A STUDY *of*

Illegal, Unreported and Unregulated (IUU) Fishing in the Arafura Sea, Indonesia

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LIST OF ABBREVIATION

BEDs	Bycatch Excluder Devices
BLL	Bottom Long Line
BRKP	Badan Riset Kelautan dan Perikanan (Agency for Marine and Fisheries Research)
BRPL	Balai Riset Perikanan Laut (Research Institute for Marine Fisheries)
B	Breadth
CPUE	Catch per Unit of Effort
D	Depth
EEZ	Exclusive Economic Zones
FAO	Food and Agriculture Organization
FMA	Fisheries Management Area
GT	Gross Tonnage
GPS	Global Positioning System
HPPI	Himpunan Pengusaha Perikanan Indonesia (Association of Indonesian Fisheries Companies)
IUU	Illegal, Unrecorded, Unregulated
IPOA	International Plan of Action
JTB	Jumlah Tangkapan yang diperBolehkan (Total Allowable Catch)
KEPPRES	Keputusan Presiden (Presidential Decree)
LOA	Length Over All
MCS	Monitoring, Controlling and Surveillance
PP	Peraturan Pemerintah (Government Regulation)
PRPT	Pusat Riset Perikanan Tangkap (Research Centre for Capture Fisheries).
PUP	Pengembangan Usaha Perikanan (Fisheries Business Directorate)
PT	Perseroan Terbatas (Limited, Ltd)
SSB	Single Side Band
TAC	Total Allowable Catch
TEDs	Turtle Excluder Devices
TL	Total Length
UU	Undang Undang (Law)
WPP	Wilayah Pengelolaan Perikanan (Fisheries Management Area)

CHAIRMAN'S FORWARD

In the modern fisheries management, Illegal Unreported and Unregulated (IUU) fishing has become a serious threat to the sustainability of marine resources. Although increasing number of countries are trying to develop their national plan of actions on IUU fishing, in many parts this activity is still common and constitutes a real danger to the local fishers.

While most of the IUU activities refer to the Illegal part, the Unreported and Unregulated components are similarly destructive, which have been overlooked in most of the IUU analyses. It is understandable that the data collection for this particular study is rather difficult, but nevertheless, we must start the process of estimating the total IUU activities, which reflect the total extraction of fisheries resources from the region. Furthermore, I want to encourage the scientists to use more comprehensive approach in conducting IUU study by including the small-scale fisheries into the equation of IUU analysis. Until then, would we be able to get the "complete picture" of the IUU activities in Indonesia.

In Indonesia, the regions most at risk from IUU fishing activities are the South China Sea, the waters around North Sulawesi and the Arafura

Sea (Purwanto 2005 pers.comm). Each of these regions experience specific problems at various levels of severity, however there are a number of similarities, including a very high level of illegal fishing in each of these three areas. In addition, the level of surveillance by the relevant forces of law and order is still very low. It has been estimated that the overall losses to the country are around 2 billion US dollars per year, which is equivalent to around 18 trillion Rupiah per year.

This report presents the results from the activities coordinated by the Research Center for Capture Fisheries, in cooperation with the Arafura and Timor Seas (ATSEF). I commend this initiative as the first publication providing first estimates of IUU activitiy in Indonesian waters. It is hoped that through this report the Ministry of Marine Affairs and Fisheries could develop management actions to reduce, suppress and eliminate illegal fishing practices and fisheries catch which is not reported. It is also recommended to extend the coverage area of this study to include the Sulawesi Sea and the South China Sea regions.

Finally, I highly appreciate the efforts by the Research Center for Capture Fisheries in making this study possible and in particular I am thankful to the financial support by FAO to this initiative. I wish the information provided in this publication would be useful to you.

Jakarta, May 2009

Dr. Gellwynn Yusuf
Chairman Agency for Marine and Fisheries Research

CONTENTS

LIST OF FIGURES

LIST OF TABLE

APPENDIX


SKALA 1 : 2.500.000
VIETNAM
PHILIPINA
SAMUDERA PASIFIK
LAUT SULU
LAUT MINDANAO
LAUT CINA SELATAN
BRUNEI DARUSSALAM
MALAYSIA
PALAU
LAUT HALMAHERA
LAUT SULAWESI
KALIMANTAN
SULAWESI
LAUT MALUKU
SELAT KARIMATA
LAUT SERAM
IRIAN
LAUT JAWA
LAUT BANDA
PAPUA NEW GUINEA
LAUT ARU
LAUT ARAFURU
LAUT TIMOR
AUSTRALIA
AUSTRALIA

"IUU fishing has far-reaching consequences for the long-term sustainable management of fishery resources." (UNICPOLOS, UN A/AC. 259/1, para. 1)

ABSTRACT

Fish catch which is not reported (unrecorded) is one of the components of IUU (illegal, unreported and unregulated) fishing activities which have become a major international issue in the past decade. Fisheries resources in the Arafura Sea Fisheries Management Area have been intensively exploited by industrial scale fishing fleets using fish trawls, shrimp trawls and bottom long lines. Based on data records, interviews and a series of workshops and consultations, this study attempts to estimate IUU in this region using the "anchor points and influence table" approach and including estimation of uncertainty using Monte Carlo simulations. Unrecorded catch is divided into catch which is thrown away (bycatch, discards), catch which is not reported, catch which is reported but not recorded or improperly recorded(misreported), and illegal fishing activities. In the early stages of shrimp exploitation, bycatch was relatively high but recently there has been an increasingly downward trend in bycatch in this fishery for about 50%. Bycatch from the capture of finfish using fishnet and bottom long lines can be considered negligible as hardly any fish are discarded. The highest level of misreported catch (95%) occurs in the bottom long line fishery, followed by the fish net fishery and is least in the shrimp trawl fishery. The highest level of illegal catch (average 35%) occurs in the fish net fishery, where fish are directly transferred (trans-shipped) from the capture fishing vessel to a foreign carrier vessel for direct shipment to the country of origin of the carrier vessel. Levels of illegal catch in the shrimp trawl and bottom long line fisheries are unknown, but are assumed to be around 5%. Several specific recommendations are made to improve the quality of data reported from the Arafura Sea.

Key Words: Bycatch, misreported, IUU, The Arafura Sea Fisheries Management Area, Indonesia

JOINT SEA SURVEILLANCE
INVOLVING MOMAF, NAVY
AND MARINE POLICE

1
INTRODUCTION

At global, regional and national levels, issues associated with IUU fishing activities currently constitute a major world-wide threat to fisheries stocks. There have already been many international initiatives supported by international organizations such as the FAO which have been engaged in the International Plan of Action (IPOA) on IUU fishing. Although an increasing number of countries are trying to develop national plan of actions on IUU fishing, in many parts IUU fishing practices are still commonplace and constitute a real threat to local fishers. Indeed, there is increasing global concern about IUU fishing practices due to the fact that global fish stocks are declining drastically. At the global level, stocks of large pelagic fish (tuna, marlin, spanish mackerel) have been reported to have declined by almost 90% in the past 50 years (Worm *et al.* 2006). This fact forces the fishing fleets of coastal nations to extend their fishing grounds to the point where they go beyond their exclusive economic zones (EEZ), a practice which is conducive to the growth of illegal fishing practices. Of course this trend is linked to the high level of demand for animal protein which can be supplied relatively cheaply from fisheries products. The continuous increase in the world population will automatically increase the demand for fish (FAO 2004, Delgado *et al.* 2003).

When discussing IUU fishing issues, there is a tendency to pay more attention to illegal fishing activities than to the unregulated and unreported components. Indeed this tendency has become generalized in many

countries. However if this situation is allowed to continue, there is a danger that the information obtained will be biased and this will have a negative effect on the management and surveillance of fisheries resources. As is the case in other sectors which rely on natural resources, those fisheries resources which have already been depleted and are continuing to decline will easily become severely overfished and furthermore will suffer from on going mismanagement if the available data and information is inaccurate (Pitcher *et al.* 2002).

In Indonesia the regions most at risk from IUU fishing activities are the South China Sea, the waters around North Sulawesi and the Arafura Sea (Purwanto 2005 *pers.com.*) Each of these regions experience specific problems at various levels of severity, however there are a number of similarities, including a very high level of illegal fishing in each of these three areas. In addition, the level of surveillance by the relevant forces of law and order is still very low. Approximate estimations suggest that overall at least 30% of world-wide fisheries catch is obtained from IUU fishing activities (FAO report 2004, Pauly *et al.* 2002).

This shows that the problem is increasingly severe, especially in view of the accelerating overall decline in available fisheries resources. In Indonesia it has been estimated that the overall losses to the country are around 2 billion US dollars per year which is equivalent to around 18 trillion Rupiah per year (see Willoughby *et al.* 1999, Gatra Magazine 2007).

An estimation of the level of IUU fishing in The Arafura Sea will enable an estimation of the difference between the fisheries statistics and the real volume of fish which is taken from a given area. In addition, calculating the volume of catches from IUU fishing will enable a more accurate estimation of the real fisheries resource potential of the Arafura Sea. With this improved estimation, it is anticipated that existing fisheries management can be enhanced by taking into account the carrying capacity of this sea area. One method which has already begun to be implemented is the adoption of an ecosystem-based approach to management, for example changes to the way in which Indonesian waters are divided into fisheries

management regions. This paper presents the results from a number of research activities undertaken by the BRPL-PRPT (Research Institute for Marine Fisheries– Research Centre for Capture Fisheries). The general methods used follow the "anchor points and influence table" approach, with Monte Carlo estimation of confidence limits (Pitcher *et al.* 2002). The final target of this paper is to list data regarding catch which is not recorded (unrecorded, unreported and misreported) and compare it with the data contained in national fisheries statistics. With an estimation of the volume of this catch, the management authority, in this case the Ministry for Marine Affairs and Fisheries can then develop management actions to reduce, suppress and/or eliminate illegal fishing practices and fisheries catch which is not reported.

CHINESE FISHING VESSELS USING INDONESIAN FLAG, OPERATED IN THE IEEZ OF ARAFURA SEA

2
OVERVIEW OF THE ARAFURA SEA FISHERIES

2.1 General Overview of Arafura Sea Fisheries

Fisheries catch which is not reported is one of the IUU (illegal, unreported and unregulated) fishing activity categories and has become an international issue in the last decade (Anonymous, 2001). The fishery resources of the Arafura Sea have been intensively exploited for some time now by three industrial-scale fisheries: a finfish trawl fishery, a shrimp trawl fishery, and a bottom long-line fishery. Small-scale artisanal catches in the area using lift nets ("bagan") and other artisanal gears are thought to be relatively low on account of the small coastal population. Hence, in this region steps taken to manage the fisheries resources in the Arafura Sea can succeed if these three industrial scale fisheries can be controlled in order to obtain optimal and sustainable yields, as well as ensuring the long-term conservation of these fisheries resources as laid out in Law No. 31/2004 concerning Fisheries.

The Arafura Sea Fisheries Management Area consists of an extensive and fertile continental shelf which is part of the Sahul shelf sea area which is divided into two parts, which are the Indonesian and Australian sectors of the Arafura Sea. There have been major fisheries activities in these two sectors for some time now, indeed since the late 1960's, with fisheries licenses issued by the Australia Northern Territory Authorities to vessels

from Taiwan, Japan and Thailand. Because there were signs of a sharp decline in fish stocks, these licenses were withdrawn in 1990 (Ramm, 1995). One of the reasons for this decision was the worry that if the demersal fish resources in this area are all part of single stocks (populations), then the collapse of demersal fisheries in one sector would cause collapse across the whole of the Arafura Sea region.

In contrast with the Australian sector of the Arafura Sea where signs of overexploitation resulted in a moratorium on license renewals, in the Indonesian sector several new licenses have been issued since 1990, adding fish net licenses to the existing shrimp trawl licenses. During the same period, there was substantial expansion of the bottom long line fishery based in Tanjung Balai Karimun, Riau with secondary bases in Probolinggo and Kupang (see map in appendix). These bottom long line vessels have recently (during 2007) begun to use the ex-fishing base of PT. Djarma Aru, Jayanti Group in Wanam in order to save on fuel costs.

2.2 The Development of Demersal Fisheries in the Arafura Sea

In general, the exploitation of fisheries resources in the Arafura Sea can be categorized in accordance with the fishing gears used, including industrial scale shrimp trawls (about 47% of the reported Arafura sea catch), fish trawls (about 48% of the catch) and bottom long-lines (about 2% of the catch), plus a number of smallscale fishing gears with very limited areas of operation. Recent developments include the introduction of off-shore gill nets and squid jiggers, so far in relatively small numbers thought to be around 3% of the current catch.

The Shrimp Trawl Fishery

The exploitation of shrimp resources in the Arafura Sea began in 1967, with an ‘exploratory survey’ programme by a number of companies involved

in an Indonesia-Japanese partnership with Indonesian-Japanese joint ventures based in Ambon and Sorong. This fishery developed so fast that the government was forced to create a legal framework with specific rules and regulations. Furthermore, in 1967 the Government promulgated Law No. 1 of the year 1967 concerning Foreign Investment, which was followed a year later by Law No. 6 of the year 1968 concerning Domestic Investment, which was further amended in 1970 to become Law No. 12 of the year 1970. Under this legal framework, through the facilities provided by Foreign and Domestic Investors as well as bilateral and multilateral loans, a total of 26 domestic fishing companies were established. By 1976 the shrimp trawling fleet in the Arafura Sea had reached 120 vessels of 100-350 GT tonnage. The vessels are double rig shrimp trawlers of approximately 35-45 m LOA, 5-7 m B, and 3-4 m D. The nets are 40 mm mesh size cod end. At this time, almost all licensed companies in the fisheries sector were involved in the capture and processing of wild-caught shrimp, and the Arafura Sea had become one of the main shrimp fishing grounds in Indonesia. The success of these joint ventures encouraged a swift expansion of the shrimp fishery in the Arafura Sea.

The main target of this double rig shrimp trawler fishery were penaeid shrimp species: the 'banana shrimp' *(Penaeus merguiensis),* tiger prawn *(P. monodon, P. semisulcatus)*, king prawn *(P. latisulcatus)* and the endeavour shrimp *(Metapenaeus ensis, M. elegans).* These tend to be mixed with around 42 other shrimp species, most of which are small in size. The proportions of the various species have not been separated in any samples or catches, except for those of the main target species that usually have higher economic values.

Many small demersal fish were caught together with the shrimp, and considered as bycatch, most of which was thrown back into to the sea dead as discards. According to the report by Naamin and Sumiono (1983), bycatch was estimated at around 80% of catch volume in 1982 (i.e., four times the shrimp catch). Under Presidential Decree No. 85 of the year 1983 concerning the capture of shrimp in the Arafura Sea, by 1983 at

the latest all prawn trawl nets were obliged to be fitted with TEDs (Turtle Excluder Devices) which were subsequently changed to BEDs (Bycatch Excluder Devices).

The Fish Trawl Fishery

The use of trawl nets to catch finfish (fish trawl), which have been subsequently referred to as 'fish nets', began to develop in 1987, with a total of 113 trawling vessels of 100-300 GT and 41 vessels of 40-50 GT recorded as operating around Southwest Papua. They moved there from elsewhere in Indonesia after a Presidential decree banned trawling in most other areas of Indonesia. The nets are generally 50 mm mesh size cod end. In addition to these legally operating (licensed) trawlers, according to information from the then Directorate General of Fisheries, it was known that there have been illegal trawling operations owned by companies from Taiwan and Korea operating in these same waters. The number of illegal vessels that operated annually was not known but was estimated at around more than 30 vessels. Because of the limited capacity of the surveillance apparatus, it was suspected that the illegal trawling fleet was increasing each year in terms of vessel numbers and size/sophistication.

In the 1990s it was estimated that the number of illegal vessels operating in Indonesian waters reached more than 100 vessels. In 2003 the government of Indonesia issued a policy to officially licensed foreign vessel with 100-300 GT through a licensing fee agreement. Illegal fishing practice in the Arafura Sea has shown a decreasing tendency starting in 2003 following the implementation of vessel re-registration policy.

The fish trawls ostensibly target fish, but in fact catch and market many shrimp, without the legal need to be fitted with BEDs. Fish trawls are mean to be hauled by single vessels, but in practice many operate as pair trawls. On one instance of aerial surveillance survey conducted in May 2005, there were sightings of pair trawls operating in the Arafura Sea. The

numbers reached up to more than 20 pairs (Wagey 2008, *pers. comm.*) All pair trawls are illegal in these waters.

The Bottom Long Line Fishery

The industrial scale bottom long line (BLL) fishery is mainly based in Tanjung Balai Karimun, Riau with subsidiary bases in Probolinggo and Kupang. (See Appendix map 1 for geographical location). More recently there has been information that the BLL vessels have begun to use Wanam fishing base, once the base of the former company PT. Djarma Aru, of the Jayanti Group. The size of these BLL vessels is 70-120 GT, and they are equipped with 'line hauler' equipment, GPS, SSB Radio, Gyro compasses, and navigational charts. Each BLL vessel deploys 1800 to 3000 hooks. There are around 10 crews per vessel and they tend to operate fishing trips of 3-4 months duration.

The fish targeted by the BLL vessels are large demersal species, including red snappers, groupers and emperors. Most of these species are slow-growing and are therefore very vulnerable to intensive fishing pressure. Indeed, the 1990 moratorium on licensing renewals in the Australian sector of the Arafura for vessels from Taiwan, Japan and Thailand (Ramm, 1995) was because of a dramatic decline in CPUE in fish like these where growth and recruitment were unable to balance the high capture rate.

2.3 The Arafura Sea Fisheries in the Context of Indonesian Fisheries Statistics

2.3.1 The Indonesian system for the collection of fisheries statistics data

Indonesian fisheries statistics were originally produced based on methods designed in 1973 by FAO expert Dr Yamamoto, using the data and information collection system shown in the following figure 1.

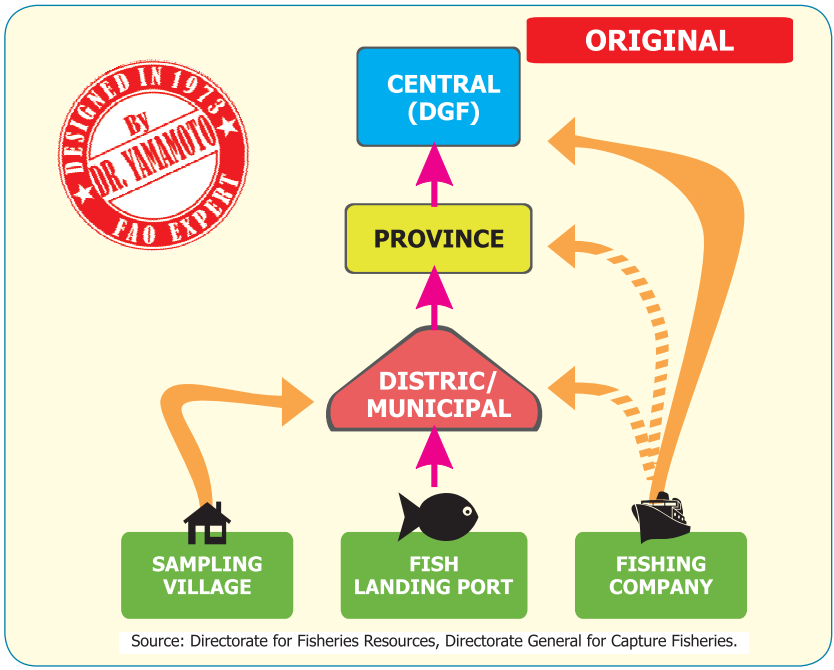


Figure 1.
The data collection system for data presented in National Fisheries Statistics.

Since then the increasing complexity of Indonesian Fisheries and the need for more detailed data and information have driven a number of additions and improvements to this mechanism as shown in the following sketch in Figure 2.

Although improvements have been made since 2003, like many fisheries statistics around the world, fisheries information and data are still based on “landing sites”, meaning that the data does not take into account where the fish was caught but is based solely on the quantities landed. Efforts have been made to group fish landing data based on Fisheries Management Area (FMA) by estimating total landing within each FMA. These estimates have been made since 1997 data and were published in a book of Production per Fisheries Management Area.

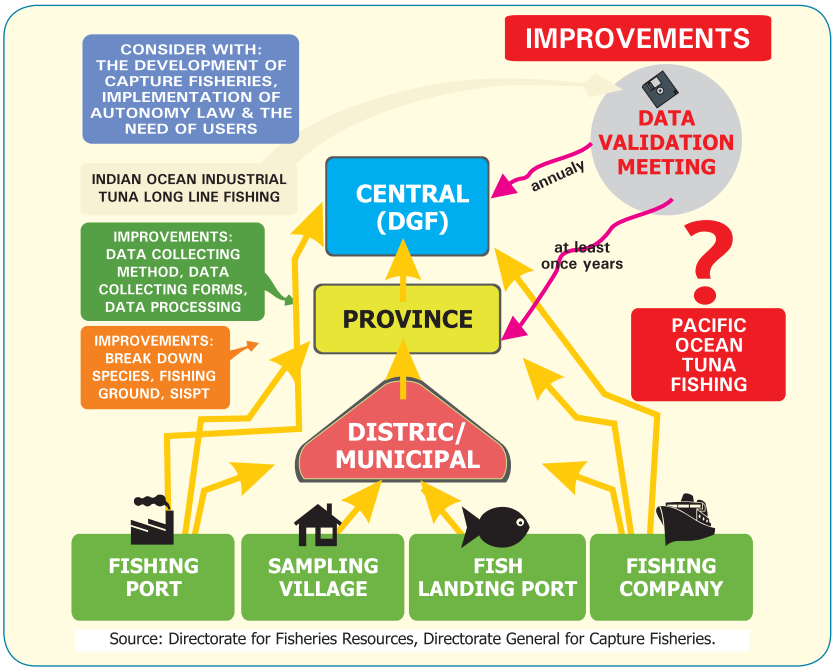


Figure 2.
Improved mechanism for the collection of fisheries data

With these improvements/additions to the data collection mechanism it is hoped that the amount of "unreported" (catch) data can be reduced so that the quality of data in terms of accuracy can be improved and respond to the needs of data users.

2.3.2 Results of fisheries statistical data collection for the Arafura Sea

Catch Data

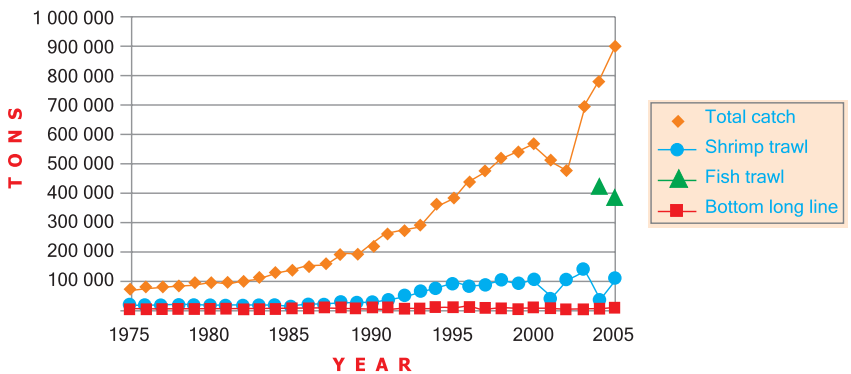
From 1975 to 1985 the volume of catch landed in the Provinces of Maluku and Irian Jaya grew relatively slowly, with a marked increase since 1991. It

is suspected that the source of the steep increase in catch volume was the landing of a proportion of the catch from fish trawls which began to operate in the mid 1980's. Up until 2004, however, the catch from fish trawls was not recorded, so that in this work it has been placed in the category of "unreported catch"; in the data sources there are no explanatory notes stating that the catch from fish trawls is included in the catch recorded for any particular fishing gear.

The recorded catch landed in the Provinces of Maluku and Papua is lower than the volume of fish caught in the waters of the Arafura Sea, because of several factors: (1) some vessels land their catch outside these two Provinces, for example the bottom long line vessels from Tanjung Balai Karimun generally land most of their catch in Probolinggo and Tanjung Balai Karimun, whereas some high value species tend to be illegally exported to Singapore; (2) fish trawl vessels generally trans-ship their catch at sea for direct transport to their county of origin.

From the explanations above it is clear that the reported catch landed in Maluku and Papua Provinces is an underestimate and does not present a true picture of the volume of fish caught in the waters of the Arafura Sea.

Figure 3.
Recorded Catch from the Arafura Sea landed in Maluku and Papua Provinces.



Source: Directorate for Fisheries Resources, Directorate General for Capture Fisheries.

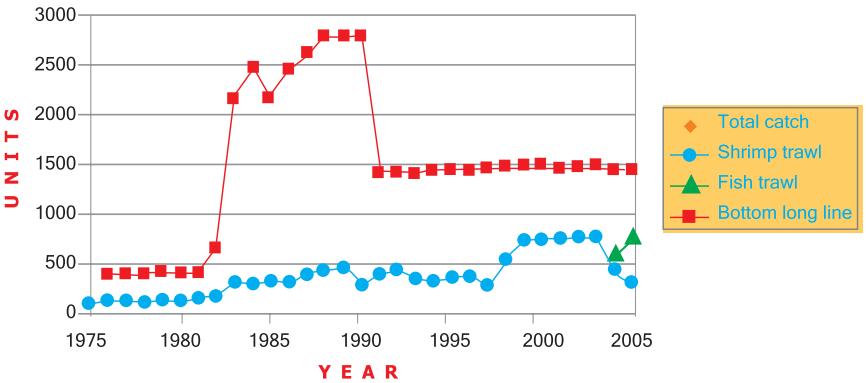
Fishing Effort

Fishing effort discussed in this paper is limited to three fishing gears which are shrimp trawls, fish trawls and bottom long lines. In Figure 4 it can be seen that from year to year there is an overall increase in the number of each of these fishing gears.

The fishing effort figures given in the main Fisheries Statistics include all fishing vessels operating legally in the waters of the Arafura Sea, both those with licences issued by the central government (> 30 GT) and those licensed by Provincial and District Authorities (< 30 GT), whereas the data held by the Directorate for the Development of Fisheries Business (Direktorat Pengembangan Usaha Perikanan, PUP) only covers vessels over 30 GT.Following a continuous increase since 1975, the number of shrimp trawls fell in 2003. In fisheries statistics prior to and including 2003, only the Double Rig Shrimp Trawl gear type was listed, however in 2004 the name was changed to BED equipped shrimp net and a new gear type called Stern shrimp Trawl began to be listed.

As with catch volume data, the data on fish trawling vessel numbers is only available from the year 2004 when the fleet consisted of 568 vessels, as in previous years fishing units using Fish Trawls were not included in Indonesian Fishery Statistics. Based on data from the PUP the number of Fish Trawls recorded for the years 1998, 1999, 2000, 2004 and 2005 were respectively 222, 599, 779, 815 and 785 units. The figure of 568 vessels given in the 2004 fisheries statistics is way below the data from the PUP which is 815 units (vessels).

The number of bottom line fishing gears (listed as set long lines in fisheries statistics) increased dramatically by over 300% in 1983 from 657 units recorded in 1983 to 2,156 in the following year followed by a gradual increase up until 1990 then in 1991 there was a decrease of around 50% from 2785 units in 1990 to only 1410 units in 1991, followed by a relatively stable number of bottom long lines up until 2005. The name "Set Bottom long line" only appeared in published fisheries statistics in 2004 with



Source: Directorate for Fisheries Resources, Directorate General for Capture Fisheries.

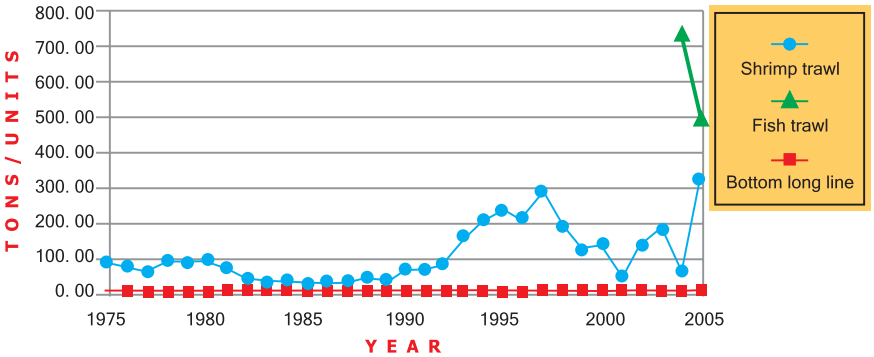
Figure 4.
Data on the number of capture gears in the Arafura Sea

a recorded total of 5 units. In previous years only "drift long line" and "set long line" were listed. Unrecorded gears and the inconsistent use of gear names, with established guidelines for standardizing gear names often not being followed in practice, have contributed to the increase in "unrecorded" catch.

Catch per Unit Effort (CPUE)

Catch per Unit Effort (CPUE) can be used as an indictor in establishing an "index of abundance", the decline or rise in CPUE can be used to estimate changes in abundance of a particular stock in a given area. In this study CPUE is calculated from fishery production and the total number of each gear type.

The aggregate CPUE for shrimp trawls tended to increase until 1996/1997 and has since exhibited a downward trend. The lowest CPUE was in the 1980s with around 20 tons per vessel, and the highest was in 2005 with a CPUE of 300 tons per vessel per year.



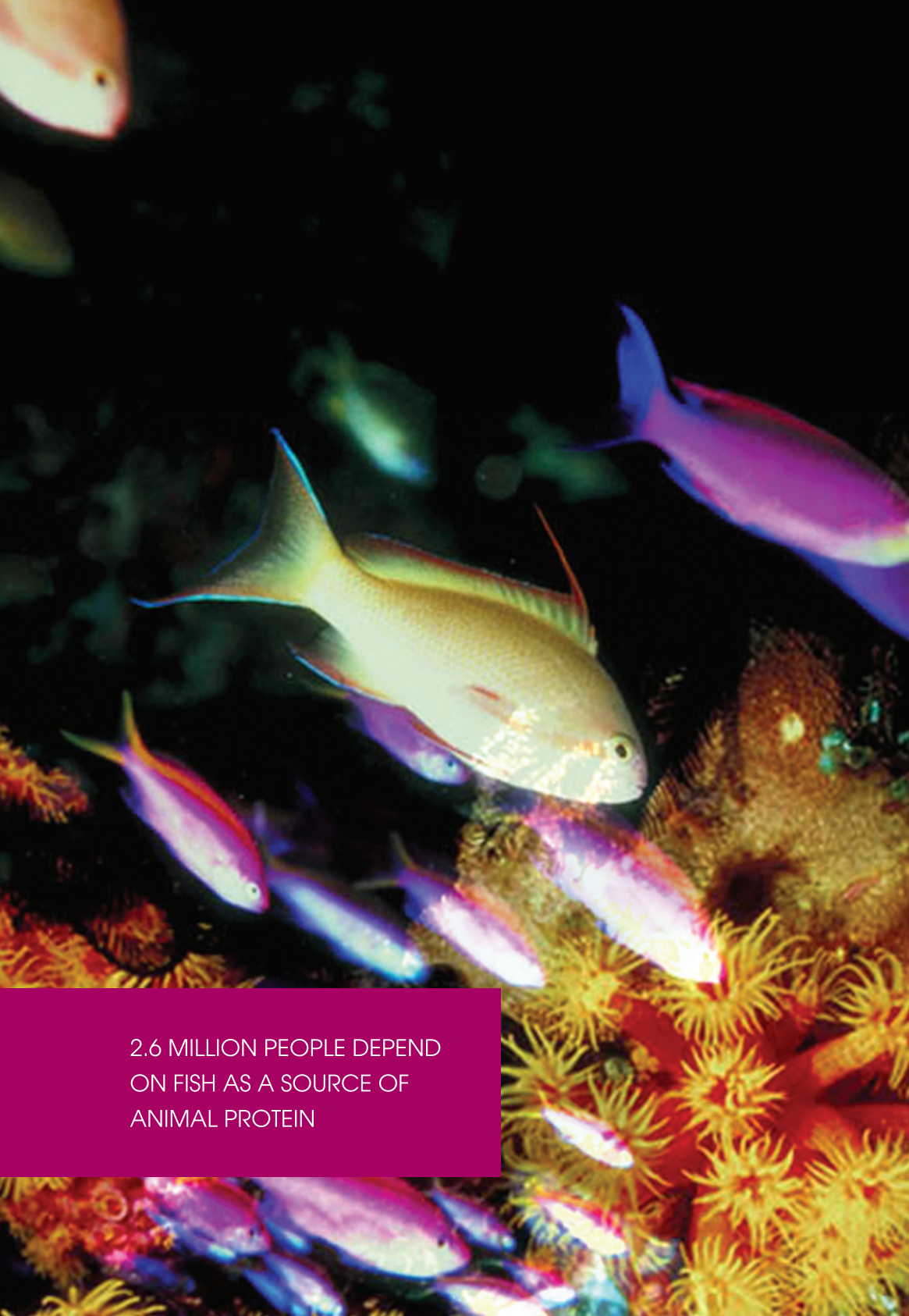
Source: Directorate for Fisheries Resources, Directorate General for Capture Fisheries.

Figure 5.
Changes in CPUE over time in the Arafura Sea.

In 2004 the average CPUE for fish trawls was around 700 tons, which fell to around 500 tons in the following year. Because of the lack of catch and effort data for previous years, the CPUE for Fish Trawls before 2004 cannot be determined from the fisheries statistics data. For bottom long line gears, the average CPUE has been stable at a fairly low level of 0.5 – 2.5 tons per vessel per year.

The CPUE for bottom long lines of 0.5 to 2.5 tons per vessel per year is exceedingly low when compared with the results of research into the rate of use of fish hooks in sizes 1 to 5 and 6 (Hook rate 1 to 5,6), and it is highly suspected that there is a substantial “unreported” catch.

Its is worth noting that the accuracy of the CPUE obtained is heavily dependent on the accuracy of the catch landing data and the data regarding numbers of vessels/gears operating in a given sea area.



2.6 MILLION PEOPLE DEPEND ON FISH AS A SOURCE OF ANIMAL PROTEIN

3
METHODS

3.1 Data Collection

The data collected includes data and information concerning catch and fishing effort as well as the legal framework related to fisheries in the Arafura Sea, including written records and publications as well as unwritten information and unpublished documents.

Statistical catch data for the Arafura Sea to be used as ”Base-line" statistics are those contained in the National Fisheries Statistics for 1976-2004 published by the Directorate General for Capture Fisheries – Ministry for Marine Affairs and Fisheries.

A desk study was undertaken in order to obtain data and information related to fisheries catch and fishing effort from the results of relevant research, as well as rules and regulations which can be used as a reference in establishing ”anchor points” and ”influencing factors" *(ref to method Pitcher et al. 2002).*

In order to obtain unrecorded data and information, a number of interviews were carried out with sources that it is believed have an in-depth knowledge of the real conditions in the Arafura Sea fisheries. These sources include a number of shrimp trawler ex-captains during the 1970's up until the 1990's, employees and past employees in fishing harbors and

Provincial/District Fisheries Services, and ex-crew members of fishing vessels that are based in Semarang, Ambon and Sorong (Papua).

3.2 Data analysis

Analysis of the data and information relating to the exploitation of fish and prawn resources in the Arafura Sea over the period 1976-2005, included qualitative analysis of the behaviour patterns which drive the misreported and unreported fisheries as well as quantitative analysis to estimate unreported data and information. The "anchor point/influence table" analysis was structured on percentages covering 5-year blocks of time from 1976: annual estimates were later obtained using annual reported catches.

From the "anchor points" data obtained, interpolation with reference to "Influence Factor" tables can be used in order to obtain an estimation of the unknown values for a given year.

Influence Factors

"Influence Factors" in this context consist of a number of components including policy, rules and regulations, decisions and actions which can influence the rise or fall of IUU fishing activities (incentives and disincentives).

Factors in the table are reviewed and analyzed to determine to what extent they influence the increase or decrease in "discards", "misreporting" and "illegal fishing".

Anchor Points

Data and information regarding catch and fishing effort for given years can be estimated with reference to an "Anchor point". An Anchor point consists of data and information regarding catch and fishing effort obtained as a

result of research or from rules and regulations which can be used as a more reliable basis or reference point for estimation.

Interpolation

Interpolation is a process used to fill in and estimate data and information for a given period which cannot be obtained from the process of anchor point determination, taking into account the factors listed in the Influence Table as provided in Appendix Table 1.

Estimation of annual base line catch

Base line catch is the total volume extracted and is estimated through multiplying the calculated catch per unit effort by the calculated effort.

Estimated value of the IUU fishing components

The total IUU fishing component is the combination of Discarded, Misreported and Illegal Fishing components. The value of each component on a yearly basis can be obtained through addition/subtraction using the following formula:

Base line catch = Statistical Data + (Discards+Misreported+Illegal)

This is accompanied by an estimation of the upper and lower limits for the estimations made for each year over the period 1976-2005.

Monte Carlo Simulation

The following step is the use of a Monte Carlo simulation to estimate the size of the likely error in the afore-mentioned catch estimations. The Monte Carlo simulation is used with square wave probability samples between the upper (max) and lower (min) values consisting of 500 iterations for each 5-year block estimation for each fishery.

The end result is the calculation of the median value and the 95% confidence interval for each simulation.

3.3 Validation of Results

During this activity five workshops have been held both in order to obtain additional data and information and to validate data obtained and calculations made.

Workshop	Month	Location	No. of Participants
1	March 2007	Ambon	10
2	March 2007	Papua	10
3	March 2007	Semarang	10
4	May 2007	Jakarta	25
5	June 2007	Jakarta	30
6	January 2008	Jakarta	40

Table 1.
Workshop Meetings in Various Locations

The first three Workshops were held in Ambon, Papua and in Semarang with the goal of collecting data and validating data and information obtained from the desk study and interviews. Most of those attending the workshop were either ex captains and crew members of prawn trawlers operating in the Arafura Sea, or researchers, lecturers and students from higher education institutes who had undertaken studies in the Arafura Sea. The following Workshop was held in Jakarta, and was largely introductory in nature, setting out the methodology, the project goals and the anticipated outputs, as well as compiling initial data necessary to project implementation. The workshop was attended by representatives from the Sub-Directorate Fisheries Resources Data and Statistics, Sub-Directorate for PUP Monitoring from the Directorate General of Capture Fisheries,

Directorate of Surveillance of the Directorate General of Surveillance, association of shrimp fishery-related businesses and researchers working within the Research Centre for Capture Fisheries.

The fifth Workshop was held in Jakarta and was attended by the Head of the National Committee for Fisheries Stock Assessment, expert staff from the Ministry of Marine Affaires and Fisheries, Directors General from the Ministry of Marine Affairs and Fisheries, the Director for Fisheries Resources from the Directorate General for Capture Fisheries, the Sub Director for Data and Statistics, The Director for Surveillance, The Head of the Research Centre within the Agency for Marine and Fisheries Research, representatives of Bogor Agriculture University, the Heads of Provincial Fisheries and Marine Services from Papua, Maluku, North Sulawesi and West Kalimantan, the Fisheries Industry Association and researchers. In this workshop the values of the "Anchor points" and "Influence factors" were presented together with estimations of the IUU Fishing components according to the calculations which had been made. A number of inputs from the workshop attendees included corrections to the proposed values which were used to improve the calculation of the values obtained. This meeting was also attended by Prof. Dr. Tony J. Pitcher from the Fisheries Centre - University of British Columbia as a expert consultant for this project. On this occasion, Prof Tony Pitcher presented in detail the application of the "Monte Carlo Simulation Programme" to be used in the final analysis to calculate the level of IUU fishing in the waters of the Arafura Sea, and also an approximate method based on a framework from N. Willoughby, which agreed in large measure with independent approximate estimates from the BRKP team.

The final Workshop was also held in Jakarta and presented the final output from this analysis of IUU Fishing in the Arafura Sea, and was attended by stakeholders including the Head of the National Committee for Fisheries Stock Assessment, Minister Advisor, Ministry of Marine Affaires and Fisheries, Directors General from the Department of Marine Affaires and Fisheries, the Director for Fisheries Resources from the

Directorate for Capture Fisheries, the Sub Director for Data and Statistics, The Director for Surveillance, The Head of the Research Centers within the BRKP, representatives of Bogor Agricultural Universities, the Heads of Provincial Fisheries and Marine Service from Papua, Maluku, North Sulawesi and West Kalimantan, the Fisheries Industry Association and researchers from the PRPT.

The material presented was generally acceptable to the stakeholders attending the meeting, who all agreed that it there needs to be a systematic improvement in the collection of fisheries statistics. Several suggestions were made by those attending regarding actions which could be taken to further clarify IUU Fishing. The Chairman of the Agency for Marine and Fisheries Research presented the results of the final workshop in front of the Minister for Marine Affaires and Fisheries who expressed his sincere appreciation of this study.

4
RESULTS

4.1 Influence Table

A number of elements which can influence the rise or fall in IUU fishing activity levels (incentives and disincentives) have been identified and are shown in Table 1 (see Appendices).

4.2 Anchor Points

Shrimp trawl: as one of the "Anchor points", research has shown that for the period from 1982 to 2002 the ratio of shrimp to fish in the catch varied from 1 : 5 to 1 : 19 with an average of 1 : 12. Estimates of the average shrimp catch per vessel per-year for the period 1991 to 2002 were obtained from the records of catch per vessel peryear over the period 1991-2002 (Hernowo, 2003) covering around 1033 shrimp trawl vessels belonging to HPPI members (HPPI is the Association of Indonesian Fisheries Companies) after being corrected using the estimated total "catch per unit of effort" for each five year period from 1976 to 2005 which was obtained from ex shrimp trawler captains. From this calculation, the total catch per Shrimp Trawl unit of effort for each of the periods 1976-1980, 1986-1990, 1991-1995, 1996-2000 and 2001-2005 was, in that order: 1085 tons, 837 tons, 679 tons, 644 tons and 581 tons.

Fish trawl: the "Anchor point" used was the "catch per vessel per trip", with a value of 210 tons based on the catch of 144 catcher (fishing) vessels which made transshipments to carrier vessels in 2000 (Badrudin *et al.,* 2004a).

Bottom long line: the "Anchor point" used was catch per boat per day, with a value of 643 kg obtained from 12 observers who were placed on "bottom long line" vessels during the years of 2001 and 2002 (Badrudin *et al.,* 2004), giving a figure of 56.7 tons total catch per boat per year.

4.3 Estimates of "Illegal", "Misreported", "Discards" and "Total Extraction"

The illegal, unrecorded/misreported and discarded catch components are in general outside of the system for collecting fisheries statistics, and require a systematic estimation system using a proven method.

In this section the end results of the "Anchor Point" calculation process taking into account the "Influence Factors" are presented in the form of "Total Extraction" or base line catch, with annual and five-yearly estimates of the value of the IUU (discarded, misreported and illegal catch) components for each fishing gear (Shrimp trawl, Fish trawl and Bottom long line).

4.3.1 Fish Trawls

Fish trawl or fish net vessels have been operating in the Arafura Sea since 1986, however landing data is only available from 2004, and efforts to collect statistic data only began in 2004.

The percentage (%) of annual fish trawl catch consisting of discards, misreported and illegal catch as well as the total resources taken (Total extraction) can be seen inAppendix Table 3, whereas five-yearly figures are shown in Table 2 and Figure 6 below.

Time Period		1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Discards	Upper		19.08	18.91	15.15	12.60	12.90
	Mid		16.59	16.44	13.17	10.96	11.22
	Lower		14.93	14.80	11.85	9.86	10.09
Misreported	Upper		78.01	78.34	79.52	25.68	21.43
	Mid		67.83	68.12	69.15	22.33	18.64
	Lower		61.05	61.31	62.23	20.10	16.78
Illegal	Upper		17.91	17.75	20.33	76.72	66.88
	Mid		15.58	15.44	17.68	66.71	58.15
	Lower		14.02	13.89	15.91	60.04	52.34

Table 2.
Five yearly percentages of discarded, misreported and illegal fish trawl catch

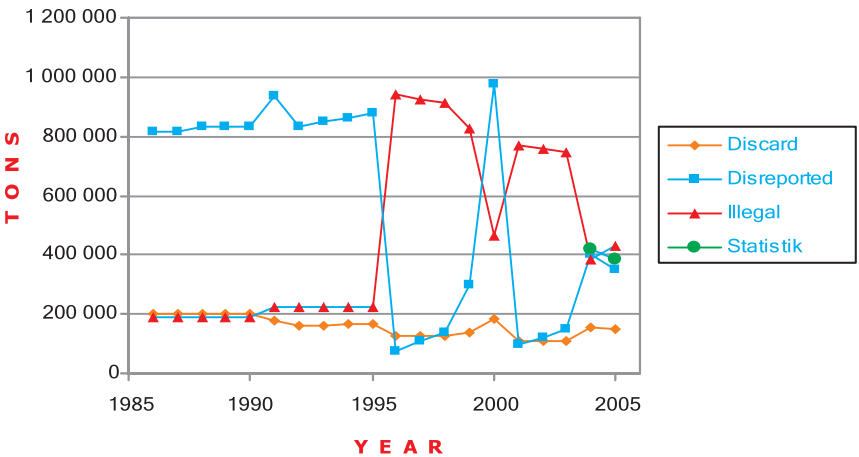


Figure 6.
Illegal, misreported and discarded catch (tons) from Fish Trawls in the Arafura Sea.

The annual estimates of legal and illegal catch for the 1986 to 2005 are shown in Appendix Table 3.

No data relating to fish trawls was recorded in official fisheries statistics until 2004, so that before that time all of the estimated catch can be classified as “illegal”, “misreported” or “discards”.

Almost all of the catch from fish trawls tends to be used, and over the 20 year period the average percentage of discards ranged from 10 – 16%. The majority of the catch consists of “misreported” catch, which in 1991 to 1995 reached a level of 70% with a volume of around 800,000 tons from vessels which held licenses but were not recorded in Indonesian fisheries statistics. There was a sharp fall in the following years to around 100,000 tons (7%), followed by an increase to reach a level of around 400,000 tons (30%) in 2005.

Illegal catch was below 17% or around 200,000 tons until 1995, then rose drastically in 1996 to form 82% (950 000 tons) then fell again in 2000 to around 450,000 tons, however in the following three years rose again to around 790,000 tons (74%). In 2004 and 2005 illegal catch fell again to around 400,000 tons or 30%. The catch from Fish Trawls began to be recorded in official statistics in 2004, with a recorded catch of 400,000 tons, around 30% (of total catch). It is likely that this development caused the decline in illegal catch to around 30% (400,000 tons).

4.3.2 Shrimp Trawls

The shrimp trawl fishery began to develop in the 1970s with joint ventures between Japanese and Indonesian companies. The main target of this fishery is shrimp, so that the Bycatch, consisting mainly of fish, tends to be discarded. The annual percentages of Shrimp Trawl discards, misreported catch, illegal catch and the Total extraction values can be seen in Appendix Table 2. The five-yearly figures are shown in Table 3 and Figure 7 below.

Time Period		1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Discards	Upper	82.80	80.50	78.20	71.94	50.83	48.68
	Mid	72.00	70.00	68.00	62.56	44.20	42.33
	Lower	64.80	63.00	61.20	56.30	39.78	38.10
Misreported	Upper	12.65	21.83	26.68	13.42	18.56	24.46
	Mid	11.00	18.98	23.20	11.67	16.14	21.27
	Lower	9.90	17.08	20.88	10.50	14.53	19.14
Illegal	Upper	30.00	25.00	25.00	25.00	25.00	25.00
	Mid	10.00	7.50	5.00	5.00	5.00	5.00
	Lower	5.00	5.00	5.00	5.00	5.00	5.00

Table 3.
Five-yearly percentages for discarded, misreported and illegal Shrimp Trawl catch

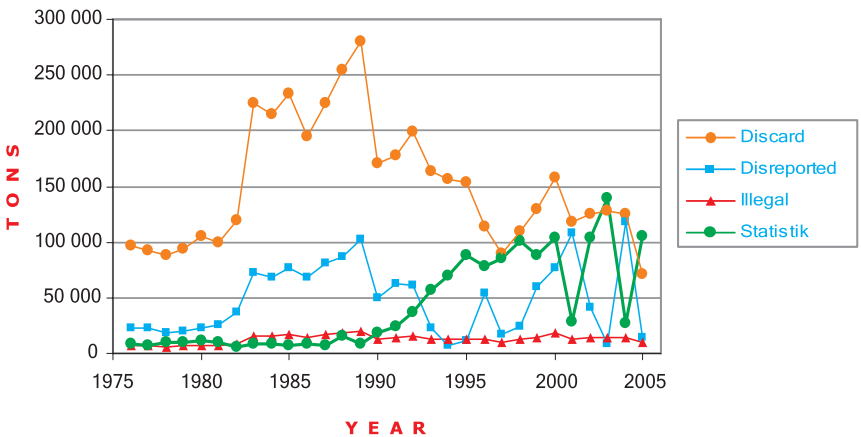


Figure 7.
Illegal, misreported and discarded Shrimp Trawl catch in the Arafura Sea.

Figure 7 below shows that over the period from 1976 to 1988, ”discards” and ”misreported” catch increased significantly from 100,000 tons and 25,000 tons in 1976 to 275,000 tons and 100,000 tons respectively in 1988 even though there was no significant increase in the percentages. This increase seems to be caused by increases in the fishing grounds (area) and number of fishing vessels. From 1999 onwards, the “discarded” and “misreported” catch was variable but with an overall downward trend.

The “illegal” catch was relatively constant at around 5% (10,000 tons), and indeed the incidence of illegal fishing activities is lower in the shrimp trawl fishery than in the fish trawl and bottom long line fisheries. The catch percentage recorded in fisheries statistics shows a marked increase, reaching around 50% of the total legal and illegal catch (100,000 tons) in 2005 compared with 10,000 tons (6%} in 1976.

4.3.3 Bottom Long Lines

The target of the Bottom long line fishery is medium to large demersal fish such as snapper and sharks, and the catch is never thrown away so that it can be said that there are no “discards” in this fishery.

The industrial bottom long line fleet mainly consists of vessels from outside the Provinces of Maluku and Papua who enter the Arafura Sea with “Andon” status (fishermen fishing in a Province other than the Province in which they live). The catch is generally taken directly to the home ports (Purbolinggo and Tanjung Balai Karimun) for immediate processing. Moreover, the tonnage of bottom line vessels based in Maluku and Papua is generally below 5 GT, and most do not have fishing licences. There are many of these small vessels spread over a wide area so that it is hard to keep a record of their catch.

These factors result in a very high level of unreported (misreported) catch which was constantly above 90% over the period from 1976 to 2005, however in terms of weight this component exhibited a downward trend

from 160,000 tons in 1976 to 79,000 tons in 2005, this is thought to be due to a reduction in total catch resulting from a decline in (target) resources.

The annual percentages for discards, misreported and illegal catch and the Total extraction for the Bottom long line fishery are given in full in Appendix Table 4. The five yearly figures can be seen in Table 4 and Figure 8 below.

Time Period		1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Discards	Upper	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
	Mid	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
	Lower	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
Misreported	Upper	100.00	100.00	100.00	100.00	100.00	100.00
	Mid	98.06	97.50	96.84	95.98	95.25	92.69
	Lower	50.00	50.00	50.00	50.00	50.00	75.00
Illegal	Upper	5.00	5.00	5.00	5.00	5.00	5.00
	Mid	1.50	1.50	1.50	1.50	1.50	5.00
	Lower	0.50	0.50	0.50	0.50	0.50	0.50

Table 4.
Five yearly percentages of discarded, misreported and illegal Bottom long line catch

The "illegal" component is due to the fact that a number of high-value species such as "Kurisi Bali" (Goldband Snapper = *Pristipomoides* spp) are sent directly to markets in Singapore without going through official procedures, and in addition a number of vessels with "drift long line" licenses actually catch fish using "set bottom long lines".

The average yearly volume is around 7,000 tons or 7% of the total catch. The high level of unreported catch results in fairly stable catches being recorded in fisheries statistics with a very low percentage of around 5% (of total catch) and an average annual volume below 5 tons.

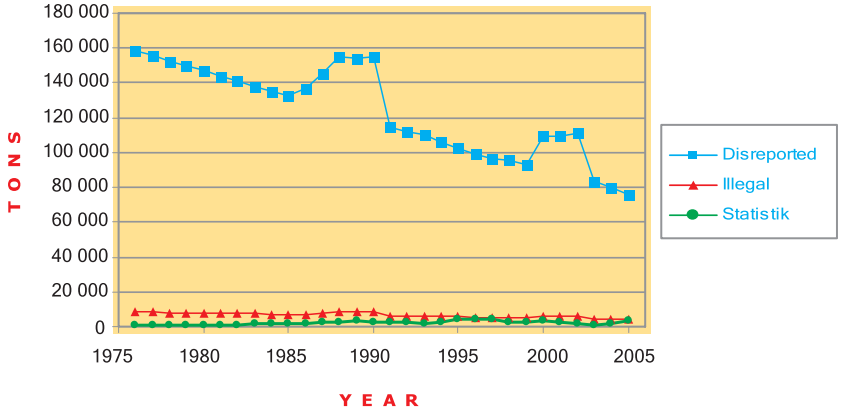


Figure 8.
Illegal, misreported and discarded catch in the Arafura Sea Bottom long line fishery

4.3.4 The three gears combined (Shrimp Trawl, Fish trawl and Bottom Long Line)

Overall, there was an improvement in fisheries statistics as in 2005 the percentage of the combined total catch recorded in fisheries statistics reached 30% (500,000 tons) compared with 3% (10,000 tons) in 1976.

The combined annual figures for discarded, unreported (misreported) and illegal catch as well as total extraction (in tons) can be seen in Appendix Table 5. The five-yearly figures are shown in Table 5 and Figure 9 below.

YEAR	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Total IUU (ton)	284,732	868,328	1,684,222	587,758	1,553,307	1,274,553
Hi	45,884	152,278	285,064	252,097	240,989	179,997
Lo	91,229	134,872	209,838	185,361	177,662	112,962
Baseline Stat	9,945	9,318	14,468	57,907	94,919	484,620

Table 5.
Five yearly percentages for discarded, misreported and illegal catch for the three gears combined

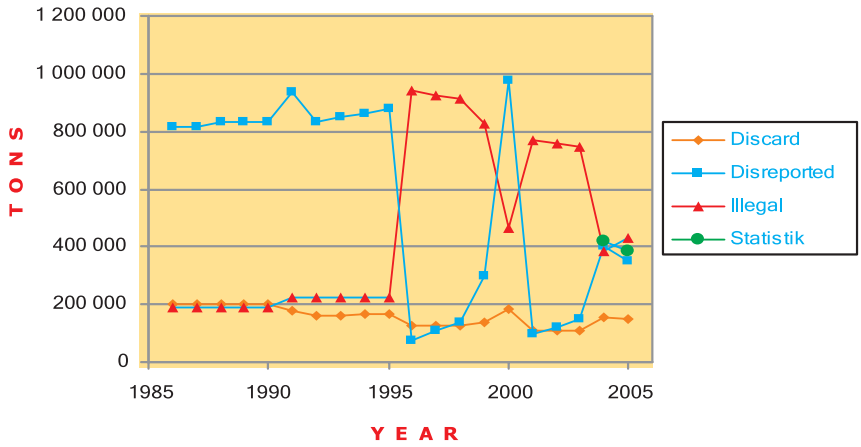


Figure 9.
Combined Illegal, misreported and discarded catch in the Arafura Sea for all three gears.

The variations in the "discards" component follow the trends for Shrimp Trawls, with a downward trend beginning in 1988 (falling from 500,000 tons to 200,000 tons in 2005). The shrimp trawl fleet made a significant contribution to reducing the levels of "discards", with an increased use of bycatch as the Arafura Sea shrimp stocks continue to decline.

The "misreported" component has been reduced compared to previous years, with a significant decrease from 1,000,000 tons in 1995 to 450,000 tons in 2005. The percentage of "misreported" catch is mainly determined by the Fish Trawl fishery, however the bottom long line fishery also makes a significant contribution.

There is also a downward trend in the "Illegal" component which fell from 950,000 tons in 1996 to 410,000 tons in 2005. The Fish Trawl fishery has a very considerable effect on the "Illegal" catch component.

Table 5. Five yearly percentages for discarded, misreported and illegal catch for the three gears combined

4.4 Monte Carlo Simulation

The Monte Carlo Simulation is applied to the five-yearly figures for estimation of "discarded", "misreported" and "illegal" catch for each fishing gear and for the three fishing gears combined. The results of the simulation are shown in the four Figures 10-13 below.

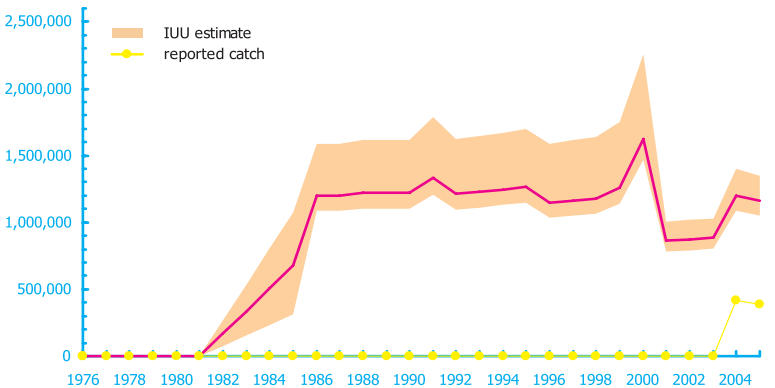


Figure 10.
Results of the Monte Carlo Simulation for IUU Fishing in the Fishnet/trawl fishery compared with reported catch (statistics).

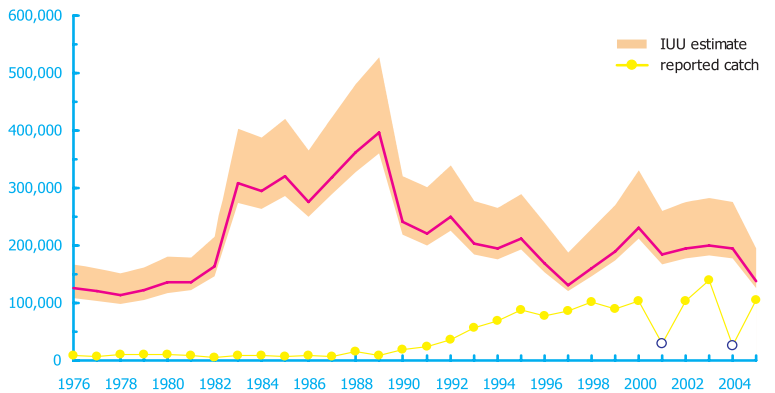


Figure 11.
Results of the Monte Carlo Simulation for IUU Fishing in the Shrimp Trawl fishery compared with recorded catch (statistics)

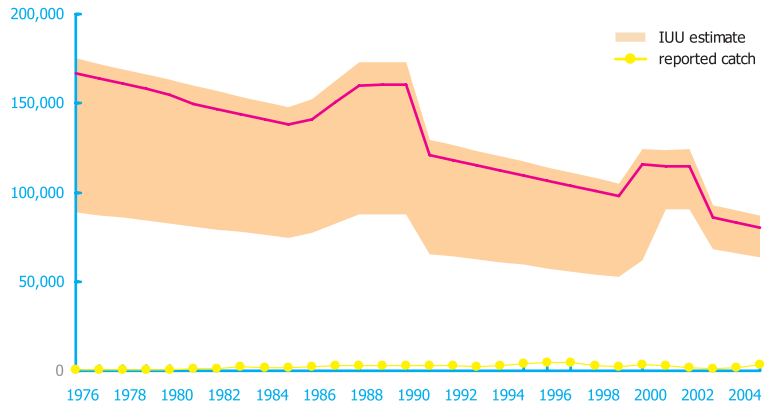


Figure 12.
Results of the Monte Carlo Simulation for IUU Fishing in the Bottom Long Line fishery compared with recorded catch (statistics)

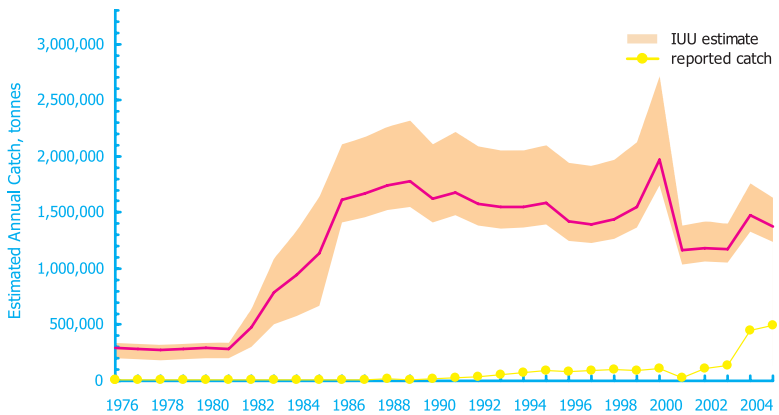


Figure 13.
Results of the Monte Carlo Simulation for IUU Fishing compared with recorded catch (statistics) for the three fisheries combined

200 MILLION PEOPLE EARN ALL OR PART OF THEIR INCOME FROM FISHING-RELATED ACTIVITIES

5 DISCUSSION

5.1 Differences between Fisheries Statistics Data and the Estimated Value of IUU Fishing in the Arafura Sea

The estimates provided from analyzing each gear separately and for the three gears combined show that there is a decreasing trend over time in the “Illegal”, “Misreported”, and “Discarded” catch components, while on the other hand the Indonesian fisheries statistics show an increase in fisheries catch.

Over the period 1996 – 2000 the average annual value of “Illegal”, “Misreported” and Discarded” catch from the three fishing gears combined were respectively 833,254 tons, 464,633 tons and 259,594 tons. Over the period 2001 to 2005, these values declined to 663,626 tons, 373,827 tons and 240,639 tons respectively, or in other words the average total annual IUU fishing volume fell from 1,652,401 tons during the period 1996-2000 to 1,494,809 tons during the period 2001 – 2005.

The main causes of the high level of “Illegal”, “Misreported” and "Discarded” catch in the Arafura Sea are:

- The position of the Arafura Sea which is bordered by several Nations and by the high seas which provides great opportunities for foreign vessels.

- The licensing system and mechanisms for implementation which need to be improved.
- Limited equipment and operational resources for surveillance.
- The low level of competency and limited numbers of staff in the field of statistics and limited availability of supporting equipment and operational resources.

Over the same two periods, the catch levels recorded in official fisheries statistics rose from 94,919 tons over the period 1996 – 2000 to 243,713 tons over the period 2001 – 2005. The decline in IUU catch levels and the increase in recorded catch in fisheries statistics began around the year 2000, and was caused by a number of policy changes concerning the concepts of Monitoring, Controlling and Surveillance, including:

1. Improvements to the quality and scope of the system and mechanisms for statistical data management (database management).
2. The implementation of new fisheries policies especially those related to the licensing and surveillance systems.
3. Increased resources allocated for surveillance and a greater emphasis on “law enforcement”

Although there has been some success in reducing “Illegal”, “Misreported” and “Discarded” catch, the volume of these components is still considerable and it is obvious that this will have negative effects on the management of fisheries resources in the Arafura Sea. The ideal condition is for all catch and fishing effort in a given area to be recorded in fisheries statistics, and for the “Illegal”, “Misreported” and “Discarded" catch to be as small as possible or even completely eliminated.

5.2 Economic and Ecological Losses

Economic Losses

It is self-evident that IUU fishing activities cause economic losses, from the catch which is not made use of (discarded) that which is illegal, and that which is not reported (misreported). Table 6 below shows the average annual estimates for total IUU Fishing catch taken from the Arafura Sea.

YEAR	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
High	330,616	1,020,606	1,969,286	1,839,855	1,794,296	1,454,550
IUU	284,732	868,328	1,684,222	1,587,758	1,553,307	1,274,553
Low	193,503	733,456	1,474,384	1,402,397	1,375,645	1,161,591

Table 6.
Estimation of average IUU Fishing catch (Tons) in the Arafura Sea showing maximum and minimum values.

Hence, the average losses from 1991 to 2005 are estimated at around Rp. 11 trillion to Rp. 17 trillion based on an assumed value of US $ 1 per kilogram of fish.

Ecological Losses

IUU Fishing in the Arafura Sea has resulted in uncontrolled exploitation which has had substantial negative effects on the resources and environment of this sea area.

Change in the composition of organisms in a certain waters provide some reaction from some disturbing effects on the community. These can be interpreted as the effort of the community in maintaining eqillibrium condition. This phenomena were often expressed in the form of inter-specific interaction occurred within the community or in the form of species replacement.

In the Arafura Sea, there has been change in species composition with regard to both predatory fish and shrimps. As an indicator of this phenomenon is the continuous decline in the catch rate for large predatory fish and penaeid shrimps (Figure14 and 15).

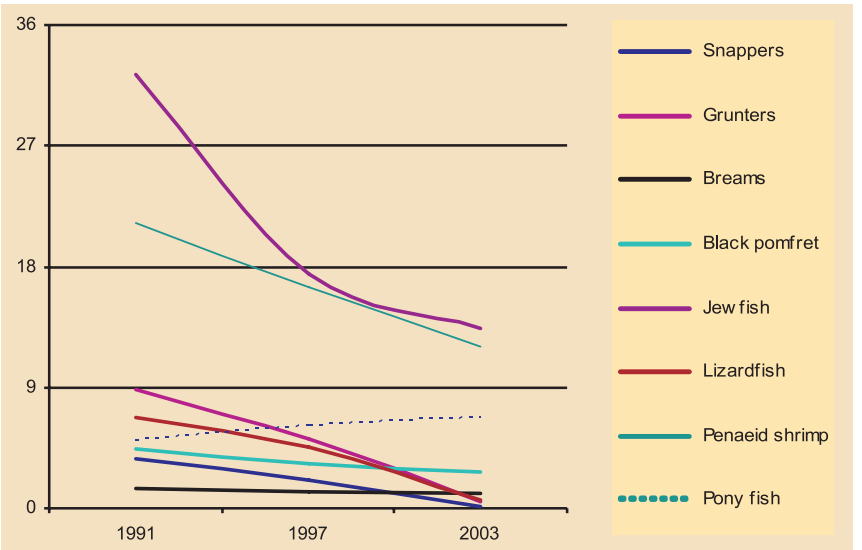


Figure 14.
Trend of catch rate (%) of demersal fish in the Arafura Sea

Analysis of species composition of caught fish for 1991, 1997 and 2003 showed that there were family variations on some major groups. There were sharp declines for the Sciaenidae group, which were the dominant species group caught in the Arafura Sea. This has been observed for other family groups from Pomadasydae, Synodontidae, Lutjanidae, Nemipteridae and Formionidae.

On the other hand, there were signs of increasing numbers of fish caught from the family of small Leiognathidae and Mullidae. Smaller fish (TL<15 cm) have also dominated the composition of fish caught. The

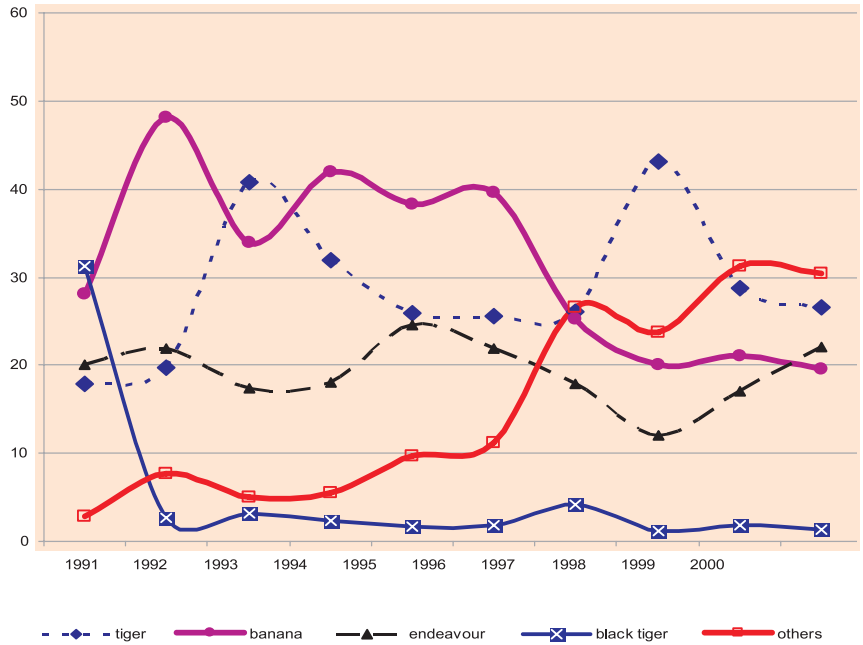


Figure 15.
Annual changes in catch compositions of the Arafura Sea shrimp fisheries in 1991-2000 (Source: Badrudin *et al.*,).

number of swimming crabs and squids also increased in fish caught in the Arafura Sea

This phenomenon has also occurred in the Arafura Sea shrimp resources, where the five group of shrimps including tiger shrimp (*Penaeus semisulcatus*), banana shrimp (*P. merguiensis*), endeavours (*Metapenaeus spp.*), black tiger (*P. monodon*), the group of brown shrimp (*Metapenaeopsis spp.*), and other some small-sized shrimp showed some difference reactions againts fishing pressures. This was happened to the annual yield of banana shrimp and black tiger during the period of 1991-2000 with the decreasing trend, while the tiger endeavour shrimp seems to be resilience as reflected by the ever increasing trend, eventhough within

the last three year this trend of production was sharply decreased. If the trend of banana and tiger shrimp production was decreasing, the trend of small sizes shrimp during the 1991-2000 was significantly increasing (Figure 14). The economic value of the small size shrimp is certainly lower compare with large size shrimp of banana and tiger shrimp.

As a result of the uncontrolled use of trawl fishing gear, the sea bottom has probably suffered considerable damage, made even worse by the disposal of large quantities of unwanted catch. The often imperfect process of decomposition of this discarded bycatch tends to cause a decrease in dissolved oxygen, for example in the Membramo River estuary in the central-western coast of Papua, the level of dissolved oxygen reached nil.

5.3 Implications for National Fisheries Statistics and Fisheries Resource Management

The National Fisheries Statistics in their true form should be a collection of information which can present a picture of the real condition of the fisheries sector past and present, and can be used as a tool for making predictions and planning the future development of the fisheries sector.

In the FAO Code of Conduct for Responsible Fisheries it is stated that each Country must ensure that the fisheries catch and effort statistics are complete, reliable, collected on-time and made available in accordance with current international practices and standards and sufficiently detailed in order to permit valid analysis. This data should be kept up-to-date in a well-ordered fashion and verified using a system which is deemed suitable for this purpose (FAO, 1995). At present, Indonesia's estimated compliance with the FAO Code is not high (for IUU: 0-20% compliance score; overall: 26-32% compliance score, ranked 40/53 countries, Pitcher *et al.* 2006).

In reality in the case of the Arafura Sea fisheries, comparison between the estimates of total IUU fishing catches and the data recorded and reported in official statistics reveals extremely large differences. It can be

seen that fisheries production recorded in the statistics is only between 0.9% - 19.4% of the true values (Appendix Table 2).

Several other studies have recently been published that employ the "anchor points and influence table" approach used here (Chile: Kalikoski and Pitcher *in prep*; Eritrea: Tesfamichael and Pitcher 2007; western Canada: Ainsworth and Pitcher 2005; Iceland and Morocco: Pitcher *et al.* 2002). Our Arafura Sea results are among the highest levels of IUU reported world-wide, and are comparable with values obtained from alternative methods of estimating Indonesian IUU (e.g., Buchary *et al.* 2008; Willoughby *et al.* 1999), but are higher than preliminary values from other areas of Indonesia (Raja Ampat, Indonesia, Varkey *et al.* 2008; Waigeo, Indonesia, Bailey *et al.* 2007; Bali Strait, Buchary *in prep.*).

This analysis demonstrates very clearly that the official statistics for the Arafura Sea fisheries are not in line with reality as regards both catch and effort in this fishery so that they do not provide a true picture of the real condition of this fishery. Fisheries management can succeed if it is supported by the availability of accurate data and information, however conversely, accurate data can be obtained if the fishery is well managed. It is thought that the improvements made in the way data for fisheries statistics are collected has had a positive effect in increasing the percentage of total catch which is recorded in fisheries statistics. Since 2001, the recorded catch given in fisheries statistics has increased sharply from 25,000 tons to 500,000 tons in 2005.

The recording of Fish Trawl catch since 2004 has enabled fisheries statistics to give a better picture of the real catch taken from the Arafura Sea. The high rate of occurrence of IUU Fishing in the Arafura Sea is an indication of ongoing poor fisheries management where the concepts of Monitoring, Controlling and Surveillance (MCS) are not implemented as they should be. The fisheries statistics for catch volume and fishing effort do not represent the real "total extraction" or the "actual effort", and therefore cannot be used to undertake meaningful stock assessment, although stock assessment is an important component of fisheries management.

5.4 RECOMMENDATIONS

Revitalisation of MCS Programme Implementation :

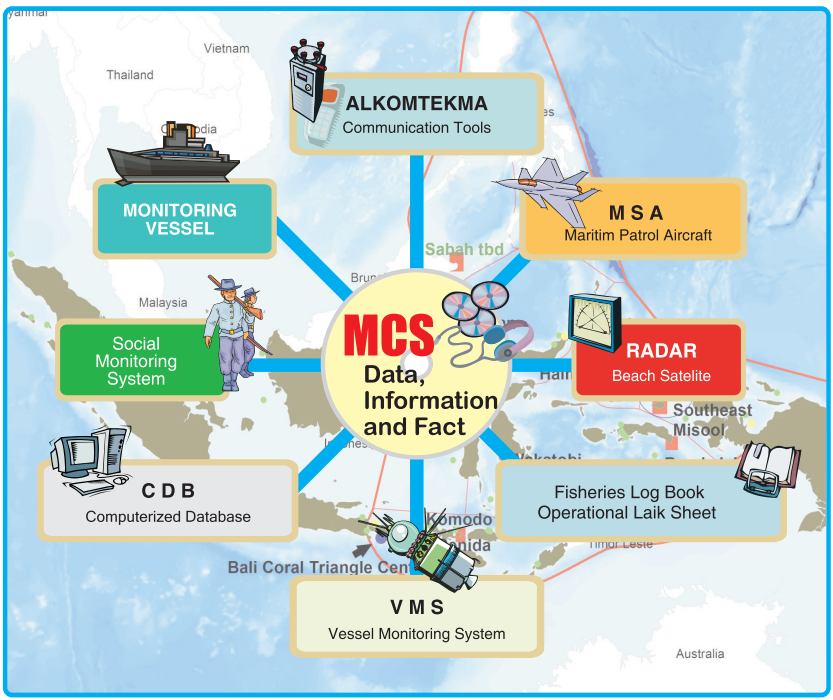
 Monitoring	improvement of data management including data collecting, analysis and storage, including increasing human resources in terms of quality and quantity, as well as infrastructure, equipment and supplies both at national and regional levels. The log book and observer programmed needs to be better organized and put in place as a matter of urgency.
 Controlling	Strengthening of the system and mechanisms for licensing can support the log book and observer programmers in the Monitoring component. National and regional licensing needs to be implemented under a common policy and must be "on line"
 Surveillance	Coordination between officers of the different authorities involved in surveillance needs to be greatly improved, in addition to increasing operational infrastructure, equipment and supplies and improving social security benefits for field staff. Law Enforcement need to be well and truly implemented.

Some more concrete actions which can be taken are :

- The statistics system needs to be free from data manipulation activities such as merely recording that the annual production targets have been reached.
- Fisheries regulations should be more specific in line with the data requirements of fishers and penalties actually imposed for infractions must be more severe.
- A policy of "no data, no license" should be implemented as a matter of urgency, through regulations from the ministerial regulation level or above, such as government regulation. This would mean that companies wishing to renew their fishing license would have to append a report containing data such as a 'log book', without which their application would be refused.

- Verification of reported fisheries catch must become a key component of overall improvements to the system. Observers can play an important role in this verification.
- The vested interest of international bodies and donors in the improvement of statistical data should be taken advantage of. For example, Australia is interested in improving Indonesian fisheries statistics, especially those relating to shared fish stocks.

Figure 16.
Revitalisation of MCS Programme Implementation



REFERENCES

Ainsworth, C.H. and Pitcher, T.J. 2005. Estimating Illegal, Unreported and Unregulated Catch in British Columbia's Marine Fisheries. Fisheries Research 75: 40– 55.

Anonymous., 2001. National forum on Illegal, Unreported and Unregulated Fishing (IUU) activities in Indonesian waters. CMPOCRC Univ. of Wollongong-ACIAR. Jakarta. Indonesia. 40p.

Anonymous., 2007. Perizinan kapal di Laut Arafura. Direktorat Pelayanan Usaha Penangkapan Ikan. Direktorat Jenderal Perikanan Tangkap. Presentasi dalam rangka 'Study on the implications of Illegal, Unreported and Unregulated (IUU) Fishing in the Arafura Sea for Indonesian fishery statistics'. PRPT, 23 Mei 2007. (Unpublished)

Badrudin, B. Sumiono dan N. Wirdaningsih., 2002. Laju tangkap, hasil tangkapan maksimum (MSY) dan upaya optimum perikanan udang di perairan Laut Arafura. JPPI. Vol. 8(4):23-30.

Badrudin, B. Sumiono and S. Nurhakim., 2004. Hook Rates and Compositions of Bottom Longline Catches in the waters of the Arafura Sea. Indonesian Fish. Res. Jour. AMFR. MMAF. Vol. 10. No. 1. (2004): 9-14.

Badrudin, S. Nurhakim and B. Fegan., 2004a. Catch Rate and Catch Composition of Trawl-Fish Net in the Arafura Sea. Indonesian Fish. Res. Jour. AMFR. MMAF. Vol. 10. No. 1-(2004): 1-7.

Bailey, M., Rotinsulu, C., and Sumaila, U.R. 2007. The migrant anchovy fishery in Kabui Bay, Raja Ampat, Indonesia: Catch, profitability, and income distribution. Marine Policy: doi:10.1016/j.marpol.2007.09.01.

Bambang Sumiono dan Ngurah N. Wiadnyana., 2006. Hasil tangkap sampingan (by catch) pada penangkapan udang komersial di Laut Arafura, in Fuad Cholik, S. Moeslim, E. Sri Heruwati, T Ahmad, and A. Jauzi. Masyarakat Perikanan Nusantara, 2006, 137-152.

Buchary, E.A., Pitcher, T.J. and Willoughby, N. (*in prep.*) Indonesia's non-recorded fish problem revisited.

Delgado, C., Wada, N., Rosegrant, M., Meijer, S. and Ahmed, M. 2003. Fish to 2020: supply and demand in changing global markets. International Food Policy Research Institute (IFPRI), Washington, DC, USA. 232pp.

FAO 1995. The Code of Conduct for Responsible Fisheries. FAO-UN. 41p. FAO 2004. Future prospects for fish and fishery products: medium-term projections to the years 2010 and 2015. FAO-UN, Rome. Fisheries Circular FIDI/972-1.

Gatra Magazine 2007

Gillett, R., 1996. Marine fisheries resources and management in Indonesia with emphasis on the Extended Economic Zone. Workshop Presentation Paper No. 1. FAO Project TCP/INS/4553. Strengthening Marine Fisheries Development in Indonesia. 35 p.

Hernowo, S., 2003, Produktifitas kapal penangkap dengan pukat udang di Laut Arafura,GAPPINDO-HPPI, Jakarta, Juli 2003.

Kalikoski, D. and Pitcher, T.J. Estimating Illegal And Unreported Fishery Catches *From Chile. (submitted)*

Naamin, N dan B. Sumiono, 1983. Hasil sampingan (by-catch) pada penangkapan udang di perairan Laut Arafura dan sekitarnya. Laporan LPPL No. 24/1982. BPPL, Jakarta: 45-55.

Pauly, D., Christensen, V., Dalsgaaard, J., Froese, R., and Torres, F. Jnr 1998. Fishing down marine food webs. Science 279: 860-863.

Pauly, D., Christensen, V., Guénette, S., Pitcher, T.J., Sumaila, U.R., Walters, C.J., Watson, R. and Zeller, D. 2002. Towards sustainability in world fisheries. Nature 418: 689-695.

Pitcher, T.J., Buchary, E.A. and Pramod, G. 2006. An Estimation of Compliance of the Fisheries of Indonesia with Article 7 (Fisheries Management) of the UN Code of Conduct for Responsible Fishing. 37 pages in Pitcher, T.J., Kalikoski, D. and Pramod, G. (eds) Evaluations of Compliance with the UN Code of Conduct for Responsible Fisheries. Fisheries Centre Research Reports 14(2): 1191pp.

Pitcher, T.J., Watson, R., Forrest, R., Valtýsson, H. and Guénette, S. 2002. Estimating Illegal and Unreported Catches From Marine Ecosystems: A Basis For Change. Fish and Fisheries 3: 317-339.

Purwanto., 2003. Struktur usaha dan armada penangkapan di Laut Arafura. Dit.Jend.Perik. Tangkap. 5 p. (Unpublished).

Ramm, D.C., 1995. Collaborative research and management – the key to the sustainable management of groundfish resources in the Timor and Arafura Seas. Paper presented at the conference'Neighbour at sea – the shared interest of Australia and Indonesia in the Timor and Arafura Seas'. Darwin, November 1995. (Unpublished).

Tan, C.K., R.Gillett, J. Sciortino and M. Shawyer., 1996. Strengthening Marine Fisheries Development in Indonesia. – Final Report. FAO Project TCP INS/4553. Strengthening Marine Fisheries Development in Indonesia. FAO Rome. 82 p.

Tesfamichael, D. and Pitcher, T.J. 2007. Estimating the unreported catch of Eritrean Red Sea fisheries. Af. J. Marine Science 29(1): 55-63.

Unar and N. Naamin., 1984. A review of the Indonesian shrimp fisheries and their management. In J.A.Gulland and B.J.Rothschild. Penaeid shrimps – their biology and management. Fishing News Books Ltd. Pp.104-110.

Varkey, D.A., Ainsworth, C.H., Pitcher T.J. and Johanes, G. 2008. Estimating illegal and unreported catches in Raja Ampat Regency, Indonesia. Fisheries Centre Research Reports *(in press).*

Venema S.C., 1997 (Ed). Report on the INDONESIA /FAO/DANIDA Workshop on the assessment of the potential of the marine fishery resources of Indonesia. Denmark Funds in Trust. FI : GCP/INT/DEN. Report Activity No. 15. FAO-UN. Rome.

Willoughby, N., Monintja, D. and Badrudin, M. 1999. Do fisheries statistics give the full picture? Indonesia's non-recorded fish problem. Pages 163-172 in Report of the Regional Workshop on the Precautionary Approach to Fishery Management. 25-28 February, 1997, Medan Indonesia. Bay of Bengal Program, Chennai, India. BOPB/REP/82.

Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotze, H.K., Micheli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J. and Watson, R. (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314(5800): 787-790.

TABLE 1. HISTORY OF THE ARAFURA SEA FISHERIES

Summary of influences on the incentives for DISCARDS, DISREPORTED and ILLEGAL catches from the Arafura between 1976 and 2005. Arrows indicate whether the influence is expected to increase ( ) or decrease ( ) incentives to discard, misreport or fish illegally.

PERIOD	CATEGORY			
	TECHNOLOGY	REGULATION	MANAGEMENT REGIME	OTHER
1970-1975	• Exploratory commercial shrimp fishery in the Arafura Sea began , Trawl types: Stern and Double Rig Trawl > 100 GT (1970) ( ) discards, misreporting, illegal fishing			• Illegal: from Australia, during the Carpentaria Gulf off season. Up to 73 Nusantara Fish, 70 71 Australian+Japanese unlicensed vessels Up to 73 : stern rigs changed to double rigs, using smaller vessels Optimal vessel size 100-150 Gt. Taiwan, pair trawl, bottom longline
1976-1980		• Presidential Decree (Keppres) No 39/1980 ( ) discards	• Indonesian Fishery Statistics introduced ( ) discards, misreporting, illegal fishing	
1970-1975	• Presidential Decree (Keppres) No. 85/1982 Regarding the use of TEDs, BEDs Trawl type: Stern and Double Rig > 100 ( ) discards • Fishnets began to operate ( ) misreporting • Fishnet entry: Director General Suprapto, after 1982	• Law (UU) No. 5/1983 regarding the ZEEI ( ) illegal fishing • Government Regulation (PP) No.15/84 Regarding the opportunities for foreign vessels to operate within the ZEEI ( ) discards, misreporting, illegal fishing	• Report on the optimum effort and potential of the Arafura Sea was published (1982)	• Jayanti Groups started operating in the Arafura Sea ( ) discards, misreporting, illegal fishing • Assumed start date of BLL operations
1986-1990	• Trawl type Fishnet > 30 GT ( ) discards, ( ) unreported		• Licences for vessels from Taiwan, Thailand and Japan no longer issued from Darwin ( ) illegal fishing	
1991-1995		• Decree of the Minister for Agriculture (SK Mentan) regarding export via ports		• Carrier vessel from Taiwan caught in Aru. The loading records were checked. Catch of 2000 tons was from 26 vessels: trawlers, gill netters, BLL l.k.. (1994).

TABLE 1.
History of the Arafura Sea Fisheries

PERIOD	CATEGORY			
	TECHNOLOGY	REGULATION	MANAGEMENT REGIME	OTHER
1996-2000		• Decree of the Minister for Agriculture (SK Mentan) No. 995/KPTS/IK.210/9/1999 ( ) illegal, misreported catch • TAC/JTB introduced in all WPP ( ) illegal, misreported	• WPP system introduced ( ) illegal fishing, misreporting	• Conflict in Maluku (starting 1999) resulting in a movement of vessels to Kendari ( ) discards, misreporting, illegal fishing • Stock Assessment conducted in the Arafura Sea (1998)
2001-2005		• Ministerial Regulation (Permen) No 13/2005 regarding the Forum for Coordinating the Handling of Fisheries Related Criminal Prosecutions (Forum Koordinasi Penanganan Tindak Pidana di Bidang Perikanan) • Law (UU) No. 31/2004 paragraph 66 item 1 regarding Fisheries Surveillance	• Government Regulation (PP) No. 54/2002 regarding fishing businesses ( ) misreporting • Ministerial Decree (Kepmen) No. 10/2003 regarding the authority of Governors/District Heads to issue licences to vessels < 30 GT ( ) misreporting • Ministerial Decree (Kepmen) No. 12/2002 regarding the reregistration of capture fisheries businesses which caused a drastic decline in production in 2004 () discards, misreporting, illegal fishing • Ministerial Decree (Kepmen) of the year 2001 regarding reregistration of vessels Ministerial Decree (Kepmen) of 2003 regarding simplification of the licensing system Licensing system, bilateral agreement for foreign flag ships operating in the ZEEI (China & Thailand)	• Conflict in Maluku (ends 2002) resulting in movement of vessel to Kendari () discards, misreporting, illegal fishing • Stock Assessment in Arafura Sea conducted (2001, 2004) • Jayanti Groups ceased operations (2002) in the Arafura Sea () discards, misreporting, illegal fishing • Carter (Carrier?) vessels allowed, on the basis that they already have landbased facilities (Processing facilities producing pindang, a traditional type of preserved fish)

TABLE 2. ANNUAL SHRIMP TRAWL CATCH FOR THE PERIOD 1976-2005

GEAR	Time Period	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Shrimp Trawl	Upper	82.80	82.80	82.80	82.80	82.80	80.50	80.50	80.50	80.50	80.50
	Discards (%)	72.00	72.00	72.00	72.00	72.00	70.00	70.00	70.00	70.00	70.00
	Lower	64.80	64.80	64.80	64.80	64.80	63.00	63.00	63.00	63.00	63.00
	Upper	13.70	14.35	11.20	11.85	12.14	18.34	21.84	22.91	22.44	23.62
	Misreported (%)	11.91	12.48	9.74	10.31	10.56	15.95	18.99	19.92	19.51	20.54
	Lower	10.72	11.23	8.77	9.28	9.50	14.35	17.09	17.93	17.56	18.48
	Upper	30	30	30	30	30	25	25	25	25	25
	Illegal (%)	10.00	10.00	10.00	10.00	10.00	7.50	7.50	7.50	7.50	7.50
	Lower	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Baseline Catch (tons)	134,432	128,735	121,900	129,875	145,254	142,239	170,485	320,794	307,680	333,909
	Baseline Stat (%)	6.1	5.5	8.3	7.7	7.4	6.6	3.5	2.6	3.0	2.0
	Baseline Stat (tons)	8,188	7,108	10,065	9,991	10,809	9,317	5,989	8,272	9,186	6,552.0

GEAR	Time Period	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Shrimp Trawl	Upper	78.20	78.20	78.20	78.20	78.20	73.31	73.31	73.31	73.31	66.47
	Discards (%)	68.00	68.00	68.00	68.00	68.00	63.75	63.75	63.75	63.75	57.80
	Lower	61.20	61.20	61.20	61.20	61.20	57.38	57.38	57.38	57.38	52.02
	Upper	27.39	28.36	26.44	28.56	22.67	26.07	22.39	10.48	3.17	4.95
	Misreported (%)	23.82	24.66	22.99	24.83	19.71	22.67	19.47	9.12	2.76	4.31
	Lower	21.43	22.19	20.69	22.35	17.74	20.41	17.53	8.20	2.48	3.88
	Upper	25	25	25	25	25	25	25	25	25	25
	Illegal (%)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Lower	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Baseline Catch(tons)	285,456	330,250	375,045	411,056	250,323	278,051	312,985	255,949	244,542	266,643
	Baseline Stat (%)	3.2	2.3	4.0	2.2	7.3	8.6	11.8	22.1	28.5	32.9
	Baseline Stat (tons)	9,089.0	7,738.0	15,045.0	8,917.0	18,249.0	23,846.0	36,861.0	56,652.0	69,669.0	87,708.0

GEAR	Time Period	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Shrimp Trawl	Upper	50.83	50.83	50.83	50.83	50.83	50.70	50.70	50.70	50.70	40.58
	Discards (%)	44.20	44.20	44.20	44. 20	44.20	44.09	44.09	44.09	44.09	35.29
	Lower	39.78	39.78	39.78	39.78	39.78	39.68	39.68	39.68	39.68	31.76
	Upper	23.82	9.53	11.12	23.36	24.97	46.09	16.55	3.48	47.90	8.27
	Misreported (%)	20.72	8.29	9.67	20.32	21.71	40.07	14.39	3.03	41.66	7.19
	Lower	18.64	7.46	8.71	18.28	19.54	36.07	12.95	2.72	37.49	6.47
	Upper	25	25	25	25	25	25	25	25	25	25
	Illegal (%)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Lower	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Baseline Catch (tons)	258,308	201,508	246,475	291,442	355,681	268,727	284,182	291,265	284,283	201,317
	Baseline Stat (%)	30.1	42.5	41.1	30.5	29.1	10.8	36.5	47.9	9.3	52.5
	Baseline Stat (tons)	77,710.0	85,667.0	101,366.0	88,844.0	103,468.0	29,124.0	103,797.0	139,477.0	26,316.0	105,731.0

TABLE 3. ANNUAL FISH TRAWL/NET CATCH FOR THE PERIOD 1976-2005

GEAR	Time Period	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Fish Net	Upper						19	19	19	19	19
	Discards (%)						16.59	16.59	16.59	16.59	16.59
	Lower						14.93	14.93	14.93	14.93	14.93
	Upper						78	78	78	78	78
	Misreported (%)						67.83	67.83	67.83	67.83	67.83
	Lower						61.05	61.05	61.05	61.05	61.05
	Upper						18	18	18	18	18
	Illegal (%)						15.58	15.58	15.58	15.58	15.58
	Lower						14.02	14.02	14.02	14.02	14.02
	Baseline Catch (tons)						0	240240	480480	720720	960960
	Baseline Stat (%)										
	Baseline Stat (tons)										

GEAR	Time Period	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Fish Net	Upper	19	19	19	19	15	15	15	15	15	15
	Discards (%)	16.59	16.59	16.35	16.35	13.33	13.07	13.11	13.15	13.19	13.19
	Lower	14.93	14.93	14.71	14.71	12.00	11.76	11.80	11.84	11.87	11.87
	Upper	78	78	79	79	81	79	79	79	80	80
	Misreported (%)	67.83	67.83	68.31	68.31	70.00	68.60	68.83	69.05	69.26	69.26
	Lower	61.05	61.05	61.48	61.48	63.00	61.74	61.95	62.14	62.33	62.33
	Upper	18	18	18	18	19	21	21	20	20	20
	Illegal (%)	15.58	15.58	15.34	15.34	16.67	18.33	18.06	17.80	17.55	17.55
	Lower	14.02	14.02	13.81	13.81	15.00	16.50	16.26	16.02	16.02	15.79
	Baseline Catch(tons)	1,201,200	1,201,200	1, 219,680	1,219,680	1,334,025	1,213,050	1,231,001	1,248,952	1,266,903	1,266,903
	Baseline Stat (%)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d
	Baseline Stat (tons)	-	-	-	-	-	-	-	-	-	-

GEAR	Time Period	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Fish Net	Upper	12	12	12	13	13	13	13	13	13	13
	Discards (%)	10.82	10.84	10.86	10.97	11.30	11.10	11.12	11.13	11.38	11.35
	Lower	9.74	9.76	9.78	9.87	10.17	9.99	10.00	10.02	10.24	10.22
	Upper	8	11	14	27	69	11	14	17	34	30
	Misreported (%)	6.74	9.35	11.89	23.61	60.06	9.89	12.40	14.85	29.56	26.50
	Lower	6.07	8.42	10.70	21.25	54.05	8.90	11.16	13.36	26.60	23.85
	Upper	95	92	89	75	33	91	88	85	33	38
	Illegal (%)	82.44	79.81	77.24	65.42	28.64	79.01	76.48	74.02	28.32	32.93
	Lower	74.20	71.82	69.52	58.88	25.77	71.11	68.83	66.62	25.49	29.64
	Baseline Catch (tons)	1,144,722	1,161,508	1,178,293	1,262,520	1,623,510	976,625	990,613	1,004,601	1,362,375	1,315,125
	Baseline Stat (%)	n.d	n.d	n.d	n.d	n.d	n.d	n.d	n.d	30.74	29.21
	Baseline Stat (tons)	-	-	-	-	-	-	-	-	418,824	384,198

TABLE 4. ANNUAL BOTTOM LONG LINE CATCH FOR THE PERIOD 1976-2005

GEAR	Time Period	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
BLL	Discards(%)	-	-	-	-	-	-	-	-	-	-
	Upper	100	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Misreported (%)	98.2	98.09	98.02	98.00	97.97	97.91	97. 72	97.10	97.41	97.38
	Lower	50	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	Upper	5	5	5	5	5	5	5	5	5	5
	Illegal (%)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	Lower	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Baseline Catch (tons)	167,257	164,352	161,448	158,544	155,640	152,736	149,831	146,927	144,023	141,119
	Baseline Stat (%)	0.3	0.4	0.5	0.5	0.5	0.6	0.8	1.4	1.1	1.1
	Baseline Stat (tons)	495	680	772	796	821	904	1,165	2,056	1,563	1,584

GEAR	Time Period	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
BLL	Discards(%)	-	-	-	-	-	-	-	-	-	-
	Upper	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Misreported (%)	97.11	96.80	96.82	96.62	96.86	96.09	96.18	96.70	95.94	94.97
	Lower	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
	Upper	5	5	5	5	5	5	5	5	5	5
	Illegal (%)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
	Lower	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Baseline Catch (tons)	146,039	155,863	165,686	165,805	165,805	123,694	120,789	117,885	114,981	112,077
	Baseline Stat (%)	1.4	1.7	1.7	1.9	1.6	2.4	2. 3	1.8	2.6	3.5
	Baseline Stat (tons)	2,023	2,648	2,785	3,120	2,724	2,978	2,801	2,120	2,947	3,951

GEAR	Time Period	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BLL	Discards(%)	-	-	-	-	-	-	-	-	-	-
	Upper	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Misreported (%)	94.29	94.32	95.77	96.13	95.72	92.54	93.63	93.60	92.73	90.95
	Lower	50.00	50.00	50.00	50.00	50.00	75.00	75.00	75.00	75.00	75.00
	Upper	5	5	5	5	5	5	5	5	5	5
	Illegal (%)	1.50	1.50	1.50	1.50	1.50	5.00	5.00	5.00	5.00	5.00
	Lower	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Baseline Catch (tons)	109,173	106,269	103,364	100,460	118,772	118,428	118,686	88,843	85,939	83,035
	Baseline Stat (%)	4.2	4.2	2.7	2.4	2.8	2.5	1.4	1.4	2.3	4.1
	Baseline Stat (tons)	4,598	4,441	2,821	2,376	3,304	2,917	1, 624	1,245	1,948	3,366

TABLE 5. ANNUAL CATCH FOR ALL THREE GEARS COMBINED OVER THE PERIOD 1976-2005

Total		Year	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Gear		Reported Catch	8,683	7,788	10,837	10,787	11,630	10,221	7,154	10,328	10,749	8,136
	IUU Estimate	Upper 95 tile	342,156	332,039	320,508	327,370	343,428	339,076	646,047	1,106,841	1,361,691	1,666,120
		Median	292,762	284,522	275,213	279,807	291,354	285,951	550,105	931,507	1,155,932	1,418,148
		Lower 95 tile	197,122	190,993	183,947	188,822	199,659	202,612	442,645	787,163	991,792	1,230,097

Total		Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Gear		Reported Catch	11,112	10,386	17,830	12,037	20,973	26,824	39,662	58,772	72,616	91,659
	IUU Estimate	Upper 95 tile	1,888,766	1,956,515	2,045,338	2,091,675	1,885,410	1,955,503	1,852,249	1,807,719	1,812,786	1,854,276
		Median	1,616,387	1,669,136	1,740,341	1,775,231	1,620,016	1,673,632	1,577,874	1,547,541	1,553,535	1,586,207
		Lower 95 tile	1,414,171	1,458,557	1,519,669	1,551,238	1,410,613	1,472,609	1,386,886	1,360,412	1,366,873	1,397,522

Total		Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Gear		Reported Catch	82,308	90,108	104,187	91,220	106,772	32,041	105,421	140,722	447,088	493,295
	IUU Estimate	Upper 95 tile	1,663,366	1,626,671	1,684,662	1,819,760	2,311,423	1,363,801	1,393,077	1,382,711	1,731,653	1,600,815
		Median	1,417,568	1,394,533	1,437,734	1,548,284	1,968,416	1,160,145	1,183,355	1,171,738	1,479,525	1,377,999
		Lower 95 tile	1,245,440	1,225,293	1,265,705	1,367,075	1,741,156	1,038,805	1,059,837	1,052,614	1,331,875	1,240,051