings using the newly published DKP Statistics according to fisheries management areas, show an increasing trend where landing have almost doubled from 2000 with 29,260 tons 50,255 tons in 2004 (Figure 4.4). The percent contribution of tuna landings in FMA-III to that of the entire tuna landings of Indonesia increased from 4.50% in 2000 to 6.97% in 2004 but attained its highest share with 8.48% in 2002.

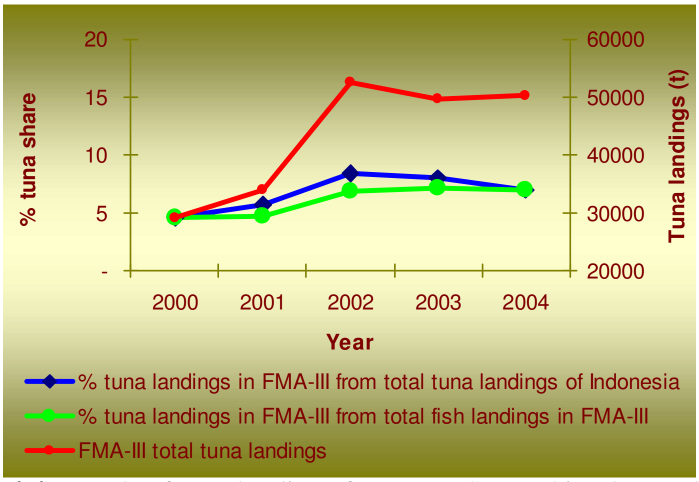


Figure 4.4. Trends of tuna landings from Java Sea and its share relative to the total landings (fish and tuna) of Indonesia based on DKP statistics by management area. Source: DKP statistics by FMAs, 2006.

Comparing the data sets from the two statistical reports reveal great discrepancy in the landing figures. The figures reported in the DGF Statistics according to provinces and coastal areas are almost as twice higher than the figures reported by in the DGF Statistics according to fisheries management areas (Table 4.2). The source and reason for such large discrepancy is not known.

Year	Tuna landings (t) from FMA	Tuna landings (t) by province
2000	29,260	
2001	33,936	62,543
2002	52,451	
2003	49,790	
2004	50,255	102,865
2005		85,233

Table 4.2. Comparison of tuna record of landings for FMA-III between the statistics based on provinces & coastal areas (DKP 2006) and by management areas (DKP-WPP 2006)

A glimpse to the total tuna landings of some of the provinces within FMA-III particularly Jawa Timur (East Java) and Jawa Tengah (Central Java) also show generally increasing trends since the seventies (Figure 4.5). For both Provinces, the tuna landings were on a hasty climb until the mid-nineties but hence to the present it has relatively reached a sort of stability and though increases have been recorded these were not really significant. What has been alarming is that, despite the rising trends on the number of boats landings is not increasing. This might indicate that the resources have reached a certain level wherein increasing the effort would not significantly increase the landings - this will lead to further degradation of the resources that the increase of effort would rather decrease output.

Trend of Landings by Species

Prior to the year 2004, reporting of species is just by major groups namely “tuna” for the large tuna species (YFT, BET, Albacore, SBFT, etc.), “tongkol” for the small tuna species (eastern little tuna, frigate tuna, bullet tuna, etc.) and “cakalang” for the skipjacks.

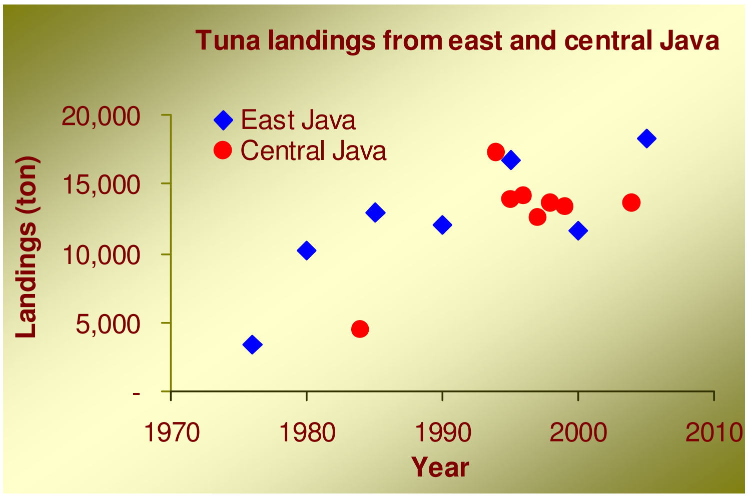


Figure 4.5. Trends of tuna landings from Java Sea and landed in the provinces of East and Central Java. Source: Provincial DKP statistics of East and Central Java (various years).

Landings as reported in the DKP statistics by provinces and coastal areas (PCA), indicates that prior to 2004, "tongkol" dominated the tunas from Java Sea with share ranges from 76%-99%, the rest are skipjacks (Figure 4.6). Large tunas first appeared in the records in 1983 with just 3 tons but have since increased in proportion to become the most dominant tuna group landed, reached its peak of 88,588 tons in 2004 and fell in 2005 with 61,635 tons (Fig. 4.6). The landings of skipjacks was somehow stayed around 5,000 tons.

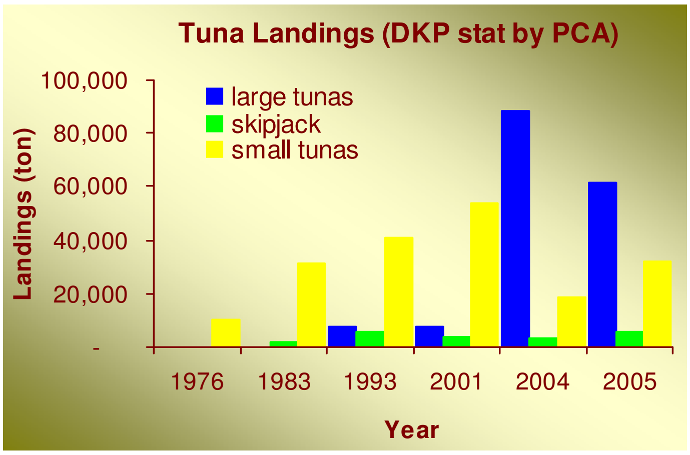


Figure 4.6. Landings by species groups of tuna in FMA-III (1976 - 2001) from the Fisheries Statistic according to Provinces and Coastal Areas (PCA). Source: DKP Statistics by PCA (various years)

As part of the improvement of statistical reporting, the DKP began reporting catch data disaggregated into tuna species in 2004.

In 2004, the large tunas identified in the DKP Statistic by fisheries management areas (FMA) are tongkol abu-abu (longtail tuna ~ 48,976 tons), madidihang (yellowfin tuna ~ 28,053 tons), tuna mata besar (bigeye tuna ~ 9,592 tons) and albakora (albacore ~ 1,967 tons) (Figure 4.7). In 2005, there was a general decreased in landings for all the species but the ranking was maintained; longtail tuna (28,267 tons) has decreased by about a half, yellowfin tuna (24,375 tons) also decreased by about 13%, bigeye (8,134 tons) fell by 15%, and albacore declined by more than a half, to that of the 2004 level (Fig. 4.7).

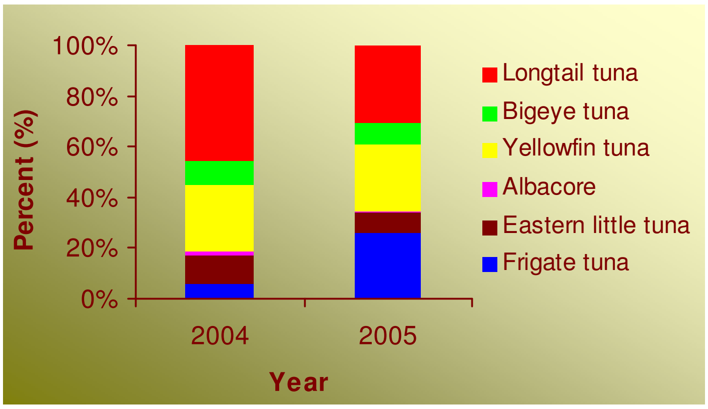


Figure 4.7. Landings (%) by species of tuna in Java Sea. Source: Fisheries Statistic according to Provinces and Coastal Areas (DKP 2005, 2006).

By comparison, statistical records presented by fisheries management areas (FMA) published in 2006 differ on the following aspects:

1. Small tunas or "tongkol" dominate the landings;
2. Large tunas or the group "tuna" consist only of the longtail tunas (tongkol abu-abu);
3. Skipjacks, yellowfin, bigeye and albacore are absent.

In 1976, the Province of Jawa Timur recorded monthly landings of the "tongkol," of which proved to be good indicator of seasonality of small tunas. Peak months of landings starts in the month of November until May with the highest on February and lean months are during June to October (Figure 4.8). Unfortunately more recent data is not available to see if seasonality has changed in recent years.

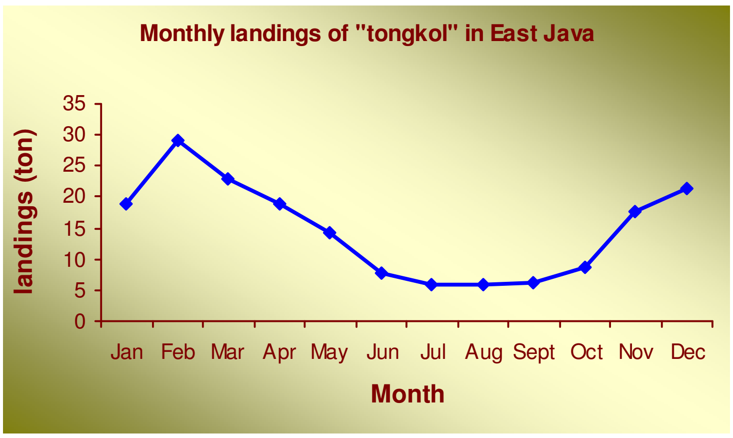


Figure 4.8. Volume of small tunas (tons) taken from Java Sea and landed in East Java. Source: Dinas Perikanan dan Kelautan Propinsi Jawa Timur, 1976.

Landings by Fishing Gear and Trends

Since there is no available information from the national statistics on how much tuna is being landed by each type of the fishing gear operating in Java Sea, the statistics of the provinces of Jawa Tengah (Jawa Tengah Fisheries Statistics 2004) and East Java (Jawa Timur Fisheries Statistics 2005) are used here.

From the records of Jawa Tengah Province, the troll line (pancing tonda) fishing gear is catching almost exclusively tunas while the landings of the drift gillnets (jaring insang hanyut) comprises almost 50% tunas (Table 4.3). The others such as the category of hook and line fishing gears landings of tuna is about 21.5% of its total catch, the rest of the fishing gears landings comprise less than 5% tuna species.

In Jawa Tengah, there are only three types of fishing gear catching tuna in significant proportion to the total catch (Table 4.3) while in Jawa Timur there are about six types (Table 4.4). Comparing the troll line landings in the two Provinces, the catch composition of troll line in Jawa Tengah are mostly tunas while in Jawa Timur only 48.67% are tunas. The same degree of differences is observed in the other fishing gears. This result suggest that fishing gears based in Jawa Timur fished a wider spectrum of fish species than those based in Jawa Tengah.

Table 4.3. Landings by gear type and percent share of tuna landed in Jawa Tengah, 2004. Source: Dinas Kelautan dan Perikanan Jawa Tengah 2004.

Gear Type	Total Fish Landings (ton)	Total Tuna Landings (ton)	Proportion of Tuna to the Fish Landings (%)
Troll Line	11.2	11.2	100.00
Drift Gillnet	10,888.8	5,154.4	47.34
Other Hook and Line	102.5	22.1	21.56
Set Gillnet	2,914.7	160.3	5.50
Trammel Net	222.9	8.0	3.59
Purse Seine	154,448.7	5,536.5	3.58
Set Longline	9,859.0	276.4	2.80
Pelagic Danish Seine	12,729.2	119.3	0.94
Demersal Danish Seine	27,109.3	155.2	0.57

Table 4.4. Landings by gear type and percent share of tuna landed in Jawa Timur, 2005. Source: Dinas Kelautan dan Perikanan Jawa Timur 2005.

Gear Type	Total Fish Landings (mt)	Total Tuna Landings (mt)	% Share of tuna to total fish landings
Troll Line	16,052	7,812	48.67
Drift Gillnet	21,947	4,047	18.44
Other Hook and Line	11,826	2,117	17.90
Longline other than Tuna Longline	279	44	15.86
Purse Seine	107,277	11,058	10.31
Other Fishing Gears	9,905	941	9.50
Pelagic Danish Seine	66,497	5,968	8.97
Set Longline	2,473	146	5.90
Trammel Net	9,858	420	4.26
Set Gillnet	14,541	470	3.23
Shrimp Entangling Gillnet	11,431	116	1.01
Beach Seine	760	7	0.91
Demersal Danish Seine	9,493	64	0.67

Fishing Capacity and Trends

Still basing from the information provided by the fisheries statistics of the provinces of Jawa Tengah and Jawa Timur on the fishing gears catching tuna, the number of units of these fishing gears in 2005 is detailed in Table 4.5. However, since these number of units of fishing gears is based on the area of registration rather on the fishing ground, there is no way to ascertain how many are actually exerting efforts on the tuna resources of Java Sea. However, it is safe to assume that most of the small-scale fishing gears are fishing in the Java Sea, such as the Danish seines, drift gillnets, the group of “other hook and line, to name a few.

Table 4.5. Number of fishing gears based in FMA-III, 2005. Source: DKP Statistics by provinces and coastal areas for 2005 and DKP Statistics Report of Jawa Tengah and Jawa Timur Provinces for 2005.

Gear Type	Total	Banten	DKI Jakarta	Jawa Barat	Jawa Tengah	Jawa Timur
Trammel Net	17392		495	2602	5671	8624
Pelagic Danish Seine	16855	588	424	3930	3195	8718
Drift Gillnet	14583	781	396	6415	1303	5688
Other Hook and Line	13996	1071	1152	444	114	11215
Demersal Danish Seine	10204	119	457	817	5179	3632
Set Gillnet	8777	2		1229	5186	2360
Shrimp Entangling Gillnet	7606	607		1393	27	5579
Purse Seine	5290	1	269	196	3167	1657
Troll Line	5187		126	94		4967
Beach Seine	4847			2625	2134	88
Encircling Gillnet	2997	16		2382		599
Set Longline	877			185	567	125
Tuna Longline	294		294			
Drift Longline other than Tuna Longline	217			208	9	

The fisheries statistics of the provinces of East and Central Java were used to show the trends of fishing activities in Java Sea (Table 4.6 and Table 4.7). In 1984 and 1994, 92% and 87% respectively, of the total number of fishing gear are just from five types (Table 4.6). By 2004, there was an increased on the number of dominant fishing gears to seven types accounting for 90% of the total number of gears. Comparing the list of fishing in 2004 to that of 1984, there are four new gear types added to the list.

The types of fishing gears dominating in the area suggests that the landings are mostly small pelagic fishes. The trends presented in Table 4.6 and Table 4.7 illustrate the dynamics of fishing in FMA-III. The resurgence of demersal gears (e.g. Danish seines, trammel nets, set gillnets) tend to indicate a possible recovery of demersal biomass in Java Sea following its collapse in the 1970s and 1980's.

A closer look at the two tables (Table 4.6 and 4.7) likewise indicate that Jawa Timur appear to be the more progressive in terms of fishing gear development and thereafter spreads to other areas. This would explain the lag time for gears to become popular in Jawa Tengah.

Table 4.6. Trends in the number of fishing gears registered in Jawa Tengah. Source: Dinas Kelautan dan Perikanan Jawa Tengah 1984, 1994, 2004.

Fishing Gears Type	1984	1994	2004
other hook and line	**6723**	**1701**	1434
Trammel Net	**5552**	**8509**	**6933**
Drift Gillnet	**4311**	**3303**	**2633**
Set Gillnet	**3728**	**2570**	**7224**
Purse Seine	**701**	808	1388
Danish Seine	573	**914**	**2241**
Set Longline	531	545	567
Beach Seine	308	96	**2515**
Stationary Liftnet	216	450	519
Encircling gillnet	161	30	0
Tuna Longline	1	5	112
Drift Longline		37	9
Mobile Liftnet		152	268
Troll Line		510	646
Vertical Handline			152

rank | 1 | 2 | 3 | 4 | 5

Table 4.7. Ttrends in the number of fishing gears in Jawa Timur. Source: Dinas Kelautan dan Perikanan Jawa Timur 1976, 1980, 1985, 1990, 1995, 2000, 2005.

Fishing Gears	1976	1980	1985	1990	1995	2000	2005
Drift Gillnet	8176	9060	11271	10281	5714	4703	5688
other hook and line	8062	7802	8836	6544	5805	9753	11215
Danish Seine	4521	4979	4505	4512	7670	8864	8718
Troll Line	2941	1229	2940	4992	3371	8751	4967
Set Gillnet	2863	2311	1599	1075	2864	3140	2360
Stationary Liftnet	1658		2680	2007	828	308	907
Beach Seine	277	78	223	9	0	0	88
Drift Longline	64	250		191	174	155	0
Purse Seine	57	620	1183	1084	1500	1838	1657
Mobile Liftnet	35	1908	14		53	347	259
Encircling Gillnet	3			40	548	81	599
Tuna Longline						162	125
Trammel Net				1155	1705	2203	10364
Vertical Handline					466		0

rank | 1 | 2 | 3 | 4 | 5

Estimate of Tuna Catches in FMA -III

Similar to Malacca Strait and South China Sea, Java Sea is not a major tuna fishing ground even though the country's primary tuna fishing port of Muara Baru is within its coastal area coverage. The quantity of tuna taken from Java Sea amounts to 50,255 tons (DKP 2006). The volume excludes landings in Java Island that were taken elsewhere.

The estimated total tuna catches using very conservative number of fishing gear, fishing days and mean catch is 87,000 tons (Table 4.8), an estimate that is 73% more than the recorded figures in the 2005 statistics. This figure is still on the lower limit considering that other gears such as set longline, drift longline, beach seine and lift nets that catch tuna as by-catch are not included in the computation, mainly due to lack of reliable fisheries parameters.

Despite the seemingly high production, all reports and interviews made with fishers and government officials points to the declining trends of catch rates when compared to the past ten years. Interviews conducted with the mini purse seine fishers point to about 90% decrease of catch, same condition with the gillnet fisheries. There had also been a dramatic increase in the number fishing vessels and the types of fishing gears as shown in Table 4.6 and Table 4.7.

Table 4.8. Estimate of tuna catches from Java Sea using various sources.

Fishing Gears	no gears 2005	no of gears used[1]	% share of tuna[2]	total fishing days/yr	annual catch/unit (mt)	Est. total fish catches (mt)	Est. tuna catch (mt)
Drift Gillnet[3]	14583	8750	0.329	105	13.00	113,747	37,410.41
Trammel Net[3]	17392	10435	0.039	180	22.50	234,792	9,219.82
Set Gillnet	8777	5266	0.044	105	12.20	64,248	2,805.26
Purse Seine	5290	3174	0.069	84	29.80	94,585	6,570.15
Pelagic Danish Seine	16855	10113	0.050	180	40.50	409,577	20,298.31
Troll Line	5187	3112	0.743	90	2.70	8,403	6,246.14
Other Hook and Line	13996	8398	0.197	180	2.70	22,674	4,474.12
Set Longline	877	526	0.044	120	3.00	1,579	68.70
TOTALS						949,604	87,092.91

1/ number of gears represent 60% of reported figures for 2005
2/ Share of tuna by gear taken from 2006 DKP statistics
3/ values of mean fishing days, mean catch taken from results of interviews

Description of Fishing Technique

Drift Gillnet

The drift gillnets in FMA-III have mesh sizes of 4 inches and a spread of 3.5 kilometers long and 20 meters depth. These fishing gears are left drifting at night at about 10-15 meters below the water surface. The net is set at about four o'clock in the afternoon and hauling starts at one o'clock midnight. Hauling may last up to nine hours depending on sea condition and abundance of catch. These are operated using mostly wooden hulled boats of about 30 gross tonnages powered by engines of about 180 Horse Power (HP). The boat has 12 crew members.

The main catch of drift gillnets in FMA-III are small pelagic fishes which includes the small tunas. The small tunas were observed to be abundant during the months of August to October. Various interviews with fishers operating drift gillnets in FMA-III, 85% of the catch, during the peak months, is composed of small species of tunas.

Mini Purse Seine

In 1971, the commercial-size purse seine fleets were first introduced in Java Sea after the banning of trawls but was proven to be not suitable trawl boats and thus the development and proliferation of the mini-purse seine.

The mini-purse seines are just like the commercial-size purse seines only smaller in size. The lay-out of the fishing gear is V-shape when cut longitudinally. The circumference of the fishing gear' mouth (wider end) is about three thousand seven hundred fifty (3,750) meters tapering to about 900 meters at the lower end (the bunt). Mesh sizes is about 0.75 inch at the bunt 1-inch and the rest of the gear is about 1-inch.

This fishing gear is usually operated in Fish Aggregating Devices (FADs). It also uses lamps of about 250-400 watts of not lesser than 10 units per fishing boat. Despite the use of FADs, fishing operation stops during full moon. One trip may last for just one day (small-scale purse seiners) and for about four to five days (large-scale purse seiners).

Infrastructure Supports

Servicing the fisheries of FMA-III are Pelabuhan Perikanan Samudera (PPS) - Nizam Zachman in Jakarta, Pelabuhan Perikanan Nusantara - Pekalongan and Pelabuhan Perikanan Pantai Karimunjawa in Central Java, PPN Kejawanan in West Java, PPN Brondong, PPP Karangantu in Banten and PPP Bawean in East Java and the other Tempat Pelelangan Ikan managed by the local government units. This is the only fisheries management area (FMA) that hosts quiet a number of national government managed fishing ports.

(Insert picture of downloading amidst the garbages).

PPS Nizam Zachman is the only first level fishing port with in FMA-III but it also service fishing fleets operating in Indian Ocean and other seas. It is strategically located in Muara Baru District. The fishing port however is beset with a lot of problems such as flooding during the highest high tide, inadequate sanitation, and very poor post harvest handling of fishes in the port during downloading of fish from the fishing boat and/or carrier boats, despite the rehabilitation program heavily funded by ADB.

The tuna longline sector of the country is on a downward spiral brought about by the declining catch rates, ageing wooden longline fleets and diminishing rents. The survey last year revealed more boats tied to the port awaiting improvements in catch rates and more subsidies from the government to pull them out of misery. A phase IV for the Nizam Zachman Fish Port Project in Jakarta has been in the pipeline to improve the landing facility and installation of water treatment (Haraguchi 2004) and the tuna sector was central to the improvement plans. With the longline currently facing severe problems and tuna production has shifted to eastern Indonesia, the question on the appropriateness of funds being poured into the Nizam Zachman Fish Port may have to be re-evaluated.

Of the second level fishing ports in FMA-III, PPN – Pekalongan was visited during this study. Most of the landed fishes are small pelagic fishes landed by mini-purse seines, drift gillnet and other medium scale fishing fleets. The sanitary condition here is better than in other fishing ports, here they uses baskets as fish containers during the downloading of fish from the boats to the auction process until taken by buyers. The auction hall is also cleaned after the auction time. Auction time is usually in the morning.

Notes on Economics of Fishing in Java Sea

This section will simply focus on the costs and revenue balances of the fisheries. Most of the data were results of the key informant interview we had with the fishers in the area. Costs include fixed investment (boat, engine and fishing gear), running expenses (which includes fuel, ice, food, taxes, marketing, etc.), and other expenses such as FADs if any. The revenue is just the proceeds from the catch. Here we would not dwell much on the complex issues involve in the economics of the capture fisheries but would simply present the direct cost and revenue picture of the fisheries in FMA-III.

Drift Gillnet

There was no primary data taken on the initial investments for the drift gillnets operating in Java Sea.

Operational cost per trip of 25 days per month is about Rp20 million, assuming they are making an average of 5 trips per year as tuna fishing is only during the high season (August to October) and medium season (March and April). The total running expenses for one year is about Rp100.00 million which is equivalent to US$9,615.38 (using the Rp10,400.00 for US$1.00 average annual exchange rate for 2006 – IMA Asia, 2006).

Mini-Purse Seine

The initial investments for a fishing vessel of 10 gross tons in 2001 was about Rp50.00 million, its inboard motor of 135 horse power was about Rp25.00 million, its generator set was about Rp15.00 million, and the fishing gear costs about Rp30.00 million, which totals to about Rp120.00 million. The annual depreciation cost for the fishing vessel is about Rp5.0 million, engine is Rp2.5 million and the generator set is Rp1.5 million, and Rp5 million for the fishing gear for a total fixed cost of Rp16.5 million; that is with the assumption that the economic lifespan of the vessel and engines is about 10 years while the fishing gear is 3 years. Operational expenses for a daily fishing trip is about Rp4.57 million which amounts to Rp731.20 million in one year with 160-fishing days.

For the large fishing vessels of 26 gross tons, acquired in 2001, the initial investment is Rp85.00 million, its inboard motor of 100 horse power and generator set (powering 10 fishing lights of 250 – 400 watts) was about Rp60.00 million. The initial cost for the whole set of the fishing gear is not available. The initial investments divided by the economic lifespan of the materials is the annual fixed cost which is about Rp8.5 million for the fishing vessel and Rp6.0 million for the generator set and the inboard motor. The operational expenses per trip, of 4 to 5 days asea and which includes the fuel, food, ice and other provisions, is about Rp4.5 million. The estimated number of fishing trips in a year is 28 which amounts to Rp126.00 million (US$12,115.38 using the 2006 annual average exchange rate) estimated annual cost of operations.

Initially there seems to be inconsistencies on the reported operational expenses, with the smaller vessel (definitely operating nearshore) spends more than the larger vessel operating offshore. This is because the smaller vessels are day boats which travelling means back and forth to the fishing ground while the larger vessels usually stays asea for about 4 to 5 days, thus saving on fuel from constant travel. This also explains the need for the smaller vessels to have engines of higher horse power which consumes more as was the case above.

The small-scale purse seiners (10-GT), on the average, are earning about Rp2.77 billion a year. Summing up all the possible expenses of including a 20% of the total annual operation for the other unaccounted expenses reaches about Rp894.44 million a year. The estimated gross income would be Rp1.88 billion; this amount would be shared upon by the owner, the fishers and the FAD (if using one) according to their respective shares.

ISSUES AND CHALLENGES

1. Fisheries Management Area Three (FMA-III) may not be major tuna fishing ground for large tunas but current production estimates point to very high small tuna production. Necessary attention should be given to the small tunas, particularly in setting up the necessary physical and capacity building support required to the reform and improvment of data collection systems. Note that a large percentage of catch of small pelagics are salted at sea and these are landed and distributed without necessarily passing through normal landing places and therefore unrecorded.
2. FMA-III is the major source for baitfishes (roundscads, sardines) that support the long line fisheries. The scientific evidence that roundscad resources are on the brink of collapse (see also chapter on bait fisheries) where the remaining biomass levels is just 15% of 1975 (Nugroho, 2006). Managing tunas meant paying attention to the management of the baitfishes as well.
3. Java Sea is also a major source of about 60% of the animal protein requirement of people in Java and Sumatra Islands, the most populous islands of Indonesia (Vuichard, 1997). This management area holds very important role in the fisheries sector of Indonesia.
4. There are indications that demersal resources are on the road to recovery but are not given due attention.
5. The apparent differences in the reported landings in Java Sea by the two fisheries statistic publications of DGF might be just a result of the newly implemented statistical scheme of reporting following the fisheries management areas from the usual practice of reporting according to coastal areas and provinces. Whatever is the cause of these conflicting information, data has to be recheck and corrected.

One of the challenges here though was not discussed in this section (see section on bait fisheries for the full discussion of bait fisheries in Java Sea) is the management towards conservation of the fisheries resources.

FMA-IV: Makassar Strait & Flores Sea

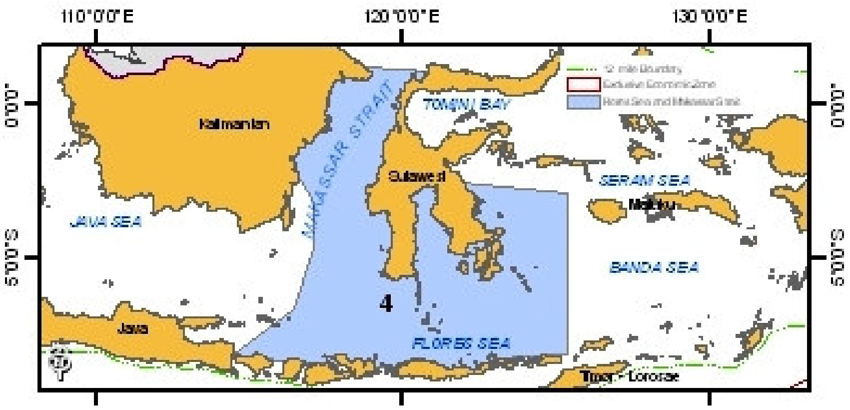


Figure 5.1. Geogrpahic location of Makassar Strait and Flores Sea.

Geographic Scope

The Fisheries Management Area Four (FMA-IV) includes Makassar Strait and Flores Sea and the other small seas and bays within the two mentioned bodies of water (Figure 5.1). Geographically, FMA-IV covers eight provinces and 60 districts and cities (Table 5.1).

Makassar Strait is a narrow deep passageway between the islands of Borneo (on the west) and Sulawesi, formerly Celebes, (east side) with an average width of about 15 km (370 km width on its widest breadth). It connects with Pacific Ocean on the north through the Sulawesi Sea. It is also link with Java Sea on the southwest and Flores Sea on the Southeast. Further, Makassar Strait is part of the famous Wallace's Line (a line defining the division of biodiversity between Australia and Asia and named after its discoverer Alfred Russel Wallace in the 1860s). Unlike the other inland seas of Indonesia, the water circulation of Makassar Strait is not affected by monsoons but is more influenced by the Pacific Ocean – the current does not change from its southward movement towards Java Sea the whole year round (Soesanto, 1961).

Flores Sea is bounded on the north by the island of Sulawesi and on the south by the islands of Lesser Sunda, Flores and Sumbawa and opens on the west to Java Sea, Makassar Strait on its northwestern most end, and east to Banda Sea; with about 240,000 km^2 of surface area. The Sea's basin is a broad plateau with a general depth of 500 m on the west with rising submarine mounts on its banks which are often capped with atolls. Southeast to the Flores Basin, where the sea plunges to its greatest depth of 5,140 meters, are two deep channels crossing. On the north of the trough are two ridges, one of which rises as the Selayar Island, flanking a shallower trough that extends up to the Sulawesi Island.


Pole & line and purse seine docked in fishing port in Pelabuhan Bajo.

Table 5.1 Provinces and respective districts and municipalities belonging to fishery management area four (FMA-IV).

Provinces	District / Municipalities
Jawa Timur	portion of Banyuwawai, portion of Sumenep
Bali	Buleleng
Nusa Tenggara Timor	Kota Bima, portions of Lombok Barat, Lombok Timur, Sumbawa, Dompu, Bima, Sumbawa Barat, Kota Mataram, Ende,Sikka, Flores Timur, Ngada and Alor
Nusa Tenggara Barat	Portion of Manggarai
Kalimantan Timur	Samarinda, Kota Samarinda, Kota Balikpapan, Pasir, Jutai Kertanegara,Jutai Timur, Kutai Barat, Bontang, Penajam
Sulawesi Tengah	Toli-toli, Buol, Palu, portion of Donggala
Sulawesi Selatan	Luwu, Wajo, Bone, Sinjai, Bulukumba, Selayar, Bantaeng, Jeneponto, Takalar, Kota Makassar, Maros, Barru, Kota Pare-pare, Pinrang, Poliwali/Mamasa, Majene, Mamuju, Luwu Timur, Mamuju Utara, Pangkajene Kepuluan

Both bodies of water, though narrow, are deep and therefore very ideal for pelagic fisheries. The water circulation of both seas also contributes to the richness of the fishing grounds. Makassar Strait serves as the exchange channels of waters from the Pacific Ocean to the Indian Ocean while Flores Sea always receives circulation from Java Sea during the latter part of the year and at the early part of the year it receives from Banda Sea.

Sources of Data

Total production, trends, species composition and fishing gear contribution to tuna landings are mostly from the statistics of DKP and from the DKP Provinces. DKP Statistics are solely reported according to provinces and coastal areas (perairan pantai). Recently in 2005, however a new publication of statistic was published and is reported according to established fisheries management areas (wilayah pengelolaan perikanan); this new statistical publication covered the year 2000 to 2004. Despite this new statistical publication format, the old format, which is the statistical reporting according to provinces and coastal areas continued. Starting 2006, therefore two sets of statistical publication have been on circulation; however since the new statistical publication format (Statistics by FMAs) covered the annals starting 2000 to 2004, there had been two sets of production estimates for five years (2000-2004).

The statistics collected from the national government and provinces are complemented by the papers (published and unpublished) by the various scientists (from Indonesia and other countries) and from the report of the students of Sekolah Tinggi Perikanan (STP) in Jakarta.

Estimation of tuna production, the present status of the tuna fisheries and issues would be mostly from the collected data of this study.

Limitations and Assumption

Statistical reporting of tunas is grouped into three categories: "*tuna*" for the large species such as bigeye tuna, yellowfin tuna, albacore, longtail, and southern bluefin tuna; "*tongkol*" for the small tunas which includes eastern little tuna, bullet tuna, frigate tuna and oceanic bonitos; and *"cakalang"* which represents the skipjacks. It is only in 2004 that the groupings were disaggregated into their actual species level.

Ubiquitous within Indonesia is the Eastern Little tuna or *Euthynnus affinis* (*Tongkol komo*) and it is the most abundant as reported on the statistics. Yet market surveys conducted during this study reveal very few observations and it is the bullet tuna of the species *Auxis rochei* that is abundant. This led us to believe that misidentification of the bullet tuna may have occurred.

Because of the limited time for this study, not all provinces were visited and focus on analysis of records were made only on the provinces that are deemed important to tuna fisheries. These include the provinces of Nusa Tenggara Barat and Sulawesi Selatan who provincial statistical data were used to complement the information from the National DKP Statistics.

As mentioned earlier, there are two sets of statistical publication, the old one which reports according to provinces and coastal areas and the new format which is according to fisheries management areas. Though this latter publication adds to the strengthening of tuna fisheries documentation system, a lot of inconsistencies on the data reported needs to be improved. Use of these data sets are clearly identified in this report.

Landings and Trends

Because there is no way to segregate the statistics from the DKP Statistics classified by provinces and coastal areas into fisheries management areas, just as we did with FMA-I, FMA-II and FMA-III, we refrained from using this statistical yearbook. Instead, we have utilized the DKP Statistics presented by fisheries management areas (Wilayah Pengelolaan Perikanan) publication which is cited as DLP-WPP 2006. Note however that as experienced from the previous FMAs, there are significant differences in the figures reported by the two abovementioned statistical reports.

The annual production of finfishes in 2004 was 680,520 metric tons representing 17.76% of the total finfishes output of Indonesia (DKP-WPP 2006). Of this production, tunas account for 123.8 thousand metric tons which is 18.2% of fishing ground's total fin fish landings. Trendwise, the share of tunas to the country's total finfish landings fluctuates from 15.8% to 17.8% (Figure 5.2).

Three provinces belonging to FMA-IV were visited during this survey, namely Sulawesi Selatan, Nusa Tenggara Barat and Nusa Tenggara Timur. Of the three provinces, Sulawesi Selatan has the highest landings of tuna which showed a generally increasing trend from available statistics since 1980. A 22% decrease in landings in 2005 from 2004 figures was observed (Figure 5.3). For the province of

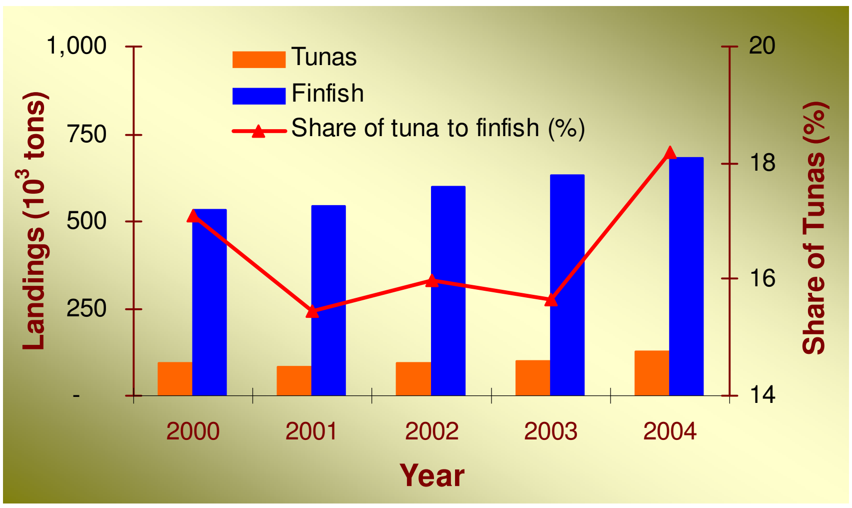


Figure 5.2 Volume (tons) and share (%)of tuna to finfish production in FMA IV from 2000-2004. Source: DKP-WPP 2006.

Nusa Tenggara Barat (NTB), landings grew from 7,854.1 tons in 2000 to 10,085 tons in 2005. In the province of Nusa Tenggara Timur landings of tuna in 1999 was about 4,538 tons and reached its highest level in 2005 to about 8,577 tons (Fig.5.3).

Combined, the tuna landings of the provinces of NTB, NTT and south Sulawesi comprise between 50% to 74% of the total tuna landings but the proportion landed shows decreasing trend over the period of 2000-2004 (Figure 5.4).

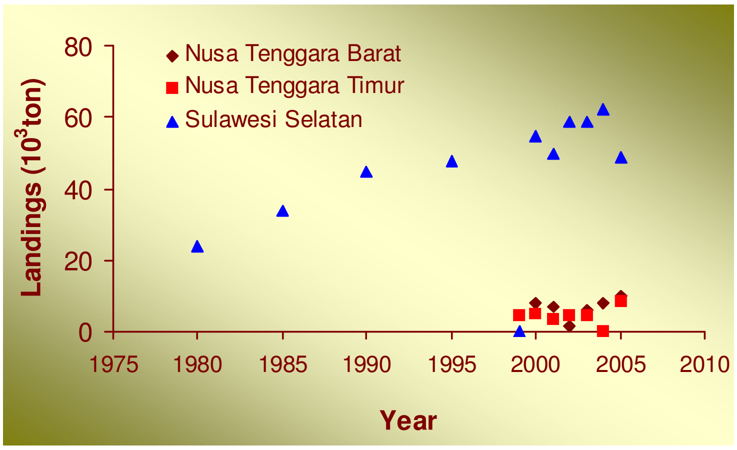


Figure 5.3 Production records of the major tuna producing provinces of fishery management area four (FMA-IV). Source: DKP-WPP 2006.

Percentage of tuna landings relative to the total fin fish landings for three major tuna provinces in FMA-IV are presented in Table 5.2. in Sulawesi Selatan from 1985 to 2005 fluctuate from 15-21%. In Nusa Tenggara Timur, from 1999 to 2005, tuna landings varied from 17-23 percent to the total fin fishes landed. In Nusa Tenggara Barat, percentage share of tuna to the total fin fishes landings steadily decreased from 2000 (13%) to the lowest (3%) in 2002 but hence have recovered and continuously increased until 2005 to 17.48%.

Landings by Tuna Species and Trends

Prior to 2004, the statistical yearbooks classify tunas by species groups as *tunas*, to describe the large species of tuna, *tongkol* for the small tunas and *cakalang* for skipjacks. In the period from 2000-2003, small tunas or "*tongkol*" dominate the landings whose production over the period increased by 30%. Skipjack more or less remained at the same production level while the large tunas' production decline by 44% over the same period (Figure 5.5).

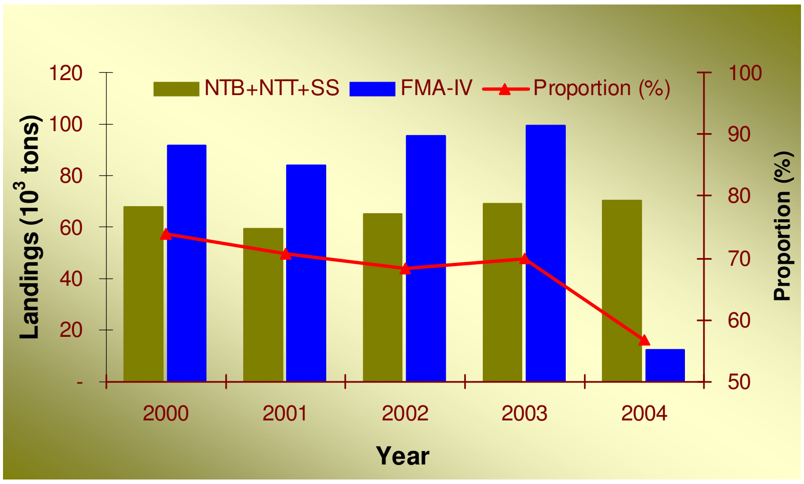


Figure 5.4. Share of tuna catch of major tuna producing provinces to total tuna production of fishery management area four (FMA-IV). Source: DKP-WPP 2006.

Table 5.2. Historical records of the volume of fish and tuna landings taken from jurisdictions of the provinces of south Sulawesi, West Nusa Tenggara and East Nusa Tenggara portion of fishery management vour (FMA-IV).

Year	Total Fish Landings (000 tons)	Tuna Landings (000 tons)	% Tuna Share
Sulawesi Selatan			
1975	192	12.0	6.25
1980	149	23.8	15.96
1985	193	34.0	17.63
1990	217	44.9	20.75
1995	236	47.5	20.13
2000	262	54.7	20.87
2001	267	49.5	18.52
2002	278	58.8	21.13
2003	279	58.8	21.11
2004	295	61.9	21.00
2005	259	48.6	18.75
Nusa Tenggara Barat			
2000	60.4	7.85	13.0
2001	60.7	6.81	11.2
2002	49.8	1.60	3.20
2003	61.3	5.95	9.70
2004	57.9	8.17	14.1
2005	57.7	10.1	17.5
Nusa Tenggara Timur			
2000	23.0	5.03	21.9
2001	19.4	3.32	17.1
2002	20.0	4.58	22.9
2003	25.3	4.59	18.1
2004			
2005	44.2	8.58	19.4

In 2004, when the tuna entries were separated into species, skipjack dominated the landings followed by *tongkol komo* (eastern little tuna) while *lisong* (bullet tuna) showed to be least (Figure 5.6). The aggregate landings of large tuna species in 2004 amounted to 43 thousand tons, dominated by longtail and yellowfin tunas (Fig. 5.6). Eastern little tuna appears to be the second most abundant landed species but as previously described, is a case of misidentification. This is because eastern little tuna is rarely present while *lisong* (bullet tuna) which are reported as very minimal, is actually the most common among the small tuna species found in the markets.

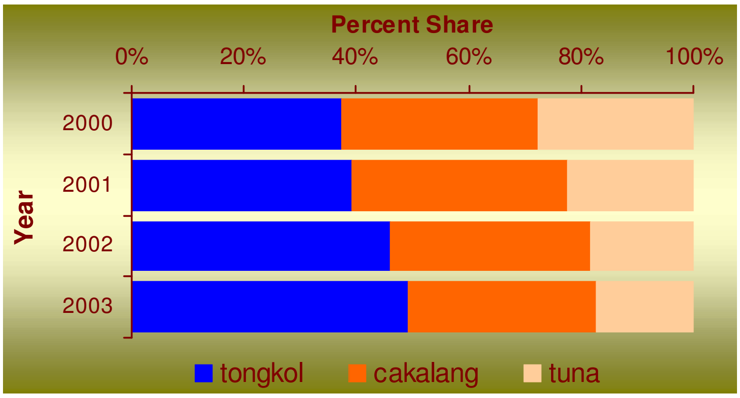


Figure 5.5. Percentage share of the landings of the three tuna categories caught from fishery management area four (FMA-IV). Legend: *tongkol*- small tunas; *cakalang*- skipjack; *tuna*- large tuna species.

Viewed on landings at south Sulawesi province shows skipjack landings doubled to 21 thousand tons from 1980 levels. Large tunas however show decline of more than 50% to just 6.7 thousand tons from a high of 16.4 thousand tons in 2000 while small tunas landings increased by 300% to 21 thousand tons from a level of 6.81 thousand tons in 1980 (Table 5.3).

The province of Nusa Tenggara Barat has not disaggregated the major grouping of tuna into species. Since 2000 to 2005, the most abundant among the tuna groups is "tongkol" followed by cakalang and then then the "tuna" group, except in 2002 when only the "tuna" group was reported (Figure 5.7). This however does not indicate that there was never cakalang and "tongkol" landed in the province; there might be some missing information in the reporting.

Just like Nusa Tenggara Barat, Nusa Tenggara Timur province has not complied with the reporting of tuna landings by species. Skipjack tunas dominated the landings from 1999 to 2003. In 2005, there was an apparent shift of species dominance to the small tunas (Figure 5.7b). Landings of large tunas seemed to have leveled off at about 750 tons from 2000 to 2005 (Fig. 5.7b).

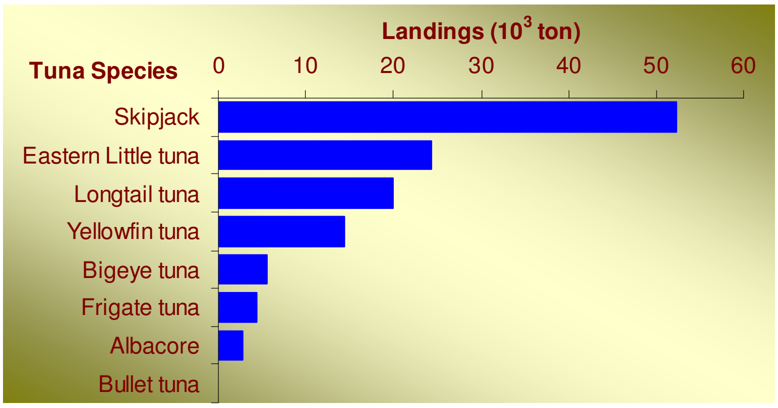


Figure 5.6 Landings of tuna in Makassar Strait and Flores Sea by species species for 2004. Source: DKP-WPP 2006.

Landings by Fishing Gears and Trends

The provincial fisheries statistics report of south Sulawesi Selatan in 2005, here used to represent FMA-IV show 17 different types fishing gears that catch tunas (Table 5.4). Of these, only four gears which include the tuna longline, pole and line, troll line, simple tuna handline and the vertical longline target the large export species. The rest of the gears such as the other hook and line, drift gillnet, purse seines, pelagic Danish seine, encircling gillnet target the small tunas and skipjack

Table 5.3. Tuna production (in thousand metric tons) by category type landed in South Sulawesi Province. Source: DKP Sulawesi Selatan Province (various years).

Year	Skipjack	Large Tunas	Small tunas
1975	5.96	6.04	nd
1980	9.77	7.25	6.81
1985	17.2	6.86	9.96
1990	20.6	10.8	13.5
1995	21.5	12.1	13.9
2000	22.8	16.4	15.5
2001	20.7	11.9	16.9
2002	21.2	12.8	24.8
2003	23.2	13.2	22.4
2004	25.3	11.3	25.3
2005	20.9	6.71	21.0

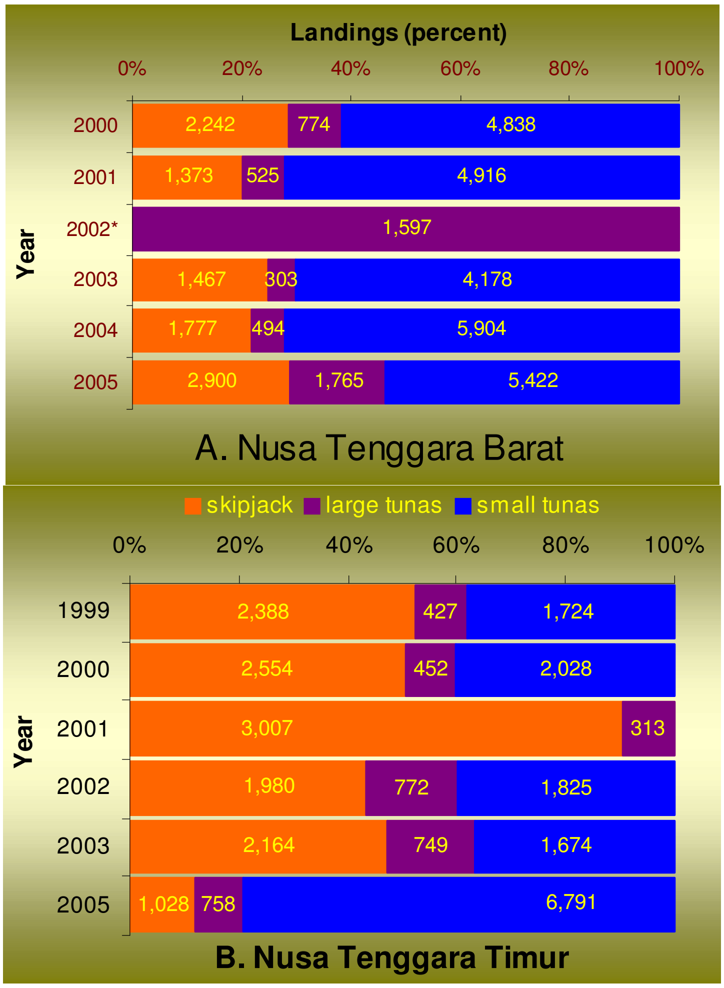


Figure 5.7 Tuna output (in thousand metric tons) by category type landed in A. Nusa Tenggara Barat and B. Nusa Tenggara Timur Provinces. Source: DKP NTB Propinsi (2000-2004). Note the absence of landings for skipjack and small tunas for 2002 in NTB and no 2004 data for NTT.

only during certain seasons while the rest of the gears take tunas as by-catch. The proportion of tunas to the total catch of each fishing gear type is presented in Table 5.4.

Interestingly, gears that catch substantial percentage of tunas are artisanal gears such as hook and line, simple tuna handline, troll line, vertical handline and small scale gillnets. For the hook and line and troll line, both large and small tunas are caught by these fishing gear types.

While gears with directed tuna catch have expectedly high proportion of tunas in their total fish catch, non-directed tuna catch by other gears (drift gillnet, other hook & line) show higher proportion that those that target the tunas. This happens because of high catch of small tunas and skipjack during certain seasons. Tunas only account for a fifth of the purse seine catch because the fleet operating in FMA IV targets the small pelagics (scads, sardines) and not necessarily tunas.

Trends of tuna landings expressed in percent share by fishing gears arecompared. Over the last 25 years three gears alternately dominate the tuna landings in South Sulawesi province. These are the troll line, hook & line and the pole and line. Major changes occurred in the ranking in 2005 where purse seine became the top tuna producer, followed by pole & line and hook & line. (Figure 5.8).

Table 5.4. Total fish and tuna catch of each fishing gear types based in South Sulawesi Province for 2005. Source: DKP Sulawesi Selatan Province 2005.

Fishing Gear Type	Total Fish Landings (000 tons)	Tuna Landings (000 tons)	Proportion of tuna catch (%)
Tuna Long Line	3.7	3.6	97.82
Pole and Line	13.4	10.3	76.51
Troll Line	16.7	6.4	38.55
Other Hook and Line	24.9	6.8	27.26
Drift Gillnet	17.6	4.5	25.59
Drift Long Lines	0.8	0.2	24.97
Purse Seine	65.2	13.6	20.80
Hand Line	3.4	0.6	18.42
Vertical Hand Line	1.1	0.2	17.70
Encircling Gillnet	10.2	1.6	15.77
Set Long Line	6.2	0.7	11.38
Pelagic Danish Seine	10.4	0.8	8.12
Shrimp Gill Net	1.8	0.1	4.38
Set Gillnet	32.3	0.1	0.29
Stationary Liftnet	5.1	0.0	0.25
Boat/Raft Lift Net	29.3	0.1	0.17
Trammel Net	0.3	0.0	0.03

Three gear types, the tuna longline, troll line and the hook and line dominated the landings of the arge export species of tunas in south Sulawesi province (Table 5.5). Over the span of 23 years beginning 1980, changes in the contribution of each gear were observed. For one, tuna longline used to be the biggest producer of large tunas in the 1980's but was replaced by troll line and hook & line. These two gears both are operated as small scale fishing gears operated by artisanal fishers.

For skipjack tunas, troll line and pelagic Danish seines are the major producer in the 1980's. In the 1990's pole & line, hook and line and troll linè`became the major skipjack tuna gears and beginning in year 2000, troll line and hook and line still dominate but drift gillnet and purse seine are added biggest contributor to the landings (Table 5.6). The production of skipjack based on landings from south Sulawesi has grown by 2.12 times from production of just 9.8 thousand tons in 1980 to 21 thousand tons in 2003 (DKP Sulawesi Selatan Propinsi, 2005).

For the small tunas (tongkol), there is an apparent shift on the types of fishing gears over the year. From pole and line in the 1980's to troll line in 1985 to pelagic Danish seine in 1990 and 1995 to drift gillnet in 2000 and purse seine in 2005, the major gears that catch the small tunas in quantity have shifted from small scale to large scale operations (Table 5.7). Furthermore, the number of gears taking small

Table 5.5. Share of production of large tunas by fishing gear types and landed in south Sulawesi province. Legend: red-most abundant; blue-2nd rank. Source: DKP Sulawesi selatan propinsi (various years).

Gear Types	1980	1985	1990	1995	2000	2001	2002	2003
Tuna Long Line	3705			23				149
Other Hook and Line	2789	4437	7491	3710	2066	498	1025	4371
Troll Line	623	1132	1084	6410	13082	9278	10857	4534
Pole and Line		74	1783	517	73	57	58	
Drift Long Line		781	5	13	21	33	58	1041
Set Long Line			6	45	39	35	63	35
Drift Gillnet	113	63	59	575	443	512	186	512
Encircling Gillnet	20	74	80	208	171	70	89	70
Set Gillnet			50	142	74	38	44	38
Trammel Net					41	16		2
Pelagic Danish Seine		153	61	24	16	351	65	351
Purse Seine		139	180	375	196	189	150	189
Mobile Liftnet					13	32	6	336
Stationary Liftnet				37		9		1609
Other Liftnets			3	11	6		6	
Trap				14				
Other Traps						678		1
Other Fishing Gears					184	117		4

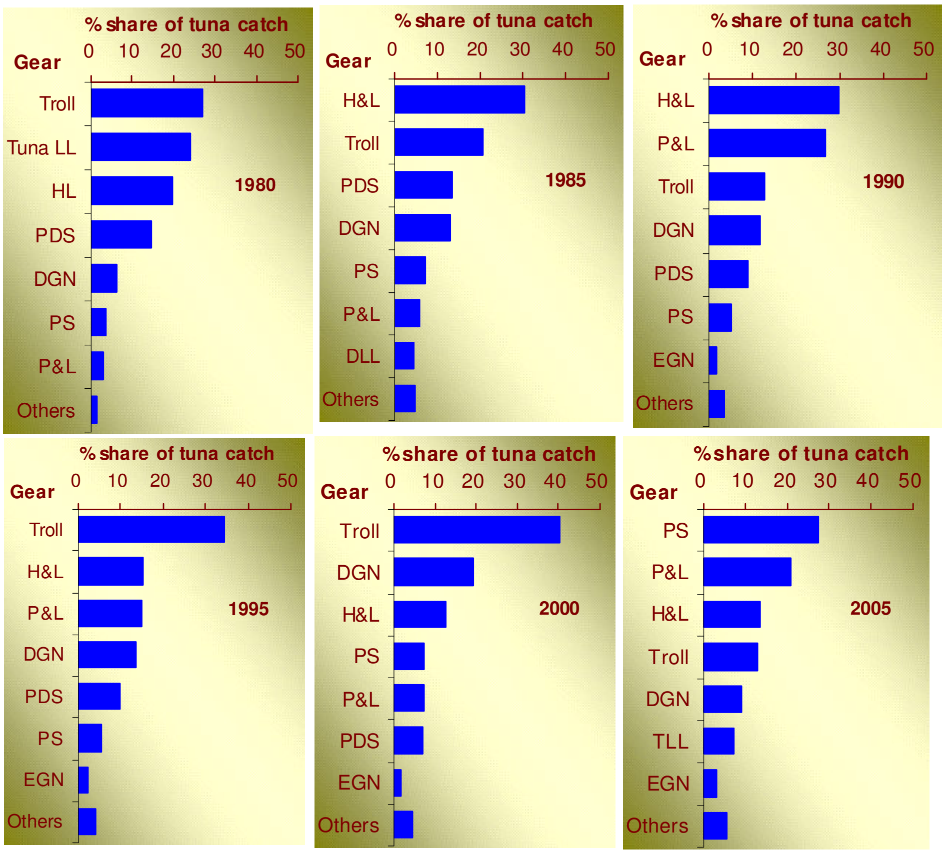


Figure 5.8 Share of tuna (%) to the total production of each gear type landed in south Sulawesi province over the last 25 years. Legend: TLL-tuna longline, H&L- hook & line, PDS-pelagic Danish seine, DGN-drift gillnet, PS-purse seine, P&L-pole and line, EGN-encircling gillnet. Source: DKP Sulawesi Selatan Propinsi, various years.

tunas as by catch has likewise increase in number to include beach seine, liftnets, traps and longlines. With the introduction of improvements in recording system, gears such as the tuna handline and vertical handline are added to the list of tuna gears.

Fishing Capacities and Trends

Compiled records of the three provinces of south Sulawesi, NTT and NTB show a total of 51.9 thousand fishing gears belonging to at least 12 types. Of this gear varieties, five are specific for catching tunas and the remaining take tuna as by

Table 5.6. Trends in production of skipjack tuna by gear type and landed in south Sulawesi province. Source: DKP Sulawesi Selatan Province (various years).

Gear Type	1980	1985	1990	1995	2000	2005
Troll Line	3286	3013	3019	7963	7358	3240
Pelagic Danish Seine	2062	2560	753	909	844	841
Pole and Line	696	1107	8019	5397	1986	10286
Drift Gillnet	510	2471	2351	3034	6938	2692
Purse Seine	29	1813	1075	1179	1511	760
Other Hook and Line	1003	4538	4584	2043	2960	1752
Tuna Long Line	2039					250
Encircling Gillnet	82	201	425	428	461	483
Mobile Liftnet	50	67	134	77	104	50
Trap	41	9	10			
Set Gillnet	13	659	214	249	393	93
Other Liftnets	2		3	8	7	
Stationary Liftnet			5	3		13
Drift Long Line		698	47	121	165	73
Set Long Line				38	26	319
TOTAL	9814	17135	20640	21451	22753	20853

Table 5.7. Trends in production of small tunas (tongkol) by gear type and landed in south Sulawesi province. Source: DKP Sulawesi Selatan Province (various years).

Gear Type	1980	1985	1990	1995	2000	2005
Pole and Line	**7779**	810	2205	1238	1966	
Troll Line	2579	**2874**	1646	1945	1489	463
Pelagic Danish Seine	1421	1846	**3132**	**3712**	2895	
Other Hook and Line	956	1310	1307	1528	1928	2689
Drift Gillnet	863	1970	2795	2867	**3052**	166
Purse Seine	810	562	1012	1105	2389	**5371**
Encircling Gillnet	75	75	305	423	300	358
Trap	42	12	38	38		
Stationary Liftnet	27	53	39	46	58	
Mobile Liftnet	20	450	318	384	525	
Tuna Long Line	19			32		487
Set Gillnet		1	222	319	148	
Other Liftnets			3	5	6	
Drift Long Line			39	242	658	48
Set Long Line			425	23	90	389
Beach Seine			17			
Tuna Handline						506
Vertical handline						187

catch or directed catch during certain seaons (Table 5.8). The figures given below do not include gears from other provinces.

From the period 2000 to 2005, the number of tuna fishing gears increased but the numbers of many of the tuna gears have probably reached their maximum number in 2003 as their numbers in the following years declined (Table 5.9). Such is generally the case with purse seine, troll lines and drift gillnets for the provinces of South Sulawesi and NTB. For NTT however, a huge rise in the number of tuna gears have been observed in 2005 where all gears save for the pelagic Danish seine showed increases (Table 5.9). The reason is that many of the fishing gears elswhere have shifted operation to NTT area where fishing still remains highly profitable.

The number of fishing vessels as exemplified by the records of the provincial statistics of South Sulawesi (DKP Sulawesi Selatan Propinsi, 2005) show the number of vessels with outboard motor double from 4716 units in 1980 to 8709 units in 2005 and an exponential rise in the total tonnage of vessels with inboard engines (Figure 5.9). The same development could be said for the rest of provinces that catch fish in FMA-IV.

For the provinces of NTT and NTB, the spread of vessel size is limited to the smaller size classes, hence there are no large vessels over 30 GT registered in these areas. This does not mean that there are no large vessels operating within their jurisdiction.

Table 5.8 Number of fishing gears registered for the provinces of south Sulawesi, NTT and NTB for 2005. Legend: T-tuna as targetted by gear; BC-tunas taken as by-catch or only during certain seasons in an opportunistic way.

Gear Type	Number	Targetted (T) By-catch (BC)
Tuna Longline	920	T
Pole and Line	479	T
Troll line	8492	T
Drift Longline	3965	BC
Set Longline	3549	BC
Other Hook & Line	15945	T /BC
Vertical Handline	577	T
Tuna Handline	4916	T
Drift Gillnet	3905	BC
Encircling gillnet	396	BC
Purse Seine	2674	BC
Pelagic Danish seine	2099	BC
Other Fishing Gear	3982	BC
TOTAL	51899	

Table 5.9 Number of registered tuna fishing gears for the provinces of South Sulawesi, Nusa Tenggara Timur, Nusa Tenggara Barat belonging to fishery management area number four (FMA-IV). Sources: DKP Sulawesi Selatan Propinsi, DKP NTT propinsi, DKP NTB Propinsi.

South Sulawesi	2000	2001	2002	2003	2004	2005
Tuna Long Line				21	868	920
Pole and Line	101	135	389	413	252	183
Troll Line	3958	4980	4284	6126	6192	4155
Drift Long Line	714	771	781	779	731	187
Set Long Line	2740	2530	2631	2712	2339	2742
Other Hook and Line	7697	8724	8534	10429	10085	8391
Vertical Hand Line					653	507
Hand Line					3124	1383
Drift Gillnet	5987	5372	5433	4263	4288	3017
Encircling Gill Net	642	623	592	623	547	396
Purse Seine	1655	1862	1754	2494	2700	2299
Pelagic Danish Seine	3563	3258	3246	3423	3728	1750
Other Fishing Gears	1283	717	754	583	434	344
Nusa Tenggara Timur						
Tuna Long Line	47	51				
Pole and Line	68	68	68	68		296
Troll Line	1458	2015	1361	1304		3041
Set Long Line			22	22		1
Other Hook and Line	5949	5528	6346	6076		6618
Drift Gillnet	2491	2240	2133	1797		3651
Encircling Gill Net				603		
Purse Seine	116	117	122	149		213
Pelagic Danish Seine	67	54	48	300		46
Other Fishing Gears	1399	1191	2117	2720		3116
Nusa Tenggara Barat						
Tuna Long Line					3	
Troll Line	832	1243	1342	1416	1615	1296
Drift Long Line	787	429	187	184	232	127
Set Long Line	180	184	295	281	359	807
Other Hook and Line	4595	4778	4456	4505	1792	936
Vertical Hand Line						70
Hand Line					2259	3533
Drift Gillnet	1849	1534	981	1125	878	888
Encircling Gill Net	19	20	21	29	29	
Purse Seine	125	127	171	194	168	162
Pelagic Danish Seine	512	518	458	438	397	303
Other Fishing Gears	1690	1115	701	313	355	522

Estimate of Tuna Catches

A total of 297.4 thousand tons was estimated for FMA-IV for the three major provinces that form the backbone of the tuna fishery. This estimate is 2.4 times the official tuna catches for the whole fishery management area four (FMA-IV). Despite this very large difference in tuna output, this estimate is on the lower range considering the following assumptions we used in our estimate:

1. The number of fishing gears utilized represent 60% of official records for 2005 for only three provinces (South Sulawesi, NTT and NTB). Only the data for vertical handline, tuna handline were totally used as interview results suggest that these are still grossly underestimated.

2. Actual operational data for catch rates, fishing days were used for the following gears: handline, vertical handline, troll, purse seine mini, purse seine medium and pole and line. Mean annual catch rates were based on taking the averages of tuna catch for peak and lean seasons and including zero catch in the computation; the same averaging procedure was used to estimate total number of fishing days. Similarly for the

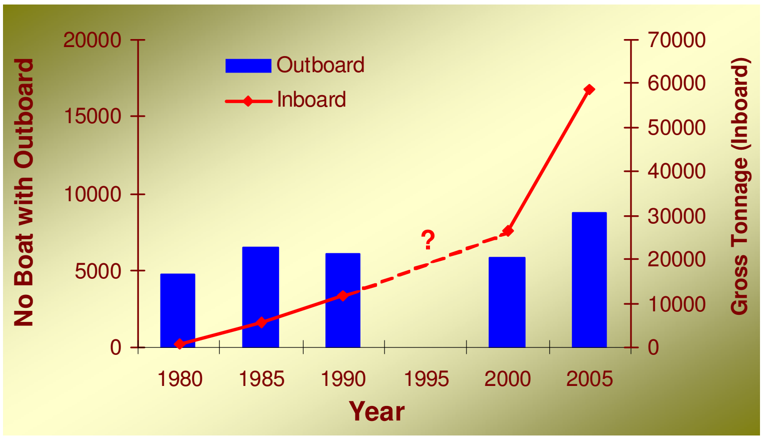


Figure 5.9 Trend in the number of fishing crafts with outboard motor and the sum of vessel tonnage for crafts with inboard engines in the province of South Sulawesi. Source: DKP South Sulawesi Statistics (various years).

data on proportion of tunas of each gear, we have used actual percentage share based on results of species composition provided to us during interviews for handline, purse seine, pole & line and troll.

3. For the rest of the fishing gears, we have used estimates based on other FMAs where we have data.

The use of 60% of reported figures on number of fishing gears is justified in order to allow for errors arising from double registration, double reporting at fishing ports particularly for the vessel larger than 10 GT. We also did not include in the computation the tuna longline gear where 920 units as well as other minor gears whose tuna share is below 1% in the 2005 fisheries statistics yearbook of the three provinces.

Of the 297.4 thousand tons estimated production of tunas in FMA-IV, about 44% are large tunas, 24% small tunas and 32% skipjack tunas. The main contributor to the large tuna production in FMA-IV are the handlines and the troll lines, mostly made up of yellowfin and very few big eye tunas. If data from East Kalimantan are

Table 5.10. Data used to estimate tuna catches in FMA-IV (for three provinces only). Sources of data: DKP provincial fisheries statistics 2005, results of this survey. Note: The footnote number on row and column defines the corresponding figure.

Fishing Gear Type	No. gears 2005	no of gears used[1,3,4]	total fishing days/yr[2,5,6]	annual catch/unit (mt)[5,6]	Est. total fish catches (mt)	% share of tuna[5,7]	Est. tuna catches (mt)
Pole and Line[2,5]	479	287	258	200	57,480	0.97	55756
Troll Line[5]	8492	5095	224	14	71,333	0.98	69906
Other Hook and Line[3,6,7]	15945	3189	240	5	15,307	0.27	4172
Hand Line[4,5]	4916	4916	140	22	108,152	1.00	108152
Vertical Hand Line[4,5]	577	577	140	22	12,694	0.20	2539
Set Long Line[1,6,7]	3549	2129	180	9	19,165	0.11	2180
Drift Long Lines[1,6,7]	3965	2379	180	9	21,411	0.25	5347
Purse Seine (>30GT)[1,6,7]	18	11	224	130	1,404	0.21	292
Purse Seine (<30GT)[1,5,7]	2656	1594	143	105	167,328	0.21	34798
Pelagic Danish Seine[1,6,7]	2099	1259	180	27	34,004	0.08	2762
Drift Gillnet[1,6,7]	3905	2343	180.000	18	42,174	0.26	10791
Encircling Gillnet[1,6,7]	396	238	180	18	4,277	0.16	674
TOTAL							**297369**

[1]/ used only 60% of recorded units
[2]/ actual fishing days
[3]/ used only 20% to account for seasonality of small tunas & skipjack
[4]/ used all gears as this an underestimate
[5]/ based on actual operational data from interviews
[6]/ estimated from other fishing areas
[7]/ based on DKP Sulawesi Selatan Statistics 2005

to be included, then the proportion of large tunas will significantly increase as the number of handlines reported by respondents operating in Makassar Strait is estimated to number around 10,000 boats!

The Tuna Fisheries

The major fisheries of tuna discussed in this section include the hand line, troll line, pole and line, purse seine and the tuna long line. This section would give a bird's eye view of these fisheries.

Pole and Line

The pole and line fisheries in FMA-IV are using two types of fishing vessels, the wooden hulled and the fiber glass hulled, most however are using the wooden hulled boats. The boats are usually 25 to 40 gross tonnages powered by 56 – 160 HP marine engines. Each fishing vessel is manned by about 15-25 people depending on the gross tonnage of the boat. During the peak months, the maximum number of days fishing is about 26 days while during the lean months maximum days at sea is only 20 however the days usually varies depending on the availability of baits (see also Chapter 13). The peak months in Bone Bay for the pole and line fishing is from October to November and from May to November in southeast Sulawesi. The lean months of pole and line fishing starts from January to May of each year.

The pole and line units used to catch the fish is composed of a 2.5 meter long thin bamboo pole. Attached at the finer tip of the bamboo is a 2.5 meter multi-filament corallon twine of 22-mm diameter where the unbarbed hook is attached at the other end of the line. The length of the line is measured such that when a hooked fish is hanging on the line, it is at the level where the fish will fit between the upper arm of the fisher and the side of his body.

This fishing gear uses false made of synthetic colored thread of various pastel colors. The fishing techniques utilizes chumming, where livebaits are thrown out into the school of skipjack, sea water is sprayed to simulate frenzy feeding and fishing commences. Livebaits used consist of anchovies, juveniles of sardines, fusiliers and other fishes which are kept in holding tanks on the boat. This will explain why pole and line boats are large so that it could accomodate several holding tanks for live baits. A boat of the size described above would normally need about 50 liters of baits per fishing operation. Baits are usually caught by stationary or mobile liftnets in Bone Bay or South East Sulawesi coasts.

Table 5.11 Estimated volume of tunas by categories using production figure in Table 5.10. The proportionality index used for pole and liine, troll line, handline, vertical handline and purse seine are based on actual interviews.

Fishing Gear Type	Large tunas	Small tunas	Skipjack
Pole and Line		5576	50180
Troll Line	35652	9088	25166
Hand Line	102744	1082	4326
Vertical Hand Line		1777	762
Purse Seine (>30GT)		242	50
Purse Seine (<30GT)		28883	5916
Other Hook and Line		4277	1069
Set Long Line		29.20	262.78
Drift Long Lines		20879	13919
Pelagic Danish Seine		2209	552
Drift Gillnet		674	
Encircling Gillnet		674	
Total	138397	75390	102203
Percent share	44.00	24.00	32.00

Pole and line fishing operates both on Fish Aggregating Devices (FADs) or by searching for schools through use of associated indicators such as sea birds and dolphins. However, beginning 2004, when fuel prices increased by 200% and subsidies removed, pole and line fleet became dependent on fishing in FADs to minimize fuel for searching fish schools. The problems of the pole and line fishery is discussed fully in Chapters 13 about the livebait problem and Chapter 14 on the impacts of fuel price increase.

Catch and Catch Rates

Based on the database available at South Pacific Commission (SPC) for pole and line fleets in FMA-IV, the total tuna catch rose steadily from 1976 (136.81 tons) to its peak in 1999 (45,772.45 tons) and have gradually decreased until 2004 by about 19% of the 1999 catch (Figure 5.10).

Catch rates of pole and line operating in Flores Sea have shown declining trend where annual catch rates of over 1 ton/fishing day in 1982 has gone down by 65% to only 373 kg/fishing day in 1989. The main reason for the decline of catch is the acute shortage of livebaits for chumming. The level of decline have been confirmed by fisher respondents who estimated current catch and catch rates as just 30% of 1980 levels!

A plot on the catch rates and available number of pole and line vessel points to a classic trend of low catch rates and high fishing pressure indicative that local overfishing of skipjack is probably happening (Figure 5.12).

The availability of livebaits is key to a successful pole and line fishing operation. But the availability of livebait situation has gone from bad to worse forcing operators to cut down on fishing frequency by as much as 40%. The problem with sourcing baits, particularly for live anchovies is a question of resource availability. Declining catch rates of baitfishes is one of the reasons for lack of baitfish supply (Figure 5.`13). The study of Widodo showed that baitfish catch rates declined by 64% over a period of five years from 1985-1989. Over the same period, the number of liftnet units increased by 56%. Again, another classic case of unregulated fisheries.

The dependency of the tuna pole and line fishery to another fishery (liftnets) show the importance of applying the ecosystem-based approach to fisheries management. The policies and regulations on the tunas should take into consideration other aspects of the fishery, in this case the source of livebaits to ensure that a particular fishery does not impact another fishery.

The pole and line fishery targets the skipjack tuna but schools of skipjack are contaminated by juvenile yellowfin. The volume of yellowfin contamination in the catch of pole and line averages about 6.16% (range: 4.0% to 9.0%) (Figure 5.14). However, records exist of higher percentage of yellowfin are present, where yellowfin

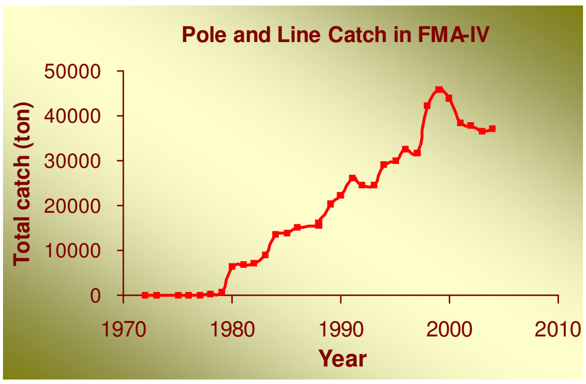


Figure 5.10. Tuna catch by pole and line fleet operating in FMA-IV. Source: South Pacific Commission Database: http:// www. spc.org

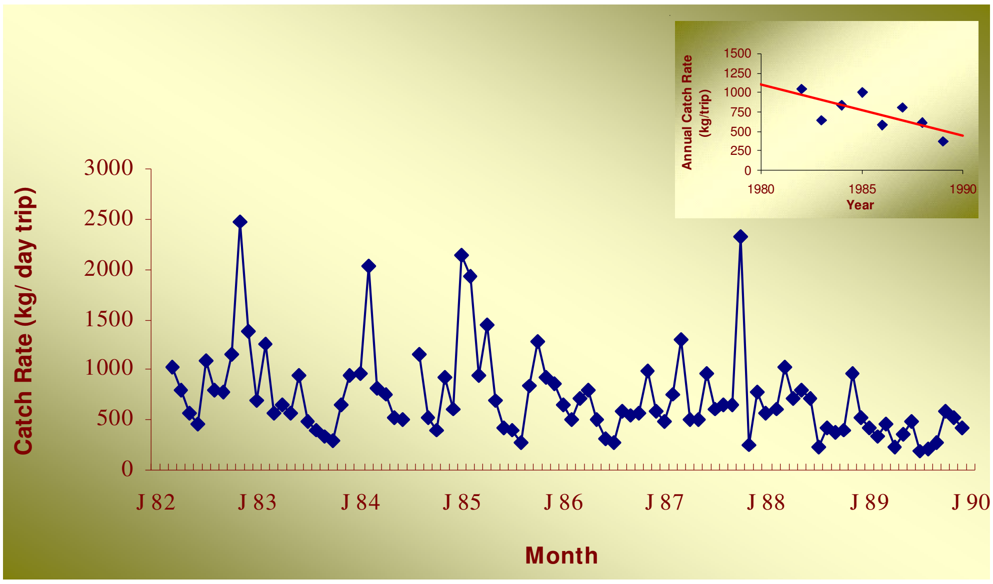


Figure 5.11. Monthly catch rates (kg/trip) of wooden pole and line vessels operating in Flores Sea from 1982-1989. Inset: same data set presented as annual mean catch fitted with a trend line. Source: drawn from data in Widodo (1990).

represent 37% of the total catch. The high incidence may be seasonal, the catches made during the recruitment run from April-May.

The sizes of yellowfin tuna catch of pole and line could be discerned from the prices which is dictated by the size of the fish. Assuming that the quality is acceptable, yellowfin class A fish are those that fall in the size range of 2.3 kg - 22 kg while class B are those falling between 1.2kg - 2.2 kg sizes (Figure 5.15).

Hand Line

The hand line fishery for tuna is the biggest in FMA-IV in terms of the number of gears and production of large tunas. There are different types of handline for tuna used in FMA-IV; the single and large hook targeting the large individuals and the multiple and small hooks targeting the small tuna species. Most of the handlines using single-large-hook are also using large-diameter nylon twines and a combination of artificial and live-fish baits. The multiple-small-hooks and line (also called vertical handlines in DKP statistics) have a wide range of variety from just 2 hooks to 150 hooks but the hooks-size is smaller (#17-#19) and the baits used are usually artificial baits. Artificial baits are commonly of colorful silk fibers, or chicken feathers.

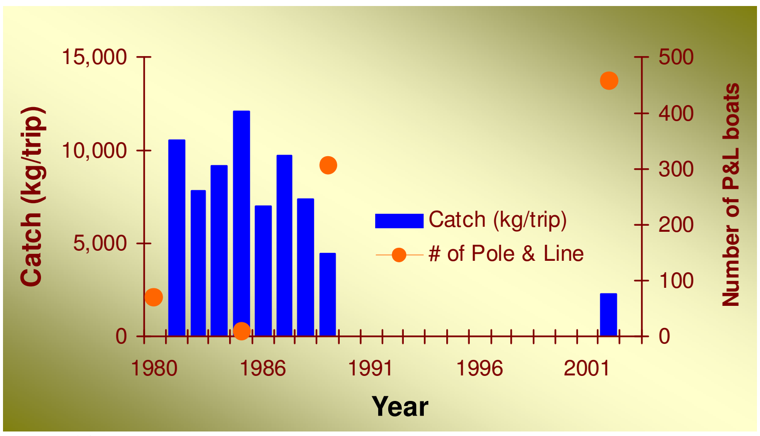


Figure 5.12. Plot of catch rates of pole and line with fleet size operating in Flores Sea. Data from Widodo (1990) and Saepul (2002).

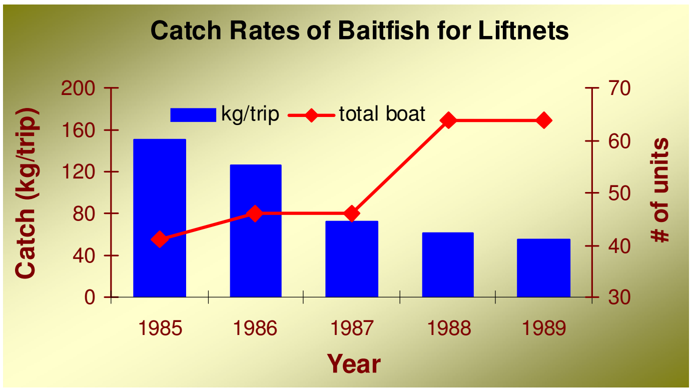


Figure 5.13. Catch rates of mobile liftnets operating in Flores Sea from 1985 to 1989. Data drawn from Widodo 1990.

Liftnet on rafts, could be moved by towing. Taken in the Bajoe Village, Kota Kendari.

The handliners for big tunas are of two types, the independent fishers and those connected to companies. The independent fishers own their boats and control where and how they market their catch. While at times these fishers seek financial assistance from traders but are generally not tied up with them formally except an unwritten contract of loyalty to sell their catch to the trader where they owe.

In contrast, those under companies get full finances from the company either in the form of operational logistics, fishing boat units or all fishing provisions. In return for being under the system, these fishers are under the terms of the company, of which may include, pricing of catc`h, area of fishing ground or the time of fishing. The system, locally called "plasma" is that the company has mother boat which act as the transport vessel carrying the small fishers and their boats in and out of the fishing grounds as well as the food and other provisions necessary for fishing.

The independent handliners are usually with boats not greater 10 GT mostly powered by 5 to 10 HP inboard or 1 25 HP outboard engines. The average number of fisher onboard one boat is one or two men. Fishing is usually at daytime; the fisher leaves port at dawn and goes back before dusk. For those with the companies, the carrier boats are usually 30 and 70 GT class which carry 5-15 small boats (<1GT) and their fishers. Upon reaching the fishing ground, the fishers will use the small boats for fishing. The fishing boats are usually powered with 5 to 9 HP engines but some are also non-motorized (sampan). The fishers will go back to the mother boat at night to rest.

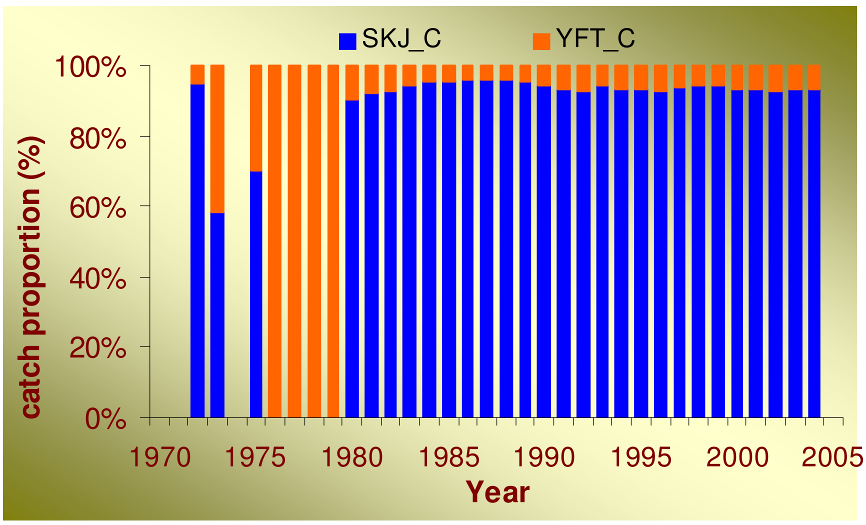


Figure 5.14. Proportion of skipjack and yellow fin tunas from pole and line catches from FMA-IV. Source: Data from SPC database (www.spc.org)

Table 5.12 Actual catch categorized according to sizes of skipjack and yellowfin tunas caught by a pole and line vessel boat (KM Mitra Jaya) operating in FMA-IV from April 7 to May 5, 2002. Note the 37% take of juvenile yellowfin tunas.

Species	Class	Size of Fish (kg)	Total Catch (kg)	Percent (%)	Species share
Skipjack	Class A	> 2.70	1722.0	24.9	
	Class AB	2.3 - 2.7	1327.6	19.2	
	Class B	1.2 - 2.2	836.3	12.1	63.1
	Class C	< 1.20	479	6.9	
	Class D	reject	0	0.0	
Yellowfin	Class A	2.3 - 22.0	1702.0	24.6	
	Class B	1.2 - 2.2	849.6	12.3	36.9
	Class C	reject	0	0.0	

The handliners identify the months of January to March as peak season for the small tuna in FMA-IV and February to April for the large tunas, the rest of the months are devoted to fishing other than the tunas.

There are about 5 major species caught by handline for big tunas, the most abundant is the yellow-fin which comprise 93% of the total catch (Figure 2.15). About 23.4% of these yellowfin tunas were mature while most are from 2 to four years of age (Merta, 1984).

Troll Line

The troll line fishery is widespread in FMA-IV. The fishery is small-scale in operation, using boats of less than 20 GT and powered with one or two 40-HP outboard engines. In most cases t2 outboard engines power the boat. Fishing operation is done around FADs or at open sea when schools of fish are indicated by the abundance of dolphins and sea birds. Sometimes schools of fish are even visibly observed from the water surface. When these situations arise, the fisher sets the fishing gear and crisscross the school of fish until there are no more fishes to catch. Fishing around FAD is simply towing the gear at a safe distance from the structure. Troll lines usually operate at daytime.

A unit of the fishing gear is composed of a mainline usually made from PE of 100-mm diameter. Attached to the mainline are branch lines set at 10 meters interval and connects the hooks to the mainline. The branch lines are of 50-mm diameter. The number of hooks in one unit of troll line varies from just one to 25 hooks. The hooks used vary from #5 to #7 commercial sizes.

Troll lines target various tuna species such as skipjacks, yellowfin tuna, eastern little tuna and frigate tuna to name some. During this study, the most dominant troll line catch is mixture of skipjacks and other species of small tunas (50%), followed by the juveniles of yellow-fin tuna (49%) and the remaining 1% is a mixture of other fishes. Here, the issue of significant catch of juvenile tunas is documented where even more contamination of juveniles than the pole and line are observed.

When compared to 10 years ago, fishers claimed than volume of catch decreased by about 50% and there had been a shift of species from a skipjack dominated catch to the apparent increased of other fishes like the juveniles of yellowfin tuna.

Purse Seine (*Gae*)

Purse seines in FMA-IV are also divided into 2 size categories, the small purse seines (<30 GT), locally called *Gae* or "*purse seine-mini*" and the big purse seines (>30 GT) [refer to chapter 8 for a complete discussion on the fishing operations and techniques of purse seine.

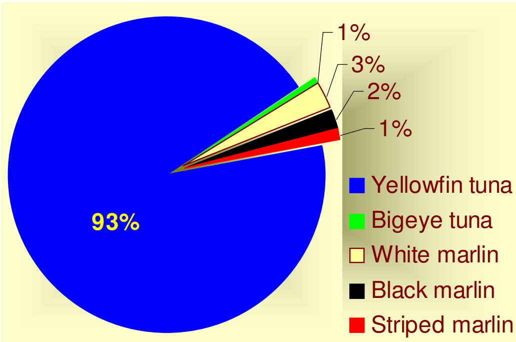


Figure 5.15. Species composition of simple handline fishing in a fish aggregation device (FAD) in Makassar Strait in 1983. Data drawn from Nasution et. al 1986.

The specification of *Gae* nets operating in Bone Bay and Flores is 280 meters long by 20 meters wide and has a 2.5-cm mesh size. The netting material is made of multifilament twines. The vessel is manned by 15 crew members. Fishing operation is at daytime only and mainly in FADs (*rumpon*). There are 77 units of *Gae* based in Bone Bay.

The *Gae* operating in Makassar Strait are bigger nets with lengths of about 270-meters and width of about 70-meters and with mesh sizes of 4-5 centimeters. Fishing operations of most Gaes in Makassar Strait are around rumpons (FADs) at daytime and mostly making just one set per day. The catcher vessel is powered by 200 HP engine. There are about 6 such fishing boats of this category using Pinrang as its home port.

The catch composition of purse seine operating in Bone Bay and Flores Sea in 2006 are mostly small tuna (56%) followed by skipjacks (22%) and mixture of other pelagic fishes (22%) [Figure 16a]. In Makassar Strait, purse seines takes more skipjack tunas (59%), small tunas (17%) and mixture of other pelagic fishes (24%) [Figure 5.16b]. There seems to be a difference in the ranking of catch composition from Bone Bay and Flores Sea (east of FMA-IV) and Makassar Strait (west); in the east the most abundant are the small tunas while in the west skipjacks dominate the catch.

Aside from the mini-purse seines which are legally allowed to operate within archipelagic waters, there are also large purse seines (>30GT) that operate illegally because of vessel size in FMA-IV. Its catch composition is shown in Table 5.13.

Trends of catch rates of purse seine based on catch per day-fishing of the big purse seine fisheries showed a decline in catch rates from around 6 tons per trip (2 -3 days) to just below 2 tons per trip. Although data used were from on-board training of students covering just two months, the data were collected at the same months of each year sampled.

Support Infrastructures

Within FMA-IV, there is one first level fishing port in Kendari, Sulawesi Tenggara (Pelabuhan Perikanan Samudera - Kendari). A visit in PPS – Kendari showed not so much activities expected for a first level fishing port. Interview with the administrators revealed that the port is not regularly used by fishing vessels especially that there are very few large fishing vessels landing in Kendari. In fact most of the activities are on the traditional landing sites.

There are also several third level ports or Pelabuhan Perikanan Pantai (PPP) namely PPP Labuhan Lombok in Nusa Tenggara Barat, PPP Kupang in Nusa Tenggara Timur, and PPP Tarakan in Kalimantan Timur.

There is an apparent lack of relatively large scale fisheries support infrastructure within the province of Sulawesi Tengah and Sulawesi Selatan. Yet interviews with tuna fishers in some communities and traders within the said provinces showed a relatively good potential of tuna. It was also observed that better quality fishes are sold in the markets compared to other areas of the country even for the big and well-supported fishing ports. The absence of good support infrastructure for fishers to sell their fish further aggravates the problem of traders and middlepersons taking full control of the markets.

The landing sites actively used by fishers in the area are the traditional fishing ports which are called Tempat Pelelangan Ikan (TPI). Hygeinic standards of these ports however is a problem; few of the traders are using tables, the fishes are just on the pavements barely covered by sacks or plastic sheets. Ice are rarely seen and seldom used. Damaged and stale fishes are a common site.

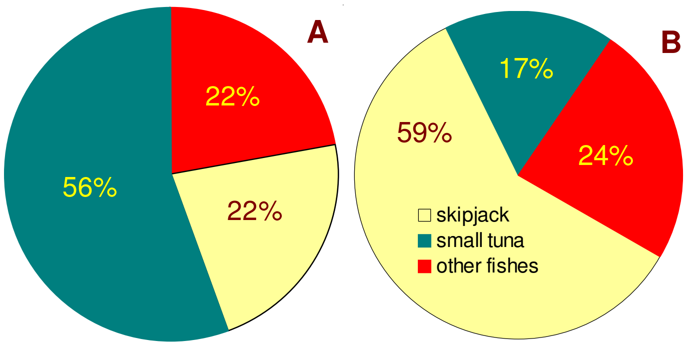


Figure 5.16. Comparison of catch composition of purse seines (Gae) operating in Bone Bay and Flores Sea (A) and in Makassar Strait (B) in 2006. Source: This study (2008).

Table 5.13. Comparison of catch composition of large purse seines operating in FMA-IV in 2006. Source: This study (2008).

Species Group	96-GT	131-GT
Roundscads	96.2	85.0
Indian Mackerels	0.0	0.13
Small tunas	47.1	14.3
Other Fishes	88.4	4.46
Total	231.6	103.8

In a far flung village in Pare-pare, fishers engage in catching tuna using simple handline in Makassar Strait. The catch rates are still very high but there are no buyers for their tunas. The number of fish to be caught and landed are fixed as the fish trader could only buy a fixed number due to lack of capital and transportation. Thus, fishers take turn to catch fish.

Notes on the Economics of Fishing

An overview on the economics of tuna fishing in FMA-IV, a simplistic approach on the costs and revenues is discussed here. Cost of fishing comprises two major categories, the fixed and variable costs. The fixed cost mostly involves the depreciation cost and maintenance of the fishing vessel, engine and the fishing gears and maintenance while the variable cost comprises the expenses on fuel, food, ice, rent/share of the FADs, labor, taxes, fees and others.

Handline

Initial investment for the handline fisheries targeting tuna is almost centered on the fishing vessel and engine because the investment on the fishing gear is minimal and the lifespan of the gear is very short that sometimes the cost is included in the

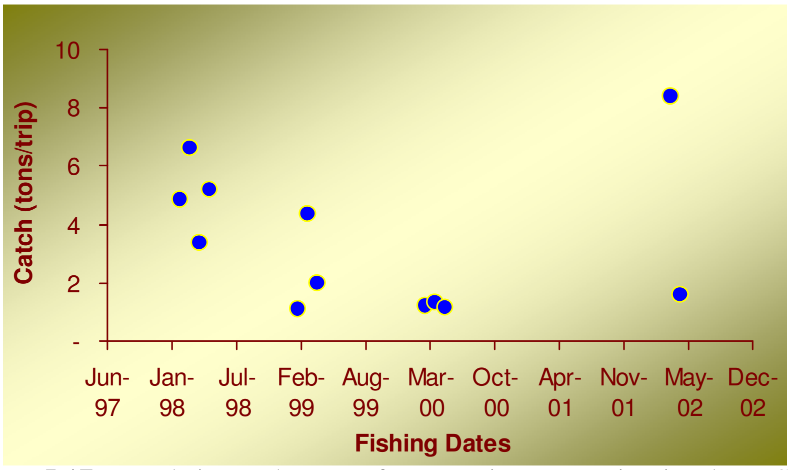


Figure 5.17. Trends in catch rates of purse seines operating in Flores Sea between 1997 to 2002. Sources of data: Irwan (1998), Riyad (1998), Irwan (2000), Rasyid (2002), Pramono (2000).

operational costs. For a fishing vessel of about 6-GT and powered with a 30-HP inboard motor the initial investment was about Rp100.00 million while for the 24-GT with inboard motor of unspecified horse power was Rp155.00 million. The above investments are translated into annual fixed cost by the yearly depreciation rate which is about Rp10.00 million for the 6-GT with 30-HP inboard motor and Rp15.50 million for the 24-GT fishing vessel. The above annual depreciation rates were calculated from assigning 10 years lifespan for both the vessel and engine. Per set of handline fishing gear costs about Rp100.00 thousand.

In a system where a company provides the mother boat, the investment of the fishers comes in two forms: their personal non-motorized boats (sampan) and the tuna handline gear. The non-motorized boat costs about Rp500.00 thousand each. The cost of the mother boat is not available but very often, these are retrofitted pole and line boats.

There had also been reports of respondents that both the engine and the fishing boat are given as grants/ loan from the government. The set-up or terms of payment was not clear but the fishers said they are paying it back through giving 20-50 kilos per trip, a repayment scheme which is anomalous. However we have reasons to belive that there is actually no payback term and the goods were given as endowment.

The setting up and initial investment for a Fish Aggregating Device (FAD) ranges from Rp5.00 million to Rp20.00 million, depending on the materials, depth and distance of setting.

The variable costs of the handline fisheries for tuna in FMA-IV includes licenses and other fees which reaches about Rp400.00 million annually. Another item in the variable costs is the annual operational or running expenses which range from Rp13.5 million (24GT), Rp19.20 million (<3GT) to Rp127.38 million (6GT). The list of expenditures on the annual operational expenses we have analysed is difficult to understand but the amount is highly dependent on the distance of the fishing ground to the home port and the bringing of ice. Those vessels highest that bring ice during fishing operations incur the highest operating expenditures as the cost of ice is twice the amount spent on other items such as fuel and food. This is because there are no ice plants accessible in the area and the fishers are dependent from outside sources or from household-produced ice.

Estimated annual income is only available for the 6 GT fishing vessel which is about Rp483.42 million. The total annual expense of the 6-GT handling fishing is about Rp168.86 million. Thus about Rp314.56 million is the gross annual income with which the fishers and all involved including the FADs would take their shares.

Pole and Line

The most significant part of the preliminary outlay in the pole and line tuna fishing venture is the boat and its engine which in 2001 is about Rp150.00 million. This is for a fishing boat in FMA-IV of about 27 GT and with inboard engine of 56 horse power. This is translated into Rp15.00 million annual depreciation costs which is an item of the financial book under the yearly fixed costs. Akin with the handline fisheries, the pole and line fishing gear durability is almost as good for just one fishing day or trip that it will be a part of the running expenses instead. Since the pole and liners in FMA-IV are mainly based on FADs, its establishment is also one if the preliminary expense outlay.

Annual operation expenses which includes the fishing gears, fuel, ice, food and other provisions necessary for a fishing operation is about Rp113.36 million. With annual gross sales of Rp 980.03 million, the gross income to be shared by all the stakeholders including the FADs share is about Rp 866.67 million. A quick look at the net income indicates that troll fishing in FMA-IV is profitable.

Troll Line

Initial investment in the troll line fishing vessels of <3GT was about Rp4.50 million and the outboard motor was Rp2.0 million. For a lifetime of 10 years the annual depreciation cost would be Rp650.00 thousand for both the boat and the motor. Initial investment for a fishing gear set was about Rp100.00 thousand; however because of the method of fishing and materials of the fishing gear (just like with other hook and line fishing gears) replacement is very often. A daily operational expense is about Rp87.50 thousands which is about Rp21.00 million in a year of about 240 days fishing.

Summing up all the costs (depreciation, operational, etc.), annually this type of fishing would have a total outlay of Rp31.85 million. Basing from their answers during the interview, the estimated annual gross sales is about Rp23.50 million. A quick glance of this fishery shows that troll fishing is a losing economic activity.

Mini-Purse Seine (Gae)

The purse seine fisheries operating in FMA-IV are mainly catching small pelagic fishes and are not really targeting the tunas, however because a large percentage of its catch are tunas, it was deemed important to include it here.

Mixed catch of juvenile yellowfin tuna, frigate tuna waiting to be iced in a port in Pelabuhan Bajo, Bone.

Initial outlay on fishing boat in 1991 was Rp4.00 million and the inboard engine of 300 HP was Rp3.00 million. The initial cost of the mini-purse seine fishing gear was about Rp3.00 million. Each FAD initially costs Rp5.00 million. In this case depreciation costs and fixed cost does not apply because the company is implementing a different system of recovering the initial costs of the gear, vessel and engine.

The total operational expenses are estimated to be about Rp36.42 million. Summing up all the costs involved in fishing annually totals to about Rp38.13 million. The estimated annual gross sale is about Rp58.11 million. From the gross sales, the expense for the FAD is taken, 10% of the remaining amount would be deducted for the fishing boat, engine and fishing gear. The remaining amount would then be divided among the owner of the vessel and the fishers according to the agreed system of sharing.

Issues and Recommendations

1. The whole FMA-IV because of its unique oceanographic characteristics (pathway of water exchanges from the Pacific Ocean to the Indian Ocean) resulting to a relatively productive fishing ground particularly for the tunas. Also, its importance to the whole

fisheries productivity Indonesia is quite high because before going finally into the Indian Ocean, it also feeds to Java Sea, Malacca Strait and other bodies of water in between. It is therefore necessary to protect these very important bodies of water, Makassar Strait and Flores Sea, composing FMA-IV.

2. At present despite the great potential of the area, infrastructure support for fisheries products do not exist. As a result, doing tuna business in FMA-IV becomes very expensive as transport costs, cost of ice and fuel add immensely to the operating cost. It results a lot of wastage as quality of fish products suffer. Such as situation consequently exert more pressure to the resources as fishers tend to catch more than what is necessary.

3. As reiterated above, the fisheries potential of the area is still very high but is experiencing an unnecessary exploitation abuses to the resources because of lack of attention and good management practices. The mismatch between the resources and and management needs to be addressed in the following aspects:

a) The mismatch between presence of tuna resources and support facilities.Ice plants are sorely missing pushing the cost of ice to levels that render cost of fishing expensive. The lack of ice also undermines the quality of tunas.

b) Lack of storage facilities. The stop gap measure used by the private sector is to bring “collecting ships” with storage facilities to the area.

c) Other support facilities need to be brought near fishing ground. As of now, all tunas needs to be shipped to export hubs in Bali, Jakarta, Surabaya or Makassar for proper export documentation.

d) Transport costs are prohibitively expensive and not sufficient to support tuna cargoes. There are no large airports to handle bigger planes to carry heavier cargo load.

4. The unregulated use of the very efficient fishing gears and methods such as the purse seines and all the kinds of gillnets would unmistakably leads to a faster degradation of the fish stocks. This is well demonstrated by the experiences of FMA-I (Malacca Strait) and FMA-III (Java Sea) whose productivity are uniquely as high. A cap on the fishing capacity needs to be placed because the area is now fished by fleets from all over the country. FMA-IV is one of the last tuna frontiers of the country and without any regulation, all fishing fleets will converge to this area.

5. Communities surrounding the area are known to be traditional fishers, historically called the people of the sea (Buginesse). When properly trained, these fishing communities could become very effective vectors of good fisheries practices when recruited into the sustainable fisheries management cause.

6. Taking a ship from Lewoleba to Larantuka on our way to Maumere allowed us to see the potential to develop a fisheries-based eco-tourism where along the route, schools of skipjack tuna and other pelagic species can be observed, with flocks of seabirds and pods of dolphins partaking the fish schools with the small-scale fishers. The sea passages between major islands make this particular area very productive.

FMA-V: Banda Sea

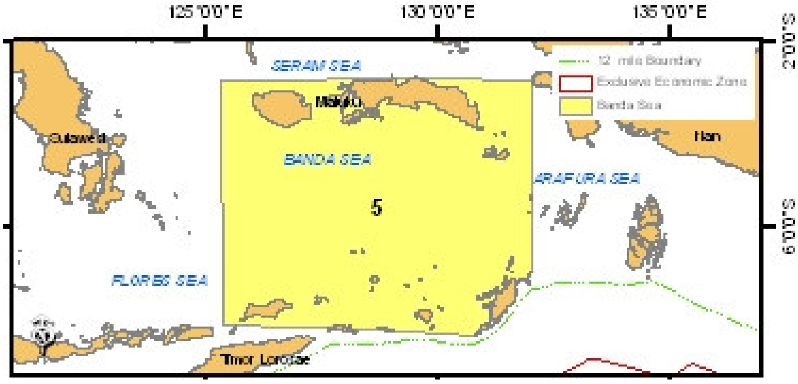


Figure 6.1. Geographic location of Banda Sea, fishery management area five (FMA-V).

Geographic Scope

Banda Sea lies central to eastern Indonesia's fishing ground. It is bounded by Arafura Sea to the east by 132° E longitude, Flores Sea to the west by 125° E longitude, Seram Sea to the north by 3° S latitude and the Sermata group of islands to the south bounded on 8° S latitude (Figure 6.1). The islands bordering the Banda Sea include Sulawesi to the west, Buru, Ambon Island, Seram to the north and Aru Islands and Tanimbar Islands to the southeast, Barat Daya Islands, and Timor to the south. Banda Sea connects the Pacific Ocean to the Indian Ocean. Its total area is estimated to be about 470,000 km^2 (Encyclopedia Britanica).

It has a very deep basin with depth of over 4,000 meters on the eastern border that gradually increases towards the east reaching depths of over 7,400 meters west of the Kai group of islands. It owes its morphological characteristics to its geological development where the confluence of three active tectonic plates occur, making Banda Sea one of the most earthquake-prone areas of the world, characterized by frequent and high intensity earthquakes. In the last century, it recorded a quake intensity of 8.5 in the richter scale.

From the fisheries perspective, Banda Sea's wide and deep characteristics offer suitable fishing area for pelagic fisheries including the tunas. However, because of few population centers surrounding it, fisheries are mainly undertaken by large commercial fleets based elswhere. The small-scale artisanal type of fishing activities are limited to the nearshore areas of the numerous islands in and around Banda Sea. Politically, Banda Sea as Fisheries Management Area Five (FMA-V); is mostly covered by districts falling within the province of Moluccas (Table 6.1).

Table 6.1. Political areas falling under fishery management five (FMA-V) or Banda Sea.

Province	Regency/District/City
Moluccas	Ambon City
	portion of Buru Island
	portion of West Seram
	portion of Central Seram
	portion of East Seram
	portion of Southwest Moluccas

Sources of Data

Data used in this section were taken from the following sources: DKP-WPP (2006) statistics of marine capture fisheries by FMAs with production data from 2000-2004, the DKP Moluccas Province statistics covering the years 2001, 2002, 2003, 2005, city of Ambon fisheries statistics (2002-2005) and summary of statistical records of the archipelagic fish port (PPN) of Ambon for years (2000-2005).

We have used the provincial statistics of the province of Moluccas, particularly the 2005 yearbook, to show the production per gear and share of each species to total tuna production of Banda Sea. But before using the data, we separated and used only those data pertaining to Ambon, Buru, southwest Moluccas, eastern Seram, western Seram and central Moluccas.

The available statistics are supplemented by the results of our interviews conducted in Ambon City and vicinity, and in Kendari on fishing vessels operating in Banda Sea. The fishers interviewed use the following fishing gears: the small-scale purse seine, troll line, handline and pole and line. We relied heavily on interview data on aspects related to estimating the tuna catches, current catch rates as well as trends of catch and catch rates for gears operating in Banda Sea. Also used as a relevant source of information is the catch data provided by P.T. Perikanan Nusantara (formerly Pt. Samudera Besar), a government owned longline fishing company.

We also utilized data from the south Pacific commission (SPC) database related to pole and line, tuna longline and purse seine fisheries operating in Banda Sea (SPC 2006).

Limitations and Assumptions

Analyzing the tuna fisheries of Banda Sea proved to be a challenge because fleets operating in Banda Sea are based elsewhere, making collection of available records difficult. Prior to 2004, tuna taken from Banda Sea are landed in the respective home ports of the tuna fleets such as Bali, Kendari, Fakfak (Papua) and Ambon. However, the increase in fuel prices has presumably changed fishing operations significantly wherein only those fishers based in Ambon (98.1%) and Papua (1.2%) fish in Banda Sea (Table 6.2). This however is not the case as interview results in Kendari revealed.

The landing centers for the big tuna fishing ventures are concentrated in selected but traditional areas while those for small scale fishing operation are widely

Table 6.2. Volume of tuna landings taken from Banda Sea. Note the shift in landings to Moluccas. Source: DKP 2006.

Landing Area	2000 tons	%	2004 tons	%
Moluccas	32713	47.6	11864	98.1
Papua	28625	41.6	232	1.92
Southeast Sulawesi	3332	4.85	0	0
Bali	4078	5.93	0	0
Total	68748		12096	

scattered, making them difficult to reach and therefore were not covered in our surveys. Likewise, we got an incomplete set of fisheries data from the Province of Moluccas.

Our estimate of tuna catches does not include the small scale sector because of lack of operational data on catch rates. Their number are believed to be significant particularly those operating from the archipelagic islands along the eastern boarder of Banda Sea. The catch of the small-scale sector from these areas are probably traded and consumed locally. As a consequence, tuna catch estimate presented in Table 6.6 for Banda Sea is underestimated by unknown proportion.

Landings

Prior to the 1970's, large tunas in Banda Sea was first exploited by Japanese longline fleets (Suhendrata and Sofri 1982) and thereafter until 2004, fishing for tunas are undertaken by domestic tuna longline fleets based from ports in Bali, southeastern Sulawesi (Kendari), Moluccas (Ambon) and Papua (Fakfak, Kaimana).

Between 2000-2004, the total tunas taken from Banda Sea have declined by over 82% from 68.7 thousand tons in 2000 to just 12.1 thousand tons in 2004 (Figure 6. 2). This trend is generated by large decline in landings over the same period for skipjack tuna (87%) and large tunas (88%).

While it may be argued that the fuel price increase in 2004 may have changed fishing fleet movement with vessels opting to fish near their respective home ports, the reason for such huge decline between 2000 to 2004 is not known. Note that the landings of small tunas is very small, probably because the catch figure was based on small tunas caught by the large commercial fleet and did not include the small-scale fleets based and operating in Banda Sea.

A closer analysis of landings between years 2000 and 2004 show that while total aggregate landings have declined significantly, the share of small tunas (bullet, frigate and bonitos) has increased from 8% to 34 % at the expense of large tunas and skipjack that have declined by 12% and 14%, respectively (Figure 6.3). Again, this development is difficult to interpret and probably generated by data collection artifacts.

Landings by Species

In 2004, skipjack tuna is the most abundant species in Banda Sea with total recorded landings of 5,286 tons (43.8%). And together with eastern little tuna (a possible

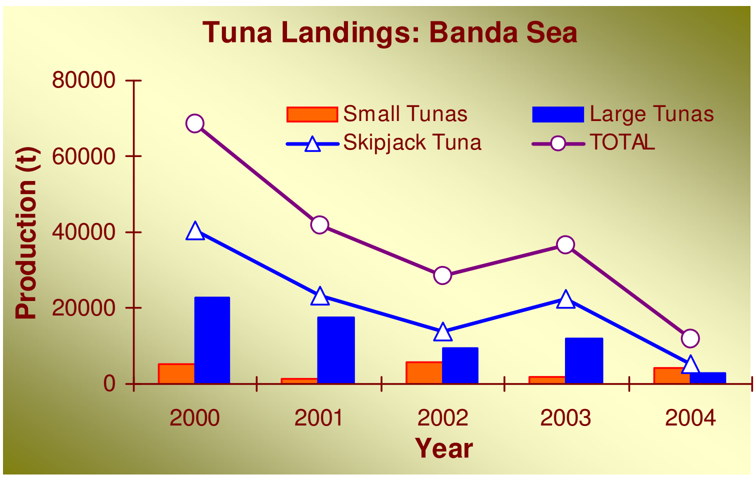


Figure 6.2. Tuna landings trend from Banda Sea for the period 2000-2004. Source: DKP-WPP 2006. Data for 2004 separated by species but regrouped into generic categories to allow comparison.

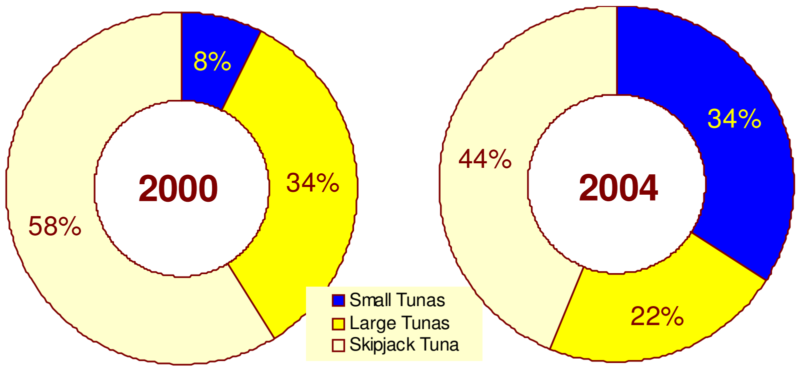


Figure 6.3. Share of small, large and skipjack tunas to total tuna landings between 2000 and 2004. Source: DKP-WPP 2006.

misidentification for Auxis spp.) of 3,863 tons production, the combined production of these two species amounts to 75% of the total tuna landings. Large tunas consisting of yellowfin, bigeye and longtail species totals to 2,667 tons or 22%.

The dominance of skipjack and small tunas over the large tunas is probably due catch monitoring artefact, where catch of purse seine, pole and line and hook & lines gets recorded because it is landed in the province of Ambon while large tunas are landed in the vessel's home ports.

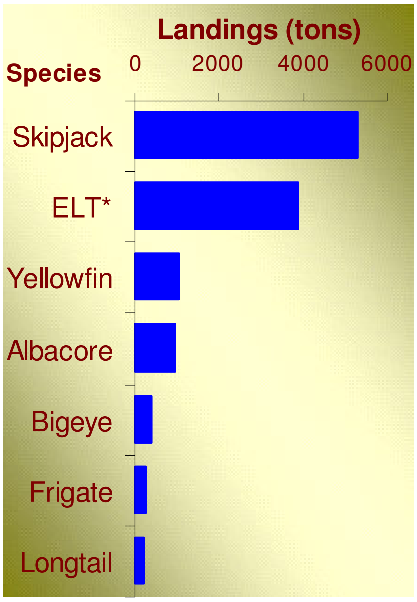
Landings by Fishing Gear

There are 18 fishing gears catching tuna in Banda Sea (Table 6.3). Expectedly among the commercial fishing gears, pole and line account for over ¾ of the total (35.6%), troll line with 20.5% and purse seine with 18.3%. These three gear types account for almost 75% of all tuna landings while the three remaining handline types account for the remaining 14.3 percent.

Non-traditional tuna fishing gears also contributes to tuna output such as liftnets, fish traps, and fish corrals with some gears such as the beach seine and liftnets landing significantly more than usual (Table 6.4).

Interestingly, the shares of tuna longline (0.3%) and drift gillnets (3.4%) to tuna output from Banda Sea are very small as compared to Indian Ocean (FMA IX). This is expected due to the very few vessels and highly seasonal tuna longline activities in Banda Sea based on records of the P.T. Perikanan Samudera Besar. It is also

Figure 6.4. Tuna landings (tons) by species from Banda Sea in 2004. Note that eastern little tuna (ELT) probably is a mix of *Auxis rochei* with some oceanic bonitos (*Euthynnus affinis, E. yaito*). Source: DKP-WPP 2006



reported that there are additional 19 units of longline based in Aru group of islands (DKP Province 2005) which possibly operate in Banda Sea for unknown frequency.

The season for tuna longline in Banda Sea is from October to December. The catch rates in early 2007 is less than 1 fish per 100 hooks. These vessels pursue fishing despite low catch rates because the target species is the bigeye and the fish sizes are usually large. Catches do get recorded in their landing areas but whether the catch data are credited to Banda Sea can not be ascertained.

Drift gillnets on the other hand abound in Banda Sea but their target species are other small pelagic fishes and its tuna catch represent only about 8% of their total fish output (Table 6.4).

Table 6.3. Share of fishing gear types to tuna landings for the province of Moluccas in 2005. Source: Provincial fisheries statistics, 2005.

Gear Type	Production (t)	%
Pole & Line	9187.6	35.6
Troll line	5299.1	20.5
Purse seine	4740.9	18.3
Other Handline	1712.7	6.63
Multiple Hook Handline	1371.6	5.31
Drift gillnet	880.1	3.41
Handline	631.5	2.44
Beach seine	623.3	2.41
Liftnet (mobile)	375.6	1.45
Encircling gillnet	339.1	1.31
Set gillnet	245.1	0.95
Drift longline	162.1	0.63
Fish Corral	154.8	0.60
Tuna longline	71.6	0.28
Fish Traps	16.2	0.063
Spear gun	15.8	0.061
Stationary liftnet	9.2	0.036
Other gears	0.2	0.001

Fishing gears and Fishing Crafts

The latest available data (2005) on the number of tuna fishing gears in Moluccas Province are as follows: purse seine with 245 units, pole and line with 216 units, troll line with 4,238 units, simple handline 2,658 and multiple hook handline with 3,040. In 2005, there are no tuna longline based in Moluccas Province.

Table 6.4. Percentage share of tuna to total fish landings of each gear type operating in Banda Sea in 2005. Source: DKP Province of Moluccas, 2005.

Gear Type	total fish (tons)	total tuna (tons)	% tuna
Pole and Line	9311	9188	98.7
Tuna longline	78	72	91.7
Troll line	8381	5299	63.2
Drift longline	636	162	25.5
Purse seine	18961	4741	25.0
Multiple hook handline	7290	1372	18.8
Other handline	11600	1713	14.8
Simple Handline	4680	632	13.5
Drift gillnet	10987	880	8.01
Guiding net	3300	155	4.69
Set Gillnet	8072	245	3.04
Mobile Liftnet	13717	376	2.74
Encircling gillnet	14524	339	2.33
Beach seine	31039	623	2.01
Fish Traps	3342	16	0.48
Stationary Liftnet	2726	9	0.34
Spear gun	9498	16	0.17
Others	329	0	0.06

Over the last five years, the trend in the number of fishing gear is declining except for purse seine (Table 6.5). The main reason is the heightened socio-cultural conflict in the province between 2000-2004 reduced fishing activities. The increase in purse seine units is due to improved catch rates beginning in 2005, probably as a consequence or reduced fishing intensity due to the conflict. The decline in pole and line units is rooted to the chronic shortage of live baits. Many pole and line boats preferred to operate more in Flores Sea in the Lesser Sunda Islands where live baitfish abounds and distance between source of baitfish and fishing ground is near. The troll lines have also been directly hit by the fuel price increase and a shift to handline fishing in the FADs becomes their alternative. Handlines showed a significant increase in numbers until 2003 but has since declined for unknown reasons.

What is not presented here and difficult to account for are the fleets that fish in Banda but land their catch in their respective homeports. Pole and line and troll line vessels from Kendari, Bone Bay, Kolaka and Buton Island travel long distances to Banda Sea and Moluccas waters to fish and return to home port to land their catch. The main reason for returning is the price of fish as well as availability of supplies (fuel, ice, etc.) in Kendari are much higher than in Ambon.

Estimate of Tuna Catches

Using the operational catch data from interviews and supported by existing data, this study estimated tuna catch from Banda Sea in 2006 to be around 129.2 thousand tons (Table 6.6). This catch estimate includes the small and large tunas and is more than 10 times the quantity of tunas (12,078 tons) reported in 2004 (DKP-

Table 6.5. Numbers of major tuna fishing gears based in Banda Sea from 2001-2005. Source: DKP Province of Moluccas (2000-2004). * - Data for handline and multiple hooks handline before 2004 are lumped with "other handline" category.

Year	Purse Seine	Drift Gillnet	Tuna Longl ine	Pole and Line	Troll Line	Other Hand-line	Hand line*	Multiple Hooks hand-line*
2001	192	2401	20	267	4827	10072		
2002	192	4330	0	226	7369	10922		
2003	223	3632	0	198	3940	19114		
2005	245	4197	0	216	4238	11357	2658	3040

WPP 2006). The reasons for such large discrepancies between the officially reported and this estimate may be due to the following reasons:

1. We have covered the small scale sector, in particular the troll line and handline fleets which represent (15.36%) of the total number of fishing gears registered in the Province of Moluccas in 2005;
2. The catch of distant fleets operating in Banda Sea and landing their catch in their respective home ports (troll line fleets from Kendari and Philippine pumpboat fleets) have been included in the computation;
3. The number of fishing units operating were carefully assessed to represent the number actually operating in Banda Sea. We have used half of the number of units of reported gears for troll and pole and line vessels.
4. The number of purse seine "*mini*" fleets operating in Ambon and immediate vicinity has risen to 425 (as provided by a fleet operator) in just one year owing to the highly profitable fishing activity in the area. We have used this number instead of the 245 units listed in the statistics.

While the estimate is already many times over the reported value in 2004, we believe that the estimate is still on the lower range as other fishing gears that are exploiting

Table 6.6 Data used to estimate the tuna catches from Banda Sea. Legend: The same footnote numbers on row and column should correspond to the identified values.

Fishing Gear Type	No. gears 2005[1]	no of gears used [2,5]	total fishing days/yr[3] or trips/year[4]	annual catch/ unit [6] (mt)	Est. total fish catches (mt)	% share of tuna [1,7]	Est. tuna catches (mt)
Pole and Line [1,2,4]	216	108	37.1	102.2	11,034	0.99	10891
Troll Line [1,2,3,]	4238	2119	149	56.9	120,529	0.632	76174
Troll Line (Kendari-based) [4,5]		150	26.4	33.2	4,979	0.632	3147
Simple Tuna Handline [1,3,5]	2658	1000	192	17.6	17,600	0.800	14080
Phil.-based pumpboats [3,5,6]		40	100	57.0	2,280	1.000	2280
Multiple hooks handline [1,2,3]	3040	1520	140	22.0	33,440	0.188	6287
Purse Seine (<30GT) [1,3,5,7]	245	425	204	77.6	32,982	0.384	12665
Drift Gillnet[1,2,3]	4197	2098	180	18.0	37,764	0.080	3025
Tuna Longline [3,5]	0	30	50	21.0	630	1.000	630
TOTAL							129179

[1]/ based on records of Moluccas province for 2005
[2]/ used only half of recorded fleet number
[3]/ number of annual fishing days
[4]/ number of trips per year
[5]/ data based on results of interviews
[6]/ tuna catch only (billfishes and other fishes excluded)
[7]/ based on actual 3-yr catch record of three units based in Ambon

the small tunas as by-catch were not included in the estimate due to lack of appropriate information from the islands along the eastern border of Banda Sea as well as other fishing gears that get tunas as by-catch. These include the beach seines, drift gillnet other longlines and liftnets whose catch could probably further raise the estimate by as much as 10-15 percent.

One of the interesting results in doing the catch estimate is that it could show the importance of the small-scale sector whose tuna output accounts for over 81.3% of tunas compared to less than 18.7% by commercial/industrial sector. Even more surprising is that the small scale sector accounts for over 98% of the large tunas produced, mainly by handline and troll line (Table 6.7). Two thirds (62.8%) of the estimated tuna catch are small and skipjack tunas. Tuna catches in Banda Sea as well as the trend for the whole country is that tuna fisheries is supported by small-scale fishing operation.

Description of Fishing Techniques

Troll line/ Handline

Fishing Fleet

There are two types of fishing fleets using troll lines that operate in Banda Sea, those based in Moluccas Province numbering about 4,238 with home ports in (Ambon, Seram, and Buru Islands) and those based in Sulawesi Tenggara and Sulawesi Selatan numbering about 150 units.

Table 6.7. Share of small and large tunas by the small-scale and large scale tuna fishing sector computed using the tuna production estimate given in Table 6. Skipjack are grouped with small tunas.

Group/Sector	Small-scale (tons)	Large-scale (tons)	TOTAL	%
Small + SKJ Tunas	57,534	23,556	81,090	62.8
Large Tunas	47,459	630	48,089	37.2
TOTAL	104,993	24,186	129,179	
Percent (%)	81.3	18.72		

There appears to be a large number of recorded units (n=14,678) of troll line for Moluccas Province in 2004 based on the National Fisheries Statistics (2005) compared to the recorded number in 2005 based on the provincial records with only 4,238 units. This is probably due to the socio-cultural conflict in the area.

The troll line fleet consists of two size classes: the medium sized 8-15 GT vessels that undertake 8-10 day fishing trips. The vessels measure about 15 x 3 x 2 m; powered by two units of 150 HP engines and has a crew compliment of 6 people. Large rectangular storage boxes for ice and fish occupy the entire length of the boat (Figure 6.5). This vessel class typically represents the fleet based in Kendari, Buton and Southeast Sulawesi that fish in Banda Sea and Moluccas Sea and return back to land their catch. It is estimated that about 150 such vessels operate in Banda Sea.

The smaller sized boats (10 x 1 x 1m) belong to the 3 GT and below class, powered by a single 15 Hp outboard motor and manned by two fishers. These makes up the bulk of fleet numbering several thousands and are based around Ambon, Seram Seas, Buton Islands.

Fishing Gears

Troll line boats carry always two types of fishing gears, troll lines and simple tuna handlines. Normally, troll lines are used in every trip but handlines are increasingly becoming popular because operation of troll lines entails high operating cost for fuel.

Troll lines used by the Sulawesi fleets are made up of two lines towed on both sides of the boat, each line is about 60-100 meters long, made of 150-mm diameter polyethyline line. Each mainline carry a jig made up of three hooks (#9) tied together (Figure 6.6). Troll line fishing is conducted around floating logs, FADs and other flotsams.

Increasingly over the last year, fishing with handlines is fast becoming the norm for many of the troll vessels. This is mainly to cope up with high fuel cost of troll fishing. Handline fishing for tuna is conducted at the fish aggregating devices. Locally called "coping", the mainline is wound into a spool, there is "C-shaped" wire with lead in the middle that serve as weight and from here, another 25 m of mainline that is connected to a swivel, and from the swivel, a wire connected to the J-hook with artificial lures made of silk fibers (Fig 6.6).

The small vessel fleets based around Ambon and Moluccas Province undertakes just day trips. They utilize jig-type hook consisting of 3 hooks tied together and

Figure 6.5. Troll line vessels in Banda Sea. left: small-scale (<3GT) and above: 10-15 GT class vessels based in Kendari, Sulawesi Tenggara. Top photo show the lure and jig of the troll line.

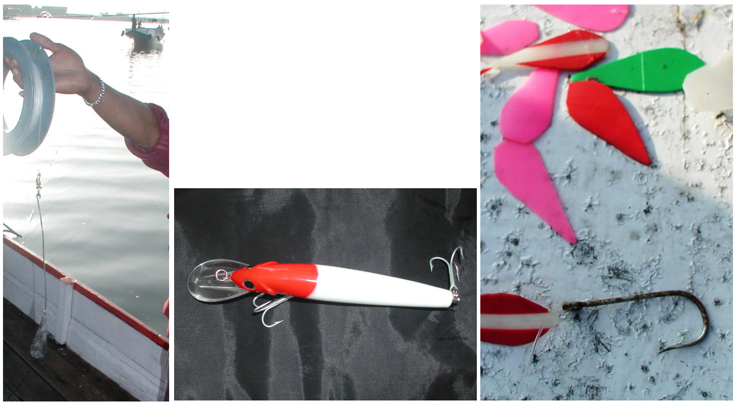


Figure 6.6 The handline with lead weight (left), troll squid lure with jig (middle) and handline hook with colored lures (right).

covered with silk threads as lures. At times during calm seas when fish don't bite, kite fishing is used to trick the fish into biting.

Fishing Technique

The trollline fleet from Kendari bring ice and all the operational supplies it needs for the 5-8 day fishing trip. The navigation time from Sulawesi to Banda Sea takes around 1-2 days. Once there, troll fishing is undertaken all day long from 6 am to 6 pm, pulling two lines attached to each side of the boat. Once the fish holds are full, they return to port. However, at times when catch is low, fishing operation shifts to handline and operate in FADs. That is why, boat captains have in their possession a list of the locations of FADs in Banda, Flores, Moluccas, Seram Seas so wherever they are, they could easily locate and visit FADs (Figure 6.7). Most boats therefore that undertake dual fishing methods also use handheld geo-positioning units (GPS). The adoption of this technology has considerably improved the navigation capability not to mention the additional safety of crew it brings.

The small vessel fleets operate similarly as their larger counterparts but returns everyday; leave port at early morning and fish until noon time and return back to deliver the catch. The boats do bring ice on board on small ice chest but these are for skipjack only; no ice provisions for the big tunas in case one is caught; instead the fishers would return immediately to sell the big tuna catch while the fish remain in good quality, which more often than not qualify for the sashimi market.

The consequence of such alternate fishing methods used contribute to the complexity of monitoring and assigning the correct catch and effort to a particular gear. The fishers do not follow fixed rules when to use each gear type. A study to look into the operation of this fleet is recommended in order to determine what adjustment to the data collection needs to be made. There is also the question on how such gears would be licensed.

Fishing grounds

Trolling areas include the southern coasts of Taliabu Island, Buru Islands, around Seram Island and around Ambon Island. Smaller vessels, as these are day boats, operate from 20-25 nautical miles from their respective home ports while larger troll line vessels could move around freely. Prevailing monsoon weather dictates the area of fishing. Figure 6.7 shows a good representation of the fishing ground of the troll fleet.

Catch, catch rates, species composition and seasonality

The target species of the troll fishery is the skipjack tuna but it also catches substantial quantities of bonitos and juveniles of the yellow fin tuna. By-catches are the small tunas, barracudas, mackerels and dolphin fishes.

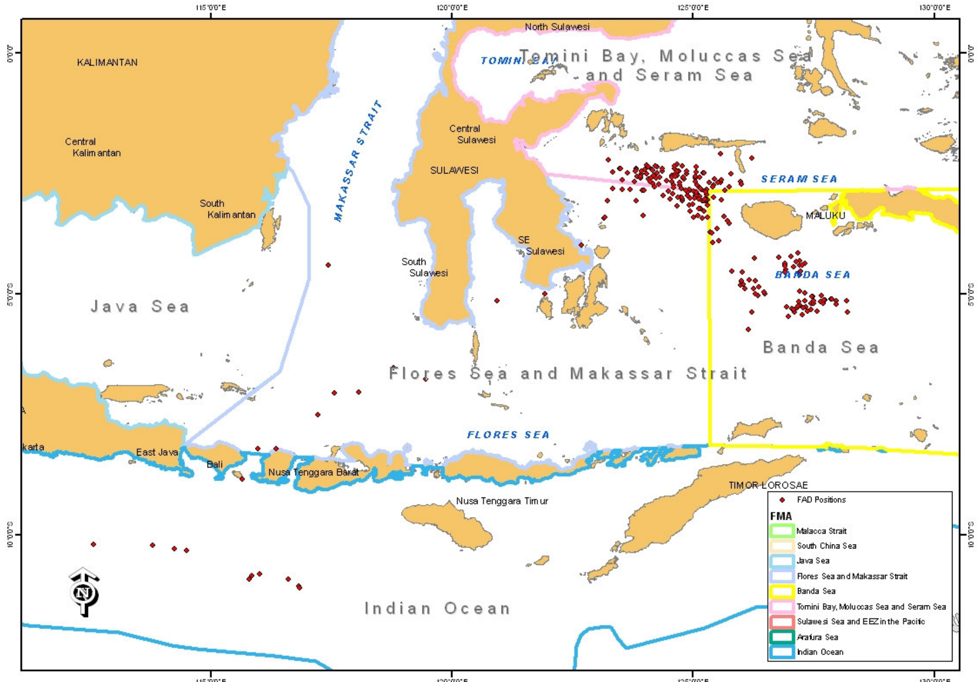


Figure 6.7 Plot of FAD locations in possession of a troll line boat captain. Note that FAD positions are present in Indian Ocean, Flores SEa and Makassar Strait.

Juveniles of the yellowfin tuna are significantly caught by troll lines, the proportion range between 20-80% depending on the area and season. On the average, catch rate of each troll vessel is between 2-3 tons per trip (5-8 days) during March to October. During the lean months from November to February, catch drops to around 1 ton/trip.

Trends

Troll line fishers agree that there are no significant changes in the catch and c atch rates of troll fishing in Banda Sea over the last 5 years. What has changed is the increased operational cost of fishing and their income but the volume of catch remained more or less the same. There is no available historical data set to show troll line catch rates from Banda Sea.

Tuna Longline

Fishing Fleet

Tuna longline fleet operating in Banda Sea belong to the domestinc fleets based in Benoa, Bali, Cilacap, Central Java and from Muara Baru in Jakarta. The exact number of units operating in Banda Sea is difficult to estimate as operation is highly seasonal and highly dependent on risks taken by boat captains. It is reported however that there are about 19 units operating out of Aru Islands. This report has not been verified.

Catch and Seasons

Presently, enterprising fleet captains from Benoa, Bali, Cilacap and Muara Bahru in Jakarta operate seasonally from October to December each year. Despite low catch rates (hook rate =<0.75/100 hooks), fishing continues because the fishery targets the bigeye which fetch a higher price and because of the large sizes of fish (~70 kg) caught.

Trends

Banda Sea is a traditional longline fishing ground where Japanese fleets fish as early as 1967 fish years before the development of the country's domestic tuna longline fisheries started in 1973 (Suhendrata and Sofri, 1987). The hook rates (per 100 hooks), at that time, ranges from 1.82 to 3.22, which is very ideal catch for tuna fishing operations (Figure 6.8).

But the productivity of Banda Sea did not last very long; in 1973, fishing operations yielded lower catch rates of just 1.36 per 100 hooks (Muchtar, 1973). Analysis of the catch records of the state-owned PT. Samudera Besar in 1983-1983 (Rahardjo 1985) showed an average of 1.53 catch rate while a similar study but covering more years between 1974-1985 (Rahardjo and Bahar 1988) showed catch rates fluctuating between 0.5-1.5 depending on the season and areas of fishing. In general, however, decline of productivity is evident, a condition that prompted the government to undertake test fishing surveys in the mid-1980's with the intent of improving catchability by changing the depth of setting of hooks. The success of this experiment paved the way for the change in fishing technique by making deeper sets that resulted signalled the exploitation of the bigeye tuna (Bahar, 1985). leading to marked change in landed species from from the shallow water dwelling yellowfin tunas to the deeper water dwelling big-eye tunas. Because bigeye fetch higher prices, higher income is realized from such shift in fishing technique.

During the study, the hook rate in Oct-Dec 2006 in Banda Sea is between 0.6-.075 per 100 hooks. The fleet, despite this low catch rate, still fish within Banda Sea mainly because of the large sizes (average size ~70 kg) of bigeye.

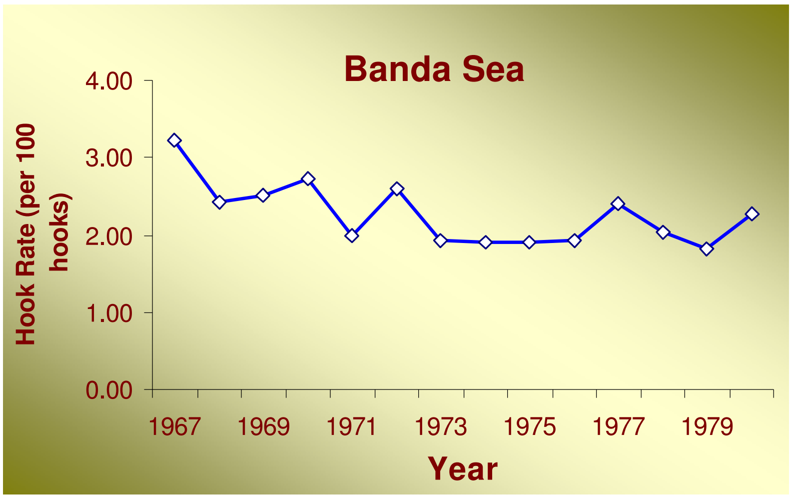


Figure 6.8 Trend in the tuna longline catch rates expressed as total hook rate per 100 hooks during the period of 1967-1979 in Banda Sea, Indonesia. Source: Suhendrata and Sofri 1989).

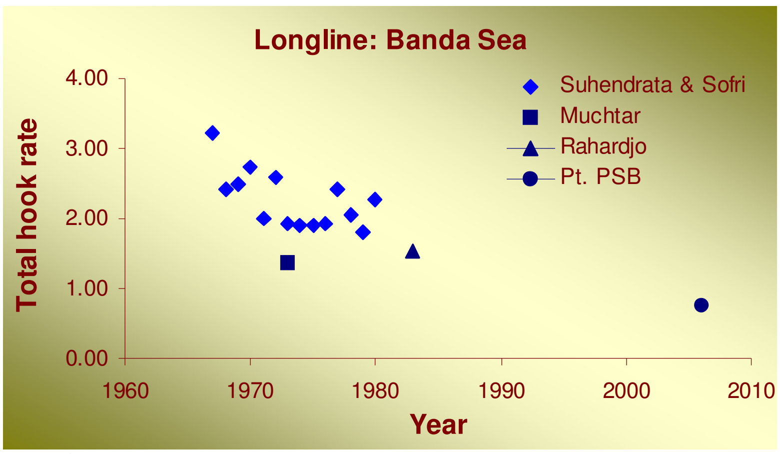


Figure 6.9. Tuna longline hook rates (numbers caught/100 hooks) in Banda Sea over the last 30 years. Source: Various authors.

Purse seine "mini"

Crafts and Gears

The vessel construction and gears used is similar to those units described in FMA VI that fish in Moluccas, Seram and Tomini Seas. There are 425 units of mini-purse seines operating in Ambon Bay and vicinity (pers. Comm, Mr. Johannes, purse seine, pole and line and FAD owner). The numerous units is attributed to the improved peace and order conditions and the very high catch rates (Table 8.8) probably due to the reduced fishing intensity during the height of the socio-cultural conflict in the past years.

Fishing Technique

The medium and small sized purse seine fleets based in Ambon (n~425) commonly operates during the day, searching for free swimming schools. An average of about 2-3 sets are made per day. The fleet also operates around FADs alternately during the season for Auxis spp. (locally called "*como or dehu*") from July-November. During this time, 3-4 sets per day are made catching an average of 3-4 tons per day. The season for scads (Decapterus spp.), locally called "momar" commences in December until February of each year, and net is set 6-7 times per day. At the start of the season, the sizes of scads are small (12-15 cm) and as the season progresses, size of fish increase (20-30 cm) until end of the fishing season and the species disappear in May.

Seasonality of catch

Catch per boat fluctuates from 0.5-5.0 tons per haul. The lean season for the mini-purse seine fishery in Ambon Bay and Seram Sea is in March and April. During these months, many of the boats simply stop operation. Analysis of actual catch records of three purse seine vessels over a period of two years (2002-2003) operating in Ambon Bay and adjacent waters showed the following results. There was an apparent decline in catch rates by about 11% from 2002 to 2003 (Table 6.8). There had also been changes in the ranking of caught fishes leading to the disappearance of some of the species (Tab.6. 8). As explained during the interview, before 2000, roundscads dominated the catch of mini-purse seines while the bullet tunas (Auxis spp.) formed an insignificant portion of the total catch. Today, bullet tunas are the dominant group. This observation was further corroborated by the fishers in the area.

Catch of bullet tunas (*Auxis rochei*) displays two peaks per year, a minor peak of abundance in April and major peak in October; both months fall around the inter-monsoon periods (Figure 6.10).

Tuna Handline

The discussion in this section consists of two gears, the simple single handline for large tunas and the multiple hook handline that targets the small tunas and skipjack. Both gears are operated in FADs but the latter may also be used at times as troll lines when free swimming schools of skipjack are sighted.

Purse seine "mini" in operation searching for fish schools in waters off Ternate, North Moluccas province.

The simple single hook tuna handline locally known as "*coping*" is similar in construction and use with handlines for tuna in Halmahera, Manado and Gorontalo and has been described in FMA VI and FMA VII (Figure 6.11). This is the same gear used by troll line fishers from Sulawesi Tenggara Province (Figure 6.6). The minor difference is the use of a lead weight some 25 meter distance from hooks. This gear targets the large tunas seeking shelter in the FADs at depths between 50-150 meters.

The other type is a multiple hook handline is made up of 25 hooks, each branch line is 30 cm long and distance between branchlines is 2 meters. The boat of multiple hook handline belong to the <3 GT class vessel powered by a 15 Hp

Table 6.8. Aggregate catch and average catch per effort data of three small purse seine operating in Banda Sea. Source: Records of purse seine operator based in Ambon.

	Year 2002		Year 2003	
Species Group	Total Catch (kg)	CPUE (kg/day)	Total Catch (kg)	CPUE (kg/day)
Scad	82650	397.4	40570	291.9
Bullet tuna	56880	273.5	44455	319.8
kawalinya	6240	30.0	1500	10.8
make	1860	8.9	1170	8.42
lamadang	450	2.2		
tola	120	0.577	90	0.65
bubara	90	0.433		
cakalang	30	0.144	45	0.32
putilae	2	0.010		
TOTAL	148322	713.1	87830	631.9

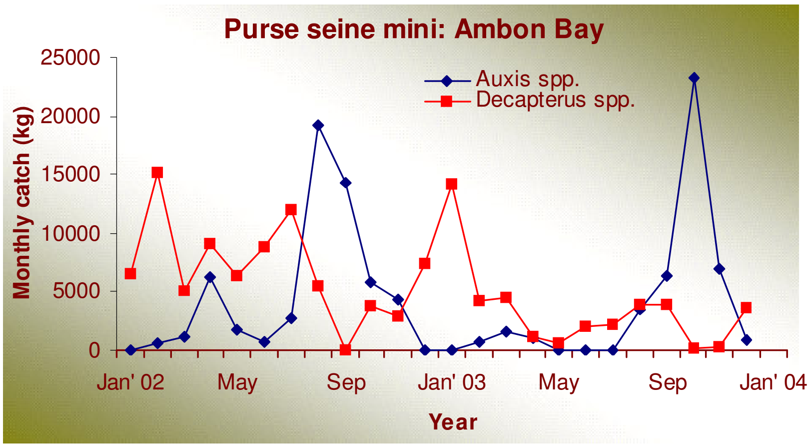


Figure 6.10. Seasonality of catch of small tunas and roundscads based on catch of three purse seine "mini" vessels fishing in Banda Sea from 2002-2003 Source: Data from records of purse seine fleet operator based in Ambon.

outboard motor. Fishing operation is daily at daytime, from early morning to afternoon, and always on FADs. Silk threads are used as artificial lures, with hooks set on the upper 50 meters.

Catch, catch rates, season and trends

The multiple hook handline target small pelagic fishes consisting of skipjack, small tunas, juvenile of yellowfin and bigeye tunas, Indian chub mackerel and bigeye scads. The general peak months are January to April and lean months are from May to July. For those that specialize in tuna hand-lining, the peak season for skipjack is west season from November to May and for juvenile yellowfin from June to October, falling during the east season. The lean months are: for skipjack is June to October and for juvenile tunas from November to May.

Figure 6.11 Multiple hooks (left) and simple tuna handline. Note the use of synthetic threats as lures.

The information on the seasonal abundance of juvenile tunas is significant information in setting policies for the very necessary regulation on the catching of juvenile tunas.

There are no published data on handlines operating in Banda Sea but the responses of two handline fishers were similar: that catch rates have declined in the last 10 years by about 50%. The daily average catch of large tunas (30-60 kg yellow fin) during the peak season has gone down from 10 to just 5 fishes per day. In the lean season, catch has gone down from 1-3 fishes per day to 0-1 fish, the zero catch is about 3-4 times per week. Similarly, the catch of skipjack has declined during the peak season from 200 to just 100 fishes and from 100 (4 luyang; 1 *luyang* = 27 fish) to just 54 fishes per day (2 *luyang*) during the lean season.

The main reason given by the fishers is that there is overcrowing at the FADs where too many boats fish on the same FADs. The distance of FAD location has likewise increased from just an hour away to 2-3 hours travel time.

Pole and Line

Fishing Fleet

Current statistics in 2005 show 216 units of pole and line vessels registered in Moluccas Province. These are based in Ambon with 16 units, in Central Moluccas with 156 units, Seram Island with 14 and Buru Island with 30 units (Figure 6.12). As expected, the places where fleet are based are areas where liftnet fishery exist where live baitfishes are sourced.

During our survey, however, we could only account for 31 vessels (1 unit in Ambon Bay, 30 units in Kohala) for two probable reasons: fleet migrate either to West Papua or Flores Sea to fish or some vessels simply stopped operation.

The fishing boats observed in the area are about 27 Gross Tonnage of about 24-m of length and 6-m of breadth powered by 155 Horsepower inboard engine. Fishing operation lasts for just a day to a week at sea. a vessel is manned by a crew of 25 fishers.

The fishing technique are similar to those operating in FMA VI and FMA VII which are described in full detail.

Notes on the Economics of Fishing

In the course of our interview, we collected operational and maintenance expenditures, capital investments and prices of fish in order for us to estimate roughly if tuna fishing in the area is profitable or not. We did not attempt to use a comprehensive tool for this analysis, instead we simply used a simple 10% depreciation cost on capital, put some amount on labor and tried to determine profits usually on a per day or per year depending on the kind of information provided by respondents.

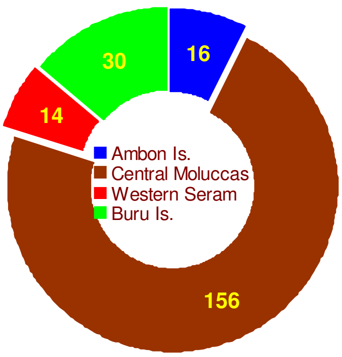


Figure 6.12. Number of registered pole and line vessels in Moluccas Province. Source: DKP Propinsi Maluku 2005.

Purse Seine

In FMA-V, there are two major types of purse seines based on the size of the fishing vessel; these are the mini purse seines and medium purse seines. The medium purse seines are highly movable and could travel from one fishing to another depending on the volume of catch and because of these, tracing these vessels would be quite hard unless one would be able to take hold of the actual logbook of the fishing vessels. The mini-purse seines on the other hand, because of their small size, are highly dependent on the resources of FMA-V, and thus are more appropriate to describe the condition of the purse seine fishing industry in the area.

Initial investment on complete set of the mini-purse seine fishing accessories in 1990 was about Rp20-25 million; that's including the boat of 9 GT, 2 outboard engines of 40 HP and the net. Annual operating costs in 2006 which includes fuel and other fishing provisions excluding food is estimated at Rp82.80 million; that is for a daily trip of about 150 fishing days a year. Estimated gross sales revenue for a year is about Rp285.99 million.

Investment recovery system of mini-purse seines in FMA-V is unique to them and not in conformity with the financial recovery procedures in the books. From the gross sales, all fishing expenses is deducted and 1/3 of the remaining revenue would be the share of the FAD while out of the 2/3 remaining, 20% would be further taken off for the maintenance of the fishing boat, engine and gear. The residual 80% of the 2/3, would be divided equally (50% each) between the owner and the crew members. The crew would subdivide their share according to their rank in the vessel such that the captain would have 2 shares, the assistant of the captain has 1.5 shares and the rest of the crew would get 1 share each.

Pole and Line

The pole and line fisheries in FMA-IV is a new development in the tuna fishing of FMA-V, the fishers started to adopt the method in the early years of this decade. Initial investment on the fishing boat of 27 GT and its 155-HP inboard engine was about Rp450.00 million while that of the fishing gears use by about 25 fishers was about Rp2.00 million.

Annual operational expenses for approximately 37 trips, spending a day (peak season) to 7 days (lean months) in the fishing ground, is about Rp270.99 million; this is excluding the costs of ice. The cost of ice wasn't included in the operational expenses because sometimes there were occasions when the ice is provided by the traders for free in exchange for the assurance of having the catch delivered to them.

The estimated gross revenue sales in a year based on the average catch for two years of fishing as provided by the owner of the fishing venture is about Rp389.42 million.

Remuneration system is in terms of sharing. From the remaining gross sales after taking off the cost of ice, 80% would go the owner while the 20% would be shared upon by the fishing crews. The captain and the engineer would have 2 shares each, the rest of the fishing crews have 1 share each.

Troll Line

A lot of the troll liners, particularly in Ambon, have received subsidies from the government in the form of free fishing boat and an outboard motor. The initial investment for a set of troll line was about Rp150.00 thousands.

The troll liners in Banda Sea travel in and out of the fishing ground daily and spend an annual average of about Rp34.56 million for operations.

Table 6.9 Infrastucture support for handling, fish storage and processing for the province of Moluccas. Source: Ambon City (2003).

Name of Port/ Private Wharf	Location	Ownership	Remarks
Archipelagic Fish Port (PPN)	Tantui	Nat'l Gov't	
Coastal fish port (PPP)	Eri	Local Gov't	
PT. Usaha Mina	Galala	BUMN	State-controlled
PT. Nusantara Fishery	Kate-kate	Private	
PT Maprudin	Gudang Arang	Private	
PT. Segara Mulia Sejahte	Batu Gong	Private	
Name of Cold Storage			**Capacity**
PT. Usaha Mina	Galala	BUMN	360/ 1 Unit
Fa. Sanu	PPN Tantui	Private	100/2 Unit
PT. Nusantara	Kate-kale	Private	1 Unit / ?100
PT. Morela	Tanah Lapang Kecil	Private	1 Unit ?100
PT. Segara Mulia Sejahte	Batu Gong	Private	1 Unit / 600

In a year, an average troll line owner would earn a gross sale of about Rp377.54 million. A quick glance at the investment and operational costs against the gross sales indicates that the troll liners of Ambon operating in FMA-V are benefiting well from the fisheries industry. This however is not always true because of market factors.

Infrastructure Support

The major port facility, a PPN is located in Ambon but the port mainly serves the domestic and foreign fleet of bottom trawlers operating in Arafura Sea. Records of landings showed that the total pelagic volume transacted in the port is only 175 tons for 2005 suggesting no tuna activity at all. Aside from the PPN Ambon, there is also another government owned port, a PPI located at Eri while there are wharves of fishing and processing companies (Pt. Usaha Mina, Pt. Nusantara Fishery, Pt. Maprudin and Pt. Segara Mulia Sejahte).

There are about 6 units of cold storage facilities with a total of 1,360 tons support the preservation of fish landed in Ambon city. The storage facility is not sufficient and an undetermined quantity of tunas caught in Banda Sea are landed elsewhere, e.g. in Kendari for troll and handline. Proctor (2007) reported a fleet 8 carrier vessels owned by Pt. Sultra Tuna based in Kendari that collects fish from 23 pole and line vessels operating both in Flores and Banda Sea.

Issues and Recommendations

1. One of the respondent's decisions to establish a purse seine is to have a sure supply of baits for his pole and line unit. The decision, it turned out is a very economically and rewarding endeavor that paved the building of two more units in a span of two years and another one under construction this year and eventually will be giving up the pole and line unit.

2. Again the use of local names has provided a source of confusion. The local name used in Ambon to describe the multiple hook handline is "*pancing tonda*", a term known nationally as the troll line. This situation has confused us during the interview because at times when unassociated schools of fish are observed, fishers use the gear as troll line.

3. Commercial fishing is undertaken by fleets from other areas that do not land their catch within Banda Sea. Improvements in the collection system to incorporate the "distant water" nature of the fisheries will address data uncertainties generated by non-reporting or double reporting of boats, catch and fishing efforts.

4. Evidence on the presence of pumpboats from the Philippines operating around Taliabu and Buru Islands needs to be addressed.

5. There is a need to strengthen support facilities for post harvest handling in Ambon or Seram where large tunas are landed. The fleets of troll lines need not go back to deliver catch back to Kendari if prices are at par and freight charges are brought to the minimum.

6. Strategies to improve quality of fish are observed to cope up with post harvest challenges. One is the "loining at sea," by the fishers themselves, which addresses the issue on quality, space requirements and cost savings that definitely increases the fishers' margin of profit. This is highly commendable development that should be pursued in many areas of the country. Capacity building on "loining at sea" should be encouraged and undertaken by the government.

The government also should start promoting the landing of loin instead of whole fish by working with the exporters and Japanese buyers to accept loin which has the same or even better quality. Doing this would translate in improved quality and quantity of fish exports for the sashimi market.

7. Another improvement is the process of setting up ship carriers that buys fish from the fishing ground. This is practiced in Ambon and Seram areas but these boats simply cater to those under a particular "plasma system". Ways must be explored on how to expand this to cater to the fishing sector outside these "plasma system".

The use of storage ships would not have been necessary if post harvest infrastructure support is available in the area. Unfortunately, while the center of tuna fishing is in eastern Indonesia, the main processing and support facilities for post harvest handling are centered in Bali, Surabaya, Makassar and Jakarta. This mismatch between landings and processing should be addressed to minimize wastage due to poor quality of fish.

FMA-VI: Tomini Bay, Seram Sea & Moluccas Sea

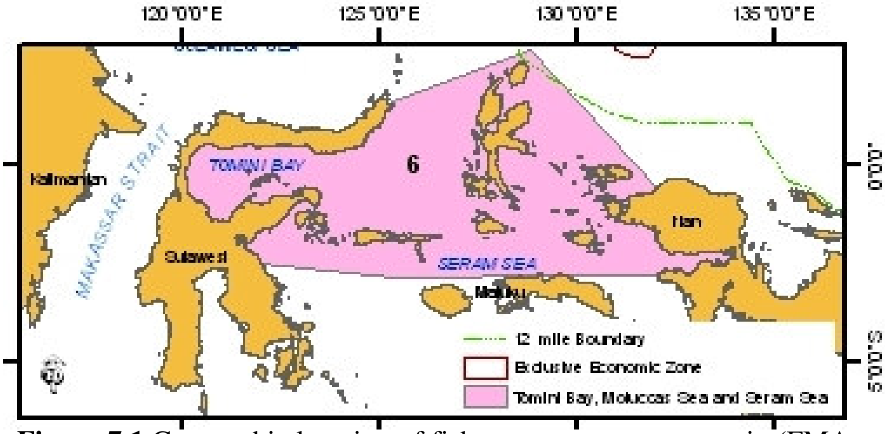


Figure 7.1 Geographic location of fishery management area six (FMA-VI).

Geographic scope

Fisheries Management Area VI, with an estimated area of 440,100 km^2 includes three major bodies of water namely Moluccas Sea, Tomini Bay and Seram Sea (Widodo et al, 1998). Tomini Bay is a deep (up to 1300m), semi-enclosed basin located on the north east part of Sulawesi Island and is bordered to the north the province of Gorontalo to the west by south by Sulawesi Tenggah. It opens to the east into Moluccas Sea through the Togian group of islands. Moluccas Sea is the largest of the three seas and has depths reaching 2885 meters. It includes water areas between North Sulawesi peninsula and Halmahera forming its northern border, to the south by the large islands of Taliabu and Mangoli and to the east the large and numerous coastal and inland seas between and around Halmahera, Obimayor up to the western section of Irian Jaya including Waigeo island. Along its northeast boundary, Moluccas sea shares its border with the Pacific Ocean. Seram Sea is located north of Buru and Seram Islands and its northern border includes the islands of Batanme (Irian Jaya and Obimayor (North Moluccas) to the north. Depths of over 5000 meters have been recorded in the western section of Seram Sea while shallow waters below 350 meters characterize the northeastern section between Obimayor and Batanme islands. It opens into Banda Sea and eventually to Arafura Sea through the passage between Kai and Aru group of islands (Figure 7.1).

Politically, FMA-VI covers thirty-one (31) regencies and cities belonging to five provinces that include the Provinces of North Sulawesi (Sulawesi Utara), Gorontalo, Central Sulawesi (Sulawesi Tenggah), Moluccas (Maluku), North Mollucas (Maluku Utara) and Irian Jaya (Table 7.1). The very deep and the large area of FMA-VI makes it ideal for pelagic fishing.

Table 7.1. Political units falling under fishery management area six (FMA-VI).

Provinces	Regency, District or City	Provinces	Regency, District or City
North Sulawesi	part of Bitung City	North Moluccas	Central Halmahera
	part of Minahasa		South Halmahera
	part of South Minahasa		Kepulauan Sula
	part of Bolaang Mongondow		Ternate City
Gorontalo	Bonebulange		Tidore Kepulauan City
	Gorontalo City		part of East Halmahera
	Boalemo		part of West Halmahera
	Pajuwato	Papua	part of Sorong
	part of Gorontalo district		Manokwari
Central Sulawesi	Parigi Moutong		Biak
	Banggai		Teluk Wondama
	Banggai Kepulauan		Nabire
	Tojo Una-una		Yapen
	Morowali		Waropen
	part of Kecil Donggala		Jayapura
			Jayapura City

FMA VI acts as a flow through area of oceanic waters and nutrients from the Pacific passing through Moluccas Sea into Flores and Banda seas before exiting into the Indian Ocean (Wrytki 1961).

Sources of data

Historical trends and information presented in this section relied a lot on the statistics provided by the DGF Statistics by Fisheries Management Areas covering the years 2000-2004 (DKP-WPP 2006) as well as the Annual Fisheries Statistics by Provinces and Coastal Areas, the Provincial Fisheries Statistics of the Provinces of North Sulawesi (1986, 1990, 1995, 2000, 2002, 2003, 2004, 2005), North Moluccas (2005), and West Irian Jaya (2005). These data are supplemented by data from literature, and the thesis of the students (unpublished) of the Sekolah Tinggi Perikanan in Jakarta.

Note that the four newly formed districts in North Moluccas (Maluku Utara) and three new districts in central Halmahera have made fisheries information from this two provinces in disarray.

Limitations and Assumptions

Data of the provincial DKP were not sufficient enough to represent the production conditions since only the data from Sulawesi Utara, Mollucas and North Mollucas were available and the only statistics common between these provinces is 2005 Provincial Fisheries Statistics which is also the latest. In addition, the fisheries Statistics from Irian Jaya is incomplete with only the production figures available and lack fishing effort data.

Fisheries data from the province of north Sulawesi (years 1986, 1990, 1995, 2000, 2002-2005) were separated into fishery management areas FMA VI and FMA VII. Included under FMA-VI are landings from the provinces of Gorontalo and partially those from Bitung and Moluccas. The non-uniformity of available statistics between provinces precludes a comparison and trend analysis. For example, the lack of production data disaggregated by species and by fishing gear for years prior to 2004 (for North Sulawesi Province) and prior to 2005 (for North Mollucas Province) have little use for time series analysis.

The Statistics from the Province of North Sulawesi was used to represent the species composition as well as the share of each gear to total production of tunas for the whole FMA -VI. This data was supplemented by various studies available for the area.

Part of the difficulty is getting the time series data is caused by changes in political jurisdictions. Before 2003, Moluccas area belongs to just three political entities consisting of North Moluccas, Central Halmahera and the city of Ternate. By 2004, there are now 8 political units whereby central Halmahera is subdivided into three, namely City of Tidore, Districts of South Halmahera and Central Halmahera; North Moluccas were likewise subdivided into four, namely West Halmahera, North Halmahera, South Halmahera and group of islands of Sula (Table 7.1).

Another limitation is the aggregation of tuna production under a general term "*tuna*." Seggregation of tuna into species only started in 2004 for the North Sulawesi and 2005 for North Moluccas. Prior to this, tunas were categorized into three groups namely *tongkol* (for small species of tuna), *cakalang* (for the skipjacks) and tuna (for the large species of tuna).

We see a possible misidentification of *Auxis rochei* as Eastern Little tuna (ELT) in the statistics. Whenever this data is used, we present the species as given in the statistics and provide a note for the correction. Another misidentification is the name assigned to "*Tongkol Abu-abu*" as blue fin tuna instead of the Longtail Tuna, *Thunnus tongkol*. We did not include the swordfish, marlins, sailfishes, king mackerels in the analysis because these species are extensively caught by non-tuna gears and seggregation of data proved extremely difficult.

Tuna Landings

The total landings of FMA-VI in 2004 was 342,614 tons of which 36% or 123,303 tons are tunas (DKP-WPP, 2006). The trend of landings show that while total fish output levelled at around 300,000 tons from years 2000 to 2004, the share of tuna relative to the total fish catch declined from 52.8% in 2000 to just 36.0% in 2004 (Figure 7.2).

Seggregation by species only began in 2003 and not all provinces have adopted this reporting scheme up until 2005, thus analysis of landing trends used the three generic groups: large tunas (yellowfin, big eye, albacore and long tail); small tunas consisting of bullet tunas (*Auxis rochei*), frigate tunas (*Auxis thazzard*), eastern little tunas (*Euthynus affinis*) and juveniles of yellowfin (*Thunnus albacares*) and bigeye tunas (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*). As Figures 7.3 depicts, both the landings of large and small tunas show a declining trend under a regime of increasing fishing effort (expressed as the total number of tuna fishing gears) had been on the rise over the same period (Figure 7.4). The very high effort in 2000 represents the number of handline reported from the district of Mongondow, North Sulawesi.

Landings of Tuna Species

Landing trends of each species of tuna is presented in Figure 7.5 using data from the DKP Fisheries Statistics by FMAs (DKP-WPP 2006). Expectedly, skipjack tuna

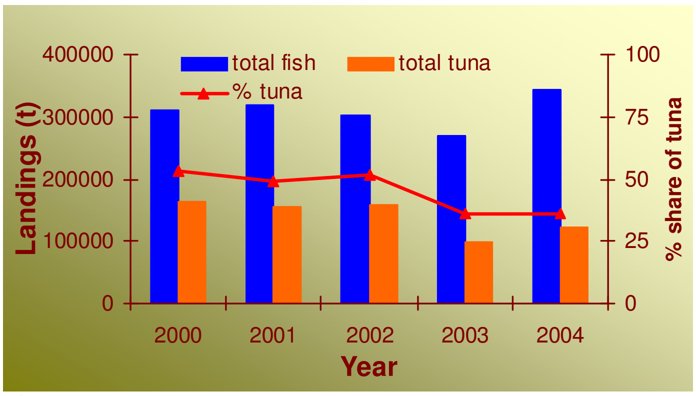


Figure 7.2. Total fish landings and share of tunas for fishery management area VI. Source: DKP-WPP (2006).

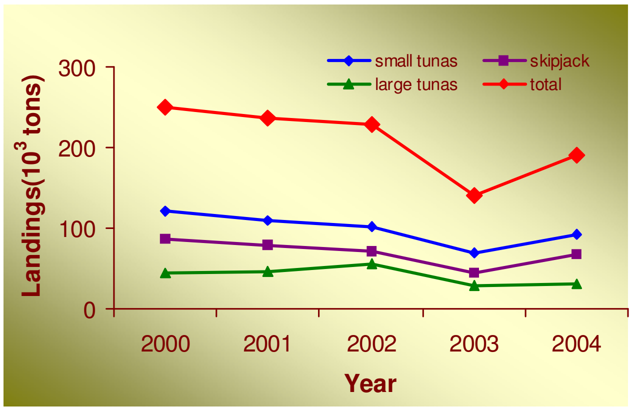


Figure 7.3 Landings of small, skipjack and large tunas from fishery management area six (FMA-VI) for the period 2000-2004. Source: DKP-WPP 2006.

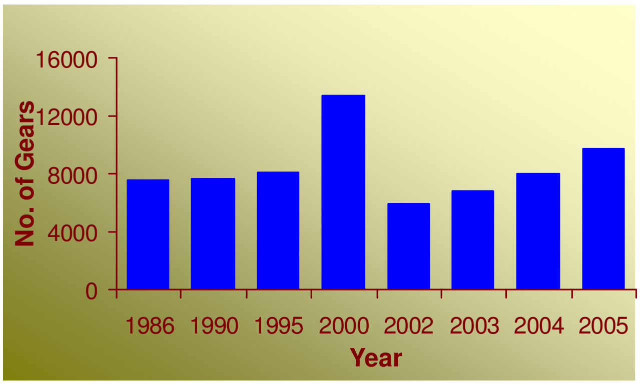


Figure 7.4 Trend in fishing capacity in FMA VI as exemplified by the numbers registered in North Sulawesi Province statistical records. Note: The provincial records were separated into FMAs VI and VII. Source: DKP North Sulawesi province (various years).

is the most abundant species as it is caught by all tuna gears and as target species by purse seine, pole and line, some vertical handlines and troll lines.

In 2004, skipjack (69,000 tons) together with the bullet tunas (26,094 tons) (but appearing as eastern little tuna) are the dominant tuna species (Figure 7.5). Large tunas are represented by bigeye (14,317 tons), yellowfin (9,813 tons), longtail (8,658 tons) and albacore (8,519 tons). Based on the results of our market and fish landing surveys in the area, it appears that *Euthynnus affinis* (eastern little tuna) is a possible misidentification of the bullet tuna, *Auxis rochei* which we observed to be very abundant in the area but which never appeared in the statistics. Eastern little tuna in comparison are very few. This situation arose probably from the use of local names in recording landings where small tunas are generically called "tongkol", a collective term for all small-sized tuna species irrespective of the species. As the entries of eastern little tuna consistently appears on record as the most dominant small tuna species, is probably an error perpetuated by the fisheries enumerators.

Fishing Gears

Nine fishing gears types are observed to catch tunas in FMA-VI. Each fishing gear type has many variations depending on the area of operation, target species and the need to adapt to changing resources. For example, purse seine comes in different boat sizes, designs and methods of operation depending on the target species. Likewise, troll line has two variants, the traditional one that simply pulls a single hook with false baits and the newly introduced kite fishing technique wherein a kite is attached to the fishing gear, a method proven to be effective especially

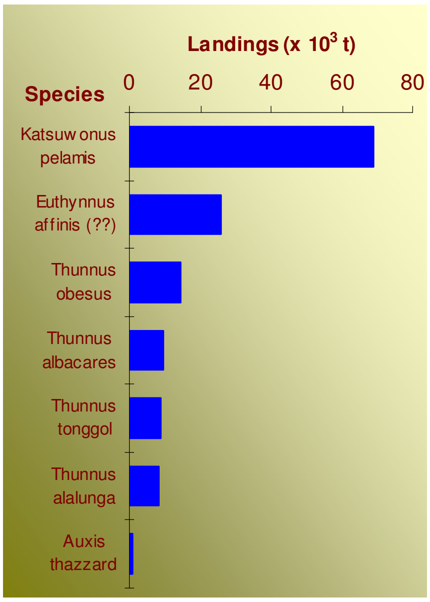


Figure 7.5 Landings of each tuna species in FMA VI for 2004 (DKP-WPP, 2006).

during calm seas. Even the simple tuna handline vary in fishing technique with the use of live baits (as practiced in Sorong, Papua) or the use of squid ink in addition to fish bait and use of drop stone technique to fish in very deep waters by the Filipino fishers poaching in Indonesian waters.

Of the gears listed in Table 7.2, the gillnets, the small purse seine called "purse seine mini", other longlines and other handlines land tunas as incidental catch but are targetted during certain seasons. The rest of the gears target the tunas all year. Note that the fishing gears listed in Table 7.2 are incomplete as we have no data from Central Sulawesi Provincial Statistics. Instead, the number of gears for the Province was taken from the report of PRPT (2006).

Catch per Gear Type

In this section, we have used the 2005 Fisheries Statistics of the Province of North Moluccas to show the share of tunas of each fishing gears type (Table 7.3). Tuna catch as recorded in Table 7.3 is with high probability, just the landings of small-scale purse seines called *pajekus.* The tuna landings of the *pajekus* account for just 14% because the fleet targets the small pelagics consisting of round scads (*Decapterus* spp.), big eye scads (*Selar* spp.) and Indian mackerels (*Rastrelliger* spp.). It probably did not include the catch of the large purse seine fleet (>100 GT) which regularly operate in these watersbut whose catch are probably recorded in FMA VII where the catch are landed. By Indonesian law, these vessels, because of their size are not allowed to operate within the archipelagic waters.

Table 7.2 Number of registered tuna gear types from the four provinces encompassing fishery management area six (FMA-VI). Sources: DKP provinces of North Sulawesi, Papua, North Moluccas. Data for Central Sulawesi taken from PRPT 2006.

Gear Type	North Sulawesi	Central Sulawesi	North Moluccas	Irian Jaya Barat	Total
Purse Seine	359	133	191	10	693
Drift Gillnet	222		175	157	554
Encircling Gillnet	0		174	77	251
Tuna Longline	494		137	198	829
Other Longline	92		34	187	313
Pole and Line	188		272	140	600
Troll Line	358		196	1376	1930
Handline	168		224	2163	2555
Other Handline	7798				7798

A typical scene at a fishing port in Sorong, West Papua. A liftnet boat and drift gillnet and pole & line boats in the background.

Share of tunas in the catches of the drift gillnet and encircling gillnet are very small with 3.1% and 1.7%, respectively, as these gears are non-tuna gears compared to the same gears operating in the coastal areas of Indian Ocean (FMA IX) where skipjack, bullet tunas and frigate tunas account for the bulk of their catch.

The contribution of each gear to the total tuna landings in Moluccas province show three fishing gears account for 92% of tuna landings in FMA VI (Table 7.4). Large tunas, in the order of volume of catch, are taken by longline, troll line, pole & line and handlines. While tuna longline account for 68% of the large tunas, the handlines catch represent a mere 4.2%. The data as presented in Table 7.4 raises two key questionable entries: the landings of longline which are reported no longer operating in FMA VI and the volume of handline catch which is very small.

Skipjack tuna are landed by pole and line, purse seine and troll lines with almost 70% accounted for by pole and line while small tunas are taken by the pole and line (80%), purse seine (14.2%), handline (3.15%) and troll line (1.48%).

The figures given for small tunas caught by pole and line appears questionable as the hooks used by pole and line are quite big. It might be probable that some of the small tunas identified here are actually juveniles of yellowfin and bigeye tunas.

Estimate of Tuna Catches of FMA-VI

We have tried to come up with an estimate of the total tuna catch for FMA-VI. This is not meant to question existing statistical entries but to have an independent estimate of catch in order to provide an index on the degree of under reporting, as it is commonly accepted. As Table 7.5 shows, the estimated tuna catch for FMA-VI for 2006 is about 131.9 thousand tons, a quantity that is 10% more than the recorded quantity for year 2004 which was 123,303 tons. However, this value is on the low range considering that our estimate did not include the fishing fleet from Central Sulawesi Province because we have not collected any data. In our method, we have used only half the number of the reported number of gears reported in cases where we did not get any other estimate of fishing capacity.

Table 7.3 Tuna share in the total landings of the different fishing gears operating in FMA-VI. Source: DKP North Moluccas Province (2005).

Gear Type	total fish landings (t)	total tuna landings (t)	% tuna
Purse Seine	31107	4333	13.9
Drift Gillnet	1161	36	3.06
Encircling gillnet	1955	33	1.69
Tuna longline	3596	2628	73.1
Other longlines	521	81	15.6
Pole and Line	29498	28779	97.6
Handlines	2295	743	32.4
Troll line	10222	7375	72.1

Table 7.4. Share of each tuna fishing gear to the total tuna landings in the province of Moluccas. Source: DKP Province of North Moluccas (2005).

Gear Type	large tunas	skipjack	small tunas	Total	%
Purse Seine	0	3505	828	4333	9.85
Drift Gillnet	0	0	36	36	0.08
Encircling gillnet	0	0	33	33	0.07
Tuna longline	2628	0	0	2628	5.97
Other longlines	81	0	0	81	0.19
Pole and Line	170	23959	4650	28779	65.4
Handlines	162	398	183	743	1.69
Troll line	814	6475	86	7375	16.76
Total	3856	34337	5815	44008	100.00

Table 7.5 Parameters used in the estimate of tuna catch for FMA VI. Note that in the absence of other estimate of fishing gear numbers, we have used half of the reported number of registered fishing gear type for 2005.

Fishing Gear Type	No. gears 2005[1]	no of gears used [2]	total fishing days/yr[3] or trips/year[4]	annual catch/ unit (mt)	Est. total fish catch (mt)	% share of tuna	Est. tuna catch (mt)
Purse Seine (<30GT) [1,2,3]	683	346	173	117.64	40,703	0.139	5658
Purse Seine (>30GT) [3,5]		24	44	396.0	9,504	0.970	9219
Pole and Line [1,2,4]	600	300	120	187.0	56,100	0.976	54754
Troll Line [1,3,]	1930	1930	240	21.3	41,109	0.721	29640
Simple Tuna Handline (Seram Sea, Moluccas	392	392	240	21.0	8,232	0.324	2667
Simple tuna handline (West Irian Jaya) [1,2,3]	2163	1082	99	11.5	12,481	0.750	9360
Phil.-based pumpboats [3,5]	1500	300	120	57.0	17,100	0.920	15732
Other handline [1,2,3]	7790	3895	240	4.8	18,696	0.100	1870
Other longline	690	345	168	25.2	8694	0.156	1356
Drift Gillnet[1,2,3]	554	277	252	136.0	37,672	0.031	1168
Encircling Gillnet [2,3]	251	126	240	262.0	32,881	0.017	559
TOTAL							**131982**

[1]/ based on aggregate number of gears from Moluccas, North Sulawesi, West Irian Jaya and Papua provinces for 2005
[2]/ used only half of recorded fleet number
[3]/ number of annual fishing days
[4]/ number of trips per year
[5]/ data based on results of interviews in Philippines

A fish market scene along a road in Sorong, West Papua.

Our estimate relies heavily on the mean catch and catch rates provided by respondents for each fishing gear type during our survey, using the lower estimates of catch rates and the number of days fishing provided to us. We used very conservative figures in the computation of number of fishing days during the peak and lean seasons and incorporating zero catch in order to get the true estimate of mean catch. In our desire to approximate the actual tuna landings, we included in the computation catch taken by the Philippine-based handline fleet and catch caught by reflagged Philippine purse seines, some of which operate illegally in FMA VI.

The Tuna Fishing Fleet of FMA-VI

The tuna fleets operating within FMA-VI consist of good mix of tuna fishing fleets from North Sulawesi, Central Sulawesi, Southeast Sulawesi, South Sulawesi, West Irian Jaya, North Moluccas, Moluccas, East Java, Bali, East and West Nusa Tenggara. FMA-VI is one of the three remaining productive tuna fishing grounds of the country. The other two areas are the Flores Sea, (FMA-IV) and Pacific side of FMA VII. The presence of fleets from different areas that lands their catch in their respective ports make the monitoring of catch and effort a major challenge.

The following sections gives a general description of the different fishing fleets operating in the area based on the current situation as observed during our survey and the changes that occurred as the fleet try to meet the challenges of tuna fishing.

Purse Seine Fleet

There are three types of purse seine fleet operating in Moluccas, Tomini and Seram Seas: the very large seiners (>100 GT), the medium sized fleets (10-30 GT) and the small-sized fleets (<10 GT).

Large Vessels

Many of these larger vessels (>100 GT) based in Bitung, North Sulawesi use the group seining fishing technique due to small capacity of the catcher vessels. Each group is called a unit and consists of 4 catchers and 1 carrier ships. Each catcher vessel (also called mother boat) has a compliment of 1 or 2 skiff boats that help set the net and retrieve the catch, three (3) light boats that also act as scout boats and about 20 to 30 fish aggregating devices (FADs) which are deployed all over their identified fishing grounds. Some of the catcher vessels operating in FMA-VI are part of the 24 catchers from Philippines that have re-flagged and operating under the new fisheries policy of July 2005 of the country.

These catcher vessels have freezer on-board to accommodate 2 to 3 days catch, and are highly mechanized - with hydraulic system to operate power blocks with T-boom, to retrieve the nets and set the FADs. Catch are transferred to fish carriers regularly which are also responsible in bringing in provisions and supplies of the catcher and the support vessels. But compared to the distant water fleet operating in the Western and central Pacific Ocean, these vessels are quite small, necessitating the need for carriers.

By law, these ships that are greater than 30GT are not allowed to fish within the archipelagic waters but some vessels regularly fish within FMA-VI and FMA -VII in clear violation of existing law.

Medium and Small Fishing Vessels

The medium and small fishing vessels differ only in size, engine horsepower and number of crew but their operation is basically the same. The small purse seine vessels called locally as "*pajekus*" are wooden boats with gross tonnage range from 3 GT to 25 GT, propelled by 40 Hp outboard engines whose number vary from 1-5 units depending on the size of the boat.

Many of these small purse seines vessels still have an observation deck or a ladder-like structure on the boat where the master fisher sit to spot fish schools. These are remnants of the time before the era of the fish aggregating devices (FADs) when boats search for schools of fish. Hauling the net is manually operated; hence the boats carry a compliment of 8 for small up to 26 crew members for larger boats.

The main target species of the small and medium sized purse seine fleet are the small pelagics and small (bullet and frigate) tunas are caught seasonally. Purse seine therefore takes only the tuna as incidental catch.

Fishing Gear

The fishing gears used by the purse seiners are similar in construction and design and vary mainly in size (length and depth) and mesh sizes depending on the target species. The nets are made of multi-filament PE nets. Net sizes range from 250-400 meters in length and 60-80 meters depth depending on the size of the vessel.

Fishing techniques

The medium and small purse seine fleet based in Bitung normally fish at night, using light boats to attract swimming schools or to lure fish away from the FADs. The light boats are small plank vessels with outrigger (d" 3GT) powered by inboard or outboard engines. Light is supplied by power from a generator set (15 Hp) or as with some small *pajekus*, from kerosene lamps (8-12 pieces).

For the medium-size purse seine fleets, structural modifications are being made on the boats and gears, mainly in the form of changing from outboard to inboard engines, and construction of fish hold to accommodate ice and fish. These structural changes are made in order for vessels to fish for longer days in more distant fishing ground as resources in the traditional fishing grounds decline. The shift to inboard motor is also to reduce operating cost as inboard diesel is more economical than outboard motors. This is an indication of decline in fisheries resources.

Figure 7.6. Left photo: A small purse seine "pajeku" landing its catch in Ambon fish port. Note the watch tower for spotting fish schools. Right photo: Thai trawlers operating in Arafura Sea tied to the port of Ambon awaiting for the next fishing trip.

Fishing grounds

The small and medium sized vessels with outboard motors are all day boats. While the larger size boats could go as far as 30 nautical miles (nm) from shore, the smaller ones just fish within a distance of 1 to 2 hours travel time (15-30 nm). The vessels with inboard motor and provisions for fish hold are able to carry ice and have space for fish storage; a feature which allows them to operate longer from 3 to 7 days. Such boats are based in Bitung and Gorontalo and fish in Tomini Bay or in Sangihe Islands. The purse seiners based in Ternate, Ambon, Obimayor and Bacan islands are mostly day boats although some vessels based in Ambon, move out to Seram Sea or in Banda Sea for several days to follow the season of roundscads. The boats based in Tomini Bay operate just along the coastal area of the respective home ports of Gorontalo, Ampana, Parigi and Poso where FADs are deployed (DKP 2006).

The fishing grounds of the larger vessels in FMA-VI are in Seram Sea, Taliaba, Buru Islands and extend eastwards north of Waigeo Island in Sorong, Irian Jaya. Their operation in FMA-VI is actually an extension of their fishing oprations which is in FMA-VII. The numbers of days large vessels spend in FMA-VI in not known as these boats, which are over 30 GT are fishing illegally. However, tuna fishers around the area do not complain because they could fish for free on the FADs owned by these puerse seine companies.

Species composition

The Provincial Statistics of North Sulawesi lists 15 major fish groups caught and landed by purse seines landing in Bitung. The ranking of species vary between places within FMA-VI. Note that landings are contaminated by the large purse seine vessels that operate also in the EEZ and FMA VII. As expected, skipjacks are the most abundant (30.4%), followed by bullet tuna (12.6%) and frigate tunas (5.28%). Roundscads account for 35.8% of the landings.

Species of large tunas are highly represented in the purse seine catch with landings amounting to 7,651.9 tons or 10.4% of the total. The catch probably represent the juvenile tunas (sometimes categorized as rejects ~ <20 kg). This needs to be verified considering that it takes a special training and practice to separate juveniles of bigeye and yellowfin.

Analysis of species composition of purse seine from North Moluccas show 25 species/ groups of fishes are caught (Table 7.7). Roundscads (*Decapterus* spp.) and big eye scads (*Selar crumenopthalmus*) account for over half of the landings

(53.9%) while bullet tunas and skipjack represent 16% and 7.3%, respectively. Large tuna species show an aggregate catch of 1.1% of the total landings (Table 7.7). Similar to the statistics from North Sulawesi, species of large tunas represent the juvenile by-catch and is most likely under reported because of the difficulty associated with identification of small-sized large tuna species.

The large number of target species of purse seines in FMA-VI is a result of the extensive fishing grounds. In Tomini Bay for instance, catch composition could differ between areas within this fishing ground where purse seine catch of fleet in Parigi is dominated by bigeye scad (*Selar crumenopthalmus*) with ~70% and round scads (15%) while in Bualeno, roundscads (70%) and small tunas (15%) account for 85% of the total landings.

Table 7.6. Composition of catch of purse seine fleet based on landings from Bitung, North Sulawesi in 2005. Source: DKP-Province of North Sulawesi.

Species/ Groups	Landings (t)	%
Roundscads	26,426.0	35.8
Skipjack tuna	22,425.4	30.4
Bullet tuna	9,342.9	12.6
Frigate tuna	3,898.3	5.28
Yellowfin tuna	3,665.2	4.96
Albacore tuna	2,072.7	2.81
Bigeye tuna	1,914.0	2.59
bigeye scad	1,785.4	2.42
Eastern little tuna	358.4	0.49
Indian mackerel	610.3	0.83
Others (15 species groups)	1,389.9	1.88

Catch Rates

Table 7.8 summarizes catch rates of purse seine operating in FMA-VI from various studies and supplemented by results of interview conducted in Ternate, Bitung, Ambon areas.

Catch rates of purse seines in FMA-VI remain high and profitable (see section on economics of fishing) but appear to have declined based on the following observations:

1. For the large vessels, the frequency of getting large catch of >20 tons from a single haul has declined to less than 10 times per year compared to the 1990's where frequency is twice per week.
2. Ten to 15 years ago, extremely huge catch of >70 tons per haul occurs about 3-5 times per year, but from period 2000 to 2007, such extremely large catch has not happened at all;
3. For vessels not operating on FADs, sightings of free swimming schools have become fewer and school sizes have shrunk to just 50% percent of 1997 levels.
4. In relation to searching schools, sightings as well as abundance of seabirds has likewise declined.
5. Change in fishing operation by staying longer at sea as shown by fleets based in Bitung and Gorontalo and in Tomini Bay and Moluccas Sea is a consequence of increased distance of fishing grounds.
6. Increase in vessel power to enable day boats to reach farther fishing grounds; and
7. Shift from outboard to inboard engine and provision for fish hold are structural changes on the vessels that support longer fishing days.

Table 7.7 Catch composition of purse seine fleets landing at Ternate fish port in 2005. Source: DKP-Province of North Moluccas 2005.

Species/ Groups	Landings (t)	%
Roundscads	6765.5	35.7
Bigeye scads	3451.2	18.2
Bullet tunas	3025.7	16.0
Skipjack tunas	1387.2	7.3
Indian mackerels	831.3	4.4
Fringescale sardines	708.0	3.7
Garfishes/ Needle fishes	707.5	3.7
Sardines	355.7	1.9
Anchovies	292.1	1.5
Hardtail scad	217.3	1.1
Rainbow runner	183.8	1.0
Frigate tunas	142.8	0.8
Yellowfin tuna	111.3	0.6
Albacore	30.1	0.2
Bigeye tuna	28.8	0.2
Longtail tuna	15.0	0.1
Others	707.8	3.7
TOTAL	18961.1	

Longline

Fishing Fleet

Based on the most current statistics, there are about 631 units of longline operating within the FMA-VI, 494 units operating from North Sulawesi and 137 units in North Moluccas. The boats from North Sulawesi are based in Kabupaten Bolaang Mongondow (229 units), South Minahasa (149 units) and Bitung (116 units). The units based in North Moluccas Province are based in west Halmahera (10 units), central Halmahera (15 units), east Halmahera (10), south Halmahera (25), north Halmahera (33), Sula Halmahera (20), Ternate City (14) and Tidore City (10).

The number of gears does not match the number of boats registered for each of the areas above. For example, while the number of tuna longline gears is 494 for north Sulawesi, there are only a total of 273 boats with weight >10 GT. Similarly for north Moluccas, there are only 123 boats with displacement of >10 GT compared with the 137 units of longline for tunas.

Fishing Grounds

During our trip, we did not see any units docked in any of the major ports except in Bitung. Our interview with a fleet manager identified the fishing ground as in northeast Sulawesi, Pacific Ocean eastwards and northwards into the high seas.

Published literature indicated extensive longline fishing in FMA-VI from 1967 to 1981 (Suhendrata and Subani 1988,). However, no mention of longline fishing for tuna in FMA-VI was noted in recent years.

Species Composition

Based on the provincial statistics of North Sulawesi in 2005, the proportion of landings by each tuna species caught by tuna longline are as follows: yellowfin with 41%, bigeye with 27.8% and albacore with 25.4% and other tunas account for 99% of the total recorded catch of this gear (Table 7.9). By-catch include sharks, dolphinfish, mackerel, and sea bass which collectively represent less than 1% of the total catch.

By comparison, the species composition of landings by longline fleet in Moluccas province showed a higher share (4%) non-tuna catch (Table 7.10).

Table 7.8. Records of catch rates of purse seine fleet in FMA-VI for the different vessel sizes and years.

Source	year	fishing ground	mean tons/set FADs	Remarks
Large Vessels			tons/day	
Sujiyanto	1999	Mollucas Sea	13.6	March - April
Sakroni	1998-1999	Mollucas Sea, EEZ Pacific, Sulawesi Sea	23.1	Dec-May n=27
this study	2007	Mollucas Sea	9.00	Jan-Feb
Medium-sized vessels				
this study	2002	Ambon Bay	0.7131	n=208
	2003	Ambon Bay	0.6319	n=139
Irwan	2000		1.31 1.13 1.22	
PRPT (2006)	2004	Tomini Bay	0.952	Gorontalo, annual
	2004	Tomini Bay	0.735	Ampana, annual mean
	2004	Tomini Bay	0.731	Parigi, annual mean
	2004	Tomini Bay	0.629	Poso, annual mean

There are reasons to doubt some of the figures shown in Tables 7.9 and 7.10. The entry of sharks and rays appear very small contrary to what are actually caught. The data needs to be verified if the weight given is simply the weight of the shark fins or are raised values based on size and number of fins landed. This is because, as practiced, sharks are removed of fins, dried and the carcass thrown overboard. As shark fins form part of the incentive of the crew, the number and volume of sharks are recorded, if at all. There is also the presence of questionable entries such as southern blue fin tuna, humpback and blue-lined seabasses. Missing too are the oilfishes that form part of the deep-sea fish community.

Baitfish

See Chapter 10 for detailed discussion of the baitfish fishery of the tuna sector.

Catch Rates

Suhendrata and Subani (1988) and Suhendrata and Sofri (1991) provided historical data on total hook rates of tuna longline by the Japanese fleet operating within North Moluccas and North Papua. The hook rates in North Moluccas between 1976 and 1981 ranged ranged 1.07 to 2.53, with highest and lowest catch rates occurring in 1978. In north Papua, hook rates were significantly higher (>3.0/100 hooks) observed during 2-4th quarter of 1978. Similarly, the work of Suhendrata and Sofri (1991) showed hook rates of longline fleets operating in Tomini, Seram and Moluccas Seas fluctuate from 1.5 to 2.5 per 100 hooks.

Recent hook rate figures for FMA-VI is not available implying that longline fleets based in FMA-VI are now fishing elsewhere. This is because the area has become too crowded with the other fishing gears and entanglement and loss of gear caused by FADs may have gone from bad to worse.

Pole and Line

Fishing Crafts

There are two types of pole and line fleet in FMA-VI, the small vessels between 5 to 15 GT called *funae or funai* (the traditional pole and line fishing boats) and the larger boats called *Huhate* whose size range from 20-100 GT. The small vessels are generally powered by 2 to 3 units of 40-Hp gasoline-fed outboard engines while the large sea crafts have inboard motor and have several large holding tanks built into the boat for storage of live baits.

The increase in vessel size was triggered by the need for more space for the livebait, a chronic problem that beset this fishing sector. For the *funai*, the increase in engine power is to bridge the increasing distance of fishing ground and source of live baitfish while for the *huhate*, the increase in vessel size is to provide more tanks for the live baitfish.

Table 7.9. Catch composition of tuna longline landing in North Sulawesi. Note the presence of bluefin tuna entry which is questionable. Source: DKP Propinsi Sulawesi Utara 2005.

Species / Groups	Landings (t)	Percent
Yellowfin tuna	6236.1	41
Bigeye tuna	4232.8	27.83
Albacore tuna	3866.2	25.42
Longtail tuna	717.7	4.72
Sharks	79	0.52
Southern bluefin tuna	43.6	0.29
Dolphinfish	18.2	0.12
King mackerel	9.7	0.06
Humpback seabass	4.8	0.03
Blue-lined seabass	1.4	0.01
Total	15209.5	100

Table 7.10. Catch composition of tuna longline landing in North Moluccas. Source: DKP Propinsi Maluku Utara 2005.

Species/ Groups	Catch (t)	Percent
Tuna	2628.24	73.1
King Mackerels	452.5	12.6
Other Fishes	371.12	10.3
Sharks	108.13	3
Rays	35.58	1
Total	3595.57	

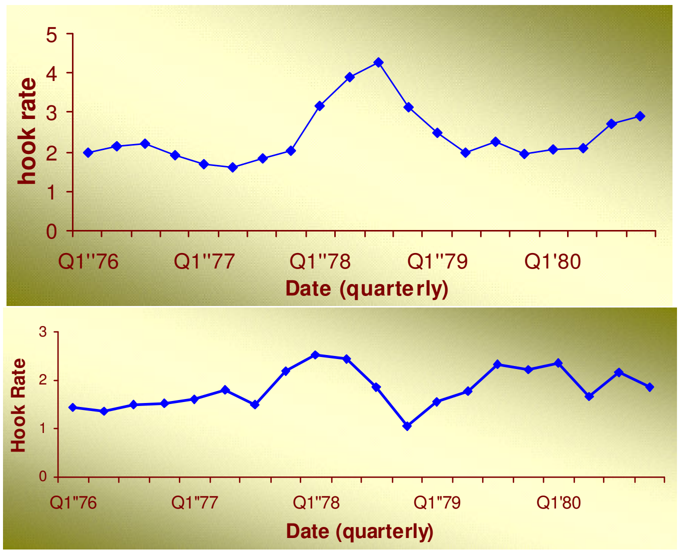


Figure 7.7. Hook rate of a fleet of Japanese tuna longline operating in northern Papua (top) and in North Moluccas Sea (below) from 1967-1981. Data drawn from Suhendrata and Subani (1988).

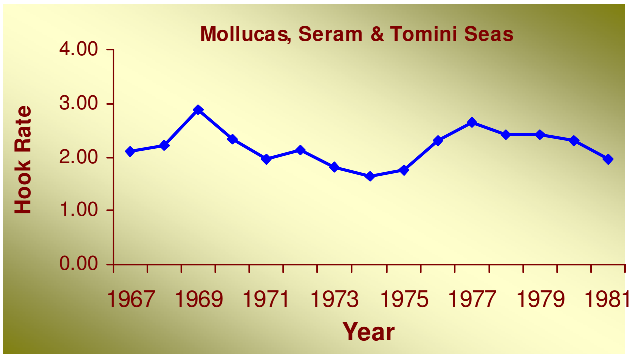


Figure 7.8. Hook rate of Japanese tuna longline operating in FMA-VI (pooled data) from 1967-1981. Data drawn from Suhendrata and Sofri (1991).

Fishing Gears

Fishing gears have remained the same, the hooks are home made without barbs. A study was conducted in the area to determine preferences for color of lures used as false bait but found little significance (Raharjo 1995).

Fishing Techniques

The major change in fishing technique for the pole and line in FMA-VI is the complete shift to the use FADs in its fishing operations. This is brought about by three reasons: a) the decreased sightings of freely swimming schools, b) the higher catch rates realized from fishing in FADs, and c) the fuel price increase in 2004. A detailed discussion on the implication of these developments to the management of tunas is presented in Chapter 13.

Fishing Grounds

The location of FADs, locally called "rumpon" or "rakit" determines the fishing grounds of the pole and line fleet. In Moluccas Sea, FADs are deployed in the area between North Sulawesi and Halmahera Island from 125.5° to127° East Longitude and from 0° to 2° North Latitude (PRPT 2006).

Many of the large pole and line vessels operate under the "plasma system" or through companies that provide not just the operational cost but also FADs and live baitfish.Those vessels not belonging to a company or "plasma system" are singly-owned vessels that operate in FADs owned by others and pay a premium for its use when accosted. However these singley-owned boats operating outside the plasma system prefers to utilize the FADs set by large purse seine companies as it is free of charge. The total number of FADs are hard to estimate but companies, as a rule provides 1:1 ratio of FAD to boat ratio for pole and line. In comparison, large purse seines vessels deploy 25-50 units of FAD for every catcher. As reported by respondents, as many as 10 pole and line vessels may fish around a single FAD.

Baitfish

A section on the live bait fishery for pole and line is presented in Chapter 10 where the attendant issues, strategies and solutions are presented.

Species Composition

Pole and line catch almost exclusively tunas and only less than half percent (0.5 %) are non-tunas (Table 7.11). Skipjack tunas are the main target and represent around 65% of the total catch. The large tuna species, presumably juveniles of yellowfin, longtail, albacore and bigeye tuna account for 34%. If these figures are correct, then the issue of juvenile by-catch for almost all tuna gears is a major concern (see discussion on by-catch). Other species caught in insignificant amounts include rainbow runner (*Elegatis bipinnulatus*), oceanic bonito (*Euthynus affinis*), Indian mackerel (*Rastrelliger kanagurta*), king mackerels (*Scomberomorus* spp.), jack trevally (*Caranx* spp.) and dolphin fish (*Coryphaena* sp.).

Species composition based on actual catch of pole and line from Halmahera Seas showed that skipjacks accounts for 73.1%, juvenile yellowfin tuna with 18.7%, bullet/ frigate tunas with 5.22% and dolphin fish with 3.00%, of the total catch (PRPT 2006).

Catch Rates

From 1950 to 1984, the catch rates of pole and line exhibited a gradually increasing trend, probably brought about by the increase in number and fishing capacity of boats. During this period, fishing is undertaken either on free swimming schools or on associated schools. Starting in 1985, fishing on fish aggregating devices was introduced by the state owned enterprises Pt. Usaha Mina in Aartembaga, North Sulawesi, Ambon, Moluccas, and Sorong, Irian Jaya. The result was a 75% increase in catch and reduced operating cost by 50%, creating the tipping point for other vessels to 75% follow suit. But because of the high cost of capitaal outlay to deploy FADs, not all of the vessels made the complete shift. It was only in 1995 or ten years later, driven by few sighthings of free schools, that the fleet finally became dependent on FADs (Table 7.12).

Seasonality of Catch

Based on the results of this study, the catch rates of pole and line vary with area and season (Table 7.13). During peak season, catch vary between 4-6 tons per fishing day with an average of one ton per fishing day during the lean months. The seasons likewise vary with area where peak season in Moluccas sea is from June to September while in Waigeo, Sorong, it comes much later from September to February (Table 7.13)

The use of FADs has significantly improved catch under conditions of reduced operating cost. The improved catch rates shown above are due to several contributing factors. These are:

1. Starting in 1990, vessel sizes increased between 50-80 GT to accomocate bigger tanks to hold more live baits. The volume of live bait carried on board determines the length of fishing which determines the volume of catch. Rawlinson showed that the average volume of baitfish used per day has increased fourfold from 1976 to1991.

Table 7.11. Species composition of Pole and line based on landings from districts of Bolaang Mongondow, south Minhasa and Bitung, North Sulawesi (2005). Source: DKP North Sulawesi provincial data.

Species / Groups	Landings (t)	%
Skipjack tuna	29207.2	65.0
Longtail tuna	5274.1	11.7
Yellowfin tuna	3664.3	8.16
Albacore	3373.2	7.51
Bigeye tuna	3077.1	6.85
Roundscads	102.6	0.23
Frigate tuna	92.9	0.21
Garfishes	51	0.11
Eastern little tuna	38.4	0.09
Indian mackerel	20.8	0.05
Dolphinfish	9.7	0.02
King mackerel	6.5	0.01
Raibow runner	3.4	0.01
Jack trevally	3	0.01
Bluefin tuna	1	<0.01

Pole & line vessel unable to go fishing due to lack of livebaits.

Table 7.12. Trends in mean catch rates (kg/day boats) of pole and line fleet operating in Moluccas, Tomini and Seram Seas presented in ten year intervals. See also Figure 7.9 Legend: */based on fishing during peak months only (source: Rasyid 2002)

Decade	1950-1959	1960-1969	1970-1979	1980-1984	1985-1989	1990-1999	2000-2005
Mean catch rate (kg/trip)	513	564	642	778	1263	1268	1851.5*

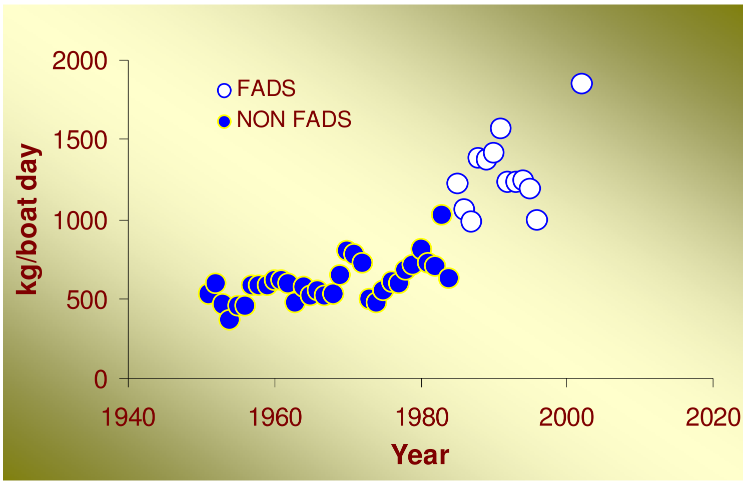


Figure 7.9. Comparison of catch rates of pole and line (kg/boat/day) fishing in fish aggregating devices (FADs) (open circles) and from freely swimming schools (closed circles). Sources : drawn from data of Purwasmita 1993 (points 1978-1992), Uktolseja (1978) (year 1973-77), Rasyid 2002 (2002).

2. Larger boats (50-70 GT) could carry more fishers (18) compared to the traditional small boats (<5 GT) with only 3 fishers.
3. Singly-owned boats join companies or "plasma" to ensure bait availability.

While the data above suggest an upward trend in catch rates, declines in catch rates for pole and line in this management area are actually happening since 2000. It was first reported as early as 1992 by Rawlinson et al, (1998) and confirmed during the interview. According to reports of respondents, catch rates have fallen between 50%-60% between 1997 and 2006 alone. The factors contributing to the decline are as follows:

1. Decline in fishing times due to shortage of bait. Naamin and Gafa (1998) reported that fleets lose about 40% of effective fishing days due to baitfish shortage, as in the case of the state enterprise Pt. Usaha Mina records of baitfish volume consumed (Figure 7.11). Furthermore, because of insufficient quantity of live baits, fishing operations last only an hour instead of the usual 2-3 hours. Even within the "plasma system", available livebaits are distributed equally among boats just to enable them to go out fishing.
2. The distance between bait source and tuna fishing ground has become very far. This is evident in the changes in fishing operation of the fleet where at present, boats undertake 3-5 day trip compared to daily fishing operation prior to 2003.
3. Some boats have utilized other sources of bait but found them not readily taken by tunas.

Pole and line fishing operation is intricately linked with a separate fishery, the lift net fishery that supplies the live baits used for chumming. Live bait availability has been a perennial problem for the pole and line fishery. Bailey et al (1981) made mention on shortage of live baits in Moluccas areas. This situation has not improved and in fact has since worsened, triggering large volume of studies on the topic. Two noteworthy research surveys were undertaken to address this issue: the ACIAR

Table 7.13. Mean catch rates during peak and lean mnths for pole and line based on results of this study.

Area	Peak season	catch rate tons/day	Lean season	catch rate tons/day
Moluccas sea	June-Sept	5-6 tons	Oct-May	1 ton
Waigeo, Sorong	Sept-Feb	4-5 tons	Mar-Aug	1 ton

Baitfish Project (1995-1999) and the WPFCC (1993). Several reviews on the fishery exists (Gafa 1986, Itano, 1993, Naamin 1994, Naamin and Bahar 1994, Naamin and Gafa 1998), description of the fishing method (Subani 1982, Gafa and Subani 1991, Itano 1993), analysis of the bait fish species (Subani 1982, Andamari et al, 1987, Banjar and Talaohu 1987, Banjar and Andamari 1900), surveys were made in search for live bait to develop the fishery (Rawung 1972) or to find baitfish substitutes (Rawung 1972; Rumahrupute et al 1987, Edrus et al, 1992a, Edrus et al, 1992b), in depth analysis of the pole and line fishery to determine changes in efficiency of both the fleets for bait and tunas (Rawlinson et al, 1998),

Blaber (1988) points to three major issues deemed critical to the sustainability of the pole and line and bait fisheries. These are: 1) analysis of existing data catch, 2) development of appropriate methods to assess stocks, and 3) development of management options (Blaber 1998). Presently, the bait fish shortage problem has worsened, triggering exodus of vessels to other areas (Flores Sea, Savu Sea) with better supply of baitfish, or exit from the fishery altogether, as exemplified by the small scale funai fleet, or to shift in fishing gear to tuna handline as discussed in more detail in the next section.

Handline

Vessels

There are two types of handline boats: a) small boats between 3-5 GT, with 40 HP outboard motor, with or without outrigger and is operated individually by boat owners themselves; and b) small boats (<1GT) outrigger type boats with 3-5 HP inboard engine or used as outboard motor with long propeller shafts and operates with a mother ship.

The first type dominated the fishery in FMA-VI and represents the traditional tuna handline. The second type of tuna handliners is a new development, as a response of the commercial sector to engage in handline fishery due to the growing demand for fresh tuna. Indonesia is the second biggest exporter of fresh tuna to Japan and catch from simple handline is the best source of raw materials for this market. The mother ship that brings these small boats to the FADs are retrofitted pole and line

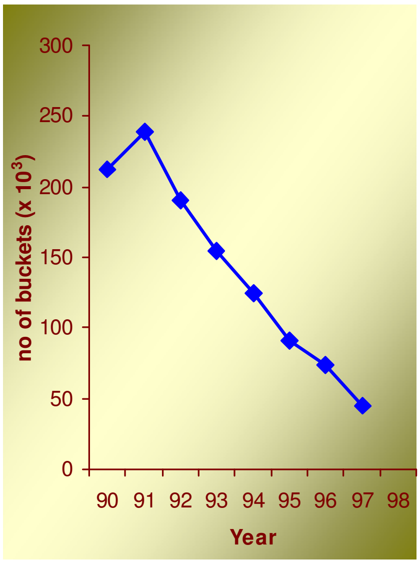


Figure 7.10. Trend in consumption of baitfish by the state-owned company, PT. Usaha Mina for its pole and line fleet.

boats.

Following the model of the Philippine tuna handline fleet, these retrofitted pole and line vessels carry as many as 20-30 boats to the fishing ground. The mother ship acts as the storage space for fish, ice, fuel and is used to deploy FADs.

Many of the pole and line companies have reinvested in tuna handline fishery. If the company is large, these companies provide the small vessels to the fishers on a partnership basis and fishers are provided with ice, fuel and food. Only the hook and line are the investment of the fisher. The price of fish bought by the company is much lower than existing prices. On the other hand, singly owned pole and line vessels converted to tuna handline operates in a similar fashion but invites handline fishers who owns boats and brings their own provisions. In such case, prices offered are much higher and the mother boat owner actually provides just the ice and the boat is used as a buying station.

Fishing Gears

The handline gear consist of a single hook (J-hook, 36 mm long, gap width 25mm) attached to a main line (nylon #12, 2 mm diameter) consisting of 300 meters until swivel and weight and use of # 90 nylon main line after weight whose length is about 15-20 meters until the hook. Each fisher usually brings 2 to 3 sets of handline as spare.

Fishing Technique

Fishing is undertaken exclusively on FADs. Fishing time depends on the type of boats. For fleets operating with the mother boat, fishing time is all day long, commences from early morning (5 A.M) till evening (6 P.M). For the individually owned boats, the length of fishing time depends on the capacity of the boat and the distance of the home port. Each fisher has to decide whether to go for quantity or quality of fish.

Before actual fishing, the fisher has to catch baits enough to last the whole day. Species of baitfish is made up of filleted small tunas (*Auxis* spp.), skipjack (*K. pelamis*) or juvenile yellowfin tuna (*T. albacares*). Fishing depth ranges between 70 to 200 m deep with fishers usually prefer deeper sets to get the larger sized individuals, particularly the higher priced bigeye tunas.

There is a marked difference between fishing techniques used by Indonesian and Philippine handline fishers resulting in a difference in catch rates (see section on notes of economics of fishing). Philippine fishers employ drop-stone technique to bring the hook at the desired fishing level at a much faster rate compared to their Indonesian counterparts, thus avoid catching the smaller-sized individuals on the shallower depths. Another difference is the use of squid ink as added attractant to the bait, a technique claimed to attract tunas based on the knowledge that squids are preferred prey of the large tunas.

One-person tuna handline boats that are brought to the fishing grounds by mother vessels.

Fishing Grounds

FADs designed for tuna fishing are distributed all over Moluccas Sea with concentration located between 126° to 127° E longitude and 0° to 2° N latitude (PRPT), around Sula Islands, Buru Island and Seram Islands and the islands extending from eastern coast of Halmahera eastwards to Waigeo Islands off Sorong, Irian Jaya. The number of FADs in FMA-VI is not known but estimates place the number between 5000-10000 units.

Species Composition

Handline for tunas catch predominantly large yellowfin and occasionally big eye tuna and by-catch species include dolphin fish (*Coryphaena* spp.), marlins, sailfish,

Table 7.14. Actual catch of tuna handline pumpboat operating in West Irian Jaya Barat consisting of 8 fishers fisihing for 10 days in January 2007. Source: This study.

Species/ Groups	Number	Weight (kg)
Yellowfin tuna	60	55-80
Big eye tuna	1	85
Dolphin fish	10	8-15
Marlins/ Sailfish	4	15-20
Opah	6	30-40
Sharks	1	20

sharks, king mackerel (*Scomberomorus* spp.) and opah (*Lampris guttatus*). Table 7.14 represent the actual catch of handline mother boat in January 2007.

Catch Rates and Seasonality

Catch rates for tuna handline is presented Table 15. According to fisher respondents, catch rate has remained at the same level in Irian Jaya, with the only difference is the increase in distance of fishing grounds from home ports. But in southeast Halmahera, fishers reported that catch rates declined by 60% compared to 1990 levels.

The catch rates of handline vary considerably between areas, between season. (Figure 7.11) and between fleets. Marked difference in catch between Tomini Bay, around Halmahera and in West Papua (Table 7.15). As stated earlier, the catch rates are likewise influenced by the skill of fishers and fishing technique employed.

Troll Lines

Vessels

The boats are small scale, usually less than 3 GT, equipped with outboard motor of 15 and 25 Hp. Vessel type varies between areas in FMA VI, in Papua provinces, fishers use a v-type construction made of ply board material without any outrigger, in Moluccas and North Moluccas province, outrigger type boats are used for trolling. The use of outrigger allows at least two lines to be towed simultaneously.

Troll line is very popular small-scale gear use all over FMA VI but particularly concentrated in areas such as Bacan, North Moluccas, Ternate City, Waigeo Island, Sorong in West Irian Jaya. Where there are traders for large tunas, there are numerous troll line fishers. Troll lines are also widely used in Biak and Manokwari, both in Papua.

Table 7.15. Catch rates and trend of tuna handline for FMA 6. Note: Data for Tomini Bay for yellowfin tuna catch only for years 2003-2004 (PRPT 2006).

Area	Peak season	catch rate	Lean season	catch rate	Trend	Tons per Boat year	Source
Waigeo, Irian jaya[1]	Oct-Dec	3-5 fish/day /fisher	Jan-Sept	0.8-1.25 fish/ day/fisher	1992: 3-4 fish/d/fisher	24.7	this study
Bacan, Halmahera[2]	Jan-Aug	200 kg/day /fisher	Sept-Dec	50-100 kg/ day/ fisher	Catch rate in 2006 only 40% of 1990 level	13.9	this study
Tomini Bay[3]	Jun-Dec	35-55 kg/day	Jan-Sept	15-40 kg/day		0.527	PRPT 2006

[1]/catch taken by Philippine pumpboat
[2]/catch taken by Indonesian vessel
[3]/refers to catch of yellowfin tuna only

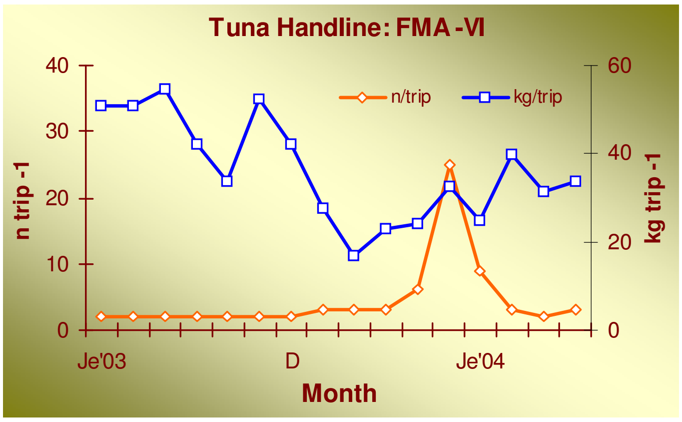


Figure 7.11. Month catch rates expressed as fish number per trip (open squares) and kg per trip (close squares) for handlines from Tomini Bay. Source: Table 7.6 of PRPT 2006).

Fishing Gears

The troll line consist of single line with a single unbaited hook at the end. The hooks are imbeded in nicely crafted lures made of wood and plastic materials whose form mimics prey such as flying fish or shrimp (Figure 7.12). Its hydrodynamic form is designed to skim the upper 1 meter water surface when towed.

The main line is about 30-50 meters long and a swivel is located 2.0 meters from the hook at the other end. Towing speed is half the normal cruising speed of about 5-6 knots.

Quite recently, kite fishing, locally called *layang layang*, was introduced in September 2006. Its use found instance popularity that by the time of our interview in November 2006, almost half of the troll line fishers based in Sorong are using this fishing technique. Based on accounts of fishers, kite fishing is effective particularly at times when the sea is very calm when fish don't take the bait. Fishers usually carry around 6 sets of hooks and troll lines, extra false lures and kites as spare.

Fishing Technique

There are usually 1-2 fishers per troll line boat. Fishing is conducted at daytime only. In Sorong, fishers leave at 6 am and arrive at fishing ground after 1-2 hours travel, usually near the FADs. Sorong fishers encircles FADs abut 50-100 meters away. Fishing operation lasts for 6-8 hours and return to port to land the catch. In Seram and Buro Islands, fishers don't fish on around FADs but simply rely on presence of dolphins and seabirds.

As practiced in Sorong, West Papua, fish caught are simply left on deck, and covered with any material to provide shade. No icing or post harvest handling is done, a practice that result in high post harvest losses due to poor quality. Fishers continue to fish up to 3-4 large tuna (30-70 kg) before they return to port. As a result, seldom will any fish qualify for sashimi grade, the last fish caught will probably get a Class B and the rest will be classified as rejects.

In contrast, quality is given a priority in Seram and Buru Islands. Because the fishing ground is days away from major landing port, troll and handline fishers undertake the correct practice of loining the tunas at sea immediately after landing the catch that result in very high quality of tunas. At sea, fishers upon hauling of the fish, slices the fish into four large slices but retaining the skin, washed with iced sea water to immediately lower the temperature, wrapped in plastic bags, the air removed, the bag sealed with rubber band and submerged in ice in styrofoam boxes. Loining at sea maintain very high quality of fish, saves on space and allow fishers could stay longer at sea to fish.

Fishing Grounds

The fishing ground for troll in Sorong is in Waigeo Island, off the north coast of Sorong, West Irian Jay, around Biak, Supiori in Cendrawasih Bay, around Buru and Seram Islands, Obimayor, Bacan, Tidore and practically around the islands between Halmahera and West Papua. The location of the fishing ground is dictated more by presence of buyers of tuna than by any other criteria.

Species Composition

Based on Provincial Statistics of North Sulawesi for 2005, at least 23 fish species are caught by troll line. Aggregate landings of the large tuna species account for 48.1% and skipjack with 48% bringing the total tuna share to 96% (Table 7.16). The rest of the species caught have equal or less than 1% of the total landings. Troll line catch both small and large sized individuals of market species, the share of juvenile tunas differ with area. In West Papua area, mature yellowfin (>30 kg) are fairly common but in Tomini Bay and areas off west Halmahera, immature individuals (<20 kg) dominate troll line catches.

Catch Rates and Seasonality

Information described in this section are results of the interview conducted in Ternate, Ambon, Seram and Sorong. Troll fishing in Sorong get better catch with a daily average of three (3) large YFT tunas (30-70 kg) per fishing day during the peak season (November to February). The rest of the year, mean catch is 1 fish per day. There are no days without any catch as during the low season, fishers switch to using multiple hook troll line to target other species such as skipjack, dolphin fish, king makerels and epipelagic species.

In Moluccas province, troll fishing is conducted in open sea and not in association with any FADs. Peak months is from November to February, catching an average of 3-4 fishes per day weighing between 30-60 kg each. The low catching season is from August to Octber where average catch is 0-2 fish per day weighing around 10-30 kg per fish. Zero catch occurs approximately six times per month of 22-25 days of fishing.

Tuna Infrastructure support

Major fishing ports in FMA-VI include Bitung, north Sulawesi, Sorong, Irian Jaya, Ternate, North Moluccas province and Ambon. The center of tuna activity for FMA-VI is in Bitung, where the processing and storage companies are based. Processing plants (producing whole fresh, frozen, canned tunas, smoked tuna, loin, steak and fillet), fishing fleet companies and export companies have invested in this area. The Bitung fishing port (Pelabuhan Perikanan Nusantara PPN) was opened in 2004 where large vessels of up to 300-400 GT class may be able to dock. Currently, the port is being used by Pole and Line, Purse seine (large and small vessels), and

Troll line vessels ready for delivery to 12 recipients annually provided by the fisheries department. Photo taken outside the fishing port in Sorong, West Papua.

Table 16. Catch composition of troll line based on the fisheries statistics of North Sulawesi in 2005. Source: DKP-Propinsi Sulawesi Utara 2005.

North Sulawesi	Landings (t)	Percent	North Sulawesi	Landings (t)	Percent
Skipjack tuna	11517.5	48.2	King mackerel	21.7	0.10
Yellowfin tuna	3244.4	13.6	Yellowtail trevally	21.6	0.10
Albacore tuna	2826.8	11.8	Wolf herring	18.9	0.10
Longtail tuna	2740.2	11.5	Indian mackerel	18.9	0.10
Bigeye tuna	2675.7	11.2	Obtuse barracuda	17.9	0.10
Red snappers	235.7	1.00	Fourfinger threadfin	10.5	<0.01
Roundscad	144.1	0.60	Rainbow runner	5.9	<0.01
Frigate tuna	128.4	0.50	Sardines	3.9	<0.01
Jack trevally	106.8	0.40	Torpedo scad	2.9	<0.01
Dolphin fish	72.6	0.30	Garfish	0.9	<0.01
Eastern little tuna	29.3	0.10	Others	2.4	<0.01
Swordfish	23.6	0.10	TOTAL	23870.6	100

handlines. There is also an international airport in Manado and major shipping port to support transport needs of the tuna industry. During our visit, construction and upgrading of facilities are in progress.

Tunas caught by pole and line, purse seine, handlines, directly land their catch to the processing plants. Traders buying tunas for processing from far away landing areas are transported by trucks to the port. The collecting vessels of companies retrieve and deliver tunas to Bitung from fleets operating in nearby areas.

In Bitung, North Sulawesi, there are about 26 companies that are involved in processing, catching and export of tunas including two Filipino-owned canneries and 4 companies that produce partially or wholly, smoked tuna (katsuoboshi) (Proctor 2007).

The province of North Sulawesi has identified tuna as one of its development thrust. The provincial government look at the tuna facility in General Santos City in the Philippines as the model to transform Bitung into a tuna export hub. The Indonesian government enjoins Philippine companies to operate from Bitung. Today, there are two Philippine owned canneries which also processes fish caught in the Philippines and PNG by the fleets owned by these companies. Also, about 24 catcher boats have already re-flagged following the new fisheries policy of Indonesia which was passed in July 2005.

There are other ports in the FMA-VI. These are in Sorong, Irian Jaya, in Ternate, North Moluccas and Ambon in Moluccas Province. The fish port in Sorong (PPPS) is no longer used for tuna since the closure of state-owned enterprise Pt. Usaha Mina in 2003 and a private pole and line company, Pt. Keselamatan Cinta Bahari in 2005. Tuna landings and tradings are undertaken in the local fish markets in Sorong in Boswesa Market and Remu Market where tunas caught by handline are landed.

The fish port in Ambon and Tual are archipelagic fish ports (Pelabuhan Perikanan Nusantara) that serve not just the tuna purse seiners, longliners and pole and liners but also local and foreign trawlers operating in Arafura Sea. The fishing port in Ternate, North Moluccas has a coastal port (Pelabuhan Perikanan Pantai, PPP) that serve mainly small purse seine, pole and line, handline and troll line fleets.

There are three major infrastructure challenges to overcome: a) reform of air and sea transport to lower freight costs that is competitive with other countries, b) infrastructure support for export of tunas from the province through a locally placed laboratory and quarantine and inspection facilities, and c) storage facilities to cater to distant fishing grounds.

Figure 7.12. Above: A troll fisher from Sorong showing the kite used in fishing. On the background are two yellowfin tunas caught. Above right: two types of troll boats used in FMA VI. Middle: Samples of lures used in troll fishing. The jig-like structure is made up of three simple hooks tied together. Right; family picture of a troll fisher from Sorong, West Irian Jaya.Note the television and stereo sets on the background

Cost of transportation from North Sulawesi is more expensive compared with air and seafreight cost in the southern city of General Santos, in the Philippines (Table 7.17).

Tuna exports need laboratory certification which currently there are only four (only three are working during at the time of survey) for the whole country located in Surabaya, Makassar, Jakarta and Bali. During the survey, in laboratory facility in Makassar was ordered closed for upgrading.

In FMA-VI, tuna fishing is limited by the presence of buyers that have sufficient storage facilities to buy the tunas. While insufficiency of post harvest support may hinder fishing and therefore good for the stocks of tunas in general, the losses arising from post harvest handling is significant.

For traders, the lack of enough sufficient storage facility where the tuna fishery occurs is partly addressed by sending collecting vessels. These are large ships with large storage capacity that anchors strategically in the fishing grounds where boats dock to unload. But this do not address the issue of prices. Fishers who are not members of "plasma system" are forced to sell at prices dictated by traders and have low priority for their catch to be bought particularly at times of peak when there is not sufficient storage space.

The practice of loining at sea in Seram Sea is a practical solution to circumvent lack of storage space for catch and ice on board these tiny handline and troll line boats. The fish are of high quality that fetch better prices. Unfortunately, the prices of chilled loins have yet to improve over the prices of chilled whole fish. Loining at sea should become the standard practice in order to improve fish quality. The government needs to expand its market of loins for sashimi to get the most income. While fishers may want to loin at sea but buyers who have quotas to meet will accept only whole fish, a situation that could readily be addressed by the government.

Notes on the Economics of Fishing

The business aspect of fishing is a major part of tuna management to determine the economic performance of each fishing operation. However, because of limited time, this section provides a simplified cost and benefit analaysis of the tuna fisheries in FMA-VI. The cost expenditures would include initial investment and operational expenses while the revenue covers the sales revenue of the certain fisheries.

Pole and Line

There are two types of pole and line in FMA-VI namely the medium scale and the *funae-funae* which are small-scale in operation. The medium to large scale pole and liners are usually company owned, thus data on investment cost is difficult to obtain. Boat captains we interviewed did not possess or share this information.

Table 7.17. Comparison of freight costs for air and sea cargo between Indonesia and Philippines to different destinations. Source: Trandjrason 2006.

	Airfreight Cost (in US$/kg)		
Origin of Cargo	**Tokyo**	**Los Angeles**	**New York**
Manado, Indonesia	2.25	4.30	4.45
General Santos, Phil.	1.85	3.00	3.50
difference	0.40	0.70	0.95
	Seafreight Cost (US$/40ft container)		
Origin of Cargo	**Tokyo**	**Los Angeles**	**New York**
Bitung, Indonesia	5400	7800.00	8250.00
General Santos, Phil.	4500	5250.00	6000.00
difference	900	2550.00	2250.00

The cost of fishing operation is however available. Annual operational expenses per boat amounts to about Rp1.26 billion (depreciation cost not included), annual estimated gross revenue is about Rp1.46 billion making a net profit of Rp 200 million. This case study represents companies that have vertically integrated operation from fishing to processing plants, or partners of processing companies.

For the fleet based in Ternate, North Moluccas province, the initial investment was about Rp300.00 million for both the fishing boat (25 GT) and its engine (240 HP). Annual operational expense is about Rp1.44 billion. Estimated annual gross revenue from sales of the catch is around Rp2.07 billion.

Based on the foregoing simple calculations, pole and liners fishing in FMA VI, particularly by smaller vessels operating is still making profits from their fishing ventures. The profits, particularly the large vessels are not much and in fact, the Rp 200 million rupiah profit, if depreciation cost and taxes are included in the computation will simply be wiped out. They continue to operate because at a profit because of processing and export of products.

As fully explained in Chapter 14, several key strategies are employed by these vessels to address two key issues that beset the pole and line fishing operations. First is the acute shortage and therefore high prices of live baits. Fishers address this by using substitute baits which are available and cheaper. Using substitute baits are not as good as using anchovies. Another strategy is for fishers to fish for bait themselves by rigging their pole and line boats as mobile liftnet. The third strategy is to join the “plasma system” where a company brings together pole and line catchers with livebait fishers and fish buyers and cold storage operators (ship with cold storage). Becoming a member of the pole and line fleet under a company assures one a steady and ready supply of livebaits.

The second issue is the high price of fuel. The strategy employed is to stop the search for swimming schools and instead fish in fish aggregating devices. Large companies and vessels under the “plasma system” usually deploys FADs that its members could use. For those individual boats with no FADs, the vessels simply pay for the use of FADs, usually amounting to 10%-20% of catch. In many instances, no payments are made to the owners of FADs because there is no watcher.

Handline

For the handliners in FMA-VI who are members of a company’s operation, the fishing boats are provided by the company on loan basis but are paid back by the fishers mostly on a monthly remuneration basis. The terms however are not fixed and depend on the ability of the fisher to pay. The initial investment on the engine is about Rp1.9 million, the annual total operational expense is about Rp15.47 million. The estimated gross revenue from sales is about Rp53.04 million a year.

The instances of finding a Filipino fisher in FMA-VI (based in Mindanao, Philippines) is not uncommon that we took the effort of visiting these fishers in their port based in the Philippines. The initial investment on the mother boat (of 20 GT) including its two inboard engines (of 160 HP) in 2003 was about Php350,000.00 (~Rp55.35 million). At present the estimate of initial investment for the fishing boat of the same tonnage but with just one inboard engine of about 160-HP (year 2006) is about PHP1.0 million (about Rp184.07 million). Annual operational expense is approximated to be Rp255.50 million. The estimated gross revenue from sale is more or less near Rp554.70 million a year.

Troll Line

The troll lines in FMA-VI are called *tonda* and *layang-layang* if kites are used. Total investment for the fishing boat (<3 GT) of *tonda* in 2005 was about Rp6.0 million while the outboard motor (15 HP) in the same year was more or less near Rp12.5 million. The investment for the tonda fishing gear was approximately Rp500.00

thousand. The annual total operational expense for a daily trip of about 240 days is estimated at Rp113.47 million. Total gross revenue estimates from sales of catch for a year is nearly Rp169.78 million.

The *layang-layang*, on the other hand, outlay for the fishing boat (<3 GT) was Rp5.00 million while for the 15-HP outboard motor was Rp13.00 million. Initial outlay for the fishing gear was around Rp210.00 thousand. The total annual operational expenditure is not far off from Rp108.50 million. The estimate for the annual gross revenue from this fishing operation is roughly Rp1.75 billion. This type of fishing venture is obviously profiting based on the simple cost benefit analysis.

Issues and Challenges of tuna sector in FMA VI:

The main issues facing this management area are as follows:

1. There is a need to improve and strengthen fisheries data collection and management system by:

   a) Improving the quality through thorough review and validation of the species names. Stop the use of local names as these contain many species and are called differently depending on the origin of the fishers.

   b) Improving the collection system by increasing the number of sampling sites (e.g. Islands of Tidore, Bacan) and also to include private ports and wharves (e.g. Pt. Raja Ampat Canning), or better still, the collecting vessels.

   c) Segregating landings for tuna handline from the rest of handlines operating. Similarly, new entries may be needed for Vertical handlines now gaining popularity to catch small tunas in FADs and for kite fishing, a variant of troll line fishing.

   d) Increase and strengthen capacity for enumerators to be able to identify fish at the species level, identify and differentiate juveniles of each tuna species as these skills are crucial to analysing by-catch of juveniles.

   e) Improve capacity of enumerators for data storage, retrieval and warehousing of data. We observed low skills to operate spreadsheet software.

   e) The 2005 provincial statistics of northern Moluccas needs to disaggregate tuna into species level.

   f) Need to develop policy that will compel tuna industtry to comply with information required by government to include number, location of FADs and other relevant information.

   g) In many areas of Moluccas, loining of fish (see item 6 below) is already undertaken and fish are landed and sold as loins. Enumerators must be trained to identify species and back calculate the total weight of fish.

2. There is a dire need to improve access to data collected either through internet or availability through distribution on CDs. Easing up the protocol for request access to data is a good step forward.

3. There is a need to include information on origin of fish caught. Tunas caught in FMA-VI are landed in major ports with the FMA-VI (Bitung, Gorontalo, Bolaang Mongondow, Sorong) but a lot of vessels, particularly for troll line and pole and line fleet from Kendari bring and land their catch in their home ports. Similarly, it will be extremely useful if the information on tuna handline pumpboats from the Philippines and large vessels could be documented.

4. All fishing fleet from other parts of the country are sailing towards to FMA-V and FMA-VI as tuna fishing in eastern Indonesia remain profitable. Therefore, tuna fleets,

Skipjack and juveniles of yellowfin tunas are peddled in pushcarts in a night market in Ternate, North Moluccas.

big and small converge to this area. Sufficient infrastructure support is missing. This is particularly evident in minor landing areas in the islands where ice supply, storage facilities, transport service to and from major ports are lacking.

5. The government, both local and national should start dismantling subsidies to the tuna sector that distorts market and trade. In the FMA-VI, subsidies come in the following form:

a. Grants for small sized fishing vessels for tuna handline fishing complete with outboard motor provided by both local and national government;

b. Grants for insulated fish boxes given to traders and market vendors;

c. Fish aggregating devices (FADs) deployed for small scale fishers to use either free of charge or in very easy repayment terms;

d. Cheaper fuel prices;

The newly constructed auction hall at Sorong fishing port remain unused as fishers and buyers continue to trade on the wharf.

6. The quality of fish in FMA-VI is much better than those observed in landing areas in Java. The improvement in fish quality is probably private sector driven where fish traders provide the necessary support, in response to the slow reaction of the government, to set up proper infrastructure and capacity building programs to get fish quality they require from fishers. These private sector driven initiatives include:

a. Shortening the distance of fishing grounds to the storage facility through the use of collecting vessels. These collecting vessels are large ships (>500 GT) with large freezing capabilities that are anchored in areas easily accessible to the fishers.

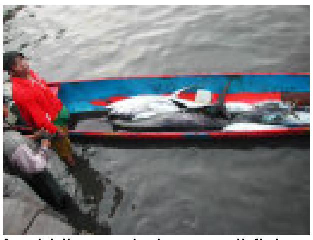
b. In remote areas such as the islands of Moluccas and Seram Islands, traders and companies provide the proper storage boxes which are insulated styrofoam boxes of proper sizes and with sufficient amount of ice.

c. In North Moluccas, lack of storage space on the handlines boats is overcome by teaching the fishers to do the quarter loining of the whole fish and proper storage procedure. This way, small boats are able to fish longer at sea, get a premium for selling loined fish (but see also 1g for repercussions on data collection).

7. Buying prices of fish remain very low in these areas because of two reasons: First, transport costs of tunas from source to export hubs (Jakarta, Benoa, Bali, Surabaya, Makassar) remain expensive as there is only 1 export hub in Bitung through Manado. Second, added cost of doing business due to corruption and extortion are passed on to the fishers in terms of lower prices.

8. Over-crowding, i.e, too many fishers fishing on a single FAD is fast becoming a problem. While solution is easily addressed by deploying more FADs, the impact of FADs on the environment as a marine debris, on the resources as it attracts juvenile tunas which contribute to overfishing problem, and on the environment as hazards to navigation should be carefully studied.

9. While fishing operation for all gears (except traditional pole and line called funae) remain profitable in FMA VI, catch rates of all tuna fishing gears are on the decline or signs of decline that manifest in increased distance of fertile fishing grounds.



A middleman helps a troll fisher sell his day's catch in a landing area in Sorong, West Papua.

10. Reform air and sea transport system to make freight costs competitive with neighboring countries (Philippines, Thailand).

11. Reform to facilitate export of tuna through provision locally of laboratory testing facilities and quarantine and inspection offices so that products need not shipped to export hubs of Jakarta, Bali, Surabaya and Makassar.

12. The tuna resources of FMA-VI is on the decline and this is a cause for grave concern. The need to put in place critical policies is necessary before the status of

resources reach a point of irreversibility. Some of the critical suggested policies needed for FMA-VI are as follows:

a. Policy regulating fishing effort, either in terms of controlling the number of fishing vessels/ gears operating in the area. Immediate steps is to recall the policy enjoining fishers to fish in eastern Indonesia.

b. Policy on regulating catch of juvenile tunas as well as other by catch that include sharks.

c. Policy regulating the use, deployment and siting of FADs.

d. Undertake a study to determine the actual amount of and impact of current subsidies on the tuna sector and recommend how this budget could be redirected to improve management of tunas.

e. A program of government aimed at improving post harvest handling particularly in building capacity for fishers to undertake loining at sea to maintain fish quality.

f. Reform support for tuna industry to focus on maintaining the health of resources through improved collection of information supported by research and development of manpower that will monitor the status of the fishery. There are less than 50 fisheries scientists all over the country working on the tunas and many of them undertake administrative rather than research activities.

g. Policy that seeks to improve and strengthen the role of the private sector in the management of the tunas through their cooperation in monitoring and even research.

The wharf turns into fish wet market. The fish in the foreground is an oceanic bonitor, *Euthynnus* sp.

Fish are transported and peddled to nearby villages using scooters.

FMA-VII: Sulawesi Sea and EEZ in the Pacific Ocean

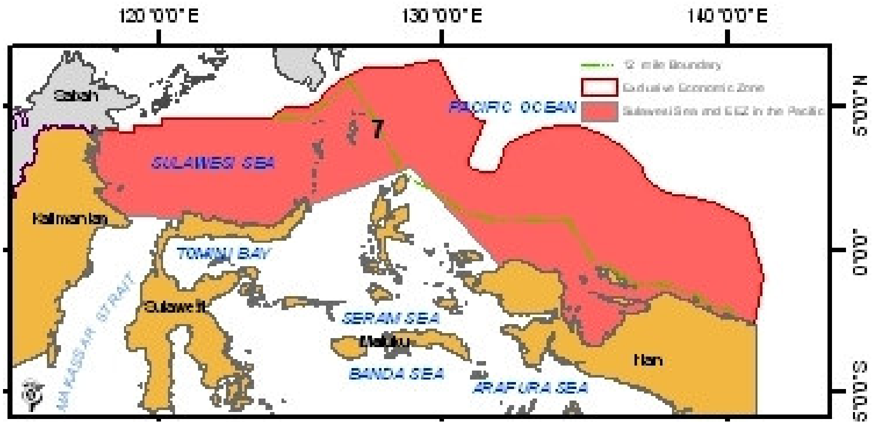


Figure 8.1 Geographic location of fishery management area seven (VII).

Geographic Scope

Sulawesi Sea and the Indonesian Exclusive Economic Zone along the Pacific Ocean constitute the breadth of Fisheries Management Area VII (Figure 8.1). Sulawesi Sea is a deep basin with an estimated area of 450,000 km^2. As a basin, it has two sills, the Sangihe Talaud group of Islands and the Sulu Archipelago which allow limited water exchange on the surface area. A deep passage through Makassar Strait is where water from the Pacific Ocean exits. Water depth averages about 4500 m and reaches over 6000 m along the southern extension of Moro Gulf in the Philippines.

FMA VII is very important in the fisheries management of Indonesia because it shares a common border with four other countries: with Malaysia to the west of Sulawesi, with the Philippines along the whole stretch of Sulawesi Sea and parts of the Pacific Ocean, with Palau Islands on the northeast portion and with Papua New Guinea to the east. Because of its location, the fisheries management of FMA VII faces more challenges not only on the local and regional fisheries matters but also from a wider suite of other challenges on piracy, illegal fishing, smuggling, pollution, climate change and other regional security concerns.

From the fisheries point of view, Sulawesi Sea together with Sulu Sea and Moro Gulf is a major spawning area of the tunas. Also, the sea corridors between Southern Mindanao and the Sangihe Talaud Island and the Sulu Archipelago are known “tuna highways”. Based on tagging experiments conducted, the yellowfin and skipjack tunas, along with large marine mammals and marine turtles, pass through.

Sources of data

This section rely heavily from three published sources: the Statistics of Marine Capture Fisheries by FMAs (DKP-WPP 2006) which covered the years 2000 to 2004, the Provincial Fisheries Statistics of the Provinces of Sulawesi Utara, Gorontalo, Maluku Utara and Irian Jaya Barat (for the years: 1986, 1990, 1995, 2000, 2002, 2003, 2004 and 2005), and from the results of our interviews at the following places: Fish market in Manado, Bitung Fish port (PPS Bitung), Bunaken Island, Fisherman's Training Center and the government offices of DKP. We utilized a lot of references in portraying the status of the fishery; specifically, we have used and re-analyzed catch rates from unpublished thesis studies of student from Sekolah Tinggi Perikanan. The data of Secretariat to the Pacific Commission (then called South Pacific Commission or SPC) was also analyzed to show the catch rates of specific fisheries, particularly for the longline and purse seine fisheries. The results of observer program of WWF for longline operating in FMA VII were also used.

With much effort, we have sorted the Provincial Fisheries Statistics of Sulawesi Utara to approximate the landings that belong to the two appropriate management areas which covers the province, FMA VII and FMA VI. The districts of Minahasa, Minahasa Utara, Sangihe, Talaud and the Kodya Manado (Manado Regency), and half of the regency of Bitung were grouped under FMA VII while Bolaang Mongondow, Minahasa Selatan and half of regency of Bitung belong to FMA VI (Table 8.1). Similarly for Irian Jaya Barat, districts were separated into three FMAs, and the districts of Manokwari and Wondrama were included within the FMA VII.

Limitations and assumptions

The separation of data of the Provincial Statistics of Sulawesi Utara attempted in this study did not involve the use of the statistical tables (e.g. LL forms) and therefore is just an approximation of the actual values. We did this to supplement data that is not covered by the capture fisheries statistics for fishery management areas (FMAs). Our aim in doing this step is to get an idea of the trend of gears as well as landings for each gear type.

To present the species composition of each gear and the share of tunas to total catch, we used the latest fisheries statistics of the Province of Sulawesi (2005). Its use is ideal because tunas are already classified up to species level. The data from observer program were used to describe the species composition and catch rates for tuna longline.

We attempted to come up with a realistic tuna production for this management area using catch data based on interviews and the carefully assessed number of fishing gears. We used a combination of values provided by interview respondents and use this information to weigh the validity numbers given in the statistics. When

Table 8.1. Provinces and local government units belonging to fishery management area seven (FMA-VII). Source: DKP-WPP 2006.

Province	District/ City/ Regency	Province	District/ City/ Regency
Kalimantan Timur	Bulungan	Maluku Utara	Halmahera Utara
	Nunukan		sebagian Halmahera Timur
	Tarakan		sebagian Halmahera Barat
	Berau	Papua	sebagian Sorong
Sulawesi Utara	Talaud		Manokwari
	Sangihe		Biak
	Kota Manado		Teluk Wondama
	parts of Bolaang Mongondow		Nabire
	parts of Minahasa		Yapen
	parts of Minahasa Selatan		Waropen
	parts of Kota Bitung		Jayapura
Gorontalo	parts of Kabupaten Gorontalo		Kota Jayapura

high discrepancy arises between published and those given by respondents, we used the value given by respondents pertaining to the immediate area where the respondents feel comfortable with the estimate.

We did not include the sword fish, marlins, sailfishes and seerfishes in the analysis as data are highly contaminated by catch from non-tuna fishing gears.

Tuna Landings

Total fish landings from FMA VII is 195,763 tons in 2004 of which tunas account for 106,685 tons representing about 55% of the total fish output (Figure 8.2). The tuna output of 2004 is 2.7 times the recorded tuna landings in 2000. The share of tunas relative to the total fish production likewise increased from 27% in 2000 to 55% in 2004 (Fig. 8.2). Such trend suggest a shift of fishing activities to the tunas, probably lured by the high returns and the dwindling nearshore resources which compel fishers to make the shift.

The provinces of East Kalimantan, North Sulawesi, Gorontalo, North Moluccas and West Irian Jaya contribute to production of tunas to FMA VII in varying degrees (Fig. 8.3). Between the period 2000 to 2004, tuna production increased by 32%, generated by large tuna landings from Sulawesi Utara (262%), Kalimantan Timur (61%) and Maluku Utara (38%). However, contribution of West Irian Jaya over the same period dropped significantly by 67% (Fig 8.3).

Tunas, prior to 2004, were conveniently grouped into generic categories as small tunas, large tunas and skipjack tuna. Using this classification, large tuna landings grew by 37% from 2000 to 2004 period when its share to total tuna production similarly increased from 35% to 48% at the expense of small tunas which landings decreased by 63% (from 17% down to just 6%). Skipjack tuna remained at about the same level, accounting for half of total tuna landings (Figure 8.4). This result suggests an important development: a shift in target species for the larger market species, presumably generated by high demand for fresh tuna largely caught by simple handline and troll line fisheries. And because the large tunas, together with shrimps, are better monitored than all the fishes partly explains the significant rise in the share of tunas relative to the overall fisheries production.

Tuna species

Based on landings for FMA VII, nine species of tunas are landed in significant quantities. These are the yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*),

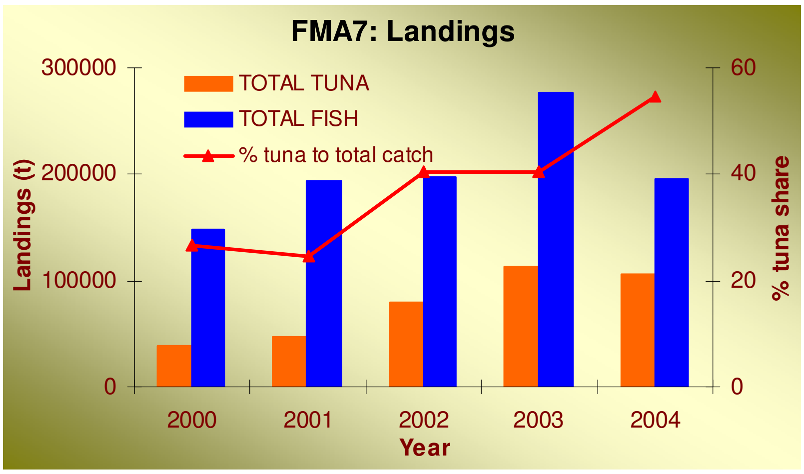


Figure 8.2. Fisheries production, total landings and share of tunas to total fisheries production for fisheries management area 7 for years 2000-2004. Source: DKP-WPP (2006).

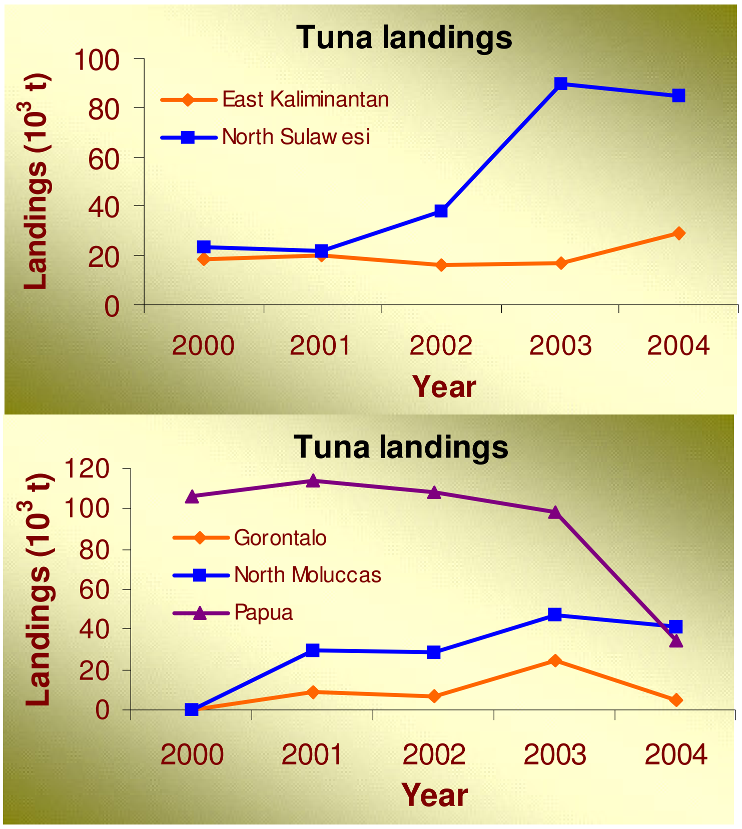


Figure 3. Landings of tuna by provinces from 2000-2004. Source: DKP (2006). Note the decline of tuna productin from Papua.

longtail (*Thunnus tonggol*), albacore (*Thunnus alalunga*), skipjack (*Katsuwonus pelamis*), eastern little tuna (*Euthynnus affinis*), bullet tuna (*Auxis rochei*), frigate tuna (*Auxis thazard*), and striped bonito (*Sarda orientalis*).

Share of landings of each species show that skipjack accounts for half of the landings (47%), yellowfin tuna a quarter (26.2%), and long tail tuna with 8.26%, bigeye tuna with 7.21% and albacore with 5% (Table 8.2). This data set also show two interesting entries: the significant quantities of longtail tunas (*T. tongkol*) and the large share of eastern little tuna (6%). From our extensive travels around Indonesia, there were only two other places where *T. tonggol* were observed in the markets, in Surabaya, eastern Indonesia and in Pangkalpinang, Bangka Belitung province. In contrast, we rarely observe eastern little tuna in the markets and we believe that the ELT entry probably are bullet tunas (*A. rochei*) which abound in all markets and landing areas in this area (Table 8.2).

There are no reports of blue fin tuna from the statistics but the species composition of longline vessels landing in Bitung and Davao, Philippines, based on the results

Fleets of small purse seine docked alongside handline boats in fishing port in Bitung, North Sulawesi.

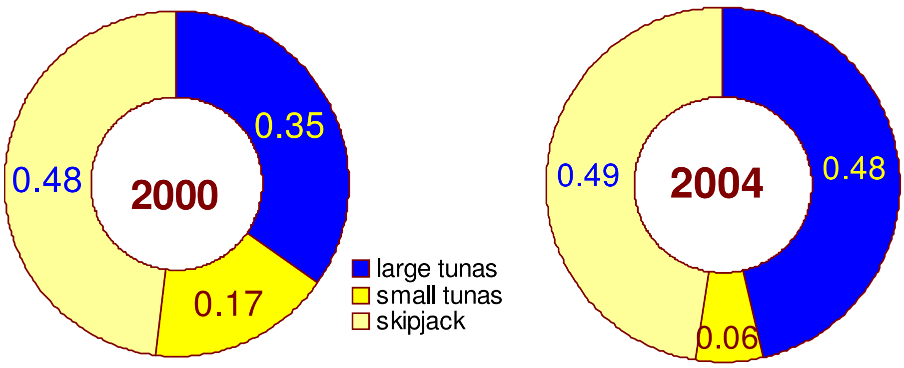


Figure 8.4. Share of major tuna groups to total tuna production.

Table 8.2. Landings by species of tuna in FMA VII. Prior to 2004, tunas were grouped into three coarse categories of large tunas, small tunas and skipjack. Legend: weights in metric tons. Question mark on entries for 2004 are doubtful entries Source: DKP 2006.

<table>
<tr><th>Species</th><th>2000</th><th>2001</th><th>2002</th><th>2003</th><th>2004</th><th>%</th></tr>
<tr><td>Yellowfin tuna</td><td rowspan="4">13690</td><td rowspan="4">16159</td><td rowspan="4">25658</td><td rowspan="4">38024</td><td>28737</td><td>26.2</td></tr>
<tr><td>Bigeye tuna</td><td>7899</td><td>7.21</td></tr>
<tr><td>Longtail tuna</td><td>9052</td><td>8.26</td></tr>
<tr><td>Albacore</td><td>5254</td><td>4.79</td></tr>
<tr><td>Skipjack tuna</td><td>18919</td><td>25298</td><td>37920</td><td>54808</td><td>51942</td><td>47.4</td></tr>
<tr><td>Eastern little tuna</td><td rowspan="4">6756</td><td rowspan="4">6123</td><td rowspan="4">16214</td><td rowspan="4">19428</td><td>3801</td><td>3.47</td></tr>
<tr><td>Bullet tuna</td><td>?</td><td></td></tr>
<tr><td>Striped Bonito</td><td>?</td><td></td></tr>
<tr><td>Frigate tuna</td><td>2935</td><td>2.68</td></tr>
</table>

of WWF observer program, accounted 33% of the catch are northern bluefin (see species composition of longline).

Tuna Catch Estimate for FMA-VII

Based on our estimate, tuna catch of FMA VII is 455.5 thousand tons (Table 8.3). This figure is almost three times (2.91) the tuna landings reported for FMA VII in 2004. How this estimate was arrived at is discussed in detail below.

Our tuna catch estimate relied heavily on the operational catch and effort data collected from interviews which represent conditions in 2006, the time when the interviews were conducted. In the estimation of catch and catch rates, we have used the lower limits of values given by respondents, incorporated the zero catch in computing for the averages, separated the catch rates between the peak and lean seasons and used the corresponding number of fishing days for each season. For tuna longline, troll and handline, catch were expressed in numbers and these were converted into weights, using mean weights of fish as estimated by fisher. [Note that experienced tuna handline fishers could estimate length and weight with high degree of accuracy]. Actual fishing days (excluding travel time to and from port of call) were used in the computation. Also considered was the shift in use of fishing gears from single-hook handline to multiple-hook handline fisheries.

In addition, separate categories were made for small, medium and large sized fleet for both purse seine and pole and line. Likewise, handlines are presented separately which included Philippine pumpboats operating in Indonesia.

Why is the discrepancy so large? One of the possible reason is the inadequacy of current tuna catch monitoring systems. As Proctor (2007) already enumerated, there is a need to expand monitoring sites to include private wharves, mainly large processing plants where bulk of tunas are landed. Much of the shortcomings in data collection is found in Papua where smalle scale fisheries for tunas (handline, troll line) in Cendrawasih Bay and vicinities are undertaken. There are the "collector vessels" or cold storage ships where catch are directly delivered and then brought elsewhere for further processing. Some of these ships actually sail directly to Japan or to other destinations. Another big reason is that our estimate include the small tunas which are not fully monitored by the current data collection system.

One of the interesting entries in Table 8.3 is the very high catch rate of small-scale purse seine during the peak months. The value of 5 tons per day fishing (of the small-scale purse seiners) is approximates catch rates for the medium sized and the large sized vessels. The reason for this is that these small purse seine fleet operates exclusively on FADs and goes fishing only if the estimated volume of fish

Table 8.3. Estimateof total tuna catch from fishery management seven (FMA-VII). See explanation below for different operational parameters used. Figures on each cell refers to footnote numbers both at the column and rows.

Fishing Gear Type	No. gears 2004[1]	no of gears used [2,3]	total fishing days/yr [4] or trips/year [5]	annual catch/ unit (mt)	Est. total fish catch (mt)	% share of tuna	Est. tuna catch (mt)
Purse Seine (>30GT) [2,4]		41	168	1,512	61,992	0.970	60132
Purse Seine (15-30GT) [3,4]	690	25	143	94	13,385	0.833	11150
Purse Seine (<15 GT) [4,5]		300	72	240	72,000	0.500	36000
Pole and Line(>15 GT) [2,4]	3163	300	237	488	146,460	0.805	117900
Pole and Line(<15GT) [2,4]		60	136	41.0	2,458	0.976	2399
Troll Line [1,3,]	11918	2394	240	89.3	213,880	0.721	154207
Tuna Longline [1,5]	982	107	11	162.2	17,352	0.805	13969
Simple Tuna Handline [2,4]	26147	1000	225	31.6	31,560	0.800	25248
Other handline [2,4]		1090	103	28.2	30,771	0.100	3077
Phil.-based pumpboats [2,3]	1500	600	120	57.0	34,200	0.920	31464
TOTAL							**455546**

[1]/ based on aggregate number of gears for North Sulawesi and Papua provinces for 2004
[2]/ estimate given by boat captain of carrier operating in the area
[3]/ number of annual fishing days
[4]/ number of trips per year
[5]/ during peak season, vessels operate only when fish quantity in FADs >5 tons, # of operation is 40 times during the peak season

aggregate in the FAD is >5 tons or more. The information is provided by the FAD guard or owner. This fishing practice results in very high catch rates and highly reduced fishing trips, providing a serious challenge for fisheries scientist on how to incorporate fishing effort of FADs (see also Chapter 13).

Generally, we feel that this tuna production estimate is still an underestimate as the contribution of fleets operating from East Kalimantan, Minahasa and other areas were not considered. Furthermore, the by-catch of other gear such as drift gillnet, set longlines and liftnets were not included in the estimates for lack of sufficient data.

From this study's estimate of tuna production (Tab. 8.3), the purse seine catch account for 23.6% of total tuna production, troll line contributes 33.9%, pole and line 26.4%, handline 13.1% and 3.07% for the longline. These foregoing results showed changing scenarios in the tuna sector of FMA VII. These are:

1. Change in the structure of the tuna fleet. The troll line fleet, a small-scale fishing operation, is the dominant fishing gear, accounting for 33.9% and has overtaken traditional fishing, large-scale fishing gears such as the pole and line with 26.4% and purse seine with 23.6%. The longline catch represent a mere 3%.
2. The growing significance of the small scale fisheries sector. Small scale fishing gears (handline, troll line, mini purse seine) has overtaken the large-scale fishing operations in terms of tuna landings accounting for 55% of the tota (Table 8.4)l.
3. Similarly, large tunas, the backbone of the luxurious sashimi market are caught mainly by small scale fishing gears, particularly the handlines where this sector's landings account for 80%. This is a surprising result and confirms that the major source of tunas for fresh, frozen loin and steaks are now from the handline and troll line fisheries. The longline fleet operating in FMA VII supply just around 20% of the large tuna catch.
4. Small tuna production is shared almost equally by the large scale and small scale tuna fleets, a changing development where it used to be the domain of the purse seine.

Table 8.4. Share of small-scale and large scale sectors in the production of large and small tunas. Data based on Table 8.3.

Sector	Tuna Production (t)	%	Large tunas (t)	%	Small tunas (t)	%
Small-Scale	252,395	55.4	56,810	80.3	195,585	50.8
Large-Scale	203,151	44.6	13,969	19.7	189,182	49.2
TOTAL	455,546		70,779		384,768	

Fishing Gears

There are 13 different fishing gears operating in FMA-VII that catch tunas. Of these, only pole and line, tuna longline and troll line catch tunas exclusively (Table 8.5). The rest of the gears catch tuna as by-catch. But data as presented in Table 1 do not reflect the true share of tunas per gear because of "lumping effect" brought about by generic classification of gears rather than by target species. This is true for purse seine, handline and to a certain extent drift gillnets. For instance, large purse seine fleets based in Bitung but operates in the archipelagic waters and EEZ target mainly the skipjack tunas while many of the small purse seine fleet pursue small pelagic fishes such as roundscads, Indian mackerel and ox-eyed scad. The tuna handline fleets also go after the large tunas seeking shelter in the fish aggregation devices FADs.

For 2005 in Sulawesi Utara show there are five fishing gears whose cumulative catch accounts for 95% of the total tuna production (Table 5). These are the pole and line, purse seine, tuna longline, troll line and handline with the first two gears accounting for 65%. Interestingly, four of the five major tuna gears belong to the hook and line type of fishing method.

But comparing these rankings with those based on estimates presented in Table 3 showed very little agreement. For one, the tuna handline which account for 13% and troll line with 34% from our estimates accounts for just 4.5% and 17.2%, respectively. The reason again is the insufficiency in the monitoring of the catch of small-scale fishing gears which are landed outside the data monitoring areas.

Table 5. Tuna output and share by gear types for the province of north Sulawesi for 2005. Data presented is not separated by FMA. Source: DKP Province of North Sulawesi, 2006.Note: there is a big difference in share of tunas for each gear as presented here and those used to compute values in Table 3 which is based on operational values from interviews.

Gear Type	Gear number	total fish landings (t)	total tuna landings (t)	% tunas to total fish	% share of gear to total tuna landings
Pole and Line	308	44925	44728	99.6	33.3
Purse seine	427	73889	43677	59.1	32.5
Troll line	2394	23871	23162	97.0	17.2
Tuna longline	107	15210	15096	99.3	11.2
Other handline	3271	13883	6026	43.4	4.50
Beach seine		4915	1307	26.6	1.00
Encircling gillnet	449	362	133	36.8	0.10
Non-tuna longline	780	626	106	17.0	0.10
Scoop net		195	89	45.6	0.10
Handline	2066	983	72	7.34	0.10
Drift gillnet	1112	5594	57	1.02	0.00
Set longline		12	8	63.9	0.00
Pelagic Danish seine	96	2217	7	0.30	0.00
TOTAL		191922	134469	70.1	100.0

The Tuna Fishery in Sulawesi Sea and Pacific Ocean

Purse Seine Fleet

What is presented in the section is a brief history of the purse seine fishery for Sulawesi Sea and Pacific Ocean. In addition, we presented the conditions and situations in the area and limited the description of each fishing fleet to those that differ from the rest of the Fisheries Management Areas.

In Sulawesi Sea, purse seine fishing was started by Philippine fleets as early as 1982 (Aprieto, 1995, Resma, 2004). It started with single boat seining searching for unassociated fish schools. The use of group seining technique probably began in Sulawesi Sea in the 1990's with the use of anchored FADs as a technology, supported by light boats and probe boats. Some progressive fishing companies, completely private-sector-driven without intervention of the governments, undertook the initiative called "joint venture agreements or JVAs". This "JVAs" was entered into with "Indonesian companies" for "chartering" agreements and was the very popular mode of getting fishing access in Sulawesi Sea. However, this practice actually circumvents existing fisheries policies on export as well as reporting requirements.

Parallel to this development, the tuna handline fishers from the Philippines started to fish in Sulawesi Sea, without any permits or license to fish, following the purse seine fleet by utilizing, free of charge, the anchored FADs deployed by the purse seine companies. The proliferation of FADs and rampant illegal fishing activities prompted serious complaints from Indonesian fishers. The Indonesian government finally acted on the matter with the issuance of Decision No. 508 in 2000, deregulating the fisheries sector. This policy put to stop any "chartering agreements" and led to the arrest of many illegal fishers and confiscation of fishing boats and gears.

This development forced the Philippine government to address the situation and negotiated fishing access agreement with Indonesia. On January 10, 2002, a fishing access agreement was signed by the two governments that allow Philippines fishing companies' access to fish in Indonesian EEZ of Sulawesi Sea, Pacific Ocean and Indian Ocean. The agreement specifies the use of the purse seine and longline fishing, and depending on size of vessels, would operate on specified distance from the shore using the archipelagic baselines of the country. Table 8.6 specifies the total number and total tonnages.

What the agreement failed to include was the access of the tuna handline fishing fleet from the Philippines. The reason for its exclusion was due to the stiff opposition by Indonesian fishers and organized fishers groups. This fishing access agreement was, however short-lived due to change in Indonesian fisheries policy that led to unilaterally cancelling all existing fishing agreements to give way to a new policy. Fisheries policy No. 6 of July 2004 would help boost the countries' fisheries sector, particularly focusing on the development and strengthening of the tuna fisheries. Under this directive, foreign companies need to have land-based investments (e.g. processing, storage), re-flagging and re-manning requirements of fishing vessels. To date, it is estimated that a total of 24 catchers from the Philippines have taken this offer.

Fishing Fleet

The exact number of large purse seine vessels is not known but the Province of Sulawesi Utara listed 22 units of ships with 100-200 GT class and another 21 boats with gross tons over 200 GT class, all but two are based in Bitung, Sulawesi Utara. These we assumed are all catcher vessels. Some of the vessels operating in the Indonesian EEZ are probably the largest ships operating in the Indonesian fishery with a handful of the ships belonging to the super seiner class of >500 GT but operating in several countries (e.g. PNG, Vanuatu).

Table 8.6 Number, type of fishing method and total tonnage of allowed fishing vessels to fish in Indonesian EEZ by Philippine fishing companies. Source: Resma, 2004

Fishing Method	Type of vessel	No. of fishing vessels	Total Tonnage of vessels
Group seining	Catcher	75	22,000
	Light Boat	300	15,000
	Carrier	150	40,000
Single Seining		10	8,000
Longline		20	4,000

Fishing Grounds

Over the years, the fishing ground of the large purse seine fleet has moved from west to east and at present seldom operate in Sulawesi Seas. Most of the large purse seine fleets operate in the area west of Sangihe Talaud group of islands (western-most fishing ground) and the main fishing ground is eastwards within the 0° to 3° N latitude and 124° to138° E longitude.

The medium and small-sized vessels operate in Sulawesi Sea; mainly those based in Manado fish just around north and north east of Bunaken Islands, while only a few boats based in Bitung on opportunistic basis, travel to FMA VII to fish. As a rule, most of the vessels based in Bitung operate in FMA VI, particularly in Moluccas Sea due to distance considerations.

Catch Rates

The catch rates provided by respondents for large purse seine fleet were computed to be about 9 tons per set which includes zero values due to operational hitches because of bad sea conditions. Using data in Table 8.7, the average catch per set in the Indonesian EEZ has dropped from 21 tons/set while in the Sulawesi Sea, from 12.1 tons/set in 1999 it decreased to just 9 tons/set. These represents a 57% and 25% drop in catch rates over the last seven years in the Pacific Ocean and Sulawesi Sea, respectively.

Medium and small-scale fleet

The medium sized purse seine vessels range from 10-35 GT, propelled by either inboard engine (for vessels > 25 GT) or 4 to 5 units of 40 Hp outboard motors. The small size vessels have between 6 to10 GT and usually have two units of outboard engines.

The statistics does not discriminate between types and number of vessels; hence there is no record on the exact number. The fisher respondents place the total number of medium and small-scale purse seine ~1,000 units for the whole province of Sulawesi Utara, with 300 units based in Bitung alone, 80 units in Manado and the rest are scattered around the other the different landing centers.

Fishing technique

The small vessels are day boats; leaves port between 4 to 8 pm and travels to the fishing for about 1 to 2 hours. They operate on FADs 70% of the time and uses light boats to extricate the fish from the FADs. The light boats are small in-board motorized plank boats (<1 GT) with outriggers. It uses either 4 or 5 pieces of pressurize kerosene lamps or four pieces of 200-watt lamps generated from a 15 Hp generator. During each operation, number of hauls could vary between 1 to 5 hauls depending on the catch and sea conditions. During the dark phase of the moon and depending on the season, they do not use FADS and simply use light boats to attract the fish.

Table 8.7 Catch rates and averages of historical data on purse seine fishing in the Indonesia EEZ in Pacific Ocean (PO) and Sulawesi Sea (various sources). Legend: numbers in parenthesis refer to the number of sets.

Sources	year	fishing ground	mean catch tons/set FADs	mean catch tons/set Non-FADs	Remarks
Large Purse Seine					
Sugiyono	1999	PO EEZ	11.59 (9)	11.93 (8)	no zero sets
		PO EEZ	9.49 (32)	16.56 (4)	w/ 5 zero sets for FADs, 1 for swimming schools
Muis, Abdul	1999	PO EEZ	31.25 (90)		37 sets long:137E-140E; lat: 0-2N
Ikhsan, M	1999	PO EEZ	27.36 (14)		zero set =3 and locw catch = 3 due bad weather
Watung	1999	PO EEZ	13.8 (41)		c(max)=96 tons/set
Sujiyanto	1999	Sulawesi	13.44 (35)		March-May; 9 sets>20 tons
AVERAGE Catch (Pacific)			**20.99**	**13.5**	**sets = 221 (FAD) sets =12 (freely swimming)**
Sakroni	1998	Sulawesi		16.9 (5)	Dec-98
	1999	Sulawesi		25.6 (21)	Jan-May
Nugraha, E	1999	Sulawesi	14.37 (14)		February: zero set=1
	1999	Sulawesi	8.89 (16)		March; zero sets=3
	1999	Sulawesi	9.98 (13)		April; zero sets=2
	1999	Sulawesi	9.61 (10)		May; zero set=0
Tonimba	1997	Sulawesi	14.48 (31)		February to May
AVERAGE Catch (Sulawesi)			**12.1**	**23.9**	**sets=84 (FAD) sets=26 (freely swimming)**

The medium sized boats operate exclusively on the FADs, and with skiff boat to help set and stabilize the position of the catcher boat. This fleet undertakes 2-days trips as travel time to fishing ground is about 12-15 hours. Lighting commences at midnight and setting of net starts at around 5 am. These boats bring ice on board.

As noted earlier, a growing number of small boats partner with FAD owners/operators and fish only when the required quantity (of fish in FADs) is present. This is why some small vessels have very high catch rates as the precondition for emptying the fish in FADs on a sharing basis (50-50) should be >10 tons.

Species Composition

As revealed by results of the interviews, the *pajekus* target the tunas; hence 85% of its catch consists of bullet tunas (30%), small skipjack called "*mesang*" (30%), juvenile yellowfin and bigeye (15%) and other small pelagic fishes (roundscads, sardines, bigeye scad) 15%.

The smaller vessels tend to differ slightly in its species composition: roundscads (40%), bullet tuna (30%), skipjack (10%), sardines and Indian mackerel with 20%. Such differences probably arise from where the two fleets operate; the small fleets are mainly coastal (20 nm) and could not go far while the medium sized fleet operates in FADs as far as 100-150 nm.

Comparing these results with a study conducted 10 years ago (Jabbar 1998), that over a 10-year period, significant changes in the species composition happened where the catch composition of mini purse seine used to be roundscads, accounting for 60-80% and other small pelagic fishes (Table 8. 8). Small tunas (bullet tunas and skipjack) were not even listed. Species replacements could be happening. At the time of the study, Jabbar (1998) mentions of a "roundscad "*malalugis*" crisis where the population is headed for a collapse (Fig. 8.5).

Tunas are graded as class A for export, B for canning and C and D as rejects. Class C & D are often what is sold in the wet market.

Table 8.8. Species composition of mini purse seine catch (%) in Sulawesi Sea based on landings of purse seine mini fleet in Aartembaga, Sulawesi Utara. Source: Jabbar (1998).

Species Groups	1994	1995	1996	1997
Roundscads	84.4	63.4	69.8	85
Bigeye scad	4.2	1.3	2.4	2.2
Anchovies	2.9	7.6	0.2	0.9
Sardines	5.7	12.3	23.9	10.9
Fringe-scale Sardines	1.3	8.2	1.1	1
Indian Mackerel	1.6	7.1	2.6	0
Total catch (t)	263.4	157.9	226.8	184.8

Catch rates

Current catch rates of medium scale purse seine averages about 6.5 tons per fishing day during the peak season (west and south season) to 2.6 tons during the east season. The catch of smaller boats averages 5-10 tons per fishing day during the peak season and 1.25 tons per day during the lean season. The unbelievably higher catch rates (higher than medium purse seines) are the result of sharing system now practiced between the boat and the FAD owner. The precondition for the boat to empty the FAD is a minimum guaranteed quantity of fish to be >5 tons. The catch (not the sales) is split equally. This practice limits the annual fishing days to 72 days in a year, of which 40 trips are made during the peak season.

Catch rates of the rest of the fleet have been falling since 2000. Owners and fishers of the medium size purse seine fleet describe catch rates in 2006 as just 50% of 2000 levels and, that catch >10 tons per set has become very rare (1-2 times/yr) compared to a weekly occurrence before. For the small vessels that regularly fish, catch now is just 40% of 2000 levels.

Declining catch rates have been recorded even before 2000. The study of Jabbar (1998) shows the collapse of the roundscad fishery in Sulawesi Sea where catch rates fell from 5.23 tons/day in 1993 to <1 ton/day in 1997 (Figure 5). This could explain the probable succession of small pelagics, i.e., the upsurge of small tunas at the expense of roundscads.

Pole and Line

The Fishing Fleet

Pole and line fishing was probably introduced by Japanese fishers in Sulawesi around 1918 (Naamin and Gafa 1998) to supply the raw materials for smoked fish (*Katsuobushi or ikan kayu*).

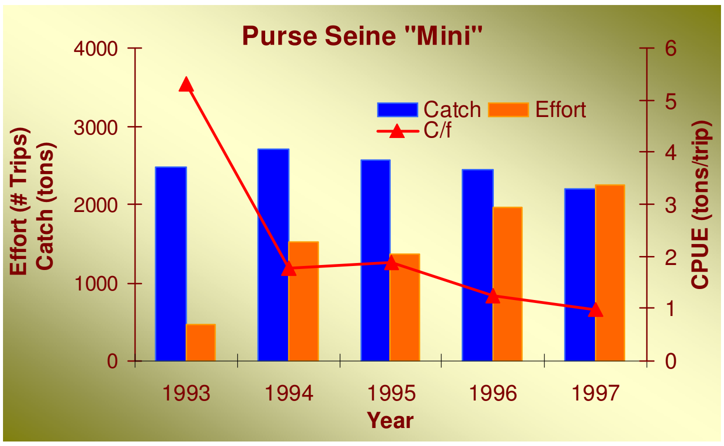


Figure 8.5. Catch, effort and catch per effort trend for the mini purse seine mini roundscad fishery of Sulawesi Sea from 1993-1997. (Data drawn from Jabbar,1998).

The fishery first developed in north Sulawesi with centers in Bitung, Gorontalo, Kemah and Manado (Naamin and Gafa 1998) and in Kendari, Southeast Sulawesi. From there, the pole and line fishery spread to the rest of east Indonesia (Ternate, Ambon, Sorong, Kupang, Maumere).

The fleet consisted of two sectors, the small scale boats called "funae or funai" that operates on the coastal areas and the large scale fleet called "huhate".

Large Scale Fleet

The boats belonging to this category range between 30-95 GT and have been classified during the early development of the fishery as industrial/government boats (10-30 GT) and industrial joint-venture boats of 85-95 GT class (Uktolseja,1978). The reason for this classification was to encourage the development of the fishery. Therefore, the first fishing *huhate* company is the government-owned P.N. Perikani Aartembaga based in Bitung that started operation in 1967 after being established in 1966 (Uktolseja 1978). Similarly, two large vessels under the industrial joint-venture operated from Ternate, Province of Maluku Utara.

The state-enterprise, P.N. Perikani Aartembaga represents the history of the pole and line development of eastern Indonesia. Operating initially with 12 units of 30-GT vessels in Bitung, the number increased to 20 vessels in 1979 and since 1980 with 30 vessels (Naamin and Gafa 1998).

By 1990, the private sector started investing in the business, albeit slowly that resulted in the number of fishing vessels grow to just below100 units. Massive buildup of fleet was observed in 2003 the number of fleet doubled in 2004 with 258 and rising by another 50% in 2005 to 388 units.

The increase in the number of boats is generally accompanied by an increase in the gross tonnage (Gafa et al, 1993, Rawlinson et al, 1998) of boats to provide larger holding tanks for live baitfish storage – a strategy to cope up with the perennial problem of bait shortage (Figure 8.7). The larger boats also allow longer fishing days.

As practiced today, many of the pole and line vessels undertake 3-day trips during the peak season from June-August and undertake 7-day trips during the lean months from September to May. This is a significant change from the usual day boat operation. These operational changes suggest low production and growing distance of fishing grounds.

Fishing Grounds

The fishing grounds of pole and line in FMA VII is determined by location of fish aggregating devices. For fleet based in Minahasa Utara and Manado, FADs are located in Sulawesi Sea fronting their sea areas. Those fishing fleet operating out of Bitung port, the location of FADs are on the east and west of Sangihe group of islands, off Lembeh Island, and vicinity of Bangka Island. There are few enterprising vessels based in Bitung who fish around Talaud Islands but the distance to port and very often, the sea conditions limit fishing opportunities. Generally, the fishing grounds as located on the map by our fishing boat captain respondents are between 2° to 3.5° N Latitude and 123° to 127° E longitude.

Pole & line boat docked at the fishing port in Bitung, North Sulawesi.

Another important consideration for fishing ground identification is the location of the source of bait (see Chapter 10: Bait Fisheries). Fishing ground should be located within the or near the source of baitfish. Baits are sourced from the liftnet (locally called *bagan*) fisheries which operates in the coastal areas, near coves, bays and embayments. Many of the pole and line vessels spend 1 to 3 hours travel (~10-25 nautical miles) from source of baitfish. However the large boats with large holding tanks for baitfish could travel greater distances and carry baits to last for 2 to 3 days fishing operation.

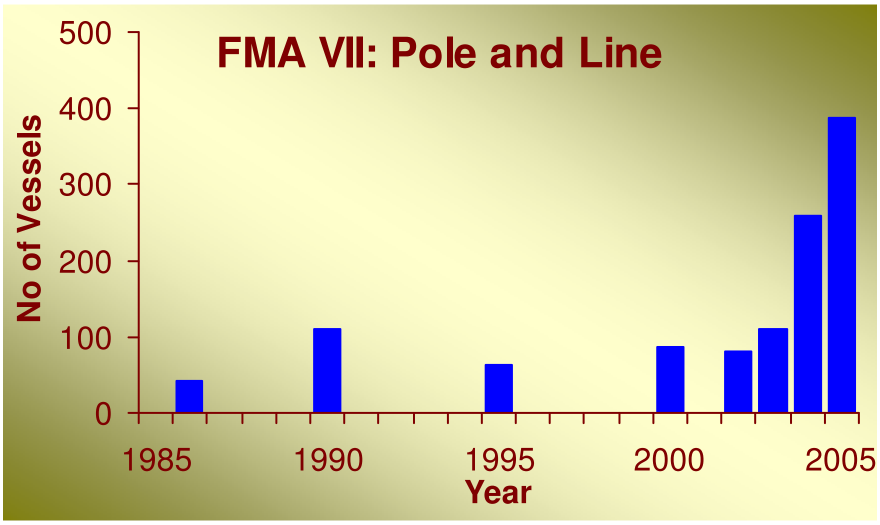


Figure 8.6. Trend in the number of pole and line vessels based in FMA VII. Source: North Sulawesi Provicial fisheries Statistics (1986-2005). Data used to separate by management area include gears from districts of Minahasa, North Minahasa (2005), Sangihe, Talaud, City of Manado and half the numbers from City of Bitung. The entry of gear number for 2002 for Minahasa was changed from 234 to just 23 as probably a typo error as the number of gear which is the same number for the next year.

Small-scale pole & line boat called funai off the shore of Bunaken Island, North Sulawesi.

Fishing technique

The pole and line boat leaves early morning (3-4 AM) to collect baitfish from the lift nets. This entails travel between 1-3 hours depending on the distance and sea conditions. The boat then travels to the FADs to fish for another 1 to 3 hours. Upon reaching the FADs, fishing commences by simulating schooling fish by spraying water and releasing the live baits. Fishers on prow of boat commence fishing using hooks with lures. The length of fishing generally last for 1 to 2 hours and depends on abundance of fish and more importantly how long the supply of baitfish lasts. Thereafter the boat heads back to port or collecting vessel to deliver the catch.

Traveling time depends on the boat's port of call. A boat from Bitung making a 3-days or a 7-days trip travels between 6-18 hours to reach the fishing ground of baitfish and use this as a temporary base of operation. Every morning after getting supply of baits, the boat would head for the FADs, stay for 1 to 2 hours and return back. Boats bring ice with them (about 300 blocks for 3-days trip) if there are no

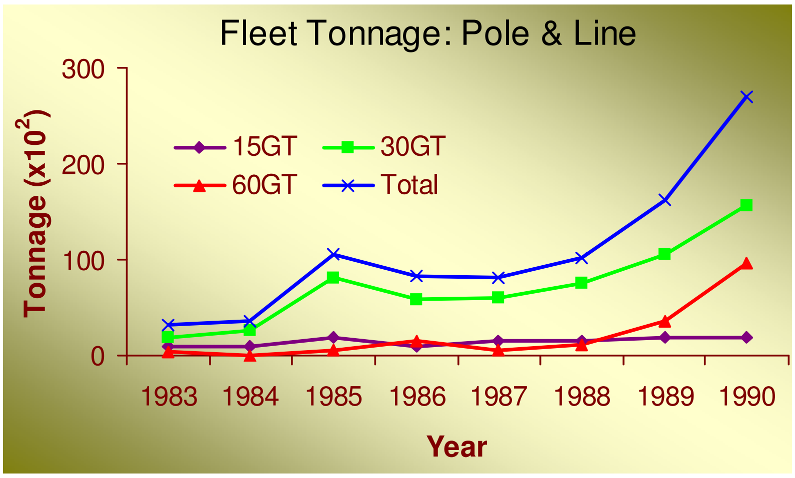
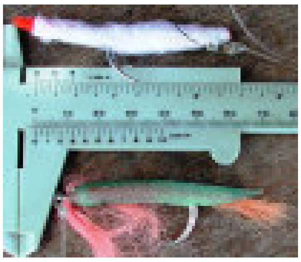


Figure 8.7 Increase in vessel number and total tonnage of pole and line vessels in Sulawesi sea. Redrawn from Table 1 of Gafa et al, 1993.



Barbless hooks with lures attched as used in pole and line fishing.

collecting vessels to pick up the catch. Sometimes, depending on the decision of the owner, they simply sell their catch to buyers nearby.

Live Baits

Pole and line fleet operating in Sulawesi Sea suffer also a chronic shortage of live baitfish since its development. The fleet adjusts two ways: by staying close to the source of bait and making special agreement with the lift net owners (or through a company) or each vessel gears up to fish for their own baitfish.

As the demand for baitfish increases for human consumption and for the pole and line fishery, the price of anchovies likewise increases. As a result, the live baitfish forms a significant part of the operating cost. An 80-GT boat utilizes about 50-60 containers called "*ember*" of live bait per day which cost about IRP 30,000 (US$ 2.88 @ 10,400/dollar, IMA Asia 2005). For a 3-day trip, each boat invests in about US$480 (Rp5 million) for baits alone.

The bait becomes prohibitively expensive that its direct consequence is the redirection of protein going to production of tunas instead of human consumption. The operation of pole and line therefore competes for food sources and its fishing operation could be compared with aquaculture using fish to produce fish.

Fish Aggregating Devices (FADs)

Pole and line companies has, since 1984, started to fish in FADs resulting in higher catches and reduced operating cost (see Chapter 7). Recently however, pole and line vessels fish exclusively in FADs. This is brought about by the declining sightings of free schools and large overhead costs in searching for unassociated schools (see Chapter 13: Other Management Considerations).

But FADs are also expensive to build, set and maintain. In Sulawesi Sea, setting and deploying of FADs has become business in itself. Large companies of pole and line and purse seines build and deploy their own FADs. Even fish traders deploy FADs for the use of tuna handline fishers in return for the exclusive access of the fishers catch. Large companies as well as "plasma companies" deploy their own FADs to support fishing operations of members of its fishing fleets.

The individually owned boats of the small and medium purse seine fleet as well as pole and line boats who do not own FADs have to pay percentage of its catch for fishing in the FADs. Many of the medium class purse seine fleet fish 70% of the time on FADs, paying a hefty 5 to 15% of the gross sales.

But many of the small-scale tuna handline fishers do not pay for fishing in FADs, particularly those that are owned by purse seine who allow them to fish on the condition that they inform the company on the status of fish schools under the FADs. Note that there is no overlap of target species as the purse seine targets the surface tunas, the tuna handline go after the large tunas in the deeper waters.

FADs in Manado are unique because a small hut is built on the raft (Fig. 8.8). The FAD is always guarded to prevent poaching. The guard informs the owner on the estimate of fish quantity present and owner informs guard the arrangements made as to who will empty the FAD. All information are relayed through mobile phones (see also FAD section on Chapter on EBM considerations).

Catch Rates

Catch rates of large pole and line vessel operating in 2006 range from 3.3 tons/day during the peak season and 1.74 tons/day during the lean season. All fishing activities are undertaken on the FADs. Indicators of declining productivity include reduced incomes as current level of catch is just 70% of 2000 levels and rising operational cost due to increased distance of fishing grounds.

Surprisingly, there were no catch rates available in the literature because all existing studies and research were conducted in Moluccas, Seram and Sorong areas.

Small scale fleet

The small scale pole and lines are called the *funae* or *funai* and are considered the traditional pole and line fishing gear. The funae or funai mainly operates in Sulawesi Sea, north Moluccas (Ternate, Bacan, Tidore) and Ambon area. It utilizes small boats (11m x 2.0m x 1.2 m) propelled by 2 to3 units of 40 HP outboard motors and manned by 10 fishers/crews. It has a large holding tank for live baitfish.

According to our respondents in the Manado area, the total number of *funae* has dramatically dropped from a high of >1000 vessels in the 1990s to just over a hundred. Presently, there are 60 operational units remaining in Bunaken and Ganga area.

The demise of the *funae* fishery was attributed to two factors: the offshore FADs set by Philippine-based purse seine which fishers claimed are catching the fishes before they could move to the coastal areas where they operate. Studies supporting this claim include the "*curtain effect*" of FADs (Aprieto 1995) and this belief was substantiated by results of tagging studies suggesting that skipjack could stay in the FAD area for about six months (Gafa and Susanto, 1991). Another reason is the shortage of bait and depletion of baitfish population. Many *funae* vessels operate an encircling net to fish for live baits. Obviously, the resource of anchovies as baitfish could not support the demand for baitfish.

One of the strategies of the small pole and line fleet to survive is to fish in distant fishing grounds. But because it could not stay more than one day at sea due to the size of the vessel, they compensated by adding more power to the boats. This explains why all the *funae* boats are overpowered. With 120 Hp to propel a very small boat, the high speed engine enables them to reach the distant fishing grounds and return the same day.

Some boats were converted into a more of profitable baitfish boats, fishing for live baitfish and supplying the pole and line fleet.

Fishing Ground

The traditional fishing ground of funae fleets fish where their larger counterparts operate, i.e, on the FADs owned by someone else. Traditionally, funae operates by searching for skipjack schools, using birds and dolphins to detect unassociated schools and log-associated schools. Since 1997, they have completely shifted to

Figure 8. A newly constructed raft of fish aggregating device (FAD) ready for delivery and deployment. Photo taken in FAD manufacturing in Manado, North Sulawesi.

FAD –based operation, resulting in better catches than before. They pay for FAD use whenever there is a guard, either in cash or in certain quantity of fish, but usually equivalen to around 10% of the gross sales.

Bait

Anchovies are the preferred baits but will use any available substitute species. Baitfishes are normally sourced from liftnet operators. However, many operators of *funae* could not afford the prices so they themselves catch their own baitfish using encircling seines. Fishing for own baitfish is common particularly during the light lunar phase where bait shortage and high baitfish prices compels many vessels to stop fishing. Each boat uses about 5 embers of baitfish a day which cost 1 million Rupiahs.

Trends

Current average catch rates range from 400 kg/day during the peak season to just 160 kg/day during the lean months. Their catch now has improved since they started fishing on the FADs in 1997. But given the current high operational costs (fuel, bait) and the perceived low prices given by fish traders, fishing is currently not profitable (see below on Notes on economics of fishing). This explains the demise of a significant part of the fhe funae fleet. Many boats were observed decaying on the coastal area, some were converted into baitfish boats while others converted boats to tuna handline fishing.

Handline

History of tuna handline fishing in Sulawesi

In the Indonesian part of Sulawesi Sea, the exploitation of large yellowfin and bigeye tuna (40-100 kg size) in FADs using handline started in the early 1980s by Filipino fishers when fishing in the Philippine part of Sulawesi and other traditional fishing grounds in Moro Gulf, Davao Gulf and Sarangani Bay became overfished.. It happened during the formative times of the development of the distant water fleet of the Philippines. Therefore it could be said that the Philippine handline fishery follow where the purse seine set and deploy their FADs because these fishers are allowed free access to these FADs. To return the favor, handline fishers inform purse seine owners on the quantity and quality of surface fishes on the FADs.

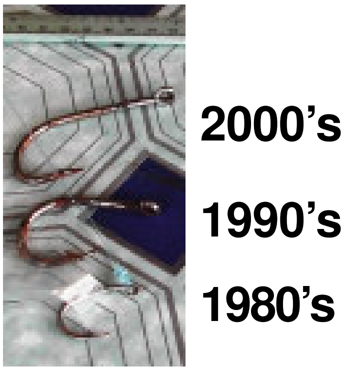
To cope up with the growing distance of their fishing grounds, the Philippine handline boats became bigger starting from 2 fisher pumpboat (<1 GT) to evolve into a 20 GT pumpboats with outriggers (dimensions 26 x 4 m x 2.5 m), with 20 fishers and carry 12 units of small boats. Currently, there are about 1,500 boats remaining from a high of about 15,000 units in mid 1980s. As their number grew and catch rates fell, many started fishing illegally within the Indonesian EEZ.

Tuna fishing has been practiced by Indonesian fishers since time immemorial. The change in the size of hooks used to catch tuna explains the major development and changes associated with this fishery (Figure 8.8).

Small pole & line boat or *funae* docked in Bunaken Island. Note the bamboo poles used in fishing.

In the past fishing for tunas is simply for local consumption; using of small hooks to catch immature yellowfin tuna just infront of the fishing village in Bunaken Island. Then an increase in hook size was made to catch bigger tunas in areas farther from the coast and catch is for the local sales in Manado market and neighboring areas. Here they use small fish and squids as baits. The advent of exports of tuna and use of fishing aggregation devices caused a shift to tuna fishing to deeper waters, using larger hooks. This has been on-going for the last 15 years. Of late, the fishers have again shifted to use live baits (bullet tunas) as catch rates continue to decline.

Figure 8.9. Sizes of hooks used for tuna handline in Bunaken Island, Manado, North Sulawesi. Note the evolution of hook sizes from 40mm (before 1990),



Yellowfin tuna catch carried on its way to the auction hall in Manado, North Sulawesi.

Fishing Fleet

The number of handline fishers is difficult to estimate because handline fishing for tuna are undertaken as part of a slew of gears used by traditional fishers. Our respondents estimate about 1,200 tuna handline boats in Manado area alone including 300 in Pulau Nain. In addition, we estimated about 300 tuna handline mother boats (out of 1,500 total fleets) from the Philippines probably operating illegally in Sulawesi Sea.

Current statistics list total handline units to be about 5,337 in 2005 (DKP 2006). The entry for handline gears as listed in the most recent statistics has yet to be refined and classified according to the target species and construction. Attempt to discriminate handline units were made in 2004 as “pancing ulur” and “pancing tegak” but these are still vague terms. Handline units should be classified according to target species for the data to be useful.

Catch Rates

According to fishers interviewed, the average catch of handline in 2006 is between 3-5 fish/day (60-80 kg size) during August to December and 0-2 fish during low season from March to July. Ten years ago, catch rate is 10-12 fish/day. Back then, the fishing ground was just in front of the village, 15-30 minutes using non-motorized boat, the bait used was artificial lure. In 1990, they started fishing around FADs and by year 2000, started to use live baits. The size of fish however has increased over the years because they now fish between 75-150 meters deep.

During low season for tunas, fishers switch to targeting skipjack and bullet tunas using vertical, multiple hook handlines (15 hooks). Here they use false baits made from synthetic colored fibers. Catch range from 50-100 pieces of skipjack and up to 200 pieces of frigate tunas.

Tuna Longline

Fishing Fleet

Primary data used in this section are based on interviews of a vessel captain and a company manager of the fishing company based in Bitung. There are about >100 units of longlines that are based in Bitung and operate in eastern Sulawesi Sea up to the EEZ of Pacific Ocean eastward until north and northeast of west Papua. Very few of these vessels attempt to operate within FMA VI due to overcrowding of other fishing vessels and obstructions posed by FADs.

About half of the fleets are in the size range of 40-60 GT adopting Taiwanese fishing techniques with 42 baskets, each basket contains 42 hooks and 6 buoys. Fishing technique depends entirely on the master of the vessel and influenced by the phase of the moon: dark phase targets the bigeye because of higher prices but during light phase of the moon, some vessels go after the yellowfin.

Different types of baits are used depending on the phase of the moon, with frozen scads and squids or a combination during lighted moon phase and live baits of milkfish (20-25 cm) during dark phase. Because of higher prices of big eye, vessels tend to make deeper sets.

Surprisingly, there is a good agreement on the number of longline vessels registered in the province of Sulawesi Utara (107) and the number given by the respondent. However, the central licensing registry for 2006 list 222 longline vessels for FMA VII. Estimates of Gillette (2006) place the number tuna longline operating in 2005 after his thorough investigation on fleet capacity to be about 50 vessels of the >30 GT.

Catch, Catch Rates and Species composition

Available records from the data base of South Pacific Commission (SPC) reflect catch of longline in Sulawesi Indonesia as fairly stable between 2,300-2,800 tons (Figure 8.10) with corresponding total hook rates of 0.7 to 1.35 for the period 2000-2004 (Figure 11). By comparison, total catch on the Philippine side of Sulawesi Sea is just one third (below 1,000 tons) but hook rates are higher than those in the Indonesian side. The highest catch was in the Moluccas Sea and Halmahera Sea longline operations.

Hook rates as presented in Figure 11 do not vary much between areas. Interestingly however is the closeness of the value of the total hook rate with the tuna hook rate which suggests the minimal catch of non-tunas in the fishing ground north of Cendrawasih Bay.

The results of the WWF observer program in 2006 allowed a detailed analysis of catch, and catch rates. The species caught are yellowfin, big eye, northern bluefin, marlins, sailfish, barracudas and sharks.

The total hook rate range from 1.04 to 3.57 while the tuna hook rate ranges from 0.82 to3.25. It is possible to compare catch rates from Indonesian territorial waters taken east of Talaud group of Islands (column 5), Indonesian EEZ (columns 8 & 9) and the high seas (columns 1-4; 6-7). It appears that the mean hook rate for the high seas is about 1.53 compared with those taken in Moluccas Sea with 1.79 and north of Irian Jaya Barat with only 0.86 (Table 8.9). These results are difficult to interpret considering the other factors that affect the catchability such as bait type, use of J and C hooks, season, among others. The results above compare quite well with the hook rates computed from the data base of SPC on longliners operating in FMA VII.

Interestingly, non-tuna catch vary highly between areas with no contamination of non-tunas in the Moluccas Sea, almost 30% for Sorong and 17% for the high seas (Table 8.10). This has implications on the WWF program to implement circle hooks on longline fleet.

Tuna Infrastructure support

The center of tuna activity for Sulawesi Sea is concentrated in Bitung. The fishing port in Bitung is a second level port or Pelabuhan Perikanan Nusantara (PPN) which was opened in 2004 where large vessels of up to 300-400 GT class may be able to dock. Tunas caught by pole and line, purse seine, handlines, directly land their catch there. Traders buying tunas for processing from far away landing areas are transported by trucks to the port in Bitung. Similarly, collecting vessels of companies retrieve and deliver tunas to Bitung from fleets operating in nearby areas.

A typical tuna handline boat used by fishers around many islands in Sulawesi Sea.

Processing plants (producing whole fresh, frozen, canned tunas, smoked tuna, loin, steak and fillet), fishing fleet companies and export companies have invested in this area. In a meeting with the representatives of the governor, the province of Sulawesi Utara is looking at General Santos City, Philippines as the model. The government has also encouraged Philippine companies to operate in Bitung. Today, there are two Philippine owned canneries which also processes fish caught in the Philippines and PNG by the fleets owned by these companies. A total of about 24 Philippine tuna vessels have also re-flagged.

In Manado, there is the landing area where handline and troll-caught tunas are landed and shipped to Bitung for final processing. The landing areas in Manado therefore serves as a transshipment point of exportable tunas (primarily yellowfin and bigeye only).

Processing and Tuna Products

Bitung as the center for the tuna market and processing is supported by 22 companies that provide storage and processing facilities. The aggregate freezing capacity of these companies is about 440 tons, an aggregate 7,735 tons storage capacity, nine ice plants with a total of 187 tons/d capacity (Sulawesi Utara Annual Report 2005). Moreover, there are two Philippine-owned canning factories producing a total of 57 ton daily processing capacity and two other companies producing smoked fish.

There are three tuna products exported as fresh and another ten products exported as frozen from Bitung. In addition, canned tuna and smoked fish are also processed and exported to major countries that include the USA, Japan and Europe.

Total tuna exports out of Bitung is 8,952 tons valued at US$ 24.61 millionfor 2006. The export volume however for the first 9 months of 2006 has declined by 71% compared with 2005 figures for the same period (Figure 8.12). The main reason for the decline in exports as provided by processors include not enough supply of raw materials, particularly for the whole fresh tunas. Another reason is corruption that led to a processing company relocating its operation elsewhere.

Tjandrason (2007) summarized the issues and problems of tuna market and trade for Indonesia to include a) high rejection rates due to high histamine content of exported products; b) low quality of fish landed; c) high freight cost; and d) lack of value adding and no new product development. In short, the tuna products coming out of Bitung is not competitive. A comprehensive discussion of the tuna trade is presented in Chapter 11.

Notes on the Economics of Fishing

Handline

The initial outlay on the fishing boat (5-GT) of handline in 2003 was Rp12.00 million while its outboard motor (40 HP) cost approximately Rp10.00 million. The total

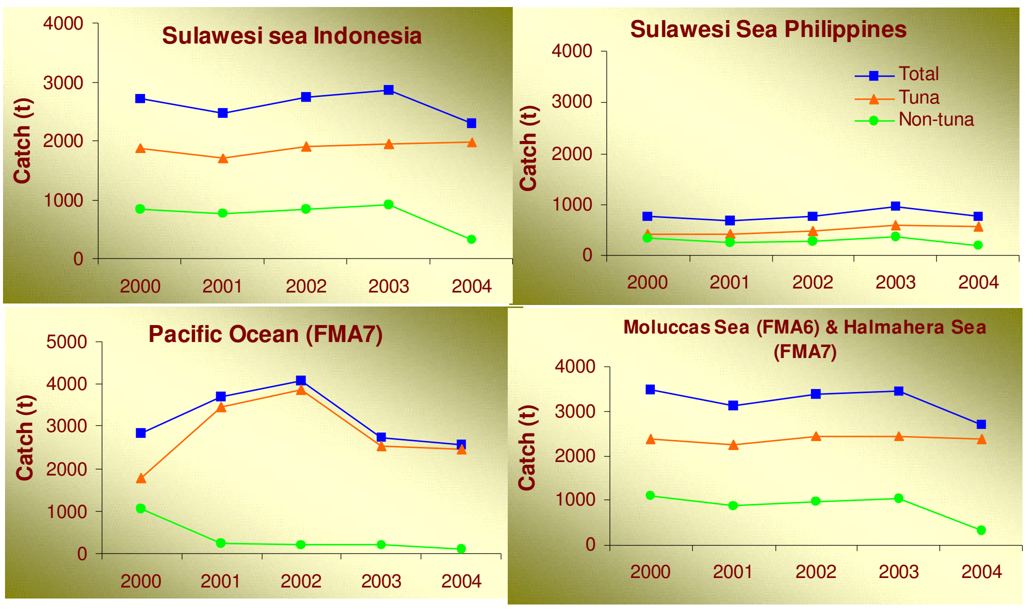


Figure 8.10. Catch of longline fleet operating in Sulawesi Sea, Pacific Ocean and Moluccas sea. Data taken from SPC database for years 2000-2004.

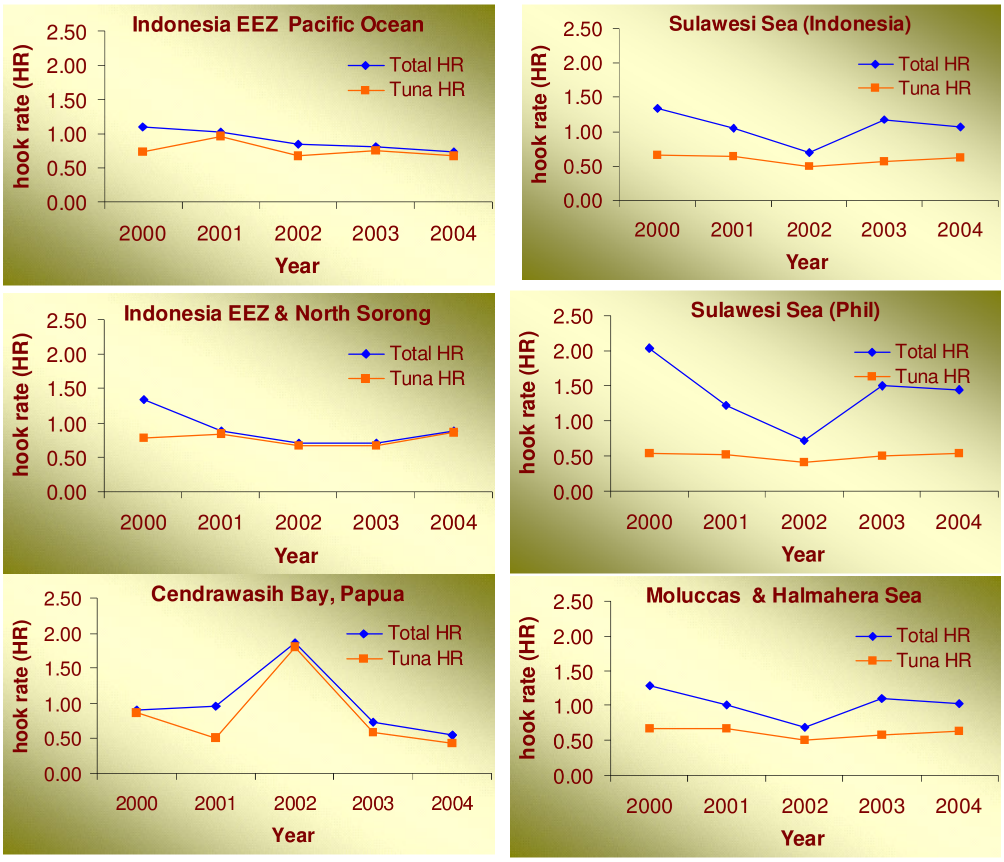


Figure 8.11. Hook rates of tuna longline for different areas of FMA7. Source: SPC database.Legend: total hook rate include all catch, tuna hook rate include only tunas excluding billfishes.

operational cost annually is estimated to be near Rp56.98 million and a set of handline costs about Rp200.00 thousand. Annual gross sales revenue is estimated to be approximately Rp91.55 million for about 34 trips. The handline fishery in FMA-VII as indicated by the data presented is still profiting from the fishing venture.

In 2004, some of the handliners invested the same boat size had approximately costs Rp20.00 million for the same size of fishing boat as above (5-GT) and about Rp10.00 million for its out board motor of 40-HP. This type of fishing spends more or less Rp87.50 million for annual operations while the cost of the fishing gear is about Rp400.00 thousands. The gross revenue from sales of fish annually is estimated to be Rp170.10 million. This further proves that the handline fishing in FMA-VII is a profitable endeavor.

The handliners from the Philippines fishing in the waters of FMA-VII invests more or less Rp180.00 million (converted from Pesos currency) for the mother fishing boat of 20-GT and inboard engine of 160-HP. For a set of handline fishing gear, investment is about Rp180.00 thousands and the average number of fishers per mother boat is 15 independent individuals; the total estimated investment for the small fishing boats and their corresponding engines would be Rp2.70 billion. The annual depreciation costs for ten years lifespan of all the fishing boats and engines mentioned above is about Rp288.00 million. The estimated total annual operation cost is about Rp302.00 million. Gross revenue from the proceeds of catch is estimated to be more or less Rp1.12 billion. It is obvious that this fishing venture is just on the financial breakeven point. This is because of the very high operational costs due to the far distance of the fishing ground from the home ports, bribes and the risks involved. The fishers are still earning a bit though because of the higher prices of fish in General Santos City, Philippines as compared to the fish prices in Indonesia.

Tempat pelelangan ikan (TPI) or auction hall in Manado after a busy day.

Table 8.9. Total fish catch (in numbers) and tuna of longline operating in FMA-VII and high seas in the Pacific ocean. Source: Observer program of WWF.

	High seas	Off Talud Islands	Off Sorong
Total fish	3861	150	952
Total tuna	3320	150	660
# hooks	216,720	8400	76608
Total HR	1.78	1.79	1.24
Tuna HR	1.53	1.79	0.86

Table 8.10. Species composition of longline catch taken from two areas in FMA-VII and in the Pacific high seas. Values in percent. Source: WWF observer program.

	High seas	Off Talaud Is.	Off Sorong
Yellowfin	22.5	53.3	37.1
Bigeye	22.0	20.0	14.4
Bluefin	39.0	26.7	18.6
Marlin	3.70	0.00	7.22
Sailfish	4.23	0.00	8.25
Barracuda	5.37	0.00	9.28
Shark	3.20	0.00	5.15

Pole and Line

There are two types of pole and line operating in FMA-VII, the small-scale funae-funae and the large scale which is akin with the pole and lines in the country. The funa-funaes were observed to just operate in two FMAs, FMA-VI and FMA-VII.

The initial investment on funae-funae fishing boat of 10 gross tons and three outboard engines of 40-HP was Rp100.00 million in 2002 while that for the fishing gear including the net used to catch baitfish was Rp3.00 million. Annual operational expense is estimated to be Rp240.88 million. The estimates of annual revenue from gross sales of just Rp146.49 million showed a losing fishing venture.

Table 8.11. Volume (t) and value (in million US$) of the 10 tuna products that are produced, processed and exported out of the 22 companies operating in Bitung, North Sulawesi for 2006.Source: Sulawesi Utara Provincial quality control office (LPPMHP) 2006.

Export Commodity	volume (t)	value (million $)	Export Commodity	volume (t)	value (million $)
Frozen (tuna products)			**Fresh**		
Tuna whole			Tuna whole	528.0	1.566
Tuuna cubes/ chopped meat	189.1	0.151	Tuna loins	59.5	0.312
Tuna loin	145.6	0.264	Tuna fillet	0.1	0.000
Tuna saku	417.5	1.871	Swordfish fillet	0.5	0.004
Tuna steak	137.2	0.382	Mixed species	3,909.0	5.864
Tuna fillet	16.0	0.104	**smoked**		
Tuna poke cubes	1.9	0.004	Kaleng	5,752.4	15.075
Tuna belly	0.4	0.001	Kayu	948.8	3.752
Skipjack whole	756.0	1.134			
Frozen (non-tuna)			**Frozen (non-tuna)**		
Marlin chunks	19.1	0.041	Scads whole	1,145.2	1.529
Marlin chopped meat	16.1	0.016	Squids	47.6	0.019
Black marlin saku	5.0	0.015	Octopus	17.2	0.048
Swordfish chunks	0.4	0.001	Shrimps	58.2	0.547
Sailfish chunks	0.3	0.001	Mixed species	2,839.9	4.162
Oilfish fillet	11.0	0.010			

Tunas are brought to the auction hall in Manado for quality grading and repacking for export.

The large pole and liners on the other hands investment on the fishing boat (80 GT) and 360-HP inboard engine was Rp1.00 billion. Assuming a 10 years lifespan of the boat and engine the annual depreciation would be Rp100.00 million. The starting investment for the pole and line fishing gears was Rp1.75 million. The total annual running cost is approximated at Rp1.26 billion. Gross revenue from sales of catch a year is more and less Rp2.58 billion. Despite the large costs presented unlike the funae-funae this fishing venture is still profiting from the fisheries.

Mini-purse seine

The investment on the pajeku fishing boat (33 GT) was Rp100.00 million, Rp300.00 million for the 300-Hp inboard engine and Rp100.00 million for the fishing gear. The total annual operation is Rp19.75 million. The annual gross revenue is about Rp1.33 billion. The fishery is definitely profiting from this venture. This is more because of the system of going out to fish only when the payao operators called and assured the fishing master that the particular FAD has at least 20 tons of fish on it.

Issues and Challenges of tuna sector in FMA-VII

1. Data collection at the provincial level.

   a. There is the need to further improve identification of landings up to species level to include not just the large tunas but the small tunas as well.

   b. The use of local names (tongkol) should be avoided as same local names in different areas refer to entirely different species. This is to address our concern on the entries of eastern little tuna which we verified to be *Auxis rochei*.

   c. Handlines needs to be categorized into different types. There are simple single hook handlines for tunas, there are vertical handlines using multiple hooks designed to catch small tunas and there is the use of kite as a variation of troll line fishing.

   d. Since fishing fleets move continuously following the fish, the source of where the fish caught should be included as important additional information. This will facilitate the production of statistics per FMA.

   e. There is the need to improve on the effort information. The use of the number of trips has very little use. The effort index should be reflective of the fishing gear as used in the area but should be convertible to a

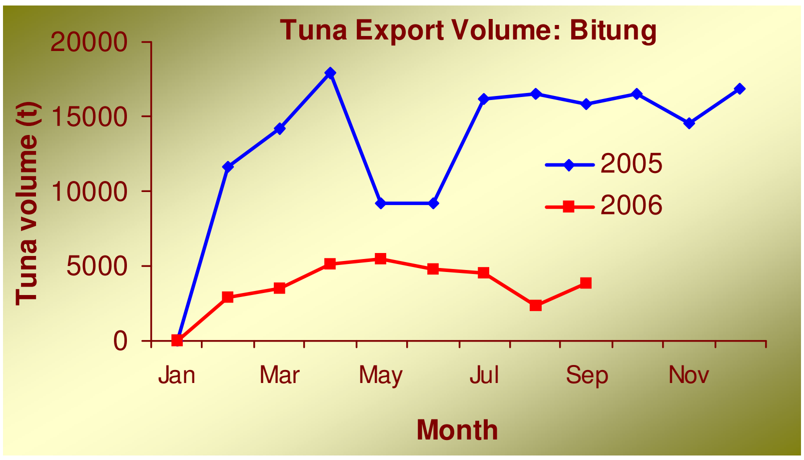


Figure 8.12. Volume of tuna exports coming out of Bitung City, North Sulawesi compared for years 2005 and 2006. Source: North Sulawesi Quality Control Center 2004-2006.

standard effort for stock assessment purposes. This could be done if the government will undertake collection of operational catch and effort data for each type of fishing gear between seasons. How this will be implemented is either through observer program or a highly efficient log-book system in place.

f. The use of mother boats to bring handline fishers to FADs and operate there for several days is becoming popular. There is a need to include them in catch monitoring system in place. The commercialization of handline fishing adds another complexity in how to collect the necessary information.

2. Coverage for statistical purposes needs to be increased. Fish landed on private ports and wharves are currently not monitored. Sangihe Group of islands needs o be covered as many of the boats operate there, particularly handlines. Proctor (2007) lists specific recommendations on how to improve data collection system in eastern Indonesia but has not included Sangihe area as a top priority.

3. Rise in fuel prices has been raised as an issue in 90% of the interviews conducted. Subsidies are enjoyed by those who knew about it and how to avail of this fuel subsidy.

4. Fish prices have remained stagnant and did not rise accordingly with the fuel prices because, as alleged by fishers, are manipulated by middlemen.

5. For pole and line, availability of live baits remains a chronic problem. The fleet has turned to other types of baits (e.g. fingerlings-sized scads, very minute skipjack) and the ecological consequences of using these highly important species as baits must be studied.

6. With the price of fuel continue to increase, dependency on the FADs by tuna gears such as handline, pole and line, purse seine and troll line will continue. The government needs to act on regulating FAD's use and establish monitoring protocol to collect information about the FADs.

7. Lack of know how of fishers on quality assessment of fish made by buyers. Many fishers feel shortchanged during the quality assessment, and complain of not getting the right prices for the right quality of fish.

8. The handling of tunas in auction halls needs to be improved, premises around auction halls needs to be sanitized, waste water needs to be treated and hygenic conditions must be set at a minimum requirement for continued operation.


Tunas are individually place in styrofoam containers called "coffins" and packed in ice.

FMA-IX: Indian Ocean

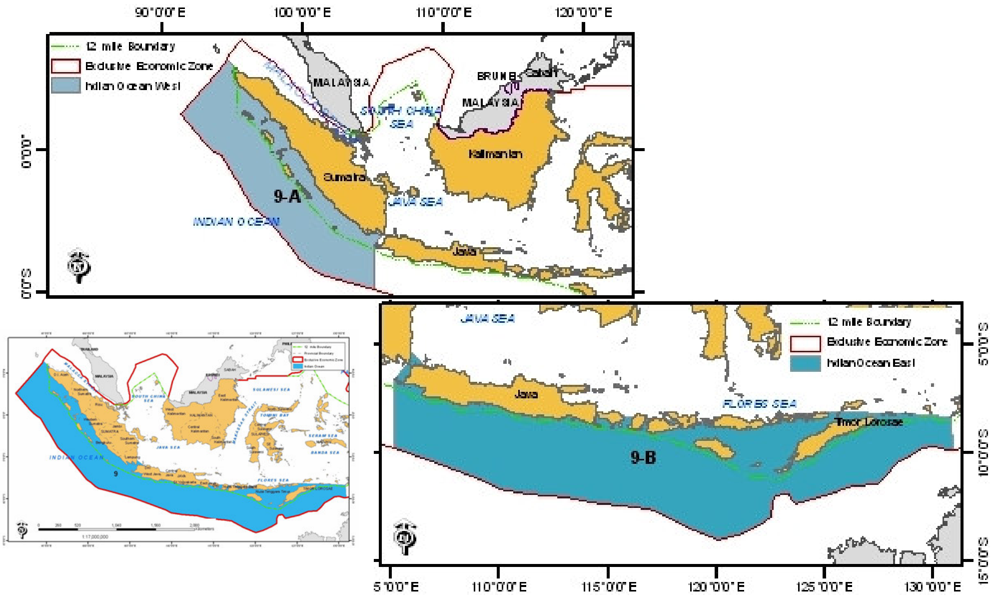


Figure 9.1. Geographic location of Fishery Management Area Nine (FMA-IX) covering the entire Indian Ocean EEZ of Indonesia. The area is divided into FMA-IXa representing western portion (above) and FMA-IXb representing the eastern portion (below).

Background

Among the fishery management areas with tuna fisheries, fishery management nine (FMA-IX) is the most studied as its domestic longline fishery used to be the tuna fisheries backbone of the country. Expectedly, most of developmental assistance for the tuna sector (with aim to develop the fishery, and improve the monitoring and assessment of tuna stocks) have been poured into the Indian Ocean (DGCF 2003, Gafa & Nishida 2000, IOTC 2003, Marceille, 1984, Ishida et al., 1994, Herrera 2000, Merta, 2000, Proctor et al., 2003, Simorangkir 2003).

The tuna fisheries of FMA-IX is unique for two reasons, significant tuna catches are taken from the Indian Ocean by its domestic longline fleet and second, the endangered bluefin tuna is also caught and landed. These are the reasons why Indonesia is important to become an active member of the regional management organizations for the conservation of tunas in the Indian Ocean (Indian Ocean Tuna Commission or IOTC) and the Commission for the Conservation of Bluefin Tuna (CCSBT) that manages the endangered bluefin tuna.

Goddess & protector of the Indian Ocean resources, this painting hangs on a wall of a hotel in Pelabuhan Ratu, West Java.

Geographic Scope

The Indian Ocean is a vast expanse of sea that covers three time-zones; it is actually the third largest body of water in the world. The Ocean is about 73.4 million km^2 with an average depth of 3,900 m with the deepest part (7,725 m) found within the jurisdiction of Indonesia, off the southern coast of Java Island (Encarta, 2002).

For statistical purposes, the Indonesian government divided their aquatic resources into nine management areas; and that, the whole Indonesian jurisdiction of Indian Ocean became Fisheries Management Area Nine (FMA-IX). There are 13 provinces and 78 districts/regencies partly or wholly covering FMA-IX (Table 9.1). Also included in FMA-IX are the small bodies of water immediately adjacent to the land masses such as Bali Strait and the Sawu Sea (Figure 9.1).

Table 9.1. Provinces and districs covered within FMA-IX. (Source: DKP Statistics by fisheries management areas, 2006).

Provinces	Regency/ District
Nanggroe Aceh Darussalam	Aceh Selatan, Aceh Barat, Aceh Besar, Kota Banda ceh, Kota Sabang
North Sumatra	Tapanuli Selatan, Tapanuli Tengah, Kota Sibolga, Nias Islands, Mandailing Natal, Nias Selatan
West Sumatra	Pesisir Selatan, Padang Pariaman, Kota Padang, Agam, Pasaman, Mentawai Islands, Kota Pariaman
Bengkulu	Bengkulu Selatan, Kota Benkulu, Bengkulu Utara, Muko-Muko, Seluma, Saur
Lampung	Lampung Utara
Bali	Kap. Badung, Tabanan, Jembrana, Karangasem, Klungkung, Gianyar, Kota Denpasar
Jawa Barat	Ciamis, Tasikmalaya, Garut, Cianjur,Sukabumi
Banten	Lebak, Pandeglang
Jawa Tengah	Wonogiri, Purworejo, Kebumen, Cilacap
D.I. Yogyakarta	Gunung Kidul, Bantul, Kulon Progo
Jawa Timur	Jember, Lumajang, Malang, Blitar, Tulungagung, Trenggalek, Pacitan, Sebagian Banyuwangi,Daker Muncar
Nusa Tenggara Timur	Kapb. Sumba Barat, Ende,Sumba timur, Kupang, timor Tengah Selatan, Timor Tengah Utara, Belu, Lembata, Kota Kupang, Rote Ndao, Sebagian Manggarai, sbagian Ngada, sebagian Sikka, sebagian Flores Timur, sebagian Alor, sebagian Mangarai Barat
Nusa Tenggara Barat	Sebagian Lombok Barat, Sebagian Lombok Timur, Lombok Tengah, Sebagian Sumbawa, sebagian Dompu, Sebagian Bima, sebagian Sumbawa Barat, sebagian Kota Mataram

Sources of data

The secondary data used in the presentation in this chapter came from the following sources:

a) national fisheries statistics of Indonesia consisting of the yearly marine capture statistics by provinces and coastal areas and by fishery management areas;

b) the provincial statistics of Sumatera Utara, Sumatera Barat, Sumatera Selatan, Jawa Tengah, Jawa Timur, Nusa Tenggara Barat and Nusa Tenggara Timur;

c) data collected from PPS Bungus in Sumatera Barat, PPN Palabuhan ratu in Jawa Barat, and PPS Cilacap in Jawa Tengah;

d) unpublished thesis of students from Sekolah Tinggi Perikanan (STP);

e) published sources or scientific journals; and

f) the internet.

Primary data are the results of interview conducted during this study and the records of fishing operations, mostly in Banda Sea and Indian Ocean from 1973-2003, by the state fishing enterprise, PT. Samodra Besar.

Limitations and assumptions

We have not included Banda Aceh in our survey as there was no fishery to speak of following the tsunami destruction in 2004. However, massive rehabilitation efforts is being poured upon in the area including the fisheries sector, of which is undertaken by FAO and Red Cross. Another reason of not visiting Aceh was, most of the fleets operating in there are based in the fishing ports of Benoa and Jakarta wherein they could be interviewed, instead.

To conveniently characterize the Indian Ocean tuna fishery, we have separated FMA-IX into FMA-IXa (western: Sumatra Island) and FMA-IXb (eastern: entire Java Island, Nusa Tenggara Barat Province and Nusa Tenggara Timur Province). Interestingly, there is a move to divide FMA-IX into two distinct management areas (Nugroho et al., 2006) but where the separation and boundaries is still unidentified.

Tuna Catch and Trends

According to the DKP statistics by fisheries management areas published in 2006, the total tuna catch from Indian Ocean in 2004 is 214.1 thousand tons and fluctuated between 175-215 thousand tons from 2000-2004 (Figure 9.2). While there was no significant changes easily seen in aggregated landings, significant changes occurred per major tuna groupings. Small tunas decline by 54% while the large tunas more than doubled in volume (105%) and skipjack increased by 16%.

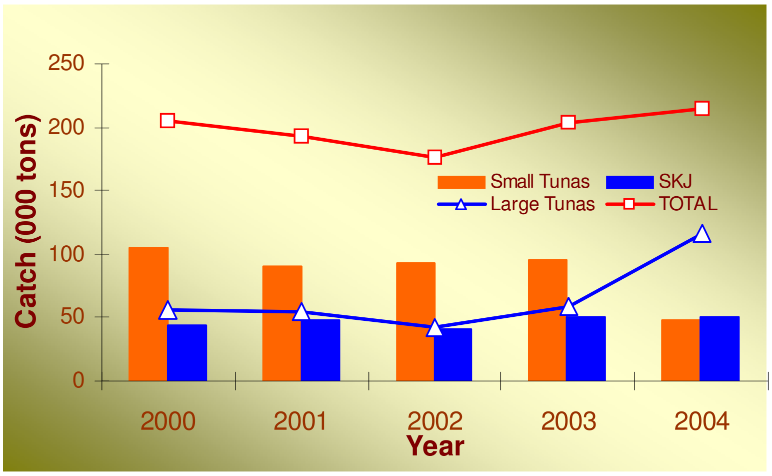


Figure 9.2. Nominal tuna catch from the Indian Ocean categorized as large tunas, small tunas and skipjacks. Source: DKP Statistics by WPP, 2006.

In order to present a detailed picture of tuna catch trends, the landings from six of the 13 provinces covering this FMA (Sumatera Utara, Sumatera Barat, Jawa Tengah, Jawa Timur, Nusa Tenggara Barat, and Nusa Tenggara Timur) were pooled (Figure 9.3a). The pooled landings indicates wide variabilities over the years but generally depicts exponential rise.

Existing data on tuna from the Indian Ocean Tuna Commission (IOTC) database show that longline catches from Indian Ocean grew exponentially from 1985 until 1999 when it has reached its maximum catch of 80 thousand tons in the year 2000 (Figure 9.3b). Thereafter, catch took on a sharp decline and in 2006, the total catch stood at 23.6 thousand tons, a value just 28% of the highest level.

FMA-IX is conveniently divided into two sub-areas for ease of presentation, FMA-IXa refers to west Indian Ocean and FMA-IXb to east Indian Ocean. The landings in FMA-IXb increased by 62.2% from 195.2 to 316.8 thousand tons while that in FMA-IXa decreased by 12.8% average (Figure 9.4). Looking at the details of trends by species-groups, the significant increased in FMA-IXb was generated by the rising volume of

Increasing fuel prices and very low catch rates forced hundreds of tuna longline boats to remain at ports in Muara Baru, Benoa and Bungus.

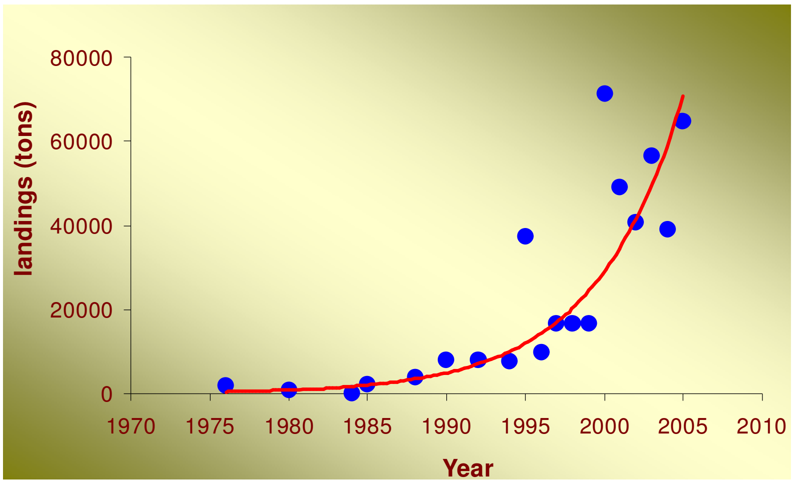


Figure 9.3a.Aggregate tuna landings from the provinces of Sumatera Utara, Sumatera Barat, Jawa Barat, Jawa Tengah, Jawa Timur, Nusa Tenggara Barat and Nusa Tenggara Timur. Red line is a trendline drawn using an exponential curve equation. (Source: Provincial Fisheries Statistics DKP, various years).

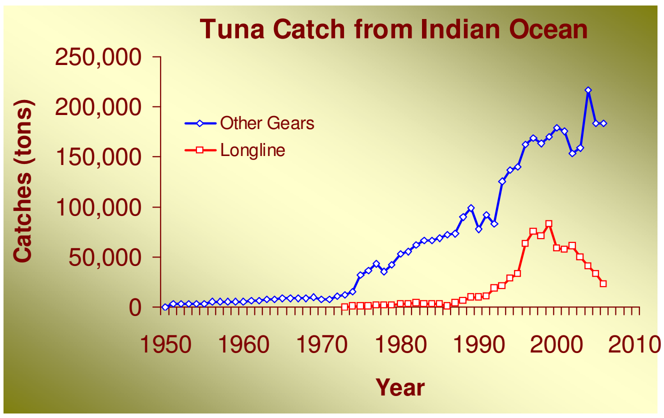


Figure 9.3b. Tuna landings from Indian Ocean - Indonesia. Note the better agreement of this data and the national figures. Source: Indian Ocean Tuna Commission (IOTC) database.

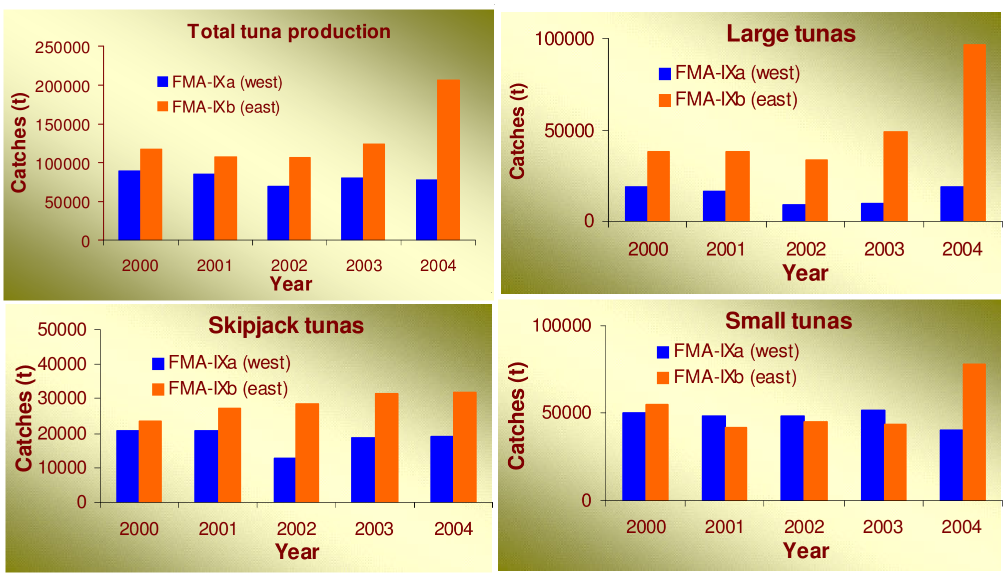


Figure 9.4. Comparison of catches of tunas between sub-areas and by tuna groupings in FMA-IX.(Source: DKP-WPP 2006).

large tuna landings while the decreased in FMA-IXa was due to the falling landings of small tunas (Figure 9.4).

There are six provinces within FMA-IXa (Sumatra Island, Table 9.1). The province of Sumatera Barat ranked first, accounting for over one-third (36.2%) of the total tuna landings in FMA-IXa, followed by Sumatera Utara and Aceh Darussalam. These three provinces account for 86% of the tuna landing records of FMA-IXa (Table 9.2). In the east Indian Ocean (FMA-IXb), Jakarta and Bali account for over 60% of the tuna landings. This is because these areas are the major host to the tuna processing, landing and export in the entire country. Recently however, more tunas are caught and landed in East Java and East Nusa Tenggara, that despite the absence of fishing ports higher than the landings sites in the communities (Table 9.2).

Table 9.2. Tuna catch by provinces and by species category. Data presented is for 2004. Source: DKP WPP 2006.

Provinces	large tunas	skj tunas	small tunas	Total
West FMA-IX	**18599**	**19102**	**16026**	**53727**
Aceh Darussalam	1467	6512	5408	13387
North Sumatra	3293	3826	6513	13632
West Sumatra	11990	7475	0	19465
Bengkulu	320	237	441	998
Lampung	1259	559	838	2656
Banten	270	493	2826	3589
East FMA-IXb	**97010**	**31741**	**31663**	**160414**
DKI Jakarta	54232	396	5109	59737
West Java	2511	2303	0	4814
Central Java	2688	2069	4	4761
D.I. Yogyakarta	14	5	97	116
East Java	8291	6824	2398	17513
Bali	26005	3295	7968	37268
NTB	902	3290	6967	11159
NTT	2367	13559	9120	25046

In FMA-IXa (west Indian Ocean), small tunas represent roughly half of the total landings while skipjack and large tunas share the other half in almost equal proportions. This is in total contrast in the east Indian Ocean (FMA-IXb) where the large tunas account for 2/3 of total tuna landings (Figure 9.5).

The difference in the landing proportions of the three tuna species-group between east and west is due to the types of fishing gears and size of operation. Small tunas and skipjack dominate in the tuna landings of Sumatra (FMA-IXa), largely supported by small and medium scale fishing activities while the large tunas are mostly landed in FMA-IXb (Java, Bali, NTB & NTT). The large tunas landed in FMA-IXb are from the

New troll line boats in Lombok add to the already saturated fishing fleet operating in Indian Ocean.

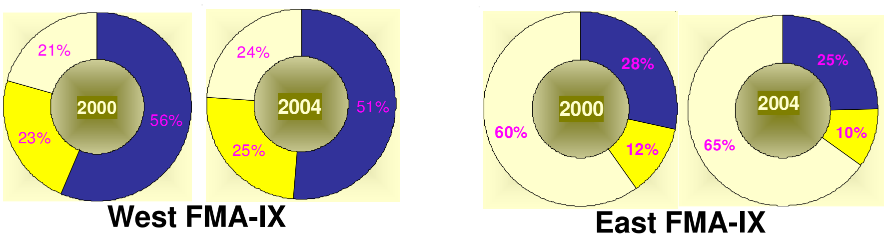


Figure 9.5. Comparison of share to production of tuna categories between the western and eastern Indian ocean. Legend: Blue-small tunas, yellow-skipjack, white-large tunas. Source: DKP Statistics by FMA, 2006.

tuna longlines, drift gillnets, pole and line fleets which homeports are in Muara Baru in Jakarta, Benoa in Bali, and Cilacap in Central Java.

There appears a shift in the dynamics of tuna landings between the three tuna species-groups. In the FMA-IXa (West FMA-IX), share of large tunas and skipjacks increased between the 2000 and 2004 years period while the small tunas decreased (Figure 9.5). A similar trend but on a larger scale is observed in FMA-IXb (East FMA-IX). The proportion of large tunas further increased from 60% to 65% while both the skipjack and small tunas fell by 2% and 3%, respectively (Fig. 9.5).

Viewed on a longer time series, share of the tunas relative to the total fish appears to have changed differently in FMA-IXa (Sumatra). Proportion of tuna from total fish landings in the province of Sumatera Barat significantly declined over the last 10 years from a high of 30% to just under 15%. In contrast, share of tunas in Sumatera Utara doubled from 7.42% in 2000 to 15.0% in 2005 (Figure 9.6).

Landings in FMA-IXb had been increasing over the last 10-15 years. For instance, in the province of Jawa Barat, all three species categories increased in landings between the period of 1998 to 2004, with the small tunas registering threefold increase. This observation is evident on tuna landings at Pelabuhan Ratu fishing port. Even the landings for skipjack and large tunas had also been increasing over the years 2000 to 2005. Respondents to interviews conducted for pelagic Danish seine, drift gillnet and other fishing gears experienced unprecedented increases in catch for 2005 and 2006. Fishers attributed such high catches to the overextended dry season that characterized much of 2005 and 2006.

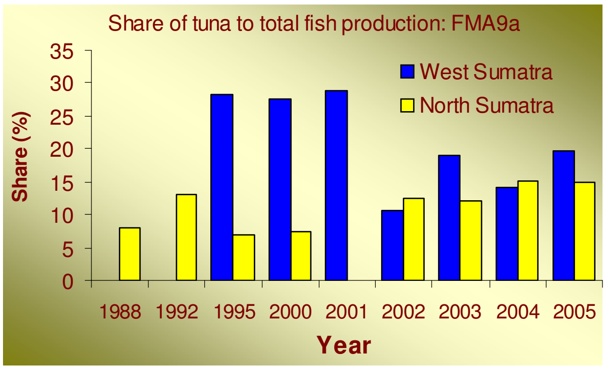


Figure 9.6. Share (%) of tuna to the total fish landings in the provinces of Sumatera Barat and Sumatera Utara. Source: Provincial statistics of Sumatera Utara and Sumatera Barat (various years).

However the increasing trends is reversed on tunas landed in Jawa Tengah where skipjack landings in 2004 reduced by 70% ten years back (Figure 9.7). For Jawa Timur Province, small tunas showed an almost exponential increase from less than one thousand tons in 1980 to over 16 thousand tons in 2000 and declined back to less than 8,000 tons in 2005.

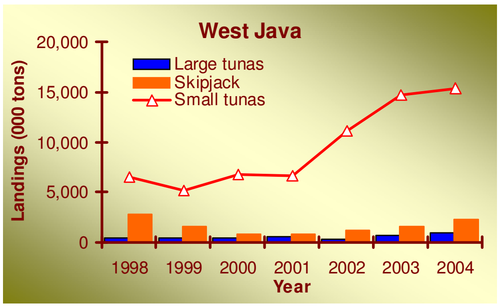
Pole & Line fleet operating in Savu Sea are docked in Kupang port.

The cause of the decline in the tuna landings of Jawa Tengah Province, when both the Jawa Timur and Jawa Barat Provinces are experiencing high catches, is difficult to determine. Perhaps the proximity of both Jawa Timur and Jawa Barat to major water passages between islands lends to this productivity.

Trends and number of fishing gears

We have separated the fishing gears that operate and fished in the Indian Ocean through registration records by regencies or districts. For most of the provinces, this is straight forward but is difficult in Surabaya, Jawa Timur where fishing vessels operate both at the Indian Ocean and Java Sea.

The total number of registered fishing gears that catch tunas in FMA-IX is difficult to determine with accuracy as data from provincial and national agencies do not agree. In FMA-IXb (east Indian Ocean), the total number of fishing gears catching tuna is over 148 thousand (Table 9.3a). In FMA-IXa (west Indian Ocean), the records of the provinces



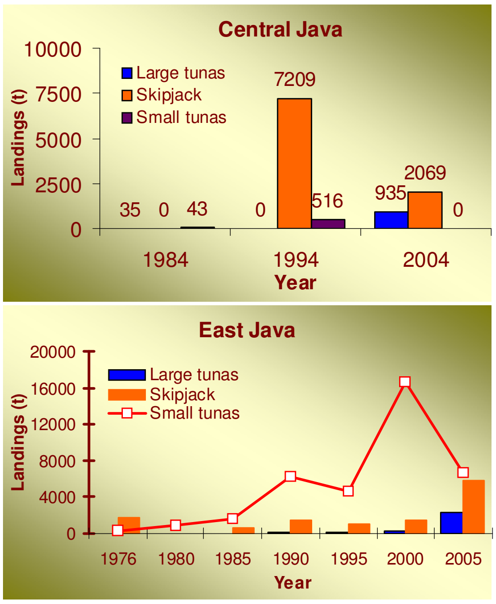


Figure 9.7. Landings of tuna from the provinces of west Java (Jawa Barat), central Java (Jawa Tengah) and east Java (Jawa Timur) by tuna species group. Source: Provincial Fisheries Statistics (DKP various years).

of Sumatera Utara, Sumatera Barat, Bengkulu and Lampung totals to over 37 thousand units of fishing gears (Table 9.3b). Summing up, the estimated total number of tuna fishing gears in FMA-IX is about 185.3 thousands. Some of these fishing gears are catching tuna incidentally only depending on season and area. Furthermore, majority of these gears are small, operated in coastal areas and have limited capability to stay long at sea.

The fishing gear that targets tuna in FMA-IXa (west Indian Ocean) are the drift gillnets and mobile liftnets; which accounts for the highest tuna landings (see also landings per gear). The typical tuna gears based in FMA-IXb (east Indian Ocean) are tuna longline, troll line and pole and line (Table 9.4).

Summarizing, FMA-IX has the most diverse number of fishing gears in the country, with at least 18 different gear types catching tunas either as target or as by catch. The types of fishing gears significantly vary between the western (FMA-IXa) and eastern (FMA-IXb) sub-areas on the following aspects:

1. the traditional fishing gears that target the tunas (e.g. tuna longline, pole and line) are predominantly present in the eastern part of FMA-IX or indicated in this report as FMA-IXb (Jakarta, Bali, NTB and NTT). Even longlines in FMA-IXa (Sumatra side) are concentrated in Lampung, an adjacent area and which fleets use the fishing ports of Nizam Zachman in Jakarta and Benoa in Bali to land its fish catch.
2. the tuna landings in the Sumatra side (FMA-IXa) mainly consist of incidental catches of drift gillnets and pelagic Danish seines wherein the share of tuna relative to the total catch of each species do not exceed 60% (Tables 9.5a&b). Only the troll line mostly based in Sumatera Utara Province target the tunas, of which 90% of the gear's landings are tunas.
3. most of the fishing gears in FMA-IXa (Sumatra side) are small to medium vessels of single ownerships while large fishing companies characterize the tuna fleets based in Jakarta and Bali, provinces in FMA-IXb .
4. non-tuna fishing gears such as the demersal Danish seine (dogol), drift gillnet, trammel nets and liftnets are the major contributors to tuna landings of FMA-IXa.
5. The share of tuna catch for each gear changes over time; drift gillnets, demersal Danish seine, set gillnet and trammel net showed increasing share of tunas in the catches for the last 10 years (Tables 9.5a&b).

Longline fleet await better catch rates in Bungus, Padang, West Sumatra.

Tables 9.3a&b. Numbers of tuna fishing gear for the provinces belonging to FMA-IXa (upper table) and FMA-IXb (lower table) sub-areas of Fishery Management Nine (FMA-IX). Sources: Provincial DKP statistics, various years.

Number of Gear Units	West Java (2004)	Central Java (2004)	East Java (2005)	NTT (2005)	NTB (2005)	Bali 2006	Total
Pelagic Danish Seine	2,086	-	3,702	624	262		6,674
Demersal Danish Seine	893	-	-	-	-		893
Beach Seine	2,628	63	110	121	748		3,670
Purse Seine	189	-	380	306	280	78	1,233
Drift Gillnet	4,782	1,199	2,105	562	13,704	6,470	28,822
Encircling Gillnet	221	-	-	109	2,718	59	3,107
Shrimp Gillnet	2,578	-	8,184	853	267		11,882
Trammel Net	2,990	514	1,140	603	929		6,176
Set Gillnet	4,846	2,191	1,914	869	3,349		13,169
Boat/Raft Liftnet	994	1,400	-	75	231		2,700
Stationary Liftnet	249	-	174	91	578		1,092
Scoop net	-	-	328	-	12		340
Tuna Longline	33	133	2,398	-	-	495	3,059
Pole and Line	-	-		-	195		195
Other Drift Longline	261	-	1,403	-	999	222	2,885
Set Longline	427	-	-	118	570		1,115
Other Handline	7,875	328	8,210	1,040	24,738	833	43,024
Troll Line	24	-	408	1,197	8,604	7,462	17,695
Handline	30	-	-	270	-	3,901	300
TOTAL	31,106	5,828	30,456	6,838	58,184	19,520	148,031

Gears (2005)	West Sumatra	North Sumatra	Lampung 2004	Bengkulu 2004	Total
Pelagic Danish seine	1599	48	0	192	1839
Demersal Danish seine	452	0	0	105	557
Beach seine	809	86	154	17	1066
Purse seine	16	351		17	384
Drift Gillnet	2406	1312	897	448	5063
Encircling gillnet	34	58	312	0	404
Set gillnet	1265	1575	616	846	4302
Trammel net	906	140	12	514	1572
Boat Liftnet	1079	279	0	0	1358
Stationary Liftnet	0	390	0	1	391
Tuna Longline	0	0	597	0	597
Set longline	277	571	923	595	2366
Drift Longline		185	277	147	609
Pole & Line	0	0	8	0	8
Other Hook & Line	6591	3729	903	4141	15364
Tuna Handline	0	91	0	0	91
Troll Line	851	11	401	35	1298
Total	16285	8826	5100	7058	37269

Table 9.4. Summary of major tuna fishing gears for the FMA-IXb (east Indian Ocean) and FMA-IXa (west Indian Ocean). Data taken from Tables 9.3a&b.

Tuna Gear Type	East	West	Total
Purse Seine	1233	384	1617
Tuna longline	3059	597	3656
Pole and Line	195	8	203
Troll Line	17695	1298	18993
Handline	300	91	391
Total	22482	2378	24860

Handline boats for ribbon fish beached in Csisolok, Pelabuhan Ratu. These boats also use troll line that target skipjack and juvenile yellowfin tunas.

6. In Sumatera Barat, trends of troll line landings of tuna is decreasing while the reverse is exhibited by the same fishing gear in Sumatera Utara, of which tuna landings is still increasing (Table 9.5a&b).

Landings and trends by fishing gear

The latest statistics of Bali Province, to represent FMA-IXb (eastern sub-region of FMA-IX), shows that two-thirds (63%) of tuna landings is from longlines and over 27% is

Tables 9.5a&b. Percentage share of tuna landings by fishing gear and year in the provinces of Sumatera Barat (upper table) and Sumatra Utara (lower table) Sources: Provincial statistics of Sumatera Barat and Sumatera Utara (various years).

Year	2005	2004	2003	2002	2001	2000	1995
Pelagic Danish seine	0.75	0.86	0.86	33.4	37.4	41.1	14.2
Demersal Danish seine	56.4	43.3	43.3	0.00	27.2	0.00	0.00
Beach seine	0	0	0	7.48	9.8	8.48	4.80
Purse seine	4.3	1.05	1.05	7.59	7.2	8.17	6.77
Drift Gillnet	44.2	32.3	32.3	3.15	5.3	4.13	8.03
Encircling gillnet	0.0	0.00	0.00	15.4	14.3	13.2	35.4
Shrimp gillnet	0	0	0	0	0	9.27	12.1
Set gillnet	38.4	31.7	31.7	3.88	7.7	7.34	7.49
Trammel net	39.6	25.3	25.3	13.0	7.3	10.0	0.83
Boat/raft liftnet	40.6	13.6	36.4	1.42	1.9	3.37	0.37
Set longline	0	0	0	18.6	50.1	33.4	0.00
Hook and Line	15.9	15.4	15.4	1.49	28.9	30.0	41.7
Troll line	24.7	29.1	29.1	72.0	87.5	80.4	95.8
Other traps	2.15	1.70	1.70	99.9	0.0	0.00	0.00
Total	19.7	14.1	19	10.63	28.9	27.6	28.2

Gear Type	2005	2004	2003	2002	2000	1998	1995	1992	1988
Pelagic Danish seine	0	0	0	0	0	0	0	1.82	1.53
Demersal Danish seine	0	0	0	0	3.33	1.17	2.12	9.54	3.49
Beach seine	0	0	0	0	0.17	0.76	4.59	2.35	4.36
Purse seine	26.5	26.5	21.4	0	5.9	5.4	9.3	20.5	6.59
Drift gillnet	44.9	45.5	54.8	17.9	25.3	26.5	23.9	16.3	14.1
Encircling gillnet	4.87	4.87	0.00	41.72	2.12	2.44	2.54	7.11	6.79
Set gillnet	0.81	0.82	1.71	0	3.71	4.95	2.08	2.18	1.17
Trammelnet	0.94	0.94	0	5.26	0	0	0	0	0
Boat liftnet	0.07	0.07	0	0	0.31	1.02	0.83	0.84	1.96
Raft liftnet	0.54	0.58	0	0	0.06	1.01	0.41	1.39	0.53
Scoop Net	0	0	0	0	0	0	0	5.48	1.40
Other Liftnets	0	0	0	0	0	0	0	15.4	1.77
Drift Longline other than tu	0	0	74.3	0	2.45	100.0	36.6	0	99.2
Set longline	2.22	2.23	5.26	100.0	13.9	9.97	11.24	5.95	7.48
Other Hook and Line	37.4	37.2	26.1	0	13.5	14.8	11.1	16.4	16.5
Troll Line	90.3	90.30	0	29.97	0	0	0	70.9	0
Simple Tuna Handline	31.5	31.50	0	0	0	0	0	0	0
Others	0	0	0	7.29	1.19	3.77	0	70.4	40.3
Total	15.0	15.1	12.2	12.5	7.42	6.87	7.02	13.0	8.08

from troll lines (Figure 9.8a). The combined landings of these two fishing gear account for 91.8% of the total tuna landings in PPS Benoa.

By comparison, in FMA-IXa (west Indian Ocean) represented by Sumatera Utara, statistics show that the fishing gears catching tunas are, the drift gillnet which accounts for almost half (49.1%) of the total landings and the purse seines which contribute 22% (Figure 9.8b&c). Handlines also land 7.2% of total landings. The landings of the famed major gears targeting tunas (such as longline and troll lines) are not significant in Sumatera Utara Province. In Sumatera Barat, out of the total tuna output amounting to 19.7 thousand tons, tuna handlines and the mobile liftnets (Bagan perahu/rakit) are the major contributors (Figure 9.8b). The mobile liftnets contributed 6,314 metric tons (32%) of the total tuna landings of the Province. The species caught are mainly juvenile skipjacks and frigate tunas. With high certainty, bullet tunas and eastern little tunas were caught as well but was probably lumped with the frigate tunas and skipjacks.

Propulsion system of handline boats line up at the back of a fisher's house in Csisolok, Pelabuhan Ratu, West Java.

Landings and trends by species of tuna

There are eight commercial species of tuna caught and landed in FMA-IX. This include the yellowfin, bigeye, albacore, skipjack, eastern little tuna, longtail, frigate and southern bluefin. The endangered bluefin are taken by longline fishing gears operating in the oceanic part of the Indian Ocean south of the islands of Java and Bali.

The composition of tunas caught in the sub-areas of fishery management area nine differs starkly. In the Sumatra side (FMA-IXa), small tunas dominate the landings, with

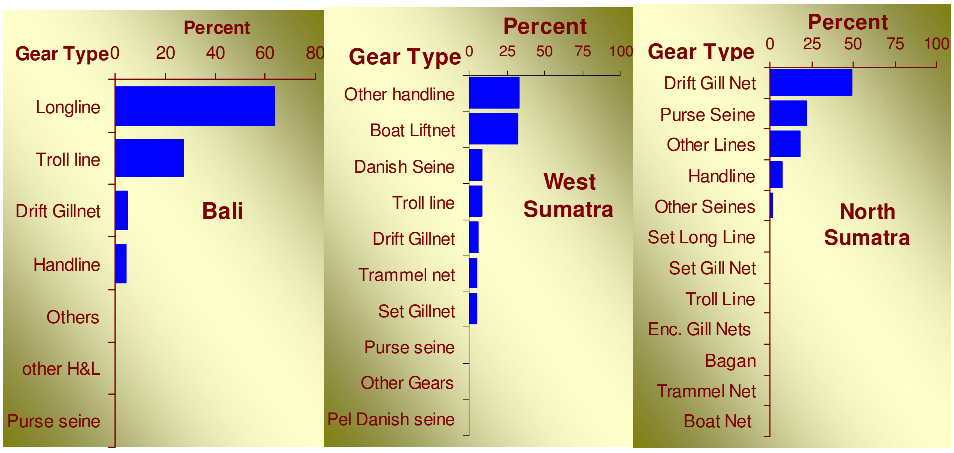


Figure 9.8. Comparison of the share of landed tunas for each gear type for the provinces of a) Bali, b) West Sumatra and c) North Sumatra. Source: Provincial DKP statistics of Bali (2006), Sumatera Barat (2005), and Sumatera Utara (2005).

frigate, eastern little tunas and skipjacks almost equally sharing an aggregate share of 76% (Table 9.6). In Bali, which represents the eastern FMA-IX (FMA-IXb), the four large tuna species consisting of the yellowfin, albacore, bigeye and longtail account for three quarters (76.1%) of the total tuna landings.

One of the interesting entries in Table 9.6 is the presence of the southern bluefin tuna. In Bali, this species accounts for 3.52% of the total catch but in North Sumatra, it accounts for about 13.4%. This entry appear erroneous given the lack of longline fleet landing in North Sumatra and most of the fishing gears operating and landings there are mainly coastal and far from where bluefin tunas are caught. This entry is probably an albacore mis-identified as southern bluefin tuna because it is not at all reported in the statistics despite its abundance in the market.

Table 9.6. Comparison of tuna species landed in Sumatera Utara Province (2005) and Bali Province (2006). Source: Provincial statistics DKP.

Species	North Sumatra (%)	Bali (%)
Frigate tunas	23.7	4.72
Eastern little tunas	24.0	7.96
Skipjack tunas	28.1	7.61
Yellowfin tunas	3.53	28.6
Albacore		22.3
Southern bluefin	13.4	3.52
Bigeye tuna	3.53	16.3
Longtail tuna	3.71	8.93
Total catch (tons)	13362	28781

Troll line fleet line up the entire length of Padang River.

Seasonality of tuna catch

The monthly landings of tuna from PPN Pelabuhanratu over six years period is used to describe the seasonal trends of the large and small species of tuna, and skipjacks. Landings of the three tuna species categories follow a 1-year peak period, the peak month shifts between years but generally falls in the middle of the year (Figure 9.9). For the small tunas, the intensity of peak abundance does not vary much between years. For the large tunas, the years 2003 to 2005 showed very high abundance compared to the three preceeding years. The skipjacks showed regular seasonal single peak of abundance in landings but with high spike of landings in 2005.

The increased volume of large tuna landings are mainly due to the rising landings of handline and troll line which have become extremely popular fishing gear. Even fishers that target the ribbonfishes (layur) now partake on the tuna rush and targets the yellowfin tunas using simple handline.

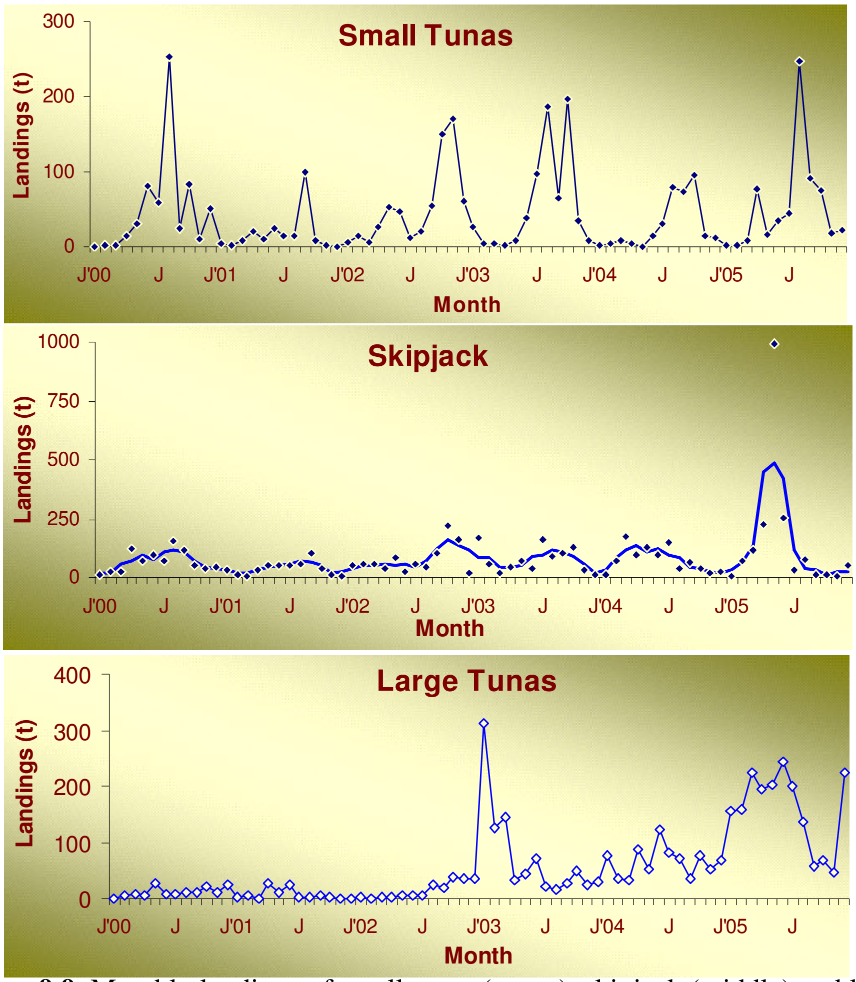


Figure 9.9. Monthly landings of small tunas (upper), skipjack (middle) and large tunas (lower) from PPN Pelabuhanratu, Jawa Barat. Line drawn for skipjack is a moving average of three data points.

Trends of the fishing gears

At the Sumatra side (FMA-IXa), tunas are taken mainly by drift gillnet, boat liftnet and purse seine. The number of these fishing gears have increased in number over the years. In Sumatera Utara, drift gillnets tripled from 448 units in 1992 to 1,312 units in 2005. Similarly in Sumatera Barat, where drift gillnets and mobile liftnets account for two-thirds of tuna landings, the number of units grew by 59% and 16%, respectively from 2000 to 2005 (Fig 9.10a&b).

At the eastern side (FMA-IXb), the traditional tuna fishing gears such as longline, troll and handline account for most of the tuna landings. In the province of Bali, the number of tuna handline and troll line increased over the periods of 2005 to 2006 while tuna longline declined from 769 in 2005 to just 495 in 2006 (Table 9.7). Similarly, purse seine units went down from 158 in 2005 to just 122 units in 2006. Even drift gillnets decline by 700 units from 2005 figures.

Drift gillnets operated on sailboats in Lombok Island are not affected by fuel price hike.

The decline of fishing gears is a cause for concern because it signaled the non-profitability of fishing operations. Declining catches and increasing operation cost brought about by the increases of fuel prices has taken its toll on tuna fishing. The detailed discussion in the impacts of fuel price increase is in Chapter 13.

Estimate of Tuna Catch for FMA-IX

The estimated total tuna catches for FMA-IX is 777.4 thousand tons. This current catch estimate is 3.63 times the official recorded tuna landings of 214.1 thousand tons. Catches landed in the Sumatra side (FMA-IXa) is about 274.6 thousand tons or 37% while the

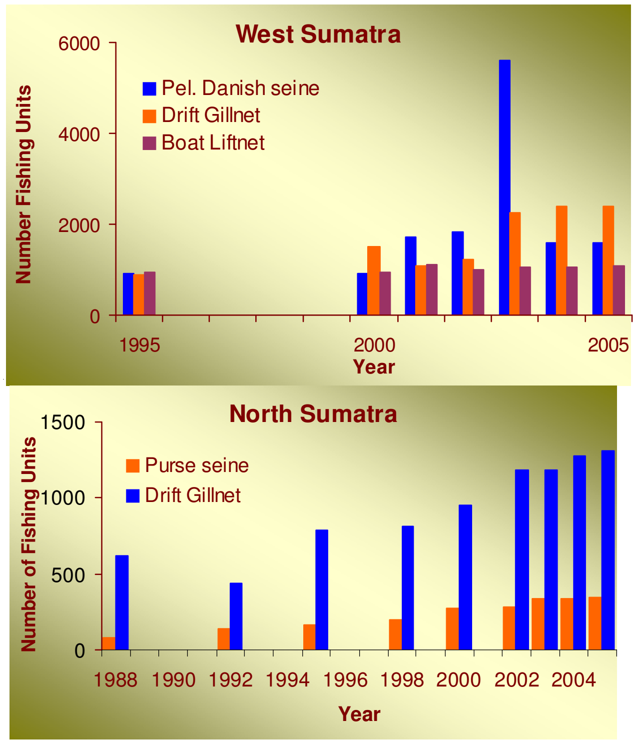


Figure 9.10. Trends in the number of tuna fishing gears registered in the Provinces of Sumatera Barat (upper) and Sumatera Utara (lower). Sources: Provincial DKP Statistics (various years).

Table 9.7. Number of fishing gears from the province of Bali from 2001 to 2006. Source: Provincial DKP Statistics of Bali, 2006.

Year	Purse Seine	Drift gillnets	Tuna Longline	Other longline	Troll line	Tuna Handline	Other Handline
2001	143	6055	529	655	9823	-	13183
2002	116	7448	545		10236	-	8547
2003	179	6123	522	279	8159	3526	6934
2004	174	7922	769	206	9453	5809	6770
2005	158	8316	769	36	9260	4526	6010
2006	122	7648	495	222	9303	6844	4330

A troll line hook and lure used by Lombok fishers.

eastern part (FMA-IXb) accounts for two-thirds of the total or 470.4 thousand tons (Table 9.8).

Viewed by species groups, small tunas ("tongkol") dominate the total estimated tuna landings with 311 thousand tons or 42% followed by skipjack with 286.3 (38.4%). Large tunas, constitute 20% of the estimate (Table 9.9). Tuna landings from eastern sub-area (FMA-IXb) accounts for two-thirds (63.1%) of the total landings; most of which are the large tunas and skipjacks.

The Tuna Fishery of FMA-IX

This section discusses current observations and analysis of data taken from various sources that covers the whole FMA-IX. Not included is the Nanggroe Aceh Darussalam (NAD). This is because at the time of the surveys, rehabilitation efforts from the tsunami event is deep underway and a major fisheries component is also being implemented by the Food and Agriculture Organization of the United Nations (FAO). The discussion would cover the entire tuna fisheries of FMA-IX including but not limited to the tuna longline fishery, which is the best known tuna fishery in Indonesia. We have given focus on other tuna fishing gears as well as the current situation of the fishery and

Table 9.8. Data used in the estimation of the tuna catches in FMA-IX. Based on interviews conducted, where number of fishing units not known, 60% of official records was used. (The footnotes refers to the numbers given at the row and columns).

Gear Type	Number of Gears[1]	No. of Gear Used [2,6]	Annual Fishing Days [3/] annual trips [4]	CPUE (tons/day or fishing trip)	Annual Catch (mt)/unit	Est. Annual Total Fish Catch (mt)	% Tuna Share	Est. Tuna Catch (mt)
Danish Seine - FMA-IX a[1,2,3]	1647	988	162	0.25	40.5	40,014	0.56	22,407.84
Danish Seine - FMA-IX b[1,2,3]	5158	3094.8	162	0.40	64.8	200,543	0.90	180,488.74
Drift Gillnet - FMA-IX a[1,2,3]	3718	2230	200	0.15	30.0	66,900	0.45	30,105.00
Drift Gillnet (<10gt)-FMA-IX b[1,2,3]		17293	162		4.7	80,931	0.60	48,558.74
Drift Gillnet (>10gt)-FMA-IX b[1,2,4]	28822	500	12		51.5	25,750	0.90	23,175.00
Handline - FMA-IX[1,2,3,5]	4292	2732	120	0.22	26.4	72,125	1.00	72,124.80
Longline - FMA-IX[1,2,3,5,6]	3227	670	232	0.24	55.7	37,306	0.95	35,440.32
Mobile Liftnet [1,2,3,7]	1079	647	197	1.05	40.5	26,204	0.41	10,638.62
Pole and Line [1,2,3,8]	195	220	171	1.73	295.0	64,900	0.98	63,602
Purse Seine(15-day trip)[9]	351	175	24	36.0	864.0	151,200	0.90	136,080
Purse Seine (7-day trip)[10]		176	36	5.89	212.0	37,312	0.27	10,074
Trammel Net[7]	906	543	24	0.97	23.2	12,598	0.40	4,988.65
Troll line - FMA-IX a	862	517	52	1.00	52.0	26,884	0.9	24,195.60
Troll line - FMA-IX b	10233	6140	192	0.14	26.9	165,043	0.7	115,530.24
TOTAL								777,409.79

1/based on official records from provinces of West & North Sumatra (2005), West (2004), Central (2005) and East Java (2005), Bali (2006), NTT and NTB (2005)
2/ only 60% of gears were used in computation
3/ total number of actual fishing days
4/ number of fishing trips per year
5/ Combined values for east and west FMA-IX which include only provinces of West Sumatra, West Java, NTT and Bali. Used only 60% of gears recorded from Bali
6/ combined vlaues for longline that includes provinces of west java, central java, east Java, Bali and NTT.
7/ Data refers to West Sumatra
8/ Data refers to Nusa Tenggara Timur
9/ Data refers to North Sumatra

Table 9.9. Estimated tuna landings by species category between sub-areas of FMA-IX.

Sub-Area	skipjack	small tunas	large tunas	total	%
FMA IX-A	67647	152673	54232	274552	36.9
FMA IX-B	218670	158525	93205	470401	63.1
TOTAL	286317	311199	147437	744953	
%	38.4	41.8	19.8		

Wind power fish dryer prototype under test in Tanjung Luar, West Nusa Tenggara.

changes. The readers are referred to studies of Simorangkir (2003), Ishida et al. (1994), Marceille et al. (1984), Merta (2000) and Proctor et al. (2003) on the studies so far made on the tuna longline fishery of Indonesia with much focus on the fleets based in Java and Bali islands.

Tuna Longline Fleet

The biography of the government-owned corporation PT. Nusantara Perikanan (erst known as PT. Samodra Besar) is the history of the tuna longline fisheries of Indonesia.

Its fleet development, catch rates, profits and loses made in recent years mirrors the boom and bust history of the tuna longline of Indonesia.

Current fleet sizes of PT. Nusantara Perikanan in 2007 is 26 vessels, of which 13 are operational, 9 units are rented out to other fishing companies and the rest are out of commission. Based on the data provided by the company, the company started in 1973 with 3 vessels, grew to 12 in 1974, and in 1975 has a fleet of 18 vessels of >100 GT. In 1992, 2 units of wooden-hulled vessels of 40 GT were acquired, the fleet continued to grow with acquisition of wooden vessels of 60 and 80 GT. By early 2002, the company has six 40-GT, nine 60-GT and three 80-GT class vessels, all wooden hulled. The company likewise invested in small 15 GT fiberglass reinforced hulls between 1993 until the present. At its peak in the 1980's, the company has an aggregate total tonnage of 1,800 GT (Figure 9.11).

The tuna longline fleet of Indonesia consisted roughly of around 1,600 boats (based on estimates made by at least 10 longline boat captains). About 495 of the fleets are based in Benoa Bali (DKP Propinsi Bali 2006) and the rest are distributed in the fishing ports of Nizam Zachman in Jakarta, Pelabuhanratu in Jawa Barat and Cilacap in Jawa Tengah. The sizes of fleets have decreased from that reported by Proctor et al.in 2003 (Table 9.10).

The longline fleets consisted mainly of three types, the large steel-hulled vessels, the mostly wooden-hulled (very few are steel-hulled) medium to large vessels (of maximum 100-GT size), and the small fleet made of steel, wood or fiberglass reinforced boats.

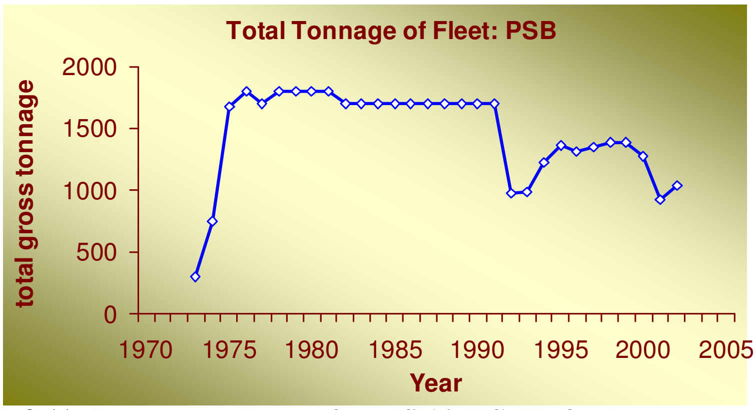


Figure 9.11. Aggregate tonnage of tuna fishing fleet of PT. Nusantara Perikanan (formerly PT. Samodra Besar).

Many of these vessels, particularly the wooden-hulled crafts, are old with inefficient storage facility on board and are not equipped with sufficient navigational equipment required for safety at sea. The living conditions aboard these old vessels also leave a lot to be desired.

Small and medium-sized vessels operate between 15-25 days at sea, larger vessels between 25-45 days at sea. This was the practice prior to 2003. With the decline in hook rate and the increased of fuel prices by almost 200%, the fishing operations have changed drastically. Medium to large boats now operate longer between 3-6 months at

Table 9.10. Number of tuna longlines by gross tonnages based in FMA-IXb (east Indian Ocean) in 2002. Source: Proctor et al. 2003.

Vessel size (GT)	Benoa	Muara Baru*	Cilacap	Total
0-30	138	-	10	148
31-60	160	61	45	266
61-100	209	294	34	537
101-200	195	521	25	741
>200	3	26	-	29
Total	705	902	114	1721

sea, making only 2-3 trips per year to save on fuel and operating cost. The smaller fleet, mainly <30 GT operate between 7-10 days at sea and supply the fresh and chilled tunas. The small fleets are now operating nearer the shore to ensure better catch yet smaller fishes.

In 2006, the fuel price increased amid declining catch from Indian Ocean has practically stopped over two-thirds of the fleet from operating. Many of the boats remain tied up at PPS Benoa, PPS Muara Baru and PPS Bungus waiting for the change of season (better catch rates) and fuel subsidies from the government. Some of the longline fleets has to stopped operating because the sizes of boats could not allow streamlining of operations to become economical. Large longline companies (e.g. PSB, DaMarina) survive because they streamlined operations making the fleet stay longer at sea and carrier vessels collect the catch and deliver supplies to the fishing boats. For the longline fleet of Indonesia, many of the 1,600 boats have single ownerships.

Fishing Techniques

Most of the longline boats operating in Indian Ocean target the bigeye tunas which requires setting deeper than when targeting the yellowfin tunas. The number of mainlines per set varies from 12-18, with each mainline having 15-17 hooks; that the number of hooks utilized per setting ranges from 1,800 to 2,600 hooks. Before 1990, many of the longline operated within the upper water column (shallow-sets) to catch the yellowfin tunas. The preference of longliners for bigeye tunas, found on the deeper part of the water column, is it higher market price than the yellowfin tunas, particularly for the sashimi grades.

Today sardines are mainly used as baits because it is much cheaper than round scads (layang). Early on, imported Pacific saury were used but its availability and high price made local fleets to look for substitutes. The roundscad is a perfect bait but has become prohibitively expensive because it is also for human consumption and exported as baitfish to Korea, Taiwan and Japan. However, since sardines are smaller (18-20 pcs/kg) and more difficult to use as baits due to its much laterally compressed body, it requires a smaller J-hook than what is used in other countries. The size of hook greatly influences the sizes of fish caught, escapement rates and the amount of juveniles and by-catch taken by the longline gear (see also discussion on Chapter 12: By catch).

Due to the consistently high demand for sashimi, about 200 of the vessels cater to this market where catch from vessels are taken by carriers every 15 days.

Fishing Grounds

The fishing ground of the domestic tuna longlines of Indonesia is undertaken mainly along the boarder of the EEZ south of Java at 110° to 114° East Longitudes and >15° South Latitude. Rarely do vessels fish south of Sumatra Island and the 100° E longitude appears to be the western border of their fishing operations. Size of fish depends also on the fishing area so fishers normally go past latitude 15° S to get to bigger sized fish. Fishing for bigeye and albacore means that the fishing depth is between 100-330 meters

Yellowfin tunas from Indian Ocean by the by troll line fleet from Sulawesi Selatan.

Boats are equipped with GPS and some crude navigation equipment. Very few of the wooden-hulled vessels have radars. For large companies such as the government owned PT Nusantara Perikanan (now renamed PT. Samodra Besar), the selection of fishing grounds is also aided by satellite generated maps that are supplied weekly at a subscription rate of US$400 per month. But usually, these maps are rarely used and more often, records kept by the company over many years and the experience of the boat captains determine where fishing is to be conducted.

Longlines also operate within the archipelagic waters, particularly in Flores and Banda Seas (Figure 9.12). Their operation is highly seasonal (October-December) and targets the bigeye tunas.

Catch Trends

Using data from Indian Ocean Tuna Commission, the catch of longlines from Indian Ocean peaked in 1999 and hence have continued on a downward trend (Figure 9.13). Looking at the species level, catch of four major species similarly have been on the decline, downfall trend started in 1999 for the yellow fin and big eye tunas and in 2003 for albacore. The catch of the Southern Blue Fin tuna fluctuated erratically but generally on the downward trend also.

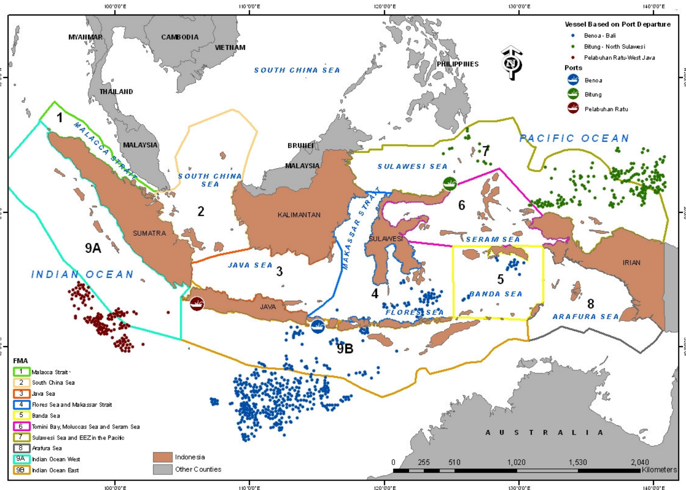


Figure 9.12. Locations of the sets of longline boats made by on-board observers during the circle hook fishing trials. Source: WWF By-Catch report, 2007.

Catch Rates

The declining catch rates, expressed as hook rate (fish/100-hooks) and CPUE (kg/day-fishing), of tuna longlines operating in Indian Ocean are presented in Figure 9.14. The fishery started in 1973 and for the first 10 years of operation catch rates were rising until the mid-1980s and hence the decline began. In the early 2007, catch rates have reached an unprofitable level of 0.36 per 100 hooks (pers.comm with Mr. Soeprioyono, Manager of Bali Branch-PT. Perikanan Nusantara).

Catch rates of tuna vary with vessel size with higher larger boats catching more than smaller ones. However, vessel greater than 100 GT caught less than those of an 80-GT class boat. This explains why the company where this data was taken from stopped using this steel-hulled large fishing crafts. The catch made by a 40, 60 and 80 gross tonnages did not differ significantly with each other but all these are significantly higher than the catch of a 15 GT boat (Figure 9.15).

While smaller vessels have lower catch rates, they are economically more efficient when the financial aspect is taken into consideration, as the requirement for initial operational and capital investments is lower (Figure 9.16). With the fuel prices continue to rise, use of smaller vessels for tuna longline is more economically sense. This is why, only the smaller vessels remains in operation at this time of crisis; the bigger fleets remain tied up at the various fishing ports.

Fish handling in Cilacap, Central Java, leaves much to be desired.

Pelagic Danish Seine (Boat Seine)

The Fishing Fleet

This fishing gear, known locally as "payang" was already used in the area long before the tuna fishery developed. Designed and used as a demersal fishing gear called "dogol", it has been modified to catch small pelagics.

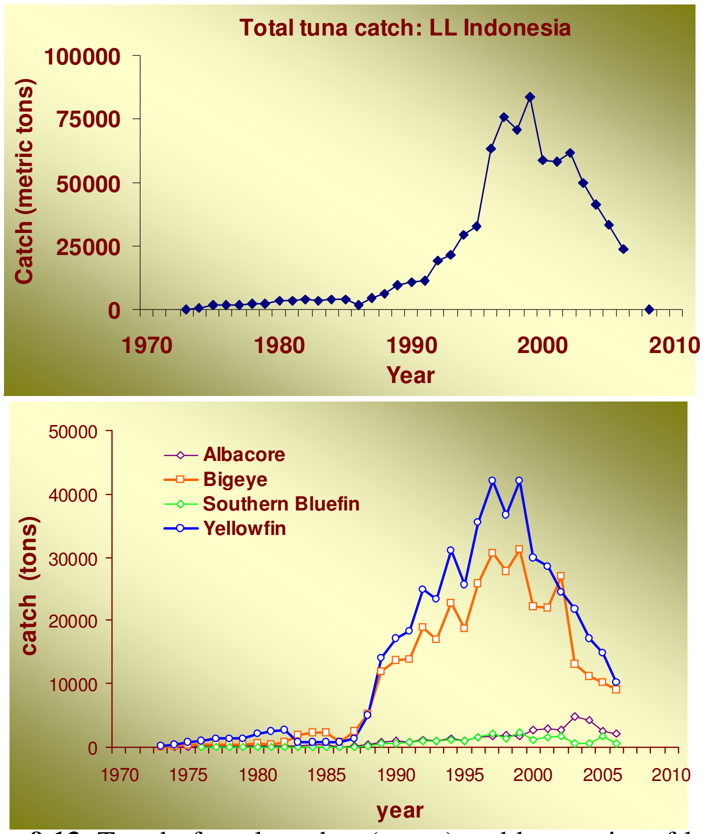


Figure 9.13. Trend of total catches (upper) and by species of longline taken from the Indian Ocean. Source: IOTC database.

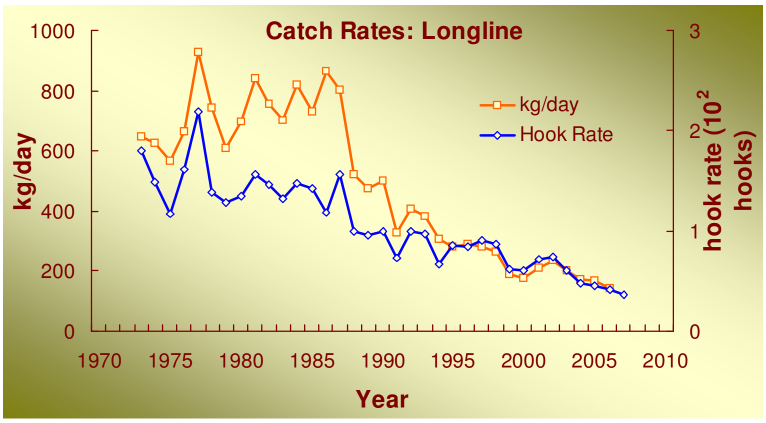


Figure 9.14. CPUE (kg/day) and hook rate (fish/100-hooks) of tuna longlines of PT. Perikanan Nusantara (formerly PT. Samodra Besar) from 1973-2007. Source: Unpublished data from PT. Perikanan Nusantara from 1970-2006. 2007 data provided by Mr. Soepriyono.

The fishing fleet of the pelagic Danish seine totals 8,321 units as of 2005 of which about 80% (n=6,674) are based in FMA-IXb. Tunas account for 75% of the catch for the fleets from Sumatera Barat while about 100% during the peak season for those from Jawa Barat. The small number of Danish seine in North Sumatra appears not taking tunas at all. Pelagic Danish seines generally belong to the 5-10 GT class, powered by outboard motor.

Fishing Techniques

Characterizing the fleets based in Pelabuhan Ratu, Jawa Barat, the boat operates daily, goes out fishing early in the day between 5-6 o'clock at dawn, travels between 2-4 hours to the fishing ground and returns to home port between 7-8 o'clock at night.

A health standard for fish handling in Muara Baru , Jakarta needs to be inplace to improve the quality of fish

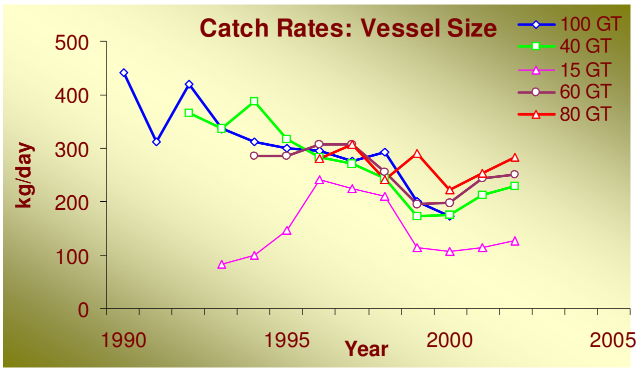


Figure 9.15. Trend of catch rates of tuna longline for different boat size classes. (Earlier data are available but the 10-years period was chosen for comparison purposes). Source: Catch records of PT. Perikanan Nusantara.

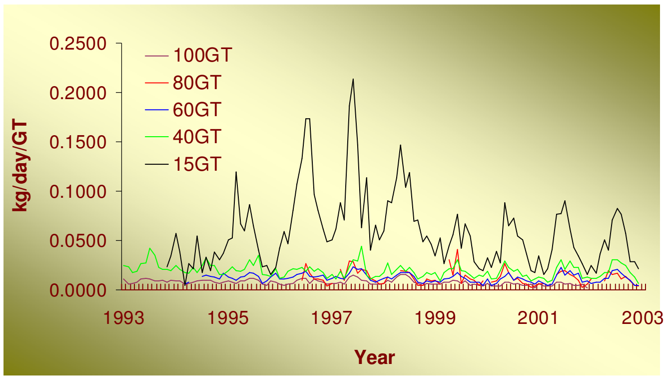


Figure 9.16. Catch efficiency (kg/dayfishing/gross ton of vessel) shows that for tuna longline, the smaller the vessels, the more efficient it becomes.

Fresh and salted, these bullet tunas are ready for boiling call *pindang*, a native way of fish processing.

The boat makes 15-20 sets per day with an average catch of 0.5-1.5 tons per day during the peak season (south winds) and 0.25-1.0 ton per day during the lean (west) season.

The net follows a typical 2-seam trawl net design with the following specifications: wings length (175-200 m), wing height at widest (60 m), wings mesh size (5, 6, 7, 8, 9, 10 cm), body length (35 m), mesh size (2, 3, 10 cm), bunt length (35 m), bunt mesh size (1 & 2 cm), mouth opening of the net ~ 45 meters through the use of bamboos as floats and stones as sinkers.

The net is set only after schools have been detected, either through sightings of birds, debris, or dolphins. The danish seines operating in Indian Ocean do not use FADs as compared to other areas of the countries where the fishing gear operates, such as in Java Sea and Malacca Strait (Bailey 1987).

Trends of the fishery

According to one of the boat captains we interviewed, catch rates for tunas have been increasing for the last three years starting in 2004. The catch levels in 2006 is 20% more than in 2005 and about 40% more than in 2004, a claim substantiated by catch rates taken from data of landings in Pelabuhan Ratu fish port (Figure 9.17). The catches of skipjacks appear to increase during the peak season over the period of 2000-2005. The main reason given was the prolonged dry season these last three years.

Seasonality

In eastern Indian Ocean (FMA-IXb), Danish seines target the tunas and their availability differ between months. Large tuna species (YFT, BET, ALB) are most abundant in March to April, small tunas follow suit in May to June and skipjack dominates in the months of August to December. Share of non-tunas (Indian mackerels, roundscads) remain low through most of the year (Figure 9.18).

Handline

Handline fishing in most areas of FMA-IX is relatively coastal compared to the other fishery management areas (e.g. FMA-VI & FMA-VII). Many fishers use handline as their secondary fishing method and many more use it only when opportunities come along such as sighting tuna schools or during the off season of their primary targeted fishing activity which is cutlass or ribbonfish. The full time tuna handline fishers operate as part of a fishing or trading company and these are found in Bali and Lombok in Nusa

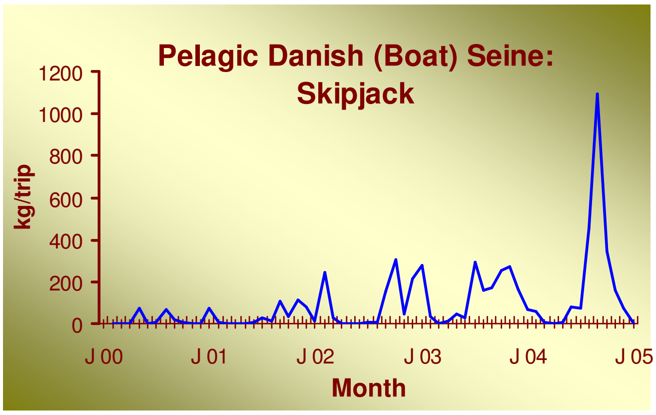


Figure 9.17. Catch rates (kg/trip) of pelagic Danish seine fleet landing at the Pelabuhan Ratu fishing port. Source: PPN Pelabuhan Ratu 2000-2005.

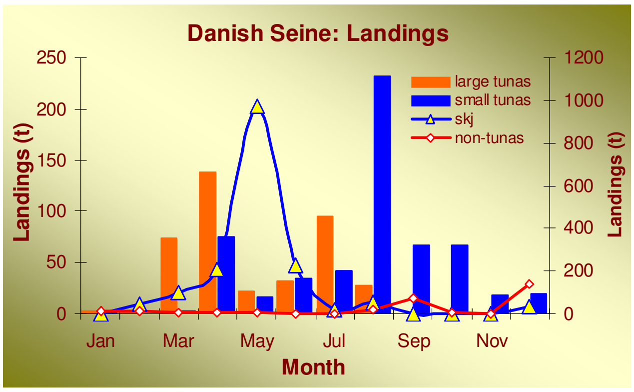


Figure 9.18. Monthly landings of Danish seine at PPN Pelabuhanratu (2005). Source: PPN Pelabuhanratu Fisheries Statistics, 2005.

Pindang are ready for delivery to neighboring markets in Java and Sumatra.

Tenggara Barat. These tuna handline is usually managed by tuna trading companies or they belong to a "plasma system". In Lombok, and vicinities, there are about 150 to 200 fishing sampans under this company which is the sole operator of this method in Lombok.

The company provides the mother boat of 7 gross tons and powered by two inboard engines of 40-HP. Onboard the mother boat are about 4 to 6 fishers with their own sampans (non-motorized boats) which they used for actual fishing. The mother boat acts as dining and resting place and as storage for their catch and provisions. They go out fishing with their non-motorized plank boats (*sampans*) at daytime and return to the mother boat at night to rest. Fishing is exclusively done around the FADs which are also set up by the company. They stay at sea for about 7 to 10 days per trip.

The handline uses mainlines of 500-mm diameter and hooks of 4 - 5 commercial sizes. Fish are used as baits. The daily fishing routine starts with catching of baits consisting of small-sized tunas and scads. Only when sufficient bait has been caught (20-30 pieces) to last for the day, will the fisher begin fishing for tuna. This daily routine is only broken when school of tunas are sighted before the bait provision is fulfilled, this rarely happens however.

The fishery catches mostly yellowfin tunas and skipjacks. The peak months is usually during the months of September and October, during which the mother ship would carry back about 500 kg of skipjacks and 20 pieces of large yellowfin tunas. The rest of the months are considered lean months, when catch is more or less half of the catch during the peak months. The fishers perceived 50% decrease of catch since 10 years ago.

In the Province of Nusa Tenggara Timur, handline fishing is likewise conducted on a part-time basis by the troll liners from as far as Sulawesi Tenggara and Kendari, particularly during the lean months when schools of tunas are chanced upon. Locally called "coping", these used to be opportunistic activities but fast becoming a real endeavor as a result of the increase of fuel cost.

In Pelabuhanratu, Jawa Barat, the main target of handline fishers are the ribbon fishes (*layur*) but becomes opportunistic tuna fishers when schools of tunas are chanced upon. They also undertake trolling activities going to and returning from the fishing ground. It is claimed that 20-30 % of their income is augmented by these part time fishing activities. Landing data of the fishing port show small volume of landed yellowfin tuna in January and April which represent 0.25% and 0.32%, respectively, of the total fish landings.

Troll Line

Troll lines in FMA-IX are primarily used for catching skipjacks, small tuna species, and juveniles of yellowfin and bigeye tunas. By-catch include king mackerels, dolphin fishes, rainbow runners, jacks and barracudas.

In the southwest coast Sumatra, the troll lines uses boats of 5-GT powered by a 33-HP outboard motor. There are more or less 300 fishing boats of this type homing in Muara Padang, and there are more of its kind distributed along the other landings ports of the the southwest coast of Sumatra Island. The fishing gear is made of 2-mm diameter nylon mainline' which is further extended into a branchline at the other end. The branchline is made of the same material but of smaller diameter twine of 1.5-mm where the hook (commercial size #3) is attached. The hooks are baited with lures made up of neon colored light plastic materials. The design and operation of this boat is to target skipjack (and tongkol).

During the fishing operation, 10 lines are towed; four lines of 7.5-m length are on the underside of the hull near the water line, two (7.5-m long) at the midlevel, one at each side and two (40-m long) at the topmost part of the vessel. This setup when viewed at the top is a series of lines arrange in a horizontal manner. Fishing is at daytime and each fishing trip lasts for 7-15 days. A troll line boat has crew of four fishers. Historical accounts of the fishers indicated no changes in the volume of catch or fish sizes but the fishing ground has significantly moved farther asea compared to 10 years ago.

Troll liners based in the Island of Java are using smaller boats of <4GT powered by a 6-HP outboard motor. The mode of operation and fishing technique is designed to target the large tunas (>10kg) swimming at the surface. The troll line' mainline is made of 300-mm diameter nylon rope, the branchline is of the same material but with diameter of 150-mm, and uses just one hook. Lures are used and are made of colorful chicken feathers. Fishing operation is daily and at daytime only. The catch is mostly composed of juvenile tunas and skipjacks. During the peak months of April to October the average daily catch is 50 kg while only 20 kg during the lean months which starts from November to February. Accounts of fishers indicate marked decreased of catch by 300% when compared 10 years ago.

Troll liners from the Island of Sulawesi are using nylon twine mainline of 150mm diameter and 50mm branchline. The hook used is actually a jig (three-pronged hook) which is unique to the fishers whose origin is from Sulawesi Island. The baits are made from colorful light fabric materials. The fishing boats are also bigger, of 12 GT, powered by 2 units of 150-HP inboard engines. The fishers (5-6 individuals per boat) do not limit themselves in the inland waters of Sulawesi but travels as far as Banda Sea and Indian Ocean wherever catch is good. In the Indian Ocean, the main catch compositions are skipjack, yellowfin (all sizes) and juveniles of bigeye tuna.

As earlier stated, a troll line boat also carries handlines and fished in FADs for large tunas and skipjack if trolling catch is not good. Because of their mobility and their ability to use two different gears, these Sulawesian fishers could not really observe significant changes in the fisheries of their fishing grounds. In the coasts of Kendari City there are about 150 units of this type that make annual excursions to the fishing grounds of Sawu Sea, Flores Sea and Banda Sea.

Further east in the Lesser Sunda Islands, troll liners are using fishing boats of 7-GT powered with 2 inboard motors of 30-HP. They fished for 7 to 10 days per trip. Their catch is composed mainly of skipjacks, yellowfin tuna of all sizes and juveniles of bigeye tuna. They only fished during the months of September and October, catching an average of 20 individuals of large tunas and about 500 kg of skipjacks. They accounted that 10 years ago, catch is better by 50% when compared to today. In the fishing port of Lombok, there are about 150 units of this type of fishing.

The use of various fishing techniques to catch the different species of tunas, really complicates data collection system. It will be difficult to separate which fishing gear or what variety catch that ceratin species of fish/tuna. The use of information taken simply from landing sites will not suffice and will provide huge errors, particularly if the information will be used to assess the status of the fishery.

There is an urgent need to really study these developments in order to develop an appropriate data collection system. Observer programs for these vessels would appear to be more appropriate.

Catch Rates

Monitoring the landings of troll boats unloading in PPS Bungus in Sumatera Barat showed catch rates of 400 kg/boat per 7-days trip in 2003 (Luthfi 2005). Catch consisted mainly of skipjack tunas. Historical analysis showed that at the end of 2003, the number of troll boats has declined to just 25% of 1994 levels (Fig 9.19). Quite evidently, even without the benefit of a solid stock assessment, 100 units of troll boats (in Padang, West Sumatra) appears to have caused the leveling of catch rate to about 400 kg/boat per trip. This graph is a good admonishment to the resource managers in thinking hard of formulating a precautionary measure to prevent further increase in fishing effort. This situation is further enhanced by the fishing efforts exerted by fishing boat from other places coming to the area to fish. Fishing effort regulation should also include these fleets that operate in the area on a seasonal basis.

Sharks and rays, by-catch of longline and gillnets for sale at auction hall in Cilacap, Central Java.

Drift Gillnet

The use of drift gillnet for tunas is prevalent in Central Java (Jawa Tengah) Province and is a major source of the skipjacks landed at the fishing port of Cilacap (PPS Cilacap). Though there are also gillnet operations for small tunas and skipjacks in Jawa Barat Province, the scale of operation is significantly smaller when compared to that of the Jawa Tengah Province.

In Jawa Tengah, offshore drift gillnets are using fishing boats of 20-70 gross tons powered with inboard engines ranging from 120 to 150 horsepower. The length of the fishing nets ranges from 1,200-m to 2,100-m with netting depths ranging from 18-35 meters. In one fishing boat there are about 10-12 fishers onboard. Just in the vicinity of Cilacap there are about 500 units of fishing boats engaged in tuna drift gillnet fishery. Their fishing ground falls within the latitudes of 8° to 10° South and longitudes of 105°

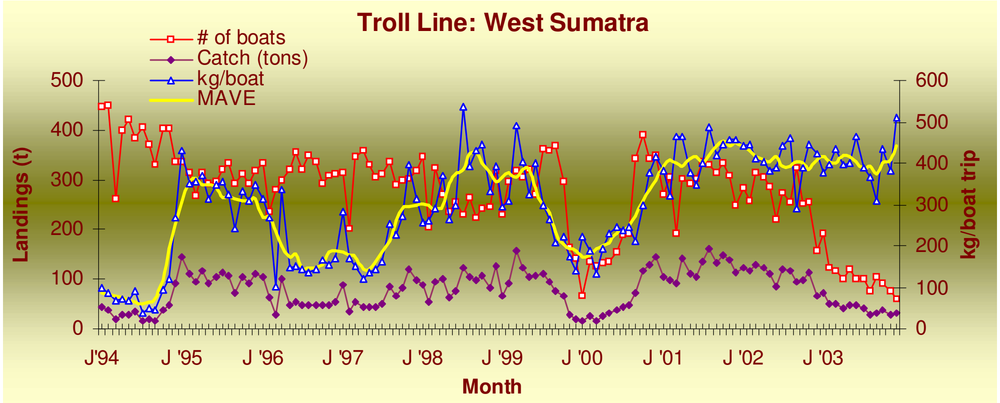


Figure 9.19. Trends in the number of troll line vessels, catch, catch rates (kg/boat/trip). Yellow line is the moving averge of three data points for catch rate. Source: Luthfi 2005.

to 110° East. One fishing trip may consist 7 to 15 days, mostly 15 days unless the catch is really good that the boat needs to return earlier; such times are usually observed during the months of April to August while lean months are observed in the months of November to February. Setting is at night time and is usually done once. Average catch per trip during the peak months is more or less 2 tons of skipjacks and 250 kg of other fishes. During the lean months however, average total catch is just 500 kg to one ton. Historical account of fishers indicated that the volume of catch had decreased by 50% over the last ten years.

The driftnet gillnets in Jawa Barat particularly those landing in PPN Pelabuhanratu target the small tuna species. Peculiar for this area, the drift gillnets are set in combination with a short longline attached at the other end of the net. The longline targets the sharks. The fishing boats used in this fishery are small-scale with gross tonnages of <3 and powered by inboard engines of five to eight horsepower. The number of vessels based in the port of Pelabuhanratu alone is about 100 of such units. The total length of the netting panel ranges from 1,200-m to 2,100-m with depth of about 18-22 meters. Fishing is undertaken daily at the waters off Java Island (Indian Ocean neritic zone) for an average of 5-6 hauls per fishing-night. During the peak months of fishing from August to October the average catch per fishing-night ranges from 100 to 200 kilograms while during the lean months of February to May the average maximum catch is only 10 kilograms. Compared from the early years of 2000, the fishers still observed an increasing volume of catch, a narrative quiet different from that of Central Java drift gillnet fishers targetting the same species. It is however interesting to note that the fishing ground of this fishery is near shore as compared to the offshore fishing ground of Central Java. Also note that the main target of the Central Java fishers are the mature skipjacks while in West Java, the fishers target the small tuna species of the genus, *Auxis,* and juveniles of the skipjacks.

Fish classified as rejects are further processed into fish barbeque and sold locally.

Analysis of landings of drift gillnet in PPN Pelabuhanratu in 2006 confirm the seasonality information provided by respondents (Figure 9.20). There are generally two peaks of abundance, each falling during the intermonsoon period but since year 2006 is considered by fishers as anomalous because of the prolonged season of high catch rates which are attributed to the long dry spell that hit Java.

The same drift gillnet fishery as that found in West Java is similar to those in West Nusa Tenggara (NTB) particularly those homing in Tanjung Luar fishing port. Here, the fishing boats are larger (10-GT) and propelled by 2 units of 150-HP inboard motors. This fishery' fishing ground is in the waters of Indian Ocean and sometimes reaches as far as Bali Sea, that a trip may lasts for an average of 25 days. This fishery is not using FADs or lights, to aggregate fishes, even when fishing is at night. One fishing unit is manned by 4-6 fishers and there are about 200 units in the vicinity of Tanjung Luar. The catch composition of this drift gillnet fishery are skipjacks, bullet and frigate tunas, and the juveniles of yellowfin and bigeye tunas. Peak season of fishing is during the east monsoon from May to December with average catch of 10 tons for seven days of fishing.

Liftnet

The liftnet fisheries in FMA-IX mostly support the pole and line fisheries. But in Padang, Sumatera Barat this fishery do not support the pole and line fleets of live baits but rather target anchovies and small tuna species for human consumption. The peak season for the small tuna species, in particular, starts in the month of September until December. The average catch during this season ranges from one ton to 2.5 tons per

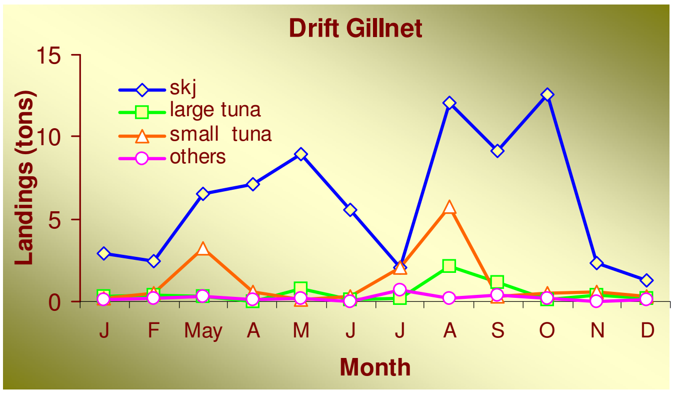


Figure 9.20. Landings of tunas taken by the drift gillnet fishery based in the fishing port of Pelabuhanratu, Jawa Barat. Source: PPN Pelabuhanratu records, 2005.

fishing-night. During this season, the catch composition is 90% small tuna species mostly the *Auxis* spp. And 10% mixture of anchovies (teri), mackerels (kembung), scads (selar) and juveniles (~500g) of yellowfin tuna (sisik or jabric). The fishing boat used in this fishery is of 30-GT power-driven by an inboard engine of 160-HP. The fishing gear is about 16,900-m^3 enclosures. To aggregate the fishes, this fishery is using a total of 154 bulbs (140-daylights and 14-mercury bulbs) installed all around the peripheries of the fishing boat. There are about 200 units in Bungus only operating this specific type of fishery.

Purse Seine

Purse seine operation in FMA-IX was believed by most to be just starting but an interview with the fishers from Sumatera indicated that this fishery has been existing even in the seventies and are mostly operated by Filipino fishers and companies but stopped operation upon the behest of local fishers who felt outcompeted in the race to catch fish. Not long after the exit of the Filipinos, the local fishers started using the same fishing technique. To date, there is a single unit owned by the state and managed and operated by PPS Bungus Management. The fishing vessel is wooden-hulled of 117-GT and power-driven by an inboard engine. This fishery fished at nights in FADs. The boat has 40 crew members. The peak fishing season is during the months of January to June with average of 60 tons per trip of 10 days while the low season is from July to December with catch averaging to just 10 tons per trip. Aside from the FADs the boat is also installed with about 30 bulbs of 1,000 watts each, which function is also to attract and aggregate fishes. This is the only boat of this type in Sumatera Barat but about 200 units of this is found in the ports of Sumatera Utara which operation is also in FMA-IX. The purse seine fleet targets the small pelagics and main tuna catch are the bullet and frigate tunas.

The collapse of the domestic tuna longline have given way for these companies to go into purse seine fishing. A port visit in Benoa, Bali and Muara Baru confirms the constructions of brand new nets, FAD anchors and floats are being prepared. Interview

Rays are stripped off their skin for leather processing.

with fishers reveal that these boats will be operated in the Indian Ocean. This development of allowing large purse seine boats (>250 GT) to operate at the Indian Ocean will likely create new sectoral conflict with the longline and small scale drift gillnets unless proper zoning and regulation of FADs are in place.

Tuna infrastructure support

Because of the vast expanse and significant fisheries activities in FMA-IX, it is supported by several first level fishing ports. Starting from the western most side the first level fishing ports supporting FMA-IX are PPS Bungus in Sumatera Barat, PPS Nizam Zachman in DKI Jakarta, PPN Pelabuhan Ratu in Jawa Barat, PPS Cilacap in Jawa Tengah, and PPS Benoa in Bali (noticed that good fishing port facilities stops in Bali and very few fishing port facilities is found eastern ward).

Visit to the PPS Bungus indicated that the said port is used mostly as transient point or standby area of longliners on their way to the fishing ground. Despite the first level category of the fishing port, there is not much activity there and only a few support facilities such as storage and the likes are installed. In fact, the port is even closed during the weekend, an indicator that it is not really a busy fishing port. Also found in the port are mobile lift nets (Bagan perahu/rakit) and small-scale purse seines. Aside from managing the ports, the port authority also directly manages two fishing boats operating as small-scale purse seines. PPS Bungus is the only first level fishing serving the southwestern coasts of Sumatra Island. There are however several lower level fishing ports supporting the fisheries of Indian Ocean in Sumatra Island, these are PPN Sibolga in Sumatera Utara, PPP Sikakap in Sumatera Barat, and PPP Lempasing in Lampung.

Going east to the Island of Java there are three major fishing ports servicing the tuna longliners operating in Indian Ocean (FMA-IX). Nearest to Sumatra Island but found not in the coastal area of Indian Ocean but rather in Java Sea is PPS Nizam Zachman in Muara Baru, Jakarta. Though this port is located facing Java Sea (most of the large fishing fleets are fishing in Indian Ocean). This fishing port might be the biggest in Indonesia and supposedly is the best in facilities as it was heavily aided by Asian Development Bank (ADB) for its rehabilitation. In this port are two major fish landing quaysides, one transshipment wharf and one wharf especially allotted for vessels uploading provisions. There are 25 processing rooms leased by different companies and a cold storage facility of 1,000 tons capacity. The fish market center is quiet large (9,865 m^2) and separate from the fish auction area (3,500 m^2). Next to the PPS Nizam Zachman is the PPN Pelabuhanratu located in the southern coast of Jawa Barat Province. This fishing port is second level in category servicing fishing boats of 15 to 60 gross tonnages. Still going east, in the province immediately next to Jawa Barat is situated the very young first level fishing port of PPS Cilacap. This fishing port started its operation as second level (PPN) in 1995 but have upgraded into a PPS level in 2001 due to the increasing occurrence of oceanic fishing vessels. Apart from these big fishing ports a number of small-scale fishing ports are also available, such as PPN Prigi in Jawa Timur which services the coastal fisheries.


Finished products of the ray skin. Note the beautiful stones that were once part of the skin of the ray.

Servicing the long liners which homeports is in Bali and the provinces further east is PPS Benoa. PPS Benoa is not a state-managed fishing port but is managed and operated by a private company, the Persero Terbatas (PT) Pelabuhan Indonesia III. There is only one landing quayside and is shared and leased upon to different fishing companies. There is one processing and fishing company which has its own private wharf, the PT Perikanan Samodra Besar, which is state-owned. Aside from this big fishing port, small scale landing sites managed and operated by private companies or local communities are also present.

Further east covering the provinces of Nusa Tenggara Barat and Nusa Tenggara Timur, the fishing ports available for the fishers operating in FMA-IX are mostly small scale in operation managed by the local communities or privately owned by the fishing companies.

Notes on the economics of fishing

The area of FMA-IX is a bit expansive and thus the costs or prices of one area may not necessarily hold true for the others even when found within the same fisheries management area.

Danish Seine

Danish seines though not necessarily targets tuna, in some of the sites such as in Jawa Barat Province, the catch is mostly composed of the small tuna species and juveniles of skipjacks that it was why it was also tackled here.

The costs of fishing boat of 5-GT for Danish Seine in 2006 in Jawa Barat was Rp15.00 million and its outboard motor of 40-HP was Rp18.00 million. If both engine and boat has a working economic lifespan of 10 years, the annual depreciation costs would be Rp3.30 million. The fishing gear costs about Rp8.00 million which when assigned with three year effective economic lifespan, the probable cost of depreciation would be Rp2.67 million. Annual total operational expense ranges from Rp40.44–259.20 million. Annual sales revenue ranges from Rp243.87–486.00 million. There were times that when a boat was not lucky, it would expend the higher end of the annual operational cost' range while just having the lower end of the annual sales revenue' range, in which case the fishing venture is actually losing, which is happening more often now according to the fishers interviewed.

Drift Gillnet

The drift gillnets in FMA-IX targeting mostly skipjacks are found in the provinces of Jawa Tengah, Jawa Barat, and Nusa Tenggara Barat. The investment for a boat of 10-GT and powered with two outboard 150-HP motors was Rp1.00 billion in the province of Nusa Tenggara Barat. While a 30-GT fishing boat powered with an inboard engine in the province of Jawa Tengah was Rp200.00 million. The differences in the costs of investments might be due to the distance of the provinces from the commercial center of the country (Nusa Tenggara Barat is more remote than Jawa Tengah). The costs also depend on the size of the gear and the year of acquisition. Investment for the drift gillnet fishing gear ranges from Rp70.00–141.00 million.

Annual operation costs ranges from Rp103.97–296.23 million in the east Indian Ocean or FMA-IXb (Jawa Island going east to Nusa Tenggara Timur). Revenue from sales of catch in a year of drift gillnets operation targeting skipjacks and the small tuna species is estimated at Rp19.38–369.34 million. There are cases when some of the fishing fleets are gaining but a lot are also on losing. A probable sign that the fishery is already showing signs of abused.

Handline

Investment on the fishing boat of <3-GT and 5-HP outboard motor in the handline fishery of FMA-IXb was more or less Rp8.00 million. Investment in the fishing gear ranges from Rp18.00 to Rp100.00 thousands, the differences is mainly due to the existing prices of the materials in the different localities and the sizes the fishers preferred for. Operational expense for a year was more or less Rp40.46 million. While the annual estimated revenue from sales of caught fish is about Rp66.67 million. From this simple presentation of handline fisheries economics, this particular fishery for tuna in FMA-IXb is still earning profit from the venture.

Pole and Line

The investments of the pole and line fisheries in FMA-IXb on fishing boats, of gross tonnages 17-30 and powered with engines of 120-HP to 12-HP, ranges from Rp240.00 to Rp350.00 million. With about 10 years of economic lifespan, the annual depreciation cost ranged from Rp24.00 to Rp45.00 million. The cost of pole and line fishing gear, for a boat of about 20 fishers, ranges from Rp500.00 to Rp800.00 thousands. Since the fishing gear is easily destroyed, it usually is renewed every fishing trip or as often as necessary that sometimes it would be more appropriate to put the costs as part of the running expenses. Annual operational costs ranges from Rp87.00-870.00 million for about 67 to 180 trips. The estimated gross revenue from sales ranges from Rp374.00 million to Rp1.41 billion.

From this simplified economic view of the pole and line fisheries in FMA-IXb, the fisheries is profiting most of the time however, as most fishing ventures are experiencing, there were times when the fisheries is losing due to various causes and that is also true with this fisheries. The losing pole and line ventures are experienced by those in Nusa Tenggara Timur and Sulawesi Tenggara. The fishers however are still finding ways to circumnavigate the situation by creating special arrangement for baits, and staying longer at sea to save fuel.

Troll Line

In Jawa Barat, investment for a troll line fishing boat of <3GT powered with a 5-HP outboard motor was more or less Rp7.70 million. In Sulawesi Tenggara, the fishing boats of 15-GT powered with two units of 150-HP outboard motors was approximately within Rp70.00 million. All the fishing gears used by a boat including 5 sets of troll lines, 2 sets of coping and all spare accessories costs more or less Rp3.00 million; this is only true for Sulawesi Tenggara fishers because they are carrying two types of the hand lines, the ordinary vertical single hook and line and the troll line.

Operational annual costs reach approximately Rp502.26 million for the troll liners of Padang, Sumatera Barat because of the distance they are traveling from and to the fishing ground. Annual operational cost of troll lining based in Sulawesi Tenggara is around Rp48.00 million.

The troll line fishers in FMA-IX are just on the breaking even point of their fishing ventures with roughly Rp48.30 million annual gross sales. This is because of the high input on fuel as the operation demands continues movement of the boat amidst the soaring fuel prices.

Longline

The sources of data presented here were culled from the term papers of the students who boarded the tuna longliners operating in FMA-IX.

Because the longline fisheries is relatively a large-scale business venture, the financial systems more or less follows the classic setup, such as making use of the fixed and variable costs to describe the economic aspect of fishing operation. The parameters usually included in the fixed cost of long line fishing operation are depreciation costs, wages, medicines, overhead cost, and administrative costs. For the depreciation costs computation, the companies assigned five to ten years lifespan for the fishing boat and one to five years for all the other initial expenses incurred in starting the fishing venture. Just to have a glimpse of the initial investments in the longline fisheries operating in FMA-IX, a wooden-hulled fishing boat of 136-GT with its diesel fed engine of 380-HP and the longline fishing gear costs Rp800.00 million in 1994. With an economic lifespan of 8 years, annual depreciation cost is Rp100.00 million. The initial cost of other accessories for a fleet of 40 fishing boats was about Rp800.00 annually. In 1992, the cost of a longliner with wooden-hulled fishing boat (of 36-GT with engine and fishing gear) was Rp100.00 million. With an economic life of 5 years, the yearly depreciation cost is Rp20.00 million. The cost of the other fishing accessories annually is Rp600.00 thousands. These expenses are included as part of the fixed costs of fishing. In addition to the depreciation costs of the fishing fleet and accessories, the fixed cost of longline fishing also include the wages of the fishing boat officers (captain, engineer, etc.) and fishers, wages of the land-based personnel, fishing fleet maintenance, overhead cost, credit facility interest, and administrative expenses.

Variable cost includes everything needed for every fishing operation such as fuel and lubricant, food provisions, ice, baits for the hook and lines fisheries, medicine, bonuses, and others which may be needed for a safe and successful fishing trip. The amount spent usually depends on the distance and length of stay at sea. Other costs are taxes and fees on the use of fishing port facilities.

According to oral accounts of most fishers, and as observed during our study, the longline fishery in FMA-IX is hardly surviving. The fishing boats are staying on ports after catching relatively nothing for several fishing operations. Such is observed in the major ports covering FMA-IX such as PPS Bungus in Sumatera Barat, PPS Nizam Zachman in Jakarta, PPS Benoa in Bali and PPS Cilacap in Jawa Tengah

Even in the mid-nineties, some companies have experienced losses brought about by decline catch and increasing operational cost (Figure 9.21). Losses from poor quality of fish contributed to the dilemma.

Issues and Recommendations

1. Official catch records do not agree. There is an urgent need to strengthen data collection, record keeping and reporting. Using total catch as an example, the records of provincial data do not add up to the national figures, the two national statistics publication (one is presented by provinces and coastal areas and the new is by fisheries management areas) and the national figures do not agree with the

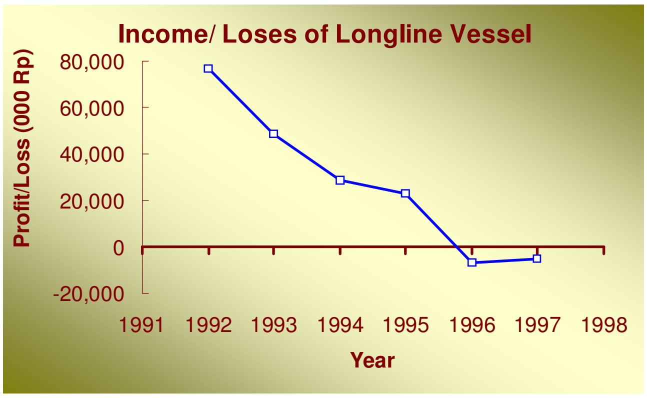


Figure 21. Profitability of tuna longline operation in Indian Ocean. Source: Saepudin 1997. Data from Eraska Nova Company.

data available at the database of the Indian Ocean Tuna Commission. Proctor et al. (2003 and 2007), have identified ways to strengthen data collection system and to standardize data entry protocols. Detailed recommendations are presented in Chapter 14.

2. Low level of adult tuna population. Using longline fleet operating in Indian Ocean as an example, indicators include declining catch (now just 28% of the highest level), low catch rates (now just 15.5%) and current hook rate is 16.6% of the highest levels in 1977). The solution to this issue is to reduce drastically fishing intensity. The fuel price hike is a welcome development that has put to stop fishing operations in 2006 by almost two-thirds of the 1,600 longline vessels. It may be a good for the government to consider maintaining the 2006 level of effort (~500 vessels) by decommissioning wooden-hulled and fuel inefficient vessels that do not conform to the National and International maritime standards. Health standards and safety at sea standards should be implemented.

Another way to implement reduction of longline effort is not to provide fuel subsidies. The longline fleet enjoys a 19% fuel subsidy that allows small profit to be made. Removal of subsidies will provide a reprieve

Gills of rays are dried, processed and sold as medicines to local and chinese drugstores.

for the adult stocks, reduce government expenditures and will not distort trade.

3. Poor quality of fish. Losses arising from poor quality fish is substantial as rejects range from 20-70%. As practiced, fishers and traders accept losses of up to 30%. There are several reasons for this issue:

a. Inefficient storage system onboard. Wooden-hulled vessels have poorly insulated storage space for fish storage. Similarly, even steel-hulled boats have non-functional freezers on board and instead carry ice. Moreover, many of these storage facilities do not have the capacity to store fish at right temperatures.

b. Poor post harvest practices. Very few fishers and operators understand processing procedures and requirements to maintain fresh fish. Fishers to not know the need to lower temperature of the fish as fast as possible to prevent histamine formation. They have little idea of the ice requirements needed to maintain freshness of fish and no idea on the different factors that affect the quality of fish. To address this shortcoming, information campaign coupled with capacity building is necessary. The training should include traders and exporters.

c. Insufficient infrastructure to support post harvest requirements. While the primary fishing ports (Muara Baru, Benoa, Cilacap) are located in FMA-IX, these are not strategically placed to provide sufficient support to where the tuna fishery is taking place. Tuna fisheries has shifted to the east that Nusa Tenggara Timur (NTT) is fast becoming the center of tuna. Yet, there are no sufficient infrastructure in-place, not even plans of having ones whether from the province or national government. To remedy the lack of good fishing ports, storage facilities are provided by collecting ships well-equipped with freezers. These ships are however mostly owned and operated by Japanese nationals. Similarly in Sumatra, the ports are underutilized, particularly in the processing sector because transport cost of products for export need to pass by the three gateways, Jakarta, Bali, Surabaya and Makassar.

d. Shortage and expensive supply of ice. Ice is one of the keys to maintain quality of fish for chilled and frozen tuna. Price of ice in villages are expensive and limited as there are many tuna fishing areas that have no sufficient access to ice supply. There are collecting ships that supply ice but such is limited to its members only.

Improper use of containers for ice storage. The choice of containers for keeping fish will greatly determine the end quality of the iced-fish. In many areas within FMA–IX and in particular in Cilacap, Jawa Tengah, the common storage container are empty polyethylene chemical containers. Fishes are simply placed inside the container with ice slurry (crushed ice in seawater). Depending on the distance of the fishing ground, this storage practice produces a significant volume of rejects ranging between 30-70% of the catch. It is recommended that these containers called “blong” no longer be allowed to be used for storage of fish because:

- These containers are chemical containers that could have been used for highly toxic substances which could leach into the fish;

· These containers have very poor insulating properties thus wasting so much ice;
· Fish are damaged physically from storage;
· These containers are difficult to handle, fill and empty and can not be stacked on top of the other, thus requiring lot of space; and has no provision for drainage of melt-water.
· Handling of these oblong shape containers which weigh about 100 kg when filled takes three people to lift.

It is highly recommended that fishers use high density polyethylene containers that has good insulation (though are extremely expensive). Also a good temporary storage or transport containers, and as what is used in many parts of the country, are the polystyrene boxes framed with wooden crates. Varied sizes of such boxes should also be made available so as that fishers could buy the appropriate boxes for a certain fish-size.

e. Cultural reasons. Except for the Sulawesi people belonging to the "Buginis" and Bajaos, who are fish eaters, the rest of the country are upland dwellers and are not used to consuming fresh fish. Most fish that are made available to them are dried and salted fish. It is highly interesting that despite the poor quality of fish sold at the wet market which contain high levels of histamine, people seem not to be affected by it. Perhaps, their affinity to utilize high amounts of hot capsicum may have the "curing" effect. This observation is certainly a worthwhile research health topic worth pursuing.

4. Insufficient coordination between local, provincial and national government units. Confusion appears to characterize management of tunas as there is little coordination between and among agencies responsible for management of tunas and fisheries in general. The whole FMA should have one set of fisheries policy for tunas, as these animals are highly migratory. Therefore, licensing of vessels, monitoring and implementation of policies should be a coordinated effort. But because of the decentralization law, local government entities have exercised jurisdiction within their waters which in certain cases contravenes with national laws. The declaration of provincial waters by certain provinces, and negotiating fishing access agreements with foreign entities are two examples of gross misinterpretation of the decentralization law that needs to be addressed (Djalal, 2007).

5. Rationalize management. The first step is to rationalize management: by dividing FMA–IX into two distinct fisheries management areas to make the governance area smaller. Interestingly, based on tuna fishery considerations, the whole island of Sumatra could be treated as a separate FMA. The remaining area to the east may probably be treated as one.

The second step is use ecosystem-based management approach to the tunas. For FMA–IX, this meant looking at the following aspects to improve tuna management.

· Manage the sardine (lemuru) bait fisheries of Bali that supports the tuna longline and livestock-feeds processing industries.

· Manage the liftnet fishery (bagan perahu/ bagan tancap) to ensure a balance between the requirement of the pole and line for live baitfishes and the consumption needs of the populace.

Fish vendor sells pindang in a local market in Mataram, West Nusa Tenggara

· Work towards the reduction of juvenile tuna by-catch by looking at ways to manage the fishing aggregation devices (FADs) and utilizing traditional knowledge to identify possible management handles; juvenile tunas are found in catch of all fishing gears but the gravity of its contamination depends on the fishing gears. Large volume of juveniles are taken by the stationary liftnets followed by boat liftnet, drift gillnet, pelagic Danish seine, troll line and purse seine. The first step is to estimate the volume of juvenile tuna take of each of these gears and identify which months are the juveniles vulnerable to which gear.

· Promote reduction of by-catch of turtles through improved coverage of use of circle hooks.

· Use precautionary measures to ensure shark by-catch will not worsen. First consideration is to find ways to discourage directed fishery for sharks such as the shark longline that is attached to the drift gillnet.

· Study the impacts of large purse seining operation in the Indian Ocean as these could generate conflicts between large- and small-scale fisheries and conflict between longline and purse seine through the use of anchored FADs.

· Undertake measures to immediately prevent further increases in fishing effort. Mass migrations of fishing fleets from other areas are happening in the coastal areas of Indian Ocean on the Sumatra side and Eastern Indonesia near Sawu Sea. Fleets by the hundreds migrate from Northern Java to as far as Sulawesi Tenggara, Sulawesi Selatan, Sulawesi Barat and Kalimantan. The government should act on these immediately so as not to shift threat of overfishing from one FMA to the next. Further, there are troll fishers in Padang who are contemplating on shifting to longline. This simply means that fishers are not well informed of the status of stocks and these fishers should be informed, if only to prevent these fishers from suffering from the same fate as the larger tuna longline fleet. Government advice is needed to help fishers choose a better livelihood.

6. Resource managers empowerment. It may also be appropriate to conduct information training on the existing fisheries managers and even top local government officials on their role and responsibilities as custodians of the resources within their jurisdiction. This include the legal "teach in" where local officials learn the legal framework of fisheries, environment and jurisdictional matters. This prevents the mis-interprettion of existing national laws as well as binding international laws that the government has signed into.

7. Allot sufficient funds for research and monitoring of the tuna stocks. This is a more general recommendation applicable to the whole country. The government revenues from tuna is enormous and ways must be found on how to plough back certain portion of tuna benefits to support long term management of the tunas.

Bait Fisheries for Tuna

Brief background

There are three major tuna fisheries that require baitfishes, the pole and line that needed live baitfishes, the tuna longline and handline. Whether for live or frozen baitfish, Indonesia needs to manage these stocks in order to ensure their sustainability and the tuna fishing they supports. The fact that these species are also exploited for human consumption adds complexity in managing this specific fishery.

Part I: Livebait Fishery for Pole and Line

The main sources of live baitfish are lift nets which accounts for 70-90% and beach seines for the 10-20%, the rest are landed by small scale purse seines (mini-purse seines) and encircling gillnets which account for less than 3%.

The liftnets have two general types, the fixed type called “bagan tancap” which is the traditional one and the mobile liftnet called “bagan perahu” which is set atop a raft or boat and could move anytime, anywhere. There are several variations of the mobile liftnets which is attributed to the unique characteristic of the area where it operates (Table 10.1). The first modification is the raft liftnet (“bagan rakit”) where the floating platform is a raft made of bamboos. The whole structure is towed very slowly by a boat to a nearby fishing ground. Because of the problems with stability, this model could not reach far fishing grounds and could only be set in highly sheltered areas. An improvement over the bagan rakit is the use of two boats as floatation support and is locally known as “bagan perahu.” This model is more stable and hydrodynamically constructed, and thus, could be towed to farther offshore. Presently, there are two models that exist; one that uses a square frame for the net called the Morotai (named after an island in north Halmahera) and the other called the Bouke-ami where the net is set by ropes and stone sinker mechanisms.

Trends indicate that the fishing ground for anchovies is moving farther offshore and that to reach the fishing ground faster, the platform of the liftnets have been modified into large boats. There are also places wherein the boat is also used as the light boat. Easy to identify, liftnet boats have very conspicuous outriggers and the boats are bedecked with lamp which are powered with a separate generator. These boat liftnets are already popular all over the country and different versions may be observed in different places (Table 10.1).

It is important to note that live bait fishery exist only in eastern Indonesia where all the pole and line fleet operates. The source of live baitfish is usually near the fishing grounds of the pole and line fleet.

Table 10.1. Types of boat lifnets operating in the different parts of Indonesia.

Area of Operation	Boat size (GT)	Target Species	Uses of Catch
Waegio Is, Sorong	50	Anchovies, Scads	mainly for baits, dead ones are dried
Kupang, NTT	10	Anchovies, Scads	for baits & human consumption
Bone Bay, South Sulawesi	20	anchovies, sardines, roundscads, Indian mackerels	for human consumption only
Padang, Sumatra	30	bullet & frigate tunas; anchovies nearshore only during season	for human consumption only

Factors affecting catch and supply of live baitfish

According to Subani (1982), the factors that affect the availability of live baitfish are:

1. season – anchovies and sardines, the two most common source of baitfish are highly seasonal
2. phase of the moon – dark phase of the moon have higher catch than the bright phase.
3. oceanographic factors such as tidal phase that creates currents caused by flood and ebb affecting operation of net as well as transparency of the water affects the schooling behavior of the baitfish;
4. presence of large predators such as whales and dolphins that drive away or eaten away by these mammals.

Literature survey reveals that while published studies on baitfish abounds (Blaber 1998), the focus was more on discovering new fishing grounds to address the chronic problem of live baitfish shortage (Rawung, 1971, 1972; Gafa and Subani, 1987, 1991, Andamani et al, 1987, Rumarupute et al, 1987, Wahyuono & Rusmaji 1987. Subani (1982) listed surveys undertaken by the research institute (BPL/LPPL) between 1967-1973. Series of six studies were recently undertaken by Indonesia-ACIAR collaboration and these were compiled in a special issue of the Indonesia fisheries research journal (Naamin and Gafa, 1998, Rawlinson et al, 1998, Andamari et al, 1998a, 1998b, 1998c, Milton et al, 1998).


First generation design of mobile liftnets mounted on rafts and towed to the fishing ground.

Despite the surveys undertaken to identify new fishing grounds for live-baitfish, the shortage problem continues to plague the fishery even until today. This is the most commonly mentioned reason for the 40% reduction of pole and line operations. This means that the results of all these studies were not translated into the establishment of policies. There were no comprehensive attempts to estimate the stocks and look entirely status of the whole resource aside from the work of Milton et al. in 1998. This study made a good attempt to estimate the stocks independent of catch and effort data.

With this situation, it is first recommended that a research program must be developed to accurately determine the status of the baitfish stocks and to develop monitoring schemes for the baitfish fisheries.

The second course of action is for the government to set guidelines/ policies on the use of these resources, whether it be for human consumption and/or for fishbaits. Anchovies (genus *Stolephorus*) are the preferred livebait species as it is hardy and represent one of the natural diet of skipjack (Merta and Suhendrata, 1987) - the target species of the pole and line fishery. Anchovies are also preferred for dried fish, which are even exported to other countries and had even been an important local and export commodity even in the 17th century (Bailey, et al. 1982)

It is very important that studies be conducted to determine the efficiency of using these different types of baits, in terms of energy lost, prices and ecosystem effects. For pole and line fishery, anchovies may rank poorly in terms of cost due to its high price but in terms of efficiency as baitfish may be high as it forms a natural diet of skipjack tunas. Its ecosystem impact is probably lower compared to substitutes now used such as small-sized roundscads and sardines which are immature and thus contribute to growth overfishing.

A way of viewing energy efficiency is in ecosystem context. Pole and line uses a lot of live baits to catch fish. This practice is analogous to the culture of carnivore fishes that requires more volume of fishfeeds to produce less volume of the cultured fish. The ratio on the volume of bait used to catch a kilogram of skipjack vary significantly between studies but with values ranging from 0.58 kg to 1.27 kg of skipjack (Gafa & Subani, 1987) and 1.28 kg to 15.6 kg of skipjack to a kilogram of bait (Salim Moch Nur, 2000). Such large discrepancies could be an effect of the size of fish schools. An attempt to prove this is described below.

A figure drawn out of Salim's (2000) data could provide insights on how efficiency ratio of bait to skipjack catch may be looked at. A plot of the bait used on catch per kg of bait showed a parabolic relationship which pinpoints to a highest efficiency ratio of catch to bait at around 45 buckets (~1.8 tons in weight) and use of more baits generate lower catch (Figure 10.1). It is probable that the shape (height and breadth) of the parabola depends on the size of fish school. This is one aspect that needs to be determined.

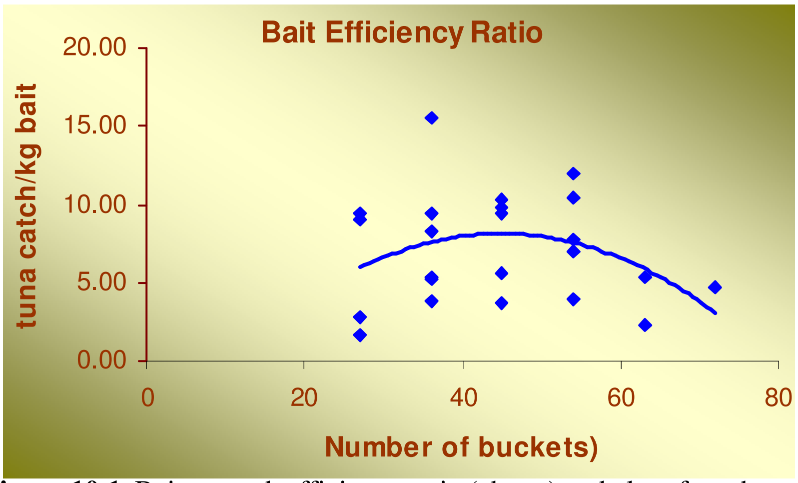


Figure 10.1. Bait to catch efficiency ratio (above) and plot of catch against catch/kg of baits used. Source of data from Salim (2000).

A liftnet boat docked in Bungus, Padang, North Sumatra with its 140 lamps.

As fishing progresses, the quantity of fish decreases, changing the size of the parabola downwards. In practical application, the bait thrower therefore must ensure that the ratio of fish to bait be maintained at that level. Putting more baits actually decreases efficiency as the chance of fish meeting the lure gets smaller.

Using available statistics from North Sulawesi Province as an example, Figure 10.2 shows how the supply (production of anchovies) and the demand (number of pole and line vessels) trends have evolved over the years. A decline in supply was accompanied by the rise in the number of pole and line vessels.

Another possible effect of using livebaits in the ecosystem which has not been investigated is the impacts of introductions of species that could possibly trigger introduction of invasive species. Had there been assessments undertaken to look into the impacts of such introductions (in areas far from where these were caught)? Had there been analysis and identification of the baitfish populations and what possible implications will the mixing of these sub-populations bring about. While small pelagics, because of their highly migratory nature, may be not pose as much risk, use of species

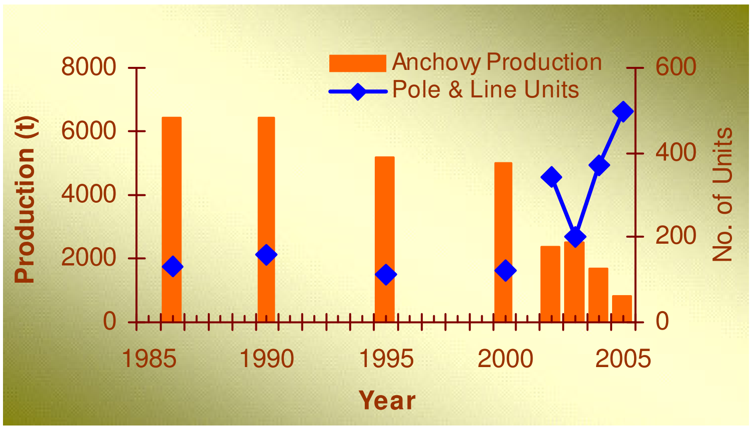


Figure 10.2. Trends in anchovy catch and the growth pole and line fleet in north Sulawesi province. Source: provincial DKP statistics.

that have restricted distribution like the fusiliers may have ecological consequences we know little about.

The declining trend of landed baitfishes is a serious threat to the tuna fishery. The scale of the problem is not limited to North Sulawesi, Moluccas, Tomini, and Flores Seas but appeared to be happening in a lot of places as well (Figure 10.3). Between 1985-1989, the catch rates has declined by 60% and the volume of landings by 30%. The data presented here is twenty years old but somehow the baitfish fishery has not collapsed, thanks to the vast fishing grounds of Indonesia that expansion of the liftnet's operations were made possible.

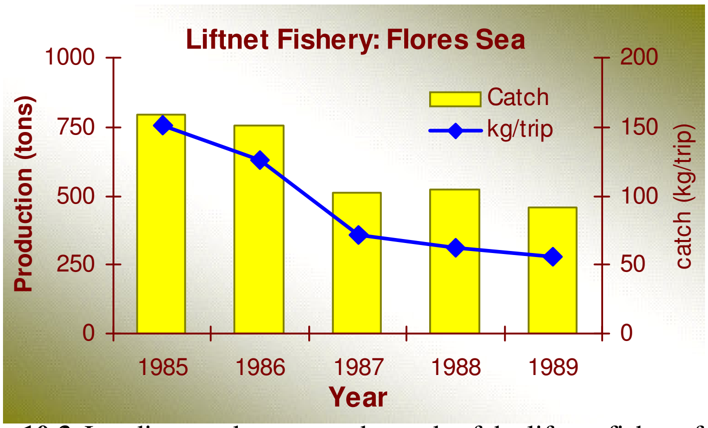


Figure 10.3. Landings and mean catch trends of the lift net fishery for baitfish in Sikka, Flores Sea from 1985-1989. Redrawn from Widodo (1990).

As Table 10.2 suggests, landings of anchovies in Flores Sea, Moluccas and adjacent Seas from year 2000-2004 increased while overall drop was observed for Banda Sea, North Sulawesi Sea and Pacific Ocean, as well as Arafura Sea.

This chronic shortage of baitfish is evident on the amount used by the fleets. As shown in Figure 10.4 is a significant 373% drop in the number of total baitfish volume used by Pt. Usaha Mina between 1990-1997. These occurred at a time when the number of fishing vessels has remained the same.

Could the baitfish resources supply the demand for live baitfish? A classic study on estimating biomass of anchovies was undertaken by Milton et al (1998) using egg production method where the biomass of anchovies were estimated in Bacan, Central Moluccas. The study concluded that the demand of the pole and line fleet operating in the area at the time of the study represent between 5-150% of the estimated biomass. This means that during the peak anchovies production, its population could support the

Stern view of a liftnet boat getting ready to leave port.

Table 10.2. Catches of anchovies (tons) from areas with pole and line fleet. Source: DKP statistics by management areas (2006).

Fisheries Area	2000	2001	2002	2003	2004
Flores & Makassar	25729	25966	23899	22001	28002
Moluccas, Seram, Tomini Seas	9501	15602	14638	14019	20169
Banda Sea	7553	5798	4633	8721	3206
Sulawesi Sea & Pacific Ocean	5576	14093	10771	14108	7919
Arafura Sea	2945	1940	3748	2428	815

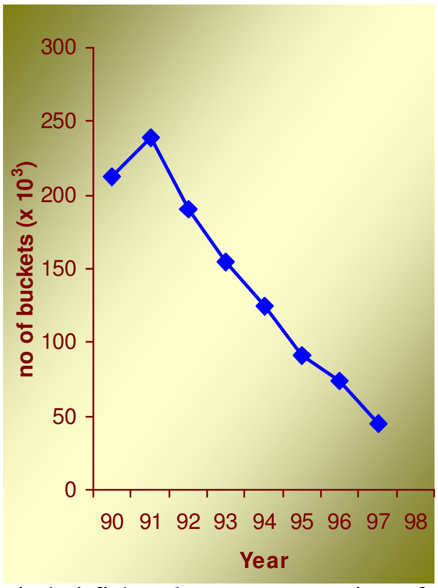


Figure 10.4. Decline in baitfish volume consumption of state fishing enterprise, PT. Usaha Mina. Data redrawn from Naamin and Gafa, 1998).

demand of the pole and line. But during low productivity season, over-extraction could significantly reduce anchovy population to critical levels that could undermine anchovies' sustainability.

One of the key ecosystem impacts of the pole and line fishery is the use of juveniles and immature individuals of economically important species as alternative to anchovies. Subani (1982) listed 41 species/groups that is used as baits in eastern Indonesia (Table 10.3). Of these, only 8 species used as baits of preferred sizes have total lengths equal or longer than the reported maturity lengths. These include two species of anchovies (*Stolephorus*), two species of sardines (Clupeidae), one species of fusilier (Caesionidae), two species of silversides (Atherinidae). The rest are immature of highly important species such as scads, jacks and Indian mackerel. The adult individuals of these species support major fisheries not just for human consumption but for baitfish (roundscads) of tuna longline. The pole and line therefore, through its use of live baitfishes with commercial importance could undermine the sustainability of these fisheries.

Of the 8 baitfish species that do not contribute to growth overfishing, only two will pass the criteria of an ideal live bait. These are hardiness (low mortality during transport in high density fish holds, highly reflective color or shining characteristics, scales do not peel off during catching and transport, and ability to last long in holding tanks.

There is therefore a need to search for other bait substitutes. This study recommends a research to determine the feasibility of using "stunted" milkfish as bait for pole and line given the following advantages:

Anchovies ready for delivery to the local market.

Table 10.3. Live baitfish species and corresponding lengths as required by the pole and line fisheries in eastern Indonesia. Data of species and sizes were taken from Subani (1987). Maturity sizes taken from Fishbase (2004).Names in parenthesis were those mentioned in the paper which were corrected. Color codes: red- high ecosystem impact; green- low ecosystem impact, yellow- medium impact.

Families/ Species	Bait Size range (cm)	Maturity size (cm)*	Rating
Engraulidae			
Stolephorus commersonii	7.5 - 12.5	7.4	green
S. indicus	7.5 - 12.5	11.4	yellow
Encrasicholina heteroloba (S. heterolobus)	7.5 - 12.5	6.4	green
Engraulis japonicus (S. celebicus)	7.5 - 12.5	12.2	red
Thryssa baelama	7.5 - 12.5	10.0	
Clupeidae			
Sardinella fimbriata	10.0 - 12.5	8.90	green
Amblygaster sirm (S. sirm)	10.0 - 12.5	15.1	red
Sardinella aurita	10.0 - 12.5	14.5	red
S. longiceps	10.0 - 12.5	16.1	red
Dussumiera acuta	10.0 - 12.5	14.2	red
Spratelloides delicatulus	10.0 - 12.5	5.5	green
Carangidae			
Decapterus kuroides	10.0 - 12.5	21.2	red
D. russelli	10.0 - 12.5	21.6	red
D. macrosoma	10.0 - 12.5	19.3	red
Alepes melanoptera (Caranx malam)	10.0 - 12.5	17.0	red
Selaroides (Caranx) leptolepis	10.0 - 12.5	13.2	red
Atule (Caranx) mate	10.0 - 12.5	19.5	red
Alepes djedaba (Caranx kalla)	10.0 - 12.5	23.8	red
Selar (Caranx) boops	10.0 - 12.5	17.2	red
Scomberoides (Chironemus) tol	10.0 - 12.5	34.1	red
Caesionidae			
Pteroceasio (Caesio) pisang	10.0 - 12.5	10.9	green
C. caerulaurea (coerulareus)	10.0 - 12.5	21.2	red
Pterocaesio chrysozona (C. chryrosona)	10.0 - 12.5	13.5	red
C. lunaris	10.0 - 12.5	23.8	red
C. (erythrogaster) cuning	10.0 - 12.5	34.1	red
Scombridae			
R. kanagurta	10.0 - 12.5	15.3	red
R. (neglectus) sema	10.0 - 12.5	15.5	red
R. brachysoma	10.0 - 12.5		red
Atherinidae			
Atherina forskalii	10.0 - 12.5	10	green
Atherinomorus lacunosus (Atherina duodecimalis)	10.0 - 12.5	10	green
Leiognathidae			
Leiognathus splendens	3.0 - 4.0	10.7	red
L. daura	3.0 - 4.0	9.4	red
Secutor (Leiognathus) insidiator	3.0 - 4.0	6.7	red
L. brevirostris	3.0 - 4.0	9.4	red
Gazza (Gaza) minuta	3.0 - 4.0	13.6	red
Mullidae			
U. sundaicus	10.0 - 12.5	14.1	red
U. (luzonicus) luzonius	10.0 - 12.5	3.1	green
U. tragula	10.0 - 12.5	18.5	red
Sphyraenidae			
Sphyraena.. spp.	10.0 - 12.5		
S. (picuda) picudilla (?)	10.0 - 12.5	29	red
Lolliginidae			
Loligo spp.	5.0 - 7.5		

a. milkfish is an herbivore and will not require fish to grow fish making this an energy efficient bait;

b. milkfish grows very fast in salt, brackish and freshwater environment and could attain the preferred bait sizes in a matter of several weeks;

c. wild fry are very abundant in Indonesia all year round and it is barely exploited;

d. fry collection could be introduced as a small-scale livelihood operation (or as fishing cooperatives) as well as its using small fishpond area (~1000 m^2)

e. the hatchery technology for milkfish has been perfected and there are milkfish hatcheries established in Indonesia;

f. the technology for stunting milkfish fry developed in the Philippines in the 1980 s could be used to ensure ample supply of live baitfishes with the sizes needed by the users all year round;

g. milkfish is a hardy species when small and could be transported even in oxygenated plastic bags. This could eliminate the need for large holding tanks of pole and line vessels.

h. Most importantly, milkfish is a natural species in the area and will pose no problem of introductions.

To address key concerns on the baitfish for pole and line, the following are recommended courses of action:

1. Undertake a thorough assessment of the stocks of baitfish, particularly for the anchovies (*Stolephorus*) and determine, based on current population levels, how much may be taken out both for human consumption and for baits. Indirect methods to estimate stocks (e.g. egg production method, larval surveys) to complement use of catch statistics and acoustic methods, are highly recommended. Egg surveys are particularly easy to undertake because anchovy eggs are easily identifiable due to their spherical shape.

2. Set a government policy on the use of baitfish species, by identifying which species may be allowed for baits taking into consideration the social, economic and ecological impacts on the continued use of immature and juveniles of the highly commercially important species.

3. Set policies/ guidelines on how anchovies may be divided for human consumption and for bait.

4. Issuance/ renewal of fishing licenses for pole and line must consider not just the status of the skipjack stocks but the status of the baitfish resources as well. This is an example of ecosystem based fisheries management applied to tunas - by ensuring that the number of licensed pole and line boat will have sufficient live bait supply and that the pole and line fishery will not jeopardize the sustainability of the baitfish resources.

5. Undertake studies on the use of milkfish as an alternative bait to sardines and roundscads. Given its advantages (as stated above), use of a fast growing, herbivorous species with technologies perfected to a full-cycle culture is the likely answer to the chronic shortage of live baitfish supply. Most importantly, it would reduce current fishing pressure on baitfish stocks and may allow recovery.

6. Undertake more focused research on the search of other bait substitutes, taking into consideration ecosystem impacts on the size and species used. The aspect of species introductions should also be looked into to avoid possible problem with "invasive species."

Juvenile of the fusilier that is used as an alternate livebait for pole & line fishing in Bone Bay.

Part II: Sardine Bait Fishery for Tuna Longline

Brief Overview

The operation of the Tuna longline fleets is dependent on baits. In the early days of the longline fisheries, in 1970's, imported Pacific saury (*Cololabis saira*) was mainly use as bait but its unavailability for the whole-year-round (partly due to import restrictions) and its ver high price prompted the fleets to the locally sourced baits such as roundscads, squids, cultured milkfishes, and sardines.

Roundscads and squids are good bait substitutes but are used sparingly, only during the lean months of the sardines, because of their prohibitive price. Roundscads are expensive because of their high domestic market value and at the same time exported as baits to other countries. That leaves the sardines as the most affordable and available baitfish. The sardines comprises about 50% to 70% of the total bait consumption of longlines. Especially for the longline fleets operating in Indian Ocean which requires more volume of sardines than the fleets operating in the Pacific Ocean where the milkfish and squids are commonly used as baits.

Sardine Fishery for Baits

Sardines are considered less ideal baits for the longline fishery as compared to squids, roundscads, mackerels and milkfish. This is because its scales easily peels off rendering it less visible underwater, its hook retention is lower and more susceptible to damage than other species (Rahardjo 1988). Among the baits used by tuna longlines, sardines showed the highest damage, highest loses and the least intact during a fishing operation (Table 10.4). It also needs to be hooked while halfly thawed for easier handling because of its body form - highly compressed laterally.

Table 10.4. Result of a comparative study of use of different species of baits for tuna longline. Source: Adapted from Table 10.2 of Rahardjo (1988).

Baitfish Type	Damaged (%)	Lost (%)	Intact (%)
Squids	5.0	5.0	90.0
Roundscads	24.1	26.7	49.2
Indian Mackerel	24.1	36.5	40.0
Sardines	32.5	48.4	19.1
Milkfish	5.8	15.9	78.3

But because of its cheaper price and its availability all-year round, sardines became the most popular baitfish species for the Indonesian tuna longline fleet. This is even enhanced by the accessibility of the sardines fishing grounds to the main fishing ports used by the longline fleets. These made sardines the cheaper bait substitute to the Pacific saury and even to roundscads and squids.


Sardine vessel fleet in Kedonganan village, Denpasar, Bali

Among the species of sardines in Indonesia, *Sardinella lemuru*, an endemic species in Bali Strait, is the main species for baits. Other sardines species have been mentioned in some of the published documents include such as *Sardinella longiceps*, *Herklotsichthys* sp., *Sardinella sirm*, and *Sardinella aurita*. Whether these are separate species or not, remains to be verified since misidentification of species have been propagated in the Indonesian fisheries literature. Analyzing the chronology of the sardines publications in Bali Strait, it appears that *Sardinella lemuru* had been misidentified as *Sardinella longiceps* in the early days, this error was propagated in all publications prior to 1991. The work of Uktolseja (1992) comparing use of baitfish species was the first to mention *Sardinella lemuru* in Indonesian literature and subsequent publications followed suit.

Trends in Catches

Over the last 35 years, total landings of lemuru and fringescale sardines in Indonesia showed gradual increases. From just 18,000 tons in 1970, landings of these two species of sardines has grown five-folds to over 100,000 tons in 2004. The highest landings was in 1998 with 154 thousand tons. (Figure 10.5).

Bali Strait is the center of the lemuru sardine fisheries which is under the political jurisdiction of the provinces of Jawa Timur and Bali. The landing centers in Jawa Timur are in Muncar and Banyuwangi while the landings centers in Bali, is in Pengembali and Kedonganan. Using available data from DKP (2006), landings of sardines from Jawa Timur increased by three-fold with over 30,000 tons between 2000 and 2004. Landings of sardines from Bali Strait reached its peak in 2002 with over 36,000 tons but hence had been on the declining trend reaching a loss of 60% in 2004 (Figure 10.6).

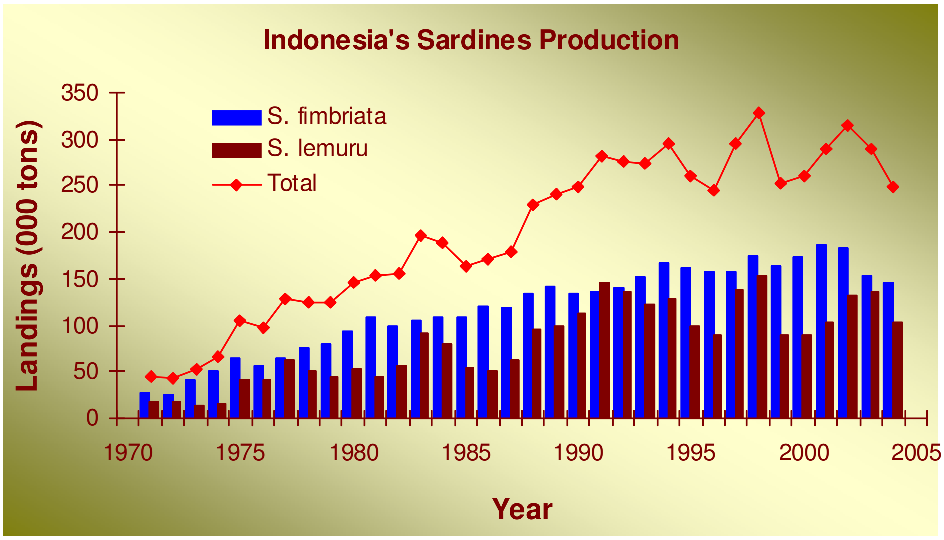


Figure 10.5. Trend of landings for the two species of sardines in Indonesia. Source: DKP National Statistics (various years).

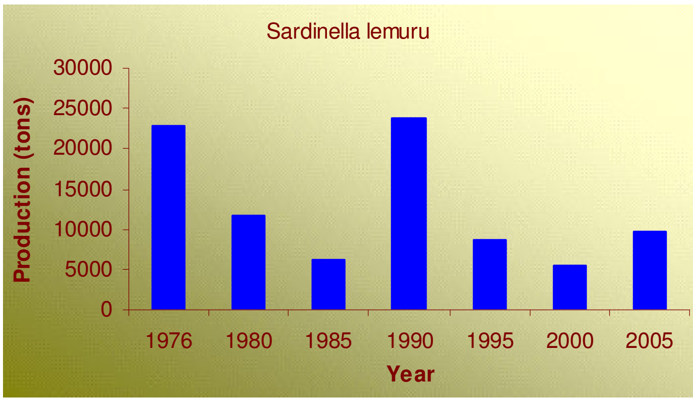


Figure 10.6. Trends in Bali sardines (*Sardinella lemuru*) landings from Jawa Timur and Bali. Source: WPP (2006).

Rattan baskets for sardines brought to fishing boats

The increasing trend for Jawa Timur is quite contrary to the results of interview we conducted. So we segregated the lemuru landings from the district of Banyuwangi and Muncar, Jawa Timur. Figure 10.7 confirmed the results of interviews that there has been decline of *S. lemuru* from Bali Strait since 1976 (our earliest available statistics) except a high spike of landings in 1990. The cause of such high landings is not known.

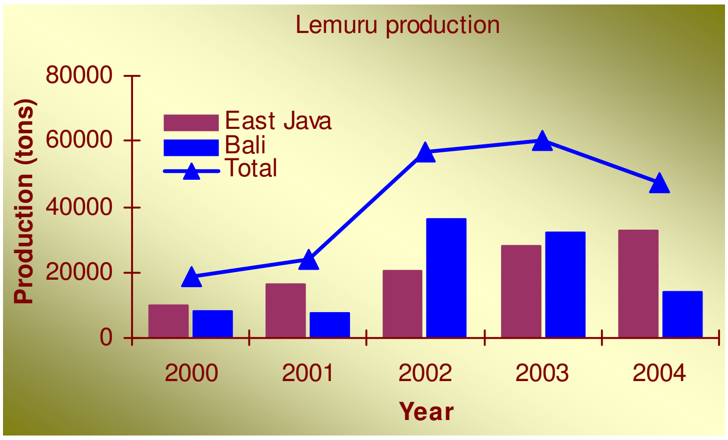
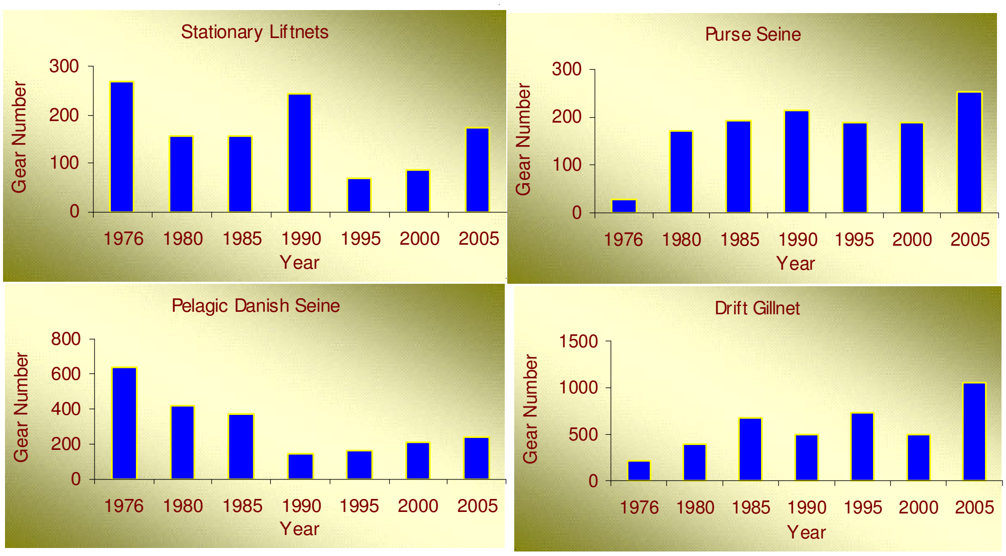


Figure 10.7. Trend of lemuru landings from the regency of Banyuwangi (including Muncar). Source: Provincial statistics of Jawa Timur (various years).

Fishing Gears and Number of fishers

Dwipongo and Subani (1972) listed five types of gears targeting sardines. These are: medium and large pelagic Danish seines (payang uras) with 440 units, cast nets operated with boats (Jala tebar dengan perahu) with 50 units, stationary lift nets (Bagan tetap) with 250 units, large traps (sero) 13 units and gillnets (jaring eder). There was no data on the number of gillnets.

Significant changes have occurred since this classic work of Dwipongo and Subani (1972) where major changes in fishing gear types were observed. Purse seine became the dominant gear overtaking the pelagic Danish seine, stationary liftnets and beach seine declined in number and drift gillnet is increasing (Figure 10.8a-10.8e).



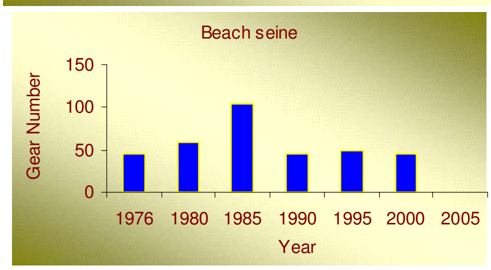


Figure 10.8. Trends in the number of fishing gears targeting the sardines in Muncar and Bunyuwangi, Jawa Timur. Source: Jawa Timur Provincial Statistics (various years).

The changes in the number of fishing gears consequently affects their correspondings shares of catch (Table 10.5). The number of fishing gear types catching Bali sardines has decreased from 11 in 1976 to just 6 in 2005. Many of the gears that ceased to contribute to sardine landings were demersal fishing gears such as the "dogol" or demersal Danish seine and bottom trawl (Table 10.5). The fact that demersal gears, cast nets and large traps were able to catch sardines may suggest that before sardines are still abundant.

At present (this study) the number of fishers was 11,780, of which the number of full time fishers (*nelayan tetap*) is 7,280 and the rest (4,500) are part time (*nelayan pendatang*) fishers.

Gear Type	1976	1985	1995	2005
Purse Seine	38.0	61.9	49.1	71.8
Pelagic Danish Seine	34.2	22.5	37.4	21.9
Mobile Liftnets	9.90	2.17	0.025	2.91
Demersal Danish Seine	4.46	0.28	0.14	0
Beach Seine	4.29	0.61	3.72	0.46
Drift Gillnet	3.47	9.44	3.7	0.84
Set Gillnet	2.67	0.94	0.41	0.78
Other Hook and Line	0.13	0	1.9	0
Other Liftnets	0.04	0	0.07	0
Scoop Net	0.03	0	0	0
Trawl	0.01	0	0	0
Others	2.76	0.99	0.017	3.33

Table 10.5. Percentage share of fishing gear type to the total landings of the sardine, *Sardinella lemuru,* every ten years beginning 1976. Source: DGF National Statistics (various years).

Size Structure and Recruitment

Lemuru sardines are spawned in the middle of Bali Strait within the upwelling vicinities. The resulting cohort first move to their nursery grounds - northwards along the coastal areas of east Java and west Bali. According to Dwipongo and Subani (1972), and Subani (1987), recruits first appear in the inner, shallower part of the Bali Strait around July with length sizes of not >7.5 cm. These are first caught by stationary liftnets in Pangpang Bay. Between August-September, the sardines grow to about 10 cm long (7-9 grams weight) and are locally called "*seminit* or *sempinit*". Liftnets, scoop nets and boat-operated cast nets exploit these small sardines.

Apparently, the sardines start to move southwards as they grow. They reach the "*protolan*" stage by October with an average length of 11.2 cm and about 10-12 g in weight. The sardines grow bigger to become "*lemuru*" which size is around 13.5 cm and weights of about 35 grams. Around these sizes, the sexes become more distinct. Once they reach the size of 15-17 cm long and have reached 45-60 grams will they be called "*lemuru kucing*". It is at these sizes that are required by the tuna longline for baits.

Seasonality of Sardines

There are two seasons for sardines in Bali strait: the peak season from November to March (west season or "*musim barat*") and the east "*musim timur*" season from April to October. The sardines are described by fishers using different names pertaining to different length sizes as described above.

Sardines being sun-dried along the beach in Kedonganan Village is processed into animal feeds.

Status of Bali Sardine Resources

Two comprehensive surveys in Bali Strait were conducted. First was the research made in 1972-1976 on board the research vessel R/V Lemuru which results are summarized in the work of Venema (1996). The second survey was done by R/V Bawal Putih from 1976-1977.

Using acoustic methods, the 1972-1976 pelagic resources survey in Bali Strait showed that at the time of sampling in July 1975, large aggregations of pelagic fish schools were observed more on the entrance of Bali Strait and along the eastern seaboard of Java facing Bali Strait. Low abundance of sardines were observed along the northern part of the Strait (Venema 1996).

This survey made several cruises in Bali Strait including two acoustic surveys in order to estimate standing stock but data proved incomplete and thus simply made a rough estimate of 50,000 tons based on sonar contacts. Subani (1987) and Gede (1992) mentioned stock abundance estimates (biomass, potential stock, standing stock) by various authors and are summarized in Table 10.6. Considering methods and various estimates, Subani (1987) suggested the average value of MSY for the lemuru sardines to be about 36,000 tons. The 2004 landings of lemuru (66 thousand tons) appear more to be the biomass rather than the MSY, assuming that the 36,000 is accurate.

Table 10.6. Various estimates of lemuru sardines biomass from different studies and methods.

Method Used	Biomass	MSY	Year	Sources
Sonar contacts	50000*	25,000	1973-1974	R/V Lemuru: 1973-75; Venema 1996
Acoustic Survey	220,000	45,000 - 66,000	1976-1977	R/V Bawal Putih 1976-1977;
Acoustic Survey		55,000	1976-1977	Buzeta et al.,1979
Surplus Production Model		35,000 - 55,000		Sujastani, 1982
Surplus Production Model		62,000 - 66,000		Martosubroto et al., 1986
Cohort Analysis	19625**			

*/ Subani (1987) cites Bjarnassen estimate of 88,000 tons using the same set of data
**/ total of biomass estimated per length class

Trends in Catch, Effort and Catch per effort

Interview results made in Kedonganan in May 2007, yielded the following information about the sardine fishery:

1. There are currently 100-200 boats fishing for sardines during the west season from October to March. The fishing gears include purse seines, drift gillnets using both multi and monofilament nets.
2. The trend in the number of small motorized vessels operating out of Kedonganan was estimated to be 1970's = 50 boats, 1980's = 100 units, 1990's = 200 units and 2007 = 300 boats.
3. Catch per boat (<3 GT) of drift gillnet using a 640 meter gillnet averages 1.5-2.5 quintal (100-200 kg) per night. In 1990, average catch was 5 quintal (half ton) or a 50% decrease in catch per night operation during the peak season.
4. Fishing commences only if there is a demand for sardines, in most cases is during fall season when the fishes are spawning and have reached the desired bait sizes of 15-20 cm in length. Otherwise, during the rest of the year, fishers switch to catching skipjack (*K. pelamis*),

bonitos (*E. affinis*) and roundscads (*Decapterus spp.*) which fetch higher prices.

5. The fishing ground has become much farther and takes two-hour travel time (15 nm) to reach fishing grounds.

6. There appears to be a general separation of target species between small and large vessels. The estimated 300 large boats, mostly purse seine and pelagic Danish seine target the roundscads while the small boats the small tunas. During the spawning run of the Bali sardines and when there is high demand, all the fleet go after the sardines.

The interview results held in May 2007 confirm the current condition of the Bali Strait sardine fisheries: declining total productivity, decreasing catch and hence income amidst increasing fishing effort. But because of the multi-species characteristic of the Bali Strait fisheries, fishers are able to fish for other small pelagic resources, thus providing relief to the otherwise very high fishing pressure on the sardines on a seasonal basis.

The low prices is a development that saved the sardine fisheries from imminent collapse as fishers switch to other higher values species as roundscads, mackerels and small tunas. Before, lemuru sardines of all sizes are exploited by various fishing gears. Today, only the small ones (*seminit*) and the very large size classes (*lemuru kucing*) are exploited and only on a seasonal basis.

Undersized sardines have very little value and therefore a disincentive that works for the advantage of the resource. This is why gears like purse seine, pelagic Danish seine and gillnets have made the switch to target other small pelagics during off-season and fished for sardines only when there is demand. However, catching of undersized fish (by stationary liftnets) continues because there is still a market for dried fish, both for food (in limited scale) and for fishmeal.

Recommendations for Management action for the Bali Sardines

Based on several studies conducted on the lemuru fishery, several authors have provided significant results and simulation studies that served as foundations for policies to manage the Bali sardine resources.

1. The first is to continue to develop and improve the methods to have an accurate estimate of the population. While *S. lemuru* is widely distributed on the western Indonesia's Indian Ocean coast (Venema 1996), the species is highly concentrated in Bali Strait providing some advantages of managing a resource in a fairly limited area. The current production of lemuru sardines is about 47,000 tons which is either over or within the various estimates of MSY. A new study to determine current biomass and standing stock is necessary.

2. The second most important issue is to address the catching of the juveniles and young adults. Of the four major gears operating, only gillnet (Jaring eder) catch the least amount of immature sardines (Table 10.7). Motorized castnet and the stationary liftnet operating in Pangpang Bay catch mainly the recruits entering the fishery.

   While some input controls are already in place such as mesh size regulation for purse seines to 1 inch (DGF regulation 1975), this has to be combined with other measures to be more effective. One suggestion is to combine a spatial-temporal regulation with minimum size. Since the demand for bait requires sizes between 15-17 cm long, locally called "lemuru kucing" and its spawning area is well defined (Ritterbush 1975, Subani (1982), the fishing area on certain seasons could be regulated, allowing only at times when the right sizes are available. A minimum size policy that goes with spatio-temporal closure is easily implementable.

We see no reason for wide-spread arguments against such a move as smaller sized fish do not fetch a good price and are converted to feeds. Such a move will protect the recruits to grow and reach maturity size and probably spawn before being caught. Except for the stationary liftnets which would be harshly hit by this policy, active fishing gears in fact have switched to more profitable target species such as roundscads and Indian mackerels and small tunas.

Table 10.7. Shares of immature lemuru catch by the different types of fishing gears operating in Bali Strait in 1967-1971. Data on Danish seine, cast net and gillnet from Dwiponggo and Subani (1972), purse seine* data from Budihardjo et al, 1990 are based on raised data.

Gear Type	% Immature	No. samples
Pelagic Danish Seine	75.0	400
Motorized Cast Net	100.0	200
Gillnet	32.3	300
Purse seine	3.84	13905269

3. There appears to be a high influence of the El Nino Southern Oscillations (ENSO) on the abundance, and therefore catch of lemuru sardines (Ghofar & Matthews 1996). Several studies made correlations of landings and amount of rainfall (Subani, 1982, Ritterbush 1975, Dwipongo and Subani 1972) but it took Ghofar and Matthews (1996) to discover the probable reason behind the good correlation of rainfall and catch - the reason being actually triggered by the ENSO.

   There is an urgent need to continue the work of Ghofar and Matthews (1996) to study the impacts of high fishing pressure on the sardine populations and how the combination of both fishing pressure and ENSO events could contribute to the dynamics of the fishery. They argued that leaving not enough spawning stock as a result of intense fishing may lead to the collapse of the population following an intense ENSO event. With the threat of the impacts of rising global temperatures triggering severe climate changes, more intense and highly irregular weather disturbances are expected and these may have serious consequences on the stocks of the Bali sardines whose strength of recruitment are influenced by the ENSO.

4. The size of baits used in tuna longline is between 15-20 cm in length. These sizes are over the length-at-maturity of lemuru sardines at 12.9 cm (Fishbase 2002). This means that the tuna fishery does not contribute to any growth overfishing. It could however, with its demand for large sizes, contribute to reduced population of the spawning biomass (recruitment overfishing). As practiced presently, the boats go after sardines only during the times when the large sizes are abundant and the prices are right. But such practices, when not regulated, may generate enough fishing pressure in a given season that may decimate the parental stock below critical level with which the next cohort would be coming from.

   How much is the domestic demand of the tuna longline for sardines? A simple calculation in Table 10.8 below show that estimated demand for sardines of sizes between 15-20 cm long is about 23,831 tons. Using the length frequency structure of sardines caught by purse seines in Bali Strait, about 99.64% represents those the 15 to 20 cm sizes for baits. The catch of purse seine based on the 2005 statistics is 25,508 tons and taking 99.64% of this is 25,405 tons which is more than the

Still gilled to the net, these sardines are classified into sizes, the large ones are frozen, packed and sold as baits for tuna longline. Small ones are dried for fish meal.

Table 10.8. Estimate of the total bait demand (in tons) of the tuna longline fleets in Indonesia.

Vessel size	No. Vessel	Annual fishing days	kg baits/d	Total baits (tons)	Sardines (94%)	Scads (3.8%)	Squid (2.3%)
> 40GT	1568	150	68	15,994	15034	608	368
<40 Gt	1045	150	50	7,838	7367	298	180
Total	2613			23,831	22401	906	548

Notes:
Vessel size and total vessels from DKP 2005 data (DKP National 2006) but used only half to account for double reporting
Annual Fishing Days from Merta et al, 2003 (BRPT 2003)
Kg Baits/day from Interview with Pt. PSB (Pt. Perikanan Nusantara)
Proportion of Baits taken from Observer program of WWF from boats based in Benoa, Bitung and Pelabuhan Ratu 2006.
When baits used in one setting is a combination, the weight of each species is equally divided.

total demand demands for baits (23,831). The sardine catch alone of purse seine from Bali Strait is sufficient to supply the domestic demand of the whole tuna longline fleet of Indonesia.

It is good management practice to note that tuna demand could reduce the parental population. The population has declined by an unknown quantity and the threat of El Nino generated by warming of SST may trigger population collapse (Ghofar and Matthews 1996). The government should start managing the sardine resources by building up the resiliency of the population against natural and man-made events. With the global warming threats which is changing existing weather patterns, this suggestion is essential.

Further suggestion is to reduce fishing pressure through the use of other alternate baits such as roundscads, particularly paying attention to the sourcing of bait materials from different fishing grounds. This way the baits sourcing is evenly spread throught the archipelago and the lemuru sardines inhabiting Bali Strait would have a reprieve thereby conserving the populations of the lemuru sardines endemic in the Strait. This scheme has to be worked out with the bait suppliers. Note that there are generally two seasons for peak catches per year and these differ between areas.

5. Government should provide guidelines on the use of the sardine resources, by allocating quantities for human consumption and for baitfish supply. Study the demand of the fishery in terms of baits required and matches this demand with the current level of baitfish resources.

6. One of the key issues that when solved will have a positive impact on the sardine management is to reduce the volume of juveniles taken by the fishery. And one of the suggested actions is for the government to think of a way to eliminate the trade and put zero market value to the undersized sardines. This is also considered as the right time because fishers made the voluntary switch to fish for other species of greater value. The only ones to be affected with this move are the stationary/ mobile liftnet and scoop net operating in Pangpang Bay and nearshore areas.

7. Undertake an in-depth study on the efficiency (energy, carbon footprint) of using different baitfish species.

8. The use of sardines as baits could probably raise some technical difficulty on the current campaign to use circle hooks in order to reduce the amount of turtle by–catch. The circle hooks being promoted have thicker diameter and this necessitates that experiments be undertaken to address this concern.

Part III: Baitfish fishery of Roundscads for tuna longline

Brief background

This section will summarize existing information on the species in relation to its use as bait of the tuna longline. Status of the stocks and its possible impacts on the tuna sector is presented under recommendations.

Catches

The roundscads known locally as "*layang*" in Indonesia belong to the genus Decapterus and are represented by five species. These are *Decapterus macarellus, D. macrosoma, D. tabl, D. russelli* and *D. kurroides*. It is not clear from the literature which species are used as baits for tuna longline, as use of local names persist not just in statistical yearbooks but in scientific publications as well. Based on interviews, red-tailed scad species (*D. kurroides*) are not used as bait which leaves four species possible for baitfish.

Historically, the "*payang*" or boat seine has been in use since the start of large-scale fishing in Indonesia where the fishery has been described (Verloop 1904, Rosendaal 1910 as cited by Nugroho 2006). Production since 1970's has been on a steep increase and has increased 10-fold to 325,000 tons (Figure 10.9).

Four major fishery management areas (fishing grounds) are the main sources of roundscads in Indonesia.These are Java Sea (FMA-III), Flores Sea (FMA-IV), Moluccas, Tomini and Seram Seas (FMA-VI) and Sulawesi Sea (FMA-VII). The aggregate production of roundscads from these areas represents 67% in 2000 to 78% in 2004 of the countries' scad output (Table 10.9).

Figure 10.9. Landings of roundscads, "layang," from major fishing grounds. Values in thousand tons. Source: DKP Statistics by fisheries management areas (2006).

Table 10.9. Landings of roundscads "layang" from major fishing grounds. Values in thousand tons. Source: DKP Statistics by fisheries management areas (2006).

Year	FMA 3	FMA 4	FMA 6	FMA 7	Sub total
2000	49.2	74.8	28.4	15.3	167.6
2001	54.8	73.7	26.8	19.4	174.8
2002	77	75.6	55.2	20.4	228.2
2003	62	96.9	32.7	42.5	234.2
2004	93.4	80.1	51.7	30.9	256.1

Fishing Gears and Fishers

Roundscads is one of the most economically important small pelagic fish, in general, and the most important fish resource of Java Sea, in particular. This species are used mainly as food and baitfish for the domestic markets. It is exported to Korea and Japan mainly for baits of tuna longlines.

At least 11 types of fishing gear catch roundscads but purse seine and pelagic Danish seine are the major gear types that target these species. These two gears account over 76% of the landings in Jawa Timur (Table 10.10) while the rest of the fishing gears (gillnets, longlines, hook and lines) take layang (roundscads) as by-catch, mainly during the peak season.

Table 10.10. Percent share of fishing gears to roundscads and total landings in the province of Jawa Timur in 2005. Source: Provincial Fisheries Statistics, Jawa Timur, 2005.

Gear Type	Total Prod. (t)	Roundscads (t)	Share of scads (%)
Purse seine	110746	15003	13.5
Danish Seine Pelagic	70427	11910	16.9
Set gillnet	15160	1979	13.1
Hook and Line	11926	1467	12.3
Trammel Net	12232	1212	9.9
Shrimp gillnet	14402	1201	8.3
Drift gillnet	21997	1169	5.3
Danish Seine Demersal	11556	522	4.5
Stationary Liftnet	8242	292	3.5
Longlines	279	4	1.4
Beach seine	781	4	0.5
Others	18651	194	1.0
Total	296399	34957	11.8

Seasons and factors affecting availability

The migration pattern of roundscads in Java Sea is related to the monsoons and has been described by Hardenberg (1937, 1938) and subsequent works by Soemarto (1958), Bailey (1987) and Potier and Boely (1990). Hardenberg (1937) as cited by Nugroho (2006) identified three groups of scads with distinct migration patterns as follows: 1) East, layang population enters Java sea with the incoming oceanic water from Flores Sea during the northeast monsoon from May to September; 2) West, layang comes with the oceanic waters from the Indian Ocean through Sunda Strait during the west monsoon that blows from November to March, and 3) layang enters Java Sea from South China Sea through the Straits of Gaspar and Karimata during the west monsoon season.

Abundance is governed by monsoon and largest catch is observed from October to December and a minor peak from March to April. Interestingly, Figure 10.10 shows a marked decline of catch during the peak season that progress until 1999.

Oceanographic factors such as salinity (Hardenberg, 1937, 1938), amount of rainfall (Salasah 2000) as well as lunar moon phase (Atmaja and Nugroho 1999) affect the distribution, abundance and availability of the roundscads.


Roundscads are the main bait used by the tuna longline of Indonesia but is also an important food fish.

Interspecies interaction

Two species dominate the catch of roundscads in Java Sea, *Decapterus russelli* locally called “layang biasa” and *D. macrosoma* or “layang deles”. While both species mingle

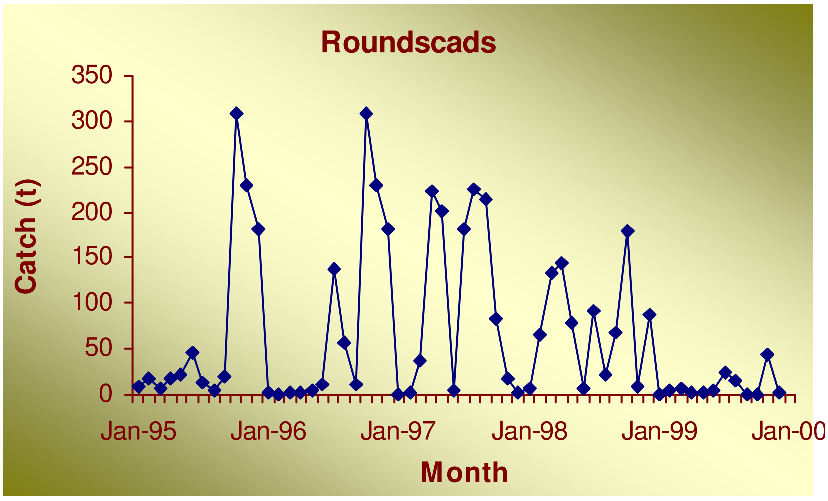


Figure 10.10. Seasonality of roundscads taken from Tomini Bay from 1995-1999. Figure drawn from Table 15 of Salasah (2000).

and are caught together, there appears to be sites where one species dominate the other. For instance, *D. macrosoma* appears to be abundant on the eastern part and *D. russelli* on the western part (Suwarso et al, 1987) probably because the former has more oceanic characteristic than the latter (Nugroho 2006).

The share of this two species appears to be changing over the last 30 years wherein the share of *D. russelli* to the total scad landings from Java Sea declined from a high of 83% in the mid-1970's to just 50% in 1995. Similarly over the same time span, the share of *D. macrosoma* grew proportionally (Figure 10.11). The biological and ecological reason for this is unknown and research to determine its causative factors is important for the management of this fishery properly.

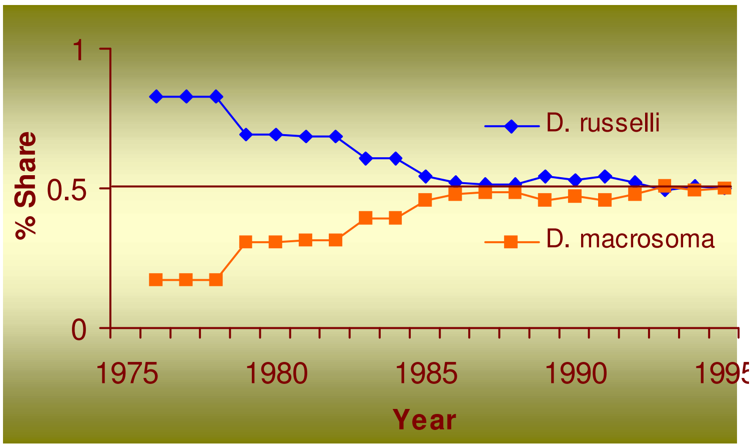


Figure 10.11. Changes in the percentage share of *Decapterus russelli* and *D. macrosoma* from Java Sea. Source: The figure is drawn from data in Appendix 1 of Nugroho (2006).

Status and Trend of the fishery

The current trend of catches and fishing intensity for roundscads in Java Sea is fully represented by an example from Pekalongan and Juwana in Figure 10.12. Nugroho (2006) made an assessment of the status of the stocks in Java Sea and concluded the following:

1. The fishing effort (total annual fishing days of purse seine) doubles every 13 years and has reached its highest level in 120,000 fishing days (Figure 10.12).

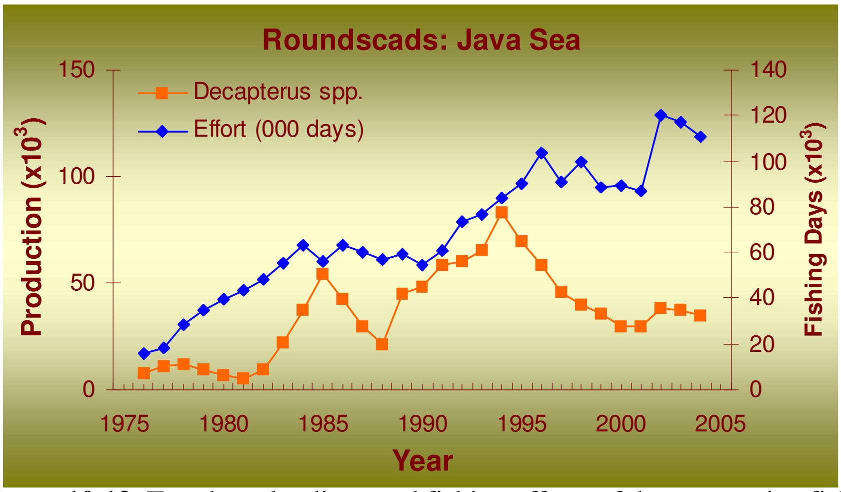


Figure 10.12. Trends on landings and fishing efforts of the purse seine fishery in Pekalongan and Juwana. Source. Appendix 1 of Nugroho (2006).

2. The production peaked in 1994 with 82.6 thousand tons and has been declining since until 2001 when apparent increases in landings over the next three years were observed.
3. Using Gompertz and Logistic Curve methods and weighing the Fmsy by incorporating F=qE (catchability coefficient* Exploitation rate), the stock actually was declining and not recovering as what the data on the last three years suggested.
4. Relative biomass expressed in percent and using 1975 as base point (100%) has declined to just 15% suggesting a very serious and dangerously low biomass level (Figure 10.13).

The steady trend of increase in production is the confluence of the unabated increase in fishing intensity and technological improvements in fishing gears and crafts. The technological improvements over the last 50 years of purse seines include motorization, use of navigational equipments (GPS, fish finder), better and larger boat sizes, use of larger and lighter nets and embracing better and cost saving technology (e.g. FADs) made fishing highly efficient. The lack of policies for the regulation of such innovations facilitated the pathway of the fishery to self-destruction.

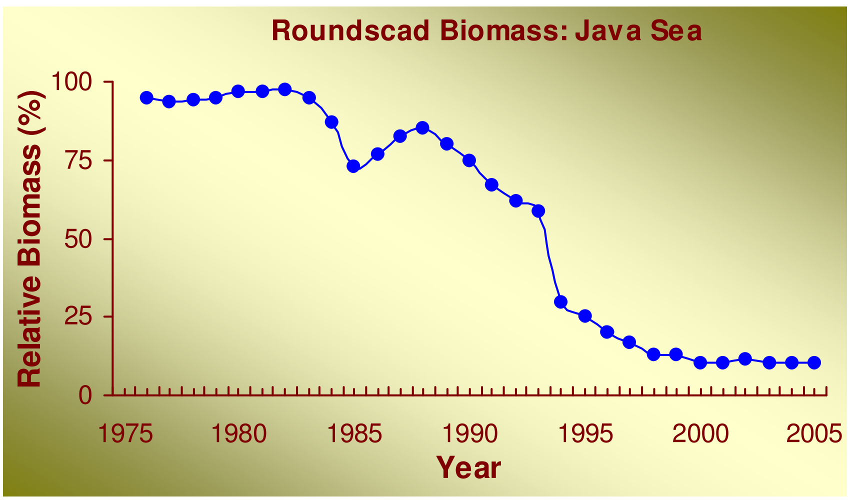


Figure 10.13. Relative biomass (%) of roundscads (*D. russelli* and *D. macrosoma*) for Java Sea redrawn from Nugroho (2006). Values used were read off from the graph and redrawn.

Purse seines, mainly the small vessels are partly responsible for the overexploitation of roundscads from Java Sea.

List of Issues and Recommended management actions

1. The most pressing issue to address is the very low status of stocks of roundscads. The solution is to reduce fishing mortality. A combination of both input (regulate boats, fishing days, closed season) and output control (minimum size law for the different species) may be necessary.

2. With the current overfished condition of the fishery, baitfish sourcing should come from other areas where stocks remain healthy and where management of the stocks are in place. The tuna sector could contribute greatly to the recovery of the population of roundscads by not getting their supply of baitfishes from Java Sea and other depleted areas and by allowing only exports of this fish species that are sourced from healthy, well managed stocks.

3. About 80% of roundscads catch by purse seine are immature fish (Atmaja & Nugroho 1995). To address the issue of juvenile catch, research needs to be conducted to develop technological innovations to minimize the capture of juvenile roundscads. Research in this direction needs to be undertaken.

4. The status of resources of roundscads are so serious that conservation actions should be immediately initiated to conserve the resources and to compliment this with actions on market and trade aspects (e.g. # 2 recommendation above). An example is a policy that allows exports of baitfishes sourced only from areas where stocks are well managed and remain healthy.

Tuna Trade

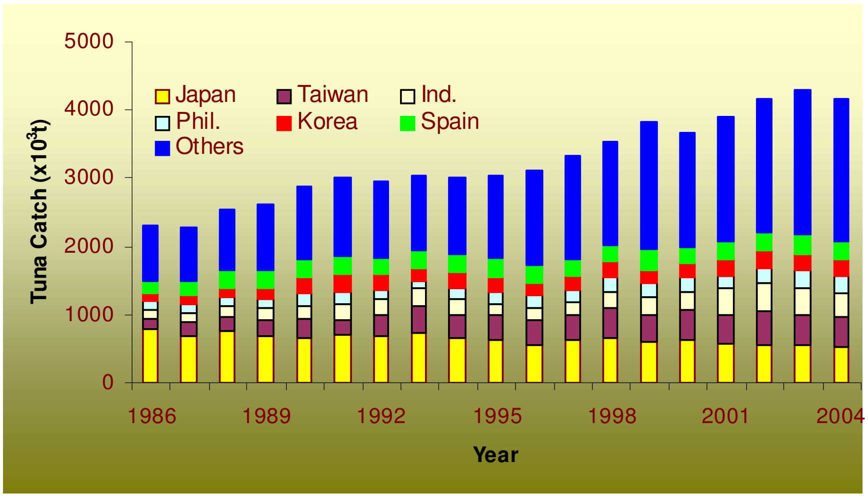


Figure 11.1. Trend of tuna catch by the world's biggest tuna producing countries. Source: Globefish 2005.

Fisheries Trade

Indonesia is a net exporter of fisheries products. The volume of exports expanded to over 0.9 million tons valued at US$1.78 billion while import volume is at 136 thousand tons with US$154 million value. The country enjoys a healthy positive balance of trade (BOT) of US$1.63 billion in 2004, upped from 1.53 billion in 2002 (DKP Statistik Pengolahan dan Pemasaran hasil perikanan 2005). Because of this performance, in 2005, the fisheries sector contributes to abut 16.3% of the Gross Domestic Product of the subsector of agriculture and about 2.18% of the national GDP.

Indonesia is the world's fourth largest fishing nation. It is also the third largest producer of tunas after Japan and Taiwan with 342 thousand tons landed in 2004 (Figure 11.1). The county s tuna output has increased by 173% over the past two decades. Its recorded landings, relative to the total global output has increased from 5.28% in 1995, reached its peak in 2001 with almost 10% and declined slightly to 8.23% in 2004 (Figure 11.2). Note that the percentage share of Indonesian tuna relative to the global catch dropped to less than 6% from 1995 to 1997.

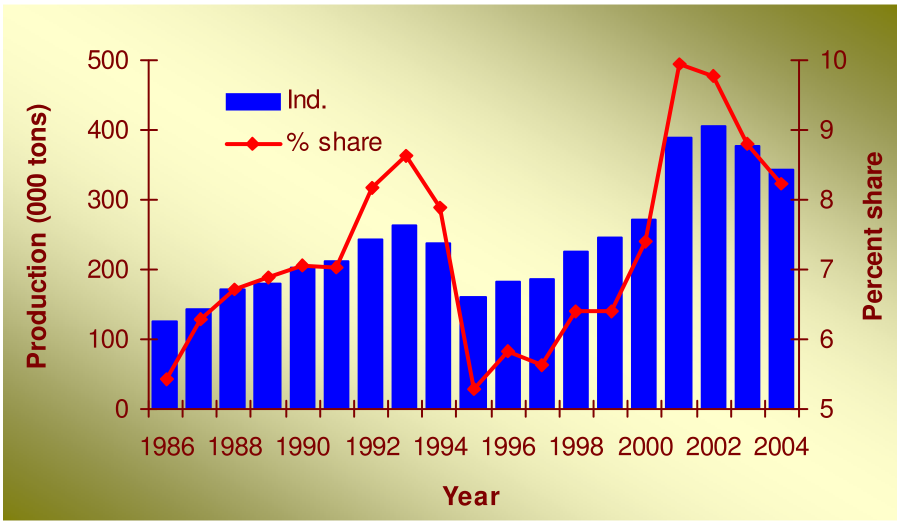


Figure 11.2. Indonesia tuna landings and its share to the global tuna catches. Source: Globefish 2005

In the last 10 years, the tuna exports of Indonesia grew from 82 thousand tons in 1997 to 92 thousand tons in 2006 but reach its peak in 2003 with volume of 119 thousand tons (Figure 11.3). The trend showed by Indonesian tuna catch is similar to the global where the peak landings were realized in 2003. Although the export volume fluctuated greatly, its value over the last 10 years are steadily on an increasing trend.

While large tuna production grew by 87% from 1999 to 2005, the share of exported tunas relative to the total tuna production fell by 30% over the same period, with a huge drop of 40% between 2003 and 2004 (Figure 11.3b). This is probably due to a

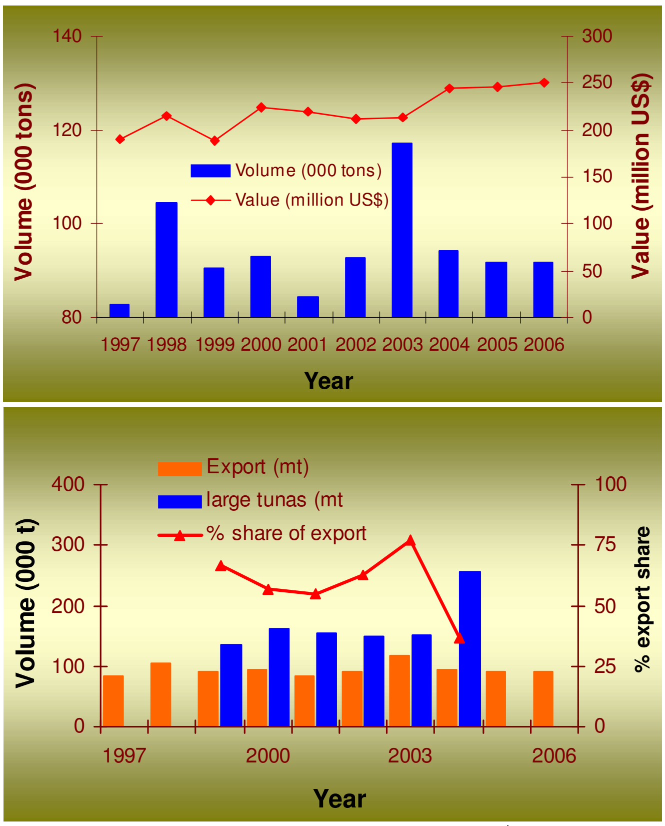


Figure 11.3. Above: Volume (in mt) and value (million US$) of tuna exports of Indonesia in the last 10 years. Below: Tuna landings (large tunas only) and percentage of exported tunas. Source: A: Globefish 2007; B: DKP Export Statistics, 2006.

combination of factors that include 1) contraction of export volume due to challenges arising from food safety considerations and, 2) difficulty of the industry in overcoming both tariff and non-tariff barriers (NTB). The data used in Figure 11.3b came from DKP national capture fisheries statistics and refer only to the landings of large tuna species. Note the large discrepancy of tuna landing figures from Globefish (2007) and DKP (2006).

The export products consist of fresh/ chilled, frozen and processed tunas. Fresh or chilled are exported as a gutted whole fish, frozen whole or frozen as loin, or tuna steaks. Processed products comes in two categories, those in airtight containers, mainly canned tuna, and not airtight containers such as the smoked skipjack (katsuoboshi). The processed products are mostly the large tuna species (such as yellowfin, bigeye, bluefin, albacore) and skipjacks.

Indonesia exports tunas to five of the seven continents, with over half (57%) of exports going to Asia, 24% to the USA and 12% to Europe (Figure 11.4). The traditional export destinations of Indonesian tuna products are Japan, Europen Union (11 countries) and USA while the Asian countries are emerging markets including China, Hongkong, Korea, Philippines, Malaysia, Singapore, Thailand, Taiwan and Vietnam. The new markets being developed include the middle east (Saudi Arabia), India, Sri Lanka, Australia and Canada.

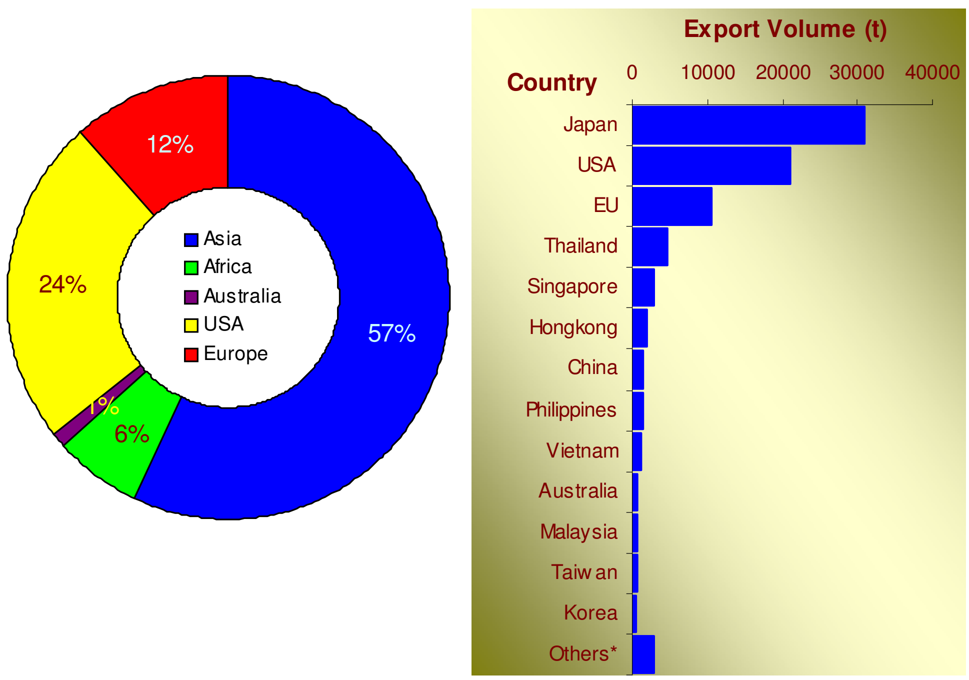


Figure 11.4. Market destination of Indonesian tuna exports for 2006 by continents (Pie graph) and by country (bar graph). Source: DKP export statistics 2006. Others include Canada, Australia, Saudi Arabia.

Indonesia s main market of fresh and chilled tunas is Japan. Fresh and chilled tuna import records of Japan from Indonesia fluctuated from 15,250 tons in 2000 to about 10,685 tons in 2005 (Figure 11.5). Despite its decreasing volume of imports, Indonesia s share to Japan s market has increased from 22% to 28% over the same period.

Over the last seven years (2000-2007), exports of canned tunas to the European market, mainly to UK and Germany, have remained at the same volume level. However, there were marked changes in trade with these countries where Indonesia s share of UK market dropped from 6% in 2000 to just below 2% in 2007(based on first quarter only). Its German market however expanded wherein the market share of canned tunas increased from 2% in 2000 to a high of almost 9% in 2005 and declined to about 6% based on first quarter figures in 2007 (Figure 11.6).

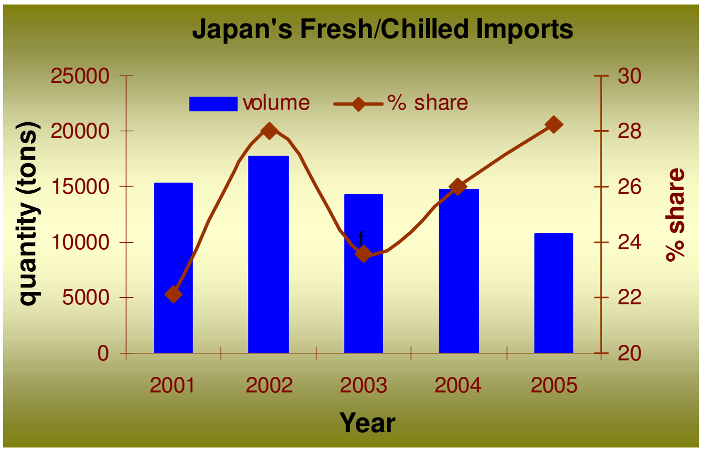


Figure 11.5. Volume of fresh and chilled tuna from Indonesia to Japan for 2001-2005 and Indonesia's share to this market. Source: Josupeit, H. (2006)

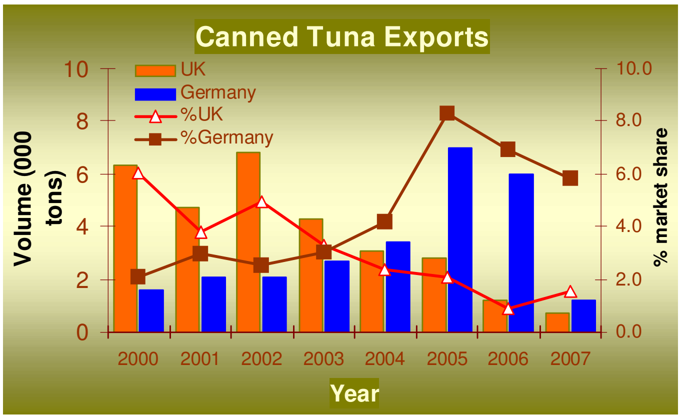


Figure11.6. Exports of canned tuna by Indonesia to UK and Germany and the share of the canned tuna market. Data for 2007 refers to first quarter volume only. Source: Globefish 2007.

Issues and Recommendations

Below are list of identified issues that beset the export of tunas.

1. Current global outlook show that supply of tunas is low resulting in the lower international trade of tunas. This situation is similar in Indonesia where exports are down due to low landings of the domestic tuna longline fleet fishing in Indian Ocean and the pole and line fleet fishing in the archipelagic waters. Overfishing is most likely the main reason.
2. The fresh/chilled tuna export is the biggest tuna product of Indonesia. Before the year 1995, the main supply were from the longline fleet but over the last 10 years, the simple tuna handline and troll fisheries are the main suppliers of raw materials for fresh/chilled tuna. Records provided by the tuna association ASTUIN members showed that longline catch represent just 32% in 2005 and 42% in 2006 of the handline catch of 2,984 tons in 2005 and 1,894 (Jan-Oct data only) in 2006 (Figure 11.7).
3. Indonesia could improve its quantity of exported tunas by simply addressing the issue of poor fish quality thus increasing the proportion of exportable tunas. As Figure 11.7 shows, only 60% of tunas caught by longline and 19.6% (2005-2006 average) were exported fresh/ chilled, which suggest that 40% of longline and 80% of handline catch were of lower quality. These lower quality fish were

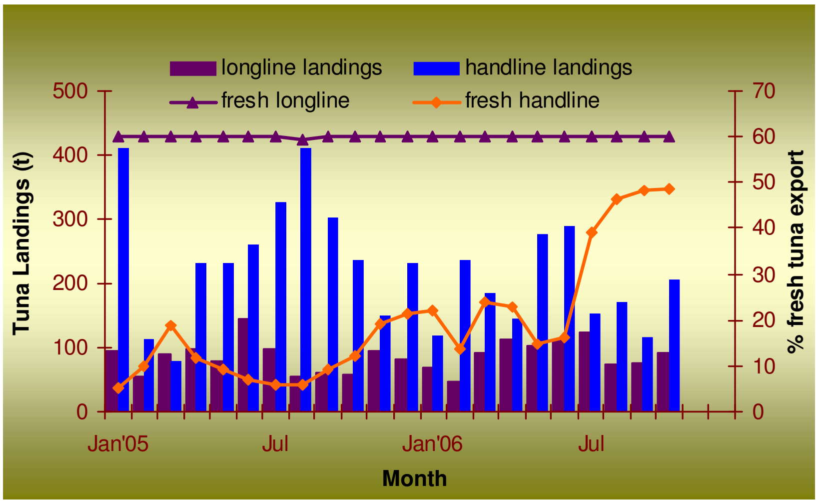


Figure 11.7. Records of the landings volume (tons) of longline and handline and respective percentage share to fresh tuna exports; data from members of the Tuna Association of Indonesia (Assosasi Tuna Indonesia or ASTUIN). Source: Tjandrason (2006)

either processed into loins for canning or tuna steaks (Grade B), or sold and traded at the local market (Grade C and D). Using actual landings of the ASTUIN members, improving the quality by just one-half of the current low quality percentages, would translates to an additional 2,332 tons of exportable sashimi grade tunas. At current values, this mean an additional price difference of about US$2.49 million (using base price of Grade C tunas).

Improving the quality of tunas also benefits the health of the local populace consuming the lower grade tunas. The downside is that tuna availability in the local market will be scarce as the high prices of Grade A would probably limit the buying capacity of ordinary consumers.

4. Development of new products and value-adding are essential to expanding export market share. The traditional types of products dominate the tuna exports. Tunas are exported as fresh (gutted & gilled whole fish, loins and bellies), as frozen (gutted & gilled whole fish, loins, chunks, fillet, steaks), smoked (smoked loin, katsuoboshi) and canned (in oil, brine solution, tomoto sauce). While tuna pouches from Thailand and Philippines have penetrated and monopolized the US markets. Also, new products such as the combination of rice and tuna in separate sachets but packed together and sold as one is developed in Thailand and are proving to be smash hit particularly to the Asian consumers spread all over the globe. Yet, product development of new tuna products in Indonesia have lagged behind. The government should encourage the private sector to venture in research and development of new tuna products.
5. Tuna prices in 2007 at the international market remain high as a result of scarce supply. Prices for fresh and chilled tunas will probably increase but canned tuna will probably go back to the 2005-2006 levels as canned tuna consumers will wait for lower prices. The demand outlook for canned tunas in the US looked damped as indicated by the skipjacks prices of Thailand and Africa at the international market shown in Figure 11.8 (Josephuit, 2007). Note that the skipjacks are the main species used for canned tuna products.
6. Demand for sashimi raw materials will likely continue to grow because of two factors: first, there is the growing number of sashimi consumers outside Japan; and second, Japan is possibly making good of its threat to ban Mediterranean bluefin tunas in entering its market unless concerned governments act on issue of sustainability. The Japanese market has braced for expected shortage of whole fresh and chilled fish by allowing more volume of chilled loins for their sashimis while the restaurants are testing new substitutes for tunas for their sashimis (New York Times, 2007).

Presently, the large rejection rates of handline and troll line caught tunas are due to inadequate facilities in small boats for cleaning, gutting and immediate lowering of the whole fish temperature to the desired levels. By opening the

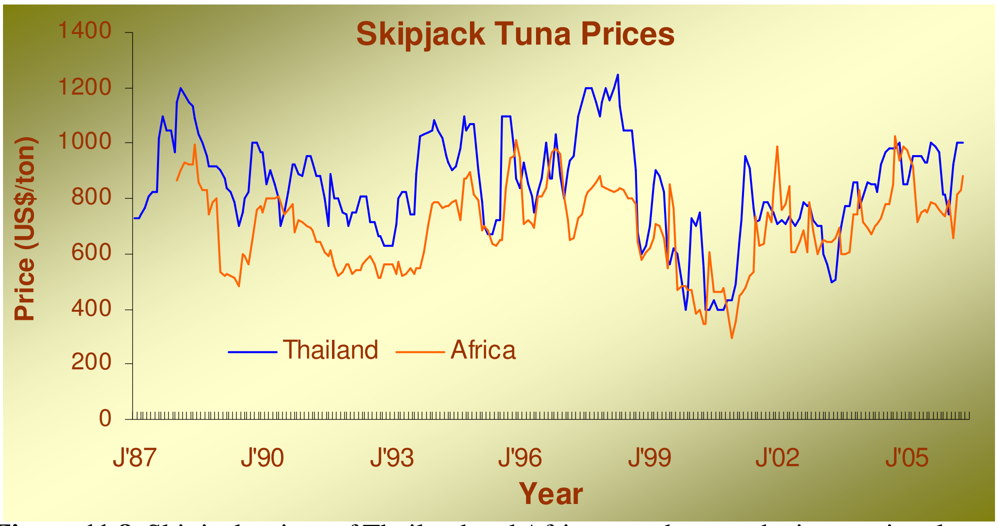


Figure 11.8. Skipjack prices of Thailand and African products at the international markets years 1987-2006 (June06). Source: Josephuit 2007.

market of loined fish for sashimi, fishers could land loined tunas instead of the whole fish and still be able to get sashimi grade prices for their fish. Loining at sea is a very good strategy in improving fish quality but is not popular among troll liners and handliners because the Japanese market don't accept loins for sashimi. A ray of hope is however seen for the fishers loining their catch at sea because the sashimi market has started accepting loined tunas. Hopefully, the Japanese market will continue to accept with equal preference the loined tuna to supply their sashimi markets.

7. The gap between landing and export prices needs to be narrowed. Prices mentioned by exporters for 2007 are around US$1,450 per ton for skipjack and close to US$2,100 per ton for yellowfin tuna. Comparatively, based on our interviews, local prices at landing areas for a whole fish ranges from US$450 to US$750 per ton for skipjack, and US$700 to US$1,500 per ton for yellowfin. Average prices of skipjack and yellowfin tuna for the whole country between 2000 and 2004 is US$556/ton and US$722/ton, respectively (DKP Statistik Perikanan Tangkap, 2006).1 As a rule, highest buying rates for tunas at the landing areas never exceeds half of the prices dictated in the international market.

   The most common source complaint of tuna fishers during the course of the survey, aside from high fuel prices, is the low buying prices of tuna. Some suggested solutions to address this issue and reduce if not prevent the alleged price manipulations of the tuna merchants are to:

   a. empower the fishers to determine the quality of their tunas. Presently, the grading of tunas are dictated by quality controllers employed by buyers. Fishers have no training nor know how to question the assessment of the quality of their tunas, thus at the mercy of the traders.

   b. enable fishers to know current buying prices at the international, regional and national markets. This will inform the fishers and will reduce price manipulations by the traders.

   c. Identify ways to wean fishers from securing credits through the tuna buyers and promote using formal credit facilities.

   d. Reduce if not eliminate the incidental cost of trading tunas from corruption. Along the domestic supply chain, tuna merchants are forced to shell out grease money to facilitate business, from transport to securing support documents. To ensure profit, these added costs of doing business are passed on to the fishers through lower buying prices.

8. There is a serious cause for concern on two recent developments that affected the tuna exports. First is the decision of the European Union to ban export of tuna from Indonesia due to sanitary and phytosanitary shortcomings (Table 11.1). This came after the recommendation of the EU mission which came to Indonesia in mid 2007. The second is the ban of Indonesia's national flag carrier to fly into Europe mainly to pressure the Government to strengthen its security provisions in its airport and to improve maintenance of its planes.

How the stoppage of flight to Europe by Garuda impacted the tuna exports could not be determined quantitatively but is assumed to be significant as exporters will utilize foreign airlines which is probably more expensive. Similarly, the automatic retention of all tuna exports into European Union places an added cost of doing business as additional US$ 500 per container is charged for storage and mandatory laboratory testing of samples of its tuna products.

The ban by EU has long been in coming. Records of histamine contamination (>50 parts per million or ppm) averaged 4% for samples analyzed between January 2005 to October 2006 (Tjanrason 2006). In some months, contamination rates even go as high as 18% (Table 11.1).

Such situation results from the inability of the government to provide sufficient and well equipped laboratory services. In late 2006, two of the four laboratory facilities that issue health certificates required for export are not functioning. This placed the burden on the two other remaining facilities. Driven to work on overcapcity, health certificates were issued without the benefit of any random samples being analyzed.

The health hazard issue for Indonesian tuna product has severe economic consequences. First, its market share will suffer as consumers in destination markets will shy away from products tainted with records of poor food safety procedures. The "loss of brand" will continue to hound Indonesian tuna products as long as the issue of health remains. Second, Indonesia runs the risk of losing its EU quota with reduced tariff in favor of Thailand and the Philippines if it fails to deliver on its quota. Indonesia gets a smaller quota compared to the two other countries and yet it takes longer time to fill up the quota. Third, the program of the government to encourage tuna investments will not prosper as planned because tuna products with Indonesia as point of origin will have automatic retention into the EU market, a condition that is not conducive for prospective investors.

Despite trade restrictions to the EU, tuna exports to Europe continue through bilateral trade agreements. Thus Indonesian tunas still find their way in European markets through the Netherlands, Germany and the United Kingdom. While latest figures suggest that tuna exports to Europe are on the decline, exports to USA show an upward trend (Globefish 2007).

Table 11.1. Monthly number of tuna products found containing significant histamine levels(>50ppm) for years 2005-2006. Source: Tjandrason (2007).

2005	J	F	M	A	M	J	J	A	S	O	N	D
Contaminated samples	6	2	12	1	0	42	4	1	0	34	0	0
Total samples analyzed	141	109	139	125	133	228	166	115	81	243	67	88
2006												
Contaminated samples	2	2	0	0	5	1	0	0	1	0	1	nd
Total samples analyzed	81	153	76	83	161	159	65	65	87	148	64	nd

Table 11.2. Comparison air and sea freight cost between Indonesia and Philippines. Source: Tjandrason (2007).

Point of Origin	Tokyo	Los Angeles	New York
Air freight USD/kg			
Manado, Indonesia	2.25	4.3	4.45
General Santos, Phil.	1.85	3	3.5
Sea Freight USD/40 ft. container			
Bitung, Indonesia	5,400	7,800	8,250
General Santos, Phil.	4,500	5,250	6,000

9. International trade of tunas needs to be competitive. To do this, the government needs to address the following issues:

a. The inadequate infrastructure facilities for tunas particularly in eastern Indonesia where the tuna fishing industry is hastily developing. The existing facilities in Muara Baru, Jakarta and in Benoa, Bali servicing the once longline fisheries in Indian Ocean are now too far from the newly emerging fishing ground of east Indonesia. The distance of thes e ports is therefore not conducive to the industry anymore as transportation costs of going there would be a tremendous burden. Storage facilities, ice plants and processing plants are better developed near fishing grounds.

b. Increase the number of international gateways for tuna and other seafood exports. Presently, the main tuna exports could pass through in only four airports (Jakarta, Bali, Surabaya and Makassar. This is because the four support facilities for export requirements such as laboratory testing and health certificates are present in these cities. Manado in North Sulawesi and Ambon are good candidates with good airports but support infrastructure are lacking.

A tuna gateway in the province of Papua would be strategic as it could serve not just the domestic but also international needs of the fleet operating in the western Pacific, the area being within four hours of air travel to leading markets of Australia, Japan, Korea and China.

c. High cost of freight makes Indonesian tuna more expensive. Tjandrason (2006) found that cost of air freight with other tuna exporters in the region (Thailand and Philippines) is more expensive by as much 30-60% (Table 11.2). The situation is similar for shipping freight costs.

By-Catch

Introduction

By-catch is one of the most significant issues affecting fisheries management today (Hall et al 2000). Tuna fishing gears take a variety of species while on the process of catching the tunas. These include long-lived, low reproductive rates such as turtles, swordfish, seabirds, sharks and rays to the juveniles of their own co-specifics.

By-catch impacts biodiversity through incidental mortalities. Economically, it is an issue of waste through discards (e.g. seabirds, turtles, carcass of sharks) or through potential loses generated by catching of the juveniles of commercially important species, undermining both sustainability of the resource and the livelihood of the peoples that depend on it.

This section seeks to presents two aspects of the by-catch of the tuna fisheries, the issue of juvenile catch of tunas by purse seine and pole and line gears and the by-catch taken by the domestic longline fishery.

Part I: Juvenile Tuna Issue

Defining the Juvenile Tuna problem

Tunas, like many pelagic fishes form schools and aggregations. This behavior is a response to improve feeding efficiencies, improve reproductive success and reduce predation mortality. Schools are formed at the surface level making the school-forming fishes highly vulnerable to surface fisheries. But the schools formed are not made of one species. Very often, juvenile tunas of yellowfin and big eye tunas swim with skipjack school. This explains why fishing gears like the purse seine, pole and line small-scale handline and troll fishing that targets the skipjack often have significant by-catch of juvenile yellow fin and big eye tunas. Why juvenile yellowfin and bigeye tunas often mix with skipjack schools of similar sizes is unclear but is the subject of extensive research.

The catching of juveniles has long been recognized as a potential problem that undermines tuna sustainability (Floyed and Pauly 1980) but it was only in the last five years that it was raised as an issue at the regional level (PREPCOM-WCPFC). This is because the volume of juvenile by catch has significantly increased due to the proliferation on the use of fish aggregating devices.

The increased popularity of FADs (both anchored and drifting) is attributed to the ability of these structures to effectively herd pelagic fishes but with the recent price increase of fuel, many fisheries within Indonesia including purse seine, pole and line and troll line fisheries have adapted the FAD technology as part of its fishing strategy (see also Chapter 13 on impacts of fuel price increase).

Catching tuna before they grow to mature sizes contributes to growth over-fishing, a situation where fish are caught before they could grow to an optimal size (highest yield per recruit), i.e. where the combination of growth potential and mortalities are taken into consideration.

The issue of juveniles has long been recognized as an issue but never prompted serious management attention; evident by lack of any precautionary management measure in place such a minimum size law for tunas despite the higher percentage of contamination. The main reasons for such inaction are because:

1. in the early days of purse seine development, the volume of juveniles is small, driven mainly by domestic fisheries with smaller vessels and with lower efficiencies;

2. the number of purse seine vessels utilizing FADs are limited as catch are mainly taken from free-swimming associated and unassociated schools;

3. the other tuna fishing sectors of longline and the pole and line are not complaining as catch rates remain profitable and there were no conflict of fishing grounds and target species;

4. there is no wastage because all juvenile tunas taken by the fishery are either processed or consumed.

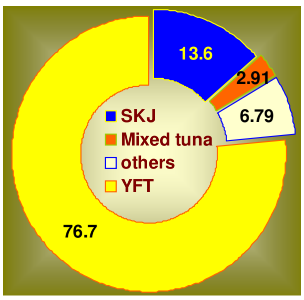
The current fully exploited status of the yellowfin- and the overfished state of the bigeye tunas in the western and central Pacific Ocean brought by increased fishing pressure on all the life stages of tunas has brought the juvenile tuna issue in the forefront.

Scale of the Juvenile Tuna Issue

The contamination of catch by juvenile tunas differs between fishing gears (Table 12.1). For purse seine, the range of values could be between 18-90% depending on the area and probably season. In Indian Ocean, the values observed were between 18 to 32% but with samples limited to the first fours months of the year. This observation was made in 1997-1998 before purse seine were eventually banned from fishing in Indian Ocean.

Pole and line likewise take substantial amount of yellowfin and bigeye tunas with range of 1.2% to 77% (Figure 12.1). Tuna longline likewise take juvenile tunas although the degree of contamination is very low both by weight (1%) and by number of fish caught (3.6%). Troll lines catch substantial amount of juvenile tunas up to 10-50% in Padang West Sumatra, 10-20% in Sorong, West Papua. Tuna handline

Figure 12.1 Catch composition (%) of pole and line from Sulawesi sea in June 2004 (Left) and from Halmahera Sea in October 2004. Source: Redrawn from Wudianto 2006.



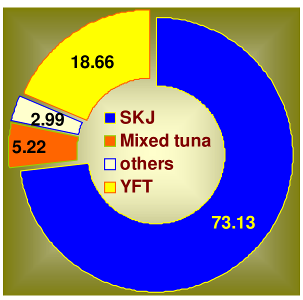


Table 12.1. Percentage yield of juvenile tunas from catches of different tuna fishing gears.

Gear	% YFT & BET	area	year	sources	number of sets
Purse seine (>100 GT)	89.47	North Sulawesi	Dec-05	PRPT 2006	n=1
Purse seine (443 GT)	17.9	Indian Ocean	Jan-Apr 1997	Granadeiro, 1997	n=38
	32.12	Indian Ocean	Feb-Apr 1998	Supiyan, 1998	n=52
Pole and Line (30GT)	7.71	Sawu Sea	May-01	Nugroho 2001	
Pole and Line	76.7 18.66	Sulawesi Sea Halmahera Sea	Jun-04 Jul-04 Oct-04	PRPT 2006	n=11
Pole and Line	13.6 8.89 10.64	North Moluccas Sea	Mar-02 Apr-02 May-02	Salim Moch Nur 2002	
Pole and Line (29GT)	21.22 1.19	Sawu Sea Sawu Sea	Mar-99 Apr-99	Da Costa Sousa 2001	n=22
Pole and Line	17.0	Tomini Bay		Wudianto 2006	
Tuna Handline Tuna Handline	99.0 1.0	Pelabuhan Ratu Sulawesi Sea; Pacific Ocean	Mar-May 05 Jan-07	Gede et al 2006 This study	
Longline (% by number) Longline (% by weight)	3.6 1.0	Indian Ocean	2004	Purwoko, 2004	n=18

would appear to be catching only the large tunas because it targets the large individuals that are found between 150-300 meters. However, handline-caught tunas in Pelabuhan Ratu, West Java in 2005 show predominantly juvenile tunas (98-100%) for the months of March-May 2005 (Gede et al, 2006). This is in total contrast with tuna handline catch in Sulawesi Sea, Moluccas sea where the only juvenile tunas caught are the ones used as bait.

The difference in juvenile catch is striking. A very experienced tuna handline fisher from the Philippines succinctly explained that … " the proliferation of juvenile tunas on handline catch is the result of two conditions:- the behavior of the juveniles, the experience of handline fisher and the status of stocks. In areas where tuna stocks are still abundant, it is difficult to target the large mature ones if fisher is inexperience because the young tunas that dwell at the surface level get to the bait first before the hook sink to the desired fishing depth." The preponderance therefore of such juveniles in the catch is a proxy indicator of tuna resource status.

The issue of juvenile catch is not limited to the yellowfin and bigeye but to skipjack as well. Pole and line catch (Table 12.2) showed 92% of skipjack and 86% of YFT+BET tunas caught are juveniles using length at first capture values of 45 cm and 55 cm, respectively (Wudianto 2006). The value of length at maturity used for yellowfin is on the lower range for the Philippines (Collette and Nauen 1983) but more recent studies show that the range of length at maturity for the yellowfin is between 100-120 (Wild, 1994, Collette and Nauen 1993, Fishbase 2005). As a rule, 100 cm fork length is used as the rule of thumb in the WPFC convention area, thus making all the yellowfin+bigeye catch of pole and line juveniles.

Table 12.2. Proportion of juveniles on catch of pole and line from Sulawesi and Halmahera Seas. Note that use of current length at maturity for yellowfin will make all the catch juveniles. Source: Wudianto 2006.

Sexual Maturity Stage	Skj Lm= 45cm	%	YFT+BET Lm= 55cm	%
Juvenile	383	77.5	343	86.6
Mature	111	22.5	53	13.4
Total	494		396	

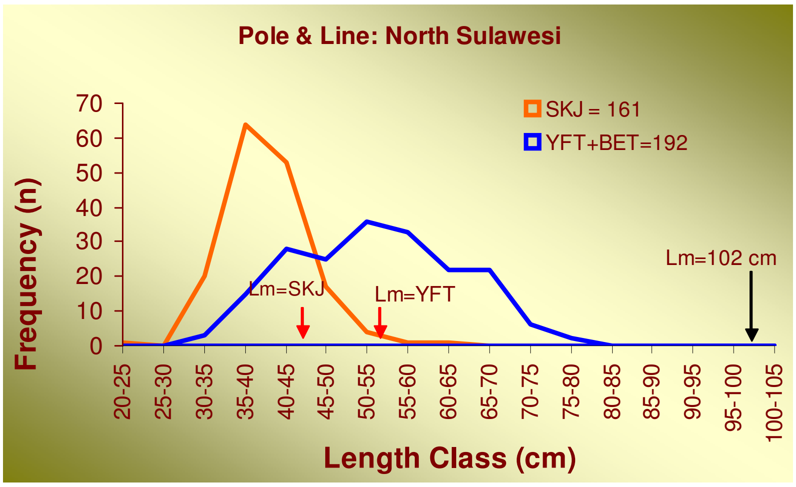


Figure 12.2. Length frequency histrogram of skipjack and yellowfin (+big-eye?) of catches of pole and line. Data redrawn from Wudianto 2006.

Just how large (or small the tunas caught) is shown by the length frequency histogram in Figure 12.2. This study undertaken by the PRPT (2006) show that most of the skipjack and half of the yellowfin measured are juveniles. This is based on the length at maturity used in the analysis. But if the value of 100 cm is used for the yellowfin, then all the fish measured are juveniles. More recent estimates of length at maturity show the values around 1 meter in fork length (Wild, 1994, Barut 2002).

How big is the volume of catch?

This section estimates the juvenile take of the Indonesian domestic fleet. Using the data available at the SPC and published in Lawson (2006), the total historical volume were estimated.

For 2006 alone, about 168.7 thousand tons out of the 277.7 thousand tons are juvenile tunas (Table 12.3) or 60.8% of the whole tuna catch from the domestic fleet have not reached the size at maturity. On catch by species, 56.6% for skipjack tuna, 70.8% percent for yellowfin and 75% for the bigeye tuna are immature individuals.

Historically the fleet has been contaminated by juveniles as shown by the three graphs below. Over the last three years, there has been a drastic decline in juvenile volume frm the domestic fishery, probably an artifact created by improved documentation of catch where entries to statistical books are now up to species level. There was no attempt to estimate volume but as the volumes have high degree of uncertainty but the volume is probably bigger than what these graphs show.

Table 12.3. Total tuna catch of the domestic fleet of Indonesia and theproportion of juvenile yellowfin+bigeye. See footnotes for percentages used to estimate juveniles. Legend: PS-purse seine, LL-longline, PL-pole & line, HL- handline Source: Lawson 2006.

Species	Est. Juvenile catch	Total Catch	% Juveniles
Skipjack tuna	115880	204710	56.6
Yellowfin tuna	31484	44450	70.8
Bigeye tuna	21430	28580	75.0
TOTAL	168794	277740	60.8

YFT: PS(100%), LL (3%), Handline (10%), PL(100%),Unclas: (80%)
BET: PS(100%), LL(0.5%),PL (100%), Unclass (100%)
SKJ: PS(60%), PL(40%), Unclass (50%)

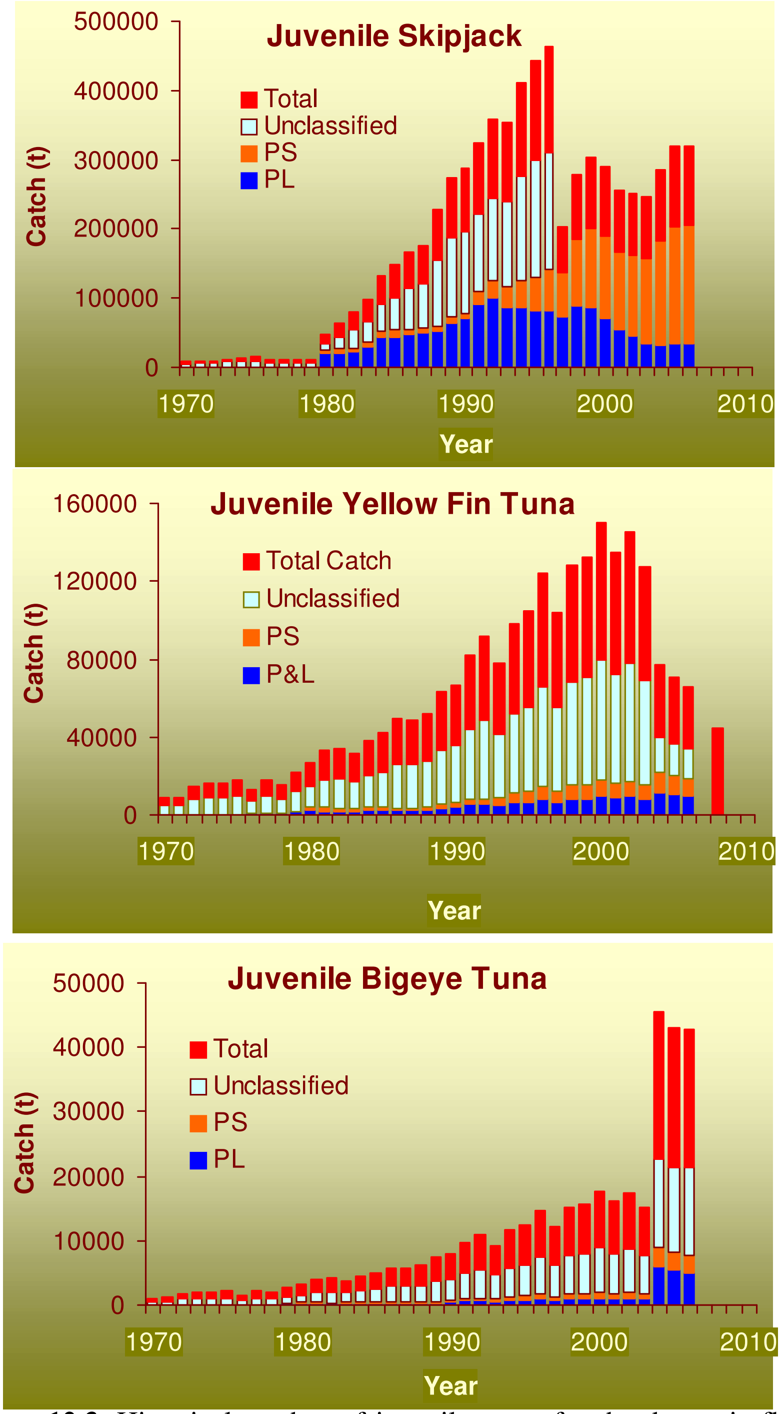


Figure 12.3. Historical catches of juvenile tunas for the domestic fleet of Indonesia for skipjack (upper), yellowfin (middle) and bigeye (lower) tunas for the different tuna fishing gears. See footnote of Table 3 for percentages used in the estimation of juvenile catch. Source: Lawson 2006.

Blaming the FADs

Most of the blame on juvenile issue is put on these floating structures. This is because most of the juvenile take of tunas are from the FADs, mainly by purse seine and pole and line fleet. The handline contributes a small amount while the contribution of gillnets is no known. The number of FADs currently in place is unknown, but it is in the hundred of thousands. These structure lifespan range between 2 months to 3 years (average is 6 months), depending on the material used, sea conditions in the area.

No government agency regulate the FADs. There is no regulation as to who could establish a FAD and how many. Currently, FADs are deployed by purse seine and pole and line, and handline operating under cooperative system. The companies of "plasma system", buyers of tunas also funds and deploys FADs for use of its fishers. In certain areas such as North Moluccas, local government subsidizes FADs for use of its small-scale fishers. In West Sumatra and in Manado, North Sulawesi, FAD companies supply and sell parts of FADs and is a lucrative business.

Recommendations

The largest volume of juveniles is taken by the pole and line and purse seine. These fleets account for 142.2 thousand tons or 84.3% of total take of juveniles in 2006 (Table 12.4). This is because these fleets are surface fisheries and fish mainly on the fish aggregating devices (FADs).

Interestingly, the main issue on juveniles are on the yellowfin and bigeye species yet over two thirds (68.6%) of the juvenile take of Indonesian fishing fleet are skipjack. The resources of skipjack, based on current biomass are still in healthy conditions (Sievert et al, 2004) but localized overfishing are happening. Key indicators are already happening such as declining catch (number and size of skipjack schools) and reduced sizes of fish.

Proper management and monitoring coupled with national and local policies could reduce the juvenile take particularly of the yellowfin and bigeye tunas whose estimated biomass in the Western and Central Pacific ocean has reach (as in the case of yellowfin and below the MSY level. The highly migratory character of these oceanic species makes it doubly difficult to manage these tunas at the regional level and concrete, immediate and effective measures need to be in place to help the population to recover above the MSY levels.

1. National policies need to be in place to address the issue of juvenile tunas. First is to have a minimum size law to catch specific tunas. The length (size) needs to be based on solid science. The sizes at maturity currently used by the government are 45 cm for skipjack and 55 cm for yellowfin. The values for yellowfin tuna needs to be reviewed as recent estimates place the length at maturity to be around 100 cm.

   Second is to review and update the current policy on fish aggregating devices (Pemasangan dan Pemanfaatan Rumpon, Nomor 251/Kpts/IK, 250/1/97) to address specific issues of the juvenile take of the fishing gears that operate at these structures. Regulating number and distance of FADs, promote sharing of FADs use between tuna fishing sectors and ban on FAD use in highly overfished areas are critical policies that will reduce the juvenile contamination of tuna catch.

   Moreover, a system to regulate and monitor the FAD deployment, number, distribution as well a way to incorporate catch made at these structure must be in place. It is admitted that a lot of research needs to be done to address the issues. But while waiting for science to become available, precautionary measures needs to be in place.

Table12. 4 Catch of juveniles (in metric tons) for 2006. Source: Lawson 2006.

Gear Type	YFT	BET	SKJ	TOTAL	% by gear
Pole & Line	9779	5056	14036	28871	17.1
Hand line	89	0	0	89	0.05
Longline	280	35.9	0	316	0.19
Purse Seine	8890	2661	101772	113323	67.2
Unclassified	12446	13677	0	26123	15.5
TOTAL	31484	21430	115808	168721	
% by species	18.7	12.7	68.6		

2. Utilize traditional knowledge and harness the experiences of the fishers who have long used FADs to aid in the development of policies. For instance, tuna handliners in Padang, West Sumatra need to enhance fishing skills to be able to fish the larger tunas in the deeper waters by learning from their North Sulawesi counterparts or learn from Filipino tuna handliners that utilize drop stone method.

A policy that regulate the harvest of fish schools that contain predominantly juvenile tunas under the FADs by purse seine is easily implemented because a diver checks out the species, sizes and quantities of school before the decision to set net is made.

A policy to regulate fishing in FADs at times when juveniles predominate in the area could easily be promulgated at different sites. Such information are well known to the handline and purse seine fishers operating in FADs. A graph presented in Figure 3 is easily extracted out of records of a boat owners records would confirm the exact months when juveniles dominate the catch. Regulating catch from FADs even for two months in a year will have significant contribution to the reduction of juveniles catch (Figure 12.4).

3. Spawning, nursery areas and migratory corridors need to be protected. The government should start identification of important spawning and nursery areas for the tunas. Better still is to establish with neighboring countries, a joint protected area to protect critical life stages of the tunas. Three important critical areas are recommended,

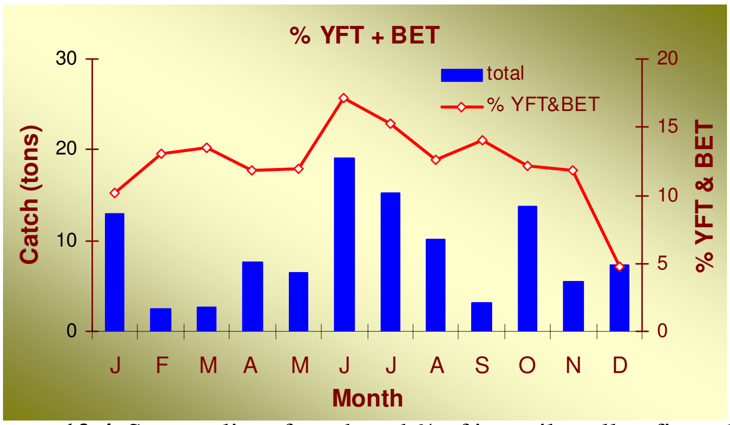


Figure 12.4. Seasonality of catch and % of juvenile yellowfin and big-eye tunas from catch of pole & line from Sawu Sea. % juvenile line is a moving average of three months. Source: Mozes 1999

the bluefin spawning area in the Indian Ocean between Australia and Indonesia and the yellowfin spawning area in Sulawesi Sea between Indonesia and the Philippines. Similar areas could be established Timor Leste to protect migratory pathways while Arafura Sea with Australia could be promoted as a tuna-free fishing area for a number of years.

4. Work canneries to improve implementation of policies designed to reduce juvenile take of yellowfin and bigeye tunas. Since most of the skipjack and yellowfin tunas end up in cans for export, the best place to implement the policy is at the processing plants and canneries.

5. Declare areas that will protect the specific life stages of the tunas. Establishment FAD-free zones to protect spawning, nursery areas as well as migration routes from fishing. Sufficiently large areas are needed which could be achieved through transboundary protected areas that are far from nearshore fisheries that could create social and economic dislocations among the many poor people.

6. Advocacy campaign to change consumption behavior of juvenile tunas which are preferred over their adult counterparts for cultural as well as health reasons.

7. Undertake research on addressing by-catch. This is done by looking at the two levers of by-catch solution, by working on the effort of the fishery and by addressing the catch per effort of by-catch. Hall et al. (2000) lists the management interventions for Effort as regulatory bans, regulatory limits, trade sanctions, consumer boycotts and gear changes. Addressing by-catch per effort include technological interventions, changes in fishing techniques, training and management actions.

8. The government should also look at other aspects of FADs. Ingles (2005) enumerates issues arising from FADs use as:

a) a marine debris, where after the raft is destroyed, the anchor and its rope made of synthetic materials will remain at sea for prolonged period of time;

b) a hazard to navigation. FAD location should be zone and nautical highways should be designated andshould be free of these structures.

c) source of conflict with other fishers. Indiscriminate deployment will lead to sectoral conflicts between FAD and non-FAD users. The conflict is already there between purse seine and longline and between FAD fishers and drift gillnet and drift longline fishers.

Summarizing, the issue of juvenile tunas has reached a level where urgent interventions is required given the biomass levels have reach MSY: for yellow fin have reached the MSY and for big eye tuna has exceed the MSY level. The impact of taking the juveniles is not just limited of the resource sustainability of the tunas, but also translates to social, economic and ecological perturbations that the potential losses of the bycatch of juveniles far outweighs the gains made from sales of juveniles.

Part II: By-Catch of Tuna Longline Fleet

Introduction

As a maritime country with abundant fisheries resources and supports one of the largest global fisheries suppliers, Indonesia's management and exploitation of its fisheries resources are of international concern. The status of Indonesia's fisheries management will determine the country's bargaining position of its fisheries products in the global market.

Indonesian waters especially in the eastern parts of Indonesia, serve as an important migratory route for over 30 species of marine mammals. In this region, six of the worlds seven turtle species including Leatherback turtle, Green Turtle, Hawskbill Turtle, Olive Ridley turtle, Loggerhead turtle and Flatback turtle are found. With its numerous islands, extensive coastline, vast areas of sea grass beds and coral reefs, Indonesia provides habitats important support critical life stages of the turtles: nesting and foraging grounds. Presently, Indonesia hosts the largest rookeries for Green Turtles and for Leatherback turtles in South East Asia. These are located in Berau Islands, East Kalimantan, and along the Northern Coast of Papua, respectively. Each season between 1865 to 3601 nests of leatherbacks are recorded at Jamursba-Medi and about 2881 nests at Wermon (Hitipeuw at al, 2007). Satellite tracking data and tracing records of flipper tags indicates that from their nesting grounds these green and leatherbacks migrate very large distances over open water to get to their feeding and mating grounds.

These marine species are recognized as being particularly vulnerable to overexploitation due to their complex life-cycles and biology. Only a few offsprings survive that reach sexual maturity. Once mature, these turtles live very long, spending different parts of their life-cycle in a wide range of habitats. They are also highly migratory, their home range often spanning the waters of several nations and the high seas. As such, every part of their lifecycle is critical to their conservation. Given the complexity of those species niches and life cycle stages, these charismatic species are vulnerable to a wide range of threats that include being taken as by-catch of tuna fishing gears, stranding, poaching, and the destruction of their marine habitat.

Wide spectrum of commercial fishing such as trawl, purse seine, long line, driftnet or gillnet take marine mammals as by-catch. They drown while trapped in demersal gillnets, trawls, purse seines or get hooked in long lines, or entangled in fishing lines, buoys, and other fishing gears. These animals are caught by fishing gears operating in different types of habitats, from the shallow coastal to the deep waters of the exclusive economic zone waters of the country to the high seas.

Indonesia, being a country with its large tuna fleet, particularly the longline, takes substantial amount of by-catch and is a cause for global concern. This section presents partial results of WWF's observer program to monitor by-catch performance of its circle hooks to select longline collaborators.

Policy Framework and On-going Activities

Set of regulations and policies are already in place to protect endangered species and help conserve the biodiversity resources of the country. The policies listed in Table 1 shows Indonesia's desire to contribute to the regional and global effort to conserve and protect the rich biodiversity resource of this country.

Table 12.5 Relevant regulations for marine endangered species conservation in Indonesia

Relevant National Decrees	Year	Remarks
Presidential Decree No. 43	1978	Ratification of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
Ministerial Decree agriculture No. 327	1978	Determination of several types of wild animal to be protected (whales, Dolphin, Crocodiles, Leatherback Turtle)
Ministerial Decree agriculture No. 716	1980	Determination of several types of wild animal to be protected (whales, Gray, Olive and Loggerhead Turtles)
Act No. 4	1982	Basic provision for management of the living environment
Presidential Decree No. 26	1986	Ratification of ASEAN agreement on the conservation of nature and natural resources
Act No. 5	1990	Conservation of living natural resources and their ecosystem
Presidential Decree No. 32	1990	Management of protected areas
Act no. 5	1994	Ratification of the Convention on Biodiversity
Government Regulation No. 7	1999	Protection of all turtle species including green turtle
Government Regulation No. 60	2007	Fisheries Resources Conservation

For instance, the Indonesian government signed on to IOSEA in March 2005 in Bangkok, formalized the Sulu Sulawesi Marine Ecoregion tri-national agreement in March 2006 in East Kalimantan, and signed the Bismarck Solomon Seas Ecoregion MOU on leatherback conservation in September 2006 in Bali.

Likewise in the fisheries conservation and management, Indonesia has recently signed as full member of the IOTC and intends to do the same for the CSBT and the WCPFC. Signing up to these international commitments meant the country's desire to comply with requirements and responsibilities of being a member to these organizations.

Similarly, activities are also being implemented to manage these charismatic species, focusing mainly on capacity building to rescue stranded marine mammals, addressing the poaching and the destruction of their marine habitat issues through advocacy and improved implementation of policies. The issue of by-catch from fishing did not merit as much attention due to lack of quantitative information as to the degree of by-catch and ecosystem impacts it generated. In short, the by-catch issue has long been recognized but how large the problem was not clear. Such issue has been addressed when a national consultation was held to discuss the by-catch issue of the Indonesian tuna long line fishery. This consultation resulted in a joint declaration to address tuna by-catch through the development of a national plan of action to be implemented by the Research Center for Capture Fisheries of the Ministry of Marine Affairs and Fisheries and the collaboration of the Indonesian stakeholders particularly by the tuna associations of Indonesia.

Methods

To validate information from the consultation and to collect the necessary by-catch related information as well as to identify the strategy to initiate a by-catch project, review of relevant studies conducted independently by government institutions such as PRPT and LIPI or in collaboration with WWF-Indonesia were undertaken. Based on results of these studies, three sets of activities were undertaken: conduct of interviews with fishers, design observer program through actual field trials and undertake sea trial experiments with C-hooks. The first activity help identify key hotspots and parameters in order to contribute to the design of the second activity: the field testing of the on-board observer program from May to December 2006 to collect initial field data on by-catch and polish the data template to be used. The third activity is to conduct field trials on the use of circles with some tuna longliners cooperators to determine its effectiveness in reducing turtle by-catch.

Results

Fisher interviews

Interviews were conducted at four sites (Fig. 12.5): 292 respondents in Java, 163 in Sulawesi, 95 in Bali, 77 in Kei Islands, Moluccas and 236 in Papua. Highlights of interview results are:

1. The survey found that there was interaction between marine endangered species and several types of fishing gears. The fishermen often spotted sea turtles during their fishing activities alluding to overlap with migratory routes for sea turtle and others endangered marine species.

2. Most respondents (%) admitted that they caught sea turtles during fishing operations and caught at least one animal from their most recent trip.

3. Respondents believe the scale of the problem is small. But considering the large number of longline vessels (+ 1600) total annual turtle take is estimated between 6.400-19.200/year (LIPI, 2005). This figure agrees well with the estimate of a government study of 4,950 turtles per year (Wiadnyana et al 2006).

4. From the survey results, it was also clear that all respondents save for the Tanimbar Kei and Papua respondents, are willing to release the turtles back to the sea. This result enabled us to develop and conduct trainings on proper handling methods of entangled and hooked sea turtles.

5. Respondents from the Tanimbar Kei island and from Papua admitted to consume the sea turtles caught. Fishers from Papua also actively hunt turtles for consumption.

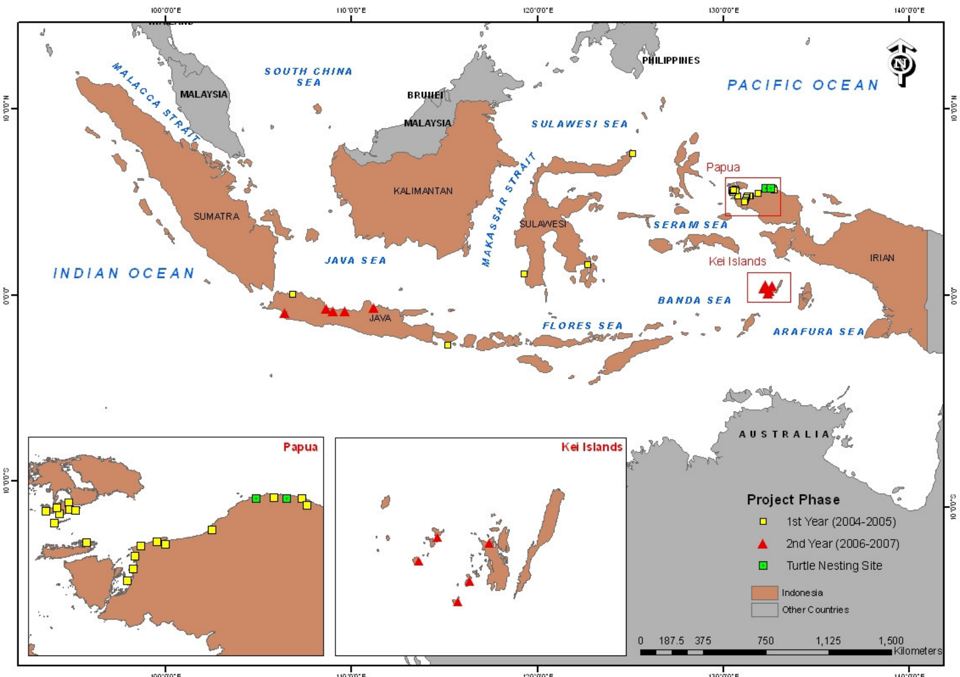


Figure 12.5 Locations of interview sites. Inset show relative areas in Papua and Kei Islands.

Table 12.6 Information study on Sea turtle interaction in various fishing gears in Indonesia (result from interview with fishermen)

Sources	Fishing Gears	Turtel By-Catch	Sea turtle species	No. of respon-dents	Survey Location
Takaendengan et al, 2005 (LIPI)	Tuna longline and Non tuna (gillnet, purse seine)	Avarage turtles per trip 0 = 2.8%, 1-5 = 80.4%, 6-10=10.3%, >10=6.5%	IO & PO: loggerhead turtles & Leatherback turtles but more in PO. Green turtles are the least frequent, mainly from Indonesian internal waters. Sea turtles sizes bigger in IO & PO compared with those caught in internal waters (<50 cm).	163	Bitung (North Sulawesi), Muara Baru (Jakarta), Cilacap (central Java), Kendari/Bau-Bau (South East Sulawesi), and Makassar/Bone (South Sulawesi
Musthofa zainudin, 2005 (WWF)	Tuna Longline	Averages (per month): • Sea turtles sightings: 5 times • Sea turtle by-catch: 2.7 times • Sea turtle by-catch from last trip: 2.3 animals • Number of sea turtle species from last trip: 1.8 species	Green and leatherback turtles	95	Benoa-Bali
Habibi et al, 2006 (TAKA)	Tuna longline, mini purse seine, purse seine, Seine Nets (payang, Cantrang, Pukat), Gill net, Longline (coastal Fishery),Others Gears (Hand line, Trap etc)	No. of turtles caught from last trip. The category are: a=0-10 turtles, b=11-20 turtles, c=21-30 turtles • Tuna longline (b=81%, a=19%, c=0%) • mini purse seine (a=69%, b=31%, c=0%) • purse seine (a=68%, b=33%, c=0%) • Seine Nets (a=56%, b=44%, c=0%) • Gill net (b=85%, a=15%, c=0%) • Longline (coastal Fishery) (b=58%, a=42%, c=0%) • Others Gears (b=75.6 %, a=22%, c=2.4%)			Java (Pekalongan, Cilacap, Pati, Pelabuhan Ratu, Rembang, Tegal, Cirebon, Lamongan)

Data from On-board observers

To validate information from the interviews, WWF also implemented trial run of putting observers in the tuna long-line fleet. The aim is for WWF to learn and understand how to best implement onboard observer activities and developed the method and simple protocols. Volunteers from a fisheries academy in Sorong were trained on the methods and data collection using the developed template. WWF collaborates with the Research Centre for Capture Fisheries (PRPT) of the MMFA and the observers were deployed on the vessels belonging t the two associations, the Indonesian Tuna Longline Association (ATLI), the Indonesian Tuna Association (ASTUIN) as well as on other individual tuna long-line Industry members

The observers collected and filled up the forms developed relating to tuna and their interaction with protected and endangered marine species such as sea turtle, marine mammals, sea birds and shark. A lot of information was collected in this first year and in May 2006 WWF started the formal onboard observer program.

From the period May to December 2006, 8 observers were deployed and covered the operation of 10 vessels. Observers boarded the longline vessels in Bitung, North Sulawesi with two observers covering the Pacific Ocean, two observers boarded in Pelabuhan Ratu, West Java and 4 others including two boat captains of longline vessels from Benoa, Bali. Vessels from Pelabuhan Ratu and Bali operated in Indian Ocean and internal waters of Banda and Flores Seas.

By end of 2007, 12 observers boarded 18 tuna longline vessels that made a total of 50 fishing trips and 1,092 settings. Longline vessels in Indonesia undertakes three different fishing operations: short trip lasting 14 days to 20 days, medium trip lasting 1-3 months and long trips each lasting 3-6 months.

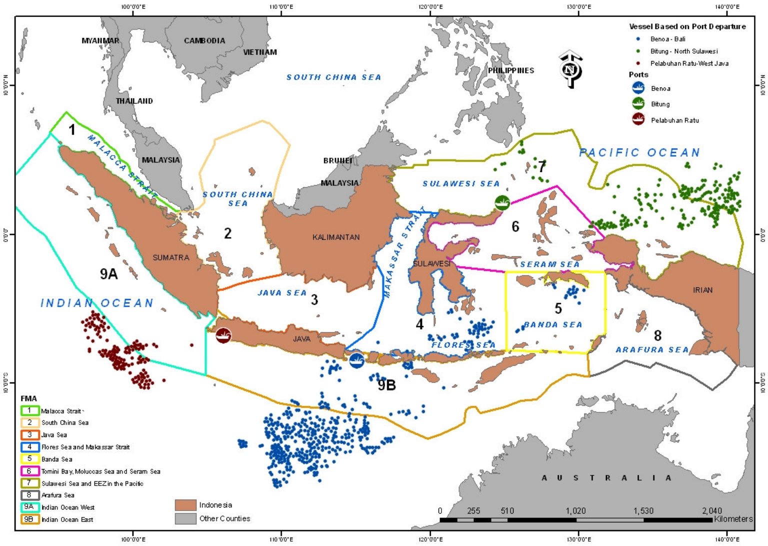


Figure 12.6 Home bases (boat icon) of tuna longline fleet participating in the observer program.

The type of data and information collected by observers including the general information (departure time and date, fishing gears, number of hooks, type of bait etc), fishing ground (setting and hauling positions), species taken as by-catch as well as observed/sighted species during fishing operations. The species covered include the sea turtles, marine mammals, sea birds and sharks. They also bring de-hooker to facilitate removal of hooks from turtles.

One hundred thirty two 132 sea turtles were caught from a total of 1,669,757 hooks that were deployed resulting on a hook rate of 0.329 (per 1000 hooks). On a per area of operation, longline based in Bitung, North Sulawesi showed the highest hook rate of 0.265 compared with 0.034 for Pelabuhan Ratu-West Java 0.03 for Benoa-Bali based vessels. With this result, the problem of turtle by-catch appears more serious in the Pacific Ocean than in the Indian Ocean and internal waters of Banda and Flores Seas.

Figure 12.7. On-board observer activities on handling of turtle by-catch. Left upper: removal of hook, upper right: size measurements, lower left: use of dehooker: lower right: releasing.

All six species of turtles are vulnerable to the tuna longline gear in varying degrees. Olive ridley account for over three fourths (77.3%) of the total turtle by-catch, followed by the green turtle with 6.8%, loggerhead and hawksbill with 4.5% each, leatherback with 3% and flatback turtles with 1.5%. Three turtles were not identified as these were let loose by fishers before being brought on deck by cutting the lines.

Overall mortality associated with turtle by-catch appears low (5.30%) with only 7 turtles dead by the time these are brought on deck. Six of the seven dead turtles are olive ridleys and this result is probably influenced by the numbers of the individuals caught. Turtles differ on the way these are caught. Leatherbacks become entangled on the lines, others are hooked in the mouth while larger-sized turtles swallow the bait and hooks that get lodged in their stomachs (Figure 12.5). Swallowing of hooks occur mainly with the use of smaller J-hooks.

All turtles captured were adults as indicated by their size measurements (Figure 12.9). Gender bias appears to influence by-catch where males also appear more vulnerable with female:male ratio of 1:3.45 (Table 12.7).

Other Species

Part of the data collected include noting down by-catch of whales, sea birds, dolphins and sharks during the fishing cruises. During the study, 1 whale, 2 dolphins, 3 seabirds and 798 sharks were caught by the longline gear (table 12.4). The whales, dolphins and seabirds were caught in the Indian Ocean and none from the Pacific Ocean indicating that the by-catch issue for these animals is limited to the Indian Ocean side or to vessels operating in the southern hemisphere. Both the whale and the dolphins became entangled in the branch lines. All three seabirds got hooked while sharks are regularly caught along side the tunas.

Mortalities related to these other by-catch differ with species. The caught whale (3.5 m fork length, species not identified) was released after removing the lines. This is made possible by pouring diesel fuel to make the whale unconscious to facilitate removal of entangled lines. Whether the diesel fuel will affect the animal is not clear. Two of the three seabirds were alive and released soon after de-hooking while only one of the dolphins could be saved.

Shark catch during the whole study period total 798 individuals which is equivalent to a hook rate of 2.26 per 1000 hooks set. The catchability of sharks differ with area where 73.1% were caught by vessels operating in Indian Ocean, mostly by vessels based in Pelabuhan Ratu where the highest hook rates for shark with 1.33 was observed. Using the plot of areas for shark take (Figure 12.12), it appears that the highest shark take are those vessels operating west of 100 E longitude, just south of the EEZ border south of South Sumatra.

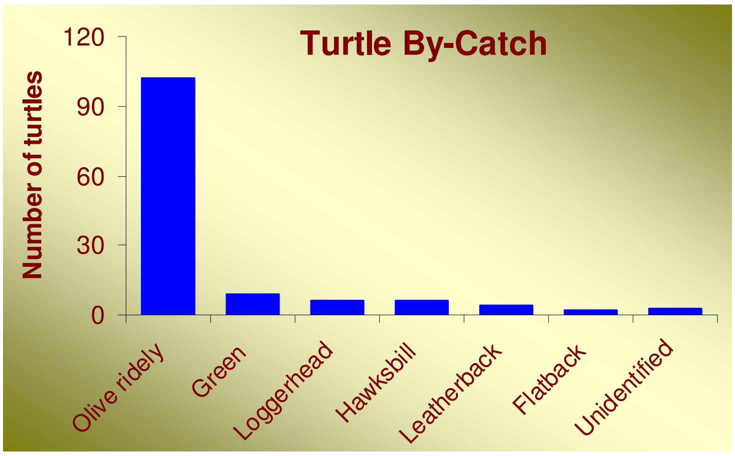


Figure 12.8. Number of turtles by species taken as by-catch during the observer sampling period (2006-2007).

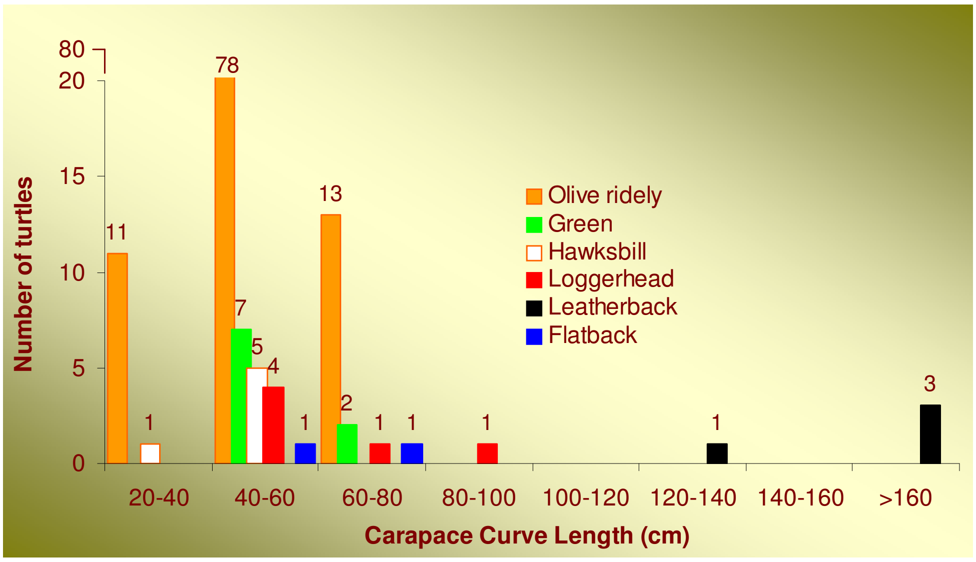


Figure 12.9. Sizes of turtle by-catch caught by the tuna longline gear. Length given as carapace curve length or CCL.

Based on size measurements, almost half (46.1%) of sharks caught have lengths greater than 1.5 meters with only 1.3% with lengths less than half meter. Likewise, there is no significant difference in catch between sexes and the result appears to follow a 1:1 ratio.

Discussion

The results of data collected during the observer program confirmed the presence of and provided the scale of the by-catch of other species from the tuna longline. The results provided first insights on possible management handles how to tackle the conservation aspects on a per species or per group basis.

Clearly, by-catch data showed that there is an overlap of areas where fishing activities are conducted and where these animals occur. For turtles and whales, fishing are conducted along their migratory paths, increasing the probability of interaction between the fishing gear and the animals.

Mapping of more areas of interaction will provide a clearer picture of what conservation measures to take. Even if current data is limited to fishing areas, data provided by Figures 12.6 and 12.10 suggest clearly the differences in by-catch

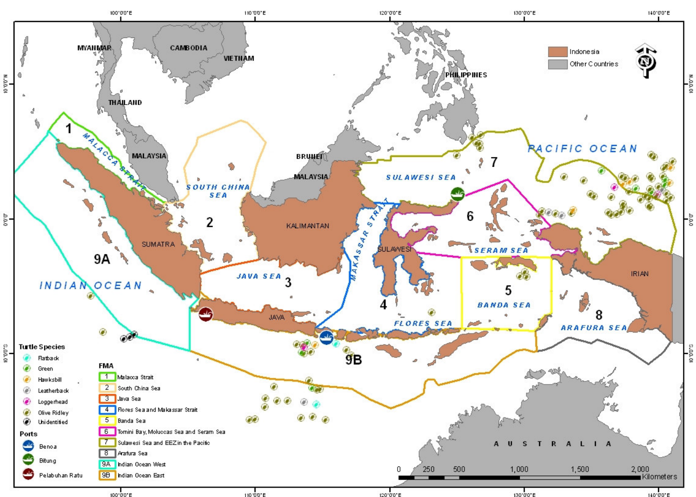


Figure 12.10. Location of occurrence of sea turtle by-catch during observation period.

Table 12.7. Summary data on by-catch of sea turtle based on observer program.

General Information	Benoa-Bali	Pelabuhan Ratu-West Java	Bitung-North Sulawesi	Total amount
No. of Vessels	12	3	3	**18**
No. Sets	768	135	189	**1092**
No. Fishing trip	35	4	11	**50**
Total No. Hooks (in thousands)	1,174	149	347	**1670**
Hooks rate (1000 hooks)	0.030	0.034	0.265	**0.110**
Olive ridley	**27**	**2**	**73**	**102**
Male	17	0	63	80
Female	10	2	10	22
Green	**3**	**0**	**6**	**9**
Male	2	0	6	8
Female	1	0	0	1
Loggerhead	**1**	**0**	**5**	**6**
Male	1	0	5	6
Female	0	0	0	0
Hawksbill	**1**	**0**	**5**	**6**
Male	0	0	2	2
Female	1	0	3	4
Leatherback	**1**	**0**	**3**	**4**
Male	1	0	2	3
Female	0	0	1	1
Flatback	**2**	**0**	**0**	**2**
Male	1	0	0	1
Female	1	0	0	1
Unidentified	**0**	**3**	**0**	**3**
Total Turtles	**35**	**5**	**92**	**132**
Male	**22**	**0**	**78**	**100**
Female	**13**	**2**	**14**	**29**

rates between areas. Mapping of interaction areas to include also areas where fishing is not conducted and identification possible hotspots could the government craft the appropriate conservation measures.

The results also provided that by-catch of turtles becomes even more complicated because the fishing gear tends to be biased against the males. Ways (e.g., use of better lines) on how to minimize entanglement of cetaceans will greatly reduce if not eliminate cetacean by catch.

While all these are on-going, capacity building of fishers on how to handle by-catch on board is highly important step that will reduce by-catch associated mortalities. Perhaps, training on by-catch handling could become a requirement to acquire or renew licenses for fishers for tuna longline. With proper training and supply of a de-hooker device, handling by-catch for turtles is less time consuming.


Leatherback entagled by tuna longlines.

Table 12.8 Summary data on bycatch shark, whale, dolphin and seabird from observers 2006-2007

Information	Benoa-Bali	Pelabuhan Ratu, W. Java	Bitung-North Sulawesi	Total amount
No. longline vessels	12	3	3	**18**
Setting	768	135	189	**1092**
Fishing trip	35	4	11	**50**
Total Hooks Set	1,174,151	148,680	346,926	**1669757**
Tuna HR	0.33	1.31	0.62	**2.26**
Shark HR	388	195	215	**798**
whale HR	0	1	o	**1**
Dolphin HR	2	0	0	**2**
Sea bird HR	3	0	0	**3**

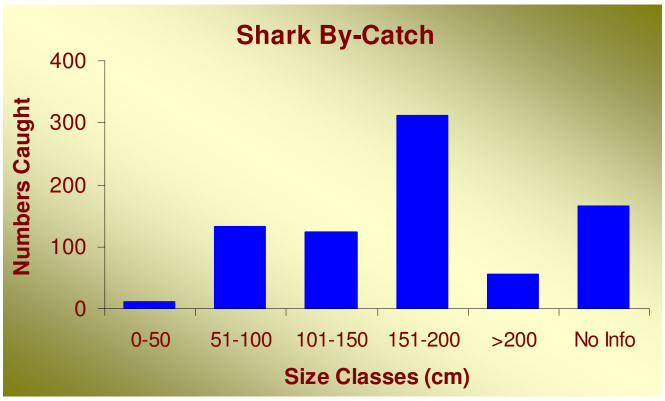


Figure 12.11. Size frequency of sharks caught by the tuna long-line gear.

Most of the turtle by-catch was observed in the Pacific Ocean where known migration routes based satellite tagging experiments were observed. Here, the most probable solution is a change of fishing techniques from two fronts:

1. Study a possible shift from the current practice of a shallow set to deeper sets. This is a difficult issue to propose much more to become a policy because a shift to deeper set would exacerbate the already overfished bigeye tuna population (Lack, 2006, Siebert et al 2004).

2. A change in use of baits from live-baits to dead baits. Use of live baits of milkfish enhances fishing efficiency not just for tunas but also for sharks and turtles. The type of baits used such as squid, scads and milkfish increases catching efficiency compared with sardines which are predominantly used by longline vessels operating in Indian Ocean.

The technologies adopted by the Bitung-based tuna longline fleet came from the Taiwanese fishing technology. This is because many of the Indonesian longline vessels operating in the Pacific employ Taiwanese for boat captains.

The size of hook appears to contribute also to the by-catch problem in Indonesia. In particular, it probably produces higher mortalities as hooks end up in the stomachs and therefore fatal. Smaller hooks also contribute to the undetermined mortality from escapement. The hook sizes currently in use are much smaller than their counterparts around the world. This is because longline boats have to use a cheaper

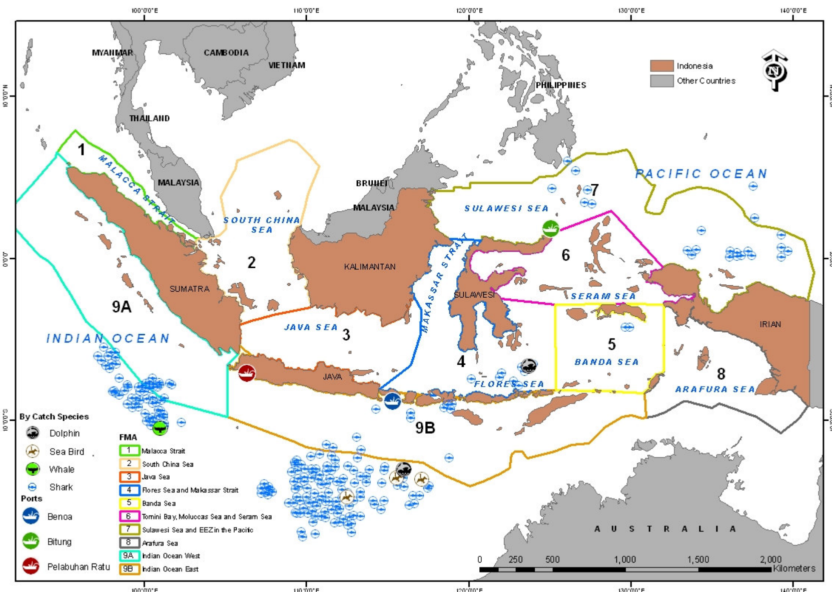


Figure 12.12. Location of the different species of by-catch.

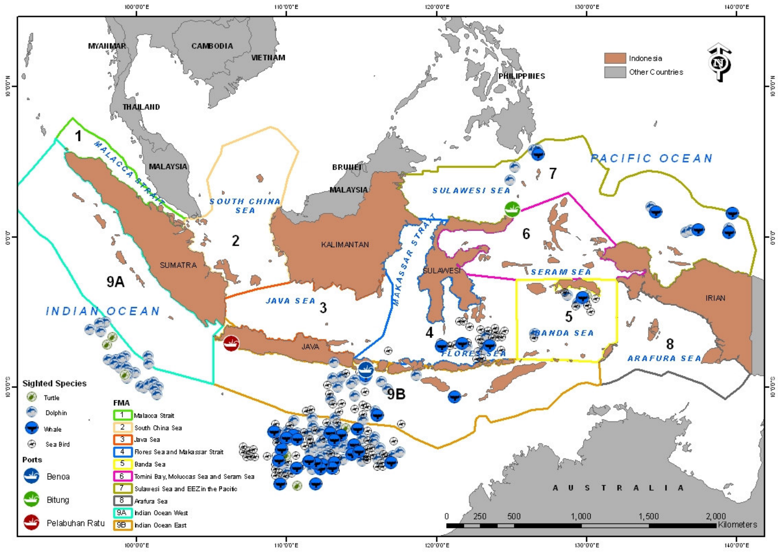


Figure 12.13. Locations of turtles, whales, dolphins and sea birds sighted during the study.

substitute for the scads, the normal baits due to price considerations. Similarly, use of small hooks for live baits is preferred to lengthen the life of the bait.

Tuna is highly migratory and transboundary species and Indonesia, as one if not the biggest tuna producing country in the world, needs to work in the international and global arena to address the tuna and the by-catch issues simultaneously. It needs to cooperate and collaborate with the appropriate regional fisheries management organizations to solicit logistical and technical support. Thus, it is a welcome development when Indonesia finally became officially a member of the Indian Ocean Tuna commission (IOTC) and intends to become a regular member as well of the Western and Central Pacific Fisheries Commission (WCPFC) and the Commission for the Conservation of Bluefin Tunas (CCSBT).

Sea birds as a by-catch issue appear to be limited to the Indian Ocean and on a limited scale. Notable sea birds were observed only along the common border with Australian. Sightings of sea birds even during fishing operations appear to be few and scattered.

Sharks appears as the most serious by-catch issue of the longline. Its hook rate is quite high, in fact even higher that the average tuna take. Shark by-catch is also a difficult issue to address for the following reasons:

1. sharks have high economic value from shark fins that fetch high prices. The market demand is currently unsatiable;

2. shark fin (size>1 m) is part of the incentive package of the crew;

3. shark carcass is also landed and sold if space is still available, hence additional income for the operator;

4. other non-fin shark parts are utilized and traded such as liver for shark oil (sizes >50 cm) used in pharmaceuticals and hard parts (teeth, jaws) sold as curios.

As long as sharks have economic value and is treated as an incentive for the crew, it would be difficult to put a policy in place. Policy considerations must take into consideration both the value of sharks and incentive system in place.

Although still with insufficient data, it appears that use of circles hooks which is discussed in more detail below, take more sharks as by-catch but highly reduced turtle by-catch.

Circle hooks Trials

After a long try of finding a collaborator to pilot test the circle hooks, a boat captain finally agreed to undertake the experiment in December 2006. Using 1000 circle hooks randomly combined with their usual J-hooks also numbering 1000, the first fishing tripped proved to be a rousing success. The results of the first 10 sets showed that the C-hooks caught more tunas and no turtles compared to the J-hooks that caught 1 olive ridley. The results were immediately relayed to other members of the fleet and members of the tuna association. That became the tipping point. Today, more vessels want to join the circle hooks program but lack of available circle hooks became a limiting factor.

Betwee the period December 2006 to September 2007, 8 vessels joined the circle hooks trial program. It was came from 4 fishing companies (PT. Sari Segara Utama, PT. MAS, PT Damarina and PT. Perikanan Samodra Besar), all the vessels based in Benoa Bali. Those vessels are KM. Sari Segara 02, KM. Sari Segara 07, KM. Samodra 36, KM. Samodra 37, KM. Samodra 44, KM. Samodra 47, KM. Mas 7 and KM. Damarina 203. These vessels undertook a total of 22 fishing trips in Indian Ocean making a total of 434 settings. Most of these vessels operated in outside of Indonesia's EEZ.

Results

Based on results of 22 fishing trips, the C-hooks outperformed the traditional J-hooks in terms of tuna catch and by-catch of turtles. C-hooks predominantly caught more (in terms of numbers) and bigger sizes of bigeye, yellowfin and blue fin (Table 12.9). In instances where C-hooks caught less fish, their sizes remain bigger than those landed by J-hooks that result in higher incomes. In terms of non-tuna by-catch, C-hooks generally showed higher catch of about 8% by weight.

The C-hooks lodged more in the mouth area compared with the smaller J-hooks where many of the hooks are swallowed. This allows easy removal of hooks resulting in better quality tunas.

Circle hooks appear to be very effective in reducing turtle by-catch where none were caught compared with 8 turtles using J-hooks. The species of sea turtles caught include 6 olive ridleys, 1 each of the flatback and leatherback species. Entanglement with branch lines was also observed in two instances, 1 for olive ridley and another for leatherback.

But C-hooks catch 18.2% more sharks than J-hooks. Unfortunately, the species of sharks were never determined. No by-catch of whales, dolphins and sea birds were observed during this circle hook trial.

Discards of other fishes are undertaken when storage space becomes limited. Most of the discarded fish are the rays. During this trial, C-hooks account for 49.3% and J-hooks 50.7% of discards. Using data from this experiment, C-hooks could decrease discarded fish up to 1.3 -41.4%.

Discussions

The success of circle hooks in getting more and bigger-sized tunas, more sharks and less turtles appear to be associated with the increase in hook size. The sizes of C-hooks promoted are much bigger than the current J-hooks commonly used by the longline fleet. Moreover, the C-hook is bent with an angle that could probably account for the high retention rate (less escapement) after taking the bait that results in more catch. This is confirmed by the lesser number of lost C-hooks compared with J-hooks.

More data will be needed to undertake a statistically significant value and to possibly identify details which may be used to carefully select pre-conditions for circle hook use.

Table 12.9.Comparison of tuna catch between C-hooks and J-hooks. Bold numbers are significant at 0.05 level.

Hook Type	Big eye	Yellow fin	Albacore	Blue fin
C-Hooks	1114	181	97	10
J-Hooks	899	129	89	5

Using current data from this experiment, circle hooks could be promoted in areas with high turtle interaction with fisheries and low shark catch such as the case for the Pacific Ocean based tuna longline fleet. Caution however should be used before promoting these in areas with high shark by-catch such as those fleets based in Pelabuhan Ratu and operating south of Sumatra where shark by-catch appear to be highest.

The observer program proved to be critical in promoting awareness among the tuna longline fishers, a condition that could not be replicated on land. The actual training of the fishers by the observers is a bonus of this program and proved to be a better strategy than doing the training and outreach onshore when most crews members want to spent time with their families when back on land.

The observer program must be expanded and could be formally adopted by the Indonesian government. Students from fisheries academies throughout Indonesia could be very suitable observers as they need on-the-job training as a prerequisite for graduation.

The better practices on reducing by-catch should be developed and advocated. The experiences and lessons learned from this observer program include use of appropriate bait (no squids and live baits), by-catch handling techniques, promotion of circle hooks (large hooks rather than small hooks) for specific fishing grounds and identifying which hotspot areas to avoid. Identification of better practices has to be expanded to other fisheries as well

To promote the use of C-hooks among the tuna longline fleet of Indonesia, the following suggestions are put forward:

1. Communicate the results of the C-hook trial experiment to other members of the tuna longline fleet for advocacy on by-catch issue and inform them of the results of the C-hook trials.

2. Facilitate discussions among fishers who have used C-hooks to share their experiences and solicit suggestions on how best to address some of the issues identified with C-hooks.

3. Expand the program to cover at least 20% or around 320 of the 1600 tuna longline vessels. The strategy is to promote this to the Pacific

Table 12.10. The comparison of tuna catch by size classes caught by C-hooks and J- hooks.

Length Class (cm)	Hook Type	Bigeye	Yellowfin	Albacore	Bluefin	Billfish	Dolphinfish
0 - 50	C-hook	11	1	1	0	9	0
	J-hook	170	2	0	0	4	3
51-100	C-hook	240	64	56	0	25	10
	J-hook	53	46	56	0	22	11
101-150	C-hook	855	115	41	1	24	6
	J-hook	709	90	36	1	6	3
>151	C-hook	15	1	0	11	20	0
	J-hook	12	3	0	5	13	0

Table 12.12 Comparison of by-catch take of shark, sea turtle and whales between C-hooks and J-hooks.

Hook Type	Shark	Sea turtle	Whale
C-hook	143	0	0
J-hook	99	6	0
Entangled			2

Ocean tuna longliners where turtle take is largest and where shark by-catch is not as serious.

4. Immediately analyze data as it comes to see possible modifications of the C-hook program as it affects by-catch of other species as well.

5. Undertake research that will help identify management policies that could reduce by-catch take of the longline. These could include trials for shallow sets using different baits, seasonality of C-hook use, etc.

6. Utilize existing traditional knowledge to help identify possible solutions to by-catch issues in the tuna fisheries. Fishers have long been exposed to by-catch and probably knows a lot about behavior, and interaction between target and by-catch species.

The current information so far is not sufficient to justify promulgation of policies to address the by-catch problem but preliminary results could allow the government now to undertake precautionary measures that will help ease and not aggrevate the current situation.

Based on data available, it is best to prioritize C-hook deployment and promotion with the Bali-based and Bitung-based longline vessels. This is based on the significant low take of turtles by the C-hooks operating in the Pacific Ocean and low take of sharks as well by the Bali-based fleet. We should defer promotion of C-hooks for the Pelabuhan Ratu-based longline whose shark hook rate is twice as high as the Bitung-based fleet and four times higher than the Bali-based fleet.

The cooperation showed by the tuna longline fishers and owners is the pillar of this project. Without them, the observer program and the C-hook trial would not have taken off. WWF looks forward to work with them until solutions to reduce by-catch. The cooperative, solution-oriented work with fishermen to reduce by-catch through this project has helped us establish a useful foundation for work on other issues of fisheries sustainability. It is encumbent upon us to publish the experiences and lessons learned of this circle hook experiment for others to emulate and learn from it.

Summary and Recommendations

Indonesia is one, if not the most important sources of tuna in the world. It owes this natural productivity to its strategic location where the South China Sea, the Pacific and Indian Oceans converge, providing the most ideal natural conditions for the tunas to proliferate, along with the over 500 coral species and over 2,000 species of coral reef-fish species and many other organisms that provide and support the natural capital resource base of the area.

The tunas are natural resources that continue to provide food and jobs to people. The tuna exports generate industries along the supply chain that provides job opportunities, even to women, and the benefits that help provide the much needed foreign revenues of the country.

But the tuna industry faces an array of shortcomings (here expressed positively as key results), that if addressed on time, could ensure sustainability of these resources and consequently economic sustainability. Details of the recommendations listed below is found at the end of each chapter.

Key Result # 1: Key fisheries information available is not sufficient to allow accurate assessment of the status of tuna stocks and serve as the basis for policy decisions.

Enumerated below are list of recommendations to make tuna fisheries stock assessment-ready.

A. The shortcomings of the current data information collection system and the recommendations to improve it have been detailed in the study by Proctor, et al. (2007). The said report suggests expansion of fisheries data collection sites, improvement of the current data collection system allowing forms to accomodate new sets of information. The recommendations also call for collecting information up to species level and disaggregating the catch by specific fishing gear types, among others.

B. Capacity of those involved in the data collection, storage and retrieval needs to be improved through intensive training coupled by the additional hiring of qualified personnel.

C. Infrastructure support should accompany the improvement of data collection system, by providing web-based support for fast and efficient exchange of information starting from the collection sites to the data centers in the provinces, to the national statistics office in Jakarta and back.

D. Collection of fishing operation info such as catch, effort, location, and measurements of fish caught for major gears should be part of the data collection system. The observer programs (both for distant water and domestic fisheries) should be further developed. This observer program could be further developed by harnessing the "on-the-job training course" of fisheries graduates as a requirement for the completion of their degrees. It could be started first with the Sekolah Tinggi Perikanan, being a state university where most of the students are on scholarship grants from the government. Assuming a good collection system is in place, this scheme could provide the data base of fishing operations important in the assessment of the resources at a very minimal cost as well as providing the necessary experience and background of the students, who will probably be next pool of resource managers and business operators.

E. On a long-term basis, develop a critical mass of fisheries science practitioners who will provide the scientific information and advice on the policies required to manage Indonesia's fisheries resources. Currently, there are less than 100 Ph.Ds working on pelagic fisheries and less than 10 who are directly involved in the assessment of tuna fisheries of the country (Dr. Subhat, pers. comm.). On a short-term basis, the country could harness the technical support of the RFMOs once Indonesia becomes a full member.

F. Research on tuna fisheries are few and sporadic and this is reflective on the amount of research funds made available. Policies need to be founded on solid science and Indonesia needs to invest heavily into tuna research. Ways may be explored on how to allocate some of the tuna revenues into research.

Key Result #2: The Indonesian tuna fisheries are currently undergoing major structural changes, changes which have important management, investments and policy considerations. These are:

a. Changing production patterns;

b. Changing tuna sectoral roles; and

c. Changing fleet structure

Key result 2a: Changing production patterns.

The share of large tunas vis a vis the small tunas has continuously showed changing trends, with the share of large tunas relative to the total tuna production increasing by

Table 14.1. Comparison of recorded tuna catch and estimate of tuna catch made by this study for each of the fishery management areas. Refer to appropriate Chapters for explanations on estimates.

Fishery Management Area (FMA)	Official Tuna Catches[1] (MT)	Estimated Tuna Catches[2] (MT)
I	12,612	12,989
II	54,344	49,745
III	50,255	87,092
IV	123,811	297,369
V	12,078	129,179
VI	123,303	131,982
VII	106,685	455,546
IX	214,140	777,410
TOTAL	697,228	1,941,312

[1]/ Source: DKP-Wilahya Pengelolahan Perikanan, data refer to 2004 figures

[2]/ Estimated tuna catches using operational fishing data for 2006, includes also small tunas. Details are presented at each particular chapters.

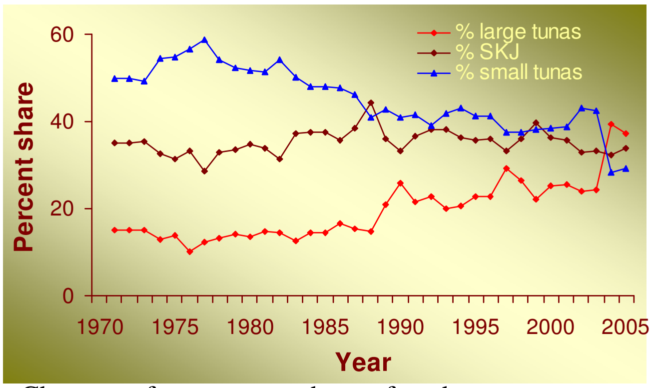


Figure 14.1. Changes of percentage share of each tuna category over time. Source: National Capture Fisheries Statistics, DKP (1970-2005).

as much as three times from 1970s levels (Figure 14.1). A proportionate decrease for the small tunas over the same period was observed where its percentage share dropped from its highest of 60% in 1977 to just 28% in 2005. The proportion of skipjack tuna remained stable between 30-40% .

Given the development support for the higher exports of the tunas with high market value, the catches of these tunas (large tuna species) are expected to grow. It is noteworthy that since 2004, the share of large tunas exceeded that of the small tunas, a trend which would probably continue in the coming years. This is brought about by the growing importance of the small scale sector in catching the large tunas in Indonesia. The details is discussed below.

Key result 2b: Changing roles of the two tuna fishing sectors

The small scale tuna fishing sector has become the major supplier of large tunas. Depending on the fishing ground, the proportion of tuna supplied by the small scale sector range from 34% in FMA-VI to 79% in FMA-V (Table 14.2). This surprising observation was based from our estimated tuna catch figures.

But an even more surprising is that the bulk of large tunas for export was caught and supplied by the small-scale sector. The estimated catches of small scale sector for large tunas exceed the estimated catch of the large fishing sector in FMA-IV, FMA-V,

Table 14.2. Share of tuna sectors (small vs. large scale) and between tuna category (large vs. skipjack+small tunas) to total tuna catches. Data based on estimated tuna catch (mt) made by this study.

	Sector	skipjack & small tunas	%	Large tunas	%	Total	%
FMA-IV	Small Scale	83311	49.2	138397	94.3	221708	70.2
	Large Scale	85918	50.8	8363	5.7	94282	29.8
	Total	169230		146760		315990	
	%		53.6		46.4		
FMA-V	Small Scale	52621	66.4	47459	98.7	100080	78.6
	Large scale	26581	33.6	630	1.31	27211	21.4
	Total	79202		48089		127291	
	%		62.2		37.8		
FMA-VI	Small Scale	13329	17.9	32123	55.9	45452	34.4
	Large scale	61202	82.1	25328	44.1	86530	65.6
	Total	74531		57451		131982	
	%		56.5		43.5		
FMA-VII	small scale	89387	36.6	130534	62.2	219921	48.4
	large scale	155137	63.4	79478	37.8	234615	51.6
	Total	244524		210012		454536	
	%		53.8		46.2		
FMA-IX	small scale	144937	26.5	131100	57.0	276037	35.5
	large scale	402331	73.5	99042	43.0	501373	64.5
	total	547268		230142		777410	
	%		70.4		29.6		

FMA-VI, FMA-VII and FMA-IX. The share varies considerably between areas and range from 56% in Sulawesi Sea and Pacific (FMA-VII) to a high of 99% in Banda Sea (FMA-V). The main reason is the bulk in supply of large tunas by hook and line and troll line which filled up the decline in catches of longline, the traditional source of exported large tunas.

Key result 2c: Changing fleet structure

Within the tuna fisheries of Indonesia, there are large scale changes in the type of tuna fishing operation brought about by three major developments that triggered these changes.

1. First is the increasing export demand of fresh and chilled tuna, mainly by Japan. This new market caused the shift of longlines fishing in Indian Ocean and Pacific Ocean to shift from frozen to fresh tuna. Yet, the supply could still not cope up with the demand partly because of the declining tuna catch. Filling-in the open niched are the small scale fishing ventures such as the handlines and the troll lines.

2. Second is the declining profitability of tuna longline and tuna pole and line fishing, which is mainly due to the depletion of the tuna stocks that is further aggravated by the increasing fuel prices. These developments forced the tuna longline industry to use smaller vessels (15-30 GT) to minimize costs of operations. Furthermore for the pole and line fishing industry, the shortage of live baitfishes adds to the problems already presented.

   As a response to these negative developments, the large pole and line vessels are now being converted into mother boats of tuna handline. Riding on the profitability of small-scale tuna handline, pole and line companies have entered into partnership agreements (*mitra kolaborasi*) with small-scale tuna organizations/ individuals by using their large pole and line vessels as mother ships: acting as storage facility and providing access to fish aggregation devices (FADs). It is expected that more pole and line fishing vessels will be transformed into mother ships for tuna handline fishers.

   Note that between 1990-2004, pole and line fleet underwent an expansion of vessel tonnage to accommodate more live baits, a move designed to address the acute live bait shortage. Such move apparently did not succeed.

3. Third, owing to the fuel price increases since 2004, the number of operational tuna longline vessels has declined to about a third of its high of 1,600 boats. An undetermined number transferred based to West Africa (Maldives) and Sri Lanka while about six (6) vessels availed of the Malaysian government fuel subsidy offer in exchange for fishing and landing in Malaysia. Others, (about 10 vessels) have retrofitted their vessels for squid jigging and/ snapper longline fishing.

   Allowing for the establishment of FADs in the Indonesian EEZ of Indian Ocean promotes shift of all FAD-based fishing methods into the area, triggering the mass transfer of fishing effort and the accompanying threats. We observed the beginning of troll line fleets migration from Sulawesi Tenggara to Indian Ocean, competing with the existing fleet from West Sumatra, this signals the advent of more pole and line fleets finding their way into the EEZ of the Indian Ocean. Also, the small-scale tuna handline are becoming even more popular. Furthermore, fishing companies have started investing in large purse seining, that construction of nets and FAD anchors already in progress in Benoa, Bali, a port used to be exclusive for tuna longline operations.

These developments only add up to the marked increase of fishing intensity in Indian Ocean and the growing sectoral conflicts between these different fishing industries. Government should now initiate a plan to regulate these activities before it eventually gets out of control.

Key Result #3: Indonesian tuna and tuna products needs to improve in order to become competitive in the global markets.

This section lists three major activities in order to achieve the level of competitiveness which translates to larger tuna catches and improved market access.

1. Removal of harmful subsidies and redirection of funds for tuna management;
2. Addressing huge post harvest losses;
3. Rationalizing tuna exports

Eliminating Harmful Subsidies

Almost all types of pervasive subsidies could be found in the fisheries sector of Indonesia. Direct grants are in the form of free fishing accessories to fishers, discounts in fuel prices, and dole-outs of fish containers to merchants and traders. Capital investments are also granted which were intially given out in the form of cash to fishers or traders, and managed by certain agencies or cooperative, but interviews revealed that no payback system has been successful so far. There are also the indirect subsidies mainly consisting of infrastructure support to development of and maintenance fishing ports and storage facilities. While the indirect subsidies are mainly good subsidies, poor planning and implementation have turned them into bad subsidies. Construction of auction halls (TPIs) in many landing areas that remain un-utilized is one of the cases of mismanaged subsidies.

This report did not estimate the amount of pervasive subsidies but it is presumed to be substantial given the extent of its use and the regular budget allocation annually. Some of the subsidies for the capture fishing sector such as providing free boats and support for FAD constructions exacerbate the already high levels of fishing intensity. The initial activities needed to address the issue of subsidies are the following:

1. Quantify amount of subsidies within the tuna sector and identify which are good and which are bad subsidies. These subsidies may be classified which are economically and socially harmful, and measures on how to minimize, if not totally eliminate these, should be developed.
2. Characterize and value these harmful subsidies and identify how the savings (from removal of these harmful subsidies) may be re-channeled to the management of the tuna resources, such as for research.
3. This information, when properly collected and synthesized, would fully arm the government to put a strong position in the current negotiations on new rules for fisheries under the WTO agreement.

Addressing post harvest loses

Reducing post harvest losses will address social, economic and ecological concerns of the tuna sector and will likely put Indonesia to a position of global significance.

Post harvest losses, defined as the percentage of catch that is below the standards, is very high. For the tunas of “sashimi grade”, the average post harvest losses is 68.8% (range: 40% for longline and 80% for handline). With this volume of “rejects” the quantity far exceeds the volume accepted. For skipjacks targeted for canning, the average loss is 35% (range 15%-60% depending on fishing gear and location).

The social impacts associated with high post harvest loses include loss of income for fishers and traders because income are proportional to the volume traded. Governments lose directly as a consequence of lesser tariff revenues and indirectly from potential investments. The ecological consequence of poor quality is that fishers tend to catch more than what is necessary in order to generate sufficient daily income. Most of the "rejects" end up being consumed locally, in many instances, putting the local populace at a higher health risk. While no statistics are available, people are at constant risk from possible histamine poisoning, diarrhea and other forms of illnesses.

Below are key recommendations on addressing this issue:

1. Set a health standard for fishing and trade that requires minimum set of post harvest equipment and required minimum training to maintain quality. Indonesia may aspire to use HACCP as its standard. Use of carbon monoxide (CO) to make the color of flesh fresh is widespread in the country and should be stopped.
2. Undertake massive training of fishers, traders and processors on post harvest handling. Undergoing training could be used as a prerequisite for securing or renewal of fishing license.
3. Provide post harvest facilities (storage facility, ice plants, ice boxes) in key centers of tuna fishing and ensure that the distance between fishing grounds and the support for post harvest facilities are kept at a minimum.
4. Promote loined instead of whole fish for sashimi. Here the government needs to work with the traders and importing countries to allow export of loins for sashimi. This will reduce the large rejection rates from handline and troll line fisheries, which are due to inadequate facilities in the small boats for cleaning and gutting, as well as immediate coolling of the whole fish. Doing this will greatly improve fish quality that is also translated to higher market value of the fish and thus higher income for fishers.
5. Poor screening at the borders of the exporting country leads more likely leads to high volume of rejection by the importing countries, which are strictly imposing international health standards. High volume of rejection equates to bad reputation of the exporting country which is the case for the exported tuna products of Indonesia. Issuance of health certificates should follow strict compliance because rejections are not just loss of money but loss of face for Indonesia as well.

Rationalizing Tuna Exports

Much of the export revenues generated from tuna are fresh and chilled products with Japan, US and the EU as the major markets. The volume of Indonesia's tuna exports depends on two factors: the volume and quality of tunas caught.

There are several major actions by which Indonesia, even without the benefit of increasing its current catch quantity, could improve its tuna export performance by undertaking the following:

1. Improve the quality by following the recommendations above.
2. Develop new processed products because value-adding are essential to expanding export market share. While tuna products of Thailand and Philippines cater to different market and use new packaging techniques (e.g. pouches), products from Indonesia have lagged behind.
3. Undertake policy actions to narrow prices between landed prices and export prices. This is particularly true for fresh, chilled and frozen tunas.

4. Address the mismatch of infrastructure support vis a vis the tuna fishing areas. The current tuna facilities in Muara Baru and in Benoa are already too far from the centers of tuna fishing located in eastern Indonesia. Addressing this issue will help reduce overhead costs, higher profits for fishers and reduces health risks.

5. Increase the number of international gateways for tuna and other seafood exports. Presently, main tuna exports are passing through four airports only, in Jakarta, Bali, Surabaya and Makassar. Manado in North Sulawesi and Ambon are good candidates due to their proximity to the tuna fishing grounds. However, support infrastructure within the airports need to be established first such as laboratory testing facility and storage as well as quarantine facilities. A tuna gateway in Papua would also be strategic as it could serve not just the domestic but also international needs of the fleets operating in the western Pacific, the area being within four hours of air travel to leading markets of Australia, Japan, Korea and China.

6. Facilitate the documentation process involved in the export of tunas by creating "One-Stop Shops" strategically located all over the country. This, hopefully, will eliminate the issue of corruption and additional costs of going from one place after another just chasing papers.

7. Strengthen the support facilities particularly in developing and providing sufficient manpower and laboratories to cater to the needs of the industry.

8. Find ways to lower the cost of freight. Currently, freight (air and sea) cost in Indonesia is more expensive by as much as 30-60% compared with Philippines and Thailand.

9. Strive to improve facilities in order to meet the health standards required by importing countries. Requiring tuna processing companies to be ISO or HACCP certified is a move in the right direction.

Key Result #4: Tuna fisheries undermine ecological integrity through unregulated by-catch of non-target species, unmanaged bait fisheries and unregulated fishing of tuna stocks.

The tuna fishing gears extract various species while catching the tunas. These include long-lived, low reproductive rates species such as turtles, swordfish, seabirds, sharks, rays and even the juveniles of their co-specifics. These species are usually refered to as by-catch. By-catch impacts biodiversity, whether utilized or not, through incidental mortalities. Economically, it is an issue of waste through discards (e.g. seabirds, turtles, carcass of sharks) or through potential loses generated by catching the juveniles of commercially important species, undermining both sustainability of the resource and the livelihood of the peoples that depend on it.

Recommended actions to address issues on baitfishes:

1. Undertake thorough assessment of the baitfishes stocks, particularly for the anchovies (*Stolephorus*) and determine, based on current population levels, how much may be taken out for both human consumption and baits. The use of indirect methods in estimating stocks (e.g. egg production method, larval surveys) to complement catch statistics and acoustic methods, are highly recommended. Egg surveys are particularly easy to undertake because anchovy eggs are easily identifiable due to their spherical shape.

2. Set a government policy on the use of baitfish species, by identifying which species is allowed for baits; taking into consideration the social, economic and ecological impacts on the continued of use of immature and juveniles of highly commercially important species.

3. Set a policy/ guidelines on how anchovies are appropriated for human consumption and for live baitfish.

4. Issuance/ renewal of fishing licenses for pole and line must consider not just the status of the skipjacks but the status of the baitfish resources as well. This is an application of ecosystem based fisheries management to tunas by ensuring that the number of licensed pole and line boat will have sufficient live baitfish supply and that the fishery will not jeopardize the sustainability of the baitfish resources.

5. Undertake a study on the use of milkfish as an alternative source of baits. Given its advantages as a fast growing, herbivorous species with technologies perfected to a full-cycle culture, is the likely answer to the chronic shortage of live baitfish. Most importantly, it would reduce current fishing pressure on baitfish stocks, providing an affordable live baitfish source that naturally occurs in the fishing ground, thus avoiding the problem of introductions.

Actions to minimize catch of juvenile tunas of tuna fishing gears

For some unexplained reasons, the juveniles of yellow fin and bigeye tunas form schools with skipjacks of similar sizes. As a consequence of this behavior, substantial amounts of juveniles of these species are caught by pole and line, purse seine, liftnets and gillnets. Even tuna handline preferred to catch juvenile tunas as baits. Based on data from WCPFC on Indonesia's domestic fleet catch, the estimated nominal catch of juveniles of skipjack, yellowfin and bigeye for 2006 amounts to 41.7 thousand tons, down by 38% from a high of 67.5 thousand tons in 2000. The greatest decline is observed in yellowfin tuna, probably a consequence of reduced stock abundance.

Much of the juvenile tuna catch is associated by the use of fish aggregation devices or FADs as a fishing strategy. Fishing fleets of purse seine, pole and line, handline have adopted this technology to minimize operational cost of searching for schools. With the sky-high prices of fuel representing between 40%-60% of total operation cost, fishing in the FADs simply makes business sense.

This study recommends the following actions to address this issue.

1. National policies need to be in place to address the issue of juvenile tunas. First is to have a minimum size law to catch specific tunas. The length (size) needs to be based on solid science. The sizes at maturity currently used by the governmen, 45 cm for skipjack and 55 cm for yellowfin, need to be re-checked as recent estimates of yellowfin's length at maturity is around 100 cm.

2. Review and update the current policy on fish aggregating devices (Pemasangan dan Pemanfaatan Rumpon, Nomor 251/Kpts/IK, 250/1/97) to address the issues on juvenile catch. Critical policies that will reduce the juvenile contamination of tuna catch are: regulating number and distance of FADs, promote sharing of FADs between tuna fishing sectors, and ban on the use of FADs in highly overfished areas.

Aside from the abovementioned fisheries issues on FADs, anchored FADs when detached from its float becomes a part of the marine debris issues and even pose hazards to navigation. These issues make it very necessary to have a system which function is to regulate, zone and monitor FAD deployment, number, and distribution. Admittedly, a lot of research needs to be done to address these issues. But while waiting for science to become available, precautionary measures need to be in place.

3. In the development of policies, traditional knowledge should not be ovelooked as these are in most cases based on realities and are cost-efficient.

4. In aid of capacity building and policy development, the experiences of the fishers who have long used FADs should be harnessed. For instance, tuna handliners in Padang, West Sumatra need to enhance fishing skills to fish the larger tunas in the deeper waters by learning from their North Sulawesi counterparts or from Filipino tuna handliners that utilize drop stone method.
5. Enact policies that protect the key life stages of tunas such as spawning sites, nursery areas and migratory corridors. The government should start with identifying the important spawning and nursery areas of the tunas. Better still is to establish with neighboring countries, a joint protected area to protect critical life stages of the tunas. Three important critical areas are recommended: the protection of the southern bluefin tuna spawning area in the Indian Ocean between Australia and Indonesia, and the yellowfin spawning area in Sulawesi Sea between Indonesia and the Philippines. Similar moves should be taken with Timor Leste to protect migratory pathways. Also, Arafura Sea with Australia could be promoted as a tuna fishing-free zone for a number of years.
6. Engage the stakeholders to help implement tuna policies. For instance, implementation of legal size limits for tunas may work well with canneries or processing plants.
7. The impact of FADs on fishing intensity is not understood but is presumed very significant. Precautionary measures such as regulating the use of FADs, and strengthening the monitoring of FADs will help in better understanding its impact. Research efforts must work with the global community on how to incorporate FAD effects on existing stock assessment models.
8. Advocacy campaign to change consumption behavior of consumers who preferred juvenile tunas over their adult counterparts for cultural as well as health reasons.
9. Undertake research on addressing by-catch. This is done by looking at the two levers of by-catch solution, addressing the catch per effort of by-catch and exploring possible management interventions such as regulatory bans, regulatory limits, trade sanctions, consumer boycotts and changes of fishing gears. Addressing by-catch per fishing effort include technological interventions, changes in fishing techniques, training and management actions.

Key Result #5: Benefits from tuna fisheries are not equitably distributed among its fishing sectors.

This section discusses three major causes of skewed benefits arising from tuna fishing: illegal fishing conducted by both foreign nationals and domestic fishers in the EEZ and territorial waters; the small benefits that accrue to local tuna fishers arising from current market and trade practices; and loss of potential revenues arising from the highly migratory character of tuna resources where most of the benefits accrue to the nations fishing outside Indonesia.

Illegal Fishing

The costs of illegal fishing to Indonesia is estimated to be about US$2 billion a year (Djalal 2007), with half of this amount probably related to tuna fishing. Illegal fishing by foreign nationals occur because the country's borders are porous, as border delimitation with neighboring countries have not been settled. As such, rampant illegal fishing violations occur in every fishery management areas with EEZs (Nugroho et al., 2007) that includes the South China Sea, Malacca Strait, Sulawesi Sea, Pacific Ocean and in Arafura Sea. Fishers from Thailand are main violators in the South China Sea and Arafura Sea, Chinese, Taiwanese and Filipinos are main violators in the Sulawesi and Pacific EEZ areas. Fishers from PR China are also fishing illegally in Arafura Sea. While there were arrest of fishers and seizure of vessels made, there were very few convictions. Corruption has mainly propagated the proliferation of many of these illegal fishing activities.

There are several ways to curb illegal fishing. First, is to strengthen the MSC system of the country; second, is to improve enforcement; and third, is to assign special courts to litigate illegal fishing cases with dispatch. The current MSC system is in place but would require large logistical support to operate effectively.

Another cause of "illegal fishing" is the questionable agreement entered into by some local government units with foreign fishing entities, using the decentralization law as framework. Such interpretation of the law needs to be clarified because foreign boats are seen operating in the territorial waters within the "provincial or regional waters" if such waters legally exists. A legal loophole probably exists because fishing privileges are given to vessels of less than 30-GT which qualifies pumpboats from the Philippines under joint venture agreements with locals to be given licenses, albeit temporary ones.

Collaborative Fishing Arrangements

The development of the Nucleus Estate for Smallholders (NES) System or *Mitra kolaborasi* is a highly desirable collaborative agreement between large fishing companies (mainly pole and line) with small scale tuna handline fishers. The company provides mother ship (a retrofitted pole and line vessel) that carries as many as 20 tuna handline boats to a fish aggregation device. The arrangement is that the company provides the supply, sometimes the boat, food and storage for the fishers and buys all the catch. Such arrangement allows small scale fishers access to fishing ground and storage facility thereby ensuring the quality of catch.

The downside of such agreements however is that small scale fishers are treated as laborers rather than partners. The prices of fish are dictated by the company. While some company actually provided financial support, there are many instances where support for boat construction by small scale fishers are provided for by loans from the banks that needs to be repaid, the company providing the guarantee to these loans. In this case, repayments are made through these companies (not to the bank directly) thus companies get additional profits from additional interests added to these loans.

There are many variations of this system, the most common ones are called the "*plasma system*", established between a trading company and pole and line boats. Particularly common in Flores Island, Kupang and lesser Sunda Islands, individual owners of pole and line boats and liftnet boats could join the system wherein the plasma or the trading company provides its members the support services such as ice, FADs to fish and live baitfish and in some instances, even fuel. In return for the services, members are compelled to deliver all their catch at company dictated prices. Generally, the buying prices are 20-40% lower than existing prices. There is plenty of room for improving the system and government should initiate studies on how best to improve benefits arising from these arrangements.

Skewed benefits due to tuna migratory behavior

Indonesia loses a lot of potential revenues from tuna due to migration outside the country. This would explain why around 31.5 thousand tons of juvenile yellowfin and bigeye are taken by various domestic fishing gears in 2006 (WCPFC database). At current prices of Rp5,000/kg, the total value of these juvenile tunas is US$17.5 million (exchange rate of Rp 9000 per dollar). If these fishes were allowed to grow to maturity sizes with only natural mortality (0.798/yr) to consider, the potential revenue is US$229.6 million. But Indonesians will barely profit from this because a large portion will get out of the country's jurisdiction to the benefit of the Pacific Island countries and the fishing nations who fish for these tunas when they become bigger. The potential loss amounts to around US$212.0 million. Its just fair therefore that Indonesia (and the Philippines) should be paid of these for them to stop catching the juveniles. These two countries, being host to the juveniles of the large tuna species are being forced to protect the young tunas by not catching them at the loss of their livelihood. WWF is currently working with an academic institution to develop a model which hopefully will be able to find a win-win solution to this dilemma.

Getting Off the Hook:
The Roadmap to Indonesia's Tuna Trade Sustainability

Stocks of tunas in many areas within the territorial and EEZ waters of the country have declined, based mainly in the total catch and the decline in catch rates that result in tuna fishing becoming unprofitable. This is true for tuna longline fishing in Indian Ocean and Banda Sea while substantial reductions in catch rates are observed in Sulawesi Sea and the Indonesian EEZ of the Pacific Ocean. Similarly, ominous signs of overfishing the tuna stocks is apparent as shown by the movement of tuna fishing fleets from the traditional fishing ground due to unprofitable operations and the increasing distance of fishing grounds, exacerbating quality of catch.

The key results enumerated above indicate that the current management efforts for tunas fall short of the minimum required to ensure sustainability and conservation of other related ventures such as baitfish fisheries, by-catch and others. Fulfilling these minimum requirements is also necessary for ecosystem-based management approach for tuna fisheries to be correctly implemented.

The roadmap to sustainable tuna trade as Figure 14.2 depicts is a stepwise set of short-term and long-term goals designed to achieve the ultimate goal of sustainable trade in about 10 years or less.

Short-Term Goals

The short-term goals within the period of 1-3 years are: a) to make tuna fisheries EBM compliant; b) Indonesia actively participating and pushing for reforms in at least three regional management organizations; c) making tuna and tuna products international

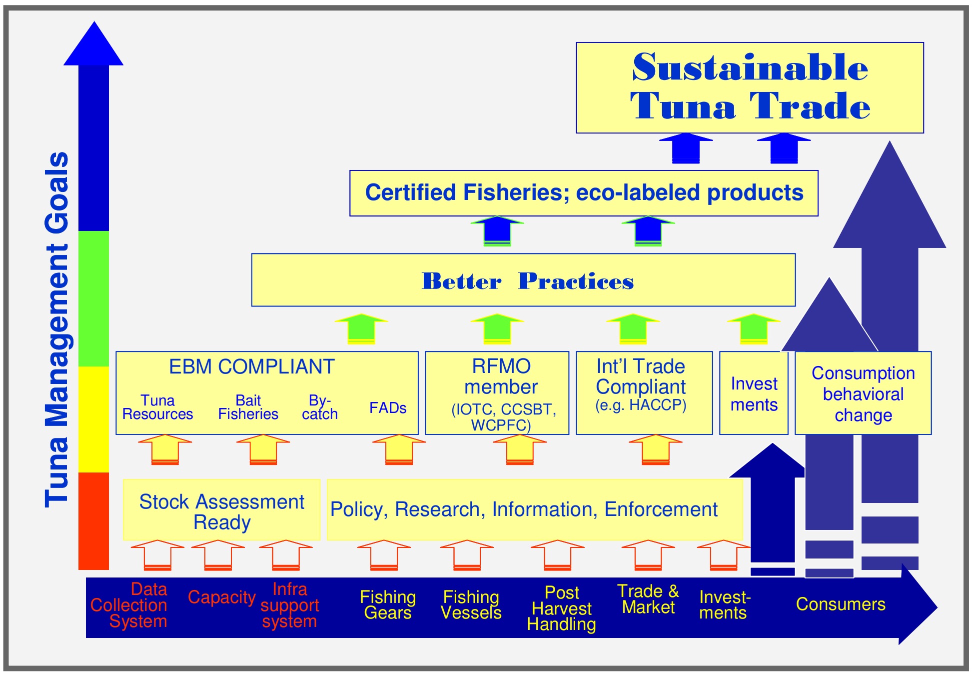


Figure 14.2. Graphic representation of the tuna management goals for Indonesia. See text for explanation.

trade compliant; d) providing conducive investment regime for tuna and tuna products; and, e) laying the foundation to change consumer consumption behavior.

The initial activities needed to achieve these four short term goals (1-3 years) would be two-fold: First, is to become stock assessment-ready; and second, to attain an enabling environment where policy, research, information, enforcement allows a seamless cooperation among and between the three levels of governance.

To make Indonesia stock assessment ready means improving data collection system, providing qualified personnel to undertake the job and ensuring infrastructure support to make this happen. Simultaneously undertaken along the same timeline are policy actions addressing key issues in regulating fishing capacity, improvement of post harvest handling capacity of tuna fishers; processors and traders; removing trade, markets and investment barriers; and advocacy among consumers about the current status of tuna stocks. This is a formidable task when viewed for the whole fisheries of the country but when separately developed first for the tuna fisheries only, it may actually become the model on which the shrimp, sardines and scads fisheries could follow.

The first of the four short-term goals is to make tuna fisheries management EBM-ready. EBM in simple terms means that tuna management will use the triple bottom line approach: address the ecological, economic and socio-cultural aspects. The tuna management equation must be able to strike a balance of all these three aspects. EBM for tuna likewise means that other fisheries in relation to the management of tuna resources, needs to be concurrently managed as well. This includes looking into the baitfish fisheries, the by-catch of turtles, sharks, rays and other non-target species, and the issue of catching juveniles of the tunas. Small tunas (bullet and frigate tunas, bonitos) and associated groups such as billfishes and swordfish likewise need to be included in the management and not simply left out as currently practiced.

The second short-term objective is for Indonesia to work with and harness the full potential of becoming a full member of the regional management organizations. At present, Indonesia has recently become a member of the Indian Ocean Tuna Commission and has expressed intention to join the Commission for the Conservation of Bluefin Tuna (CCSBT) and the Western and Central Pacific Ocean (WCPFC). Indonesia is a powerful tuna producing country and it could use these regional organizations to provide, on a short term, technical and logistical supports to many of the reforms needed while long-term plan for capacity building and development of sustainable funding mechanism is being developed.

The third short-term objective is to reform the tuna trade to make tuna exports and its products competitive internationally. This requires: a) the substantial reduction, if not the elimination of wastage in tuna fishing as a result of poor post harvest handling; b) improving services in support of exporting products; and c) encourage research on development of new tuna products.

Reducing waste for at least 50% will result in doubling the volume of exports, without increasing the intensity of fishing, translating to more revenues and income. Sadly, in 2007, the exporters could hardly fill-up the 9,000 ton quota given by EU to Indonesia under reduced tariff rate of 12% while competitors like the Philippines and Thailand have filled up their 15,000 ton quotas immediately within two-months.

Reforming the bureaucracy for tuna exportation will reduce cost and make exports competitive. High freight costs, delay in processing of papers, insufficient number of laboratories that issue health certificates and corruption are among the issues that require immediate government attention.

Major revenues from tuna mainly come from exports of raw materials (fresh-, chilled-, frozen-whole fish, and loins, steaks, etc) and minimally from package-processed tunas. Government should encourage research to develop new processed products and new packaging techniques that cater to the growing spectrum of consumers with various tastes and preferences. For example, Indonesia could take the lead in processing

Halal tuna products to cater to the global Muslim consumers. Similarly, processors should jump into the "organic / healthy or/ nutritious foods" bandwagon that now occupies one third of supermarket shelves and is growing. Tunas today are just known for sashimi, sushi or canned tunas designed for sandwiches or food additives. However, new products from tunas could be developed by looking more into its organic components, for example the omega-3, fish oils or other anti-oxidants found in thousands other products. Following the model of corn which extracts such as the High fructose Corn Syrup (HFCS), a cheaper substitute for sugar, finds its use in thousands of products for food, cosmetics and industry products. Research in this direction may discover component products derived from tunas, particularly frigate, bullet and bonitos that may be developed following the example of corn.

The fourth-short term goal is to provide a conducive investment climate through a well planned tuna development, an area where the government has started addressing. One of the most recent government policy in July 2005 is the unilateral cancellation of fishing access agreements giving way to development-oriented access agreements that compel fishing nations to invest in the country: fishing companies should establish processing plants and land their catch in Indonesia, and fishing ships be manned predominantly by Indonesian crew members.

This is a welcome move to the foreign fishing companies but at the moment are dilly-dallying until these three things are addressed:

a) improve the "brand name" of Indonesia in the world market;
b) remove or eliminate harmful subsidies that create monopolies and to level-off the playing field; and
c) address "corruption issues" which have made doing "tuna business" expensive and difficult.

Landing the tunas and investing in processing plants in Indonesia mean that the origin of the product would be Indonesia. However, at present most EU countries have policies of automatically retaining the products from Indonesia at the borders for health inspection. This causes not just considerable delay but additional expenses as well for laboratory testing which exporters must shoulder, adding significant cost to the product.

Subsidies directed to capture must be eliminated to reveal the true cost of fishing for tunas. Subsidies tends to distort prices and costs of investments.

While it is difficult to prove corruption, one may look into the number of divestments in the tuna sector since 2005 by foreign companies and understand the reason(s) for closures or transfer of operations elsewhere.

The fifth short-term goal is to lay down the foundation for consumers to be informed of what is going-on in the tuna fisheries, issues that consumers need to know. This requires transparency in the way tunas are managed. Advocacy and communications campaign should address this goal and rally consumers to help implement some of the key polices.

Mid-term Goals: Better Practices & Certified Tuna Fisheries

The mid-term goals (3-5 years) is an elaboration of the short term goals where better practices are documented and implemented on a per fishery management area. Implementation of better practices is a continuing process, utilizing adaptive management, and whenever possible, scaling up successes in small fishing grounds to larger management units. For the EBM, this means, continuous research so that the decision making process is always founded on solid science. For the RFMO, experiences on the domestic front should be shared to the region. Indonesia must become a major decision maker in these organizations as it is both a resource and a fishing nation. It could form independent coalition "blocks" with its neighbors to influence reforms which these regional organizations badly need. The strength of the RFMO depends on the strength of its individual members and Indonesia could show that a "bottoms up" approach is a logical way to enforce and manage a transboundary and migratory resource such as tunas.

Should Indonesia succeed in reforming its international trade and address the attendant issues besetting it, then this country could utilize its trade and market influence in order to complement the resource management of other countries in the region. Indonesia, with its sheer volume of exports backed by a good "brand name", could become a global leader in tuna, looking to the EU, Japan and USA more as partners and not simply as an exporter.

A gauge to evaluate how good tuna management has started to take roots in the country is for a tuna fishery or several fisheries to become certified, preferably by MSC. This could only happen if the short and medium-term goals have been sufficiently achieved. Becoming certified will take time but foundations need to be set within the short term period. It takes a lot of pain and sacrifice to become certified and incentives must be high enough to convince stakeholders to proceed with the process.

However, there are two underlying assumptions that should be fulfilled within the short term period which will determine the success of the enumerated activities above. First, is the issue of governance framework where all these tuna activities will be undertaken. The roles of each of the three levels of governance: national, regional/ provincial and district, under the regime of managing tunas on a fishery management area basis needs to be clearly defined and understood. Many of the jurisdictional issues arise from the maritime boundaries of the country which have yet to be defined. For instance, the boundaries of the internal waters within its archipelagic waters, territorial seas and exclusive economic zones needs to be settled and roles of each of the governance units clearly defined (Djalal 2006). How do these maritime categories be incorporated into the fishery management areas of the country? How does the flow of information, enforcement of rules, enactment of implementing guidelines, resolutions of conflicting policies between and among the three levels of governance be resolved? These sets of questions need to be answered well if the recommendations given above are to succeed.

The second less controversial but equally daunting question is where to source funds needed to support all these recommendations. There are possible sources that include redirection of some of the GAA developmental funds, removal of and redirection of government subsidies and, development of new scheme to raise funds from revenues generated from tuna sector.

In summary, the status of tuna stocks in Indonesia is at level where correct interventions using the ecosystem-based management approach, when done very soon, could translate into a sustainable tuna trade in the near future. The data and the sets of recommendations contained in this report could provide the basis for the development of a comprehensive tuna plan that will provide a long lasting food, jobs and livelihood to the stakeholders alongs its product chain.

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