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**THE COST OF BEING APPREHENDED FISHING ILLEGALLY: EMPIRICAL EVIDENCES AND
POLICY IMPLICATIONS**

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THE COST OF BEING APPREHENDED FISHING ILLEGALLY: EMPIRICAL EVIDENCES AND POLICY IMPLICATIONS^{1, 2}

Abstract: We present a conceptual model for the analysis of the costs and benefit aspects of the risk inherent in IUU activity. We then proceed to develop and present a map of IUU incidences as reported in the Fisheries Centre's *Sea Around Us project* IUU global database. This map shows that IUU activities are quite widespread geographically. We next present an analysis of the cost and benefit aspects of risks of IUU fishing. A number of interesting results emerged from this analysis, including the result that for the cases analyzed as a group even a high probability of being apprehended will not change the current favorable calculation of the potential net benefits of IUU fishing activities. Finally, we discuss three case studies using our conceptual framework, which allowed us to make some valuable deductions.

1. Introduction

1. Illegal fishing is conducted by vessels of countries that are parties to a fisheries organization but which operate in violation of its rules, or operate in a country's waters without permission, or on the high seas without showing a flag or other markings (FAO 2001). Unreported catches are not reported to the relevant authorities by the fishing vessels or flag state, whether they are parties or not of the relevant fisheries organization. This category includes misreported and underreported catches (FAO 2001). Unregulated fishing is normally conducted by vessels flying the flag of countries that are not parties or participants in relevant fisheries organizations and therefore consider themselves not bound by their rules (FAO 2001).

2. Illegal, unregulated, unreported (IUU) fishing occurs not only in the high seas, but also within exclusive economic zones (EEZ) that are not 'properly regulated'. IUU fishing leads to the non-achievement of management goals and sustainability of fisheries (Pitcher et al. 2002; Corveler 2002). When stock assessments are performed on fisheries, reported catch and effort data is used. However, the underreporting of illegal catches results in the absence of a significant part of the annual catch that is not included in the assessment (Pauly et al. 2002; FAO 2000a). The depletion of many stocks, for example, of Patagonian toothfish (*Dissostichus eleginoides*) has occurred partly because of the inaccuracy of the catch data. Significant decreases in some fish stocks have become an increasing concern especially because further restrictions on legal fishing can also exacerbate illegal fishing.

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^{2.} We thank our colleagues, especially, Louisa Wood, Robyn Forrest and Jordan Beblow (for the incidence Map), Reg Watson, Tony Pitcher, Daniela Kalikoski and Daniel Pauly for providing us with insights, information and data, Kevin McLoughlin, James Fox and Ilse Keesling for their assistance with the Indonesian case study; and Sachi Wimmer and Denzil Miller for their assistance with the Antarctic case study. We thank the *Sea Around Us project* (SAUP) and the Pew Charitable Trusts for making this work possible by initiating the IUU Global database.

3. The issue of IUU fishing has therefore been receiving increasing attention among scholars, fisheries managers, governmental, intergovernmental and non-governmental organizations. For instance, the FAO has begun the implementation of an International Plan of Action (IPOA) where all states and regional fisheries organizations are introducing effective and transparent actions to prevent, deter and eliminate IUU fishing and related activities (FAO 2003). A good understanding of the economics of IUU fishing is important in order to design appropriate measures. What are the cost and benefit aspects of risks inherent in IUU activity? This paper explores these questions. It discusses the possible drivers of risk and the costs associated with fraud, avoidance and apprehension in relation to IUU fishing activities. A model is presented and substantiated using case studies to help establish how IUU fishing vessels take such costs and benefits (monetary and social) into account when deciding on whether to engage in IUU fishing or not.

4. The rest of this paper is organized as follows. Section 2 conceptualizes a model for fishers' decisions on IUU fishing. The literature is briefly reviewed followed by a presentation of the key drivers of IUU fishing from the point of view of the violator. The formal model is detailed in Appendix 1. This is followed in Section 3 with the presentation of a global picture of IUU incidence, and then a presentation of three case studies to illustrate the scope and diversity of IUU fishing. Finally, we conclude the paper in Section 4.

2. Conceptualizing a Model for Fishers' Decisions on IUU Fishing

5. Since the first formal economic model developed by Becker (1968) on the subject of criminal activity, several reasons have been advanced in the economic literature explaining why people engage in such an activity. Becker (1968) and the papers immediately following him argued that criminals behave essentially like other individuals in that they attempt to maximize utility subject to a budget constraint. The economic argument was very strong in this explanation of illegal activity, embodied in what has come to be known as deterrence models (Kuperan and Sutinen 1999; Charles et al. 1999). These models argue that an individual commits a crime if the expected benefits or utility from doing so exceeds the benefits from engaging in legal activity. The models focus on the probability and severity of sanctions as the key determinants of compliance. Additional motivations have come to be recognized in the recent literature, namely, that moral and social considerations play a crucial role in determining whether an individual engages in illegal activity or not (Tyler 1990; Sutinen and Kuperan 1999). With regards to IUU fishing there is evidence to support the hypothesis that moral and social considerations, as well as economics play a role in the degree of IUU fishing that an individual decides to engage in (Kuperan and Sutinen 1999; Bergh and Davies 2004). However, the case studies discussed later in this paper indicate that moral and social considerations are weak in the case of distant water fleets, which are the predominant operators on the high seas.

6. Following Becker (1968), Kuperan and Sutinen (1999), Sutinen and Kuperan (1999), and Charles et al. (1999), we assume more explicitly that the following direct drivers and motivators play a role in fishers decision-making on whether to IUU or not to IUU:

- 1) Benefits that can be realized by engaging in the illegal activity;
- 2) The probability that the illegal activity is detected or the detection likelihood driver. This depends mainly on the level of enforcement or the set of regulations in place;
- 3) The penalty the fisher faces if caught;
- 4) The cost to the fisher in engaging in avoidance activities. This depends on the set of regulations in place and the size of the budget allocated by the fisher to this activity;

- 5) The degree of the fishers' moral and social standing in society and how it is likely to be affected by engaging in IUU fishing.³

2.1. Benefits from IUU fishing as a driver

7. For many fishers, the potential to benefit from IUU fishing motivates them to engage in the illegal activity. To some extent the higher the economic return in a 'legal' fishery the lower is the tendency to engage in IUU fishing. In other words, if a fisher is doing well financially, i.e., making a sizeable profit from fishing 'legally' then the probability of cheating is low, alternatively if the fisher is losing money, and there is the potential to derive benefits from 'illegal' fishing then the probability of cheating increases. There is also the factor of greed, i.e., the fisher may be making a profit but still engages in IUU fishing because of the desire to increase profits. The following factors are important in determining the potential benefit to the fisher if they cheat:

- Catches – the more catch that can be realized by engaging in IUU fishing the higher the probability that a fisher will engage in IUU fishing, *ceteris paribus*.
- Catch per unit effort or the time it takes to catch the fish is also a consideration since the more time spent searching for fish to and from the fishing grounds, the more the cost as well as the increase in the probability of getting caught;
- Price – this is related to catch and if prices are too low then in most cases there will not be a financial incentive to cheat. This logic breaks down when food security is a driving factor. However, for the purposes of this study food security is not the focus;
- Cost of fishing, which includes consideration of the cost of labor, capital, fuel, license and royalty payments, etc.

2.2 The expected penalty drivers

8. *Detection likelihood driver:* The higher the probability of getting caught the lower the incentive to cheat, *ceteris paribus*, and hence, the higher the risk that the violator will be caught. The major factors that contribute to this driver are, (i) the effectiveness and efficiency of the enforcement system; (ii) social acceptance of cheating in society; (iii) awareness of the regulations; and (iv) the level of non-governmental or private organizations involvement in detecting infringements.

9. *The avoidance driver:* A rational fisher engaging in IUU fishing in a situation where there is some degree of enforcement will take measures (such as engaging in transshipment of catch) to reduce the chances of being detected, this is denoted avoidance activity.

10. *The penalty driver:* The severity of the penalty when someone is caught is also an important driver in the decision of a fisher to cheat. The more severe the penalty the lower the likelihood of cheating, *ceteris paribus*. This driver is related to the detection likelihood driver in that if there is no enforcement then the severity of the penalty is meaningless. For example, in Florida where a net ban was instituted the county with the highest level of NON-compliance was also the county that either dismissed the most cases or imposed the minimal economic penalty to net fishers (Kely 2002). The types of penalties that are applied include: (i) the amount of the fine; (ii) confiscation of the boat; (iii) confiscation of the catch; (iv) exclusion from the fishery; and (v) history of prosecutions/application of the penalty. For example, in Senegal the fines are doubled for foreign fishing vessels that repeatedly operate outside of the fishing

³ It is worth noting that we are here not dealing with small scale fisheries, where community cohesiveness allows for social control (see example, Ruddle, 1989).

access arrangements⁴. In the state of Victoria in Australia, first time offenders are served with a Penalty Infringement Notice (PIN), however, the penalty for repeat offenders can include seizure of the catch and vessel, imprisonment and other penalties (Parliament of Victoria 2000).

2.3. Moral and social drivers

11. Many have observed that the deterrence model alone does not adequately explain why people engage or choose not to engage in illegal activities such as IUU fishing; rather moral and social factors also play a crucial role (Tyler 1990; Sutinen and Kuperan 1999). It has been observed that a given population of fishers, for example, can be classified into (i) chronic violators, (ii) moderate violators and (iii) non-violators (Kuperan and Sutinen 1999). Chronic and non-violators generally make up a small portion of a given population. The former have the tendency to undertake IUU activities no matter what, while non-violators will not engage in IUU fishing under any condition. Moderate violators, on the other hand, will only bypass regulations if the potential economic gain is high enough to cover the potential penalty they may face given the size of the penalty when caught, and the probability of being caught. Secondary influences that may affect the decision of moderate violators to IUU or not to IUU are the legitimacy of the regulation (and fishery management organization), and the norms of behavior, including both the general behavior of the fishers and the moral code of the individual fisher (Tyler 1990; Kuperan and Sutinen 1999). Gauvin (1988) and Bean (1990) have estimated that about 10% of fishers in the Massachusetts lobster and Rhode Island clam fisheries flagrantly violate major regulations. The other 90% of fishers normally comply with regulations. These estimates are not just relevant to these two fisheries: Feldman (1993) presents a number of estimates for other fisheries that are similar to these numbers.

2.4. A formal model

12. From the above conceptual framework, we developed a formal model of the economics of IUU in line with the literature (see Appendix 1). According to this model, the objective of the fisher is the maximization of the potential gains from engaging in IUU fishing moderated by moral and social considerations. If the fisher engages in IUU activities in a fishery in which there is close to no regulation, then the fisher faces close to zero probability of being caught implying that the expected penalty the fisher faces is also close to zero. In this situation there will be very little need, if any, to undertake avoidance activities. Moreover, the IUU fisher will choose the level of IUU activity such that the marginal revenue from the activity is greater or equal to the marginal cost of engaging in the activity, which in this study equates to the sum of the marginal cost of fishing and the marginal moral and social cost of engaging in IUU fishing. If the fisher undertakes IUU fishing when there is enforcement, then the fisher will choose the level of IUU fishing such that marginal revenue is equal to or greater than the sum of marginal cost of engaging in IUU fishing, and the potential marginal fine if caught.

3. IUU Incidence and Case Studies

13. First, we present a general picture of IUU fishing based on the Sea Around Us project (SAUP: www.seaaroundus.org/) IUU database, and then we present and analyze three case studies using the conceptual framework and model developed in this paper.

14. The three case studies are selected to give a varied coverage of the different situations under which IUU fishing takes place. The Namibia case study gives us the opportunity to describe the level of IUU fishing in waters that went from virtually zero regulation to a situation with relatively good level of regulation. The Patagonian tooth fish example is presented to illustrate how high market prices can be the

⁴ See <http://www.fao.org/docrep/V9982E/v9982e3n.htm>.

key driver for IUU fishing⁵. The northwest Australia case study is presented to illustrate how fishers will shift to illegal practices if there is more abundant and well managed resources in other national waters despite the risk of detection and apprehension.

3.1 General picture of IUU fishing in the world

15. Figure 1 below summarizes IUU incidence in the world. This is a map developed from the SAUP database on global IUU fishing at the UBC Fisheries Centre. It contains data on discards and unregulated fishing activities that have been extracted from government fisheries department publications (such as annual reports and media releases) and databases, and data on illegal fishing activities that have been described in the media (e.g. Intrafish, FIS), fisheries management reports and peer-reviewed literature (see Pitcher et al. 2002). The data is spatially referenced by FAO area or sub-areas depending on the level of detail provided. The analysis (Figure 1 and Table 1) presented here are therefore based on incidences that are published and therefore possibly biased to those cases where a large fine is handed down or the offence had a significant impact on the environment or fishers. It is worth noting that both the database and the map are 'living' research products as they are constantly being improved as more data is accumulated (see www.seaaroundus.org for updates).

16. Figure 1 represents the spatial distribution of vessels incriminated in IUU activities. Most of these observed/reported IUU activities are in the EEZ of the country detecting the infringement. Our data indicates that fewer IUU activities are reported in the northern hemisphere. This may be a reflection of the resources expended on monitoring, control and surveillance. Nevertheless, the map does indicate that even with the limited information we currently have, IUU fishing is widespread spatially.

Figure 1. Number of Incriminated Vessels for Fishing Illegally Between 1980 and 2003



Source: Based on Sea Around Us IUU database; www.seaaroundus.org).

⁵ We find this point to be interesting and important to make even though the current paper focuses on risk issues.

3.1.1. Cost and benefit aspects of risks inherent in IUU activity

17. Table 1 is a representation of the model presented in Appendix 1, except that the moral and social components are not included. This is because for the cases presented in the table, these drivers of IUU fishing are at best very weak. We have also implicitly assumed that the cost of any avoidance activity by a given vessel is included in the vessel's variable cost (see below), and the benefit of such action to the vessel is to reduce the effectiveness of monitoring, control and surveillance (MCS) activities (that is, reduce θ) for the vessel. The table lists a number of IUU fishing vessels that have been apprehended while illegally catching fish in different parts of the world. The first entry for instance, is a Spanish vessel apprehended by Australian authorities. The vessel, at the time it was apprehended, contained 116 tonnes of Patagonian toothfish with an estimated market value of USD 630 000. This vessel was fined USD 435 000. The 'Catch' and 'Fines' Columns are completed with actual data. The numbers in italics in the 'Value' Column are calculated using the reported IUU catch and the global price of the fish in question. US prices (computed using data at http://www.st.nmfs.gov/commercial/landings/gc_runc.html) are used as proxies for global fish prices. This is reasonable given that recent studies have demonstrated that prices for many fish species tend to be co-integrated (Asche et al. 1999). The variable cost of fishing as a percentage of landed value was calculated using information in Lery et al. (1999).

18. Recall that θ denotes the probability of detection of IUU fishing – it is therefore crucial in the calculation of the cost and benefits of the risk inherent in IUU fishing. The current lack of data does not allow us to say what the value of θ is for the cases in Table 1, but it is probably safe to say that many of them will have probabilities of detection that are well below 0.2 or a 1 in 5 chance of being detected. More work to determine prevailing detection probabilities for IUU activities in different fisheries around the world will be very useful in progressing the current analysis. This will also increase the utility of this work to fisheries managers in their effort to tackle the problem of IUU fishing.

19. Given the data situation, we explore the question, will the potential benefits of engaging in IUU be greater than the potential costs when $\theta = 0.2$, given the fines imposed, the value of the catches, and the variable cost of fishing (assuming fixed costs to be sunk)? In other words, will the ratio of potential total costs to expected revenue from IUU fishing be greater than or equal to 1? From the Table 1, we can see that only four of the 16 cases proved to be uneconomical with a 1 in 5 chance of being detected. Similar calculations when $\theta=0.05$ and 0.1 showed that the total potential cost exceeds the expected revenue only for Case 15.

20. Another interesting question explored is, what fines should have been imposed on each of the cases in Table 1 to make the costs aspects of risk at least equal to the benefits aspects for an MCS system when the probability of detection, $\theta = 0.2$. The calculations show that on average, for the cases studied, current penalty levels will have to be increased 24 times to ensure that IUU fishing is uneconomic. The equivalent numbers when $\theta=0.05$, and 0.1 are 173 and 74, respectively.

Table 1. Cost and Benefit Aspects of Risks of IUU Fishing when there is a 1 in 5 Chance of being Apprehended (i.e. $\theta = 0.2$)

Cases	Vessel/ Gear country	Arresting country	Fishery	Catch (t)	Catch value (USDD)	Expected revenue ¹ (USD)	Variable cost ² (USD)	Fine ³ (USD)	Expected Penalty ⁴ (USD)	Total cost ⁵ (USD)	Total cost /expected revenue ⁶	New Fine ⁷
1	Spain (longline)	Australia	Patagonian toothfish	116	630 000	504 000	(0.70%) 439 091	435 000	435 000	874 091	1.04	0.75
2	Russia (trawler)	Unknown	Cod & haddock	24	1 138	916	(0.66%) 747	22	22	769	0.83	38
3	Australia (boat/diver gear)	Australia	Abalone	11 000	75 000	60 000	(0.70%) 52 500	26 250	26 250	78 750	0.96	1.4
4	Chile (longline)	Chile	Patagonian toothfish	33	610	488	(0.45%) 273	420	420	693	0.73	2.55
5	Iceland 1	Unknown	Finfish	-	6 250	5 000	(0.70%) 4 375	2 250	2 250	6 625	0.97	1.4
6	Russia (trawler)	Russia	Cod and haddock	48	1 138	910	(0.66%) 747	22	22	769	0.83	38
7	Russia (trawler)	Argentina	Fish include anchoveta	2 685	485 985	388 788	(0.62%) 300 399	24 138	24 138	324 537	0.79	18
8	Russia (pots)	Japan	Crab	60	47 820	38 256	(0.62%) 29 648	7 414	7 414	37 062	0.81	5.8
9	High seas (longline)		Patagonian toothfish	200	2 200 000	1 760 000	(0.70%) 1 533 333	100 000	100 000	1 633 333	0.88	11
10	Mexico (bottom trawler)	Mexico	Shrimp	5	27 575	22 060	(0.56%) 15 337	5 455	5 455	20 792	0.74	6.2
11	Russia (pots)	Russia	King crab meat	0.214	2 456	1 965	(0.66%) 1 621	34	34	1 655	0.83	50
12	China (bottom trawler)	Russia	Alaska Pollock	6	11 022	8 818	(0.39%) 4 304	1 171	1 171	5 475	0.51	19.4
13	Russia (gillnet)	Russia	Greenland halibut	132	119 328	95 462	(0.59%) 69 833	690	690	70 523	0.73	185
14	Canada (longline)	Canada	Sablefish	2.72	12 063.2	9 651	(0.70%) 8 408	15 385	15 385	23 793	1.19	0.4
15	Norway (longline)	Mauritius	Patagonian toothfish	200	440 000	352 000	(0.70%) 306 667	2 400 000	2 400 000	2 706 667	2.23	0.38
16	Spain (longline)	Uruguay	Patagonian toothfish	201	2 122 560	1 689 600	(0.70%) 1 472 000	1 632 000	1 632 000	3 104 000	1.06	2.6

1. Expected revenue = $\theta * 0 + (1 - \theta) * \text{catch value}$. This captures the fact that when apprehended catch from IUU fishing is usually confiscated.
2. Variable costs are the cost of operating the vessel as distinct from the fixed costs of acquiring the vessel.
3. Reported fine imposed, assumed to be the total fine including the confiscation of catch/vessel, flag state's fine, where applicable.
4. The product of the probability of detection (in this example 0.2) and the fine imposed.
5. The sum of variable cost and the expected penalty.
6. The ratio of the potential total cost of IUU to the potential value of engaging in IUU. A value of 1 and above implies engaging in IUU activity is not a profitable proposition.
7. The number of times the reported fines need to be multiplied by in order to make the potential gain equal to the potential cost of engaging in IUU when $\theta = 0.2$. This gives an average multiple of about 24. Similar calculations for $\theta = 0.05$ and 0.1 , shows that multiples of 173 and 74 are needed.

21. From the results presented above one can make the following observations:

- Given the current combination of fish price, IUU catch levels, variable fishing cost levels, and the level of fines imposed in vessels caught engaged in IUU fishing, the current fine levels will not serve as a deterrent for two-thirds or more of the cases reported in Table 1 when the probability of detection is equal or less than 0.2;
- For most of the cases, the probability of detection must be well above 0.2 for it to serve as a deterrent;
- The reported fines for the cases analyzed will have to be increased many-fold even for fisheries that are monitored to ensure that there is a 1 in 5 chance of being detected, for the fines to serve as serious deterrents to IUU fishing.

3.2. The Namibian EEZ

3.2.1. Background

22. Namibia has an extensive coastline bordering the highly productive northern Benguela current ecosystem, which is dominated by pelagic fishes, mainly sardine, anchovy and horse mackerel. The demersal ecosystem is dominated by the valuable stocks of hake. The food web off the Namibian coast is mainly represented by seals as the top predators, hakes, squid, snoek, and chub mackerel as the piscivorous species and horse mackerel, round herring, saury, sardine and anchovy as the main pelagic prey, and lightfish, lanternfish and goby as the main demersal preys (Shelton 1992; Palomares and Pauly 2004).

3.2.2 IUU fishing before independence

23. Before independence in 1990, the Namibian EEZ suffered illegal, unreported and unregulated fishing because it was virtually a free-for-all fishing zone. There was little or no surveillance of most fishing operations in Namibian waters, hence there was a massive race for the fishery resources of Namibia mainly by distant water fishing fleets (DWFs) beginning in the 1960s (Anon. 1994). Fleets from the former USSR and Spain arrived in 1964; followed by Japan, Bulgaria and Israel in 1965; Belgium and Germany in 1966; France in 1967; Cuba in 1969; Romania and Portugal in 1970; Poland in 1972; Italy in 1974; Iraq in 1979; Taiwan in 1981; and South Korea in 1982 (FAO Yearbooks of Fishery Statistics for hake). Sumaila and Vasconcellos (2000) demonstrate that the impacts of this were huge and negative, resulting in the over-exploitation by distant water fleets with the consequence that the newly independent Namibia inherited an altered ecosystem whose productive potential was severely reduced (Willemse and Pauly, 2004). In addition, the country suffered huge socio-economic losses during this period due to the activities of DWFs⁶.

24. The fishing activities in Namibian waters were not regulated so reporting of catches was very poor, and also many who would normally not fish there without permission, fished there illegally anyway. This 'free for all' situation implied that all the direct drivers of IUU fishing were skewed in favor of fishers who want to undertake IUU fishing activities – what we call 'the IUU Fisher's Paradise'. The potential of gaining additional revenue from IUU fishing without any risk of being caught is high. Penalties are non-existent, and the violators enjoyed zero cost of engaging in avoidance activities. In terms of our model, the situation in Namibia's EEZ during this period is captured by the optimality condition expressed by equation (3).

⁶. It is probably not possible to discuss DWF's in the legal context before UNCLOS and the establishment of the 200-mile EEZ in 1977 since one cannot claim that the fleets were fishing illegally.

25. The revenue side of this equation was quite high due to the huge quantities of fish caught by distant water fleets in the years prior to independence. The official statistics, which are suspected of being underestimates, shows that 1.4 million tonnes of sardines were caught in 1968. Before these large catches, pre-1968 catches were reported to have been between 100 000 to 600 000 tonnes, most of it taken by distant water fleets. The race for Namibian hake started in 1964 and reached a peak in 1972 when 800 000 tonnes of hake were reported to have been caught. The catches were lower between 1972 and 1980 at about 150 000 tonnes. Catches improved again to around 400 000 tons in 1985, and this declined again until 1991 when Namibia took full control of its resources for the first time. Again most of these catches were taken by DWFs. It is reported that up until 1985, 99% of hake catch was landed by DWFs. After 1985, approximately 90% was still landed by DWFs (Anon. 1994; Sumaila and Vasconcellos 2000). Horse mackerel was also heavily targeted by DWFs active in Namibia's exclusive economic zone (EEZ) before independence. Annual catches were seldom below 300 000 tonnes, with the peak of 570 000 tonnes landed in 1982, according to the statistics.

26. One can argue that the cost side of equation (3) was relatively low compared to the revenue side implying that the amount of IUU fishing inputs will have to be very high before equation (3) is satisfied. Essentially, under the circumstances prevailing in Namibia's EEZ before independence, and the fact that most of the fishing was by DWFs, one can argue that moral and social considerations are virtually non-existent. Hence, the only cost that mattered was the fishing cost, which from all indications must have been well below the revenue from IUU fishing. This scenario is in effect the IUU fisher's paradise – zero risk of being caught and penalized, and zero risk of losing moral or social standing in the societies they come from. It should be noted that this result could easily be extended to most of high seas IUU fishing situations.

3.2.3. IUU fishing after independence

27. The new Namibian government that took office in 1990 put fisheries at the centre of its agenda. It made the return of full control (to Namibia) of fishing in its EEZ a primary goal of the government. Just before independence in 1990, more than 100 foreign vessels were fishing illegally in Namibian waters. During 1990 and 1991, 11 Spanish trawlers and one Congolese trawler were arrested for illegal fishing and successfully prosecuted; most of them were forfeited to Namibia by the Namibian courts. It has recently been reported by WWF (1998) that with the announcement of the EEZ regime by the independent government, there was a drop of more than 90% in the number of unlicensed foreign vessels fishing in the area. Namibia achieved this feat by quickly putting in place a fisheries management system with a strong monitoring, control and surveillance component, the primary goal of which was to restrict fishing to only those entitled to do so, and ensure that fishing activities are carried out within legal and administrative guidelines (MFMR 1999). By so doing the government of Namibia quickly moved the IUU fishing environment from an IUU Fisher's Paradise to an IUU fisher's Hell: Suddenly θ and F turned positive, immediately impacting on fishers' risk calculations and decisions on whether to IUU or not to IUU. Indeed, the regulators increased θ to close to 1, and F significantly in the beginning to serve as a signal to all IUU fishers that it meant business. To achieve this, Bergh and Davies (2004) report that in the 2001 and 2002, 41% and 42% of the fishing industry revenue has been used to pay for monitoring, control and surveillance activities, respectively. More concretely, the annual running cost of the Fisheries Observer Agency (FOA), the organization responsible for providing observer services to the MFMR, is about NAD 20 million⁷ (Per. Comm. Mr. Hafeni Mungungu, CEO of FOA).

28. The other components of the optimality condition, namely, avoidance, moral and social also became elements that carried weight in the risk analysis of a potential IUU fisher. In the first place, because of the now significant value of θ and F those who planned to engage in IUU fishing would most

⁷ USD 1 equal to NAD 7.07 (Namibian dollars) in March 2004

probably have to engage in avoidance activities too. This increases the total cost to them of engaging in IUU fishing, and therefore has a dampening effect on their appetite for engaging in the illegal activity. Secondly, because DWF fishing was eliminated, restricting fishing to only Namibian-based fishing companies, the moral and social standing considerations became relevant. All of these together resulted in a significant drop in IUU fishing. According to Bergh and Davies (2004), the goal of restricting fishing activity to only those entitled has been fully achieved, while more work is needed with respect to the goal of ensuring that fishing activities are carried out within administrative and legal guidelines, because this goal has only been partially achieved thus far.

29. There are many reasons for the success of Namibia in tackling its huge IUU fishing problem after it gained independence. Some of these are specific to the country while others can be generalized to other countries. A key positive factor for Namibian fisheries is the fact that it is a major contributor to the country's national wealth. It is estimated that fisheries contribute over 10% of the country's national income (Lange 2003). This prominence accords the fishing sector high national priority, which allows the Ministry of Fisheries and Marine Resources (MFMR) to get the resources it needs to put in place an effective MCS system. A second point is the fact that Namibia had a number of negative examples from around the world on how not to manage its fisheries because it attained nationhood only recently. This opportunity appeared to have been used effectively - to the extent that the Namibian Constitution has sustainability requirements stipulated in it. The legal system was also designed to give the courts the power to deal with illegal fishing activities. The geography of Namibia also played a part. The coast of Namibia is shielded from the population by a strip of harsh desert land resulting in only two major fishing ports along its coast. This meant that coastal fishing communities never really developed along the coast. This had a positive socio-cultural consequence on the management of the resources in that there was no coastal community with long term claims to fishing rights on the marine resources. Finally, the country took drastic and dramatic initial enforcement of fisheries regulation in its EEZs, which sent a clear signal to potential violators, with a huge positive effect on keeping IUU fishers out of the country's EEZ.

3.3. Patagonian toothfish

3.3.1. Background

30. The Patagonian toothfish is a long-lived, slow growing species. It matures at ages greater than 10 years, lives up to 50 years and can reach lengths of up to 2 metres and weighs up to 130 kg (TRAFFIC 2001). Larger fish normally inhabit greater depths while younger toothfish live in shallower waters (depths ranging from 400 to 3500 m). It preys on fish, crab, squid and prawns and is preyed upon by sperm whales and elephant seals. Due to the slow growth and late maturity, this species is extremely vulnerable to overfishing. Other Patagonian toothfish market names are Bacalao de profundidad (Chile), Butterfish (Mauritius), Chilean Sea Bass (USA, Canada), Robalo (Spain) and Mero (Japan) (TRAFFIC 2001). It is worth noting that until the late 1980s, the then Soviet Union caught most of the toothfish (CCAMLR Article XXIV). Presently the main catch countries are Chile, Argentina, France, Australia, UK and South Africa (TRAFFIC 2001). Most IUU catch is landed in Mauritius, as the catch documentation scheme has effectively eliminated IUU catch landings in CCAMLR member countries (TRAFFIC 2001). Toothfish catch is exported primarily to Japan and the US as well as Canada and the EU (TRAFFIC 2001).⁸

31. The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was established in 1982 with headquarters in Hobart, Australia. Its aim was to deal with the depletion of krill and some fish stocks in the Southern Ocean, in particular the Patagonian toothfish stocks. There are 39 participating countries on the Convention of which 24 are member countries. CCAMLR governs most of

⁸ It should be noted that the IUU trade follows the legal market to the importing countries once it has been landed at a port.

the waters in the Antarctic region. Although there are regulations set by CCAMLR as conservation measures, there is still a large quantity of toothfish caught illegally in the EEZs of the Sub-Antarctic Island territories and in the Southern Ocean area managed by CCAMLR. Unregulated and unreported catch occurs inside and outside of the CCAMLR area (TRAFFIC 2001). Any country within the CCAMLR area governs its own EEZs but operates under regulations (catch limits, gear restrictions) set by CCAMLR.

32. Patagonian toothfish is caught in the Antarctic Southern Ocean, which is divided into three statistical areas defined by FAO and governed by CCAMLR. Area 48 covers the Atlantic Ocean Sector; Area 58 covers the Indian Ocean Sector and Area 88 covers the Pacific Ocean Sector. The Southern part of Area 58 is a prime target area for catching Patagonian toothfish as well as the southern part of Area 88. Within the CCAMLR area, toothfish fishing hot spots are located near Prince Edward Islands, South Africa (Sub Area 58.7); Crozet Islands and Kerguelen Islands, France (Sub Area 58.6); and Heard and Macdonald Island, Australia (Sub Area 58.5).

3.3.2. *The evolution of the toothfish fishery*

33. The Soviet Union started fishing toothfish in the mid 1980s after the decline of the icefish fishery (Kock 1991; 1992). The development of the legal toothfish fishery followed the collapse of the Austral hake, *Merluccius australis*, and Golden Kingclip, *Genypterus blacodes*, fisheries in Chilean waters and some of the Northern fish stocks (TRAFFIC 2001). Until 1997, there were virtually no regulations on the amount of toothfish catch implying that the relevant optimality condition is that expressed in equation (3), with zero probability of being caught. There were catch limits placed on the longline toothfish fishery in 1990 but these were not actively enforced. The incentive to engage in IUU fishing was consequently high since the probability of being caught was zero even within the EEZs in the CCAMLR area. However, in 1997, it was reported that 80-90% of current total toothfish catch was illegal, constituting 2-3 times the legal catch limits for the fish stock. This information forced all countries with EEZs in the CCAMLR area to establish regulations and limits on the fishery, and begin to manage their waters more effectively. F and θ then assumed positive values within most countries' EEZs. θ is likely to be greater than 0.2 in Australian waters where the amount of patrol vessels is extremely high. F was at first very low as most vessels considered the small fines simply an additional operating cost and the resulting fines issued by courts were very small. However as will be discussed below, new penalty measures issued by Australia for example has rendered an F value that is very high, sometimes 1, when vessels are sunk. Other CCAMLR region countries are following Australia's actions.

3.3.3 *Management Schemes*

34. More enforcement and regulation measures were brought to bear on the fishery in 1998 when all toothfish vessels operating within the CCAMLR area were required to carry a vessel monitoring system (VMS) - a satellite-tracking device to track the co-ordinates of each vessel. Also, all vessels operating in the CCAMLR were required to mark their gear appropriately to decrease the amount of longlines cut when inspectors approached. More rigorous measures were taken in further attempts to decrease the amount of IUU fishing on Patagonian toothfish. CCAMLR implemented the Catch Documentation Scheme (CDS) in May 2000 for all CCAMLR member countries for all areas and fisheries with vessels catching toothfish. Before the CDS was implemented, South Africa, Uruguay, Spain and Namibia, all members or acceding states of CCAMLR accepted IUU toothfish at their ports. After the CDS was implemented, Mauritius remained the only country to accept IUU toothfish, as it is not a member country (TRAFFIC 2001). The CDS tracks the trade of Patagonian toothfish at all CCAMLR members' ports (TRAFFIC 2001). The Catch Documentation Scheme aims to identify the origin of all toothfish landed or imported into countries of contracting parties. It was recommended that all toothfish landings be denied if there was no documentation to show that the toothfish had been caught within the convention area and conforming to the conservation measures issued by CCAMLR. Non-contracting parties can be issued a CDS to be

accompanied and verified with all landed toothfish. As these new management schemes developed from 1997-2002; it helped reduce the attractiveness of IUU fishing of Patagonian toothfish.

3.3.4. Benefits drivers

35. There is a strong economic incentive to engage in IUU activities in the Patagonian toothfish fishery because of the strong demand for the fish and hence, the high market price it commands, and the fact that stocks of the fish have been declining over time (TRAFFIC 2001). Toothfish is considered “white gold” by the commercial longline fleets (ISOFISH 1999). The market price of toothfish has increased from approximately USD 6/kg in 1996 to over USD 11/kg in 2000. That is, an increase of almost 100% in just three years (Statistics Canada 2001) and there are still other reports that toothfish sells for even higher prices.

36. The variable cost estimates from Table 1 for toothfish longline are approximately 70% of the total catch value (Lery et al. 1999)⁹. By using this percentage even on an annual scale, the net value of illegal catch is still very high. As indicated in the next two sections, the level of detection is very low in this fishery making these profits substantial and attractive to fishermen.

Table 2. Estimated Annual Legal and Illegal Catches (Values) of Patagonian Toothfish in the CCAMLR Area

(all values in USD million, except price which is in USD)

Year	Legal catch (t)	Illegal catch (t)	Price per kg	Illegal catch Value	Variable costs ¹	Net Value
1996/97	32 736	68 234				
1997/98	27 868	26 829	6.05	162	113	48
1998/99	37 319	16 636	9.11	151	105	45
1999/00	25 242	8 418	11.19	94	65	28

1. Variable costs estimated from Lery et al. (1999) used from Table 1 for longline vessels catching Patagonian toothfish.

3.3.5. Detection drivers

37. The development of governance over the Patagonian toothfish fishery has increased significantly since the fishery was first established. This case study can be divided into two time periods: before there were any regulations on the fishery and after the regulations were set in order to conserve the much depleted stocks. There are certainly numerous organizations and countries working together to stop IUU fishing of toothfish. Although many conservation measures have been implemented, due to the large fishing area and the high level of co-operation needed to combat illegal fishing, the detection of IUU fishing in this fishery is still relatively low, which probably implies that few of such activity are currently captured in the SAUP database.

38. The likelihood of being caught is fairly low outside the CCAMLR area since surveillance is very costly (TRAFFIC 2001). The Australian Government apprehended a vessel at an expense of AUD 1 million and 80 days of pursuit (COLTO 2003). CCAMLR does not carry out any enforcement activities itself, but rather each country within the area is responsible for its own waters. Some countries such as Australia, South Africa and France are taking rigorous enforcement actions. For example, Australia has prohibited all toothfish longline fishing in its EEZ and patrol with armed vessels (COLTO 2003). The Catch Documentation Scheme and the Vessel Monitoring System are designed to make it difficult for

⁹ These estimates should be taken with caution as costs may differ between “legal” vessels and IUU/FOC vessels.

vessels to land illegal toothfish or fish in illegal areas. The obstacle in decreasing the amount of toothfish catch is the lack of cooperation from all member countries. This case is more complex than the Namibian case because there are so many countries involved. Non-contracting countries who are invited to CCAMLR meetings and who are aware of the concerns on IUU fishing activities for toothfish are still known to issue Flags of Convenience (FOC), for example, Belize and Panama (TRAFFIC 2001).

39. Since the implementation of the CDS and VMS as well as port inspections, illegal catches have decreased from about 68200 tonnes in 1996 to 8400 tonnes in 2000 (CCAMLR 1998; 1999; 2000). The estimated legal reported catch of toothfish was 51% of the total catch in the CCAMLR area and IUU landings were 49% from 1996-1999. After the CDS was implemented in 2000, IUU landings decreased to 25% of the total catch (CCAMLR 1998; 1999; 2000). The decrease of illegal catch could be due to the increased port inspections and the CDS and VMS projects but unfortunately are most likely due to the underestimation of the catch due to transshipment activities, underreporting and misreporting, as Japan and the US have not observed a decrease in imported catch (TRAFFIC 2001).

40. The VMS costs are taken upon by each CCAMLR member country. Each country needs one base station to monitor its own vessels that costs approximately USD 30-50 000, paid for by the member country. Each vessel requires

41. On-board instrumentation has a capital cost of approximately USD 20 000, which is very minor compared to the high prices received for even just one trip catch (see the “Volga” price below (in Penalty driver section)-AUD 1.9 million for one trip catch. (D. Miller, Executive Secretary CCAMLR. Hobart, Tasmania, Pers. Comm. 2003. FAO has reported that the operating costs of the FFA VMS to be approximately 0.3 % of all operating costs or 0.05 % of the total value of production per year per vessel (2003).

3.3.6. Penalty driver

42. The maximum penalty under Australian jurisdiction when caught with illegal toothfish catch is AUD 550 000¹⁰ along with the confiscation of the entire catch on board (Wimmer, Manager - IUU Fishing Fisheries and Aquaculture Department of Agriculture, Fisheries and Forestry Australian Government, Pers Comm. 2003). More recently a new law has been passed that increased the maximum penalty to AUD 825 000 for vessels longer than 24 metres (COLTO 2003) as well as recovering the cost to pursue the vessel. However, in the court system in Australia, it is very rare that a vessel will actually be fined the maximum penalty. As Australia is the leading enforcement country with regards to IUU toothfish fishing, they have managed to apprehend several known pirate vessels. Some penalties that have been enforced are as follows:

- Confiscation of catch, for example, the “Volga” had 136 tonnes of toothfish seized worth AUD 1.9 million and also paid AUD 1.9 million to have the vessel released (equivalent to the assessed value of the boat, fuel and fishing equipment);
- Fines imposed on Captain and crew of vessel, for example, an Uruguay vessel the “Viarsa 1” was fined AUD 20 000 to each crew member (crew of five men); the captain of the “South Tomi” a longliner was issued a fine of AUD 136 000 (the highest fine ever issued by Australia);
- Sinking of vessel, for example, the “South Tomi” was the first boat to be sunk; the “Lena” has also been ordered to be sunk.

¹⁰ AUD 1=USD 0.773 in February 2004.

43. These more extreme measures enforced by Australia are taking into account that previous fines or penalties were not substantial to deter the operators from continuing to fish illegally after paying their penalty. Other countries (e.g., Chile, South Africa, France etc.) have also increased their penalty fines for the conviction of IUU fishing (TRAFFIC 2001). However, although these seem like severe penalties to deter fishers from IUU activities, it is noted that one of the crewmembers on the “South Tomi” was caught again fishing illegally aboard the “Viarsa 1” two years after his boat was sunk (COLTO 2003).

3.4.7. Avoidance measures

44. Outside of member countries’ EEZs, the risk of being detected and prosecuted is zero as there are no enforcement measures in the high seas. The only reported case (we are aware of) where apprehension has occurred outside a country’s EEZ was when Australian patrols pursued an IUU vessel from within Australian waters into the high seas before finally seizing the vessel. In order to decrease the risk of apprehension within the EEZs, the avoidance measures taken by the vessels have been primarily in the loopholes of the management schemes enforced i.e. CDS and VMS (TRAFFIC 2001). The most prominent measures of avoidance used that have worked very effectively are:

- **Flags of Convenience:** operators can buy a flag from a country with the assurance that the issuing country will turn a blind eye to any of the operator’s activities. By flying such a flag, the vessel can move through the high seas without complying with any regulations;
- **Transshipping catch and landing it under different species names, trans-fuelling and even changing crews at sea to avoid detection at ports** (TRAFFIC 2001). There is a group of boats (the “Alphabet” boats) organized by one country whereby they put the older less valuable longliners in the path of the patrol vessels so that the newer more valuable boats can continue fishing without being caught. The loss of older boats are considered worthwhile business risks;
- **False coordinates under the VMS** so that the vessel country cannot identify the exact location of the boat (COLTO 2003).

3.4.8. Moral and social drivers

45. The toothfish fishery is an international fishery where most vessels are operating outside of their national waters. Since this is the case, the moral obligations or social considerations of cheating and fishing illegally are non-existent. The economic incentives of high prices are so enticing that the threat of being “black-listed” is not enough to deter illegal fishers. However, there are many non-governmental organizations that labor to detect and publicize vessels catching toothfish illegally. TRAFFIC, a wildlife trade monitoring network and Greenpeace Oceans-Stop Pirate Fishing are currently working to publicize illegal operators and the names of the companies, and vessels involved in IUU fishing of toothfish. The Coalition of Legal Toothfish Operators, COLTO, works with these agencies to promote the identity of illegal operators. The coalition is also offering monetary rewards of up to USD 100 000 to anyone with information regarding illegal vessels (COLTO 2003). Although it is a large reward, knowing that this is a serious concern, COLTO is willing to offer this money in hopes of minimizing illegal toothfish catch. This has proven quite successful in gaining valuable information for the apprehension of illegal vessels. ISOFISH, the International Southern Oceans Fishing Industry Clearing House was developed as a project in 1997 to report on IUU activity over a 3-year period. This data was distributed to appropriate agencies and governments and resulted in a decrease of IUU catch, and promoted the schemes now used by COLTO and several other NGOs. These actions are likely to improve the risk of violators losing their moral and social standings thereby influencing the level of IUU fishing they choose to engage in.

3.4. Northwest Australia

46. The discussion here draws heavily on Wallner and McLoughlin (2000) and Fox et al. (2002). In the waters off Northwestern Australia there is a long tradition of fishing by Indonesian fishers. In 1974 a Memorandum of Understanding (MOU) between Indonesia and Australia was signed which included the area of the Australian Fishing Zone (AFZ) in which Indonesian fishers (specifically within the 12 nm territorial limit around Ashmore reefs, Cartier Island, Seringapatam reef, Scott reef and Browse Island – MOU box) primarily exploit resources using small-medium sized sailing craft. In 1989 the area accessible to Indonesian fishers (MOU box) was extended to include the waters between the reefs negotiated in the 1974 MOU. While the early 1990s saw an increase in the number of apprehensions in this box, more recently apprehensions in the box declined (Table 3). However, overall in the AFZ of northwest of Australia, apprehensions have increased with over 138 apprehensions in 2003 up from 111 in 2002 (www.fis.com)

Table 3. Vessel Apprehensions in the MOU Box 1988-1999

Year	Number of vessels
1988	1
1989	2
1990	2
1993	2
1994	63
1995	21
1996	6
1997	1
1998	7
1999	2

Source: Fox et. al., 2002.

47. The decline in apprehensions may be due to several factors: increased awareness of the MOU box and its rules, decreasing fish stocks and therefore less interest in the area and enforcement activities being a deterrent.

48. The Australian government undertakes regular aircraft and vessel surveillance patrols in the area. These patrols have a multitude of purposes including detection of vessel fishing illegally in the AFZ. Between July 1992 and November 1994, 38% of the Indonesian vessels, often motorized and large, sighted by air surveillance were fishing illegally in the AFZ. Research by Campbell and Wilson (in Wallner and McLoughlin 2000) identified 5 Indonesian fisheries in the AFZ, including (i) shark line and longline fishery, (ii) sedentary species (trochus/trepang) fishery, and (iii) demersal finfish fishery, the remaining

two fisheries lacked sufficient detail for further analysis. We will structure the rest of the discussion in this section around these fisheries.

3.4.1. Shark line and longline fishery

49. This fishery is primarily based outside of the MOU Box and fishers are often detected and directed to the MOU Box or apprehended. Recently this fishery has been focusing more on the MOU Box. Although the fishery has been established for a long time, the recent rise in the price of shark fin from IDR¹¹ 150 000/kg (60 USD) for quality cuts in the early 1990s to IDR 600 000 (USD 75) for first class fin in 2002 has seen a surge in fishing activities. The increased value of shark fin has generated an increase in effort and catches in this fishery, and an increase in illegal vessels (motorized) fishing in the MOU box as well as areas outside of the MOU box since 1988. A fishing trip for shark fin catches 5 to 6 kg/vessel worth approximately IDR 3.6 million (USD 432).

Benefits drivers

50. The fishing effort in this fishery in early 1990s is estimated at about 5000 boat-days and shark catch at 800 tonnes, with approximately 200 tonnes taken illegally (Wallner and McLoughlin 2000). The apprehension rate for illegal fishers (primarily motorized vessels) is 25% (this equates to 80 vessel incursions per year) and they spend 3-4 days in the AFZ before being apprehended. It is estimated that boats that are not detected spend approximately 7 days in the AFZ. Wallner and McLoughlin (2000) caution that a number of assumptions have been made in deriving these estimates. Some shark fishers earn IDR 400 000 (USD 100) per year fishing primarily in the AFZ. Indeed fishing in Australian waters is an important source of income for many Indonesian fishers (Fox et al. 2002).

Table 4. Estimates of Shark Fishing Effort and Catch by Boat type 1992-1994

Boat Type	No. boat trips	No. shark fishing days	Mean fin catch per boat (kg)	Wet fin catch per trip (kg)	Wet shark catch per trip (kg)	Annual shark catch (t)
sailing	160	3200	30	130	2600	416
motorized (illegal)	80	420	26	113	2260	158

Source: Based on Wallner and McLoughlin 2000.

51. Although the catch per illegal boat is less than for legal boats, the number of days fishing per trip is also much lower, 5.4 days/trip compared to legal boats which is approximately 20 days/trip (avoidance behavior). Shark fin export prices are as high as USD 120/kg. If a vessel goes undetected the value of the catch is (USD 26 x 120) USD 3 120, which makes the trip quite profitable. Therefore fishers can gain nearly the same economic benefit but in much less time.

3.4.2. Sea cucumber (*Trochus*) / Mollusk (*Trepang*) Fishery

52. Trpang is the principle target species of this fishery, which is focused on the reefs in the MOU Box. There is a nature reserve surrounding Ashmore Reef, which extends to the 50 m isobar and therefore attempts to protect sedentary species. Although there is a vessel present 9 months of the year, it is thought that during the other 3 months compliance is low. Over the last few years, effort has increased on reefs and shoals to the north of the MOU Box. Trepang catches are quite variable ranging from less than 100 kg to

¹¹. 1 USD = IDR 8 726.50 (Indonesian Rupiah) in April 2004.

1000 kg/vessel trip (median catch 100 kg) with declining catches over time expressed by many Indonesian fishers (Fox et al. 2002). Catches of *Trochus* are also variable ranging from less than 10 kg to 1000 kg/vessel trip (median catch 14 kg). Again most illegal activities in the fishery are undertaken by motorized vessels targeting trepang. The average catch of trepang for an illegal vessel is 157 kg.

Benefits drivers

Table 5. Catch and Effort Estimates by Boat Type for Trepang Taken from Reefs within and near the MOU box 1992-1994

Boat Type	No. boat trips	No. trepang fishing days	Mean trepang catch per boat (kg)	Wet trepang catch per trip (kg)	Annual trepang catch (t)
sail	144	4 320	196	2 156	310
motorized	100	450	157	408	31

Source: Wallner and McLoughlin 2000

53. The market price of trepang varies from USD 1.80 to USD 35.10/kg dry weight depending on the species. It is estimated that each ‘legal’ trip generates approximately USD 1 240 per vessel per trip, for illegal vessels a trip is worth approximately USD 1 100. Illegal boats spend much less time fishing, approximately 4.5 days/per trip compared to sail powered vessels which spend about 30 days per trip. While the catch per boat is less for illegal fishers, the daily catch rate is much higher. Many fishers consider the trip worthwhile if they return with a profit of more than IDR 2.5 million (USD 2 500), less than IDR 2.5 million is considered just a success and less than IDR 1.0 million (USD 1 000) is a significant loss and increasing debt.

3.4.3. Demersal Finfish Fishery

54. There are three types of vessels in this fishery that fish illegally in the AFZ:

- Well equipped Taiwanese pair trawlers with Indonesian fishing licenses or under a joint venture with an Indonesian company, they target red snappers and other demersal fish;
- Highly efficient Indonesian longline vessels or “ice boats” which are well equipped including hydraulic line haulers. They carry ice so that the product is fresh when it lands in the Singapore market. Although the capacity of these vessels is 20t most detained vessels had caught 3 to 5 t of fish after one week of fishing. Nine boats were apprehended between November 1992 and November 1994;
- Artisanal fishers from Indonesia who use ‘low tech’ methods. They are the most numerous group and they undertake the longest trips (average of 35 days/trip).

Benefits drivers

55. The data on illegal vessels in this fishery is uncertain, however, for this study we assume that most vessels fish for a maximum of 7 days in the AFZ before steaming to Singapore to sell their catches in the fresh fish markets. In this study a price of USD 25/kg for the fish is used based on Erdman and Pet-Sode (1996). Therefore the value of the catch when landed in Singapore is approximately (4 t/trip * 25/kg) USD 100 000.

56. Legal fisher's catch approximately 175 kg per trip; most of this is dried and therefore of much reduced value. Assuming approximately USD 5/kg price of dried fish gives approximately USD 1 000. However, rarely is a trip just for fish, other more valuable species such as shark and trepang are included. Nevertheless the total value is much less for legal fishers compared to illegal. Compared to the artisanal fleet, the illegal fleet of trawler and longline vessels take a relatively small tonnage of the demersal reef fish but in a very short time.

Detection Drivers

57. Australia has an active air and sea surveillance program and Wallner and McLoughlin (2000) consider the detection rate to be relatively high (25%). The Indonesians also consider the probability of detection to be high (Fox et al. 2002).

Penalty Driver

58. If the vessel is apprehended, it is escorted to an Australian port and the crew detained until the case is heard in the courts. If the captain and crew are found or plead guilty often the vessel is confiscated and destroyed which means further hardship for the captain and crew who are in complex financial/debt arrangement with financiers in Indonesia.

59. According to Fox et al. (2002) a typical shark fishing vessel with its gear including fishing lines, hooks and nets is valued at approximately IDR 18 million (USD 1 800 to 2000). If the boat is a single owner-operator venture then the risk is concentrated in a single vessel and spread among the captain and crew, The owner's ability to generate an income is lost if the boat is confiscated and destroyed. If they are not in debt to finance the purchase of the vessel then their only recourse is to work for another vessel as either a captain or crew. Their incomes drop from 30-50% of the profits to 10% or less depending on the number of crew. Crew earnings are often between IDR 100 000 and 500 000 (USD 12 – 59) per year. The debt for the cost of the hooks and other supplies (IDR 5 to 6 million) is spread among the crew. If the owner has borrowed funds to finance the vessel then the loan remains and to repay it they often become a captain or crew for the financier who dictates when and where they fish. An indebted captain is often required to sail more frequently and in riskier weather conditions by the financier to pay off the debt. Access to moneylenders is costly: 5% per month compare to the bank rate of 18% per annum (Fox et al. 2002).

60. If the vessel is part of a larger fleet under a single ownership the risk of losing the vessel is spread over the fleet and the risk related to the gear is spread over the crew and captain. The impact of confiscating the vessel is much less for these operations since they can purchase a used replacement vessel at a very low price. Often the profit from two or three trips pays for the cost of the vessel for these large fleets.

Avoidance measures

61. The illegal vessels use faster boats as well as communication and navigation technology superior to the legal sailing craft. Many vessels also use hydraulic lines. Vessel owners also stop off at the last Indonesian port, island of Rote, to remove the engine from the boat so that they are not apprehended in the MOU box. Therefore much of the avoidance costs are tied up in the technology. Vessels also avoid staying for long periods of time in the AFZ, usually spending about 25% of the time that legal vessels spend in the MOU waters. Larger vessels will dash into the AFZ, fish for a period of time and then dash back into Indonesian or international waters, other larger vessels act as motherships and anchor just outside of the AFZ while smaller vessels take the risk of fishing illegally for short periods of time, returning with their illegal catches to the mothership (Wallner and McLoughlin 2000).

Moral and social drivers

62. For many Indonesians that take the decision to fish illegally (use motorized vessels in the MOU Box or to fish outside of the MOU Box regardless of the vessel type) in the AFZ is based on the relatively abundant marine resources found in the AFZ compared to severely overexploited marine ecosystems in Indonesia and therefore the prospect of good catches. Fox et al. (2002) also noted that “they made a conscious decision to fish there, just as their elders and ancestors had done so”. They felt they had no alternative but to fish there, as resources in other areas were no longer available. Some fishers also said that if Australians did not utilize the resources then they thought it was not wrong to fish it (Fox et al. 2002)¹².

63. For many Indonesians, if they are not caught, a single trip can provide the same economic return as a year of fishing in Indonesian waters. In relative terms, the economic return is small compared to the fisheries listed in Table 1 but for the Indonesian fishers it is high enough to motivate them into action. For example, at Taka Bone Rate in South Sulawesi many fishers who remain in Indonesia have annual per capita incomes of less than USD 300 (Sawyer 1992). However, many fishers from Taka Bone Rate join on as crew on vessels going to Australia to fish and there they earn substantially more from a single trip. Many of the fishers on these illegal vessels are deeply in debt and desperate to reduce their debt or to provide funds needed to meet social and family obligations. Indonesia lacks a social net for it's economically disadvantaged and therefore the need to meet family obligations is high among fishers. For some fishers there is an additional social driver due to the long history of Indonesians fishing in the area and therefore a sense of moral right to fish irrespective of the vessel restrictions. Fox et al. (2002) interviewed Indonesian fishers and many expressed the view that Australia has accommodated traditional fishers through a MOU, but only if they fish using traditional vessels, which are usually sail powered and therefore less efficient and more time consuming than motorized vessel.

4. Discussion

64. Often the economic gains from IUU fishing are significant enough to motivate fishers to engage in these actions. In some cases, for example, the high valued Atlantic tuna fishery, where high prices have lead to an increased amount of IUU fishing, ICCAT has estimated that Flag of Convenience (FOC) vessels take 10% of all tuna catches by IUU fishing, which is unaccounted for in stock assessments. Another case, of course, is the Patagonian toothfish fishery discussed above that has been fished down quite severely because of IUU fishing, to the extent that it is now endangered. In this case, the incentive is very high as Chilean seabass sells on the illegal market for approximately USD 24 per kilo (BBC 2003). As the demand for fish in the market increases and effort limits are being placed, there are more incentives to fish illegally (FAO 2000a). As the restrictions on legal fishing become greater, with quotas set, gear regulations enforced, and stock sizes managed, there is an increase in the motivation to participate in IUU fishing. Therefore more attention needs to be accorded this problem otherwise current mismanagement of the world's fishery resources because of inaccurate stock assessment will only intensify.

65. In the case of Indonesians fishing in Australia AFZ the monetary stakes are relatively low. The high level of apprehensions and consequential loss of vessels, gear and catch is not a deterrent. Some fishers have had more than 22 vessels confiscated and destroyed (Fox et al. 2002) and yet the number of apprehensions in northern waters continues to increase. The risk of increasing their debt to financiers does not limit owner-operators and laborers from fishing illegally, and the owners of large fleets can spread the risk over the entire fleet. The lack of marine resources in their own waters, combined with few alternative income generating activities and the returns of fishing relative to the alternatives still make IUU fishing a better choice.

¹² See also Butcher (2002) for a similar story from Thailand.

66. It is also important to take into account the fact that there are many ways in which fishers can bypass regulations to engage in illegal fishing. Fishers can easily underreport catches and discard many low-value fish. They can also engage in transshipment at sea which is difficult to detect (Angel et al. 1994). There are some cases where vessels report catches of one species for another in order to avoid quota non-compliance (Angel et al. 1994). Some IUU fishing occurs in the high seas, which, due to its large area, is very difficult to monitor and survey (Bours et al. 2003). Most of the illegal fishing (breaches against national fisheries statutes) is detected in the EEZ of countries, especially where there is an aggressive surveillance and enforcement program. However, this does not necessarily reflect the total IUU situation for two reasons:

- 1) On the high seas regional fish bodies have passed relatively few fishing regulations to control who has access to the resources. The North Atlantic and the waters managed by ICCAT are the exceptions where there are quotas and joint regional enforcement or national enforcement initiatives to encourage compliance among member states. However, if a non-member country fishes in the high seas contrary to the regulations as seen in non-ICCAT countries fishing for tuna in the Atlantic, the mechanisms are limited in applying penalties to offenders;
- 2) Similarly, regulations regarding by-catch and other non-target species caught on the high seas are generally not covered in regional fishing regulations or in required trip reporting and therefore not well captured in many databases.

67. In the face of these big challenges, monitoring, control and surveillance activities are still very limited in scope in many fishing areas. From 1979-1993, the estimated observer and aerial surveillance coverage of the high seas was 5% which is not enough to catch all illegal practices. What is more, with vessels that have been caught, operators cover the fine as operational expenses, and simply purchase another vessel and start all over again (Agnew 2000). Since the net profits of each vessel usually exceed the price of the vessel, abandoning that vessel once apprehension occurs is not a major problem for most operators (Agnew 2000). Many vessels use fake operating companies to avoid having to pay fines when caught. The true identity of the vessel is never detected and the company name changes many times (ISOFISH 2000). Surveillance and enforcement of the high seas will be very expensive, making monitoring systems difficult to implement on a regular basis, especially, in developing countries (Agnew 2000).

68. A number of lessons can be drawn from the case studies. First, learning from the Namibian experience, the incidence of IUU fishing in an area can be reduced significantly by sending strong signals from time to time to potential violators that swift action will be taken against them. Second, when NGOs and non-governmental agencies take action in an IUU related case; the significance of moral and social considerations for the fishers, as well as the probability of being apprehended can be enhanced, as demonstrated by the Patagonian toothfish case study. NGOs make it a primary objective to publicize the operators or companies engaging in IUU activity. Although the social obligations are non-existent if the fisher is outside their national waters, the knowledge of its illegal activity made public to the vessels' country could provide an incentive to decrease its IUU fishing. Third, the use of vessel monitoring systems is highly effective in tracking vessels, and for the operators themselves is an inexpensive tool. From the surveillance side, the implementation of VMS reduces the amount of surveillance required and therefore more time can be spent on inspections rather than finding the vessel. From the fishers' perspective, VMS will increase the probability of being caught and therefore in order to continue to fish illegally, avoidance measures must be increased. The consequence of this is to make IUU fishing less attractive. Finally, from the Northwest Australian example we learn that measures to deal with IUU fishing when the violators suffer extreme poverty can be very challenging. Under these circumstances fines and other penalties may not act as a disincentive to IUU fishing.

69. Finally, we can see three ways in which this contribution can be extended to make it even more relevant to policy makers and managers. First, the map presented here needs more data to be fed in it. This means more effort at building the SAUP IUU database is necessary. Second, the improved database can then be used to improve and extend the model calculations presented in Table 1. To further enhance the table, more effort at estimating the value of θ for different fisheries is warranted. Finally, our observation in the last line of the paragraph above on how extreme poverty can pose a problem for current measures at reducing IUU fishing demands that this model needs to be extended to make it flexible in tackling

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APPENDIX 1. The Formal Model

In this section, we formalize the discussion above into a model. Following on the earlier discussion, we assume that the decision to engage or not to engage in IUU fishing depends on the potential net benefits (*NB*) from illegal fishing moderated by moral and social considerations. Let *NB* be defined in a broad sense by the following function:

$$NB = f(h(A, e, x), \theta(e, A, R), F, m(e), s(e)) \quad (1)$$

$$NB_h > 0; NB_\theta < 0; NB_F < 0; NB_m < 0, \text{ and } NB_s < 0.$$

Where *h* is the catch from IUU fishing by a given fisher; *e* stands for IUU fishing inputs; *x* is the biomass of fish available; *A* denotes the level of avoidance activity undertaken by the fisher; the variable *R* is the set of regulations in place; θ is the probability of detection; *F* is the penalty a violator faces when caught; *m* denotes the individual's moral standing, which is assumed to be inversely related to the IUU fishing inputs; and *s* represents the fishers social standing in society. This variable also depends inversely on the degree of IUU fishing undertaken by the fisher.

To be more specific, equation (1) is rewritten as:

$$NB = [ph(A, e, x) - T(e, A)] - \theta(e, A, R)F - m(e) - s(e) \quad (2)$$

Where *p* is the unit price of fish caught; $h_x > 0$, $h_e > 0$; $h_A < 0$; *T*(*e*, *A*) denotes the total cost of IUU fishing; $\theta_e > 0$, $\theta_A < 0$; $\theta_R > 0$. The first and second terms in equation (2) denote the total revenue and total cost of IUU fishing, respectively; $0 \leq \theta \leq 1$ is the probability of the fisher being caught and convicted if found engaging in IUU fishing. When there is only partially successful regulation and enforcement, the value of θ lies between 0 and 1. *F* denotes the penalty the violator faces if caught, and to obtain the total expected penalty to be paid by violators, the probability of detection is multiplied by *F*.

The optimality conditions [no 3.2]

The objective of the fisher is assumed to be the maximization of the potential gains from engaging in IUU fishing moderated by moral and social considerations, that is, the maximization of equation (2).

If the fisher chooses not to IUU then *NB* as described in equation (2) is zero. And that is the end of the story.

If, on the other hand, the fisher chooses to IUU in a situation where there is close to no regulation, then the fisher faces close to zero probability of being caught, that is, $\theta \approx 0$, implying that θF is also close to zero. In this situation there will be little if any need for undertaking avoidance activities, *A*, hence *T*(*e*, *A*) is reduced to *T*(*e*) and *h*(*A*, *e*, *x*) reduces to *h*(*e*, *x*). The first order condition under no enforcement is therefore simply:

$$ph_e = T_e + m_e + s_e \quad (3)$$

That is, at the optimum solution, the IUU fisher will choose the level of IUU activity as represented by the decision variable, e , such that the marginal revenue from the activity exactly matches the marginal cost of engaging in the activity, which here means the sum of the marginal cost of fishing and the marginal moral and social cost of engaging in IUU fishing. Equation (3) states that it is not enough for the fisher contemplating whether to IUU or not to IUU to seek to make the marginal cost of IUU fishing equal to the marginal revenue – the marginal revenue has to be more than the marginal cost to cover the loss of moral and social standing that the fisher suffers as a result of engaging in IUU fishing. In fact, it is possible that for a given fisher, the loss in moral and social standing is high enough to make engaging in IUU fishing not worth it under all possible marginal revenue scenarios. From equation (3) one can conclude that for non-violators, m_e and s_e are high enough for them to outweigh the marginal revenue from IUU fishing under all possible scenarios.

If the fisher undertakes IUU fishing when there is enforcement, that is, when $\theta > 0$, $F > 0$ and by implication $A > 0$, the optimality conditions become:

$$ph_e = \theta_e F + T_e + m_e + s_e, \quad (4)$$

and

$$-\theta_A F = T_A - ph_A \quad (5)$$

Equation (4) says that in the optimum, the fisher will choose the level of IUU fishing such that marginal revenue is equal to the sum of marginal cost of engaging in IUU fishing, and the potential marginal fine if caught. Equation (5) stipulates that the marginal gain to the fisher from engaging in avoidance activity must be equal to the marginal cost of avoidance plus the marginal loss in revenues from catch due to avoidance activity. In other words, the fisher weighs the risk of being caught and penalized ($\theta_e F$), the risk of losing moral (m_e) and social (s_e) standing in society, against the expected gain (ph_e) from engaging in the activity. Note that in the case of equation (3) the risk of being caught and penalized is not present.