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Net economic impacts of achieving maximum economic yield in fisheries

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Abstract: Improving the economic performance of fisheries is becoming increasingly important in fisheries management, and in some cases, maximum economic yield (MEY) is set as a key management target. However, associated with MEY is a level of fishing activity that is lower than would otherwise occur, even in fisheries managed to achieve the maximum sustainable yield. This will result in losses in economic activity elsewhere in the economy, potentially resulting in a net loss to society in the short to medium term. In this paper, an input-output framework is used to estimate the net economic impact of achieving MEY in Australian fisheries. While incomes are reduced in other sectors of the economy, the net impact of achieving MEY in fisheries is dependent on how total catches are likely to change relative to their levels under current management. It is argued that, at least in most Australian fisheries, achieving MEY will result in a net economic benefit to society. Local communities are likely to be included among the set of main beneficiaries, with potential losses being incurred elsewhere in the economy. Sectors that potentially lose as a result of the transition to MEY previously benefited from overcapitalisation in fisheries, and hence higher incomes in these sectors were an artefact of the market failure in fisheries.

Key words: maximum economic yield, fisheries management, net economic impact, input-output analysis

Net economic impacts of achieving maximum economic yield in fisheries

Over the last decade, there has been increasing interest in the use of economic instruments in the management of fisheries.(2006; Sanchirico 2003), and the benefits from achieving economically optimal levels of harvest (Costello *et al.* 2008; Grafton *et al.* 2007). Internationally, while most fisheries management policies aim to achieve a wide range of objectives (Hilborn 2007), economic objectives are gaining increasing importance in determining fisheries management strategies (e.g. Pascoe *et al.* 2009; Ward and Kelly 2009);.

In Australia, the Australian Fisheries Management Act 1991, which relates to Commonwealth fisheries, specifies maximising economic efficiency as a key management objective. As noted above, inclusion of economic objectives is common in most fisheries legislation, but what this means for fisheries management is generally poorly defined (Hilborn 2007). However, in 2007, the Australian Commonwealth fisheries harvest strategy policy was developed that specifies that harvest strategies "will be designed to pursue maximum economic yield in the fisheries" (DAFF 2007, p4). Maximum economic yield (MEY) in turn is defined as "[t]he sustainable catch or effort level for a commercial fishery that allows net economic returns to be maximised" (DAFF 2007, p54). Consequently, since 2007, MEY has been considered the primary target reference point for Commonwealth fisheries. State fisheries managers are also becoming increasingly interested in MEY as a management target, with State fisheries observers on most Commonwealth fisheries management advisory bodies.

Fishing at MEY will maximise economic profit to the vessel owners, and is also likely to increase crew wages depending on the share system used in the fishery and the state of the stocks currently. In fishing dependent coastal communities, higher incomes will increase demand for other products in the local economy, with subsequent flow on effects in production, incomes and employment. Also the extra profits can through taxes benefit society as a whole by using this surplus into public investments. However, opponents to economic management instruments argue that achieving MEY may also have negative impacts on fishers and other groups (e.g. McCay 2000; McCay 1995; Palsson and Helgason 1995). This is because reducing the excess fishing effort to achieve MEY is likely to result in a decrease in the number of fishing vessels, which in turn will result in a decrease in employment and hence in the wages spent on the local economy. Similarly, those industries supplying the fishing industry will realise a decline in demand for their products, with subsequent flow on effects to the rest of the economy (Heen and Flaaten 2007). Others argue that producing yields lower than the maximum sustainable yield (MSY) result in fewer benefits further along the value chain (i.e. processing, retail etc) that add (and therefore produce) more value than the fishing process itself (Christensen 2009). Overall, opponents argue that, potentially, achieving MEY in fisheries – as it is traditionally defined – may result in a net economic loss when these flow on effects are considered (Bromley 2009).

In this paper, the net economic impact of achieving MEY in Australian fisheries is estimated using an input-output modelling framework. The key winners and losers are also identified. A number of scenarios are examined in terms of the implications of MEY in terms of fisheries production and input use for a range of different types of fisheries. Increases in profit levels in fisheries is compared to reductions in incomes both in fisheries and induced through changes in input demands.

Implications of MEY for effort, revenue and net economic returns

While the term “MEY” refers to a yield or level of output, MEY is more a concept than actual value (Dichmont *et al.* 2009). Unlike maximum sustainable yield (MSY), which is an actual harvest level, MEY requires both output and input use to be simultaneously at their economically optimal levels. Inputs include fishing effort (an abstract concept encompassing the level of physical vessel inputs used in the fishery as well as their utilisation) as well as the stock biomass. Similar yields to MEY can be achieved with different combinations of effort and biomass, but only one such combination will result in economic rents being maximised in the fishery.

The traditional bioeconomic model of the fishery assumes that the price of outputs is perfectly elastic and the marginal cost of effort (i.e. labour, capital and other inputs employed in the fishery) is constant. Given this, and assuming logistic growth for the stock biomass, both the catch and the revenue curves will have a similar quadratic shape, and the cost curve will be linear (Figure 1). Given this model, MEY can be defined as the combination of effort (E_{MEY}) and output ($MEY=R_{MEY}$/price) that maximised the difference between the revenue and cost curves, and is identified as the point where the slope of the revenue curve is equal to the slope of the cost curve (i.e. marginal revenue equals marginal cost). In most fisheries, the effort level exceeds this optimal level as the existence of economic rents provides an incentive for additional effort to enter the fishery. The resulting equilibrium output level may be higher or lower than at MEY depending on the slope of the cost curve. In high unit cost fisheries, the level of output at MEY may be lower than the unregulated (or open access equilibrium) yield level (i.e. R_{OAE1}), while in low unit cost fisheries the output at MEY may be greater than the unregulated level (i.e. R_{OAE2}). Management can also affect the combination of effort and output, resulting in the level of output at MEY diverging from the current harvest levels. In most cases, stocks are not in equilibrium, so that the current catch may differ to its equilibrium level. This may be a result of management that restricts catch or effort. Hence, actual catches in a high cost fishery may be lower than at MEY even though the equilibrium catch level is expected to be higher.

Figure 1. Approximately here

In practice, MEY is not as simple to define (Dichmont *et al.* 2009). The optimal level of effort, and associated catch, vary with changes in input and output prices. Further, fleets are not homogeneous, so the marginal cost of effort – even if constant for individual vessels – changes as the fleet composition changes. Further, the model illustrated in Figure 1 relates to a single species fishery harvested using a single technology. However, most fisheries are characterised by a number of fishing systems that catch a variety of species in differing combinations. Globally optimal catches of the different species and effort levels for the different fishing technologies can be estimated, but these bear little relationship to an optimal catch of an individual species considered in isolation, or the optimal effort level of an individual fleet segment.

Despite the difficulty of defining the level of effort required to reach MEY, the principle is still the same. Economic rent is maximised at the point where there is the highest difference between the costs of harvesting the fish and the revenues obtained from the catch. Although equilibrium catches at MEY may be higher or lower than the current disequilibrium catches, MEY in most instances will require a reduction in fishing effort in the form of a reduction in the number of fishing vessels. In the traditional single species model, it can be shown that the effort at MEY is half that at the open access equilibrium (Clark 1990). Empirical studies in a wide range of multispecies fisheries have suggested that fleet reductions in excess of 50% may be necessary to maximise economic profits, even those currently subject to management (Eggert and Tveteras 2007; Hoff and Frost 2007; Pascoe 2007). This reduction in capacity necessary to achieve MEY is also accompanied by a reduction in employment, and hence incomes of the crews subsequently displaced. Lower yields at MEY may also result in the total income to the remaining crew also declining. The magnitude of this change will largely depend on the crew payment system.[1] For crew that are paid on the basis of revenue share, then total crew incomes will move in direct proportion to the total yield. For crew that are paid on the basis of net revenue (i.e. revenue less running costs such as fuel), then higher stock levels may result in reduced cost per unit catch (the so-called stock effect; Clark and Munro 1975), and crew incomes may increase even if total yields (and revenues) decrease. At the individual crew member level, incomes are likely to increase regardless of payment system, as the total number of crew members is likely to decrease by more than any decline in yield at MEY.

The economic impact of achieving MEY will have a flow on effect to other intermediate and final demand sectors in the economy. In the intermediate sector, some sectors supply the fishing sector with goods and services (e.g., fuel, equipment, insurance) and other sectors higher up the supply chain (e.g., processors, retailers) demand fish products. For suppliers to the fishing sector, a reduction in capacity will reduce demand of inputs. This in turn will make the manufacturers of these inputs reduce demand of other goods from their suppliers and so on.

[1] See McConnell and Price (2006) for a review of crew payment systems.

For intermediate sectors demanding fish products (like processors) changes in supply will have a direct consequence upon these sectors, and indirect impacts on other intermediate sectors supplying these sectors. The extent of this impact will depend on the dependency of these sectors in the domestic fishing industry as well as the level of catches at MEY compared to current disequilibrium catches. In most countries that have experienced declines in fish supply due to overfishing, processors and other related sectors have largely managed to source their product elsewhere, or have been relatively able to adapt their production to other products (Wilen 2009). As a result, the potential negative impacts of moving to an MEY target is likely to be relatively minor for these sectors.

The final demand sector represents the purchase of intermediate goods and services by consumers. The loss of income from the displaced crew will reduce final demand of goods and services although; this loss can be offset by the remaining crew's incomes if catches increase at MEY relative to current disequilibrium catches. Finally, the increase in profitability with increased efficiency can benefit society as a whole through increased taxes by using this surplus into public investments. Overall, the net economic returns from a broader perspective will only increase if the improvement in fishery profitability as well as incomes to crew exceeds the losses in other sectors of the economy. This is largely an empirical question, and is likely to differ from fishery to fishery based on the differing input needs of the different fishing technologies.

Overview of Australian fisheries

In Australia, fisheries management responsibilities are divided between the Commonwealth Government (i.e. the federal level of government) and the individual State Governments.

Fisheries wholly within State territorial waters (within 3 nautical miles of the coast) of a single State are fully under the jurisdiction of that State Governments. Fisheries that are fully outside the 3 nautical mile zone are fully under the jurisdiction of the Commonwealth government. Management responsibilities for fisheries that straddle the State-Commonwealth boundary are determined through an “Offshore Constitutional Settlement”. Management of these fisheries varies considerably, ranging from individual transferable quotas (ITQs) in many fisheries to basic input controls (e.g. limited entry and closures) in others.

Australian fisheries are dominated by high valued species, such as lobster, abalone and prawns (Figures 2 and 3). In 2006-07, the total value of Australian fisheries production was $1.4 billion (ABARE 2008), with around 80 per cent of the value of this catch taken in State managed waters. While the specific target of MEY relates to Commonwealth fisheries, considerable interest has also been shown by State governments, particularly for lobster fisheries in the first instance.

Figures 2 and 3 around here

The rock lobster fisheries are Australia's most valuable, accounting for 20% of total fisheries revenue in 2006-07. These are managed at both the Commonwealth and state fishery level. The Commonwealth rock lobster fishery, located in Torres Strait, exploits the tropical rock lobster (*Panulirus ornatus*), and is managed through both input (seasonal closure, boat and gear restrictions) and output controls (size limit). State fisheries (South Australia, West Australia, Tasmania, New South Wales and Victoria) mainly fish the southern rock lobster (*Jasus edwardsii*). State fisheries use quota management systems (total allowable catches, and ITQs in some states), as well as input controls such as limited pot numbers and fishing time.

Tropical prawn fisheries are ocean based, while temperate prawn fisheries are more estuary based. Geographically, the tropical prawn fisheries include the State prawn fisheries in New South Wales, Queensland and Western Australia, and the Commonwealth prawn fisheries in the northern Australian waters (the northern prawn fishery, or NPF) and Torres Strait (Figure 3). The temperate prawn fisheries include those of South Australia and Victoria (Figure 3). All prawn fisheries are currently managed using input controls, although ITQs are to be introduced in the NPF (AFMA 2004; Newton *et al.* 2007). The Commonwealth prawn fisheries have an explicit management objective of MEY, and both the NPF and Torres Strait prawn fisheries have had substantial capacity reductions during 2005 and 2006 in order to help achieve this objective.

The tuna and billfish fisheries include the eastern and western tuna and billfish fisheries, southern bluefin tuna and the skipjack tuna fishery, and are all under Commonwealth jurisdiction. The eastern tuna and billfish fishery is dominant in volume but second in value to the southern bluefin tuna fishery (Hohnen *et al.* 2008). In general, the tuna and billfish fisheries are overfished due to effort and catches not being restricted effectively in the past. New management arrangements for capping effort, and the introduction of individual transferable effort units, are being developed for the eastern tuna and billfish fishery. The southern bluefin tuna fishery is currently subject to ITQs. Other finfish fisheries are in a similar situation to the tuna fisheries. The Commonwealth fisheries are all managed using ITQs, but non-binding limits on catches have resulted in limited capacity reduction (Pascoe and Gibson 2009) and subsequently excessive fishing effort. This high fishing effort has lead to low and even negative net economic returns (Newton *et al.* 2007). As with the Commonwealth prawn fisheries, the Commonwealth fisheries (both tuna and other finfish) were also subjected to capacity reductions during 2005 and 2006 as part of a national capacity reduction program.

The input-output methodology

Input-Output (I-O) analysis was first introduced by Leontief (1941). Since then, I-O has commonly been employed by environmental and resource economists (Druckman and Jackson 2009; Eide and Heen 2002; Kronenberg 2009; Llop 2008; Spörri *et al.* 2007). I-O is built in the notion that the production of output requires inputs. In other words, the production of industries, such as fish by fishers requires inputs such as bait, food, ice, fuel, boats, insurance, etc. In turn the manufacturers of these other goods will need to buy goods from their suppliers and so on, thereby creating a multiplier effect.

The inputs and outputs for every industry in the economy are summarized in an I-O transaction table. This table is the base of the I-O model and it is defined in terms of a series of equations, given as:

$$\sum_{j=1}^{s} a_{ij} X_j + Y_i = X_i \quad \forall s \tag{1}$$

where a_{ij} is the proportion of total production of industry i that is sold to industry j as an intermediate input into industry j, Y_i the sales from industry i to final demand, X_i the total sales of industry i, and s the number of industry sectors. In matrix form, this can be expressed as $(\mathbf{I}\text{-}\mathbf{A})\mathbf{X}=\mathbf{Y}$. The level of production in each sector can therefore be determined by

$\mathbf{X}=(\mathbf{I}\text{-}\mathbf{A})^{-1}\mathbf{Y}$, where $\mathbf{A}$ is the *intermediate usage matrix* and $\mathbf{Z}=(\mathbf{I}\text{-}\mathbf{A})^{-1}$ is the open Leontief inverse. In an open input-output model only the productive sectors of the economy are assumed to be *endogenous* while the final demand of goods and services are assumed to be *exogenous*. In a closed input-output model, one more column and row, for total household consumption and fishers' wages are included into the **A** matrix. This will form a new matrix **B** and $(\mathbf{I}-\mathbf{B})^{-1}$ which is the closed Leontief inverse matrix. **B^** rows and columns will represent the same rows and columns as **Z**. The matrices **B^**, and **Z** are used to derive the I-O multipliers. Further details are provided in the supporting information.

Three different types of effects make up multipliers – the direct effect, the production induced effect and the consumption induced effect. The *initial effect* (or *direct effect*) refers to the initial dollars spent: if there is an increase in the final demand for a particular product, there will be an equivalent increase in production in order to satisfy demand. For example, a one unit increase in final demand will result in a one unit increase in production. The *production induced effect* (or intermediate effect) is the purchase of extra goods and services by producers in order to supply the extra goods demanded by the direct effect. The producers of these intermediate inputs will also subsequently need to increase their input use to meet this demand, and so on. As a result of the direct and production induced effects, the level of household income throughout the economy will increase as a result of higher employment. A proportion of this extra income will be re-spent on final goods and services in the local economy. This is the *consumption induced effect* (or induced effect).

Data and assumptions

The Input-Output table

The model was derived from the latest Australian national I-O table available (2004-05), produced by the Australian Bureau of Statistics (ABS). The 109 sectors in the ABS national I-

O table were aggregated into 10 sectors,[2] and the fishing sector (one of the 10) was disaggregated into 13 sectors. Capture fisheries were disaggregated into seven sectors – abalone, rock lobster, tuna and billfish, other finfish, temperate prawns, tropical prawns and other fisheries, the latter consisting of crustacean and mollusc fisheries not elsewhere included. Aquaculture was disaggregated into six sectors – prawns, salmon, tuna, edible oysters, pearls and other farmed fish. As the study was not concerned with aquaculture, these were not further considered separately.

The disaggregation of the capture fisheries was based on the values of production, cost structure information and the distribution of production to other intermediate sectors and final consumers. Information on cost structures in the disaggregated sectors was obtained from a number of sources, primarily based on costs and earnings studies in these sectors (see supplementary information for full details, including the final I-O table).

Assumptions relating to input reductions and yields at MEY

As noted previously, moving to MEY will require a reduction on fishing effort and hence capacity of the fishery. The extent of this reduction will depend on the existing level of total fishing effort, capacity and stocks relative to this required to achieve to MEY. Previous studies in other fisheries have considered a considerable reduction in the fishing fleet capacity of between 50 and 79% to maximise economic profits in range of European fisheries that were both overcapitalised and overexploited (Eggert and Tveteras 2007; Hoff and Frost 2007;

[2] The ten aggregated industries were agriculture and forestry; fishing; mining; processed food and drinks; textile and wood products; fuel, chemicals and metal products; boats, machinery and equipment; construction, manufacture and repairs; and government and services.

Pascoe 2007). In 2005 and 2006, fleet sizes in Commonwealth fisheries were reduced by between 30% and 60% (with an average of 46%) as part of a $150 million Commonwealth Government buyback scheme (DAFF 2007). This was instigated to reduce overcapacity in the fisheries in order to improve the biological sustainability and economic performance in these fisheries. In the Western Australian rock lobster fishery, estimates of MEY suggest that vessel numbers would need to decrease by around 50-60% (WA Department of Fisheries 2009).

For most Australian fisheries, catch and effort at MEY has not been assessed. In the northern prawn fishery, catches of tiger prawns at MEY are estimated to be around 16% higher than current catch levels (Kompas *et al.* 2008). Similarly, in the south east fishery, total catches at MEY are expected to be around 30% greater than current levels, although in the short terms catches of some species will need to be decreased (Kompas *et al.* 2008). In contrast, estimates of the catch at MEY in the Western Australian rock lobster fishery were 10 per cent lower than the current catch levels (WA Department of Fisheries 2009). However, price increases resulting from changes in fisher behaviour (e.g. targeting larger lobsters) may more than offset the decrease in catch, resulting in higher revenues at MEY.

Given that MEY has not been assessed for most Australian fisheries, a number of scenarios were examined and applied equally to all fisheries.[3] For the purposes of the analysis, it was

[3] Abalone were excluded from the analyses. The commercial fisheries have been effectively controlled (in most cases through ITQs) for many years and are already extremely profitable. Stocks are also exploited heavily by recreational fishers and illegal poachers (attracted by the high profitability in the fishery). A substantial capacity reduction in the commercial sector is likely to have less of an impact on total fishery profitability than a reduction in recreational and illegal activities.

assumed that all fleets would need to be reduced by 50% in order to achieve MEY. This is an assumption rather than an actual known requirement to achieve MEY, but is consistent with the degree of capacity reduction found in the previously cited studies. For fisheries already closer to MEY or even MSY, this assumption will result in an overly pessimistic impact on regional economies. Further, we are using national rather than regional multipliers. At the regional level, multipliers are usually lower that the national level as many inputs are imported into the region. Hence, impacts in the immediate coastal communities are likely to be lower than the national impacts estimated in the analysis.

Output levels (and hence revenue) may also vary from the current values at MEY, depending on catch levels at MEY relative to the current (base year) catches. The analysis was undertaken with a range of alternative revenue outcomes, including an increase by either five or 10%, no change, or decrease by either five or 10%. These assumptions are relatively conservative since previously cited examples suggested that, for the limited number of Australian fisheries in which, MEY has been assessed, catches at MEY may range from 10% lower to 30% higher than the 2004-05 levels In the short term, if the fishery has severely depleted stocks, then greater reductions in catch may be necessary, although catches would be expected to subsequently increase by more than 10%.

Input costs would also decrease as fleet size decreased. However, the full 50% reduction in line with fleet capacity was not imposed as some underutilised capacity no doubt existed, so some increase in individual effort is likely in response to the higher profits. A key input to fisheries production is fuel. These costs were assumed to decrease by 40%, assuming that recovery of overfished stocks and reduced crowding externalities will increase individual catch rates.

Reduced capacity will reduce the number of licences, and the extent of government management services that need to be provided. However, many of these services are not related to the fleet size (e.g. stock assessments), and there is also a smaller pool of vessels to pay for these services. As a result, management costs (provided by the Government and services sector) were assumed to decline by only 25%. Other intermediate inputs were also assumed to decline by only 45%, as increased individual activity would increase the use of these inputs.

Crew are currently paid a proportion of the revenue. It was assumed that this proportion would remain constant (i.e. the fewer crew would all be paid individually more), with the total payments varying with the assumption about revenues under MEY.

Scenarios and results

Production, consumption and total income multipliers

The production (indirect), consumption (induced) and total income multiplier values for the six wild fishing sectors examined (i.e. excluding abalone) for the base model (i.e. 2004-05) and the five "MEY" scenarios are given in Table 1. For example, from the base model, for each Australian dollar of sales generated by the wild tuna industry there will be a total of \$3.57[4] respectively in income generated by businesses in Australia. Of this, \$1.00 is solely the

[4] All values are in Australian dollars in 2004-05 prices.

impact of a direct change in demand for tuna, while, $1.17 and $1.40 represent the additional production and consumption induced effects respectively in other sectors of the economy. For the production and consumption income multipliers a value greater than one implies that the respective induced effects of a change in income are greater than the direct effects.

Table 1. Approximately here

The differences in value for the production, consumption and total income multipliers generally relate to differences in the cost structure of the sector. This is both across sectors for a given scenario, and between scenarios for a given sector. The income multiplier is largely dependent on the proportion of wages to other intermediate inputs. The smaller are wages to other inputs, the higher the income multiplier. This is because a change in demand required to generate an extra dollar in wages will have a bigger impact to other industries supplying inputs to the sector under consideration.

Economic distribution effect and net impact of achieving "MEY"

The changes in direct, production (indirect) and consumption (induced) income effects and net economic impacts in the different scenario analyses (no change, 5 and 10% increase and 5 and 10% decline in catches) compared to the base year are presented in Table 2. The net economic impacts are estimated after evaluating the direct effect (wages and profits to the fishery) and the production and consumption induced effects. As would be expected, profits to the fishing sectors have increased with a reduction in capacity under all scenarios, while total wages varied depending upon the output assumption.

Table 2 Approximately here

The impacts of wages in other intermediate sectors (indirect effect) and consumption (induced effect) were estimated by multiplying the wages obtained in fisheries by the appropriate income multiplier (From Table 2). Overall, income in intermediate sectors decline the most followed by consumption expenditure. This is not surprising since reduction in capacity has reduced the need for inputs from intermediate sectors, including labour. Consumption induced effects derive from changes in incomes (wages in particular) in both the fisheries and other intermediate sectors. While the latter is affected by the capacity reduction (which is fixed under all scenarios), the former depends on the level of catch (and hence revenues) at MEY relative to the initial condition.

An assumption was made that, predominantly, crew wages were spent in the local community, while wages in intermediate sectors were spend outside the local fishing communities (as many of these goods and services would be produced elsewhere and imported to the local economy). On the basis of this assumption, consumption induced income changes in the local fishing communities will track changes in crew wages rather than fleet capacity changes. If maintaining economic activity in local fishing communities is seen as an important social consideration in fisheries management, then achieving MEY may still result in gains to local fishing communities even with large capacity reductions provided that catches at MEY are at least the same if not greater than the initial level.

Profits in the I-O framework are effectively considered a leakage from the system, and hence do not feed back into the generation of additional economic activity. While some large companies exist, the Australian fishing industry – particularly the large inshore sector managed by the States – is dominated by small, owner-operated businesses (Evans and Johnstone 2006). Hence, increased profits form part of the income to a large number of individuals, and it would be reasonable to assume that at least some of this additional income would be spend, while the remainder would be invested elsewhere in the economy, potentially contributing to additional growth and incomes in other sectors. The consumption induced impact on wages arising from increased profits in fisheries assuming all, half or nothing is consumed is illustrated in Figure 4. Only the outcomes under the assumption of ±10% change and 0% change in revenues are illustrated. However, it can be seen that allowing for increased consumption derived from increased fishery profits will, in most cases, result in positive induced incomes, and in others greatly decrease the level of loss estimated when this additional consumption was ignored. If we further assume that a large proportion of any increase in profits will be consumed locally, then much of these benefits will flow to local communities directly.

Discussion and conclusions

The purpose of this paper was to investigate the net economic impact of reducing fishing capacity in order to achieve MEY in fisheries. While the analysis was applied to Australian fisheries, these fisheries share common features with a wide variety of fisheries internationally. Further, the net impacts were assessed with a range of potential revenue outcomes, enabling general lessons to be learned. The results are hence important to fisheries managers and policy makers since they provide an indication of the profitability gains to different fisheries and the potential costs to fishers, the intermediate sector and final consumption of goods and services due to changes in fisheries wages and induced incomes through changes in input demands.

The analysis suggests that the two main changes in the fishing sector as a consequence of achieving MEY, namely fleet reductions and changes in revenue,have different impacts on different parts of the economy. The fleet reduction necessary to achieve MEY results in lower input demand and hence lower input costs to the fishery. However, lower input demand from the fishery leads to a loss of incomes in the intermediate sectors. This in turn flows through the economy in terms of reduced consumption, with an additional loss in incomes as a result. Fleet reduction also results in loss of employment in the fishing sector, although the impact of this on economic activity will depend on the second main impact of achieving MEY, namely changes in catches and revenues. Revenues may either increase or decrease, and the impact on consumption, and consumption induced incomes, will depend on the direction of this change.

In this analysis, the reduction of input costs in the fishery increases profits even when revenues were assumed to decline by 10%. Increases in profits more than offset the losses in other areas of the economy provided catches at MEY were no less than the initial (pre-adjustment) level. Hence, it could be concluded that MEY produces a net benefit to society under such circumstances. Effectively, incomes from other parts of the economy are transferred to the fishing industry in terms of higher profit. This is consistent with the concept of rent dissipation in fisheries, as incomes generated in the intermediate sectors form part of the cost of fishing. As rent is dissipated in fisheries through increased input use, incomes in intermediate sectors increase. Consequently, it could be argued that the existence of these incomes in intermediate sectors is an artefact of the market failure in fisheries. However, when rent generation in fisheries is viewed as a transfer out of other sectors, it is understandable that such targets are less desirable politically.

When profits are considered a form of income (as would be the case for owner-operator vessels and small companies), additional consumption induced income is generated, such that net benefits may exist even with some decrease in total output. The extent to which this may occur is difficult to determine. However, unconsumed profits are likely to be invested elsewhere in the economy, potentially stimulating economic activity in other sectors. These impacts are excluded from traditional I-O analyses.

When investigating the effect of MEY on local communities, the effect is likely to be beneficial provided that the extra income earned by the crew (and increased profits) is spent within the communities. This ignores social consequences such as reduced crew employment. However, Australian fisheries in their current state are characterised as providing relatively low earnings for labour and lack of obvious career paths to attract and retain quality people. As a result, the industry has difficulty in competing with other industries for quality skilled labour and is characterised by a high labour turnover (Evans and Johnstone 2006). This implies that crew are generally highly mobile, so displaced crew should have little difficulty transitioning to other industries.

The analysis may overstate the reduction in incomes following fleet capacity reductions. In many cases, less than a 50% reduction in fleet size may be necessary to achieve MEY. A smaller fleet reduction would result in lower negative production and consumption induced effects. The analysis also does not consider the impact of price changes. Prices for most of the high valued species (e.g. lobster, prawns, abalone and tuna) are largely driven by external markets as most of the product is exported. For the domestic fish market, prices are generally inflexible (Bose 2004). Hence, it is expected that quantity changes resulting from achieving MEY will have little impact on the price. However, the shift to MEY will require changes in the management structure that will also provide incentives for fishers to maximise the value of their output. To achieve MEY, some form of rights-based management system will need to be introduced into the fishery to remove the incentives that will otherwise dissipate the increased economic profits. In Australian fisheries, ITQs are seen as the most likely candidate to achieve this for most (but not necessarily all fisheries). Slowing down the fishing activity through removing the incentives to race to fish provides an opportunity for fishers to take greater care of their catch, as well as change their fishing behaviour in order to target higher valued individuals (e.g. larger animals that receive a higher price per kg). Improvements in quality leading to higher prices following the introduction of ITQs have been observed in several fisheries (Bernal *et al.* 1999; Grafton 1996).

This study suggests that, overall, achieving MEY is likely to result in a net increase in incomes in the economy, although sectors that previously benefited from overcapitalisation in fisheries will incur losses. When taking into account potential price increases that may arise through more effective management measures, and the potential consumption induced effects arising from increased owner-operator returns, these gains may be substantial.

Figure 1. The basic bioeconomic model

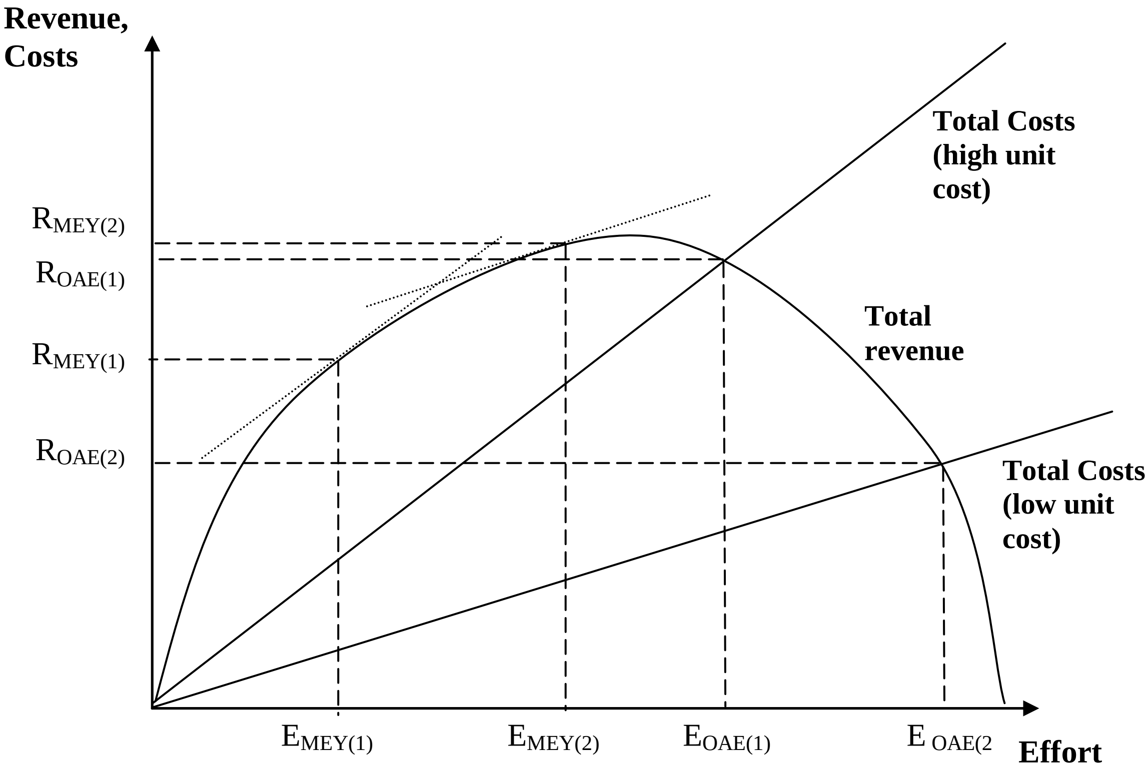

Figure 2. Value of production, Australian fisheries 2006-07 (source: ABARE, 2008)

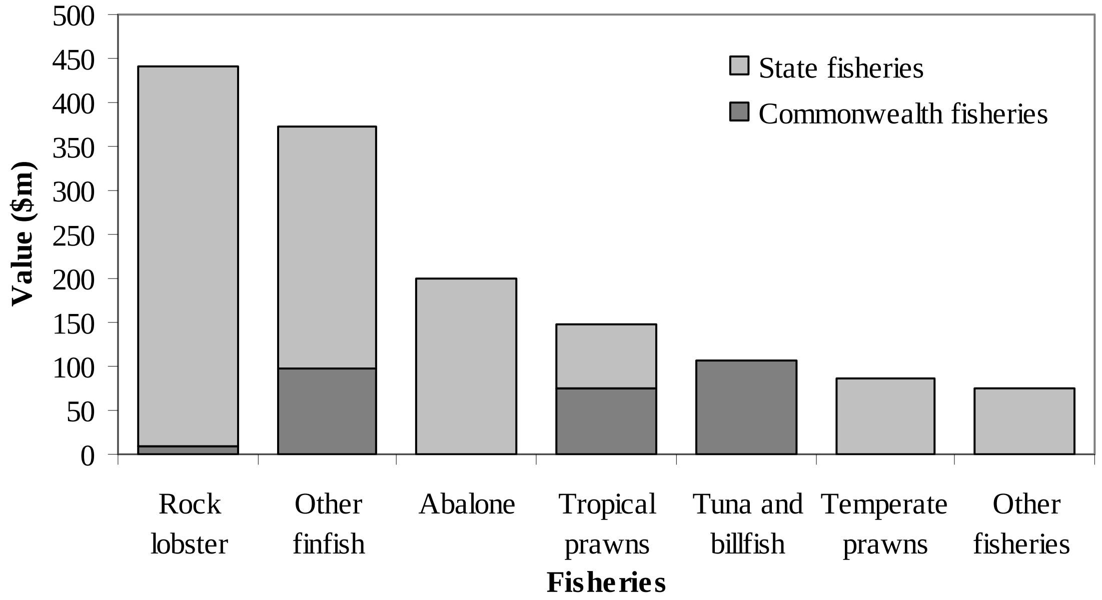

Figure 3. Approximate location of wild fisheries

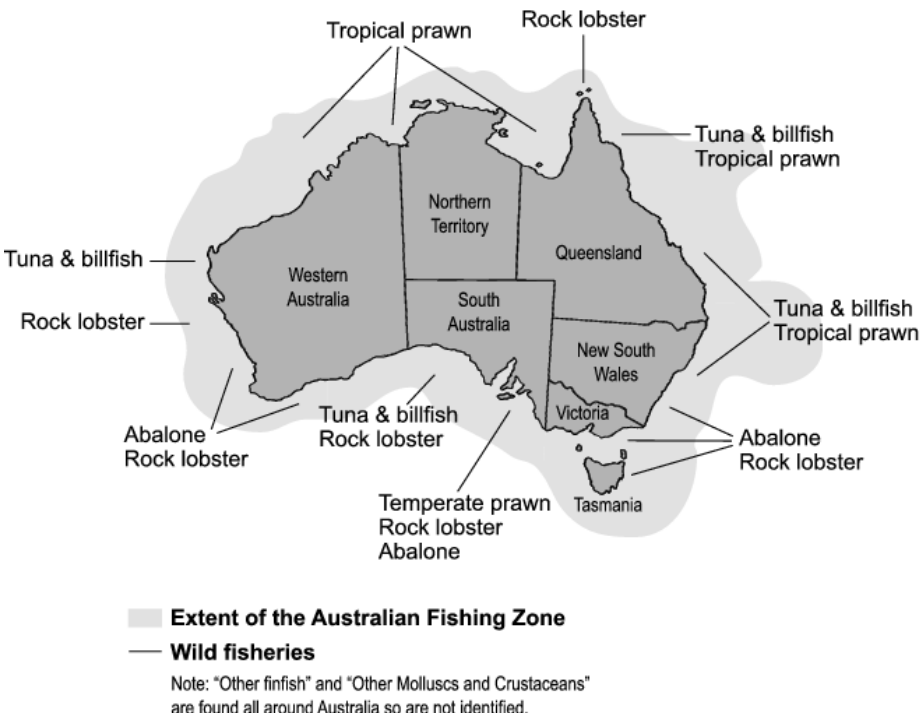

Figure 4. Consumption induced income for the ±10% and 0% change in catch scenarios when 0%, 50% and 100% of profits are spent as wages (i.e. final consumption of goods and services).

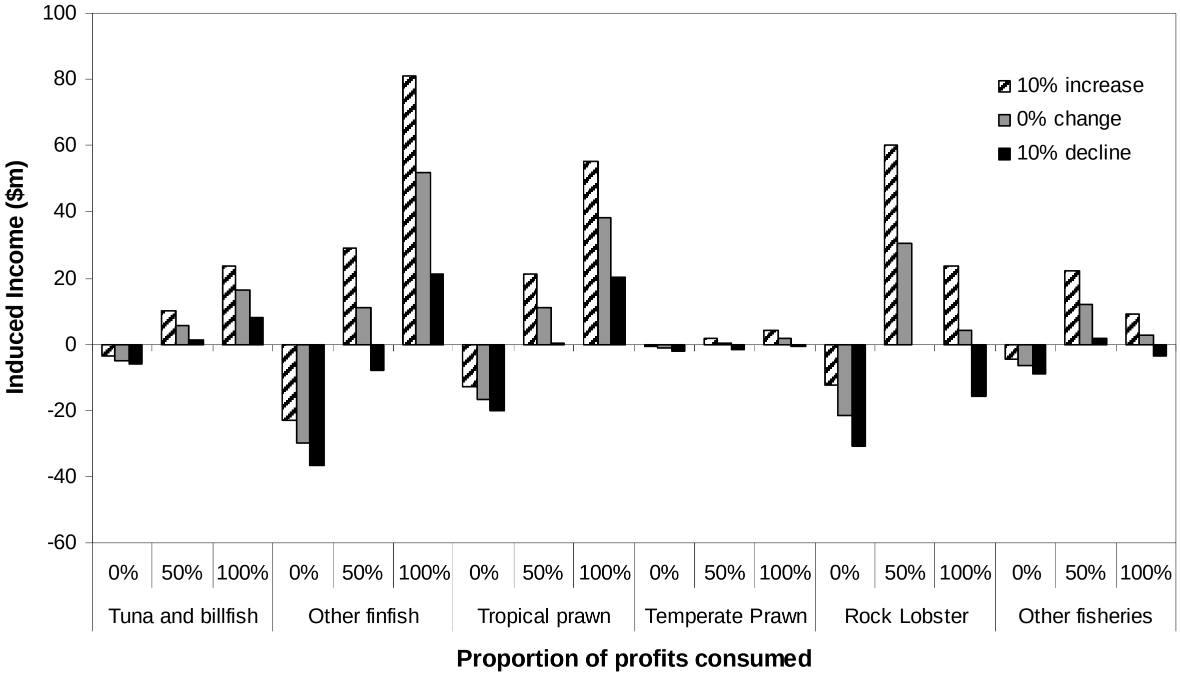

Table 1. Production (indirect), consumption (induced) and total (type 2) income multipliers in the base and scenario analysis

	Base	Revenue at MEY relative to 2004-05 level				
	2004-05	10% increase	5% increase	0% change	5% decline	10% decline
Tuna and billfish						
• Indirect effect	1.169	0.678	0.710	0.746	0.785	0.829
• Induced effect	1.404	1.086	1.107	1.130	1.155	1.183
• Total effect	3.572	2.764	2.817	2.875	2.940	3.012
Other finfish						
• Indirect effect	1.075	0.573	0.600	0.630	0.655	0.700
• Induced effect	1.343	1.018	1.035	1.055	1.071	1.100
• Total effect	3.419	2.590	2.635	2.684	2.727	2.799
Temperate Prawn						
• Indirect effect	0.487	0.266	0.278	0.292	0.308	0.325
• Induced effect	0.962	0.819	0.827	0.836	0.846	0.857
• Total effect	2.449	2.085	2.106	2.129	2.154	2.182
Tropical Prawn						
• Indirect effect	1.156	0.632	0.662	0.695	0.732	0.772
• Induced effect	1.396	1.056	1.076	1.097	1.120	1.147
• Total effect	3.552	2.688	2.737	2.792	2.852	2.919
Rock Lobster						
• Indirect effect	0.584	0.320	0.336	0.352	0.371	0.391
• Induced effect	1.026	0.855	0.864	0.875	0.887	0.900
• Total effect	2.610	2.175	2.200	2.227	2.258	2.292
Other fisheries						
• Indirect effect	0.806	0.440	0.461	0.484	0.509	0.537
• Induced effect	1.169	0.932	0.945	0.960	0.976	0.995
• Total effect	2.975	2.372	2.406	2.444	2.486	2.532

Table 2. Change in income to the fishing industry, the intermediate and final demand sectors for the different scenarios compared to the base year (2004-05) and likely impact to final consumption will have to the local and non-local consumption

	Revenue at MEY relative to 2004-05 level				
	10% increase	5% increase	0% change	5% decline	10% decline
Tuna and billfish					
• Crew wages	1.8	0.9	0.0	-0.9	-1.8
• Owners' income (profits)	25.2	21.9	18.6	15.3	12.0
• Wages in intermediate sectors (indirect effect)	-7.5	-7.5	-7.5	-7.5	-7.5
• Wages in final consumption of goods & services (induced effect)	-3.7	-4.3	-4.9	-5.4	-6.0
• Impacts to local consumption	1.2	0.6	0.0	-0.6	-1.2
• Impacts to non-local consumption	-4.9	-4.9	-4.9	-4.9	-4.9
• Net effect to the economy	15.8	11.0	6.3	1.5	-3.3
Other finfish					
• Crew wages	10.3	5.2	0.0	-5.2	-10.3
• Owners' income (profits)	102.3	89.9	77.4	66.2	52.5
• Wages in intermediate sectors (indirect effect)	-46.1	-46.1	-46.1	-46.8	-46.1
• Wages in final consumption of goods & services (induced effect)	-23.1	-26.5	-29.9	-33.7	-36.6
• Impacts to local consumption	6.7	3.4	0.0	-3.8	-6.7
• Impacts to non-local consumption	-29.9	-29.9	-29.9	-29.9	-29.9
• Net effect to the economy	43.4	22.5	1.5	-19.5	-40.5
Tropical Prawn					
• Crew wages	5.5	2.8	0.0	-2.8	-5.5
• Owners' income (profits)	64.7	57.3	50.0	42.7	35.3
• Wages in intermediate sectors (indirect effect)	-25.5	-25.5	-25.5	-25.5	-25.5
• Wages in final consumption of goods & services (induced effect)	-12.9	-14.7	-16.5	-18.3	-20.1
• Impacts to local consumption	3.6	1.8	0.0	-1.8	-3.6
• Impacts to non-local consumption	-16.5	-16.5	-16.5	-16.5	-16.5
• Net effect to the economy	31.8	19.9	8.0	-3.9	-15.8
Temperate Prawn					
• Crew wages	1.1	0.5	0.0	-0.5	-1.1
• Owners' income (profits)	6.1	4.9	3.8	2.7	1.5
• Wages in intermediate sectors (indirect effect)	-2.1	-2.1	-2.1	-2.1	-2.1
• Wages in final consumption of goods & services (induced effect)	-0.7	-1.0	-1.4	-1.7	-2.1
• Impacts to local consumption	0.7	0.4	0.0	-0.4	-0.7

• Impacts to non-local consumption	-1.4	-1.4	-1.4	-1.4	-1.4
• Net effect to the economy	4.4	2.3	0.3	-1.7	-3.7
Rock Lobster					
• Crew wages	14.3	7.2	0.0	-7.2	-14.3
• Owners' income (profits)	84.6	71.9	59.3	47.4	34.0
• Wages in intermediate sectors (indirect effect)	-33.3	-33.3	-33.3	-33.3	-33.3
• Wages in final consumption of goods & services (induced effect)	-12.3	-16.9	-21.6	-26.2	-30.9
• Impacts to local consumption	9.3	4.7	0.0	-4.7	-9.3
• Impacts to non-local consumption	-21.6	-21.6	-21.6	-21.6	-21.6
• Net effect to the economy	53.4	28.9	4.4	-19.3	-44.5
Other fisheries					
• Crew wages	3.2	1.6	0.0	-1.6	-3.2
• Owners' income (profits)	28.9	24.3	19.7	15.1	10.5
• Wages in intermediate sectors (indirect effect)	-10.4	-10.4	-10.4	-10.4	-10.4
• Wages in final consumption of goods & services (induced effect)	-4.6	-5.7	-6.7	-7.8	-8.8
• Impacts to local consumption	2.1	1.0	0.0	-1.0	-2.1
• Impacts to non-local consumption	-6.7	-6.7	-6.7	-6.7	-6.7
• Net effect to the economy	17.1	9.8	2.6	-4.7	-11.9

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Net economic impacts of achieving maximum economic yield in fisheries: supplementary information

The purpose of this document is to provide supplementary information on income multiplier estimation as well as a brief critical justification of the input-output methodology rather than general equilibrium modelling.

We also provide details on data sources used in the analysis. As data were not available for all fisheries, or were available for only part of the fishing sector included in the analysis, a number of assumptions were required to generate the transactions table used in the analysis. These assumptions are also detailed below.

Income multiplier estimation and limitations

The simple income multiplier shows the effects of the initial income effects plus all of the production induced rounds of extra output. The total income multiplier captures the two effects captured by the simple multiplier plus the consumption induced effects. The calculation of these two multipliers is obtained by multiplying the following matrices:

$$\text{Simple multiplier} = \mathbf{W}^*\mathbf{Z} \qquad (2)$$

$$\text{Total multiplier} = \mathbf{W}^*\mathbf{B}^\wedge \qquad (3)$$

Where **W** is the initial income effects vector obtained by dividing each industries' wages by its corresponding level of output. From these, the production, consumption and total effects (aka Type II multiplier) due to a one dollar increase in the wages of the industry investigated can be estimated. The Type II multiplier is the sum of the production and consumption induced effects plus the value of 1 representing the initial effect.

Production induced effects = (simple multiplier – **W**)/**W**

Consumption induced effects = (total multiplier – simple multiplier)/**W**

Type II = Total multiplier/**W**

As with most modelling techniques, there are certain limitations to I-O models. Foremost of these is that I-O models assume that production is subject to constant returns to scale. That is, an x% increase in final demand will result in an x% increase in the use of intermediate inputs. Further, they are assumed not to vary through time (i.e. are static) and that the pattern of inter-industry linkage is insensitive to changes in the relative price of inputs. Finally, I-O assumes excess supply in factor markets. That is, any increase in demand can be met without any pressure on factor prices.

An alternative methodology for assessing flow on effects from changes in the fishery is sector is the development of Computable General Equilibrium models (CGE). These have an advantage in that they allow for substitution of inputs within the economy in response to a change in factors prices. For example, the increased availability of labour as a result of the reduction in crew employment would lead to a reduction in labour prices, and growth in other sectors that could use these inputs. Further, they do not require the assumption of constant returns to scale. A key disadvantage of CGE models is that they require an even larger amount of data that is often not possible to trace when investigating smaller industries such as fisheries (Berck and Hoffmann 2002). Further, their added complexity – particularly if non-linearities are introduced – requires greater aggregation of the sectors to find a solution. As the fishing industry in total represents less than half of 1 per cent of the total GDP in Australia, changes in the sector will have very little impact in a CGE model other than what can be estimated using an I-O model. Further, disaggregating the industry into different fisheries would also result in even fewer benefits of a CGE model relative to an I-O model.

Information used to develop the I-O model

The value of production for each of the 13 sectors was obtained from the 2004-05 production tables supplied by the Australia Bureau of Agriculture and Resource Economics (ABARE 2008). The ABARE estimate of the total value of Australian fisheries production in 2004-05 ($2,086 million) was smaller than the estimated value of fisheries production in the I-O table from ABS for this same year ($2,500 million). To maintain consistency with the remainder of the table, the total values for each of the wild and farmed fish sector from the ABARE data were increased by the same proportion in order to equal the value of fisheries production in the ABS I-O table.

The costs structures (representing input use) for each fishing sector were derived from published cost and earning studies (Table 1). Data were available for one or more fisheries within each fishing sector. For those fisheries where information was not available, costs structures in similar fisheries were assumed to be representative. For the wild fishery sectors, the proportion of inputs going into the seven new sectors in the year 2004-05 were obtained from ABARE's survey reports and the Primary Industries and Resources of South Australia (PIRSA) in their economic indicator reports (Table 1).

Information on cost structures relating to the six new farmed fisheries sectors, were also derived from a number of sources (Table 2). In some cases, data were not available for Australian production (e.g. salmon and pearl farming), so data from other countries and sectors were used. In other cases, data were available but were relatively dated. In these instances, it was assumed the proportion of inputs into the aquaculture sectors have remained constant over time.

The distribution of the output of the different wild and farmed fisheries sectors were estimated based on ABARE's export reports (ABARE 2008), Ruello & Associates (2008) report on the Queensland seafood supply chain in 2008 and consultations with experts in the field. These data were used to allocate the outputs to the different sectors as intermediate inputs. Total outputs across all fisheries to each intermediate and final use were given in the original ABS I-O table.

The Input-Output table is presented in tables 3 and 4. The six farmed fish groups have been aggregated in order to reduce the size of the Input-Output table in this document. In Table 3 the inter-industry matrix and value added section for the different intermediate sectors is presented. The number of intermediate sectors expands this table into two pages. In the first page agriculture and forestry, aquaculture and the different wild fisheries is presented. The continuation over the next page of table 3 represents all the other intermediate industries. In Table 4 the final demand and value added for the different intermediate sectors is presented.

Table 1. Data sources and assumptions used in the analysis- capture fisheries production

Fishery investigated / Location	Data available on financial performance	Location of fishery in report	Reference	Assumptions
Tropical prawns (Commonwealth, QLD, NSW, WA)	Northern prawn (NP) fishery (average per boat) 2004-05	Commonweatlh (between Cape York in QLD and Cape Londonderry in WA)	Vieira and Hohnen (2007)	WA prawn fishery assumed to have a similar cost structure to that of NP
	Torres Strait prawn fishery (average per boat) 2004-05	Commonwealth (Torres Strait)	Vieira and Hohnen (2007)	QLD and NSW prawn fisheries assumed to have a similar cost structure to Torres Strait fishery
Temperate prawns (SA, VA)	Gulf Saint Vincent prawn fishery 2004-05	SA	Clark et al. (2008)	VA prawn fisheries assumed to have a similar cost structure to Gulf St Vincent prawn fishery
	Spencer Gulf and West Coast prawn. 2004-05	SA	Clark et al. (2007f)	
Rocklobster (Commonwealth, NSW, VA, QLD, WA, SA, Tas)	SA Northern Zone Rock Lobster Fishery, 2004-05	SA	Clark, et al. (2007a)	Commonwealth and other states are assumed to have a similar cost structure to the average rocklobster fishery production in Northern and Southern SA
	SA Southern Zone Rock Lobster Fishery, 2004-05	SA	Clark, et al. (2007b)	
Abalone (NSW, VA, WA, SA, Tas)	SA Abalone fishery, 2004-05	SA	Clark, et al. (2007c)	Assumed the SA fishery represent production costs of other states
Other fisheries (i.e. molluscs and crustaceans) (Commonwealth, all states)	SA Blue Crab fishery, 2004-05	SA	Clark, et al. (2007d)	The fishery’s cost structure represent that of other crustaceans and molluscs
Tuna and billfish (Commonwealth, WA, SA, NT)	Eastern tuna and billfish fishery (average per boat) 2004-05	Commonwealth	Vieira, et al. (2007)	Assumed the fishery represents the costs of WA, SA and NT tuna fishery
Other Finfish (Commonwealth, all states)	Gillnet, hook and trap sector (average per boat) 2004-05	Commonwealth	Vieira, et al. (2007)	The sector assumed to represent total shark production
	Commonwealth trawl sector (average per boat) 2004-05	Commonwealth	Vieira, et al. (2007)	Total finfish minus tuna, sardines and sharks
	SA Sardine fishery, 2004-05	SA	Clark, et al. (2007e)	Assumed the fishery represents the costs of production in other states (VA and WA)

Queensland=QLD; NSW=New South Wales; NT= Northern Territory; SA=South Australia; Tas=Tasmania; VA=Victoria; WA=West Australia

Table 2. Data sources and assumptions used in the analysis- aquaculture production

Sector investigated / Location	Data available on financial performance	Location of fishery in report	Reference	Assumptions
Prawns (NSW, QLD)	Prawn farm model, 2000	QLD	Johnston (2000)	Assumed cost structures valid for 2004-05
Oysters (NSW, QLD, SA, Tas)	Oyster sector cost structure, 2006-07	SA	Econsearch, personal communication, February 2009	Assumed cost structures valid for 2004-05
Pearls (WA, SA)				Cost structure assumed to be generally similar to that of oyster production, with a larger labour component
Salmon (NSW, Vic, SA, Tas)	Norwegian salmon (average farm) 2004-05	Norway	www.fiskeridir.no	Australian salmon producers assumed to have a similar cost structure to Norwegian producers
Tuna (SA)	Tuna farming sector cost structure, 2006-07	SA	Econsearch, personal communication, February 2009	Assumed cost structures valid for 2004-05
	Mussel farming (average farm) 1989-90	VA	Treadwell, et al. (1991)	Cost structure assumed to have remained similar over time. Also other farmed molluscs are assumed to have a similar cost structure to mussel farming
Other (All States)	Barramundi farming (average farm) 1989-90	QLD	Treadwell, et al. (1991)	Cost structure assumed to have remained similar over time. Also other farmed finfish (except salmon and tuna) are assumed to have a similar cost structure to mussel farming
	Crayfish farming (Yabbies, Marron and Redclaw) (average cost of each crustacean in farms), 1989-90	Farm model	Treadwell, et al. (1991)	The farm models assumed to represent the average Australian production

Queensland=QLD; NSW=New South Wales; NT= Northern Territory; SA=South Australia; Tas=Tasmania; VA=Victoria; WA=West Australia

Table. 3. Inter-industry matrix and value added sections in the Input-Output table

Inter-Industry matrix	Agriculture & Forestry	Aquaculture	Other finfish	Other fisheries	Rock Lobster	Tuna and billfish	Tropical prawn	Temperate prawn	Abalone
Agriculture & Forestry	6,334.0	0.0	0.0			0.0	0.0	0.0	0.0
Aquaculture	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other finfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other fisheries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rock Lobster	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tuna and billfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tropical prawn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperate prawn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Abalone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mining	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Processed food & Drinks	1,033.0	112.4	4.9	3.2	28.7	6.4	1.2	0.2	0.9
Textile & Wood products	224.0	2.2	6.6	0.8	3.5	5.8	6.1	0.3	1.8
Fuel, chemicals & metals	1,997.0	7.0	68.0	18.4	45.5	10.5	67.8	2.9	2.8
Machinery & Equipment	183.0	11.2	28.0	12.2	17.8	5.2	21.6	1.8	5.2
Construction & Repairs	545.0	14.7	20.0	7.9	16.4	3.2	13.9	1.5	5.5
Trade & Transport	3,326.0	39.3	97.3	8.3	42.7	10.8	21.2	3.0	12.5
Government & Services	2,920.0	51.5	24.7	9.7	36.3	5.4	20.3	2.2	13.9
Total Intermediate Uses	**16,586.0**	**238.3**	**249.5**	**60.4**	**190.9**	**47.5**	**152.0**	**11.9**	**42.5**
Value added									
Wages	5,543.0	137.4	103.4	32.2	143.4	17.7	55.2	10.9	49.8
Profits	19,176.0	223.1	46.6	52.4	124.5	10.9	11.7	16.1	153.7
Taxes less subsidies	194.0	2.6	2.3	0.6	1.5	0.3	1.2	0.2	1.1
Imports	848.0	19.3	17.3	4.7	11.2	2.1	9.2	1.8	8.3
Total Production	2,700.0	139.5	40.3	13.1	33.2	7.4	35.6	2.3	7.6

Table. 3. Inter-industry matrix and value added sections in the Input-Output table (continuation)

Inter-Industry matrix	Mining	Processed food & Drinks	Textile & Wood products	Fuel, chemicals & Metals	Machinery & Equipment	Construction, & Repairs	Trade & Transport	Government & Services	Total Industry Uses
Agriculture & Forestry	46.0	17,085.0	1,677.0	219.0	1.0	105.0	1,864.0	794.0	28,125.0
Aquaculture	0.0	64.3	0.0	0.0	0.0	0.0	298.3	0.0	362.6
Other finfish	0.0	85.8	0.0	0.0	0.0	4.0	45.7	33.0	168.5
Other fisheries	0.0	4.7	0.0	0.0	0.0	0.0	38.8	0.0	43.5
Rock Lobster	0.0	102.1	0.0	0.0	0.0	0.0	90.0	0.0	192.1
Tuna and billfish	0.0	42.8	0.0	0.0	0.0	0.0	5.0	0.0	47.8
Tropical prawn	0.0	66.0	0.0	0.0	0.0	0.0	62.9	0.0	129.0
Temperate prawn	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	4.3
Abalone	0.0	145.2	0.0	0.0	0.0	0.0	20.0	0.0	165.2
Mining	10,362.0	379.0	139.0	18,797.0	136.0	527.0	1,445.0	3,453.0	35,262.0
Processed food & Drinks	36.0	6,840.0	114.0	359.0	146.0	300.0	10,783.0	2,085.0	21,854.0
Textile & Wood products	204.0	1,764.0	4,179.0	1,349.0	663.0	5,871.0	6,717.0	10,617.0	31,615.0
Fuel, chemicals & Metals	3,571.0	2,844.0	2,433.0	23,890.0	7,844.0	23,039.0	8,630.0	10,777.0	85,248.0
Machinery & Equipment	671.0	291.0	277.0	662.0	3,958.0	6,620.0	4,272.0	6,768.0	23,805.0
Construction & repairs	1,607.0	836.0	960.0	1,505.0	921.0	56,614.0	11,579.0	21,941.0	96,591.0
Trade & Transport	3,880.0	7,927.0	3,653.0	10,083.0	7,456.0	10,754.0	19,906.0	29,432.0	96,652.0
Government & Services	7,051.0	6,864.0	7,389.0	14,439.0	7,597.0	36,728.0	74,241.0	210,454.0	367,847.0
Total Intermediate Uses	**27,428.0**	**45,341.0**	**20,821.0**	**71,303.0**	**28,722.0**	**140,562.0**	**140,002.0**	**296,354.0**	**788,112.0**
Value added									
Wages	8,767.0	10,066.0	11,159.0	19,403.0	12,929.0	39,025.0	78,093.0	245,583.0	431,118.0
Profits	36,003.0	7,781.0	8,197.0	14,953.0	5,391.0	34,111.0	44,911.0	193,564.0	364,726.0
Taxes less subsidies	-626.0	354.0	337.0	280.0	249.0	935.0	4,533.0	8,087.0	14,353.0
Imports	514.0	588.0	561.0	996.0	618.0	1,695.0	6,061.0	14,061.0	26,016.0
Total Production	3,456.0	3,216.0	6,150.0	21,579.0	11,553.0	13,723.0	13,718.0	26,982.0	103,356.0

Table 4. Final demand and value added sections in the Input-Output table

Final demand matrix	Final Consumption Expenditure		Gross Fixed Capital Formation			Changes in Inventories	Exports	Total Final Uses	Total Industry Uses + Total Final Uses
	Households	Government	Private	Public Enterprise	General Government				
Agriculture & Forestry	4,708.0	133.0	2,244.0	0.0	0.0	2,945.0	6,892.0	16,922.0	45,047.0
Aquaculture	294.1	42.4	0.0	0.0	0.0	0.0	61.2	397.6	760.2
Other finfish	206.7	25.2	0.0	0.0	0.0	6.4	52.7	291.0	459.4
Other fisheries	120.0	0.0	0.0	0.0	0.0	0.0	0.0	120.0	163.5
Rock Lobster	252.4	0.0	0.0	0.0	0.0	2.0	58.2	312.6	504.7
Tuna and billfish	24.0	0.0	0.0	0.0	0.0	0.0	14.0	38.0	85.8
Tropical prawn	146.9	26.5	0.0	0.0	0.0	-37.4	0.0	136.1	265.1
Temperate prawn	25.9	13.0	0.0	0.0	0.0	0.0	0.0	38.9	43.2
Abalone	97.9	0.0	0.0	0.0	0.0	0.0	0.0	97.9	263.1
Mining	393.0	0.0	236.0	76.0	42.0	1,790.0	37,743.0	40,280.0	75,542.0
Processed food & Drinks	29,263.0	39.0	248.0	13.0	27.0	-39.0	15,941.0	45,492.0	67,346.0
Textile & Wood products	9,270.0	2.0	1,079.0	59.0	208.0	178.0	4,814.0	15,610.0	47,225.0
Fuel, chemicals & Metals	10,178.0	1,609.0	3,100.0	162.0	297.0	437.0	27,483.0	43,266.0	128,514.0
Machinery & Equipment	12,455.0	7.0	12,307.0	420.0	768.0	587.0	9,113.0	35,657.0	59,462.0
Construction & repairs	14,723.0	2,769.0	93,256.0	8,117.0	13,106.0	-72.0	1,561.0	133,460.0	230,051.0
Trade & Transport	125,970.0	2,824.0	17,915.0	515.0	1,474.0	13,939.0	28,029.0	190,666.0	287,318.0
Government & Services	217,886.0	152,846.0	21,674.0	3,817.0	2,239.0	-4.0	18,326.0	416,784.0	784,631.0
Total Intermediate Uses	426,014.0	160,336.0	152,059.0	13,179.0	18,161.0	19,732.0	150,088.0	939,569.0	1,727,681.0
Value added									
Wages	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	431,118.0
Profits	0.0	0.0	0.0	0.0	0.0	-29.0	0.0	-29.0	364,696.9
Taxes less subsidies	46,334.0	0.0	13,620.0	21.0	63.0	-2.0	1,395.0	61,431.0	101,800.0
Imports	45,473.0	1,921.0	29,518.0	841.0	2,081.0	1,095.0	5,911.0	86,840.0	190,196.0
Total Production	**517,821.0**	**162,257.0**	**195,197.0**	**14,041.0**	**20,305.0**	**20,796.0**	**157,394.0**	**1,087,811.0**	**2,815,492.0**

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