MARINE CAPTURE FISHERIES POLICY FORMULATION AND THE ROLE OF MARINE PROTECTED AREAS AS TOOL FOR FISHERIES MANAGEMENT IN INDONESIA

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ABSTRACT

The FAO Code of Conduct for Responsible Fisheries states that conservation and management decisions for fisheries should be based on the best scientific evidence available. Studies show that most of Indonesia's capture fisheries are either full or over-exploited. However, the fishery sector is still expected to contribute to the increase of Indonesia's GNP through an increase in total catches. Furthermore, the current practice of using catch-effort data and Maximum Sustainable Yield models to inform Indonesia’s fisheries policies is flawed, putting sustainability and long-term profitability of Indonesia's fisheries at risk. In this paper, the authors argue that to ensure the survival of Indonesia's fish stocks and fisheries: fisheries policy must shift from development-oriented management towards management for sustainability. Furthermore, fisheries managers must accept that 'untapped resources' may not exist or cannot be exploited profitably, and that any transfer of fishing effort between fishing grounds may contribute to collapse of local fisheries. Also, fisheries managers should change the management paradigm from MSY models to eco-system based management, wherein Marine Protected Areas should play an important role.

Keywords: capture fisheries, Indonesia, management, over-exploitation, policy

INTRODUCTION

It is the responsibility of Indonesia's government to manage its natural resources for the greater benefit of all citizens (cf. Article 33 in Indonesia's Constitution of 1945 and Law No.6 of 1996), while ensuring long term sustainability of its management approaches. This also holds for Indonesia's living marine resources, such as fish, sea cucumber, and shellfish among others lobster, shrimp, giant clam *(kima)*, and pearl oysters. The vision statement of the Ministry of Marine Affairs and Fisheries (DKP) emphasizes that marine and freshwater ecosystems should be maintained for coming generations *(Vision, Mission and Program of DKP, http://*

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www.dkp.go.id). What all of these living resources have in common is that they are renewable; different from natural resources such as oil or copper, nature can actually replenish what was taken for consumption or for sale. However, there is a limit to what nature can produce. If man takes more than this limit, the resources will degrade, resulting in lower replenishment, in turn resulting in further resource degradation, and ultimately, in the complete loss (collapse) of the resources.

Unfortunately, this 'collapse' scenario has become a reality for many of the world's fisheries - the Food and Agricultural Organization of the United Nations estimates that 75% of the world's marine fisheries are fully-exploited, over-exploited or already depleted - only 25% of the world's fisheries are under-exploited (FAO Fisheries Department, 2002). Total catch by the world's marine fishery in 2000 was 5% lower than during its peak in 1995 (excluding China, because of uncertainties in its fishery statistics). Once it is depleted, it may take a long time for fish stocks to recover, even after cessation of fishing - for example, haddock, redfish and cod in the Northwest Atlantic are still not showing signs of recovery after the implementation of a near-complete ban on fishing in the nineties (FAO Fisheries Department, 2002). The global picture is that the world's total catch is decreasing, and that fishers anywhere in the world need to sail farther and to fish deeper because of dwindling fish stocks.

Indonesia's Ministry of Marine Affairs and Fisheries is aware of the problem of over-exploitation in the Western part of Indonesia's seas, notably the seas around Java. Driven by a public expectation that the fishery sector must contribute to increasing Indonesia's GNP through increased total catches, DKP is now looking for 'untapped potential' in Indonesia's Eastern seas (Widodo, 2003). The question is to which extent Indonesia's Eastern seas can sustain further intensification of their current fisheries. Are the seas of eastern Indonesia among the 25% of the world's fisheries that, according the FAO, can be developed further?

Indonesia certainly seems to be heading for further intensification of its marine capture fisheries. Recently, governments are actively attracting foreign investors to exploit so-called "untapped resources" in Indonesia: the website of the British Embassy in Indonesia invites the British fishing industry to take advantage of this opportunity, 'by supplying used fishing vessels, possibly with crews, fishing gear, gill-nets, trawling, pole and line, purse seining, consultancy services and technology transfer'. A sign at international arrivals at Bali International Airport from the Investment Board East Java Province invites foreign investors to take advantage of the untapped potential of the fisheries industry in East Java. It should be noted that not only large-scale fishing operations contribute to over-fishing: recent research in Fiji shows that artisanal fisheries may depress fish stocks to such an extent that lower levels of reef ecosystems including reef-building corals themselves are impacted through cascading effects in the ecosystem (Dulvy *et al.* 2004).

In this paper, an investigation was conducted on whether Indonesia's fish stocks can keep up with higher exploitation rates and how Indonesia's fishery development policy is guided. Furthermore, the role of Marine Protected Areas, traditionally thought as an instrument for biodiversity conservation, as a tool for management of Indonesia's marine capture fisheries was also studied.

MATERIALS AND METHODS

In this study, policy recommendations provided by various experts since early 1995 to the Ministry of Marine Affairs and Fisheries, formerly Directorate General of Fisheries (DGF) under Department of Agriculture are extracted. Important documents that were consulted included: FAO studies by Venema (1996) and Gillet (1996), a study commissioned by DKP (Pacific Consultants International, 2001a; 2001b; 2001c) and reports from the National Committee on Stock Assessment (2001; 2003). Regarding Indonesia's fishery statistics, recommendations were provided by Dudley and Harris (1987) and Pet-Soede et al., (1996).

The status of fishery resources is still the main consideration in policy formulation for Indonesia's fisheries development. Maximum Sustainable Yield (MSYor *potensi lestari)* is still the primary tool to assess the status of fisheries resources (Ministry of Marine Affairs and Fisheries, 2002; Sularso, 2005). The status of Indonesia's marine capture fisheries is reviewed by the research unit of DKP (PURISPT), as well as by researchers from universities and experts from fishing companies who arc all represented in the National Committee on Stock Assessment. The results are summarized in a tabular format stating the status of fisheries, categorized as: under-exploited, fully-exploited, over-exploited, or for which the status is uncertain.

In this paper operational policies of DKP are cross-checked with policy recommendations and information on status of the fisheries. DKP's operational policies arc as outlined in a Ministerial Decree (Ministry of Marine Affairs and Fisheries, 2002), and in papers by DGs in various internal DKP's meetings shared through *http:// www.dkp.go.id/.* Furthermore, MSY-based fisheries management is reviewed and compared with the application of ecosystem-based management where marine protected areas play an important role.

RESULTS

Maximum Sustainable Yield (MSY)

DKP bases its estimates of Indonesia's fishery potential on a calculation method that can be traced back to the 1930's, when the Norwegian fisheries biologist Hjort introduced his theory of equilibrium fishing - catching an amount of fish that is equal to the amount offish that is added to the population through growth and reproduction. Hjort also stated that the amount offish that can be caught is maximal if the fish population is fished down to about half of its pristine (i.e. un-exploited) biomass. It follows that to provide management advice, fishery scientists must monitor both the fish stock and the number of fishing vessels. Once the fish stock has decreased to half of its pristine size, the total number of vessels (or nets) should be kept constant and no more new licenses should be issued. Of course, monitoring fish stocks is expensive, and even now, 70 years later, it is almost impossible to get good estimates for the amount offish in the sea.

Another scientist, Schaeffer, solved this problem in the 1950s through a method that is based on analysis of yearly catch and effort data (Smith, 1988). It is this method that DKP, as many other fishery management agencies all over the world, uses to estimate the potential catch. In essence, DKP collects information on the number of fishing vessels and the total amount offish that they catch, and a fairly simple calculation results in an estimate of the potential catch as well as an estimate for the size of the fleet that would be required to realize this potential catch. This potential catch is often referred to as the Maximum Sustainable Yield (MSY) (Fig. 1).

In Indonesia's fishery policy, management objectives are determined by MSY. In consideration of the precautionary principle, the management objective for Indonesia's fishery has recently been set at 80% of MSY (Ministry of Marine Affairs and Fisheries, 2002). As the total yield of maximum economic return is lower than MSY (Gulland, 1983), including the precautionary principle in this case makes both sense as well as cents.

There are at least five studies on MSY: (a) DGF/CRM review of data from late 1980's by Martosuebroto, (b). DGF 1995 review of data from early 1980's, (c). Indonesia/FAO/DANIDA 1995 review of all available data (Venema, 1996), (d) Ministry of Marine Affairs and Fisheries (2001) based on hydro-acoustic survey and observation on commercial fisheries and (e) a review by Pacific Consultants International (2001c). Pacific Consultants International presents six different MSY estimations that vary between 3.67 and 7.7 million tons, the estimate amounting to 6.26 million tons. This estimate was officially adopted through Ministerial Decree of DKP No. Kep. 18/Men/2002.

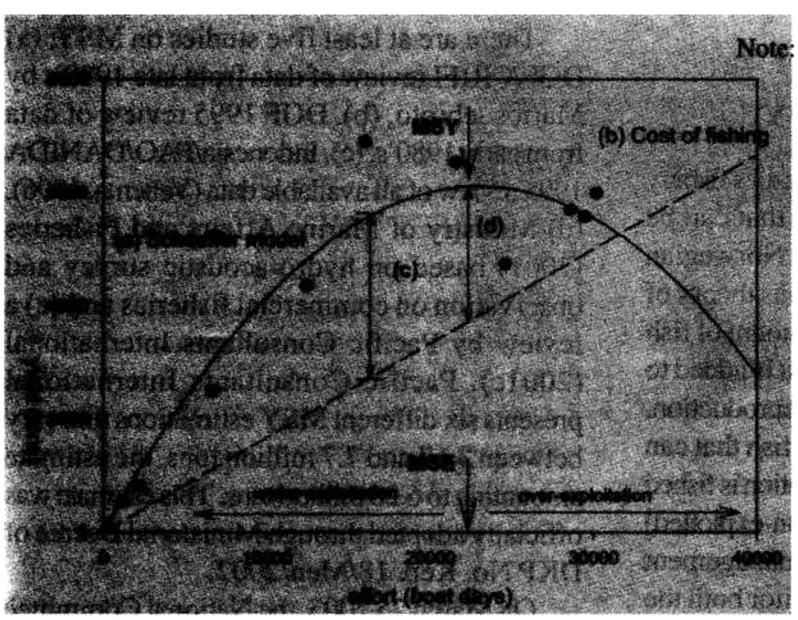
On March 25 2003, the National Committee on Stock Assessment *(Komisi Pengkajian Stok Nasional)* decided to review this estimate for MSY. A National Coordination Meeting organized by DKP on May 25 - 27, 2005 in Jakarta, changed the MS Y estimate to 6.4 million tons per year (Ministry of Marine Affairs and Fisheries 2005b; available at *http://www.dkp.go.id/)*, and DKP targeted a Total Allowable Catch of 5.1 million tons (80% of MSY) to be achieved by the end of 2006. This MSY estimate is based on an assessment held by DKP in 2001 (Ministry of Marine Affairs and Fisheries, 2001)

The conclusion is that MSY estimates vary as much as a factor two, whereas the most recent estimate for MSY is 6.4 million tons per year. According to the most recent fishery statistics, Indonesia's production of marine capture fisheries was 4.88 million tons in 2004 (Ministry of Marine Affairs and Fisheries, 2005a). DKP projects a catch increase of 0.22 million tons in two years. To achieve this target, DKP plans to invite foreign investment through subsidies. The question is whether the difference between MSY and the realized catch means that there is scope to expand Indonesia's capture fisheries.

Three important problems with the calculation of MSY should be considered. First of all, the outcomes of the calculation are only as good as the quality of the fishery statistics that are being used as input. Secondly, the calculation method is based on a number of assumptions that are rarely met, the two most important assumptions being that the fish stock is in equilibrium and that the catch per unit fishing effort (catch per fishing vessel per day) is a good indicator for the size of the fish stock. Finally, the results of the calculation are often misinterpreted.

Quality of fishery statistics

Especially in Indonesia's dispersed multi-gear and multi-species fisheries, statistics are very difficult to collect - it is impossible to collect statistics on every catch that is landed along the 80,000 km of Indonesia's coastline. Therefore, a sampling system for collecting fisheries statistics was designed nearly 30 years ago. It is based on measuring some of the daily catches at the villages, after which the average daily catch is multiplied by the number of vessels and the number of fishing days to get an estimate for the yearly catch (Yamamoto, 1980 *in* Pet-Soede *et al*, 1999). Various studies have demonstrated weaknesses in the fisheries statistical system, and these weaknesses are compounded by the DKP's lack of resources to properly implement the system (Dudley and Harris, 1987; Venema, 1996). Furthermore, DKP acknowledges that there is a huge problem of illegal, unregulated, and



Note: The Schaeffer model (a) is a parabola (yield = *a* * effort + *b* * effort^2), where *a* and *b* are estimated by fitting the yield – effort observations Here, *a* = 0.53 and *b* = - $1.15 \cdot 10^{-5}$. The fishing effort needed to achieve MSY is Maximum Sustainable Effort (MSE). It follows that MSE = *-a*/(2*b*) = 23,007, whereas MSY = 6,100 tons. Under exploitation is the area where the actual effort < MSE, whereas over-exploitation is the area where actual effort > MSE; in both under- and over-exploitation, the yield is lower than MSY. The cost of fishing (b) is here assumed to increase linearly with effort. The economic return of the fishery, i.e. the difference between the yield (a) and the cost of fishing (b), is maximal at an effort level lower than MSE (compare (c) to (d)). Graph adapted from Sparre & Venema (1992) and Gulland (1983).

Figure 1. Data on the total annual yield (Y-axis) and the total effort to realize that yield (X-axis) of a hypothetical fishery over a 10 year period (black dots).

unreported fishing. Obviously, catches realized through illegal, unregulated, and unreported are not accounted for in the statistics. The FAO study reported by Venema (1996) specifically mentions the lack of data from Eastern Indonesia.

A recent study commissioned by DKP recommends the following: 'In view of the questionable quality of the data and statistics on fisheries presently being compiled, arising from the reliance of an obsolete data collection system based on a sampling framework and methodology developed about 30 years ago, the government should set up an independent or autonomous data and information centre solely responsible for the collection, compilation, analysis, interpretation, reporting and dissemination of fisheries statistics.' (Pacific Consultants International, 2001b). The conclusion must be that MS Y estimates from these flawed data must be treated with extreme caution. This caution is unfortunately lacking in current management.

Equilibrium of fish stocks

Schaeffer's MSY calculation assumes that the fish stocks are in equilibrium, meaning that if the fishing effort remains constant, the catch and the exploited fish population will remain constant as well. However, in a developing fishery (a fishery where the fishing effort is gradually increasing), a fish population will need time to adjust to the higher fishing effort, meaning that if the increase in effort would cease, the fish population would continue to decrease over some years until equilibrium is reached. The time period needed to reach equilibrium is unknown. Recent research suggests that many fish stocks have been continuously decreasing since they were first exploited, with the fish population being depleted by 80% in the first 15 years after onset of exploitation (Myers and Worm, 2003). This means that many fish stocks have never reached equilibrium. Consequently, applying Schaeffer's calculation to these catch and effort data would have severely over-estimated the MSY.

Another example that shows that current catch levels rarely represent a fishery that is in equilibrium is the fishery for live reef food fish supplying markets in Hong Kong. This fishery rapidly expanded as fishing grounds around Hong Kong became depleted (Bentley, 1999; Sadovy *et al.*, 2003). Only after the damage has been done we can conclude that the fishing effort in the areas (including in eastern Indonesia) that are now depleted of target species, must have been too high. After the stocks have collapsed we can conclude that the catch was not from a stock in equilibrium, but from a stock that was still declining. It is not unlikely that many of Indonesia's fisheries are exploiting stocks that are actually declining instead of being in equilibrium. Therefore, there is a serious risk that current MSY estimates are much higher than the catch that can actually be sustained over the long term by Indonesia's fish stocks.

In an equilibrium fishery, a catch *higher* than maximum sustainable yield is a contradiction in terms. In reality, however, catches higher than the estimated MS Y sometimes occur (see for example the two yield observation > MSY in Figure 1), and often these are interpreted as a sign of over-exploitation. Though catches higher than MSY are certainly a matter of concern, such differences are more likely to be a result of errors in the data on which the MSY estimates were based or of natural variations in the fish stock, which are common in short-lived pelagic species such as *lemuru* and *tembang*. Therefore, if the catch turns out to be higher than earlier MSY estimates, this should be understood as evidence that the assumptions underlying the MSY estimation were not met, and that the MSY estimate itself should be interpreted with care.

Catch-per-unit-effort as an indicator for stock size

All over the world, fishery scientists use catch-per-unit-effort data to assess the status of the stock. By doing so, fishery scientists assume that as the stock is decreasing fishers will land gradually smaller catches. The assumption equals fishing to a lottery: if there are fewer prizes in the pot, then there will be fewer wins. By making this assumption, they hugely underestimate the adaptive skills and resourcefulness of fishers. After

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all, once a fisher is unsatisfied with his daily catch, he will probably move to other sections of the reef where fish is still plentiful. At some time, he may even switch to more effective gears, or he may target other species that are more plentiful. As the last remaining fishing grounds have been fished out, there will be a sudden collapse of the fishery, as happened to the Canadian Atlantic cod fishery in the 1990s (Walters and Maguire, 1996).

Interpretation of Maximum Sustainable Yield estimates

Another common problem is the interpretation of MS Y estimates, and how current catch levels are used to generate management advice (Gillett, 1996). Indonesian fisheries managers have in the past interpreted a total catch below the MS Y as a sign that there is still scope for further expansion of the fishery. It seems that the difference between Indonesia's realized catch of 4.88 million tons (2004) and the estimated MS Y of 6.4 million tons is currently also interpreted in this erroneous way (Ministry of Marine Affairs and Fisheries, 2005a; 2005b). Policy makers in Indonesia fail to understand that the difference may well be an indication for over-exploitation.

Over-exploitation means that the effort is so high that fish do not get the time to grow and reproduce, resulting in a catch that is actually lower than could have been realized with a lower fishing effort (Fig. 1). Hence, an evaluation of the status of the fishery is only meaningful with consideration of the fishing effort, and MSY by itself is not suitable as a management target. Management should consider current effort levels in comparison to the Maximum Sustainable Effort, MSE, i.e. the estimated effort at which MSY is achieved (Fig. 1). Most of the analysis done for individual fisheries actually showed that levels of MSE were already surpassed and that these fisheries therefore were yielding reduced catches due to over-exploitation (Widodo *et al*., 2003).

The lack of consideration of Indonesia's fishery managers for MSE resulted in the lack of a well-defined strategy on how to limit access to Indonesia's fishery. The current licensing system could be used to limit access by restricting the number of licenses issued, but so far a limit in terms of fishing capacity has not been defined nor is a procedure in place to stop issuance once such limit would be reached.

Status of Indonesia's fisheries

A recent workshop assessing the status of five Indonesian fisheries showed that each of the assessed fisheries showed clear signs of over-exploitation (Widodo *et al.,* 2003). For these fisheries, experts recommended restrictive measures (closing of fishing grounds, limiting issuance of licenses, lower total allowable catches, etc.) and reductions in the capacity of the fleet (Widodo, 2003). However after concluding that there is a discrepancy between the biological production of Indonesia's fish stocks and the country's expectation for higher catches, the workshop decided that the earlier estimate for Indonesia's MSY (according to this workshop 6.4 million tons, which is close to the estimate of 1997) could still be achieved by exploring and intensifying fisheries in waters outside the study area and by exploring unconventional resources such as deep sea fish stocks. Another recommendation formulated in the workshop proceedings is to keep the total effort at its present level. Though the workshop acknowledges the challenged status of Indonesia's fisheries, its recommendations and findings are ambiguous: restrictive management versus further exploration and intensification, and an unfounded belief in the existence of under-exploited stocks while most if not all studies shows that the status of those fisheries in Indonesia that are assessed is either over-exploited or uncertain. Additional recommendations to increase fish production include (ii) improvement of post-harvest techniques; and (iii) technology-based aquaculture, including genetic manipulation. Also, the workshop recommended that management should consider ecosystems rather than single species, and the workshop highlighted the need for better monitoring of fish stocks, habitats and ecosystems.

There are at least 15 studies on the status of Indonesia's marine capture fisheries per Fisheries

Management Area (*WPP, Wilayah Pengelolaan Perikanan)* and species category in the catch. The result is summarized in Table 1. Numbers in italics represent the number of assessed fisheries that are under-exploited, fully-exploited, over-exploited or for which the status is uncertain (although study found some indicators to the onset of full- or over-fishing, but authors do not confident to conclude so).

In general, it shows that 56 out of 129 conclusions stated that Indonesia's fisheries are over-exploited, 26 conclusions stated that fisheries are fully-exploited, 8 conclusions for uncertain and 37 conclusions stated that fisheries are under-exploited. From all studies conducted specific to each Fishing Area, most of the fisheries are either full or over-exploited, except for Fisheries Management Areas of Banda Sea, and Seram Sea and Tomini Bay. However, these do not represent the fishery status of eastern Indonesia. With respect to red snapper (demersal) fisheries in Arafura Sea, Badrudin and Blaber (2003) concluded that if fishing pressure to be maintained at present level (2002), the fishery will soon collapse and may never get a chance to recover.

DISCUSSION

The recent policy document commissioned by DKP (Pacific Consultants International 2001b) devotes an entire chapter to 'De-emphasizing MS Y'. It is understandable, but unfortunate, that despite this policy recommendation DKP still uses **MSY *('Potensi Perikanan Tangkap')* in its** communications - potential investors may be unaware of the uncertainties in the estimates and may even perceive the difference between the current annual catch and the estimated MSY as an encouragement for further investment in capture fisheries.

Not only in Indonesia, but also in many other of the world's fisheries, the concept of MSY has proven to be ineffective in guiding fisheries management. Especially in Indonesia's multi-gear and multi-species fishery, it is almost impossible, or at least prohibitively expensive, to get the high quality data that are necessary for the estimation of MSY; and if these data were available then it is likely that the calculation would give overly optimistic estimates of the catch that fish populations can sustain over the long term. It is indeed time to de-emphasize MSY as a management objective.

The policy document commissioned by DKP is also very clear about the status of Indonesia's marine capture fisheries: 'With fisheries facing certain depletion and imminent collapse, not only in Indonesia but also throughout the world a continuing emphasis on uncontrolled or unmanaged development and expanded production as had been pursued in the country over the last 30 years is clearly ill advised. To check further uncontrolled expansion and reverse over-fishing, a different set of fresh policies and strategies is needed' (Pacific Consultants International, 2001b). The policy document further recommends to 'Create, build and arouse awareness to change the perception and mindset of the people to stop romanticizing that the country's seas have over-abundant or overflowing resources, in particular fisheries resources' (Pacific Consultants International, 2001a). In this light, the recent announcement of the plans to invest in the marine capture fishery around Papua and any other plans to intensify marine capture fisheries in any part of Indonesia can only be regarded with the greatest concern.

Not only Indonesia's fisheries, but also its fishery management is in a crisis. Whereas most (if not all) credible stock assessments conclude that the status of Indonesia's fisheries is either uncertain or over-exploited, DKP is expected to manage the fishery in such a way that its contribution to an increase in GNP by somehow realizing ever-increasing catches from a limited resource. Whereas DKP officially admitted that some fisheries are already over-exploited (Ministry of Marine Affairs and Fisheries, 2002), DKP's policy still is to increase production from 4.88 million tons to 5.1 million tons in 2006, possibly by inviting foreign investments leading to increased effort.

Restrictive measures by definition result in a short-term decrease in total catch and therefore

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Table 1. Result from various studies on the status of Indonesian marine capture fisheries per Fisheri Management Area (*WPP, Wilayah Pengelolaan Perikanan*) and per species category of the catch

FISHERY/ STATUS	FISHERIES MANAGEMENT AREAS:									Total	Sources
	1	2	3	4	5	6	7	8	9		
Large-Pelagic											Widodo *et al.* (2003); MoMAF (2001); Merta *et al.* (2003)
Under-Exploited		*1*			*1*	*1*		*1*	*1*	5	
Fully-Exploited	*1*		*1*	*1*					2	5	
Over-Exploited							2	*1*		3	
Uncertain										0	
Small-Pelagic											Atmadja and Nugroho (2003); Widodo *et al.* (2003); MoMAF (2001); Atmadja *et al* (2003); Merta *et al.* (1996); Aziz (2001)
Under-Exploited		*1*		*1*	*1*	*1*	*1*	*1*	*1*	7	
Fully-Exploited			*1*							1	
Over-Exploited	*3*	*1*	2	*1*	*1*		*1*		*1*	10	
Uncertain			2							2	
Demersal											Widodo *et al.*(2003); Badrudin*et al.* (2003); Sumiono (2002); MoMAF (2001); Badrudin and Blaber (2003); Sumiono *et al.* (2003); Atmadja *et al* (2003); Badrudin *et al* (1996); Aziz (2001)
Under-Exploited		*1*	*1*		*1*					3	
Fully-Exploited	*1*	2	*1*	*1*		*1*			*1*	7	
Over-Exploited	2	*1*		2	*1*		*1*	*5*	*1*	13	
Uncertain	*1*		*1*							2	
Reef-Fish											MoMAF (2001); Aziz (2001)
Under-Exploited		*1*								1	
Fully-Exploited	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	9	
Over-Exploited			*1*	*1*	*1*		*1*		*1*	5	
Uncertain										0	
Penaeid-Shrimp											Widodo *et al.* (2003); Wedjatmiko (2003); MoMAF (2001); Badrudin and Sumiono (2002); Aziz *et al.* (1996); Aziz (2001)
Under-Exploited						*1*			*1*	2	
Fully-Exploited							*1*	*1*	*1*	3	
Over-Exploited	*1*	*3*	2	2	*1*	*1*	2	*3*	*1*	16	
Uncertain	*1*			*1*				*1*	*1*	4	
Lobster											MoMAF (2001); Aziz (2001)
Under-Exploited	*1*	*1*	*1*		*1*	*1*	*1*	*1*	*1*	8	
Fully-Exploited										0	
Over-Exploited				*1*						1	
Uncertain										0	
Squids											MoMAF (2001); Aziz (2001)
Under-Exploited					*1*	*1*	*1*		*1*	4	
Fully-Exploited		*1*								1	
Over-Exploited	2		2	2				2		8	
Uncertain										0	
All-Fishery											MoMAF (2001)
Under-Exploited		*1*		*1*	*1*	*1*	*1*	*1*	*1*	7	
Fully-Exploited										0	
Over-Exploited	*1*		*1*							2	
Uncertain										0	
Total conclusions per category											
Under-Exploited	1	6	2	2	6	6	4	4	6	37	
Fully-Exploited	3	4	4	3	1	2	2	2	5	26	
Over-Exploited	9	5	8	9	4	1	7	11	4	58	
Uncertain	2	0	3	1	0	0	0	1	1	8	

Note:
Fisheries Management Areas: 1=Malacca Strait; 2=South China Sea; 3=Java Sea; 4=Makassar Strait and Flores Sea; 5=Banda Sea; 6=Seram Sea and Tomini Bay; 7=Sulawesi Sea and Pacific Ocean; 8=Arafura Sea; 9=Indian Ocean
Numbers in italics represent the number of assessed fisheries that conclude under-exploited, fully exploited, over-exploited or for which the status is uncertain
MoMAF = Ministry of Marine Affairs and Fisheries (DKP)

in an immediate failure to contribute to the overall goal of the Ministry. It is unlikely that short-term losses from restrictive management can be offset by expansion of aquaculture, which requires significant capital investment, or by exploration of untapped resources, which may not exist or which may not be economically viable (as is the case for the fishery for small demersal species in some areas, *cf.* Venema, 1996). The only way to break through this impasse is by creating understanding in Indonesian society and in DKP that development in capture fisheries should not be measured by ever-increasing production figures, but rather by a credible effort towards building a profitable, socially responsible and environmentally sound industry that sustains livelihoods of present and future generations of coastal communities.

A powerful alternative to MSY - oriented management is fishery management based on establishing networks of Marine Protected Areas (MPAs). The IUCN (International Union for the Conservation of Nature and Natural Resources) definition of a MPA is: 'an area of tidal or sub tidal terrain, together with its overlying waters and associated flora, fauna and historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment'. Besides their function as an instrument for biodiversity conservation, MPAs are increasingly advocated as a fishery management tool that should be integrated into coastal zone management plans (Gell and Roberts 2002; National Research Council, 2001; Roberts and Hawkins, 2000; Ward *et al.,* 2001).

Scientific evidence that MPAs with substantial no-take zones result in higher fish biomass, larger-bodied fish, and a more natural species composition is already strong (27 studies reviewed in Roberts and Hawkins (2000). Scientific evidence is growing for the more difficult to demonstrate commercial benefits of no-take areas (3 studies reviewed in Roberts and Hawkins (2000). Roberts *et al.* (2001) report that a network of five small reserves in St Lucia increased adjacent catches of traditional fisheries by between 46 and 90%, whereas reserve zones in the Merritt Island National Wildlife Refuge (Florida) have supplied increasing numbers of world record-sized fish to adjacent recreational fisheries since the 1970s. After studying the effects of closed areas on the fishery on spiny lobsters in New Zealand, Kelly *et al.* (2001) conclude that emigration of juvenile and adults lobsters from the closed area into adjacent fishing grounds may greatly reduce the long-term losses of local fishers from lost fishing opportunity. The main reason for the scarcity of field studies that scientifically prove commercial benefits of MPAs is the difficulty of doing experimental, replicated research on ecologically meaningful scales that includes fisher's response to closing fishing grounds. However, the mechanisms that can be deducted from the proven effects on fish populations within no-take areas are compelling.

Mechanisms of how increased biomass and body size of commercially important species within no-take areas can provide benefits for commercial fisheries are *(cf.* Roberts and Hawkins 2000): (1) spill-over of adults and juveniles from no-take areas into surrounding fishing grounds; (2) export of planktonic eggs and larvae from no-take areas into surrounding fishing grounds; (3) prevention incomplete collapse of the stocks of exploited species in case fishery management in surrounding fishing grounds fails, providing a basis for population recovery after more effective fishery management in surrounding fishing grounds has been put in place. Furthermore, MPAs provide a tool for protection of sensitive sites, such as spawning aggregation sites for reef fish (Johannes, 1998). Another advantage of MPAs over other fishery management tools, such as effort, gear and quota regulations, is that the effect of closed areas within MPAs may be more straightforward to explain to stakeholders, especially if the closed area includes spawning or nursery grounds. Though costs for establishing and managing networks of MPAs are substantial, benefits far outweigh costs. A global network of MPAs covering 20-30% of the seas on Earth would cost $5-19 billion per year, but it would increase sustainability of a global marine fish catch currently worth $70-80 billion annually and such a network may help sustain unseen ecosystem services worth roughly $4.5 - 6.7 trillion each year (Balmford *et al.,* 2004). The amount needed to establish and manage a global network of MPAs is less than the amount spent by developed world economies on harmful subsidies to industrial fisheries ($15-30 billion per year) (Balmford *et al*, 2004).

The policy document commissioned by DKP recommends declaration of at least 10% of Indonesia's seas as MPAs (Pacific Consultants International, 2001a). Recently the Directorate General of Coastal and Small Islands has shown a keen interest to develop a strategy for the establishment of MPA networks in Indonesia and established a forum of governmental and non-governmental agencies, the National Committee on Marine Conservation in Indonesia (Decree 43/P3K/III/2004). This forum comprises a steering committee and a technical committee with 3 working groups which provide technical input for draft policies focusing on development of a National MPA strategy, development of sustainable fisheries management, and development of policies for species and genetic conservation. At the interface of the MPA strategy and sustainable fisheries topics, one of the main roles and greatest challenges of the technical committee will be to formulate policy advice to develop more sustainable fisheries through incorporation of MPA networks as tools in national as well as local fisheries management.

CONCLUSION

In conclusion, studies show that most of Indonesia's capture fisheries are either full or over-exploited. DKP's plan to increase fishing effort is flawed, putting sustainability and long-term profitability of Indonesia's fisheries at risk. The future of Indonesia's marine capture fisheries depends on:

- A shift in the Ministry of Marine Affairs and Fisheries policy from development-oriented management towards management for sustainability, where stabilization of catches may be acceptable or even desired and where a decrease in fishing effort may be necessary.
- Acceptance in the Ministry of Marine Affairs and Fisheries and in Indonesian society as a whole that 'untapped resources', at least in capture marine fisheries, may not exist or cannot be exploited profitably.
- Acceptance by fisheries managers that any transfer of fishing effort from over-exploited fisheries to areas with so-called 'untapped resources' is ill-advised and may contribute to further collapse of local fisheries rather than to a sustainable increase in GNP.
- A shift in fishery management from reliance on over-simplistic MS Y models to eco-system based management, wherein Marine Protected Areas should play an important role

The recently formed National Committee on Marine Conservation in Indonesia will be an important tool to achieve the above mentioned necessary policy shifts, if this Committee succeeds in maintaining strong relations with Indonesia's fishery managers, providing timely, clear and practical policy advice on the basis of currently available information, avoiding any perception that MPAs are only suitable for biodiversity conservation, and making a strong case for MPA strategies in ecosystem based management of capture fisheries.

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