Potential impacts of management measures on artisanal fishers in Indonesian shark and ray fisheries: a case study of Cilacap

Working Paper No.127
December 2005

The views presented in this paper are those of the author(s) and do not necessarily reflect those of the Asia Research Centre or Murdoch University. Working papers are considered draft publications for critical comments by colleagues and will generally be expected to be published elsewhere in a more polished form after a period of critical engagement and revision. Comments on papers should be directed to the author(s) at m.tull@murdoch.edu.au

A revised version of this paper is published in Bulletin of Indonesian Economic Studies, 44 (2), August 2008: 263-288

© Copyright is held by the author(s) of each working paper: No part of this publication may be republished, reprinted or reproduced in any form without the permission of the paper’s author(s).
1. INTRODUCTION

Sharks, skates and rays belong to the *Elasmobranchii* subclass; class *Chondrichthyes* (Hickman *et al.* 2000; Watts 2001; Vannuccini 1999). Until the 1970s, sharks and rays as a fishery resource were relatively underutilised and poorly valued. However, international fishing pressure on elasmobranch stocks has rapidly increased since then, predominately driven by increased demand for shark fin (Bonfil 1994; Castro *et al.* 1999; Clarke 2004; Walker 1998). This has raised concerns about the sustainability of elasmobranch stocks across the world. However, a lack of accurate information relating to shark catches and the biological stocks themselves has made it difficult to make definitive statements about sustainability. Furthermore, the potential for overexploitation of shark and ray stocks is high due to their unique biological characteristics. These characteristics include a slow growth rate and prolonged life span, delayed sexual maturation, low fecundity, a low natural mortality rate and a biomass reproductive replacement rate that is closely related to the size of the breeding biomass (Bonfil 1994; Bonfil 1997; Castro *et al.* 1999; FAO 2000a; Stevens *et al.* 1999; Walker 1998; Watts 2001). Commonly functioning as the apex predator in marine food chains they also have an important role in preserving the ecological balance of the ecosystems in which they live (Kitchell *et al.* 2002; Baum & Myers 2004). The combination of these factors has led to calls, largely from international organisations such as the Food and Agricultural Organisation (FAO), for the development of a greater focus on the research, management and preservation of world shark and ray resources. Efforts are now increasing in line with these recommendations, including an increased number of national shark management plans.

This type of management and research focus is particularly desirable in Indonesia which has the largest recorded shark and ray catch in the world, equivalent to 12.1 per cent of the total world catch in 1997 (Vannuccini 1999). This fishery has two sectors, the large scale or industrial sector and the small-scale or artisanal sector, with the latter believed to be the more significant contributor to the total shark and ray catch (ACIAR 2003; Thia-Eng, *et al.* 1997). The Indonesian waters from which this catch originates, exhibit some of the highest levels of elasmobranch diversity and endemism in the world (ACIAR 2003; ACIAR 2004; Keong 1996). Despite this bio-diversity value, a rapid increase in fishing pressure in recent years combined with a lack of research and poor management currently threatens the overall sustainability of Indonesia’s fishery resources (Bonfil 1994; Keong 1996; Purwaka & Sunoto 2002). Indeed, anecdotal evidence suggests that overfishing is currently occurring in a number of instances at a localised level (Keong 1996).
There has thus been an urgent need for action through an increased research and management effort to ensure that these shark and ray fisheries are sustainable and their benefits for Indonesian society maximised. Indonesia’s fishery managers in the future may need to enforce a reduction in the catch of shark and ray by fishers. However, in the Indonesian case, where the fishery is dominated by an artisanal sector, a management-induced reduction in catch is far from simple due to the unique characteristics associated with these artisanal fisheries. In particular, the impoverished nature of artisanal fishing communities poses a serious dilemma for management as restrictions on catch can have potentially serious impacts on the incomes and well-being of artisanal fishers, their families and communities. Managers thus require an understanding of these potential social and economic impacts on the wellbeing of artisanal fishing communities so that informed judgments about the benefits and costs of potential management strategies can be made.

This working paper is an attempt to contribute to an understanding of such impacts by quantifying the potential changes in the income levels of artisanal fishing communities because of restrictions on shark and ray catches in Indonesia. More specifically, it first evaluates the possible impacts on artisanal fishing boat viability and then the resulting impacts on the budgets of artisanal fisher-folk and their families. The shark and ray fishery at Cilacap on the south coast of Central Java is the case study focused on in this paper. The evaluation forms part of the Australian Centre for International Agricultural Research (ACIAR) project titled ‘Artisanal shark and ray fisheries in Indonesia and their relationships with Australian resources’. This broader project aims to evaluate the overall status of the artisanal shark and ray fisheries in Indonesia, focusing on their biological and socio-economic characteristics. A further key objective is to assess the extent to which shark and ray stocks are shared between Indonesia and Australia. The current study contributes to the socio-economic objectives of the project. It utilises information from a variety of sources to compile a data set from which a quantitative estimate of the potential impacts on artisanal fisher income of reductions in shark and ray catch can be made. The paper tests the hypothesis that the incomes and overall welfare of artisanal fishers at Cilacap are sensitive to reductions in the catch of shark and ray. The current study will serve as a foundation for future work within the ACIAR project, which will involve case studies of possibly two additional ports where shark and ray are landed. These include Tanjung Luar (Lombok), and Muara Angke (Jakarta), West Java. The outcomes of this work will inform future policy making about the potential consequences of catch restrictions and may therefore improve management decision-making capabilities.

The paper is structured as follows. First, the characteristics of the Indonesian fishery sector will be discussed, with a particular focus on its artisanal fisheries and its shark and ray
fisheries. Some background information on the case-study fishery, Cilacap, is then presented. Following an outline of the methods used the results of the boat profitability and household income analysis will be discussed. We will then outline the findings, their implications for management and any recommendations for future case studies.

2. INDONESIA’S FISHERY INDUSTRY

Indonesia is the largest archipelagic nation in the world, containing approximately 17,500 islands with an overall coastline in excess of 82,600 km. This provides Indonesia with access to an extensive fishery resource (Suboko 2001). Indeed the fishery sector made a contribution of approximately 2.4 per cent to Indonesia’s GDP in 2001 (BPS Statistics Indonesia; 2003). This value was associated with a recorded catch weight in 2001 of approximately 5.1 million tons of which marine fishery production contributed 3.9 million tons (76.5 per cent) (BPS Statistics Indonesia; 2003). Relative to its contribution to GDP, the contribution of the fishery sector to the labour force is larger, providing some 4.5 million Indonesians with jobs in 2000 (Suboko 2001). The sector also generates employment indirectly through job creation in the areas of fish processing, transportation, marketing and other support industries such as boat building and fishing gear manufacture (Naamin 1995). More importantly, such employment is often of individuals in low income brackets and the poor, particularly within artisanal fishing communities (Dudley & Tampubolon 1986).

According to Suboko (2001) the Indonesian catch predominately comprises of shrimp and tuna, but other important components of the catch include trevallies, Indonesian mackerel, skipjack, oil sardine, anchovy, scad, sardinella, pony fishes and catfish. Of the total catch landed, close to 50 per cent is sold and consumed as fresh product while the remaining proportion is processed or preserved through methods such as salting, drying, boiling, smoking and freezing (Suboko 2001). Indeed, being a relatively cheap source of protein, fishery products make an important contribution to the dietary needs of Indonesians providing nearly two-thirds of the animal protein supply in Indonesia. (ACIAR 2003; FAO 2000b; Thia-Eng et al. 1997).

The national fishery is generally divided up into two sectors, the large-scale sector and the artisanal sector (Bailey et al. 1987; Kramer, et al. 2002; Pollnac 1991; Suboko 2001). The large-scale fishing sector utilises larger boats (as defined by the Indonesian government normally over five gross tonnes); fishing gears which retrieve catches on a much larger scale; and less restricted fishing areas (Kramer, et al. 2002; Pollnac 1991). The sector is more technologically advanced than the artisanal sector, typically targeting more highly valued species, the majority of which are predominately caught for export such as shrimp, tuna and skipjack (Suboko 2001). However, the artisanal sector is the dominant component of the
marine capture fishery, making up approximately 80 per cent of the total catch weight (Thia-
Eng et al. 1997).

A key question, however, is how should the artisanal sector be defined? As defined by
Pollnac (1991) artisanal fisheries are:

- generally located in rural and coastal areas, near lagoons and estuaries, they typically
overlap with such rural activities as agriculture, animal husbandry and aquaculture;
- they are highly labour intensive and use a minimum of mechanical power; while they
may include some motorised boats, they generally exclude mechanised gear; they
retain primitive technology for handling and processing (few of them use ice or cold
storage facilities) with the result that harvesting losses are significant; they harvest
stocks with a small biomass, compared to deep sea pelagic fish stocks, which contain a
large variety of species suitable for domestic consumption; and they supply most of
the cured fish and fish intended for direct human consumption (Pollnac 1991: 261).

Campbell and Wilson provide a useful context specific description of the Indonesian artisanal
sector:

The Indonesian artisanal fishing sector (often called the small-scale sector) embraces
the people, technology, skills and knowledge of the indigenous Indonesian fishing
industry. Within the artisanal sector the relation between owners of vessels or perahu
and those who work on them is not just a matter of employer and employee but
incorporates cultural norms influencing sharing of resources and access to
employment. The term artisanal clearly excludes forms of industrial fishing that rely
on Western metallurgy, wage labour and scientific navigation. At the other extreme,
artisanal unequivocally includes small sail and paddle-powered fishing vessels
constructed according to traditional Indonesian boat building techniques, and owned
by families or villages. There is, however, a great deal of fishing endeavor that falls
between these two extremes (Campbell & Wilson 1994: 2).

They note that the sector has adapted foreign technology to its fishing methods and
thus as a sector includes motorised as well as sail-propelled vessels. They also point out that
while the fishing activities of artisanal sectors in general are typically limited to local and
inshore waters, in the Indonesian case its artisanal sector has fished distant-shore waters,
including in Australian jurisdictional waters, since the 17th century when strong commercial
links with China encouraged the harvesting of tripang. They argue that Indonesia’s artisanal
fisheries are in fact primarily commercial fisheries and not subsistence fisheries as is
commonly believed.

Typically, artisanal fishing communities tend to be associated with a low socio-
economic status and poverty (Bailey 1982; Panayotou 1982; Payne 2000; Pomeroy & Cruz-
Trinidad 1996). This economic situation obviously influences their fishing and overall
‘livelihood’ strategies. Pomeroy suggests that poverty implies a short run survival strategy for
such fishers and that

[...]these [artisanal] fishermen, due to limited mobility and lack of alternative
employment to move out of the fishery, will utilise whatever resources are available to
them (technology, skill, capital) to harvest as many fish as possible… These
fishermen, living at the subsistence level, have what is called a high discount rate
concerning use of the resource - they prefer profits and food now rather than a continual flow into perpetuity (Pomeroy 1991: 41).

A key aspect of livelihood strategies, which essentially describe how individuals or family units strategically survive and improve their standard of living, is ‘livelihood diversification’ (Allison & Ellis 2001; Ellis 1998; Van Oostenbrugge 2004). Livelihood diversification involves the pursuit of a number of work activities (such as other forms of agriculture) in addition to fishing to improve income and reduce income uncertainty (Allison & Ellis 2001; Ellis 1998; Van Oostenbrugge 2004). Indeed, work by Van Oostenbrugge et al. (2004) on the coastal community of Ambon and the Lease Islands in the Central Moluccas, Indonesia, showed that employment in artisanal fisheries is often accompanied by other forms of agricultural employment which can also be linked to the high proportion of fishermen who are apparently employed part-time (ACIAR 2003). Furthermore, the ease of entry and exit into and out of such artisanal fisheries allows greater flexibility for the pursuit of livelihood diversification strategies and can be linked to an apparent tendency for migration between fishing villages for income purposes (Kramer et al. 2003; Van Oostenbrugge et al. 2004). Additionally, each individual family member also becomes an important means through which additional income can be earned for the household (Ellis 1998). Women and children often play an important role as income earners and in the processing and marketing of fisheries products. (Bailey & Jentoft 1990). Indonesia’s artisanal fisheries clearly make a vital contribution to the livelihoods, employment and dietary requirements of Indonesia’s low income population.

The shark and ray fisheries of Indonesia

At the international level, Indonesia’s shark and ray fisheries are very significant. In 1997 the fishery recorded a catch of approximately 95,600 tonnes according to FAO records, of which 59,450 tonnes (62.2 per cent) were sharks and 36,100 (37.8 per cent) were skate and ray (Vannuccinni 1999). While this catch only made up 2.6 per cent of Indonesia’s total fisheries catch, it made up 12.1 per cent of the international shark and ray catch, making Indonesia the largest shark and ray fishery in the world (Vannuccinni 1999). Furthermore, the fishery has exhibited the highest sustained development rate of any elasmobranch fishery in the world growing from a much smaller catch of approximately 20,000 tonnes in the seventies (Stevens et al. 1999). The fishery’s catch may also be severely underestimated for as Bonfil (1994) points out, the FAO’s records of shark and ray catch may fall short of the actual catch by as much as 50 per cent due to that part of the catch that goes unreported, particularly discarded bycatch.
Elasmobranch catches have a widespread distribution throughout Indonesian waters and are dominated by the artisanal sector. Large-scale long-line fishers, fish trawlers and prawn trawlers are also believed to take a significant bycatch of shark and ray (ACIAR 2003, Keong 1996). Catches are most often utilised for shark fin, shark liver oil as well as shark and ray meat (Keong 1996, Rose 1996). Some target elasmobranch fisheries do exist in Indonesia and include demersal *Rhynchobatids* for fins, *Carcharhinads* for fins (particularly white and black tip reef sharks), *Daysatids* (rays) for flesh and skin and *Squalids* and *Hexanchids* for squalene and oil (Keong 1996).

As in many international elasmobranch fisheries, the high international demand for shark fin poses as one of the greatest risks to the sustainability of Indonesia’s elasmobranch stocks due to the increased emphasis on finning which it has created, largely driving the increasing catch trend (Castro *et al.* 1999; Clarke 2004; Parry-Jones 1996; Rose 1996; Suzuki 1997; Walker 1998; Watts 2001). Exports of dried and salted shark fin have exhibited dramatic growth, increasing from a level of 179 tonnes in 1980 to 894 tonnes in 1996, and estimates of the current level are in excess of 2000 tonnes per annum (ACIAR 2003). These trends have been linked to reports of localised elasmobranch depletions in some Indonesian waters, which have forced fishers to shift their focus to more remote areas (Keong 1996). Furthermore, it has been suggested that shark finning has also become less profitable due to an apparent reduction in the size of sharks and fins being caught by fishers (Keong 1996). A further major issue associated with the shark fin trade is the highly wasteful and inefficient practice of dumping shark carcasses following removal of fins (Rose; 1996). Keong (1996) points out that such practice in Indonesia occurs to a larger degree in more remote areas where due to isolation from consumer markets the shark meat from the carcass has a low value.

The vulnerability of elasmobranchs to over-exploitation, the bio-diverse nature of Indonesia’s stocks and the level at which exploitation is taking place, are all factors which have combined to raise concerns about the current state of Indonesia’s shark and ray fisheries and highlighted the need for effective action to properly manage these valuable resources.

**Fishery Management**

The significance, size and multidimensional nature of the Indonesian fisheries sector make its management difficult (Dudley & Tampubolon 1986; FAO 2000b; Wahyono 1994). There is a need for management measures that are appropriate, effective and enforceable. However, it is on these grounds that Indonesia’s fisheries management structures and procedures are often criticised. In response to such shortcomings and because of the general reform process since the 1997 economic crisis, much reform and restructuring has taken place in fishery
management policy (Patlis et al. 2001). Such reform has particularly been in the form of decentralisation whereby a large amount of the responsibility for fishery management is handed from the central government to local government, fishery users and civil society. This has accentuated community based fisheries management (CBFM) systems in Indonesia already prevalent amongst traditional fishing communities. Key conditions for further successful decentralisation of fisheries management in Indonesia include the adequacy of the legal framework, capacity building and revitalisation of local and traditional institutions (Satria & Matsuda 2004).

There are many artisanal-focused forms of management. Indonesian law excludes commercial fishing vessels from fishing in near shore artisanal waters (Kramer et al. 2002; Purwaka & Sunoto 2002; Wahyono 1994). A ban on fish trawling in Indonesian waters was implemented in 1980-1 following conflicts between trawlers and artisanal fishers and an inability to keep trawlers out of near shore waters (Rice 1991; Wahyono 1994). Although its effectiveness is open to question, this move has been widely commended as it potentially benefited artisanal fishers and their families (Rice 1991; Priyono & Sumiono 1997, Butcher 2004). The government has also provided credit schemes to enable Indonesian artisanal fishers to improve their working capital, however, most have been associated with poor repayment rates (Pomeroy & Cruz-Trinidad 1996; Martosubroto 1987; Wahyono 1994). Traditional forms of artisanal fishery management include ‘adat laws’ (Fox 1996; Purwaka & Sunoto 2002) and ‘sasi’ which aim to control access to coastal as well as land resources through particular regulations (Akimichi 1996; Fox 1996; Pomeroy 1995).

Until recently there has been little effort to address any of the critical issues associated specifically with shark and ray fishing in Indonesia (Bonfil 1994; Keong 1996; Stevens et al. 1999). Little if any information existed on elasmobranch catch and species composition and little attention had been paid to the sustainability of these fisheries (Keong 1996; Stevens et al. 1999). However, in response to these issues some recent effort has been made. The ACIAR project ‘Artisanal shark and ray fisheries in Indonesia and their relationships with Australian resources’ is evidence of such action. One of the project’s aims, in line with recommendations of the FAO’s (1999) ‘International Plan of Action for Sharks’, is to formulate a National Plan of Action (NPOA) for Sharks for Indonesia (ACIAR 2004). Also, with similar aims and highly influenced by the recommendations of the FAO, is the South East Asian Fisheries Development Centre’s (SEAFDEC’s) ‘Management of Shark Fisheries and the Utilization of Sharks in the South East Asian Region’ project in which Indonesia is a participant. The project aims to encourage and support the formulation of management policy for shark fisheries for the South East Asian region though promoting increased research.
3. CASE STUDY SITE: CILACAP
The port city of Cilacap, found in the regency of Cilacap on Central Java’s south coast, adjacent to the Indian Ocean (Figure 1) is one of the few large sheltered ports on the south coast of Java and an important hub for the fishing, transport and trading industries (AGS Southwest Pacific Area 1945; BPS Statistics of Jawah Tengah 2002). The regency, with 1.6 million people, had the second largest population in Central Java in 2001. The regency also had the highest gross regional domestic product (GRDP) in Central Java of 19.6 billion rupiah in 2001 and the second highest level of GRDP per capita in Central Java of approximately 12 million rupiah (BPS Statistics of Jawah Tengah 2002). Agricultural production (which includes fishery production) is the third largest sector in Cilacap contributing 13.37 per cent of GRDP. Due to the coastal location of Cilacap it would be reasonable to expect that fishery production makes a significant contribution to this broad agricultural value (BPS Statistics of Jawah Tengah 2002). Such fishery production is centered on two landing sites in Cilacap, Pelabuhan Perikanan Nusantara and Tempat Pelelangan Ikan-Sentolo kawat, the latter of which is the smaller of the two landing sites.

The prevailing climate at Cilacap can be defined according to three general seasons. The southeast monsoon season from April to September tends to be mainly fine but strong southeasterly winds do occur. Conditions then change from September to December when the winds are generally calm, fog may occur on some days and by November rainfall increases substantially. Finally, December to March is the southwest monsoon season and is associated with strong squally winds and heavy rain (AGS Southwest Pacific Area 1945). Fortunately, Cilacap did not experience any significant direct impact from the Tsunami in 2004.

Figure 1. Location of Cilacap, Central Java, Indonesia.

Source: Taken from FAO (2000b).
Dharmadi et al. (2003) in their study of shark by-catch in Indonesian tuna fisheries observed that the shark and ray catch in Cilacap is predominately composed of bycatch from its tuna fishery. They reported that surface long lines and bottom long lines are the two dominant gear types utilised in the fishery (Dharmadi et al. 2003). The surface longline boats were observed to spend seven to fifteen days out at sea while the bottom longline boats were reported as spending between twenty and forty five days out at sea (Dharmadi et al. 2003). Furthermore, Dharmadi et al. (2003) report that the majority of the shark and ray catch landed in Cilacap was processed locally largely involving the salting or drying of shark and ray flesh and the processing of shark and ray skin into fashion accessories such as belts, wallets and bags. As far as the authors are aware this work by Dharmadi et al. (2003) is all that currently exists on shark and ray fishing activities at Cilacap. Likewise there has been little work performed on the socio-economics of fishing activities within the region.

4. DATA SOURCES AND METHODOLOGY

4.1 Data

Boat Catch Data

2001, 2002 and 2003 boat-trip catch data collected daily by the Cilacap provincial fishery authorities were utilised. This data records total fishery catch composition, weight and value as well as total number of landings on a monthly basis. It is generally accepted that such fisheries data is typically associated with various inaccuracies and inconsistencies and thus should only be used and analysed with these shortcomings in mind. Additionally such data records the catch landed and not the actual catch, ignoring what happens to the catch before being reported (Fegan 1999). For instance, Van Oostenbrugge et al. (2004) observe that 2 kg of food-fish is paid to each crewmember as partial payment for labour prior to the catch reporting and Bonfil (1994) points out that there may be a significant amount of unrecorded catch composed of discarded bycatch of shark and ray. Further catch data recorded in 2001 down to the boat-level for the smaller Cilacap landing site, Tempat Pelelangan Ikan- Sentolo Kawat (which are included in the aggregated monthly values for 2001 for Cilacap) proved useful to check assumptions relating to individual boat activity.

Socio-economic data were collected via a survey of boat skippers at Cilacap from 2001 to 2003 using the questionnaire contained in Appendix 1. Due to limitations in the collected data, information from other sources was also used.

4.2 Analysis of Boat Operation

The analysis assumed that all boats recorded at Cilacap were artisanal. Characteristics assessed included effort (number of trips) and fishery catch weight and catch revenue
characteristics in terms of ‘shark and ray’, ‘non-shark and -ray’ and ‘total catch’.  

Mean monthly catch revenue values per boat were first derived by dividing the catch weight and revenue values by the number of trips recorded in any given month. Assuming boats make one trip and catch landing per month, the calculated values were then summed to derive a representative annual value of shark revenue, non-shark revenue and total revenue for each of the three years 2001, 2002 and 2003. From these an overall mean value was derived for the three years. The robustness of the assumption of one boat trip per month could not be tested due to the aggregated form of the data but the assumption does appear consistent with data so far collected in preliminary boat surveys at Tanjung Luar, East Lombok.

The lack of data on boat operational and investment costs for Cilacap meant that information collected in the ACIAR survey of a fishing boat operator at Tanjung Luar, East Lombok, had to be utilised. The derivation of this value from a boat outside of Cilacap is obviously not ideal, however, the per trip value, as will be shown, was fairly consistent with Suzuki’s (1997) observed cost of 530,000 rupiah per trip per boat for a shark fishery in West Java and Fegan’s (1999) reported cost of 529,500 rupiah per trip for a snapper fishing boat in East Lombok. Likewise the derived investment cost was observed to be consistent with the work of Van Oostenbrugge et al. (2004) who provide an equivalent figure of 67.7 million rupiah.

The lack of local data on annual long run capital costs meant that such a value had to be derived from Van Oostenbrugge et al. (2004). These values included maintenance, depreciation and interest costs, and were converted from rice equivalents (the price paid for a kilogram of rice) in 1997 to prices in rupiah for 1997 according to a mean rice price per kilogram of 1063.80 rupiah in 1997 (National Logistics Agency 2000). Adjustment of these values was then made to 2001, 2002 and 2003 prices using the relevant implicit GDP price deflator values provided by the Asian Development Bank 2004 to derive an overall representative value for this time period. Support for the derived value is provided by the Food and Agricultural Organisation (1986) who provide an equivalent value for artisanal tuna gill net boats in South Sulawesi, Indonesia in 1979-80 which, when adjusted to 2001 prices, equals approximately 9.1 million rupiah. The authors acknowledge, however, that significant mechanisation has taken place in Indonesia’s fisheries since 1980 and may reduce the validity of this estimate (Wahyono 1994).

For the final estimation of annual returns to fishing it was assumed that the boat owner was also the boat’s skipper. A number of studies have shown that while this assumption is not always true, it holds true in many cases in Indonesia (Fegan 1999; Kramer et al. 2002; Pollnac & Crawford 2000; Zen et al. 2000). Pollnac and Crawford (2000: 86) observe different ownership characteristics for different vessel types and further observe that smaller boats tend
to be owned by users, thus supporting this assumption within the artisanal context of the current study. The next step involved a share system being assumed whereby 50 per cent of catch profit would go to the boat owner and 50 per cent to the crew. This share system received support from observations by FAO (1986), Suzuki (1997), Van Oostenbrugge et al. (2004) and Zen et al. (2000). The crew’s collective share of profit was divided by seven; the assumed number of crew per boat determined according to field observations (not survey data). Finally, the owner’s share in the analysis also included a deduction for annual long-term capital costs. The derived owner’s annual return was then also converted to an annual percentage return on the owner’s investment.

Where required, cost values were adjusted to account for price level changes over the three years 2001-03 using implicit GDP price deflators for Indonesia, provided by the Asian Development Bank (2004). Thus, each calculation of representative values for 2001-03 utilised these adjusted values, thereby improving the accuracy of the analysis.

4.3 Analysis of the Household
Calculation of household incomes for both boat owners and crew members were based on the derived income values in the boat operation analysis and also the findings of Hart’s (1980; 1986) socio-economic study of Sukodono, a village in Central Java. ‘Income from fishing’ for both boat owner and crew member derived in the boat operation analysis was used as the basis from which to calculate ‘total household income’ utilising Hart’s (1980;1986) socio-economic classing system. This classing system assigns individuals and households to three classes (I, II and III) based on their asset ownership characteristics (Class I households being significant asset owners and Class III households being minimal asset owners). By assuming boat owners (and their households) to be Class I individuals and crew members (and their households) to be Class III individuals, Hart’s findings were used to estimate ‘income from sources other than fishing’, and ‘income from other household members’ (it was assumed that wives in the households were the only other sources of household income). These values were then summed to derive an estimate of total household income for both boat owner and crewmember. The implied assumption that households in Sukodono are similar to those in Cilacap is reasonable, as both are located in Central Java, but Java’s diversity (Naylor 1991) and the fact that Cilacap is a large port city and not a village, could reduce the reliability of this approach.

Throughout the household analyses Booth’s (2002: 182) observed mean rural household income for Central Java of 5,756,835 rupiah as well as a derived household poverty line in 2001 for Indonesia of 4,800,528 rupiah per year (BPS-Statistics Indonesia
2003; BPS-Statistics of Jawa Tengah Province 2002) were utilised for the purposes of comparison.

4.4 Direct-Impact Analysis of Reductions in Shark and Ray Catch
A spreadsheet sensitivity analysis for the derived profit and income values was run to evaluate the potential impacts on boat profitability. Five catch categories were determined and arranged into columns - ‘Current value’, ‘25 per cent reduction in shark catch’, ‘50 per cent reduction in shark catch’, ‘75 per cent reduction in shark catch’ and ‘100 per cent reduction in shark catch’. While the choice of these levels of catch reduction was arbitrary they allow an evaluation over the whole range of potential management responses. The rows of the spreadsheet were arranged to list the various revenue and cost components of the boat’s operations. First, the different levels of revenue for each level of shark catch were entered into the spreadsheet. Second, derived values for the dependent variables in the analysis (including catch revenue, boat profit, crew member wage and returns to boat owner) were entered into the spreadsheet along with the constant cost components (total variable costs and long term capital costs) so that the overall impact on the boat was evaluated.

An additional spreadsheet sensitivity analysis was also run for the household income levels of both boat owner and crewmember. The different levels of income from fishing associated with the different shark catch levels were first entered. Then other sources of income for household head and wife’s household income were entered as constants. The total household incomes were then calculated.

In principle, it is possible to undertake an indirect-impact analysis, using economic multipliers, showing flow-on effects of both fishing activity and fisher-household consumption activity to the local economy. Such analysis can reveal the implications of reductions in shark catch for income and employment in the wider economy. Bautista et al. (1999: 14, Table 3) give an income multiplier (direct plus indirect effects) for the income of nonfarm low-income rural households of 1.601, which implies significant flow-on effects of increases or decreases in fishing activity. However, there is insufficient information to assess detailed aggregate impacts at Cilacap so this is not attempted in this paper.

5. RESULTS
5.1 Catch data
Figure 2, which shows the total number of recorded landings (or trips) per month for the three years worth of data, reveals an obvious and significant drop in effort in 2003 relative to 2001 and 2002. Indeed total recorded trips were 5,181 in 2003 compared to 10,219 and 9,095 in 2001 and 2002 respectfully. Seasonality in fishing activity at Cilacap is not apparent in the effort data except for a significant reduction in total landings, which occurs in December each
year. Similarly, as is shown in Figure 3, total catch value in 2003 is lower in all months compared to 2001 and 2002 and shows no obvious signs of seasonality. An interesting feature, however, is that as Figure 4 shows, while the weight of catch in 2003 is lower than in 2001 and 2002, it has declined much less than effort and total catch value. Thus, the value of catch per kilogram decreased in 2003, which may explain the reduction in effort.

Figure 2. Number of trips recorded at Cilacap per month 2001-2003.

Figure 3. Total recorded catch value at Cilacap, 2001-2003.
Figure 5 shows shark and ray catches for 2001-2003. There is some evidence of seasonality with higher shark and ray catches in June/July and September/October; effort drops from November onwards due to the onset of the wet season. Figure 6 shows that from 2001 to 2003 shark and ray catches accounted for between 1-6 per cent of total catch values; the average share was only 3 per cent. It is clear that revenue from sharks and rays are only a minor part of total catch value.

Figure 5. Shark and ray catches at Cilacap, 2001-2003.
5.2 Analysis of current boat operation

Revenue and cost value estimates for boat operation are presented in Table 1. The annual crewmember’s wage was approximately 2.5 million rupiah and the annual total return to the boat owner was approximately 17.3 million rupiah. The boat owner’s fifty per cent share of catch profit is reduced significantly with the deduction of annual long-term capital costs of approximately 9.3 million rupiah derived from Van Oostenbrugge et al. (2004). Annual operational costs were estimated at approximately 7.5 million rupiah and total investment at 71.6 million rupiah giving a value for annual returns on investment for the owner of 11.13 per cent.

Figure 6. Shark and ray catches as a proportion of total catch value (2001-2003)

<table>
<thead>
<tr>
<th>Table 1. Mean representative values for revenues and costs of boat operations at Cilacap for the years 2001, 2002 and 2003.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>Shark Catch Revenue</td>
</tr>
<tr>
<td>Non-Shark Catch Revenue</td>
</tr>
<tr>
<td>Total Boat Revenue</td>
</tr>
<tr>
<td>Total Operational Costs</td>
</tr>
<tr>
<td>Net Revenue</td>
</tr>
<tr>
<td><strong>Calculated wage per crewmember</strong> (50% of net income divided by 7)</td>
</tr>
<tr>
<td>Calculated returns accruing to boat owner (50% of net income)</td>
</tr>
<tr>
<td>Annual maintenance, depreciation and interest costs (derived from Van Oostenbrugge et al. (2004))</td>
</tr>
<tr>
<td><strong>Calculated net returns accruing to boat owner</strong> (includes deduction of annual maintenance costs)</td>
</tr>
<tr>
<td>Returns on investment for the owner as a percentage given an investment value of 71,603,999 rupiah</td>
</tr>
</tbody>
</table>

5.3 Analysis of current households

Boat owner household

Table 2 illustrates average total boat owner and crewmember income in 2001-03. The calculated annual value for income from other activities is a value of approximately 1.2 million rupiah and gives the average boat owner a total annual income of 9.1 million rupiah (assuming Class I status). The owner’s wife’s income was approximately 2.4 million rupiah and the boat owner’s total annual household income 11.5 million rupiah.

Crewmember household

Table 2 shows that crew members are estimated to achieve annual incomes from fishing of 2.5 million rupiah and total annual incomes of approximately 3.3 million rupiah given the assumed Class III status. The income of the crewmember’s wife’s is estimated at 1.9 million rupiah per annum, which gives a total household income of approximately 5.2 million rupiah.

Table 2. Household income and its components for both boat owner and crew.

<table>
<thead>
<tr>
<th>Boat Owner</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat owner's income from fishing</td>
<td>7,969,820</td>
</tr>
<tr>
<td>Boat owner's income from other activities</td>
<td>1,177,783</td>
</tr>
<tr>
<td>Wife's income</td>
<td>2,387,836</td>
</tr>
<tr>
<td>Total Household Income</td>
<td>11,535,440</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crew Member</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew member's income from fishing</td>
<td>2,471,141</td>
</tr>
<tr>
<td>Crew member's income from other activities</td>
<td>797,516</td>
</tr>
<tr>
<td>Wife's income</td>
<td>1,913,767</td>
</tr>
<tr>
<td>Total Household Income</td>
<td>5,182,424</td>
</tr>
</tbody>
</table>

Source: Calculated from Cilacap catch data, 2001 and Hart (1986).
Notes: Estimated using calculated income of boat owner and crewmember combined with the proportional sources of household income observed by Hart (1986) for Class I and Class III households respectively. All income values in Rupiah.

Impact Analysis of Reductions in Shark and Ray Catch

Table 3 presents the spreadsheet sensitivity analysis of shark catch impact on boat operational viability. Annual boat profitability drops by about 3.7 per cent to 33.3 million rupiah with a total ban on shark catch. Profitability is reduced by 0.9 per cent with every 25 per cent reduction in shark catch. The decrease in each crewmember’s wage is relatively slight and proportional to the fall in boat profitability; dropping 3.7 per cent from about 2.47 million rupiah to 2.38 million rupiah with a full reduction in shark catch. The boat owner’s returns, on the other hand, are more seriously affected, falling by 8.1 per cent from approximately 7.97 million rupiah to 7.32 million rupiah. The boat owner’s annual return on investment falls from 11.1% to 10.2%.

The impact on boat owner and crewmember household income are presented in Table 4. For every 25 per cent reduction in shark catch the owner’s household income level is reduced by approximately 1.4% per cent and that of the crewmember by 0.4 per cent. The impact on household income is presented graphically for both cases in Figure 7 in which the
more pronounced impact on boat owner’s income relative to the crewmember is readily apparent.

Table 3. Impact on boat operational viability of reductions in shark catch.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Current Value Scenario</th>
<th>25% shark catch reduction scenario</th>
<th>50% shark catch reduction scenario</th>
<th>75% shark catch reduction scenario</th>
<th>100% shark catch reduction scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue from shark catch</td>
<td>1,293,035</td>
<td>969,776</td>
<td>646,517</td>
<td>323,259</td>
<td>0</td>
</tr>
<tr>
<td>Revenue from non-shark catch</td>
<td>40,777,173</td>
<td>40,777,173</td>
<td>40,777,173</td>
<td>40,777,173</td>
<td>40,777,173</td>
</tr>
<tr>
<td>Total Catch Revenue</td>
<td>42,070,208</td>
<td>41,746,949</td>
<td>41,423,690</td>
<td>41,100,432</td>
<td>40,777,173</td>
</tr>
<tr>
<td>Total Variable Costs</td>
<td>-7,474,236</td>
<td>-7,474,236</td>
<td>-7,474,236</td>
<td>-7,474,236</td>
<td>-7,474,236</td>
</tr>
<tr>
<td>Boat profit</td>
<td>34,595,971</td>
<td>34,272,713</td>
<td>33,949,454</td>
<td>33,626,195</td>
<td>33,302,937</td>
</tr>
<tr>
<td>Calculated wage per crewmember</td>
<td>2,471,141</td>
<td>2,448,051</td>
<td>2,424,961</td>
<td>2,401,871</td>
<td>2,378,781</td>
</tr>
<tr>
<td>Returns to boat owner</td>
<td>17,297,986</td>
<td>17,136,356</td>
<td>16,974,727</td>
<td>16,813,098</td>
<td>16,651,468</td>
</tr>
<tr>
<td>Long term capital costs.</td>
<td>-9,328,165</td>
<td>-9,328,165</td>
<td>-9,328,165</td>
<td>-9,328,165</td>
<td>-9,328,165</td>
</tr>
<tr>
<td>Net return to boat owner</td>
<td>7,969,820</td>
<td>7,808,191</td>
<td>7,646,562</td>
<td>7,484,933</td>
<td>7,323,303</td>
</tr>
<tr>
<td>Return on owner investment (%)</td>
<td>11.13</td>
<td>10.90</td>
<td>10.68</td>
<td>10.45</td>
<td>10.23</td>
</tr>
</tbody>
</table>

Source: Derived estimates. Note: All revenues and cost values in rupiah.

Table 4. Impact on the household incomes of both boat owners and crew members of reduction in shark catch.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Current Value Scenario</th>
<th>25% shark catch reduction scenario</th>
<th>50% shark catch reduction scenario</th>
<th>75% shark catch reduction scenario</th>
<th>100% shark catch reduction scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner's Household</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner's Fishing Income</td>
<td>7,969,820</td>
<td>7,808,191</td>
<td>7,646,562</td>
<td>7,484,933</td>
<td>7,323,303</td>
</tr>
<tr>
<td>Total Household Income</td>
<td>11,535,440</td>
<td>11,373,810</td>
<td>11,212,181</td>
<td>11,050,552</td>
<td>10,888,922</td>
</tr>
<tr>
<td>Scenario household income as a proportion of current household income</td>
<td>100.00%</td>
<td>98.60%</td>
<td>97.20%</td>
<td>95.80%</td>
<td>94.40%</td>
</tr>
<tr>
<td>Crew Member's Household</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crewmember's Fishing Income</td>
<td>2,471,141</td>
<td>2,448,051</td>
<td>2,424,961</td>
<td>2,401,871</td>
<td>2,378,781</td>
</tr>
<tr>
<td>Total Household Income</td>
<td>5,805,785</td>
<td>5,782,695</td>
<td>5,759,605</td>
<td>5,736,515</td>
<td>5,713,425</td>
</tr>
<tr>
<td>Scenario household income as a proportion of current household income</td>
<td>100.00%</td>
<td>99.60%</td>
<td>99.20%</td>
<td>98.81%</td>
<td>98.41%</td>
</tr>
</tbody>
</table>

Source: Derived estimates. Note: All income values in rupiah.
Figure 5 Impact on the household income levels of both boat owner and crew of reductions in shark catch for the mean analysis.


While the results are likely to be a good representation of the relative importance of shark catch to boat operational viability and household income, the analysis is subject to a number of qualifications. First, it is possible that assumptions and estimates are inaccurate (eg boat costs); second, the use of mean values is likely to represent any large positive outliers associated with large boats in the fishery rather than the smaller and less profitable boats; third, the analysis is based on one site only and the findings may not apply at locations like Tanjung Luar where sharks and rays are major target species; finally, the static nature of the analysis means it does not account for potential changes in behaviour by fishers and households that may occur in response to the changed circumstances associated with a reduction in shark catch. Such dynamic responses are an important issue for fishery management purposes and are considered in more detail below.

In the context of the boat’s operations, a number of responses to the imposed reductions on shark catch are possible. A substitution of effort to other types of fishing or indeed other boat related activities is a possibility. Indeed Nikijuluw (1998) described how the development of the tourism industry in the village of Jemluk, Bali Island allowed some boat owners to specialise in tourist-focused activities, which then took pressure off the village’s fishery. However, the degree to which such options are available at Cilacap may be limited. In the case of those boats that strongly rely on shark, they would be forced to focus on tuna like
the majority of boats in the fishery, thus increasing the pressure on the tuna stocks. Alternatively, there is the potential for a shift of fishing activities to another location where boat profitability is potentially greater. Cost cutting could be another option pursued by boat owners. Due to the profit sharing arrangement, this could involve a reduction in the crew’s share of profit rather than a reduction in the number of workers employed. The price for shark and ray may also increase with restrictions thus adding another important variable to understanding boat behaviour. Indeed such an outcome could encourage increased illegal shark fishing practices (Bailey 1987; Pomeroy & Cruz-Trinidad 1996).

The possible responses of the household are also many. In line with observations made by Hardaker et al. (1985) and Sawit and Obrien (1995) regarding household production analysis of farm-households, household heads (owners or crewmembers) may substitute their time into other income earning activities and the labour supply characteristics of all other household members may also change to make up for the lost income from fishing. Direct responses to imposed shark catch restrictions may also eventuate where household members are employed in ancillary fishery activities. Indeed field observations Susilowati (2003) revealed that females and youth were involved in a number of ancillary fishery activities including various forms of fish processing such as salting, drying, smoking and packing, fish marketing activities and also the unloading of catch (by youths only). Furthermore, the existence of a number of shark and ray processing facilities in Cilacap as observed by Dharmadi et al. (2003) imply that this may be an important source of direct impact from shark restrictions. Changes in the household’s labour supply may also extend beyond the Cilacap labour market if migration takes place to other labour markets, a common occurrence in artisanal fishing communities in Indonesia (Kramer et al. 2002).

6. CONCLUSIONS
Currently, Indonesia’s elasmobranch fishery is effectively an open access one and it is generally accepted that in order to avoid a ‘tragedy of the commons’ management measures need to be introduced. This study has attempted to provide some quantitative estimates of the effect of potential catch restrictions on the livelihoods of boat owners, fishers and their families. We found that the average boat operating at Cilacap appears to be profitable providing a high return to boat owners and an adequate wage for crewmembers. However, as a source of boat revenue, shark and ray catch appears to be of minor importance, which suggests that while reductions in shark catch will affect boat revenue, operational viability will not be threatened and the boat owner will still receive an adequate return on investment. According to our estimates, the household income levels of both boat owners and crewmembers will be reduced by only 5 per cent and 2.5 per cent respectively by a full
reduction in shark catch. Income levels are high in the boat owner’s case and at a sufficient level in the crewmember’s case, when compared to Booth’s (2002) calculated mean rural household income level for Central Java. Thus, the paper does not support the hypothesis that the incomes and overall welfare of artisanal fishers at Cilacap are sensitive to reductions in the catch of shark and ray. However, there may be fishers and households that source their income from boats that operate at the margin, struggling to make profit or that are more reliant on shark and ray catch, and thus could potentially be more vulnerable to any changes in management settings. In addition, catch reductions will lead to a reduction in shark processing activity, which will affect households and the wider economy. The current findings are subject to a number of limitations and, as they are based on one site only, may not apply to other locations such as Tanjung Luar. Given the risk that catch restrictions could have serious negative direct and indirect impacts on the livelihoods of artisanal fishers and their families, further research is needed before general conclusions can be drawn about the importance of shark and ray fishing to artisanal fishers.

NOTES

1 They will be referred to simply as sharks and rays throughout or collectively as elasmobranchs.

2 Campbell and Wilson (1994) describe the existence of three distinct sectors that have developed because of the Indonesian government’s policy to modernise its fishing industry, which was introduced in 1966. The smallest sector is comprised of large steel boats, often owned by licensed foreigners or by joint ventures, which has nearly all of its catch exported. The medium sector comprises Western-styled wooden trawlers and purse seiners. The third, artisinal sector, dominates; making up (at the time) 70% of all fishing boats and 90% of total production.

3 Except for work by White et al. (1989) in their publication titled ‘The Coastal Environmental Profile of Sengara Anakan-Cilacap, South Java, Indonesia’. However the region studied is quite distinct from the more urbanised area of the Cilacap port and thus has limited relevance to the current analysis.

4 Data obtained by ACIAR project researcher Mr Dharmadi Dharmadi and is known as SL-3 type data.

5 From here on referred to as the ‘2001 TPI Sentolo Kawat catch data’.

6 Collected with the assistance of ACIAR project researcher Ms Tuti Susilowati.

7 They will be termed simply ‘shark catch’, ‘non-shark catch’ and ‘total catch’ throughout the rest of the paper.

8 Assumption based on field survey data for Java in 2001 collected with the assistance of Ms Tuti Susilowati.

9 The authors acknowledge that this and the assumption of owner being skipper are two critical assumptions in that they have significant impacts on the derived income levels in the analysis.


11 Derived from a poverty line of 1,200,132 rupiah per person per year (BPS–Statistics Indonesia 2004: 584) and a mean number of household members for Cilacap of four ((BPS–Statistics of Jawa Tengah Province 2002: 56).
REFERENCES


APPENDIX 1

Socio-economic study of shark/ray fishermen

Outline

I. General
II. Fishing operations
III. Knowledge of fishermen concerning shark resources
IV. Post-catch activities of shark fishermen and their families

Date

Place of interview

I. General

1. Name and age of respondent

2. Type of work performed by respondent
   (a) Principal
   (b) Sideline

3. Number of household dependents
   (a) Children
   (b) Relatives (staying in the same household)

4. Family religion
   (a) Islam
   (b) non-Islam

5. Highest level of education achievement
   (a) Elementary
   (b) Technical school
   (c) High school
   (d) Other

6. Reasons for working in the fishing industry
7. Length of time as fisherman (in years)
   (a) In fish catching sector
   (b) non-fishing sector

8. Will your children follow the same line of work?
   (a) Yes
   (b) no
   (State reasons in either case)

II Fishing operations

9. Do you own the boat you fish on?

10. What year did you buy your boat?

11. How much did it cost when you brought it?

12. What is the length of the boat overall...... width.....?

13. What type of engines do you have? Nil/outboard/inboard

14. What equipment do you have on your boat? Radios, depth sounder, GPS etc

15. How much money do you spend each month for maintenance and repair of your boat and equipment?

16. How much money was spent on each item on your last trip?
   Ice
   Bait
   Gear
   Fuel
   Food
   Other

17. Did the crew share these trip expenses?

18. How far did you travel on your last trip?

19. Location- where did you fish?

20. Do fishermen from outside your area also catch sharks here?
21. How many fishermen including you were on board for your last trip?

22. How long were you away on your last trip?

23. How many trips do you usually take per month?

24. How many kilos of sharks and rays do you usually take per month?

25. Catch composition by boat?
   (a) Sharks...
   (b) Rays...
   (c) Other species ...

26. What price did you get for your last catch?
   (a) Sharks
   (b) Rays
   (c) Other species

III. Knowledge of fishermen concerning shark resources

27. Why do you choose to catch sharks/rays? Explain.

28. How do you identify shark-fishing localities in your area?

29. At the present time, is there any increase or decrease in the total number of sharks/rays being caught? (a) Yes (b) no (State reasons)

30. In your opinion, who owns the sea and the fish in it? Elaborate.

31. Do fishing communities need to conserve the sharks/rays that form your regular catch? (a) Yes (b) no (State reasons)

32. How large (in weight) should sharks caught be?

33. Are there any rules set by fishermen for the catching of sharks/rays- in this area? (State your knowledge of this matter)

34. Are there any rules set by government for the catching of sharks/rays in this area? (State your knowledge of this matter)

IV. Post-catch activities of shark fishermen and their families

35. On trips during the past 12 months what did you usually do with your fish?
   Tick the best answer
   All of the catch was sold
   Some of the catch was sold
   Some of the catch was taken home to eat
   All of the catch was taken home to eat
   Some of the catch was given to the crew
   Some of the catch was given to family and friends.

36. Do you bleed you fish when you catch them?
37. Do you ice your fish down when you catch them?

38. Do you use salt water mixed with ice to chill your fish?
39. Where do you sell your fish? Tick one used most often
   Markets
   Restaurants
   Roadside sales
   Friends/neighbours/family

40. How do you pay your crew?
   % share of gross revenue
   % share of net revenue
   % share of catch
   Bonus/incentive

41. Do your crewmembers have jobs other than fishing?

42. How much in gross sales does your boat usually make every year?

43. After expenses, what percentage of your family income comes from fishing?

44. Which part of the shark is given priority in processing?
   (a) fins (b) heart (c) flesh (d) skin (e) whole fish (Explain reasons)

45. How many people are involved in the processing of sharks?

46. How much time is taken up with shark processing activities?

47. Which members of your family are involved in shark processing?
   (a) Children (b) wife (c) wife and children (d) wife, children, and local residents.

48. What are the duties of women in shark processing, and how much time do they spend on such work?

49. Who decides/determines whether womenfolk will be involved in the processing of sharks?

50. How are women paid for the work involved in shark processing?

THANKYOU FOR YOUR COOPERATION