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Beyond GVP: The value of inshore commercial fisheries to fishers and consumers in regional communities on Queensland's east coast

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Executive Summary

What the report is about

This report examines the potential economic benefits to regional communities from the Queensland inshore fisheries (pot, net and line fisheries). In doing so, the project has developed a series of questionnaires and analysis tools that could be potentially applied in other regions with fairly minimal modification. The report outlines the theory underpinning these methods, as well as their application. The results of the analysis indicate that the inshore fisheries produce substantial local benefits well in excess of their own gross value product (GVP).

The study was undertaken by economists and social scientists from CSIRO and JCU, with significant input from research students from QUT also.

Background

Fisheries in Queensland, and elsewhere, are coming under increased pressure from other potential resource users for access to the resources. These include the fish resource itself (i.e. by recreational fishers), as well as encroachment on the area of the fishery through conservation based closures and onshore activities (e.g. port development) that impact where vessels may operate (and potentially the resource itself). Quantifying the potential impact on fisheries is necessary (but not sufficient) to ensure that resources are used most effectively, and that all costs of alternative resource uses are taken into consideration in decision making.

The value of fisheries, and hence the potential impact of alternative uses, goes beyond the landed value of the catch. Fisheries play a key role in many coastal communities, directly generating income for local residents as well as stimulating other sectors through the demand for inputs into fishing as well as through expenditure from the income generated. The supply of fresh fish to the local community also provides other benefits.

Aims and objectives

The aim of this project was to attempt to estimate some of the key additional benefits that the fisheries generate beyond just their value of production. The project considered four different approaches.

- Alternative methods to assess the direct value of the industry;
- Assessment of the potential direct value of the industry if it was operating at full capacity;
- The flow-on effects from the fisheries to the regional economies in terms of additional economic stimulus; and
- The benefits to local consumers of access to locally caught fish.

A secondary aim of the study was to develop a transferable methodology that can be applied in other regions.

Methodology

The project analysis was undertaken in four different stages using three different methodologies, to address each of the different objectives above.

In the first stage, a range of different financial approaches often used to value companies were explored. In finance, the value of a company is not related directly to how much it produces (i.e. GVP), but depends on a number of different metrics such as the capitalised value of the shares, the total value of capital invested in the company (i.e. the total capital assets less debts), or the discounted (expected) future profits. These measures are related e.g. the capitalised value of the shares should reflect the discounted expected profits, and the licence values were taken to reflect fishers expectations of future profits. These different approaches were applied to the fisheries to determine how applicable they were in describing the industry value.

Gross value added (GVA) was also estimated for the inshore fleet. GVA represents the contribution of fishing to gross domestic product, and is derived by subtracting the cost of intermediate inputs from the fishery revenue. GVA therefore includes the income and profits generated by the fishing sector.

In the second stage, Data Envelopment Analysis (DEA) – a mathematical modelling approach deriving from the area of productivity analysis – was used to estimate the current level of capacity utilisation in the industry, and from this the potential output if all vessels were operating at full capacity. DEA compares the levels of outputs and inputs used in different production units (in this case taken as a fishing area), and separates how differences in production between areas are due to differences in efficiency (which may represent underlying local stock abundance and composition) and capacity utilisation.

In the third stage, we estimated vessel level production induced multipliers using a new approach developed by one of the members of the project team. This approach uses survey based information on expenditure – both quantity and location – to develop an estimate of the potential regional impact. The approach was extended to consider expenditure of crew and owners to capture the consumption induced impacts resulting from the income generated in the fishery. The results were tested to confirm if there were significant differences between regions and between different fishing activities, and whether a ‘general’ multiplier could be applied.

The fourth stage involved the application of a choice experiment approach to determine Queensland consumers’ willingness to pay for locally caught produce. An internet survey of just over 1,000 Queensland residents was undertaken, asking questions about fish consumption as well as presenting a set of scenarios with differing price, quality and location of catch characteristics. Based on the choices of the respondents, the willingness to pay for local product could be derived from a multinomial logit model.

Results and key findings

The estimates of GVP, book value (the combination of total licence values and capital values less debt), and discounted future profits differed substantially for the line and net fishery, but were reasonably consistent for the pot fishery. GVP reflects the catch and prices in the year in which it was measured – effectively a ‘spot’ value of the fishery. In contrast, both book value and discounted future profits (reflected in the licence values) potentially represent a longer term estimate of value. However, these latter measures are also problematic: licence values reflect the state of the licence market as well as future expectations about the value of the fishery – with considerable latent effort in the fishery the supply of licences may exceed the demand, depressing these prices. Inshore fisheries are also relatively less capital intensive than offshore fisheries, so the total capital value does not necessary reflect its potential value. Obtaining capital values (and licence values) requires survey information to be collected, and is also potentially influenced by sample bias. Consequently, GVP is considered the most practical, if not the most theoretically appropriate, measure of the *direct* value of the industry, although this does not capture the full economic benefits that fishing may produce beyond GVP.

GVA for the inshore fleet was high relative to GVP. Ignoring GVA in such circumstances may understate the economic importance of fishing, particularly when GVP is relative low. GVA therefore provides an additional measure of value that should be considered when assessing the importance of the fishing industry to the economy.

The DEA modelling found that many areas were operating at or near full capacity, with differences in catch from the different areas reflecting more 'inefficiency' (in this case differences in local resource abundance and composition) than capacity underutilisation. This implies that the industry is operating close to its potential given the current fleet size.

The multiplier analysis found that there was no real significant difference between the production multipliers of the inshore boats nor between regions. The average regional multiplier for these vessels was around 1.9, which implies that for each dollar of value produced by the fishing industry, and additional $0.90 is generated in the local economy due to the purchase in inputs (i.e. total impact of $1.90). Consumption induced multipliers, however, were found to be substantially higher: for every $1 of income generated by the fishery (i.e. crew payments, owner share), an additional average $1.94 was generated local, giving a total flow on effect of $2.94 (i.e. an income based multiplier of 2.94). The proportion of income generated per dollar of output varied considerably both within and between the fleets, averaging around 35% for pots, 39% for inshore line and 67% for inshore nets. Based on these results, given the fishery GVP of around $46m in 2012-13, an additional $41m may have been generated through production induced effects in the regional economies, while a further $33m was generated through the consumption induced effects.

The consumer survey found that most Queenslanders eat seafood regularly, and most purchase fresh fish at least once a month. Respondents expressed a preference for local seafood if available. From the fisher survey, between 40% and 50% of catch from the inshore fishery is sold locally. From the choice experiment, respondents were willing to pay an average of 11% more for locally sourced fish. No doubt some, but not necessarily all, of this additional value would have been captured by fish retailers. Whether a benefit to the consumer or retailer, this represents an additional benefit of around $6m a year from the fishery as a whole. Retail value added (excluding this benefit) was estimated to be around $17m at the Queensland level from the sale of the fishery output, although these estimates were based on limited observational data.

The combination of these results suggests that the combined economic value of the Queensland inshore commercial fisheries (pots, line and net fisheries) was in the order of $143m in 2012-13 (the most recent year for which data are available), of which only about one third was represented by the fishery GVP.

Recommendations

The project developed a range of survey instruments and analysis tools to derive these values. The tools were developed with the objective that they may be readily transferable to other fisheries to undertake a similar analysis. However, the transferability of these approaches will not be known until they are tested elsewhere. It is suggested, therefore, that a similar exercise be undertaken in another jurisdiction to test the transferability of the methods.

Keywords

Regional economic benefits, Consumer benefits, Queensland fisheries

Introduction

There are multiple threats to ongoing access/operation of commercial inshore fisheries (finfish and crab) along Queensland's east coast. These include port developments and expansions, coastal development, public perception (which influences management) and competition between fishing sectors (which also influences management). These threats to access could adversely affect not only commercial fishers themselves, but also secondary industries as well as the availability of seafood to local communities.

It could be assumed that reducing these threats and ensuring ongoing operation of commercial fisheries and local seafood supply is desirable, for many social and economic reasons. Yet there is little information about the value inshore commercial fisheries and fishing businesses provide to communities aside from the much used GVP, which has long been criticised by some as a nonsensical measure of value to the local community (McPhee and Hundloe 2004). Such a measure of the first sale value of the product does not capture the economic benefits derived in the local community from the fishing activity, or the relative value of local seafood compared to non-local seafood for consumers.

Without knowing the total economic value of commercial fisheries and local seafood for regional communities, decisions regarding management of, access to resources are likely to be ill informed. Real value information can be used to ensure appropriate access of fishers and consumers to fisheries resources, better assess the economic impacts of other coastal activities that negatively affect fishing, or better inform reallocation processes where necessary. While understanding the total economic value of the fishing industry is not sufficient to answer all resource allocation issues on its own, it is necessary information to ensure that community benefits from natural resource use are maximised.

This project was developed in collaboration with industry and in consultation with the Queensland FRAB. The project arose as a result of increasing frustration by both commercial and recreational fishers in the lack of understanding of the true contribution each sector makes to the Queensland regional economies, and inconsistencies in approaches that attempted to address these issues on a partial basis. Two earlier versions of the project were subsequently proposed in 2011 which included both recreational and commercial fisheries in a bid to look at consistent approaches to valuing the economic contribution of each sector. The two projects had a slightly different focus – one being of more relevance to recreational fishers and the other of more relevance to commercial fishers – but both addressed similar issues for both sectors.

The earlier proposals were both unsuccessful in obtaining funding, but as a result this revised project was identified as the highest priority on the Queensland FRAB priority list for the 2012 round. Discussions were held in mid-2012 with Queensland FRAB members to discuss the scope of the project. Based on these discussions, the project was revised to focus on commercial fisheries only in the first instance, with the potential to assess recreational fisheries in subsequent (follow on) studies. Recreational fishing representatives were present during these earlier meetings and agreed that the scope should be limited to commercial fisheries in the first instance.

A second project was also developed ('Adapt or Fail: Risk management and business resilience in Queensland commercial fisheries', FRDC Project 2013-210 (Tobin *et al.* 2016)) to examine the effects of different business models on resilience in the fisheries (rated as the second priority of the Queensland FRAB). As both projects had similar requirements in terms of fishery economic data, resources were pooled for this part of the study and a single survey undertaken, with the outcomes utilised by both projects.

Objectives

The project title "Beyond GVP" has two meanings. First, the project seeks to identify if there are alternative measures of *direct* fishery value that better reflect the economic value of the fishing industry than the value of its sales (i.e. GVP). Second, the project seeks to identify and measure the economic benefits that are generated locally in the process of fisheries production. That is, the benefits *beyond* the direct value.

The project focuses on the inshore commercial finfish and crab fisheries within Queensland east-coast. These fisheries are believed to be regionally important both as a source of income generation and also a source of fresh fish to local consumers.

The main objectives of the project were to:

1. Determine the economic value of the fisheries using a range of different approaches, drawing on financial and economic measures of industry or firm value;
2. Determine the flow-on economic value of inshore commercial fisheries, these being the additional benefits generated locally through the economic activity; and
3. Estimate the benefits consumers derive from having access to locally produced fish.

Finally, based on the experiences in estimating the different values above, the project aimed to develop a transferable methodology template for measuring the value of commercial fisheries to regional communities for a broader range of fisheries.

Method

Introduction

The Queensland commercial inshore fisheries consist of three main components:

- An inshore net fishery
- A line fishery (that also extends offshore)
- A crab (pot) fishery

The focus of this study was the Queensland East Coast Inshore Finfish Fishery and the Queensland Mud Crab Fishery. The fisheries run the full length of the Queensland coast, with most fishing effort occurring along the central Queensland coast.

The project focuses on three specific aspects of value to the local economies:

1) Direct economic value of commercial fishing;
2) Flow-on economic value to regional economies; and
3) Economic value of local seafood products to consumers (consumer surplus);

Details on the methods employed to estimate these values are provided in the following sections.

Underlying these components is the need to develop a transferable framework, such that the approach could be readily applied elsewhere. This requires the development of relatively simple, but robust, approaches that can be implemented in other states or regions.

Direct economic value of the commercial fisheries

A range of traditional measures of value exist. These measures were used to develop a range of values for the fisheries, derived from information from an economic (cost and earnings) survey of the fisheries as well as logbook information. The potential economic value was also assessed based on estimates of full capacity utilisation. The analysis of capacity utilisation also provides information on the efficiency and productivity of the fisheries, and how this has changed over time. Using spatial information, it also helps identify which areas are of key value to the fisheries.

Economic (cost and earnings) survey

An economic survey was run in conjunction with the Adapt or Fail project (Tobin et al. 2016). Interviews with fishers took place between August and November, 2014. In total, 188 fishing operators along the Queensland coast were surveyed, with most providing economic data suitable for use in the project. Full details of the survey are presented in the associated project report.

The aim of the economic survey was to provide information necessary to derive initial estimates of economic value for the fisheries. The survey also provides a snapshot of the economic performance of the fleets, as well as providing a measure of the level of incomes currently being generated in the fishery. The survey collected information on revenue and costs for individual fishing vessels. Vessels were grouped based on their main gear type in order to derive summary statistics. A detailed breakdown of the costs was provided.

The key statistics measured for each gear type was the mean, relative standard error, minimum and maximum values for each item. The relative standard error represents the degree of confidence in the mean estimate, given the amount of variability in the data and the same size. Standard errors (SE) are given by

$$SE = s / \sqrt{n} \tag{1}$$

where *s* is the sample estimate of the standard deviation and *n* is the number of observations. The relative standard error (RSE) is expressed as a percentage, and given by

$$RSE = \left(SE / \bar{x}\right) * 100\% \tag{2}$$

where $\bar{x}$ is the sample mean. The RSE provides a confidence interval around the sample mean. It could be expected that, at least 95% of the time, the true population mean will lie within +/- *t*RSE* of the sample mean, where *t* is the value of the t-distribution. The value of *t* is usually around 2, but varies based on the sample size (the smaller the sample, the larger the *t* value). The relationship between *s*, *SE* and $\bar{x}$ is shown in Figure 1, for the case where t=1.96 (as would be the case for large samples).

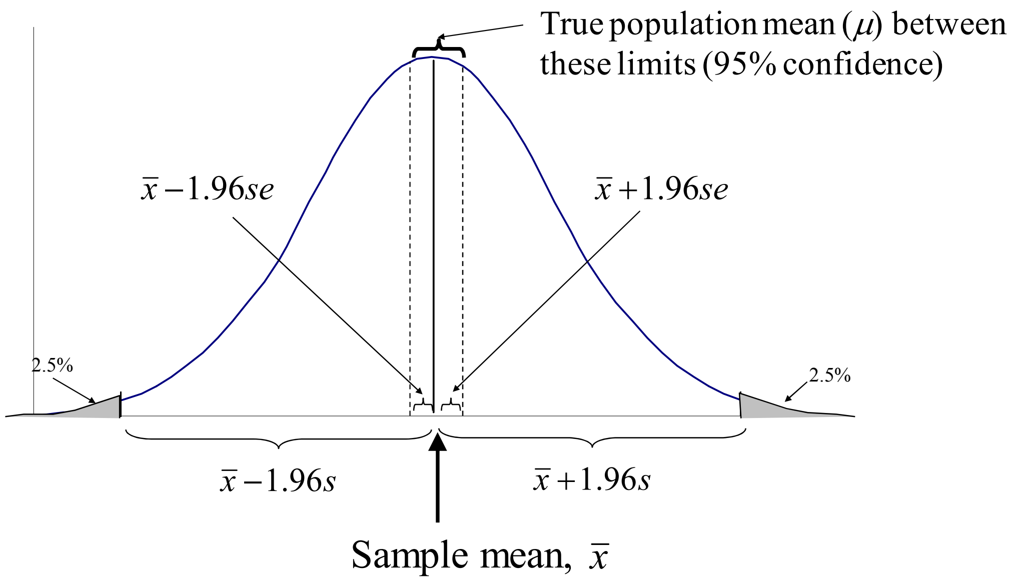

Figure 1. Relationship between mean ($\bar{x}$), standard deviation (S) and standard error (SE)

The RSE provides a relative measure of confidence in the sample mean. Estimates with an RSE of greater than 25% should be used with caution due to possibility of high sampling error (Australian Bureau of Statistics 2013). This rule of thumb is generally in regard to large data sets – as the standard error is inversely proportional to sample size (equation 1), the larger the sample the lower the standard error and the greater the confidence that the sample mean reflects the population mean. In the fisheries context, where population numbers themselves are often small and hence only small sample sizes are available, the RSE associated with mean values of sample estimates are often be above this level (for example, see George and New (2013)). Consequently, there is often greater uncertainty around the true population mean in fisheries surveys than surveys of other industries.

The key measures derived from the data include total revenue, crew incomes and full equity profit. Full equity profit represents the level of profits generated in the fishery regardless of who owns the capital, and excludes interest payments and leasing costs. While these costs represent true financial costs to the fisher, in an economic context they could be seen as reallocation of the profits to different owners of the capital (e.g.

banks, who effectively own a portion of the vessel, and other fishers who may own quota but lease it out). Ideally, full equity profits should also include a deduction for the value of unpaid (e.g. owner operator) labour. However, there was generally insufficient information available to derive these values reliably. Hence, the profit measure also included the value of the unpaid labour.

Other key financial measures include the value of capital in the fishery – both physical capital (i.e. boats) and other capital in the form of licence and quota values, the rate of return to capital (an indication of the relative performance of the industry compared with other industries), and the level of debt. The rate of return to capital (RRC) is derived from the full equity profits divided by total capital value (both licence and boat), given by:

$$RRC = \frac{Full\ equity\ profit}{Boat\ value + Licence\ value} \quad (3)$$

However, as the measure of full equity profits includes owner operator income, it may overestimate of the true financial performance of the vessels.

Alternative methods for valuing industries and firms

In business, turnover is just one indicator of the value of the firm. Extrapolating from this, GVP may not be the most appropriate proxy measure of the value of the fishing industry. Financial valuations of firms use a range of approaches. Most notable financial valuation methods, such as the discounted cash-flow model (DCF), dividend discount model (DDM) and balance sheet methods, are widely accepted as effective valuation tools for companies. By deriving an average firm profile, valuations provided by these methods could be extrapolated to provide an approximate valuation of the industry. The findings and critiques of these methodologies in the Queensland commercial fisheries context are presented below.

Discounted future profits/cash flow based methods

Given that licence values (in theory) reflect discounted *expected* future profits in the fishery, an alternative measure of GVP to measure fisheries' values is the total licence value. Rearranging Equation (3), licence values can be given by

$$licence\ value = \frac{E(full\ equity\ profit) - i(boat\ value)}{i} \quad (4)$$

where the second term in the numerator represents the opportunity cost of capital. Coglan and Pascoe (2010) found a (weak) relationship between the implicit discount rate and the type of management, suggesting that the value of the fishery is as much dependent on the type of management as it is on the current turnover or profitability.

The relationship in equation 4 assumes that (expected) full equity profits are constant over time. This is a simplification, as the flow of profits will vary over time, and provided an estimate of this flow can be made a more appropriate measure of the potential licence value (and hence fishery value) can be derived. The discounted cash flow (DCF) model, used for financial valuation of firms, derives a firm's value from its discounted future free cash flows (Steiger 2010). In this case, the licence value is assumed equivalent to the present value of future profits, with the appropriate discount rate derived from firm risk relative to its 'market', namely the rate of return in other fisheries and the relative riskiness of these other fisheries.

In the context of commercial fisheries, a vast majority of fishing companies are unlisted which makes the determination of appropriate discount rate difficult as it does not reside in any particular market. Damodaran

(1999) provide an adapted DCF model, which utilised shadow markets (i.e. unregulated credit markets such as hedge funds and other non-bank financial institutions) in an effort to apply the model to unlisted companies. An alternative approach is to use information from comparable publicly traded firms which are affected by the same fundamental economic forces. Listed aquaculture companies were researched though only one comparable firm could be found. Ideally, more comparable firms would have provided more solid results. The chosen firms comparability was tested by utilising a method presented by Damodaran (1999). The correlation of historical revenues and operating incomes were calculated and a high positive result indicated comparability.

The comparable firm beta is then calculated and used to derive its unlevered beta ($\beta_{(unlevered)}$) utilising this equation:

$$\beta_{(unlevered)} = \frac{\beta_{(levered)}}{(1+(1-taxrate)\times(\frac{Debt}{Equity}))} \tag{5}$$

An assumption that the unlisted company's beta will converge on the industry average beta is applied.

$$\beta_{(unlistedfirm)} = \frac{\beta_{(unlevered)}}{(1+(1-taxrate)\times(\frac{IndustryAverageDebt}{Equity}))} \tag{6}$$

The result is then used to estimate the optimal debt ratio based on the unlisted firms operating income and cost of capital.

$$\beta_{(unlistedfirm)} = \frac{\beta_{(unlevered)}}{(1+(1-taxrate)\times(\frac{OptimalDebt}{Equity}))} \tag{7}$$

The result can then be used to derive the cost of equity by utilising the basic Capital Asset Pricing Model (CAPM) where rf is the risk free rate; β is the firm beta and $R_{(m)}$is the market rate of return.

$$E_{(r)} = rf + \beta \times (R_{(m)} - rf) \tag{8}$$

$E_{(r)}$ is then used in the calculation of the discount rate, also known as the Working Average Cost of Capital.

$$WACC = \frac{D}{V} \times (1-t) \times r_D + \frac{E}{V} \times r_E \tag{9}$$

The future cash-flows of the firm are then adjusted by considering risk and time period (Hoffman *et al.* 2013). The Present Value (PV) of the firm represents its current value and is derived by summing the discounted cash-flows. The discount rate limitation extends to the DDM model with additional model aspects being unable to include the unique fundamentals of a fisheries market.

The aim of the above was to demonstrate that the licence value of the vessels is equivalent to measures used in finance to value a firm. While it may not be possible to derive a discounted cash flow in practice, in many cases the licence value is directly observable through recent trades, assuming the markets are working efficiently. While this is not always the case for fisheries, studies elsewhere (e.g. Newell *et al.* 2002) have found a rational economic relationship between fishing output and input prices as well as between quota lease and sale prices, with increased quota prices being consistent with increased profitability. Similarly, Huppert *et al.* (1996) found evidence suggesting that permit or quota prices relate to expected fishing returns. Hence, this method could potentially be adapted to provide a basic value of commercial fisheries, similar to that of GVP.

Asset (book) values

Balance sheet methods, for example the book-value of a firm, equates value with a firm's assets and often provides a different result than market value (Fernández 2007). A key limitation of this method is the potential distortion of value based on under or over-capitalisation. For example, a fishery with more boats may catch less fish than one with fewer but is valued at a much higher price due to its additional assets.

Basically, the book-value approach involves looking at the difference between Total Assets and Total Liabilities of a company:

$$BV = TotalAssets - TotalLiabilities \tag{10}$$

Gross value added (GVA)

Gross value added represents the additional income and other benefits generated by an industry after the cost of the intermediate inputs have been deducted from the value of total output (GVP). More specifically, gross value added (GVA) represents the sum of incomes generated (both crew and owner-operator), boat profits, depreciation, returns to capital and taxes paid.

GVA represents the contribution of the industry to overall gross domestic product (GDP), and hence is a measure of the contribution of the industry to the overall economy. As it is a smaller value than GVP, it is often not considered a "useful" indicator of fishery performance by the Australian industry, but is often considered a key measure elsewhere (Cardinale *et al.* 2013). Studies elsewhere have also shown that small scale fisheries in particular tend to have a high GVA relative to their GVP, and hence ignoring GVA may result in these sectors being substantially undervalued (Zeller *et al.* 2006).

Capacity utilisation and potential output

Two common concepts exist:

- Input based concepts of capacity, where capacity is measures in terms of physical inputs (e.g. number of boats, total gross tonnage, total kilowatts etc.);
- Output based concepts of capacity, where capacity is measured in terms of potential output given the set of inputs.

While the former is often the basis of fisheries management (i.e. target fleet size), the latter is the approach most commonly used in the literature, and is the definition adopted under the Food and Agriculture Organisation (FAO) International Plan of Action for the management of fishing capacity (Pascoe *et al.* 2003; Ward *et al.* 2004).

The analysis of capacity also has two related concepts: *excess capacity* is the difference between the potential output and the current output, while *capacity utilisation* is the ratio of the current output to the potential output. In the literature, most attention has been given to the estimation of capacity utilisation, from which potential output can be derived.

In practice, capacity is a relative measure, as the true potential output is unobserved and can never be known with certainty. However, based on observed output in the past (or by other vessels), estimates of capacity output can be made. In Figure 2, an example with two outputs being produced by five vessels all using the same level of inputs is given. The first four of these vessels (A to D) define what is known as the frontier, as each produces the greatest (but different) combination of the two outputs.

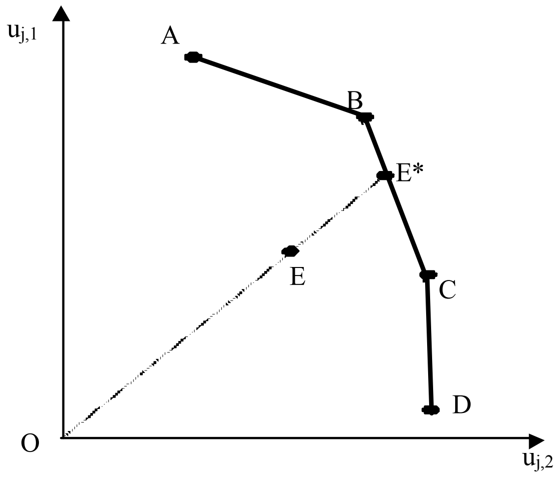

Figure 2 Two output example, all vessels using the same inputs

The fifth vessel (E) produces a lower quantity of both outputs. Given than we know that higher levels are possible (as we have seen these in boats A-D), the potential output of E can be estimated by extrapolating to the equivalent frontier level (E*). We assume that the vessel can increase both species by the same proportion (i.e. $E^* = \phi E$). Hence, E* is our capacity output of E, E*-E is the amount of excess capacity, and E/E* is the capacity utilisation (also given by $1/\theta$).

Efficiency and capacity analysis estimation

In practice, we often have multiple outputs in fisheries, and all vessels do not use the same level of inputs. In some cases, we only have annual fishery level information rather than individual vessel data.

Two general approaches have been developed to consider capacity utilisation in such circumstances: Stochastic Production Frontiers (SPF) and Data Envelopment Analysis (DEA). Both of these approaches were primarily developed to estimate technical efficiency, which is a closely related concept to capacity utilisation, and (as seen in the next section) also forms part of the capacity utilisation estimation.

There are several differences between SPF and DEA. The first is statistically based, and attempts to separate out random error from efficiency or capacity utilisation. Stochastic production frontiers are often considered better at estimating technical efficiency in fisheries due to the often high degree of 'luck' (both good and bad) involved in fishing,[1] particularly when efficiency is estimated over a small time step (e.g. a day, week or month) (Lee and Holland 2000; Tingley *et al.* 2005). In comparison, DEA is a non-parametric approach, which means that it does not account for random variation.

While multi-output version of the SPF approach have been developed and applied in fisheries (e.g. Pascoe *et al.* 2007; Pascoe *et al.* 2010; Pascoe *et al.* 2012), these are often limited in terms of how many species can be practically included. Further, their estimation requires assumptions to be made about the relationship

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[1] Commercial fishing involves the pursuit and capture of an unseen fugitive resource. Fish movement is highly susceptible to short and long term environmental fluctuations, so fish may be in one spot one day and another place the next. While skipper skill is an important component of efficiency, and helps to reduce the impact of these environmental effects (through better knowledge of both the environment and how fish respond), "luck" remains an important factor affecting output in most fisheries (e.g. Pascoe and Coglan 2002).

between inputs and outputs that may not be valid in all circumstances. In contrast, DEA can include a large number of species, and is more flexible in terms of assumptions around returns to scale and production technologies.

For these reasons, DEA is generally considered better for capacity estimation in multispecies fisheries than SPF (Färe *et al.* 2000; Pascoe et al. 2003; Tingley *et al.* 2003). Studies applying DEA to individual vessel data which is then averaged over the period of the data have been found to be less sensitive to stochastic error (Ruggiero 2007), reducing this perceived disadvantage. Further, the estimation of 'unbiased' capacity utilisation (detailed in the next section) has also been found to be less sensitive to random error (Holland and Lee 2002).

DEA is well established in the economics literature for productivity analysis (Färe *et al.* 1989; Färe and Grosskopf 2000; Färe et al. 2000), and in fisheries in particular (Reid *et al.* 2003; Tingley et al. 2003; Vestergaard *et al.* 2003; Walden *et al.* 2003; Herrero 2005; Pascoe and Tingley 2006; Maravelias and Tsitsika 2008; Tsitsika *et al.* 2008; Collier *et al.* 2014; Lee and Rahimi Midani 2015).

Data Envelopment Analysis: mathematical development

While it is not essential to understand the mathematics underlying DEA in order to undertake capacity analysis, a description of the different models underlying the different productivity measures is useful in demonstrating their key relationships.

The general form of the output-oriented DEA model for firms producing *m* outputs using *n* inputs is given by:

$$Max\ \Phi_1 \tag{11}$$

Subject to

$$\Phi_1 y_{1,m} \le \sum_j z_j y_{j,m} \quad m \in M \tag{12}$$

$$\sum_j z_j x_{j,n} \le x_{1,n} \quad n \in N \tag{13}$$

where Φ_1 is a scalar showing by how much the production of each firm can increase output, $y_{j,m}$ is amount of output *m* by firm *j*, $x_{j,n}$ is amount of input *n* used by firm *j* and z_j are weighting factors. The set of inputs (*N*) can be separated into fixed (e.g. vessel size) and variable (e.g. time spent fishing) inputs. For estimation of capacity utilisation, only fixed inputs are considered in the analysis (i.e. included in the set *N*), while technical efficiency estimation involves the inclusion of both fixed and variable inputs. A default assumption in DEA is constant returns to scale (CRS).[2] This is not realistic in many fisheries applications. However, variable returns to scale (VRS) can be imposed by adding a further restriction

$$\sum_j z_j = 1 \tag{14}$$

[2] "Returns to scale" describes the relationship between changes in fixed inputs and outputs. Increasing returns occurs when output increases (decreases) more than proportional with an increase (decrease) in fixed input use (e.g. boat size), all else being equal. Decreasing returns to scale exists when output increases (decreases) at a lesser rate than fixed input use. Constant returns exists when the rate of output and input change are the same. Variable returns to scale allows for increasing, constant and decreasing returns within the same fleet.

Most studies have adopted the VRS assumption, as this is more consistent with general production theory (with decreasing returns to scale a common feature of most empirical studies), and also provides a more conservative estimate of capacity. For example, in Figure 3, The VRS frontier is generally below the CRS frontier, except at the point of constant returns to scale on the VRS frontier. Vessel C is operating at full capacity based on the VRS frontier, but is underutilised based on the CRS frontier. Similarly, vessel E is underutilised compared with both frontiers, but more so if constant returns to scale is assumed.

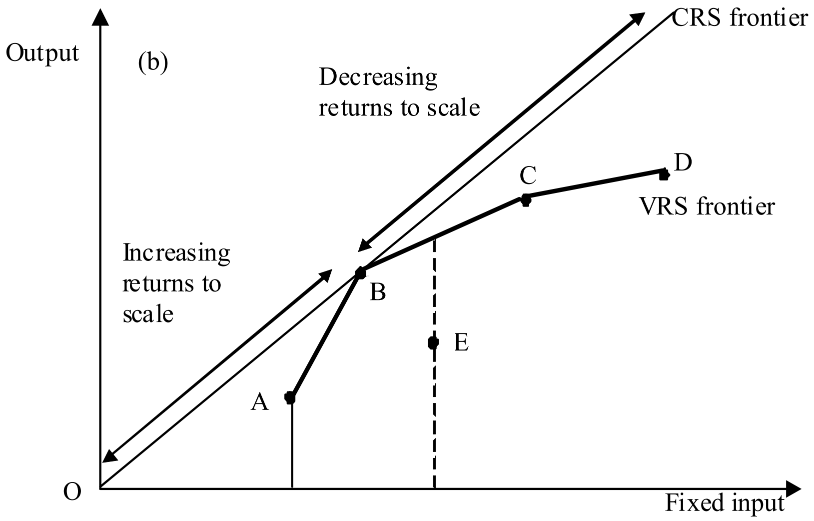

Figure 3 CRS versus VRS assumptions, one input and one output model

The same DEA model is used for both estimation of technical efficiency and capacity utilisation, the difference being the treatment of variable inputs. Capacity output is defined as Φ_1 multiplied by observed output (y), using fixed inputs only in the model. This also assumes that all inputs are used efficiently at their optimal capacity. Therefore, this measure represents the technically efficient capacity utilization (TECU), and is given by:

$$TECU = y \bullet (\Phi_1 y)^{-1} = \Phi_1^{-1} \quad . \tag{15}$$

The measure of TECU ranges from zero to 1, with 1 being full capacity utilization (i.e. the vessels is catching as much as is possible given its fixed input use). Values less than 1 indicate that the firm is operating at less than its full output potential given the set of fixed inputs. As this measure reflects both technical efficiency and capacity utilisation, it is likely to be biased downwards as part of the increase in output may be due to improved efficiency rather than just improved capacity utilisation (Färe et al. 1989). Hence, an adjustment is necessary to separate out the capacity utilisation component to correct for this bias. An adjusted or 'unbiased' estimate of capacity utilization can be estimated by:

$$CU = TECU \bullet TE^{-1} = \Phi_2 \bullet \Phi_1^{-1} \quad . \tag{16}$$

where Φ_2 represents the extent to which output can increase through using all inputs efficiently (i.e. including both fixed and variable inputs into the model analysis), and TE is the estimated level of technical efficiency, given by:

$$TE = \Phi_2^{-1} \tag{17}$$

This 'unbiased' measure also has other advantages; DEA is often criticised as a means of estimating efficiency as it does not account for random error. However, as any distorting effects of random error are similar (at least in terms of direction) in both Φ_1 and Φ_2, the ratio of the two is less affected by random noise (Holland and Lee 2002).

Total factor productivity and technological change

Change in stocks and technology from one period to the next can be effectively measured as productivity change. Caves *et al.* (1982) defined the Malmquist index of productivity change between a given base time period (e.g. time 1) and time period *t* as

$$M_0{}^1 = \frac{D_0^1(x_t, y_t)}{D_0^1(x_1, y_1)} \tag{18}$$

where $D_0^t(x_t, y_t) = \min\{\delta : (x_t, y_t / \delta) \in S^t\}$ (which is an alternative and more general expression for the Φ_1 terms used in the earlier models), x_t is the set of inputs used in period *t*, y_t is the set of outputs produced in period *t*, and S^t is the production possibility set (i.e. technologically feasible and technically efficient output set for a given input set) in time period *t*. The subscript "0" indicates that the measure refers to a particular DMU under consideration. Alternatively, the index can be determined with reference to the current period, such that.

$$M_0{}^t = \frac{D_0^t(x_t, y_t)}{D_0^t(x_1, y_1)} \tag{19}$$

Färe *et al* (1994) developed a version of the Malmquist index as the geometric mean of both measures (i.e. equations (18) and (19)), and demonstrated how by using both indexes, changes in productivity between time periods can be further disaggregated into efficiency change (both pure technical efficiency and scale efficiency) and pure technical change assuming constant returns to scale.

Regional economic flow-on effects

Flow on effects from production are usually estimated from 'multipliers', which represent the change in economic activity in the region from a one dollar change in output from the industry of interest (i.e., in this case the fishery). The use of regional multipliers can allow for the representation of complex interrelationships of an economy by considering an entire system of interlinked regional expenditure.

Regional multipliers can be derived using Input-Output models or Computable General Equilibrium (CGE) models. The former is static, in that it assumes that other sectors do not change their production processes in response to the change in output from one of the industries in the economy, while CGE allows for other industries, prices and costs to adjust also in response to the change in the industry considered. The complexity of the latter make them less appropriate for small regional analysis, although regional models have been developed. Development of regional models using either input-output analysis or CGE require substantial detail about all the industries in the economy, not just the industry of key interest.

An alternative method to input-output analysis has been developed to estimate regional and industry specific multipliers based on cost shares and location of expenditure, both derivable from a survey of key industries of interest (Stoeckl 2007). This produces estimates of multipliers that are equivalent to input-output based multipliers under some conditions, and have been found to produce similar estimates in most conditions (given the restrictive assumptions of I-O based multipliers, the alternative estimates are considered appropriate estimates in most cases).

This alternative approach, detailed below, has been used in this study. To validate the results, we have also reviewed existing input-output studies for Queensland and elsewhere (both fisheries specific and more generic) and compared the results of these with those for the Queensland fisheries considered.

Estimation of regional multipliers

Input-Output (IO) analysis is used to estimate the net effect of a change in final demand in the different sectors of the economy. The method is based on a model of the economy such that $AX + Y = X$, where A is a matrix of technical coefficients; X is a vector of total outputs; and Y is a vector of final demand. This equation is rearranged to give:

$$X = (I - A)^{-1}Y$$

$$\Delta X = (I - A)^{-1}\Delta Y \quad (20)$$

The total regional impact on output is then able to be estimated by change in final demand, with $(1 - A)^{-1}$ being a matrix of sector level multipliers.

However, these models have the potential be costly to develop and the availability of appropriate data is often an issue. Therefore, a different approach has been taken in this report which utilises work done by Stoeckl (2007) which presented "another 'short cut' to estimating regional multipliers". It is based on the traditional Keynesian multiplier, and derived by utilising collected regional data to estimate an expenditure function.

This approach involved the collection of survey data regarding commercial fishery cost and revenue where; each business (i) was asked to provide information on (1) the attributable proportional total costs of different inputs $- j$: $(R_{j=1,\dots,n})$; and (2) the proportion of expenditure in local regions on these purchased inputs $(\theta_{j=1,\dots n})$. The proportional total cost of individual commercial fisheries expenditure in local regions (ρi) is then able to be estimated utilising this equation:

$$\rho_i = \sum_{j=1}^{n} R_j \theta_j \quad (21)$$

The revenue data collected during the surveys was used to estimate the proportion of saved revenue of each Fishery (PS_i) and were combined with estimates of ρ_i to calculate (M_i), the 'multiplier' of an individual Commercial Fishery

$$M_i = \frac{1}{1-(1-PS_i)\rho_i} \quad (22)$$

Equation 20 will equate to equation 22 when an entire region's expenditure patterns are identical (both industries and households) for all individuals and all businesses within an industry, such that:

$$(I - A)^{-1} = \frac{1}{1-(1-PS_i)\rho_i} \quad (23)$$

which also ensures that the multiplier derived in Equation 22 would equal that of the traditional Keynesian multiplier. It's unlikely this assumption holds and may lead to inaccurate results. Therefore this *business-level* multiplier does not provide general equilibrium regional multiplier information. However, it has the advantage that it does not need to assume homogeneity, and hence different impacts may be realised based on which individual business change.

A survey was developed to determine expenditure patterns for the Queensland fisheries surveyed in order to derive these estimates. A copy of the survey is provided in the Appendix B. The survey was implemented online, as well as a postal/telephone survey. Further details on the use of the survey instruments are given in the results section.

Value to consumers

There is evidence from producers and retailers that consumers prefer locally caught produce (Tobin *et al.* 2010; Calogeras *et al.* 2011), and hence gain additional benefits from consuming local fish (compared with just consuming fish per se). These consumer benefits are generally ignored when considering economic value of commercial fisheries. These benefits to consumers are known as consumer surplus, and represent the difference between what consumers are willing to pay for the product and what they actually pay. Measures of consumer surplus in recreational fishing are widespread and are often used as measures of the economic value of the sector (e.g., Prayaga *et al.* 2010; Raguragavan *et al.* 2013; Pascoe *et al.* 2014a), but evidence of this consumer surplus in seafood consumption is limited and largely restricted to analysis of ecolabelling (e.g., Gudmundsson and Wessells 2000; Johnston *et al.* 2001). Studies in other food sectors have found varying results, from substantial benefits from consumption of local food (Disdier and Marette 2012; Tempesta and Vecchiato 2012) to few or no significant benefits (Weatherell *et al.* 2003). Other studies have found that provision of 'local' produce is a key tourism attractor with substantial benefits being generated (Brown and Hershey 2012).

These values, if they exist, contribute to the total economic benefits generated by the regional fishing industry. Ideally, market data could be used to 1) identify if a premium exists for locally caught fish[3] and 2) estimate the consumer surplus of locally caught fish relative to non-local fish. Given sufficient information about the price paid for fish and their characteristics, hedonic pricing techniques (Lancaster 1966) can be used to disentangle the value of each component, including the value of being locally caught. This would require a wide cross section of data on price and detailed characteristics of what is being sold. However, given the fragmentation of the market for fish (many small stores selling fish in different forms – some cooked, some fillets etc., and most not specifying the required characteristics of the fish sold) such data are not available nor practical to obtain.

Estimating consumer benefits

Given the lack of market data to estimate these values, alternative valuation techniques are required. Two broad categories of alternative valuation techniques exist – revealed preferences and stated preference approaches. These approaches are often used for deriving non-market values of environmental services, but are also suitable for deriving benefits to consumers over and above the price they are required to pay (i.e. consumer surplus).

Revealed preferences are based on observed behaviour. The most common revealed preference approach used is the travel cost method, which is based on the premise that for people to incur the cost of travel to undertake an activity or visit an area, then their derived benefits must have at least equalled (or exceeded) the costs. Travel cost modelling approaches have been applied in a wide range of recreational fishing studies (e.g. Li 1999; Shrestha *et al.* 2002; Prayaga et al. 2010; Pascoe et al. 2014a) as well as for valuing other

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[3] Price premiums represent a transfer of some of this consumer surplus to the retailer. This is in itself another source of value but an underestimate of the total economic value.

marine related activities and assets (e.g. Carr and Mendelsohn 2003; Ahmed *et al.* 2007; Chae *et al.* 2012; Mwebaze and MacLeod 2012; Pascoe *et al.* 2014b).

Potentially, a travel cost model could be used to assess the benefits of consuming locally caught fish, but this would be complex given the large number of potential alternative competing fish retail outlets, and often lack of information before hand of what will be available at each store (in terms of species and where caught). An alternative method of valuing non-market benefits is to therefore generate a series of hypothetical markets where alternatives are limited and known in advance, and costs of access to each are the same (such that the choice is then dependent on the characteristics of the goods provided and their prices).

Under the stated preference method, respondents are directly asked to answer questions that elicit their preferences for a given situation (Carson and Louviere 2011). One type of stated preference method is the contingent valuation method (Carson *et al.* 2001; Carson 2011). This technique is used when an economic valuation is required for a public good. The valuation is obtained by using a stated preference type survey (Mitchell and Carson 1989; Carson and Louviere 2011). The 'contingent' aspect of contingent valuation refers to the answers given by respondents being 'contingent' or conditioned on the way the question is asked. The survey should thus be carefully constructed in order to avoid influencing respondents, which may lead to inaccurate willingness to pay or accept estimates (Carson et al. 2001; Carson 2011). Another criticism of the contingent valuation method is the incapability of the method to examine a large number of preferences at once (Carson 2011). Given these issues, other techniques can be used.

An alternative to contingent valuation, and a method that has dominated environmental valuation in recent years is choice modelling. Discrete choice experiments are a stated preference method of valuation, whereby respondents are asked to choose from a set of mutually exclusive alternatives, characterised by a number of attributes which vary according to a given number of specified levels (Adamowicz *et al.* 1998). Unlike the contingent valuation methodology, the choice modelling technique has the ability to consider multiple attributes and options at once (Bennett and Blamey 2001). The utility gained from each option can be estimated through analysing the trade-offs between the choices made (Adamowicz et al. 1998; Hensher *et al.* 2005).

Generally, an individual will want to maximise their utility subject to their budget constraint. Thus, an individual will choose one option over another, provided the utility received from the chosen option exceeds that of all other options and the chosen option is affordable to the individual (Hensher et al. 2005). However, as proposed by Lancaster (1966) and underlying the hedonic price theory discussed above, utility is not derived from choosing the product as a whole, but rather from the sum of the characteristics of the chosen product.

Choice modelling also builds on this concept, where the choice of an option is based on the characteristics of that option and the utility it provides. However, where hedonic pricing is dependent on a market price being available, which reflects the 'average' of the combined utility of a wide range of consumers given the available supply, choice experiments are based on decisions of individuals, which may vary between individuals. To allow for this variation in preferences between individuals, choice modelling is also based in random utility theory (RUT) (Thurstone 1927; McFadden 1974; Manski 1977), where an individual's utility (U) is composed of two main components. The first component is the systematic or known component of utility V_{ni}, whereas the second component is the random or unexplainable component of utility ε_{ni}. Following Hensher et al. (2005) the formal derivation of individual (n)'s utility for a good *i* can now be seen as:

$$U_{ni} = V_{ni} + \varepsilon_{ni} \tag{24}$$

As the random component of utility remains unobservable, the aim of the method is to elicit an individual's utility from the observable component of utility. There are many variables which may influence a person's utility. As specified by Hanley *et al.* (1998), explanatory variables which are generally examined include the individual characteristics of the respondent (S_n) (e.g. this includes but is not limited to socioeconomic and attitudinal characteristics) and the attributes of the good in question (Z_i). Following Hanley et al. (1998) the utility equation may be specified as:

$$U_{ni} = V(Z_i, S_n) + \epsilon(Z_i, S_n) \quad (25)$$

Given a choice set (*C*), which consists of options *i* and *j*, the probability of an individual choosing option *i* over alternative options *j* is determined by the extent to which the utility derived from *i* exceeds that derived from *j* (as in equation 26). In simple speak, equation 26 states that the probability that an individual will choose option *i*, from choice set *C,* is equal to the probability that the utility received from option *i* is greater than the utility received from any other option in the choice set (option j) (Hanley et al. 1998).

$$Prob(i|C) = \text{Prob}\{(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn})\} \quad \forall j \in C \quad (26)$$

To estimate these probabilities, certain assumptions need to be made about the distribution of the unobservable error terms. Most commonly, the errors are assumed to be independently and identically distributed (IID) (McFadden 1974). That is, the probability of preferring one option over another does not depend on the presence or absence of other 'irrelevant' alternative options (Ben-Akiva and Lerman 1985). For example, the relative probabilities of purchasing a locally caught fish or imported fish do not change if prawns are added to the choice set as an additional option. Following Hanley et al. (1998), if these assumptions are satisfied, then the probability of choosing option *i* over all other options *j* can be formally defined as:

$$Prob(i) = \frac{exp^{\mu v_i}}{\sum_j exp^{\mu v_j}} \quad (27)$$

where μ is a scale parameter. Typically, an individual's probability of choosing a particular option is most commonly modeled using a multinomial logit (MNL) model (Louviere 2001; Hensher et al. 2005). The MNL model is estimated using maximum likelihood estimation (McFadden 1974; Ben-Akiva and Lerman 1985). Other approaches have also been developed, mainly to capture greater heterogeneity in the results. These include latent class models, which essentially estimate a set of 'different' models for subsets of the sample (e.g. Wallmo and Edwards 2008) and mixed logit models, which essentially assumes that each individual has potentially different parameter values in the model (e.g. Kragt and Bennett 2011).

The use of the choice modelling approach, however, also has some challenges. As a stated preference method, choice modelling suffers the possibility of hypothetical bias (Hensher 2010). There is also the cognitive burden placed on respondents when completing the choice set, which may result in fatigue or the risk of ignoring attributes (Bennett and Blamey 2001). If a status quo or opt-out option is included, there is also the possibility of respondents misusing this option to avoid making difficult choices (Bennett and Blamey 2001). There is also the potential for respondents to protest against the choice set task. For example, respondents may continually choose the status quo, opt out or another option if they disagreed with the task or options presented to them (Bennett and Adamowicz 2001). If any of these cases were to arise, the results of the choice experiment would result in biased estimates. However, there are ways of mitigating these issues.

Choice modelling has become a common tool for valuation in natural resource management. For example, choice modelling has been used in the context of eliciting the willingness to pay for improvements to various sites and resources. This includes, but is not limited to the generation of values for: recreational moose hunting (Boxall *et al.* 1996), wetlands (Birol and Cox 2007), rivers (Morrison and Bennett 2004; Hanley *et al.* 2006), urban parks (Concu 2007), lakes (Schaafsma *et al.* 2012) and the Great Barrier Reef (Rolfe and Windle 2013).

Choice experiments have also been recently undertaken to elicit values relating to preferences for locally produced products (James *et al.* 2009; Yue and Tong 2009; Holmes and Yan 2012; Roosen *et al.* 2012; McCaffrey and Kurland 2015; Meas *et al.* 2015). These studies in other sectors are all very recent – reflecting the fact that the benefits from local produce is only just being realised, and in one instance was described as the "new organic" (Roosen et al. 2012) in terms of marketing benefits.

Estimating the parameters and determining willingness to pay

From equations 25 and 26, the level of utility derived a choice will depend on the attributes of the choice (one of which will be its price) and also the attributes of the individual making the choice. Given a set of i alternatives, an individual will chose that which provides the most utility relative to the other alternatives. We can model this through a series of equations, given by

$$C_{i,n} = ASC_i + \alpha P_i + \beta X_i + \gamma_i Y_n \quad \forall\ i = 1\ to\ i, n = 1\ to\ n \tag{28}$$

where $C_{i,n}$ is the choice variable, such that $C_{i,n}$= 1 if individual n chooses alternative i, otherwise $C_{i,n}$=0, ASC_i is the alternative specific constant, which reflects the probability of choosing alternative i independent of its attributes, P_i is the price attribute associated with alternative i, X_i is a vector of alternative specific attributes, and Y_n is a vector of individual specific attributes. In this formulation, the attributes of the individuals affect only the probability of choosing a particular alternative independent of its attributes. Interaction terms can be included to determine how individual attributes affect willingness to pay for alternative attributes.

For the purposes of model identification, it is convenient to estimate the models by normalising the alternative specific constants to one of the alternatives (e.g. alternative 1), giving the equations

$$C_{1,n} = \alpha P_i + \beta X_i + \gamma_i Y_n$$

$$C_{i=2\ to\ i,n} = \delta_{i=2\ to\ i} + \alpha P_i + \beta X_i + \gamma_i Y_n \tag{29}$$

where $\delta_{i=2\ to i} = (ASC_i - ASC_1)$. The models are estimated simultaneously using multinomial logit regression.

The willingness to pay (WTP) for each attribute is derived from $-\beta/\alpha$, where β is the coefficient of the attribute of interest and α is the coefficient of the price variable. These are marginal values, and represent the additional willingness to pay for the good compared from one that has a base level of attributes. The standard error of the willingness to pay can be derived from $-\sigma_\beta/\alpha$, where σ_β is the standard error of the parameter of the attribute of interest (Hensher et al. 2005).

Design and implementation of the survey instrument

A key element of a choice experiment is the survey instrument (the questionnaire) and how it is to be administered. In this case, an online survey was developed, with a target of 1000 responses from Queensland residents. A market research company was sub-contracted to administer the survey. The survey was run during March 2016.

The questions in the online survey are presented in Appendix 3. These questions were based on those generally collected in choice experiments, including details on socioeconomic characteristics of the respondents. In this case, as we were interested in seafood consumption, we also asked about their general level of seafood consumption, preferences for different forms of fish (e.g. cooked or fillets) and species, and where they generally purchased their seafood (e.g. from supermarkets, fish mongers or fish and chip shops).

The choice set was largely based on the types of options given in other studies, namely location caught, price, some measure of sustainability (as an alternative to organic which has been used in agricultural studies such as that by Yue and Tong (2009)). Other studies around seafood consumption were also reviewed to help determine the final choice set, which are presented in the results section.

Even with a limited number of choices and attributes, the number of potential combinations can increase substantially, requiring respondents to answer a large number of questions (and hence face the possibility of cognitive burden identified by Bennett and Blamey (2001)). Optimal designs, however, can be derived that ensure that a sufficient combination of options and attributes are presented to enable parameter estimates to be significantly identified in the model (provided they are, in fact, significant). NGENE software (Choice Metrics Pty Ltd 2012) was used to develop a D-efficient design, which maximises the information content of the parameter estimates. Details on these are reported in the results section.

Retail value and value added

Although not a major part of the study, an estimate of the retail value and retail value added was also made as part of the total post-harvest value. This is potentially a complex value, as the true value and value added depends on the final product form (e.g. restaurant meal vs fish and chips vs fresh fillet) and the costs of its production (for value added). For simplicity, and for consistency with the choice experiment, the estimate of retail value assumed all fish was sold as fresh fillets. As a result, it underestimates the total retail value, but allows for at least a consistent measure ignoring final product form.

Information on retail margins for fresh fish is limited. The focus of the choice experiment was on fresh barramundi, as this was widely available and market prices could be observed in several different retail outlets across the state. We assumed that similar margins apply to all other Queensland species, once allowances for different conversion rates have been taken into account. In the case of barramundi, the conversion rate from whole to fillets was 38% (http://www.chefs-resources.com/seafood/seafood-yields/). An informal observational ‘survey’ of different fish retailers (e.g. supermarkets and fish mongers) in Brisbane and Townsville was undertaken by the project team. While prices varied considerably (between $40-$50/kg), a base price of $40/kg was established for use in the choice experiment and also to estimate a lower bound on retail value added. This was compared with the landed price for 2013-14 (derived from ABARES (2015) and adjusted for inflation), and a factor of 1.65 for landed to retail price was derived. This factor was applied to the estimated fishery landed value to derive an estimate of the total retail value. The original fishery GVP was deducted from this to derive the retail value added.

Results

Economic performance of key fleets

As noted in the methodology section, economic information collected for the Adapt or Fail project was also used for assessing economic performance in this project. The aim of co-ordinating the data collection between the two projects was both to save money and also – more importantly – reduce the chance of survey fatigue on the industry. The survey was designed to meet the needs of both projects.

For this project, of key interest were boats using lines, net and pots as their main fishing gear. Information on offshore line and trawl boats were also included in the survey, but used in the other project. In total, information on 71 boats was available (Table 1). The representativeness of the sample is difficult to determine, as information on non-surveyed boats is not available, and in many cases the exact number of boats in each fleet is unclear. Vessels may hold more than one licence (symbol). Logbook records of fishing activity by area may also double count (or more) vessel numbers if they operate in multiple areas.

Based on the GVP derived from the logbook data (see the next section) and the average revenues derived from the survey (see below), the sample represents a high proportion of the value of the fishery, especially for the line boats (Table 1). However, the sample also included some high value line boats which may distort this figure. For boats using pots, the sample represented a smaller proportion of the total value of the fishery, but there were sufficient observations to suggest that relatively reliable estimates of many revenue and cost items could be made.

Table 1. Survey sample

	Line	Net	Pots
Boats	11	23	37
Share of GVP	70%	42%	16%

The key cost and earnings information for the three fleets are presented in Table 2, while the observed ranges are presented in Table 3. The relative cost shares are also depicted in Figure 4. Key measures of economic performance are full equity profits and the return on capital. These are high for all three sectors. However, an allowance has not been made for owner-operator labour, so they are not true estimates of full equity profits and therefore inflated estimates of return to capital. Instead, the measures reflect the amount of income available to the fishery from fishing, which is a combination of their own labour and their ownership of the capital. Studies elsewhere (Boncoeur *et al.* 2000) suggest that such measures are more appropriate when examining small-scale fisheries that are not capital intensive.

Looking at all costs proportionally, different trends emerge and the main costs contributors of specific fisheries can be determined. Crew costs are generally low in the fisheries, reflecting the dominance of owner-operator activity. In contrast, land based staff costs are relatively high for the net and pot boats. These results may be distorted, as operators often provide a salary to a family member (often the spouse) for taxation purposes. However, these costs legitimately contribute to the level of income created in the fisheries.

Table 2. Mean values of main revenue and cost items, average per boat, 2013-14

	Line		Net		Pot	
	mean	RSE	mean	RSE	mean	RSE
Business revenue 2013/14:	214,545	61%	430,373	45%	125,369	15%
Crew costs:	2,000	60%	13,724	28%	4,473	36%
Skipper costs:	-	-	-	-	-	-
Land based staff costs:	-	-	74,524	67%	10,721	51%
Vessel repairs and maintenance:	11,442	43%	12,767	19%	13,192	22%
Fuel costs:	8,833	34%	18,004	19%	19,051	13%
Other catching costs:	5,071	49%	10,032	27%	11,643	24%
Licence lease costs:	1,883	36%	2,444	45%	1,195	30%
Quota lease costs:	1,375	35%	187	59%	156	66%
Other annual operating costs	8,401	15%	14,807	32%	12,151	11%
Total business costs:	86,877	49%	217,272	43%	68,744	24%
Full equity profits	129,332	68%	214,413	83%	57,514	12%
Return on capital	97%		37%		25%	
profit share of revenue	60%		50%		46%	

Table 3. Data range (minimum and maximum), 2013-14

	Line		Net		Pot	
	min	max	min	max	min	max
Business revenue 2013/14:	10000	1500000	9000	4100000	25000	699658
Crew costs:	0	8000	0	46420	0	34471
Skipper costs:	0	0	0	0	0	0
Land based staff costs:	0	0	0	794766	0	140000
Vessel repairs and maintenance:	0	40000	0	35000	0	88670
Fuel costs:	0	27500	0	52285	0	66090
Other catching costs:	0	21500	0	53000	0	83000
Licence lease costs:	0	5200	0	15000	0	6000
Quota lease costs:	0	3000	0	1500	0	2500
Other annual operating costs	2826	12180	0	80000	3400	30100
Total business costs:	9000	500000	6000	1700000	5000	622584
Full equity profits	-25000	1001500	-638379	4040000	-45000	170000

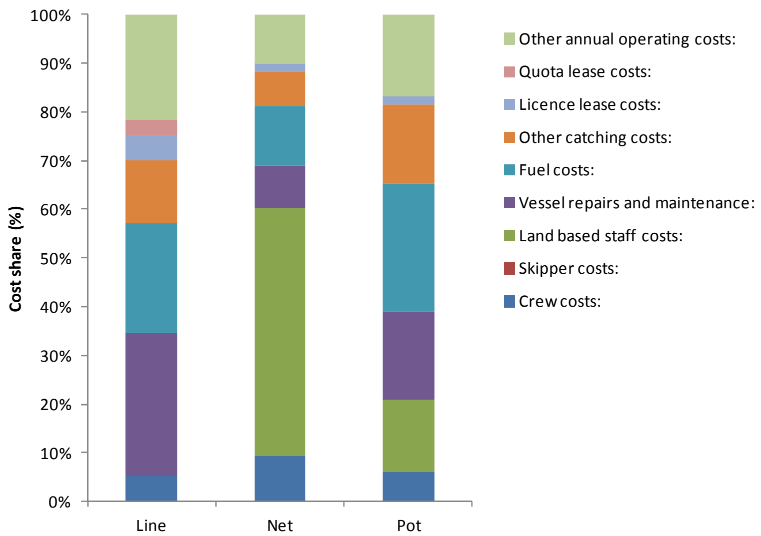

Figure 4. Proportions of total business costs

All fisheries utilise some proportion of family, paid and unpaid crew (Figure 5, Table 4) with in-shore pot fisheries demonstrating the highest proportion in both categories. These figures exclude the owner-operator.

Table 4. Employment produced by the inshore fisheries, average per boat 2013-14

	Line		Net		Pot	
	mean	RSE	mean	RSE	mean	RSE
FULL-TIME non-family workers/crew (paid):	0.545	100%	0.83	74%	0.05	70%
FULL-TIME family workers/crew (paid):	0.091	100%	0.09	100%	0.08	74%
FULL-TIME family workers/crew (unpaid):	0.091	100%	0.04	100%	0.08	74%
PART-TIME non-family workers/crew (paid):	0.091	100%	0.87	43%	0.19	61%
Percentage personal income from fishing industry:	67.3	18%	74.8	10%	85.3	6%
Percentage household income from fishing:	53.6	23%	65.0	11%	75.9	7%

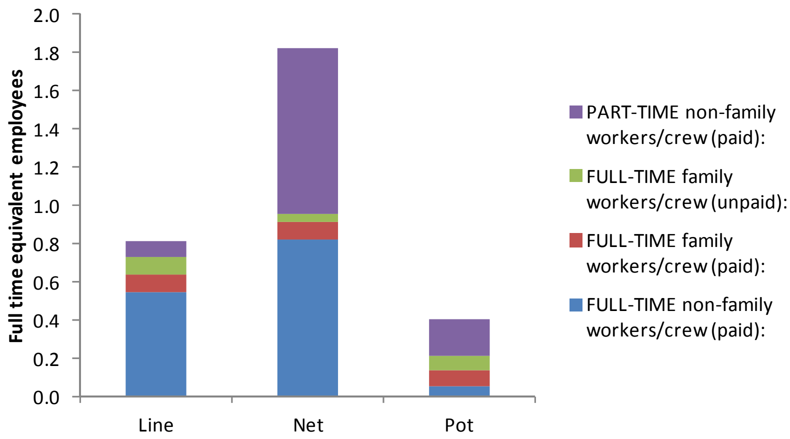

Figure 5. Employment (total numbers)

In most cases, fishing represents a high proportion of both the fisher and household income (Table 5). This is particularly the case for the pot (crab) fishery. The net fishers, which are also the highest employer per boat, are also the highly dependent on the fisheries for their personal income. Inshore fisheries have substantially higher license values compared to vessel value, with net fisheries being identified to have the greatest difference (Figure 6, Table 5). Equity levels are relatively high in all three fleets on average, although for the net fleet the average debt exceeds the average value of the physical capital assets.

Table 5. Capital assets and levels of debt, 2012-13, average per boat

	Line		Net		Pot	
	mean	RSE	mean	RSE	mean	RSE
Capital assets						
Vessel 1 age now (years):	1.2	10%	1.13	10%	1.11	5%
Vessel 1 age now (years):	17.5	16%	16.42	14%	16.98	10%
Vessel 1 value now:	52,750	14%	22,761	22%	43,861	15%
No. tenders/dories:	0.6	53%	2.22	26%	1.39	18%
Ave. dory/tender value:	20,000	20%	8,416	18%	10,590	18%
Value of license/s:	94,571	24%	247,738	53%	125,409	13%
Finance costs						
Monthly business loan repayments:	1875	85%	635	57%	222	37%
Annual Loan repayments:	30000	74%	17067	44%	4944	36%
How much of this was interest?:	1500	-	6700	-	2166	19%
Interest rate charged:	10%	0.10	9%	12%	6%	5%
Debt	20,258		75,620		35,538	
Equity	87.3%		73.8%		80.7%	

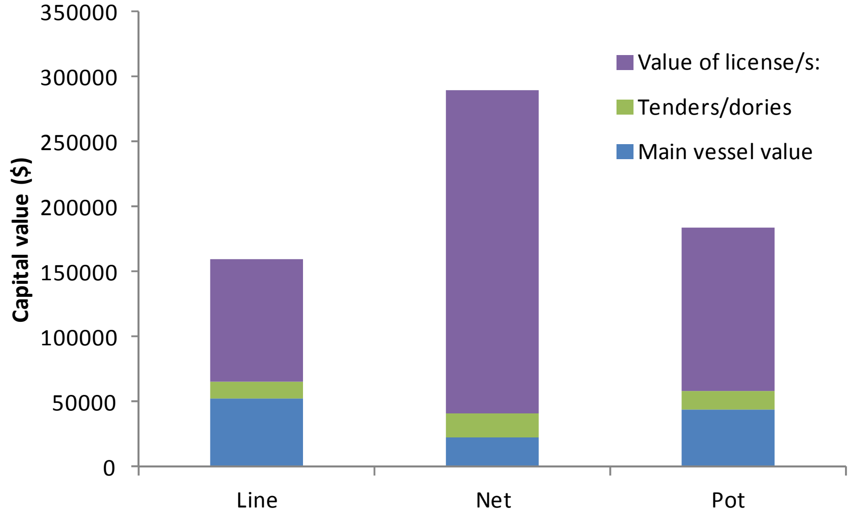

Figure 6. Capital values, average per boat, 2013-14

Measures of economic value of the fisheries

Three alternative measures of value were examined: the traditional gross value product, the total discounted expected future profits in the fishery and the book value of the capital assets.

Gross Value Product

Net and line fishery

The key species and average price in 2011-12 (the most recent year that data are publically available at the moment, ABARES (2013)) caught in each component are summarised in Table 6.

Table 6. Key species and most recent price information

	Average price ($/kg)
Tropical snapper	6.22
Barramundi	9.17
Bream/Nannygai	8.00
Mullet	2.50
Tailor	4.34
Whiting	3.72
Threadfin	4.35
Shark	3.00
Mackerel	5.55
Other species	4.34

Between 1999-2000 and 2012-13, GVP of the net fishery was roughly around $30m a year based on 2011-12 constant prices (Figure 7). In 2013-14, this declined roughly 26% to around $24m. Catches of the key species also declined by a similar magnitude. The cause of this large decline has not yet been determined.

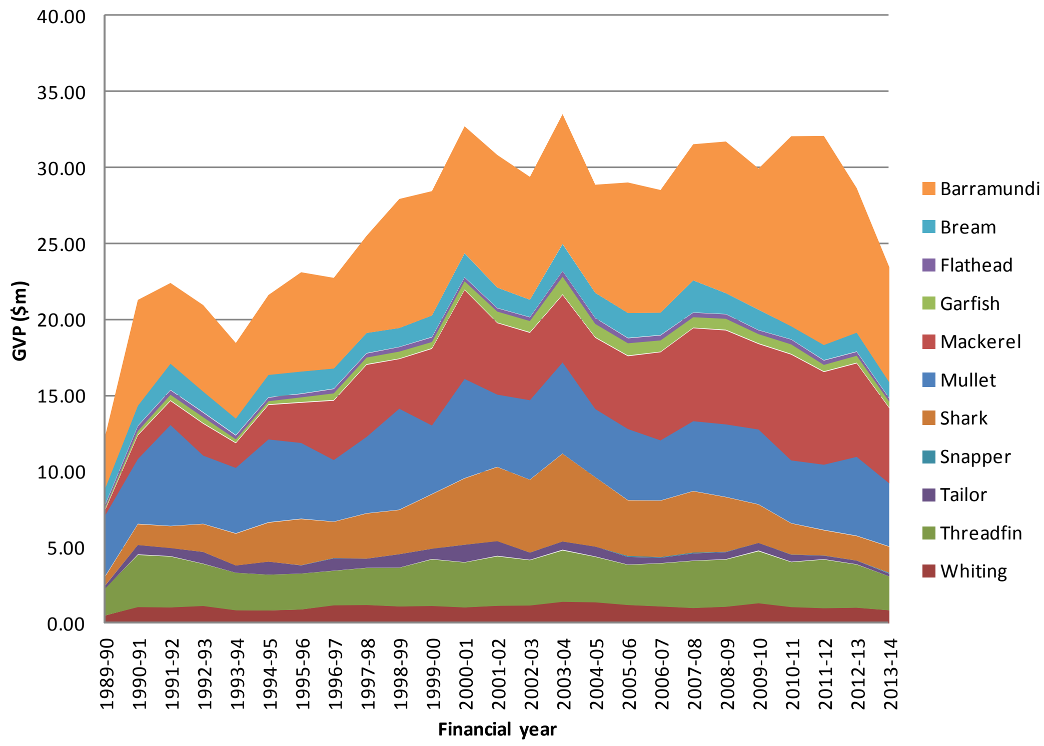

Figure 7. GVP each year, Queensland net fishery

For the inshore component of the line fishery, GVP appeared to be at its greatest in the late 1990s, declining substantially in 2003-04 (Figure 8). The rapid expansion from 1995-96 to 2002-03 may have been a response to expectations about the rezoning of the GBR (i.e. establishing a catch record), with the subsequent decline possibly corresponding to the RAP process in the GBR. Since 2010-11, GVP is estimated to have been only around $3.4m. Most of the value of the line fishery is taken offshore, with high valued species such as coral trout, red throat emperor and other reef fish.

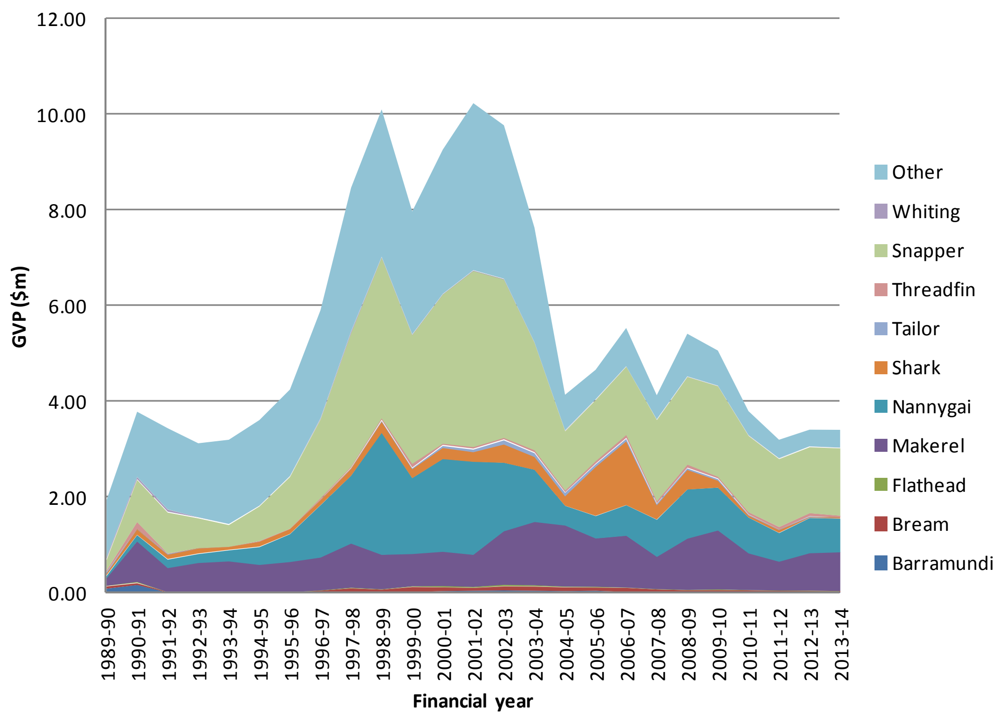

Figure 8. GVP in the inshore component of the line fishery

Pot fishery

The pot fishery focuses on crabs, although small amounts of some finfish species are caught as incidental byproducts.

The fishery has expanded rapidly since the early 1990s. Most of the growth in value has been through increased catches of mud crab (Figure 9). Mud crabs are the most valuable of the three species, with an estimated price of around $16/kg (compared to around $5.50 for the other two species). In 2013-14, GVP (excluding byproduct species) was estimated to be around $30m in 2011-12 prices, with this value being fairly constant since around 2009-10.

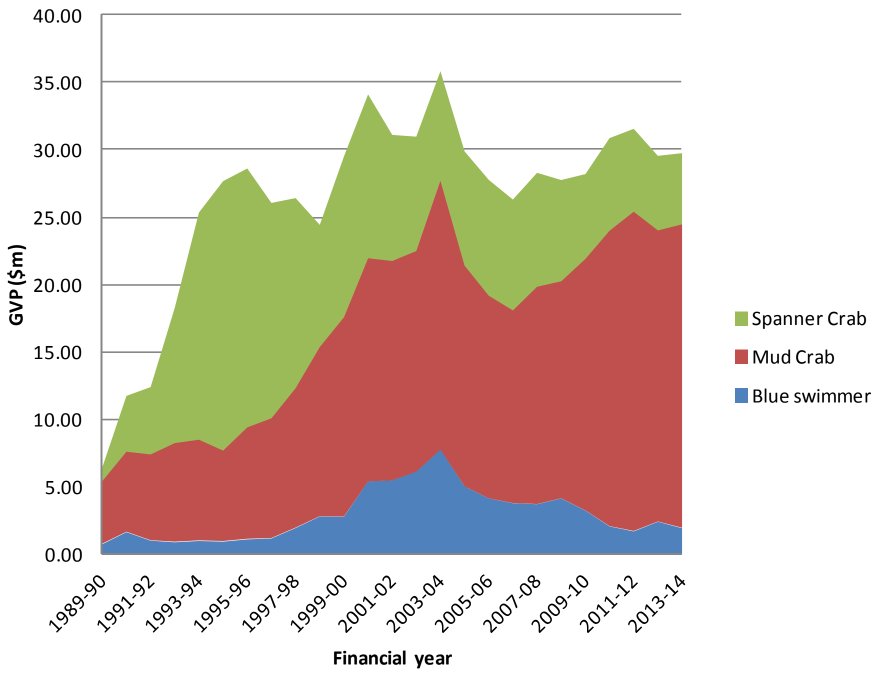

Figure 9. Estimated GVP for the pot fishery (excluding byproduct species)

Discounted future expected profits and book values

As noted in the methodology section, licence values (in theory) reflect discounted *expected* future profits in the fishery. An alternative measure of GVP to measure fisheries' values is the total value of licences, which should approximate the total discounted expected future profits. By using observed licence values, no assumptions need to be made about an appropriate discount rate, as the value reflects the operational discount rate used by fishers.

Book values extend this further, by considering also the physical capital invested in the fishery, less any debt on this capital. This represents the capitalised value of the fishery.

The estimated total discounted future profits, book value and GVP in 2013-14 of the three fisheries, based on the survey and logbook data, is given in Figure 10. No consistent trend across the three fisheries exists. GVP reflects the catch and prices in the year – effectively a 'spot' value of the fishery, while both book value and discounted expected future profits (reflected in the licence values) potentially represent a longer term estimate of value. However, licence values – which affect both the latter measures – are also affected by the management in the fishery. Uncertainty about the future of the fishery and the potential to continue to make sustained profits effectively increases the fishers' discount rate and reduces their time horizon, both of which lower the licence value and hence expectations about future profits.

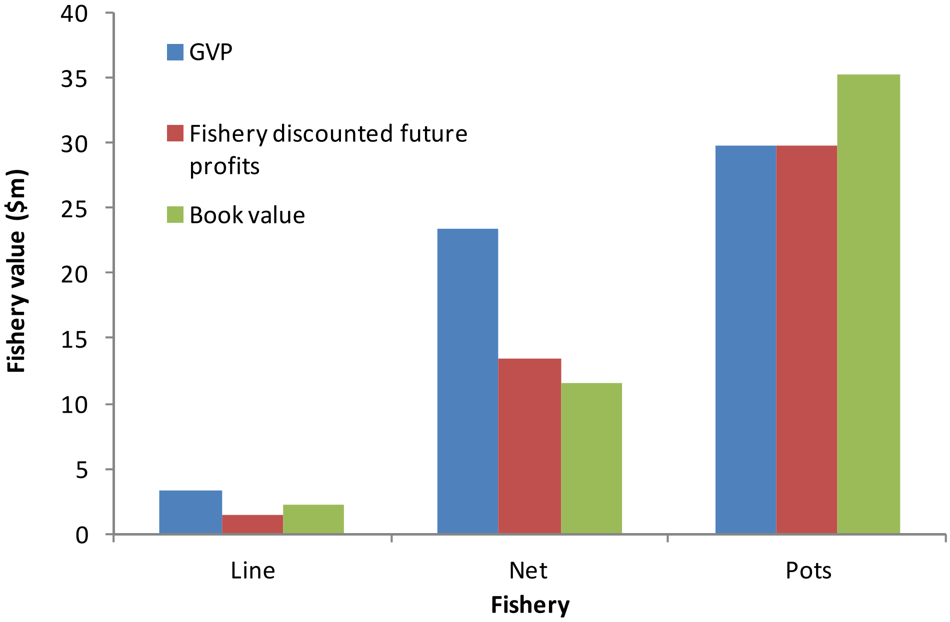

Figure 10. GVP, discounted profits and book value, 2013-14

Gross value added

Estimates of gross value added by each of the sectors were also derived from the survey data and extrapolated to the fishery level. As the line and net fisheries used relatively few inputs other than labour, the GVA was a high proportion of the total GVP. In contrast the pot boats used a relatively higher share of intermediate goods in their production. Nevertheless, GVA still accounted for over half the GVP (Figure 11).

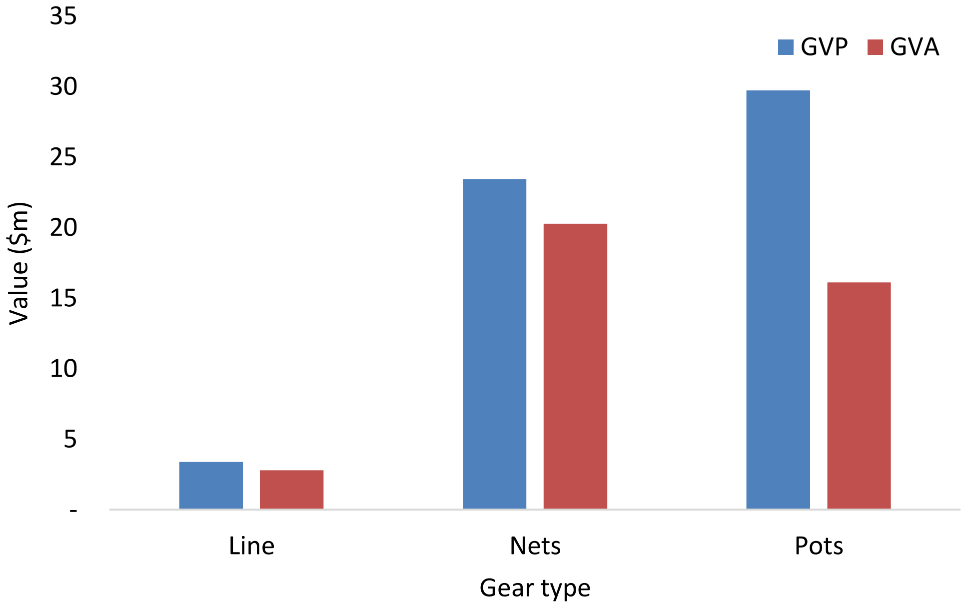

Figure 11. GVP and GVA, 2013-14

Capacity utilisation and potential output

Initial analysis was undertaken at the level of the fishing grid. This allows an aggregate analysis to be undertaken, but taking into account potential fluctuations in spatial abundance of the resources. Although most previous studies of DEA have been based at the vessel level (e.g. Tingley et al. 2003; Tingley and Pascoe 2005; Lindebo *et al.* 2007; Schrobback *et al.* 2014), the use of regional level data is common in other applications, particularly for inter-regional or international comparisons (e.g. Despotis 2004; Afonso and St Aubyn 2005; Despotis 2005; Sharma and Thomas 2008). An advantage of spatial level analysis in the fisheries context is that it provides information as to which areas are most highly utilised, and hence of major importance to the industry. Low utilisation may reflect relative low stock abundance or high costs of access.

At the fishing grid level, information was only available for the net and pot fisheries. While line fisheries information were – in principle– available, separating inshore fishing activity (i.e. targeting species from the inshore east coast finfish fishery) from the offshore activities (i.e. the coral reef finfish fishery) was problematic for a number of grid cells.

Net fishery

Information on the net fishery was obtained through the QFISH data base (qfish.daff.qld.gov.au) for the period 1990-91 to 2013-14. All grids that recorded both catch and effort using nets were selected for use. Grids that had less than 5 vessels operating over the year were excluded (under the confidentiality requirements of DAFF). In total, 1850 observations were obtained over the period 1990-91 from 111 grid cells.

The key inputs used in the analysis were the number of vessels operating in a grid cell over the year (the fixed input), and the average number of days fished (the variable input) by each boat in the grid. The outputs were the catch (in kg) of whiting, threadfin, shark, mullet, mackerel, and barramundi, with all other species aggregated into an 'Other' category (Figure 12). Prices of each species were derived from ABARES (2013) for the 2012-13 financial year (the most recent available), and assumed constant over the period of the data. Hence, any change in revenue is assumed due to change in quantity landed and not price.

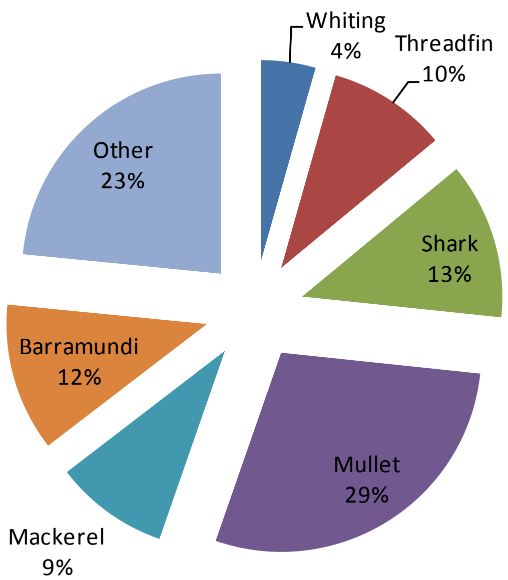

Figure 12. Catch composition, net fisheries, 1991-2014

Information on stocks was not available, with the exception of mackerel (Lemos *et al.* 2014), and to a lesser extent mullet (Bell *et al.* 2005). Stock levels are likely to vary by different amounts in different grids in each year. Similarly, the fishing power of vessels is also likely to have changed over the period of the data. To allow for these, total factor productivity was derived using the Malmquist index measure described in the methods section. Total factor productivity can be disaggregated into technical change and efficiency change, where the former represents a shift outwards (or inwards) in the production frontier, while efficiency change measures how close, on average, the region is to the efficient production frontier.

In this case, technical change captures the effects of management change (e.g. change in regulations that affect production, including area closures within a grid), stock changes which result in catch increasing or decreasing for a given input level, and technological change reflecting new harvest technologies that increase catch for a given level of inputs. Estimation of technical change requires a balanced panel data set. That is, information on each grid must be available for each year. As a result, the technical change measure was derived using a subset of the full data (involving 1143 observations from 39 grids where fishing activity took place every year).

From this, technical change increased substantially from 2000, peaking around 2012 then declining by 2014 (Figure 13). However, productivity was still over 40% higher in 2013-14 than in 1990-91. In contrast, cumulative efficiency was roughly similar over the period of the data, indicating that while the frontier had moved outwards, catch in each region changed proportionally with the frontier (rather than moving closer to the frontier).

Although the fleet declined in size over the period of the data, largely through a series of buybacks, and with this the potential for less efficient boats to leave first, there was no substantial increase in the cumulative efficiency change, but a large increase in TFP. Removal of less efficient boats would see the frontier staying where it was but average efficiency increasing. Rising TFP implies the frontier is shifting outwards, while relatively constant efficiency change suggests that the fleet are all moving out at around the same rate. This suggests that the key driver of the TFP may be environmental, such as stock change that affects all vessels equally.

Information on stock size is limited as stock assessments are not routinely undertaken for the fishery. The most recent stock assessment for mullet (Bell et al. 2005) – the major species in the fishery – estimated stock abundance only to 2003. Stocks of mackerel generally increased from 2000 to 2012 (Lemos et al. 2014), but this was by a lesser proportion than the derived TFP over the same period. Assuming other species' stocks moved in similar ways, much of the change was likely to be technology driven (e.g. gear change) rather than stock driven.

The catch of each species was adjusted using the cumulative technical change measure to provide an equivalent catch given the level of effort, taking into account the observed combined stock and technological change over the period of the data. Technical efficiency and capacity utilisation was then estimated using the revised data.

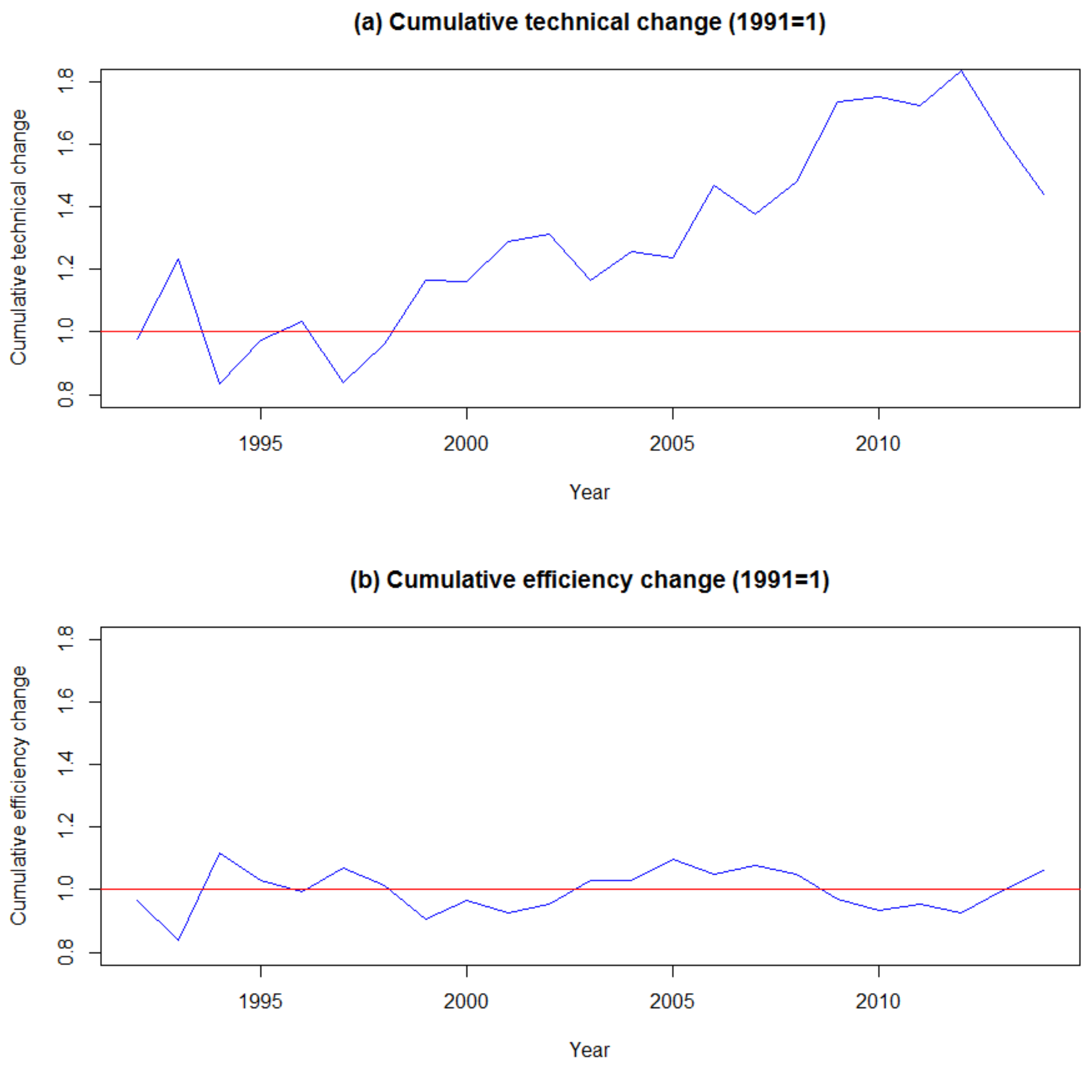

Figure 13. Cumulative technical and efficiency change, Net fishery, 1991-2014

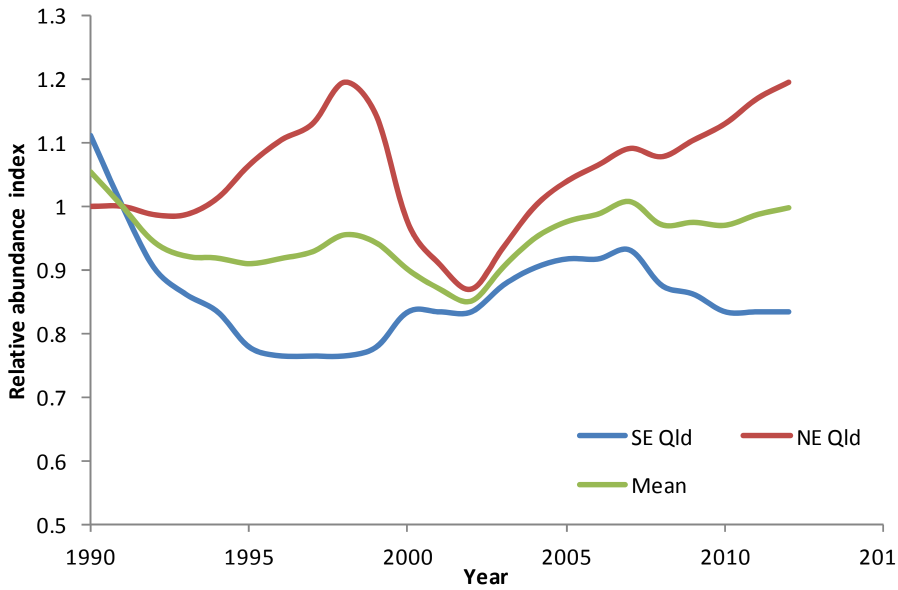

Figure 14. Relative index of estimates of grey mackerel (1-12 year old) biomass

For consistency with the TFP the base of the index is 1991. Derived from Lemos et al. (2014)

The distribution of technical efficiency and (unbiased) capacity utilisation is given in Figure 15 and Figure 16. A high proportion of areas have low apparent efficiency levels, indicating that catch per unit effort is relatively low. This reflects the relative stock abundance distribution, with more abundant areas having a high apparent 'efficiency' level. This distribution was also relatively constant over time (Figure 16). Capacity utilisation was also fairly widely distributed, but with a high proportion of regions operating at or close to full capacity. Expansion of fishing activity in the regions with lower capacity utilisation, however, could increase total output. However, as the analysis does not take into account the costs of fishing, such an expansion may not be realistic.

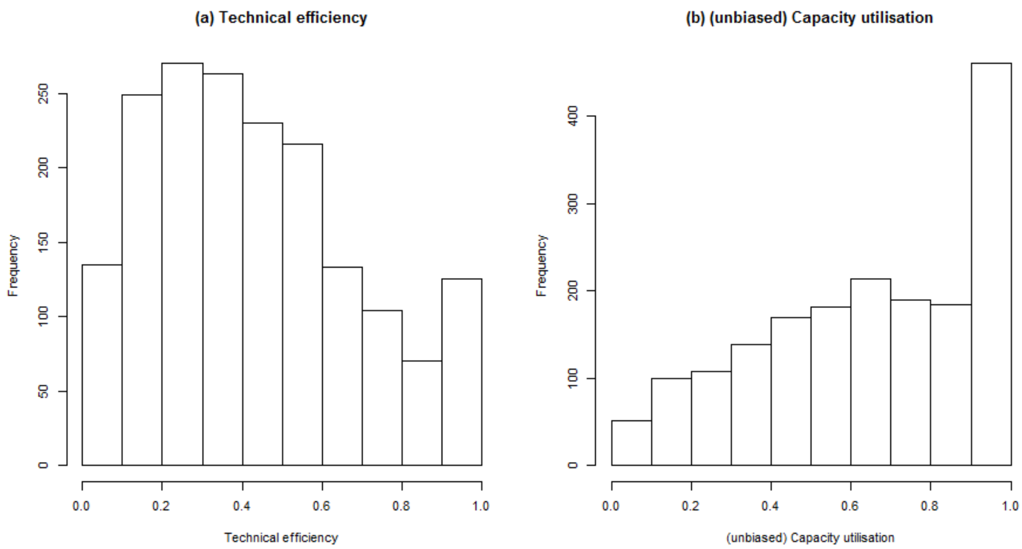

Figure 15. Distribution of efficiency and capacity utilisation, net fishery, 1991-2014

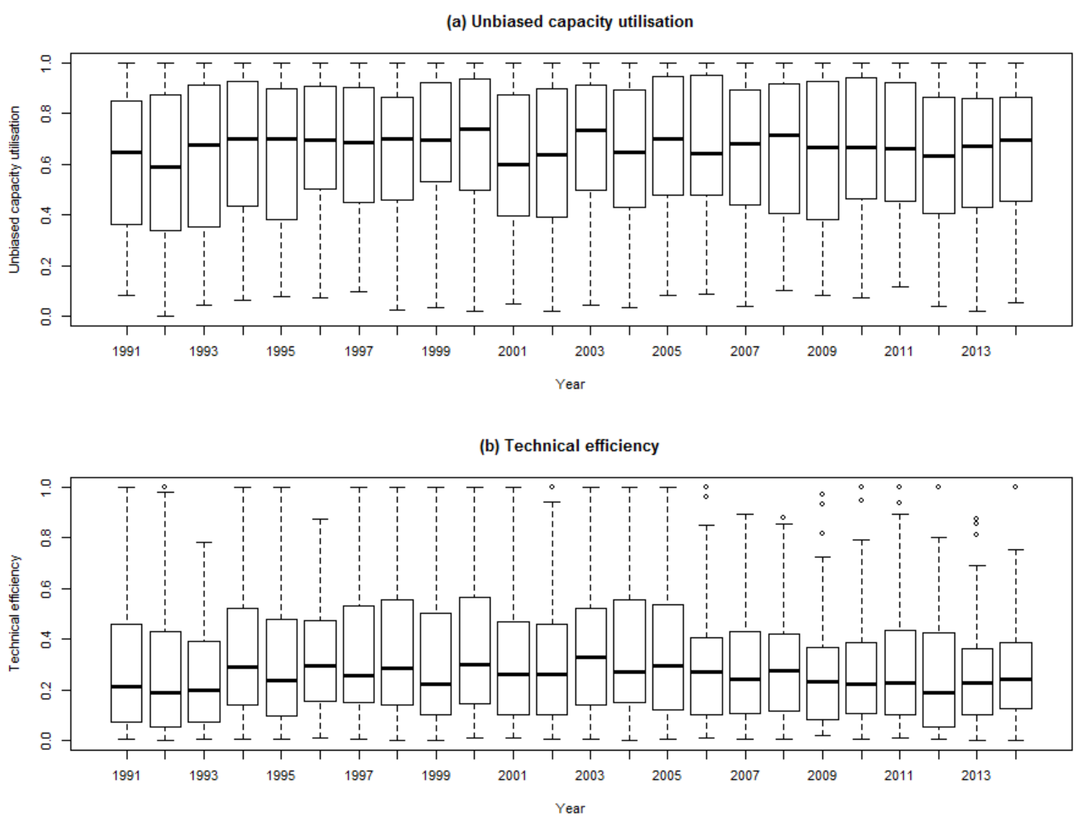

Figure 16. Efficiency and capacity utilisation by year, net fishery, 1991-2014

The potential (capacity) revenue in the fishery was derived through dividing the regional revenue by the capacity utilisation score, and aggregating to derive estimate of observed and capacity GVP. As implicit in Figure 16, the capacity revenue closely tracked the observed revenue. Over the period of the data, the fleet size (in terms of active boat licences) generally declined (see Table 7). However, GVP increased until around 2004,[4] after which it declined at a faster rate than the decline in active vessels. This is also despite an increase in productivity over this latter period.

Table 7. Observed and capacity GVP, net fishery 1991-2014

Year	Observed GVP	Capacity GVP	Active licence numbers
1991	17.2	21.6	692
1992	20.2	24.7	660
1993	14.1	18.2	675
1994	20.0	24.7	665
1995	19.7	23.8	641
1996	19.9	24.9	661
1997	24.3	30.6	685
1998	26.0	32.2	685
1999	21.1	25.6	595
2000	21.2	26.5	616
2001	23.8	31.5	630
2002	21.2	28.1	633
2003	23.8	29.1	628
2004	25.4	32.3	650
2005	22.2	26.5	614
2006	16.8	21.0	546
2007	18.7	23.7	554
2008	17.1	22.7	558
2009	15.7	20.5	566
2010	14.6	18.4	516
2011	13.9	18.6	494
2012	13.2	16.7	493
2013	13.9	17.7	481
2014	13.6	17.4	444

Crab fishery

A similar approach was undertaken for the crab fishery. Information on the crab fishery was also obtained through the QFISH data base (qfish.daff.qld.gov.au) for the period 1990-91 to 2013-14. All grids that recorded both catch and effort using pots were selected for use. As before, grids that had less than 5 vessels operating over the year were excluded (under the confidentiality requirements of QDAF). In total, 11,468 observations were obtained over the period 1990-91 from 99 grid cells.

As with the net fishery, the key inputs used in the analysis were the number of vessels operating in a grid cell over the year (the fixed input), and the average number of days fished (the variable input) by each boat in the grid. The outputs were the catch (in kg) of blue swimmer, mud crab and spanner crab, with all other species aggregated into an ‘Other’ category (Figure 17). Prices of each species were again derived from ABARES (2013) for the 2012-13 financial year (the most recent available) as well as information provided by the industry on another project. As with the net fishery analysis, prices were assumed constant over the period of the data, such that any change in revenue is assumed due to change in quantity landing and not price.

[4] Anecdotal evidence suggests that this apparent increase may have been due to over-reporting by fishers hoping to gain a higher payout through buybacks or to be able to retain unused symbols (fishing licence endorsements) to retain access to the fishery even if not actively engaged in it.

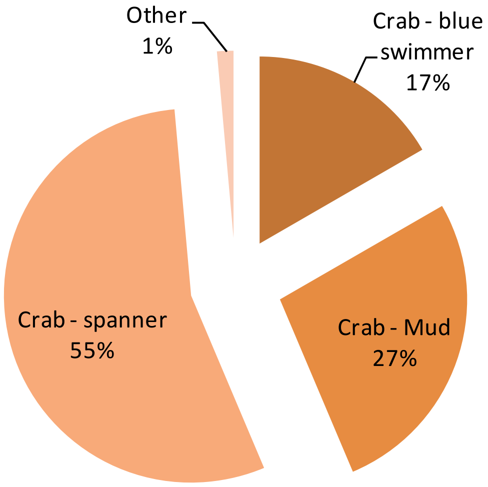

Figure 17. Catch composition, crab fisheries, 1991-2014

Cumulative technical change in the fishery appeared to decline between 1991 and 1995, but has generally increased since that point (Figure 18). Limited stock assessment information suggests that stocks of spanner crabs in 2008-09 were around 20% greater than 2000-01 (Brown 2010), consistent with the trends in the cumulative technical change. Given that potting is a generally low-technology fishing activity, assuming that most of this technical change is due to stock changes is reasonable.

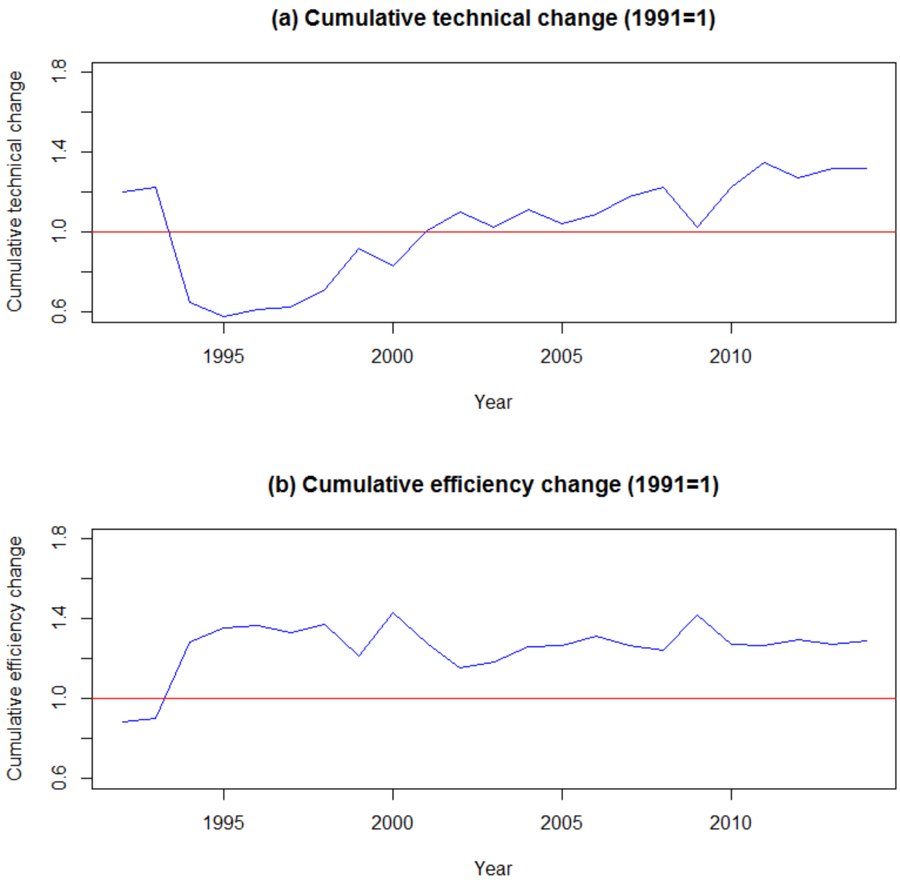

Figure 18. Cumulative technical and efficiency change, Crab fishery, 1991-2014

In contrast, cumulative efficiency change increased over the same period during which the technical change decreased, and has remained relatively constant since around 1995. The decline in technical change and the increase in cumulative technical efficiency coincides with a large increase (more than double) in fishing activity between 1991 and 1995 (Brown 2010). Boat numbers and days fished have both generally declined since 1997.

The output measures were adjusted for technical change as before and the capacity utilisation over the period of the data re-estimated. As with the net fishery, a large proportion of 'inefficient' grids reflect differences in local stock abundance, with the most abundant grids having high efficiency scores (Figure 19).

Similarly, a high proportion of the grids are operating at or close to full capacity (Figure 19). Capacity utilisation appears to have increased across the fishery over time (Figure 20), corresponding to the reduction in fishing effort. Such an increase has been observed in other fisheries, as reduced competition allows the remaining vessels to increase their own capacity utilisation (Holland *et al.* 1999; Squires 2010; Pascoe et al. 2012).

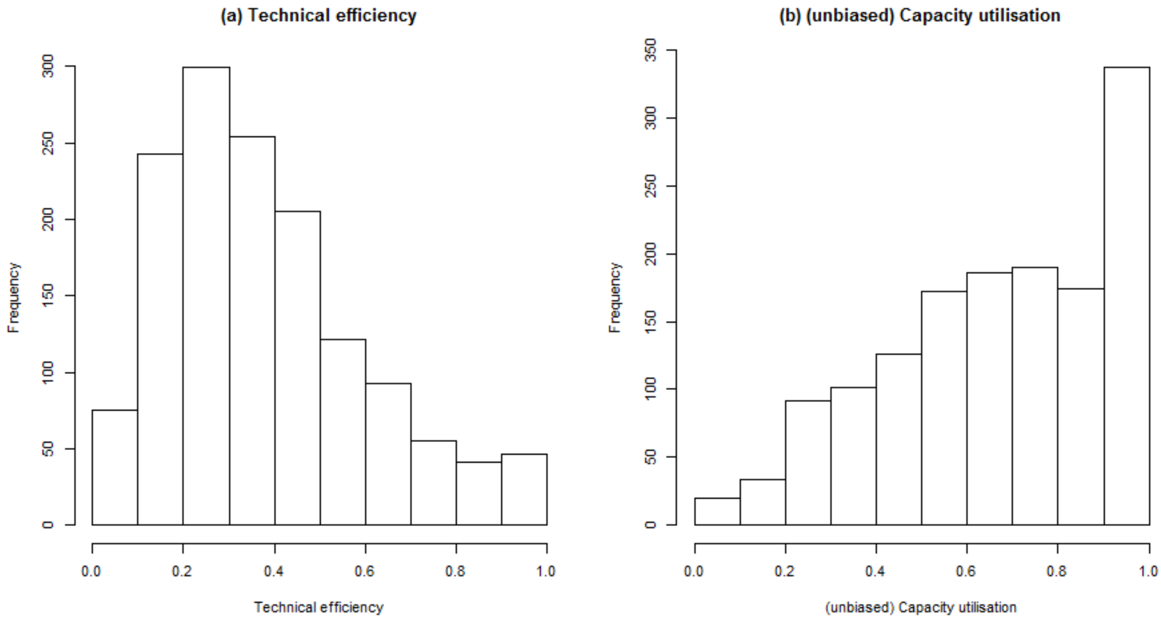

Figure 19. Distribution of efficiency and capacity utilisation, crab fishery, 1991-2014

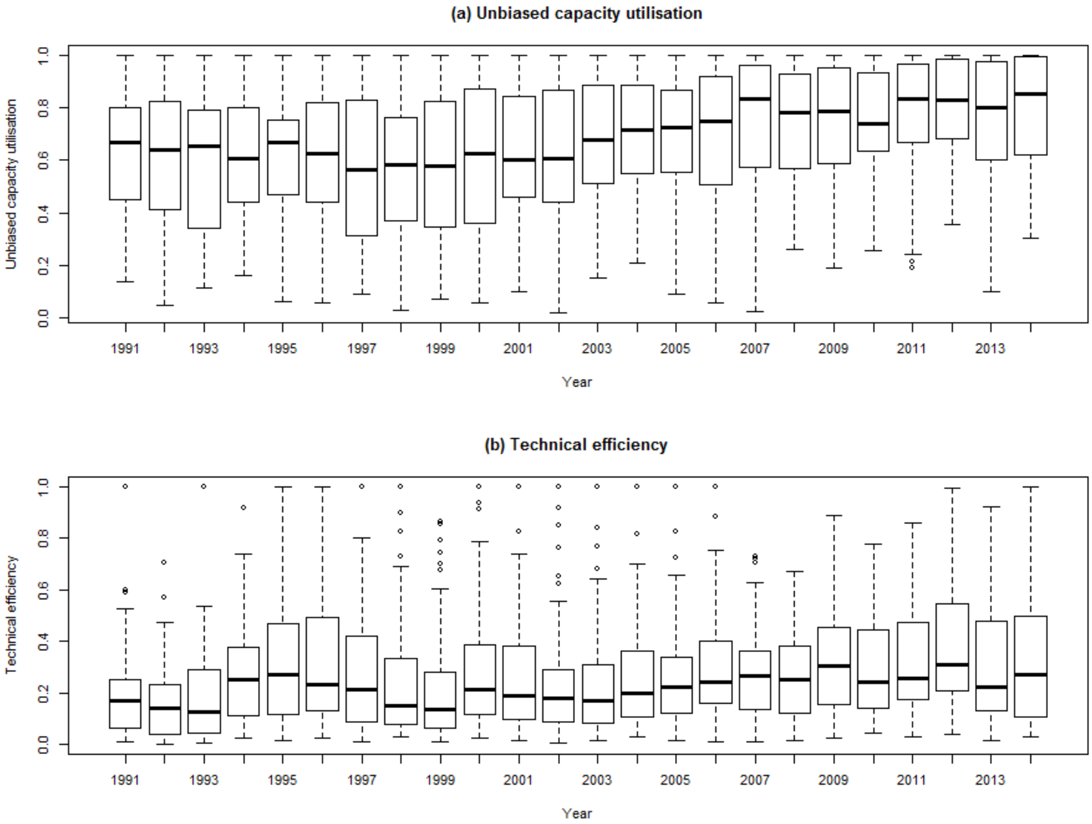

Figure 20. Efficiency and capacity utilisation by year, crab fishery, 1991-2014

The general increase in capacity utilisation has also resulted in a decrease in the gap between observed revenue and capacity revenue over time (Table 8). As with the net fishery, the decline in both observed and capacity GVP has largely resulted from the decline in active licence numbers.

Table 8. Observed and capacity GVP, crab fishery 1991-2014

Year	Observed GVP	Capacity GVP	Active licence numbers
1991	14.3	18.7	692
1992	11.8	16.5	660
1993	18.4	24.3	675
1994	49.0	72.5	665
1995	61.2	84.9	641
1996	59.2	86.8	661
1997	53.6	83.7	685
1998	47.4	68.8	685
1999	34.1	47.5	595
2000	45.5	64.9	616
2001	43.6	58.6	630
2002	36.6	51.7	633
2003	39.2	50.1	628
2004	41.6	52.1	650
2005	37.3	45.0	614
2006	32.8	40.5	546
2007	28.7	34.7	554
2008	29.4	35.5	558
2009	34.8	41.8	566
2010	29.1	33.8	516
2011	29.0	33.2	494
2012	31.3	35.3	493
2013	28.3	32.3	481
2014	28.8	32.1	444

Local and regional impacts

The analysis of local and regional impacts involved two components. First, a review of existing studies and estimates of fisheries output multipliers was undertaken in order to provide a benchmark against which the project derived values could be assessed. Second, vessel level information on expenditure levels and location, derived from a survey of the industry, was used to derive vessel level multipliers, following the method derived by Stoeckl (2007). These were subsequently used to estimate the potential flow-on benefits to the regional economies associated with different types of fishing vessels.

Review of previous studies

Economic multipliers are expressed as factors by which to multiply the value of production of an industry to estimate the total impact of that industry throughout the regional economy (Jacobsen *et al.* 2014). Multipliers can also be developed to estimate the regional employment and income effects, although the methodology used in this study does not extend to these other benefits.

The key drivers of the magnitude of multipliers is the level of leakage in the regional economy. That is, the proportion of local expenditure to total expenditure. Industries with relatively high local expenditure have correspondingly high regional multipliers compared to those industries that import their inputs from elsewhere. Similarly, industries that use a large number of intermediate inputs have larger multipliers than industries that use few inputs other than labour (e.g. many service sectors).

Jacobsen et al. (2014) derived a global estimate of the 'average' output (revenue) multiplier in marine industries, and found this to be around 2.25, with substantial variation between industries and countries. A range of fishery specific output multipliers estimated for a range of countries is presented in Table 9, while estimates of output multipliers for Australian fisheries is given in Table 10. Other input-output studies in regional Queensland with a natural resource focus are also given in Table 11.

In Table 9, the studies by Sumaila and Hannesson (2010) and Dyck and Sumaila (2010) are both based on the same I-O tables (derived from the Global Trade Analysis Project database (www.gtap.agecon.purdue.edu)), but provide different estimates of the multipliers. No explanation is given for the large differences in values between publications. Additionally, no explanation as to why they are so high compared with other international studies was given.

Most (nearly all) previous Australian and Queensland studies did not identify a separate commercial fisheries sector, but instead grouped it with agriculture and forestry. One study (Norman-López and Pascoe 2011) developed national level multipliers for a range of specific fisheries, including some Queensland based fisheries. These likely overestimate regional multipliers as there are more 'imports' of goods and services at the regional level (i.e. from other regions). State level multipliers for fisheries have been derived in South Australia (e.g. see EconSearch (2014)).

A common feature of the Australian natural resource management studies is that they are also generally based on relatively old data (Table 11). National input-output tables (from which the regional tables are generally derived) are developed every 5 years by the Australian Bureau of Statistics, the most recent available tables being for 2009-10. Most studies since then have adjusted relevant parts of the tables although the fundamental linkages between sectors are generally assumed the same as in 2009-10. Many of the existing studies have used even earlier national tables as their base.

The distribution of estimated fisheries output multipliers both internationally and from Australia are compared in Figure 21. From this, it appears that fisheries output multipliers in Australia generally have a higher proportion of high multipliers than international studies, with over half the Australian estimates being greater than 3.5, compared with less than 20% of international studies.

Table 9. Summary of international fisheries related output multipliers

Country/region	Fishery type	multiplier	reference
Ireland	all	1.56 [a]	Morrissey and O'Donoghue (2013)
Hawaii	Tuna longline	2.42	Leung and Pooley (2001)
	Small commercial boats	2.54	
	All boats	1.61 [a]	Arita *et al.* (2013)
		2.24	
US North East shelf	All – State level	1.87	Hoagland *et al.* (2005)
	All – County level	1.83	
US Pacific Coast	Sable fish fixed gear	1.84	Leonard and Watson (2011)
North America	all	3.52	Dyck and Sumaila (2010)
Africa	all	2.59	
Asia	all	2.67	
Europe	all	3.12	
Latin America	all	2.05	
Oceania	all	3.27	
World (average)	all	2.80	
Africa	all	3.88	Sumaila and Hannesson (2010)
Asia	all	2.99	
Europe	all	7.98	
Latin America	all	3.34	
North America	all	5.65	
Oceania	all	4.99	
Korea	all	1.78 [a]	Lee and Yoo (2014)
Taiwan	all	1.90 [a]	Chiu and Lin (2011)

a) Type I multipliers (excludes income induced effects, just direct and production induced effects)

Table 10. Summary of Australian fisheries I-O studies

State/region	Fishery	multiplier	Reference
Australia	all	3.69	Dyck and Sumaila (2010)
Australia	all	5.79	Sumaila and Hannesson (2010)
National level	Northern Prawn	3.844	Norman-López and Pascoe (2011)
	Eastern Tuna and Billfish fishery	4.144	
	South East trawl	3.603	
	Gillnet, Hook and Trap	2.646	
South Australia	Abalone	3.47 [a]	EconSearch (2012); 2014)
	Rock Lobster	3.00 [a]	
	Lakes and Coorong	4.75 [a]	
	Marine Scalefish	4.70 [a]	
NSW	all	2.42	NSW Department of Trade & Investment (2012)

a) include downstream impacts e.g. processing, retail

Table 11. Other Queensland NRM I-O studies (non-fisheries)

Region	Industry/focus	Model base year	Reference
Central Highlands	Coal industry	1997-98	Ivanova and Rolfe (2011)
Range of regions (regional models)	Resources sector	2005-06	Rolfe *et al.* (2011)
Not Queensland specific	Resource extraction	2008-09	Rayner and Bishop (2013)

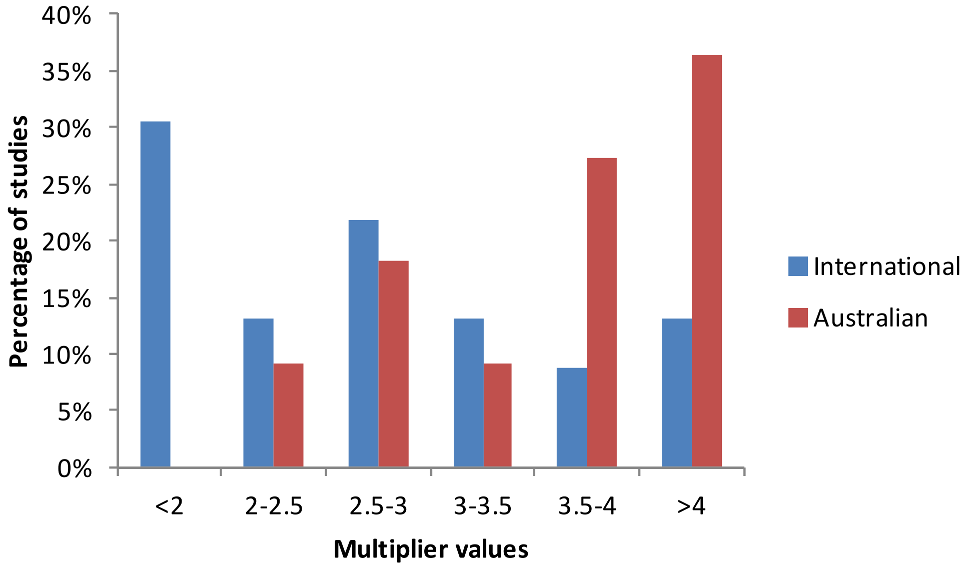

Figure 21. Comparison of Australian and International output multipliers

The traditional input-output multipliers have three main components: a direct effect, and indirect effect and an induced effect. The direct effect represents the actual production of the fishery sector, while the indirect and induced effects are the additional benefits to the regional economy. The magnitude of these regional effects can be derived by subtracting 1 (one) from the multiplier and multiplying the remainder by the fisheries production.

Data used in the analysis

The primary source of data used in the study was derived from a series of surveys of fishers, covering the 2013-14 financial year. The survey collected information on the cost structure of the different fishing activities, as well as where the costs were incurred. The surveys also collected information on where personal expenditure was undertaken. Early draft survey questionnaires also asked about personal expenditure breakdown, but this was felt to be too onerous. Instead, ABS data on household expenditure for Queensland was applied.

Survey sample and responses

The sample was divided into two groups, based on information collected in the Adapt of Fail project. Of the 188 fishers surveyed in the Adapt or Fail project, 68 agreed to participate in a follow on survey either online or by phone, and a further 92 agreed to participate in a telephone/postal survey.

The online survey (Appendix B) was implemented in February 2015. The survey was first piloted with a small subset of fishers who were informed that they were part of the pilot program and asked to provide feedback on the survey. The survey was modified based on the feedback received, and fully implemented in March 2015 using contact details provided by participants in the Adapt or Fail project. Reminders were sent weekly over April and May to non-respondents. Despite this, only 16 responses were received (Table 12), of which only half were usable. Of those that were not usable, respondents only completed their location and broad revenue and cost category, but no more. Three other fishers phoned to say they were no longer fishing, and had minimal activity on the survey period.

Table 12. Survey response from the different surveys

Survey method	Sample	Responses	Fully completed responses	Usable responses
Online – first survey	68	16	8	8
Online – second survey	*	25	7	21
Telephone survey	92	33	33	33
Postal returns		4	3	4
Total		73	47	65

* All QSIA members contacted via email with survey link and pdf copy of survey

For the postal and telephone survey, the questionnaire was redesigned to ask for the more detailed financial information at the end, in the hope that this would result in at least the distribution of expenditure being provided (Appendix B). Fishers were mailed a hard copy of the survey, and followed up with a phone call to arrange a time for a full interview. Three fishers returned the survey by post, and 33 agreed to be interviewed by telephone (Table 12). The telephone interviews proved to be the most effective, with all surveys being fully completed and usable.

Preliminary results from the surveys were presented to the Queensland Seafood Industry Association (QSIA). QSIA proposed that they assist with a second online survey, based on the more successful telephone survey questionnaire. For the second online survey, QSIA sent an email to all members outlining the study and provided a link to the (revised) online survey. QSIA also sent a pdf form version of the questionnaire to those who requested it. This resulted in an additional 25 online responses and an additional postal (email) return. As with the first online survey, a high proportion of the responses were incomplete, although (unlike the first survey), missing values could be largely interpolated from other information provided (e.g. revenue estimates could be based on skipper payments and vice versa; where detailed expenditure values were missing, averages based on other similar vessels were used). In all cases, the location of expenditure was provided.

Sample demographics

The survey was administered along the east coast of Queensland, and responses from 16 different local government regions were received (Figure 22). The highest proportion of responses came from the Frazer coast region, encompassing Hervey Bay, Maryborough, and Urangan. Over half the sample fished in the inshore net fishery to some degree, although most boats used several gears over the year (Figure 23).

A wide range of fishing experience was observed in the data, ranging from 3 years to 55 years, although between 20 and 30 years was the most common level of experience (Figure 24). This wide range was also observed over main gear type (where the gear use was greater or equal to 50% of total gear use) (Figure 25).

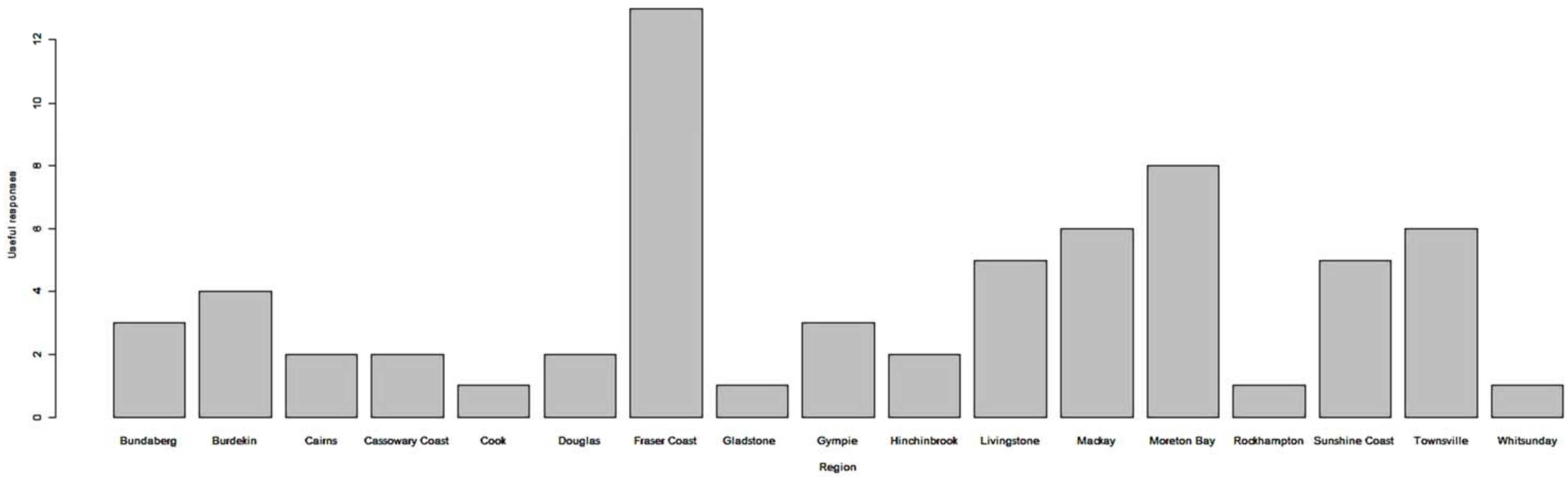

Figure 22. Distribution of survey responses by local government area

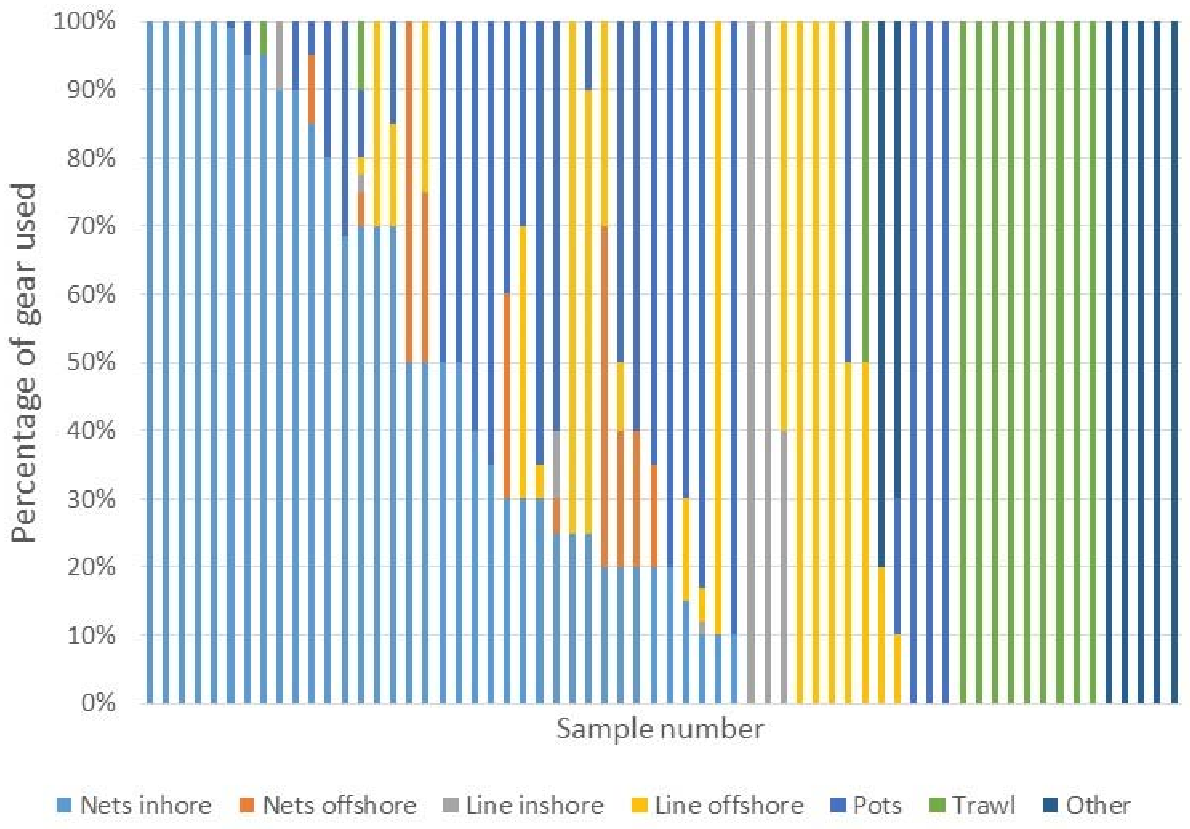

Figure 23. Gear use in the survey sample

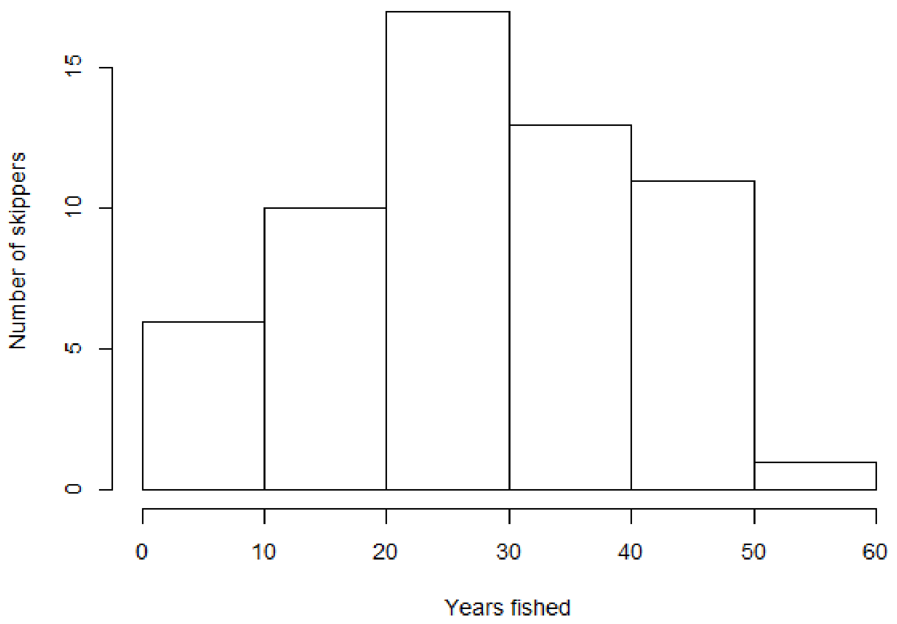

Figure 24. Distribution of fishing experience

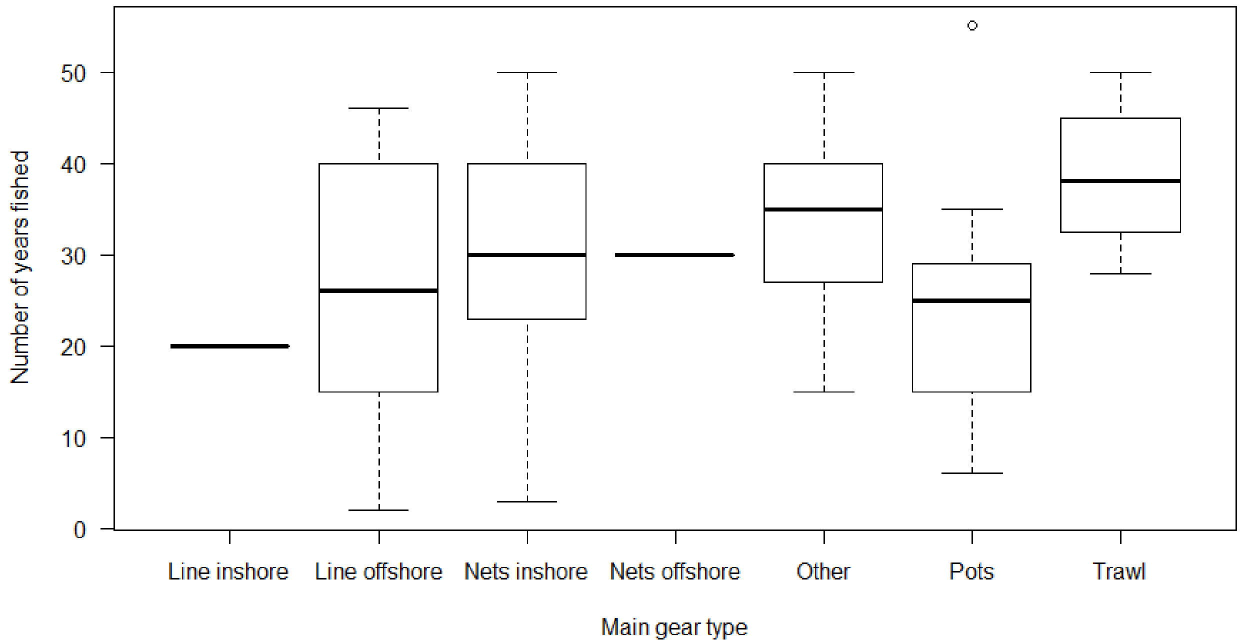

Figure 25. Fishing experience by main gear type

Consumer expenditure

Information on average consumer expenditure was taken from the ABS household expenditure survey for 2009-10 (ABS 2011), using information for Queensland (Figure 26). This was grouped into the same categories used in the fisher survey to derive where household expenditure took place. An implicit assumption is that household expenditure patterns (which are not dependent on fishing activity) are the same for all household (i.e. the same for both crew and skippers) and have not changed since the last ABS survey.

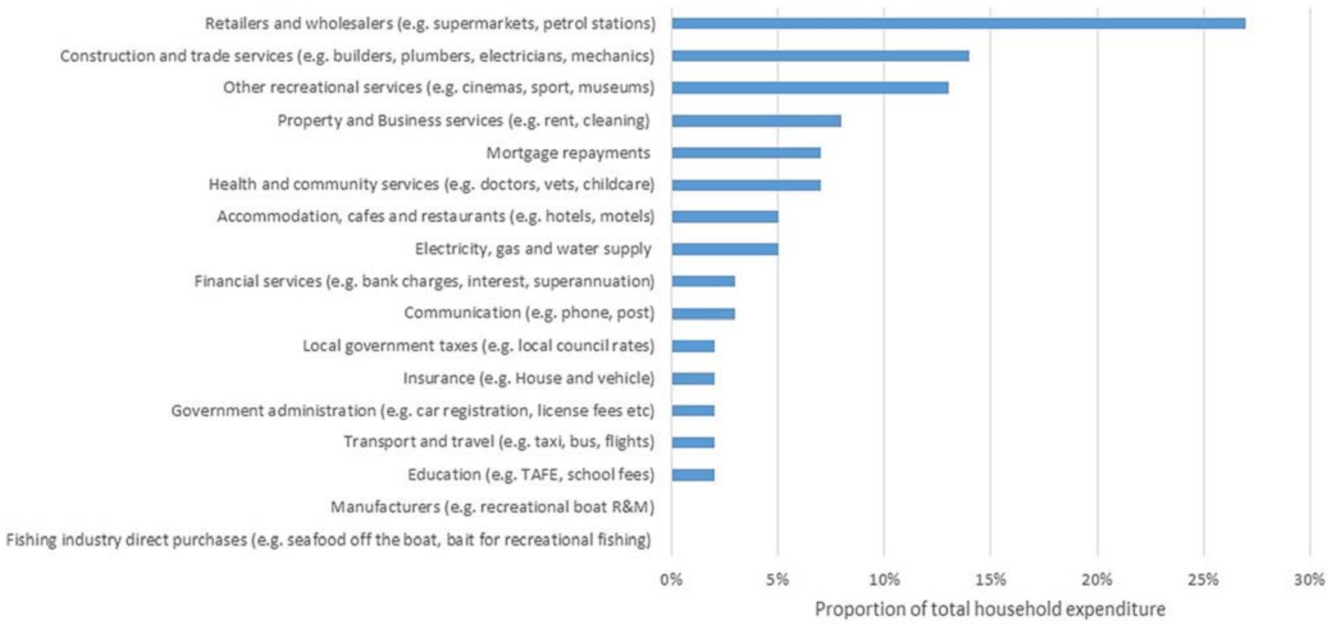

Figure 26. Household expenditure distribution, Queensland

Revenues, costs and expenditure patterns

From the survey results obtained, revenues and total costs were generally lower for the inshore fleet than the offshore fleet (Figure 27). In Figure 27, the dotted lines indicate the range of 95% of the data, the box represents the range between the second (i.e. 25%) and third (i.e. 75%) quartile, and the solid bar in the box represents the median value.

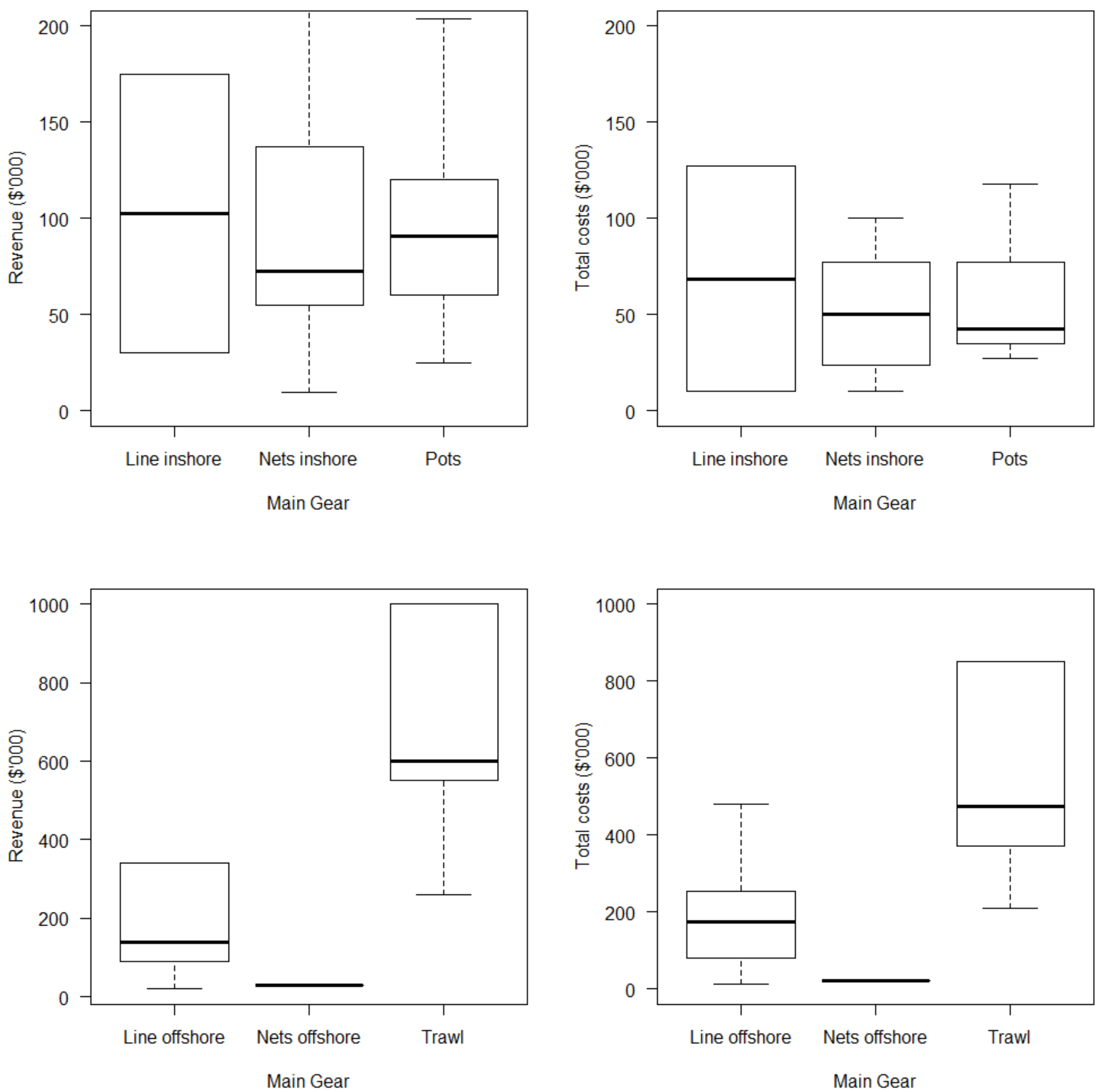

Figure 27. Revenues and costs for inshore and offshore fleets

Crew costs and fuel costs generally had the highest cost shares (Figure 28). Crew costs varied considerably, from zero to 50%. For some of the smaller vessels with no crew, an allowance for owner operator labour has not been made (although information on this has been collected). Income related benefits are estimated separately from production related regional benefits.

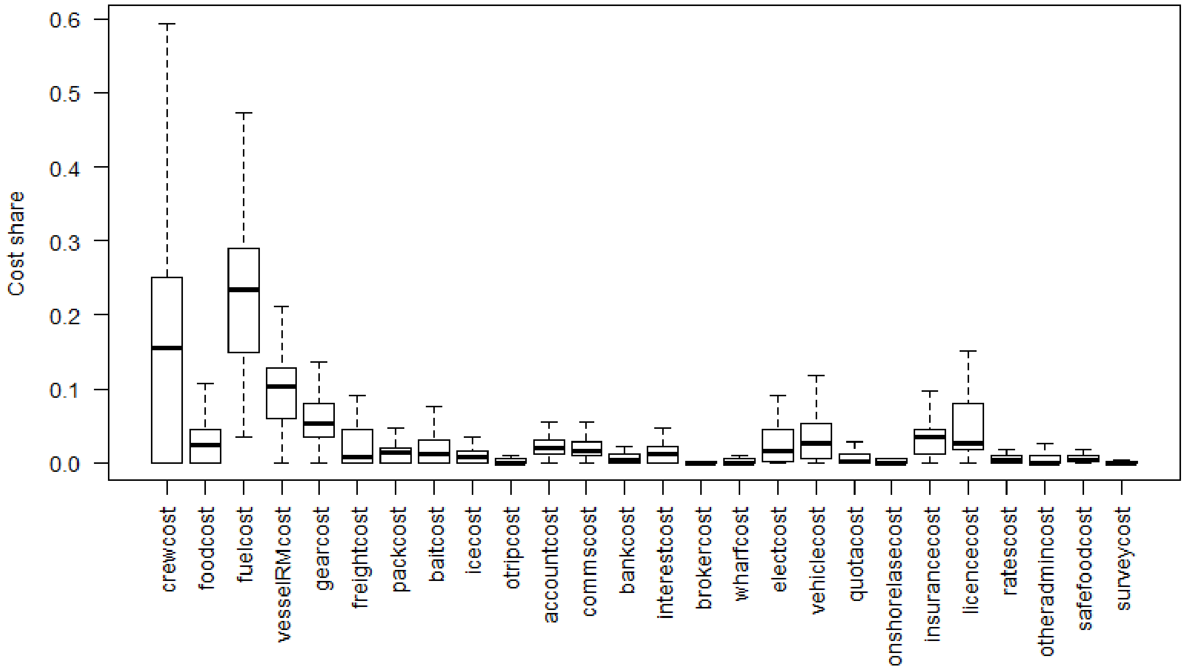

Figure 28. Cost share of key cost items, 2013-14

The proportion of local expenditure of these items also varied considerably (Figure 29). Local in this case was defined as the local government area in which the vessel was based. Most variable costs (crew, food, fuel and repairs) had a high proportion of local expenditure. Where the costs had not been incurred (e.g. crew costs in some cases), this was recorded as zero local expenditure. This will not affect the multiplier estimate as there is no corresponding expenditure share, but potentially distorts some local expenditure shares in Figure 29.

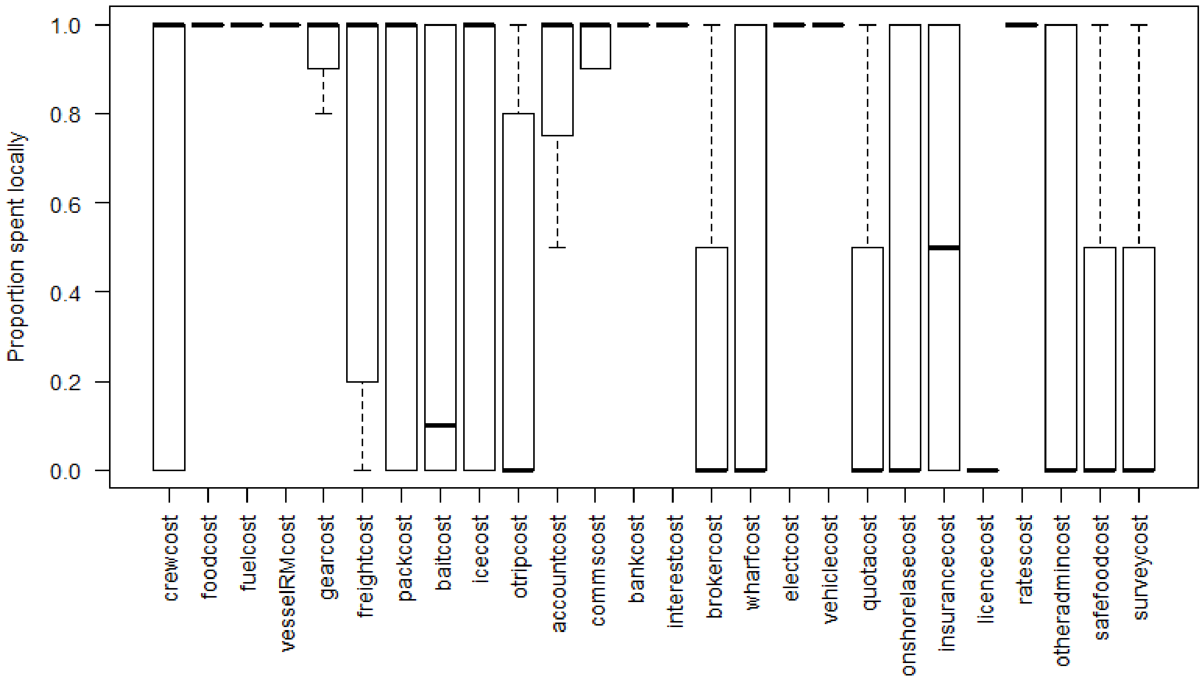

Figure 29. Proportion of costs spent locally

Incomes generated

Local incomes generated in the industry (i.e. profits, skipper payments and payments to crew who live locally) also vary considerably, with those produced by the offshore fleet generally being substantially higher than those produced by the inshore fleet (Figure 30).

Figure 30. Local incomes generated by offshore and inshore boats

As a share of vessel revenue, the income generated also varied considerably both within (Figure 31) and between main gear type (Table 13).

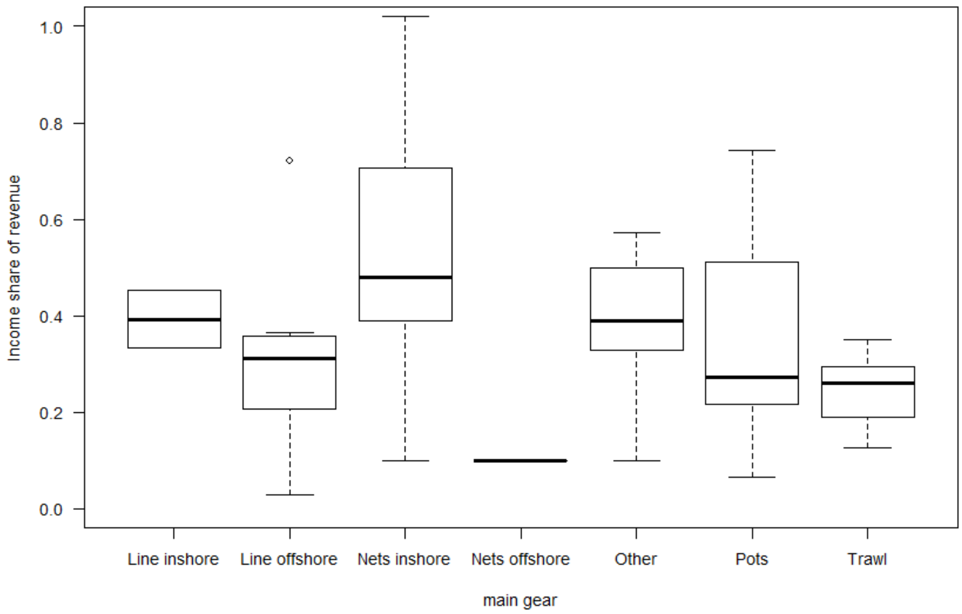

Figure 31. Distributions of incomes generated as a proportion of boat revenue

Table 13. Average income generated as a proportion of boat revenue

Gear	Line inshore	Line offshore	Nets inshore	Nets offshore	Other	Pots	Trawl
Proportion of revenue	0.393	0.296	0.674	0.100	0.369	0.355	0.248

Fishing industry production multipliers

'Raw' multipliers

From these data, the regional output multipliers at the vessel level could be derived. In most cases, the multipliers were estimated to range from around 1.5 to 4.5 (Figure 32), consistent with the distribution of multipliers estimated elsewhere for Australian fisheries (Figure 21). Unlike the previous input-output studies, however, which produce only a single average value for an industry, the method used in this study produces individual vessel level multipliers. Traditional input-output analysis works only at an aggregate level. That is, the flow-on effect for the whole fishery would be assessed on the basis of one 'average' multiplier value and the total output from the sector. An advantage of the alternative approach is that impacts can be derived at the individual vessel level taking into account heterogeneity in both production and expenditure patterns, producing a distribution of impacts.

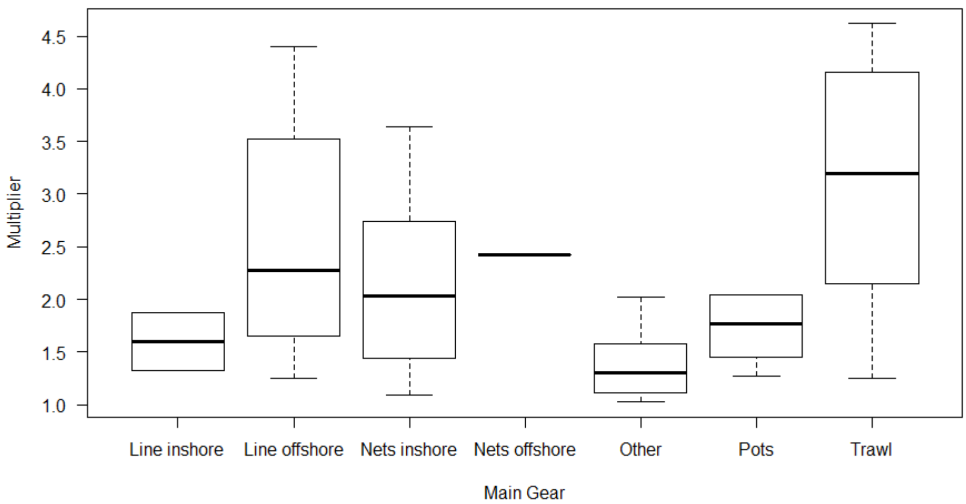

Figure 32. Distribution of multipliers by main gear type

Given these multipliers, the potential distribution of flow on effects to the regional economies can be derived. From the economic survey, the revenues of the different boats varied considerably both within and between a given fleet type. The potential additional flow on effect was estimated by multiplying the adjusted multipliers (i.e. deducting 1 to remove the direct effect) by the revenues of boats classified as using each gear type. The resultant range of flow-on effects illustrated in Figure 33 (limited to boats with revenues less than $1m) demonstrates the potential range of additional benefits.

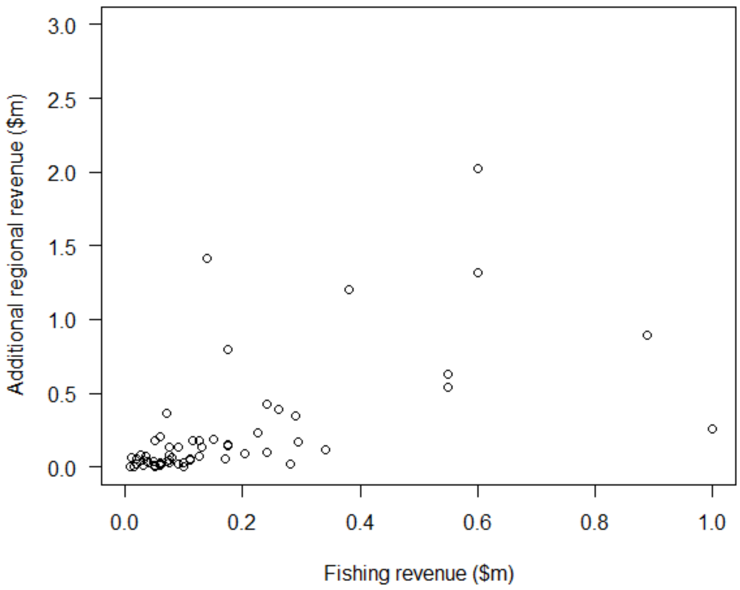

Figure 33. Regional flow-on benefits compared to fishing revenue

Generalised multipliers

Given that different data were obtained from vessels with different combinations of gear use, operating in different regions and at different scales, regression analysis was used to attempt to derive a more generic set of multipliers (and their associated ranges). An a priori assumption was that the ability to obtain more inputs locally was likely to be a function of the population size and generally economic conditions in the region. This was represented in the analysis by local population size and the local government area index of relative socioeconomic advantage and disadvantage (SEIFA) (ABS 2013). Boats with higher revenues generally also had higher costs, so were assumed to have an incentive to source more inputs from outside the region. The type of gear used would also affect input used, so would be expected to influence the multiplier.

Two variants of the model were estimated: one with a nonlinear specification and the other with a linear specification. Each model contained the same variables (appropriately transformed), namely the population of the LGA, the index of socioeconomic advantage and disadvantage (ABS 2013) (both representing potential regional effects), the vessel revenue (representing scale), and the proportion of time spent using each gear type (0 to 1). Zonal dummy variables representing central and southern Queensland (with northern Queensland effectively captured in the intercept). In each case, the full model was estimated, and stepwise regression used to derive the most appropriate reduced form of the model. A small number of outliers were also excluded. The results of the nonlinear model and the linear model are given in Table 14 and Table 15 respectively.

In both cases, the analysis suggested that there was no real significant difference between the multipliers for the inshore fishing activities (nets, lines and pots) and also the offshore nets. However, relatively few observations were available for the offshore nets, which may have influenced this result. Offshore line, trawl and 'other' activities did have significantly different multipliers. While the parameter for offshore line was not individually significant in both models, removing this variable reduced the overall fit of the model (as determined by both the adjusted R-squared term and the AIC).

Also in both cases, there was no apparent regional influence to the multipliers. The regional characteristics were not significant and excluded in both models, as were the broader zonal dummy variables. The scale of the operation (described by the boat revenue) was also not significant.

Table 14. Nonlinear model of factors affecting production multipliers

	Full model					Reduced form				
	Estimate	Std. Error	t value	Pr(>|t|)	Sig	Estimate	Std. Error	t value	Pr(>|t|)	Sig
Intercept	0.7257	1.5821	0.4590	0.6486		0.5800	0.0633	9.1590	0.0000	***
Ln Population	0.1247	0.0755	1.6510	0.1056						
Ln SEIFA	-0.1511	0.1674	-0.9020	0.3716						
Ln Revenue	-0.0731	0.0557	-1.3110	0.1965						
% Nets inshore	0.0203	0.4570	0.0450	0.9647						
% Nets offshore	-0.0702	0.6600	-0.1060	0.9157						
% Line inshore	0.1333	0.6191	0.2150	0.8304						
% Line offshore	0.4866	0.5159	0.9430	0.3506		0.2742	0.1778	1.5420	0.1288	
% Pots	0.1606	0.4751	0.3380	0.7369						
% Trawl	0.6240	0.4235	1.4730	0.1475		0.4518	0.1280	3.5290	0.0009	***
% Other	-0.3009	0.4819	-0.6240	0.5354		-0.3765	0.1575	-2.3910	0.0203	**
Zone2 (Central Qld)	-0.0914	0.1566	-0.5830	0.5625						
Zone3 (Southern Qld)	-0.3131	0.1751	-1.7880	0.0804	*					
R-squared	0.365					0.304				
Adjusted R-squared	0.228					0.266				
F	2.426					7.988				
Pr(>F)	0.016					0.000				
AIC	61.853					51.445				

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 15. Linear model of factors affecting production multipliers

	Full model					Reduced form				
	Estimate	Std. Error	t value	Pr(>|t|)	Sig	Estimate	Std. Error	t value	Pr(>|t|)	Sig
Intercept	4.4080	4.5930	0.9600	0.3420		1.9091	0.1536	12.4320	< 2e-16	***
Population	0.0000	0.0000	0.6610	0.5120						
SEIFA	-0.0028	0.0045	-0.6210	0.5380						
Revenue	0.0000	0.0000	0.9650	0.3390						
% Nets inshore	0.2355	1.2080	0.1950	0.8460						
% Nets offshore	0.2666	1.6610	0.1600	0.8730						
% Line inshore	0.1666	1.6400	0.1020	0.9200						
% Line offshore	0.8778	1.3590	0.6460	0.5210		0.5976	0.4313	1.3860	0.1714	
% Pots	0.4951	1.2510	0.3960	0.6940						
% Trawl	1.0540	1.1260	0.9350	0.3550		1.0979	0.3104	3.5360	0.0008	***
% Other	-0.3039	1.2760	-0.2380	0.8130		-0.6814	0.3819	-1.7840	0.0799	*
Zone2 (Central Qld)	-0.3055	0.3948	-0.7740	0.4430						
Zone3 (Southern Qld)	-0.8002	0.5543	-1.4440	0.1560						
R-squared	0.335					0.266				
Adjusted R-squared	0.161					0.226				
F	1.930					6.653				
Pr(>F)	0.055					0.001				
AIC	168.176					155.967				

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

The final models both only explained less than a quarter of the variability in the estimated vessel level multipliers. The remainder of the variability may reflect either measurement error (i.e. fishers' estimates of how much of their inputs were sourced locally in some cases may have been incorrect) or reflect variation in individuals' preferences as to where they source their inputs (some may choose to source locally, while others choose to source from outside the region).

Given these model results, generic estimates of the average multipliers (and their standard errors) for each gear type could be derived (Table 16). The corresponding 95% confidence intervals associated with these multipliers are shown in Figure 34. The confidence interval ranges in Figure 34 are largely consistent with the observed ranges from the individual vessel data (Figure 32). The means and ranges are also similar for both models.

Table 16. Mean and standard error for gear type multipliers

	Nonlinear model		Linear model	
Gear type	ln(mean)	ln(se)	mean	se
Nets inshore	0.5800	0.0633	1.9091	0.1536
Nets offshore	0.5800	0.0633	1.9091	0.1536
Line inshore	0.5800	0.0633	1.9091	0.1536
Line offshore	0.8542	0.1573	2.5067	0.3815
Pots	0.5800	0.0633	1.9091	0.1536
Trawl	1.0318	0.1114	3.0070	0.2701
Other	0.2035	0.1439	1.2277	0.3490

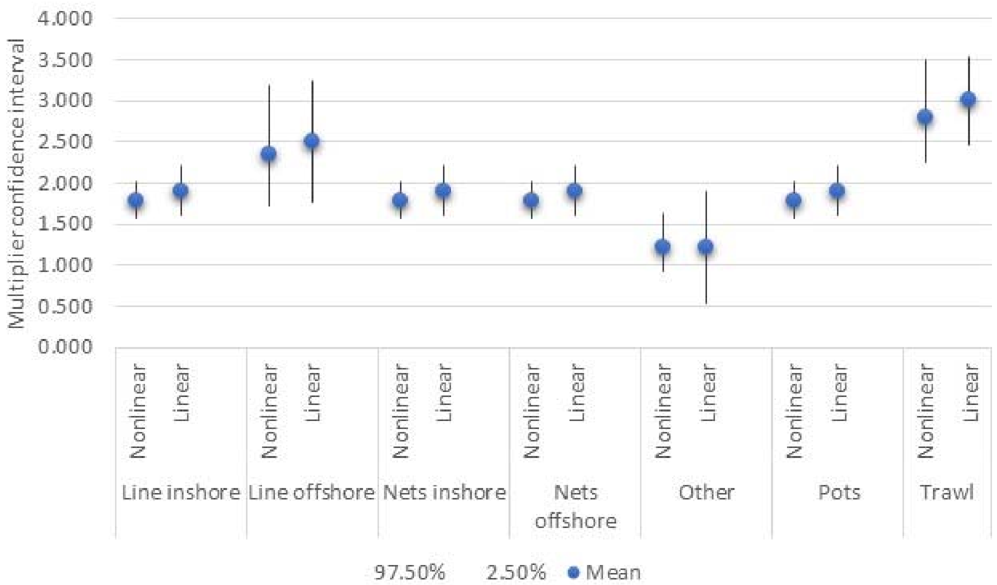

Figure 34. Average and 95% confidence interval for the multipliers by gear type

Consumption multipliers

Fisheries production also generates income for both the skipper/boat owner and crew. Much of this income is spent on day-to-day household requirements (Figure 26), much of which is sourced locally (Figure 35).

As with the fisheries production multipliers, consumption multipliers can be derived from the expenditure information (Figure 36). These are not related to fishing activity per se, so are not presented by fishing gear. However, they generally have a similar range as the production multipliers estimated earlier. Median values of the multipliers are fairly similar along the Queensland coast, although the range appears wider in Central Queensland. T-tests of the differences between the Zones, however, found no significant difference, suggesting that they all are sampled from the same normal distribution (Table 17).

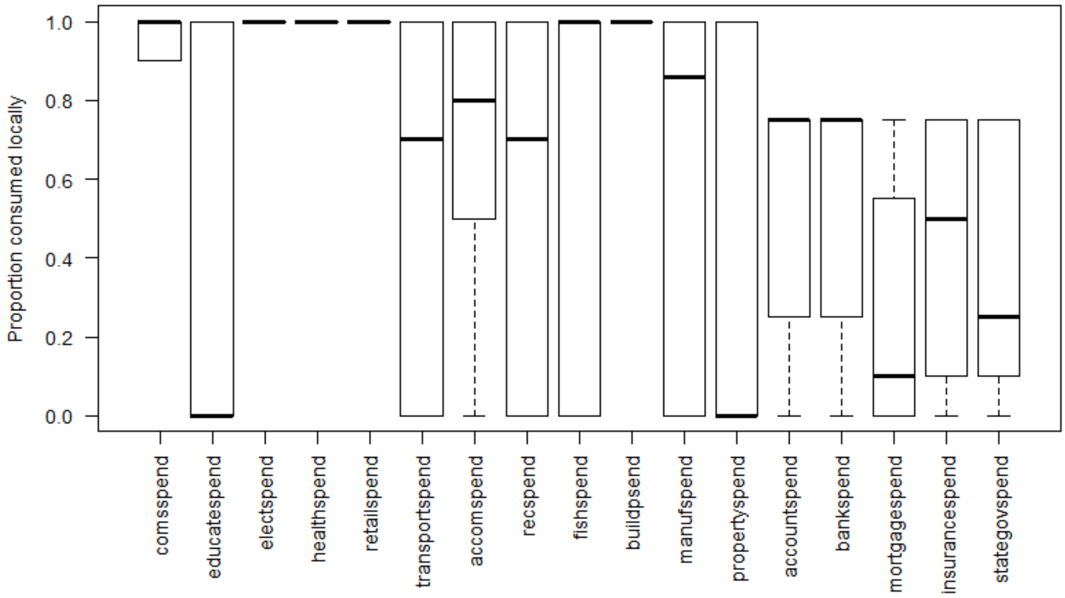

Figure 35. Proportion of personal household expenditure spent locally

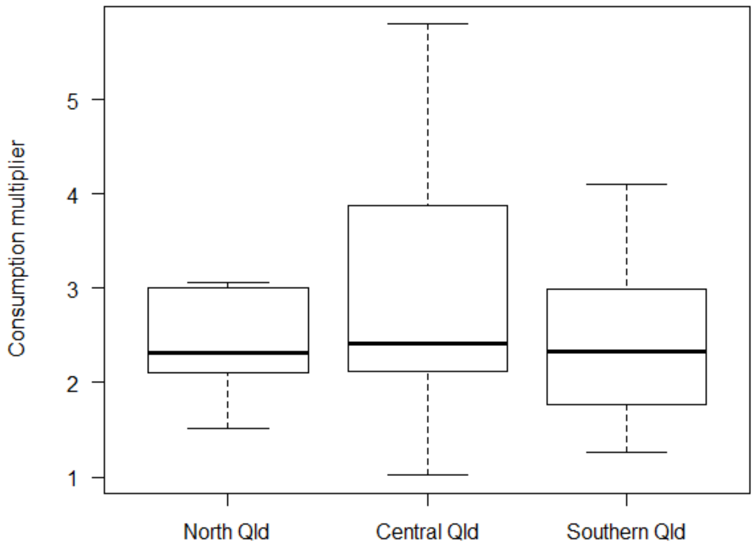

Figure 36. Derived personal household expenditure multipliers

Table 17. Comparison of zonal multiplier distributions using a t-test

Zone X	Zone Y	t-value	p-value
North Queensland	Central Queensland	-1.1318	0.2636
North Queensland	Southern Queensland	0.0866	0.9316
Central Queensland	Southern Queensland	1.1522	0.2551

Given this, the expenditure multipliers can be assumed to be the same for the whole Queensland east coast, with a mean of 2.937 and standard error of 0.2024, giving a 95% confidence interval of 2.541 to 3.334.

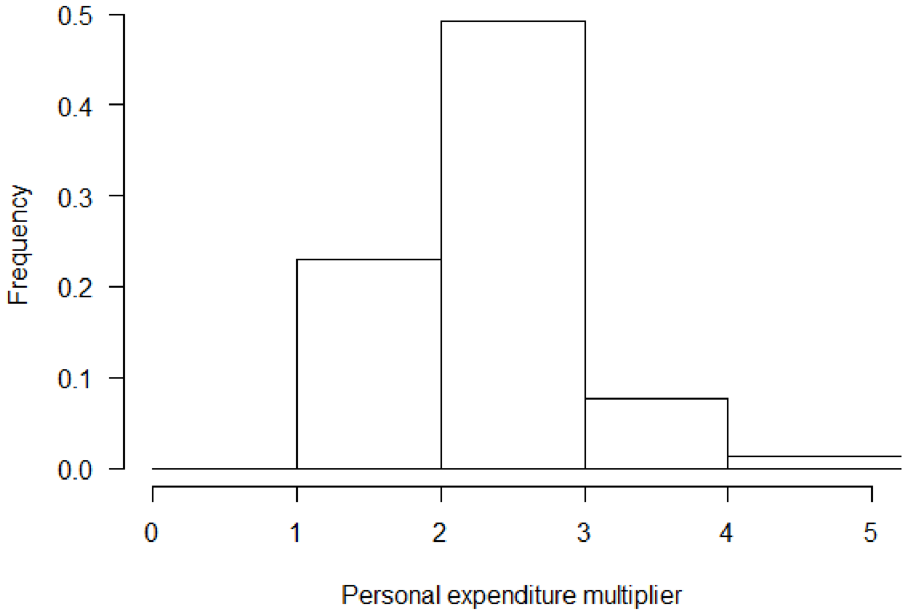

Figure 37. Combined distribution of the personal household expenditure multipliers

Example of potential regional impacts

An example of the potential additional benefits from fishing is derived for inshore fleet operating in the Cairns region for 2013-14. Catch of each species by gear type was available through the QFISH database (http://qfish.fisheries.qld.gov.au/). As the database does not distinguish between inshore and offshore fishing activities, an estimate of inshore activity was made through removing species caught predominantly in the offshore fishery. Queensland price data for the main species were available from ABARES (Stephan and Hobsbawn 2014).

Based on this, the GVP for the inshore fishery was in the order of $1.9m, with most deriving from net and line fishing (Table 18, Figure 38). In contrast, additional activity generated though both production and consumption (i.e. due to the incomes generated) ranged from between $2.7m to $4.7m, with a most likely value of around $3.7m. Combined, the inshore fishing industry in the region is responsible for generating over $5.6m – nearly three times the actual value of landings.

Table 18. Estimated GVP and additional benefits from the inshore fishery ($'000), Cairns Region, 2013-14

	Pot			Net			Line		
	lower	mean	upper	lower	mean	upper	lower	mean	upper
GVP		173			1009			723	
Additional production	105	157	209	613	917	1221	440	658	875
Additional consumption	93	117	141	1072	1348	1625	435	546	658
Total beyond GVP	198	274	350	1686	2266	2846	874	1204	1534

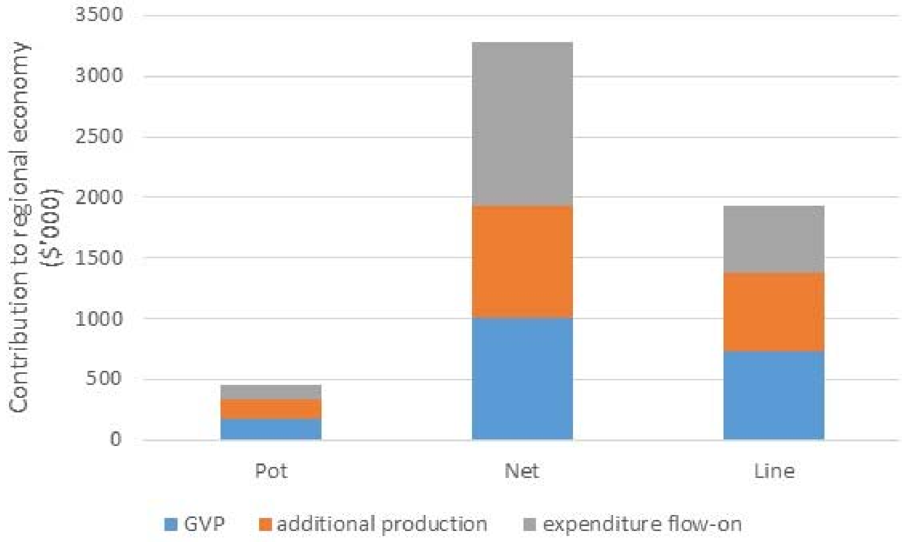

Figure 38. GVP and additional value generated, inshore fisheries, Cairns Region, 2013-14

Consumer benefits of local seafood

From the literature, there is evidence that consumers benefit from having access to locally produced products (Yue and Tong 2009; Holmes and Yan 2012; Roosen et al. 2012; Meas et al. 2015). The aim of this part of the project was to assess these benefits.

As detailed in the methods section, a choice experiment was developed to assess the lively consumer benefits from having locally caught fish available. Previous studies, mostly in agriculture, had been reviewed to identify potential attributes for inclusion in the choice set.

Local supply of seafood

In the fisher survey used to estimate flow-on effects to local communities, fishers were also asked where they sold their catch. While there was wide variability in individual responses, on average the inshore fleets (net and line) tended to sell between half and 60% of the catch locally, either directly to the public or local retail outlets (fish and chip shops, restaurants etc.) or to a wholesaler/agent who also sold the product locally (Figure 39).

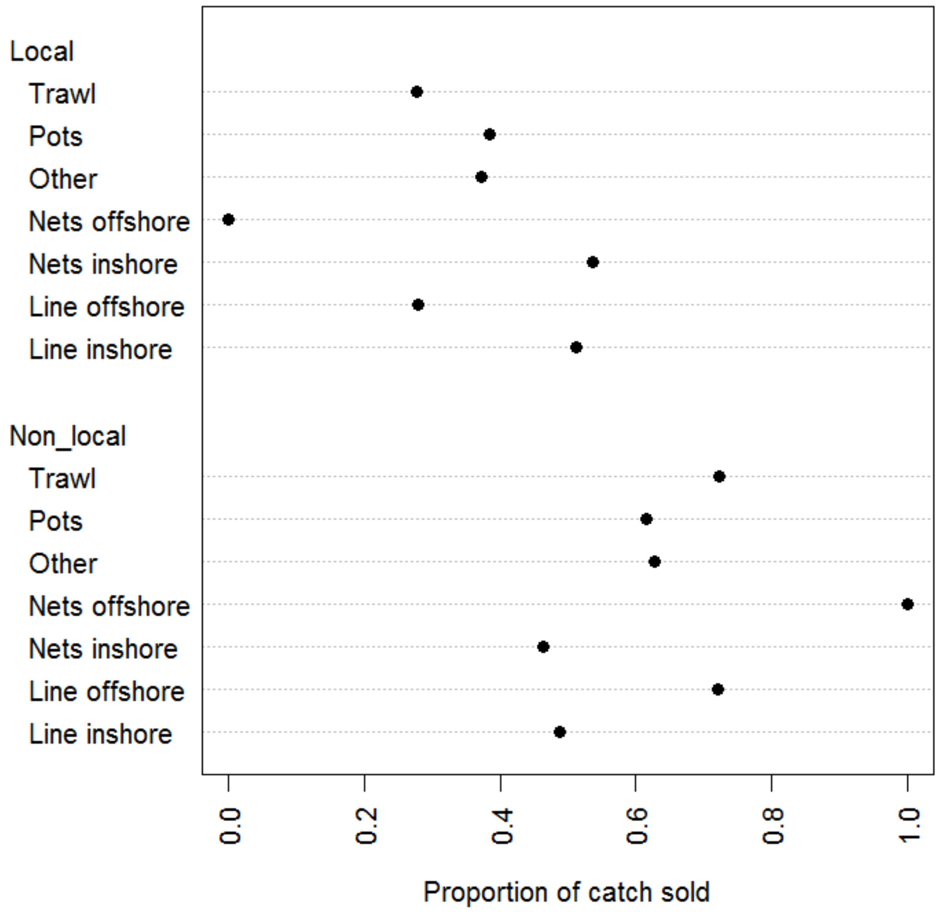

Figure 39. Final destination of catch

In contrast, fleets operating mostly offshore (nets, lines and trawl) tended to sell most of their product outside of the area (or to agents who subsequently sold it outside the area). Many of the products from these fisheries are aimed at the export market (e.g. prawns, coral trout) and major metropolitan markets.

Choice set attributes and scenarios

Undertaking a choice experiment to measure the benefits to consumers of locally caught fish requires determining an appropriate choice set containing a range of attributes, and a realistic scenario to present to potential survey respondents.

Given the large number of potential fish species for sale along the Queensland coast, each with differing prices, sold in different outlets (e.g. some in supermarket, some in fish and chip shops), it was decided to develop the scenarios and corresponding choice sets for one species – barramundi. Barramundi is a key species in the Queensland inshore net and line fisheries, and is caught commercially throughout Northern Australia (Figure 40). It is also widely available in supermarkets, fish and chip shops, cafes, restaurants and fish mongers along the Queensland coast. A previous study had also identified a strong preference for locally caught barramundi (Calogeras et al. 2011), although this previous study did not quantify the value of these preferences.

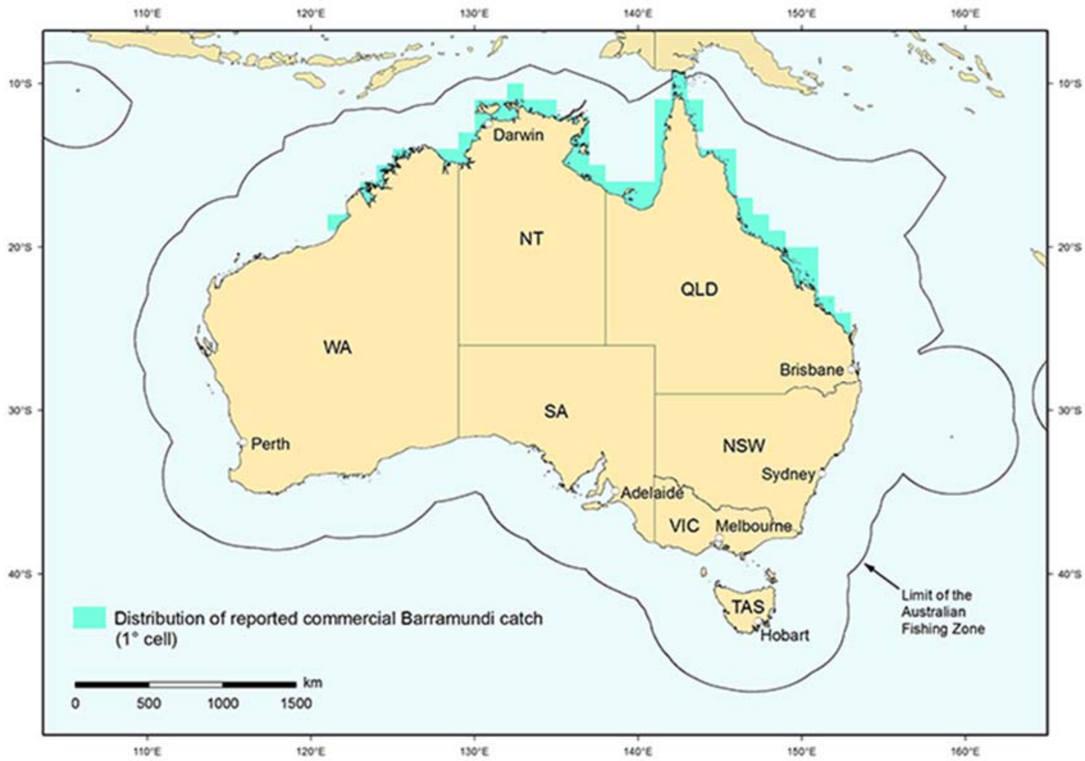

Figure 40. Distribution of commercial barramundi catch
Source: www.fish.gov.au/Barramundi.aspx

Barramundi is also farmed (in Australia and internationally) and imported. Initially, the project team considered including mode of production (farmed or wild caught) in the set of attribute, as well as imported as an alternative origin. However, an informal survey of market prices in supermarkets and fish shops in both Brisbane and Townsville[5] by the survey team found that there were considerable price margins already between wild caught Australian fish and farmed or imported barramundi. Given that the focus of the research project is on the value of local fisheries, it was decided to limit the options to fresh, wild caught barramundi only.

[5] This involved project team members visiting their local supermarkets and fish shops and reporting the prices for barramundi by origin. Labelling laws requited all imported barramundi to be labelled as such. Farmed barramundi was also usually labelled, and usually there was a choice between farmed, imported and wild caught barramundi in the larger supermarkets.

The key attributes used in the choice experiment are presented in Table 19. Price levels were based on the observed ranges of prices for fresh wild caught barramundi during the informal survey of local retail outlets in Brisbane and Townsville. "Origin" was specified as produced locally, produced in Queensland or produced in Australia. A freshness attribute was also included, following Darby *et al.* (2008), who suggested that consumers value the locally grown aspect of a product independently to a freshness guarantee. Adding this attribute separates out these effects to gain a better estimate of the value of local origin. In the survey, the freshness guarantee was specified as being less than 24 hours old. Sustainability is also believed to affect consumer preferences, with the Marine Stewardship Council in particular advocating market benefits of sustainability certification, supported by evidence that certification can result in a price premium (Roheim *et al.* 2011).

Table 19. Fish attributes selected for the choice experiment

Attribute	Attribute levels
Price ($/kg)	$40, $42, $44, $48, $50
Sustainability:	from a source accredited to be sustainable not specified
Freshness:	Guaranteed fresh not specified
Origin:	Produced locally Product of Queensland Product of Australia

The choice experiment requires a 'realistic' scenario to try and avoid hypothetical bias. In this case, the scenario developed by the project team involved the respondent hosting a dinner party for friends, and requires fresh barramundi fillets for their recipe:

> *"You have friends coming for dinner and you have found a good recipe requiring fresh barramundi fillets. We have chosen barramundi for the scenarios as it is widely available in Queensland, is both farmed and wild caught in Australia, and is also imported. It is also very tasty. In the scenario, however, we are only considering Australian wild caught Barramundi, as we are most concerned about differences due to sustainability, freshness and distance from where caught.*
>
> *You have four local fish retailers who each stock fresh barramundi fillets sourced from a wild fishery. The retailers are all located side by side allowing you to see what is on offer in each before you purchase.*
>
> *The fish shops all source their fish from different suppliers, who also get their fish from different fisheries. Ana, Ben and Con all display the key characteristics of the fish they are selling, Deb does not. The prices in each shop may also vary. You are able to see what each is offering before deciding where you will buy your fillets."*

The key features of the scenario are that the fish shops are identical in appearance and adjacent, so that the consumer is able to make an informed choice as to which shop to buy from based on the information provided in each of the four shops. A purchase in at least one of the shops is required each time (there is no option not to buy from any of them – otherwise their dinner guests would go hungry!). The fourth shop (Deb) represents the status quo – offering the lowest price each time but not providing any information on where the fish is from or the characteristics of the fishery. The a priori assumption is that consumers who are not interested in any of the characteristics specified would always choose Deb's shop. Individuals who are concerned about the freshness, sustainability or catch location will choose one of the alternative outlets provided the additional price is less than (or equal to) their willingness to pay for this characteristic.

The questionnaire (Appendix C) also asks questions about the socio-economic characteristics of the consumer, as well as their general preferences for seafood. These will be used to explain differences in willingness to pay not related to the characteristics of the fish.

Efficient survey design

Given the number of attributes in Table 19, there are 60 potential combinations [5*2*2*3] that each fish shop could present. A comparison of two fish shops could yield 1770 potential combinations [60*(60-1)/2]. Ensuring that all possible combinations were compared results in an unrealistically large number of comparisons to present to potential respondents.

An appropriate experimental design can provide sufficient information to derive the model parameters without requiring all possible combinations to be presented. A commonly used experimental design in choice experiments is the D-efficient design. Given the functional form of the final model, and prior estimates of the parameter values, the combinations required to minimise the potential errors in the model can be estimated. In this case, we imposed parameter values of either plus or minus 1, reflecting the expected signs on the parameters (but naïve estimates of the parameters). We also imposed a restriction that the final set should consist of 4 blocks of 6 choice sets (i.e. 24 choice sets in total).

A D-efficient design was derived using NGENE (Choice Metrics Pty Ltd 2012), a software package developed specifically to derive optimal choice sets for choice experiments. An illustration of one of the four blocks produced by NGENE is given in Figure 41. In each case, Deb's seafood is the status quo – providing lowest prices without additional characteristics indicated.

Block 1

	Ana's	Ben's	Con's	Deb's
Origin	Local	Queensland	Queensland	Australia
Sustainability certified			Yes	
Freshness guarantee		Yes	Yes	
Price ($/kg)	$40.00	$44.00	$42.00	$40.00
I would buy (select one)	☐	☐	☐	☐

	Ana's	Ben's	Con's	Deb's
Origin	Local	Local	Australia	Australia
Sustainability certified	Yes		Yes	
Freshness guarantee		Yes		
Price ($/kg)	$44.00	$42.00	$42.00	$40.00
I would buy (select one)	☐	☐	☐	☐

	Ana's	Ben's	Con's	Deb's
Origin	Queensland	Australia	Local	Australia
Sustainability certified		Yes		
Freshness guarantee	Yes		Yes	
Price ($/kg)	$48.00	$42.00	$44.00	$40.00
I would buy (select one)	☐	☐	☐	☐

	Ana's	Ben's	Con's	Deb's
Origin	Queensland	Queensland	Local	Australia
Sustainability certified	Yes		Yes	
Freshness guarantee			Yes	
Price ($/kg)	$44.00	$40.00	$42.00	$40.00
I would buy (select one)	☐	☐	☐	☐

	Ana's	Ben's	Con's	Deb's
Origin	Australia	Local	Local	Australia
Sustainability certified	Yes	Yes		
Freshness guarantee			Yes	
Price ($/kg)	$44.00	$44.00	$48.00	$40.00
I would buy (select one)	☐	☐	☐	☐

	Ana's	Ben's	Con's	Deb's
Origin	Local	Queensland	Queensland	Australia
Sustainability certified	Yes	Yes		
Freshness guarantee	Yes			
Price ($/kg)	$44.00	$50.00	$42.00	$40.00
I would buy (select one)	☐	☐	☐	☐

Figure 41. Example of one block from the NGENE design

Survey responses and respondent details

An online survey company (the Online Research Unit) was commissioned to implement the survey, with a target sample of 1000 responses from Queensland. Although much of the Queensland population is based in Brisbane and the south east, the company aimed for a higher proportion of non-metropolitan responses to ensure a sufficient sample was obtained from coastal communities as well as the main metropolitan areas.

The distribution of overall responses is shown in Figure 42. As designed, a higher proportion of respondents were obtained from outside the Brisbane region. Over 90% of the respondents lived less than 100km from the coast, with 50% of these half living less than 20 km from the coast. The sample included a small proportion (4%) of respondents from inland areas greater than 200km from the cost.

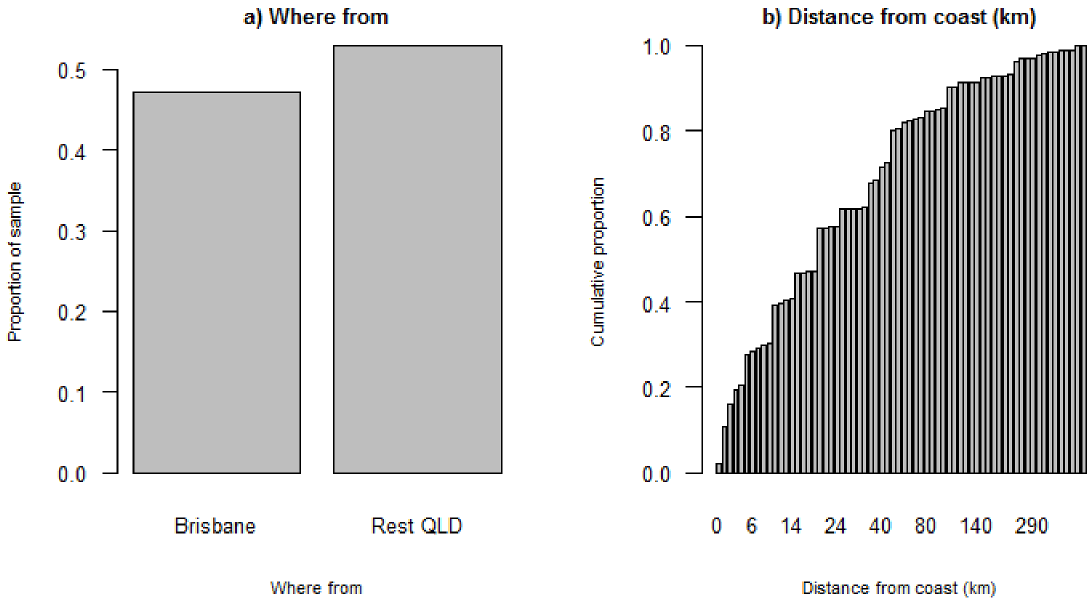

Figure 42. Distribution of survey sample

The sample was fairly well distributed by gender, with a higher proportion of females. A high proportion of respondents were either employed or retired. Incomes and ages were also well distributed (Figure 43). Comparing these with State level demographics is complicated, as the sample has been deliberately skewed to collect a higher proportion of non-Brisbane responses. Incomes in regional areas are believed to be lower on average than in the metropolitan areas, so the higher proportion of low incomes may reflect the deliberate sample skew. The higher proportion of female respondents, however, is unexpected. Quotas were not imposed in the sample to ensure a more balanced set of respondents. The possible effect of this on the results will be examined in subsequent sections.

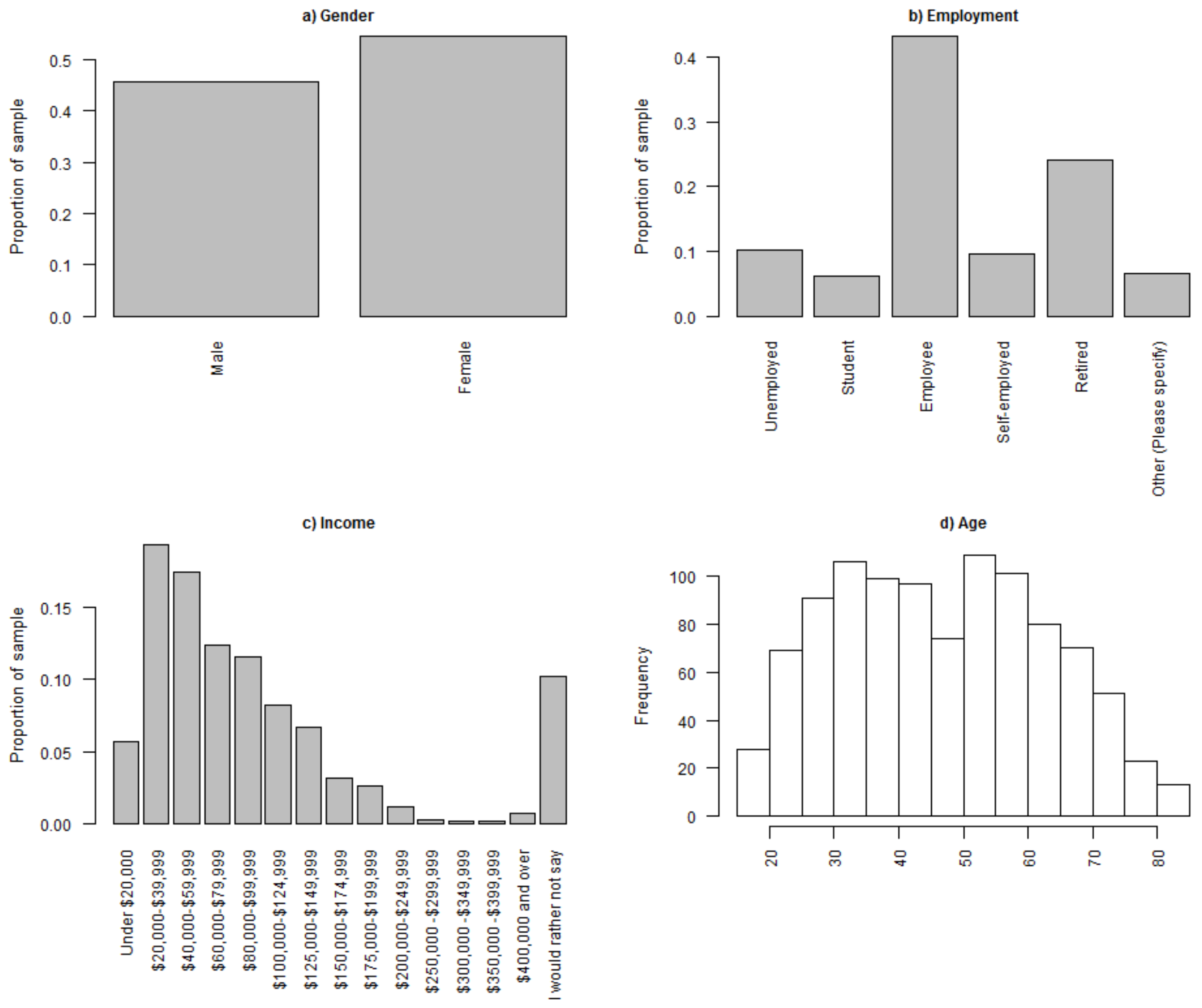

Figure 43. Sample demographics

Seafood consumption

Around 90% of the survey respondents ate seafood over the last 12 months, with most of these eating seafood at least once a week (and generally more frequently) (Figure 44).

Taste was the main reason for both eating and not eating seafood (Figure 45), i.e. people either liked seafood or they did not. Variety in the diet was also an important component of the decision to eat fish. Despite the reported health benefits of seafood (e.g. Daviglus *et al.* 2002; FRDC 2004; Larsen *et al.* 2011), this did not have a large influence on the propensity to eat fish. In the question asked to generate Figure 45, individuals were able to provide more than one answer, so the results suggest that health concerns were of interest to only around 30% of the sample.

Similar results have also been found elsewhere. For example, Trondsen *et al.* (2003) found that health concerns were not a main factor driving fish consumption (although many individuals in their sample also took fish oil supplements for health reasons). However, Trondsen et al. (2003) also found that issues such as price, difficulty in preparation and availability were main barriers to consumption, issues that were less relevant to the Queensland sample who did not eat fish.

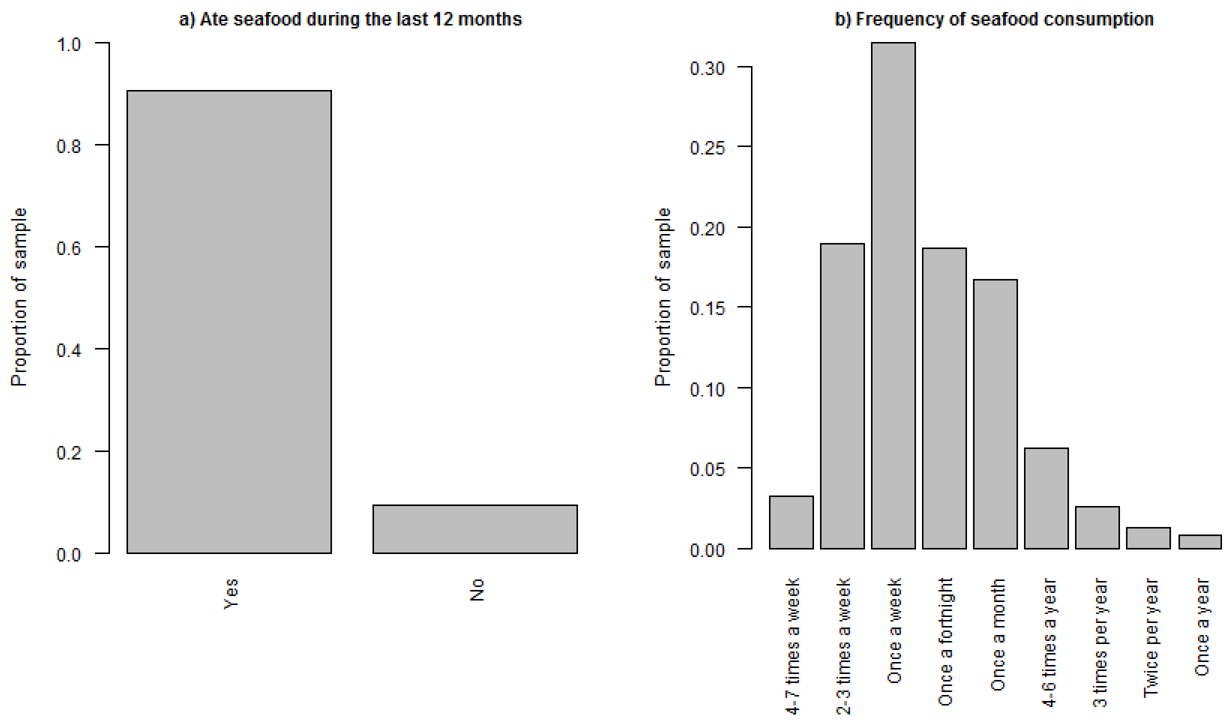

Figure 44. Seafood consumption of survey sample

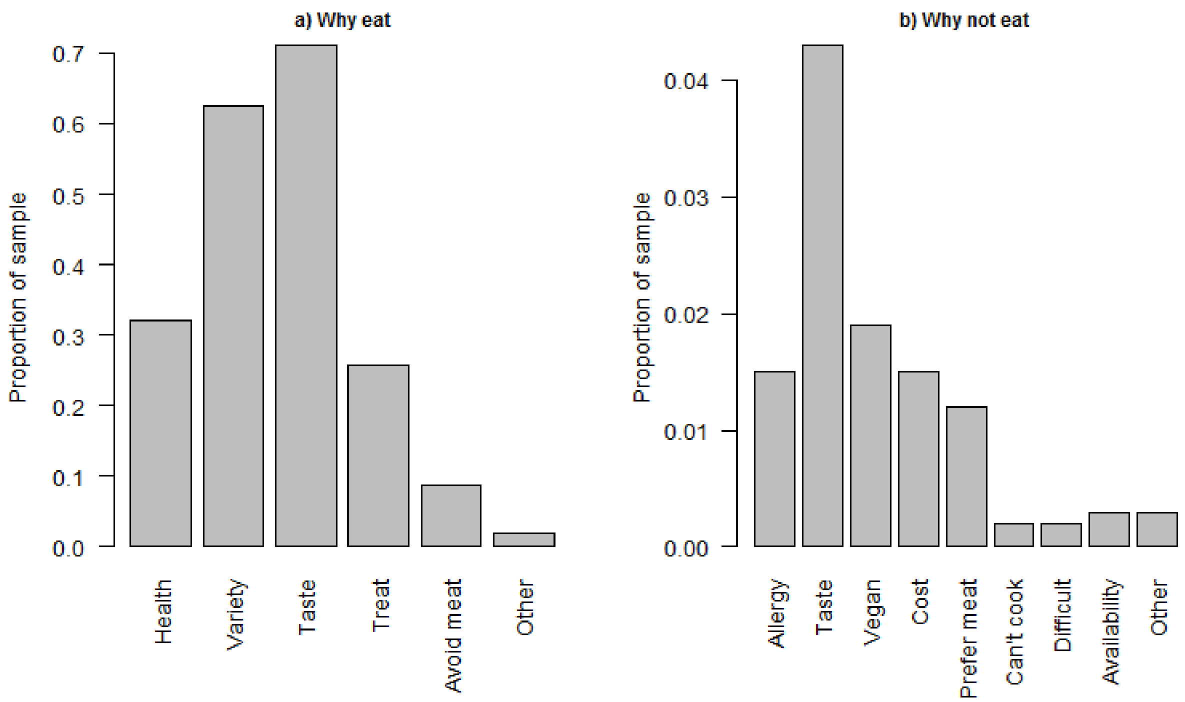

Figure 45. Reasons for a) eating seafood; b) not eating seafood.

About 90% of the sample bought fresh fish from supermarkets, with 80% buying fish at least once a month (Table 20). Most (85%) also bought fish from a fish monger, although this tended to be less frequent than supermarket purchases. Less than half of the respondents bought fish direct from the fisher, and around one quarter bought fish through the internet.

Table 20. Purchases of fresh fish from different outlets

Frequency	Supermarket	Fish Monger	Direct	Internet
Never	11.4	18.9	55.2	79.4
4-7 times a week	1.5	0.9	0.7	0.9
2-3 times a week	4.9	3.4	2.8	2.4
About once a week	20.5	13.3	5.9	4.4
About once every 2 weeks	13.3	11.7	3.5	2.2
About once a month	22.1	14.7	7.5	4.4
About 4-6 times a year	11.8	11.8	5	2.9
About 3 times per year	6.5	9.9	4	1.3
About 2 times per year	4.7	7.2	5.6	0.7
About once a year	3.4	8.3	9.7	1.3

Note: Based on responses from only those who ate seafood in the last 12 months

For most of the sample, the origin of the fish purchased was fairly important (Figure 46). The median importance was similar across all retail outlets, although a much wider distribution of importance scores was observed for the internet purchases. Only the importance scores of those who actually purchased fish through these outlets were included. While some individuals placed very low scores on the importance of origin for all outlets, for most consumers the origin was fairly important.

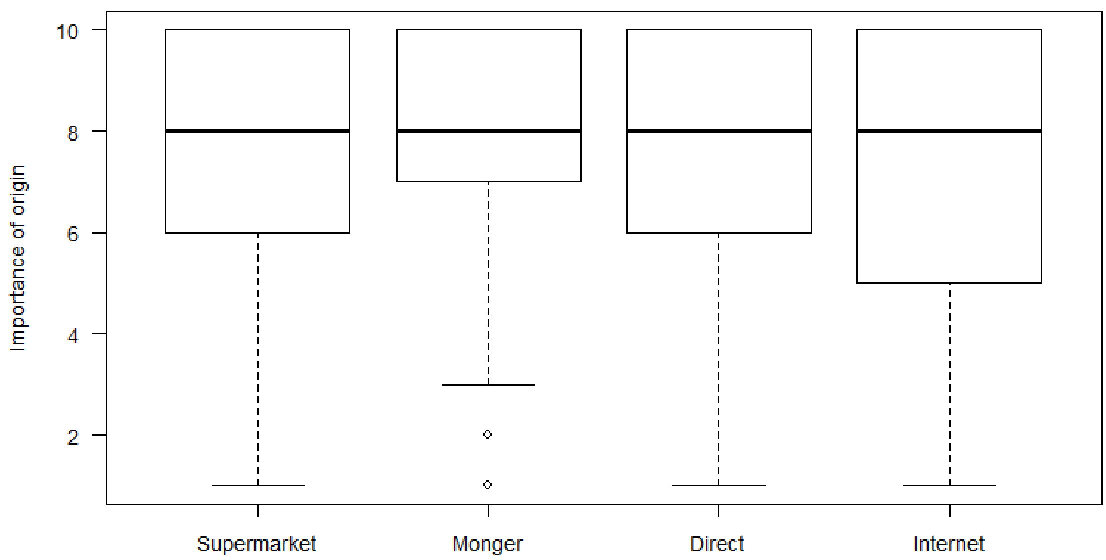

Figure 46. Importance of origin of fish, purchasers only

Almost 90% of the survey respondents stated that they preferred to buy local product when available (Figure 47). However, the definition of 'local' varied considerably between the different respondents. While around 55% considered local to be less than 100 km from the retail outlet, over 30% considered local to be from anywhere in Queensland or Australia (Table 21). These perceptions are not closely associated with distance from the coast, although a greater share of respondents living more than 100 km from the coast (over 40%) considered local to be anywhere in Queensland or Australia, compared to around 30% of respondents living less than 10 km from the coast (Figure 48).

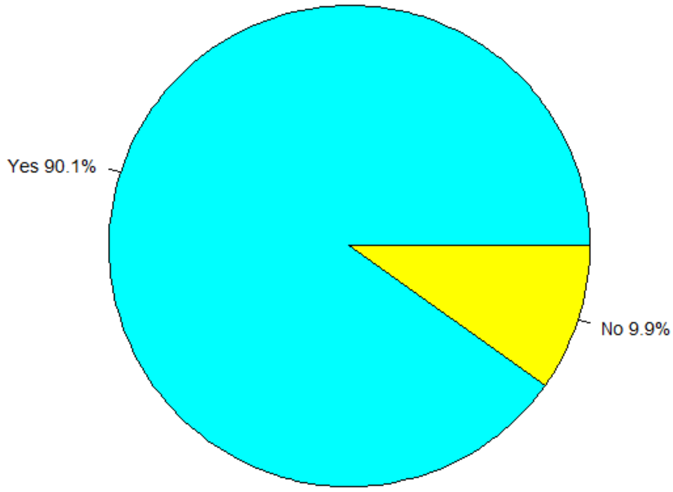

Figure 47. Prefer to buy locally caught product

Table 21. Perceptions of 'local' and how far the respondent lives from the coast

Distance considered 'local'	Distance live from the coast					
	<10	10-20	20-50	50-100	>100	Total
Within 50km of retail outlet	14.6	4.3	5.8	2.1	1.6	28.4
Within 100km of retail outlet	9.7	5	8.4	1.9	2.2	27.2
Within 200km of retail outlet	4.6	1.6	1.9	0.3	1.2	9.6
Within 500km of retail outlet	0.7	0.7	0.1	0.9	0.3	2.7
Anywhere in Queensland	7.5	3.1	4.4	2.1	2.8	19.9
Anywhere in Australia	4.4	2.4	3.5	0.6	1.2	12.1

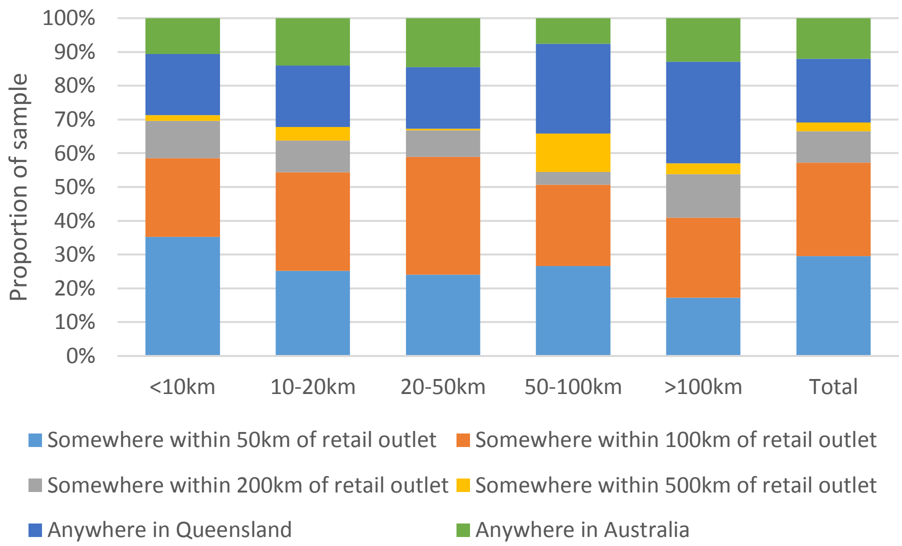

Figure 48. Perceptions of 'local' and how far the respondent lives from the coast normalised by relative sample size

The preference for local product was largely linked to a perception that it was fresher, and also a desire to support the local fishing industry (Figure 49). While minimising food miles was also important to some respondents, this was marginally (but not significantly) less important than the other two reasons, although the median score was the same for all three reasons examined.

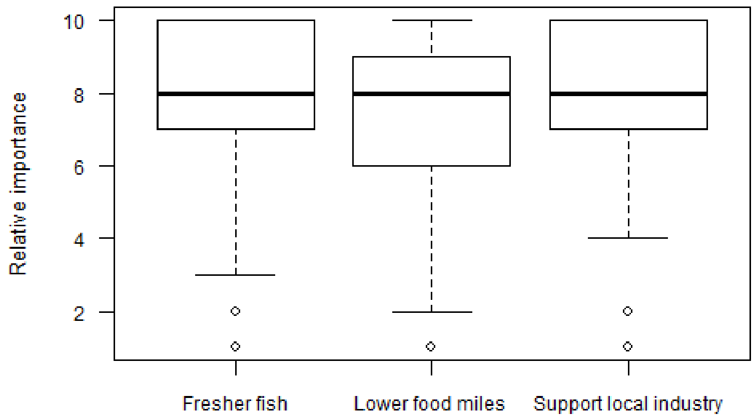

Figure 49. Reasons for preferring 'local' fish

Respondents were asked to identify up to three of the main species they purchased as fresh fish fillets at each outlet, and the results compiled to reflect the frequency of purchase. Salmon (i.e. farmed Atlantic salmon) was the main species purchased from all outlets, followed by wild barramundi and snapper (Figure 50). A wider variety of species are purchased online, although the total volume of this is relatively low.

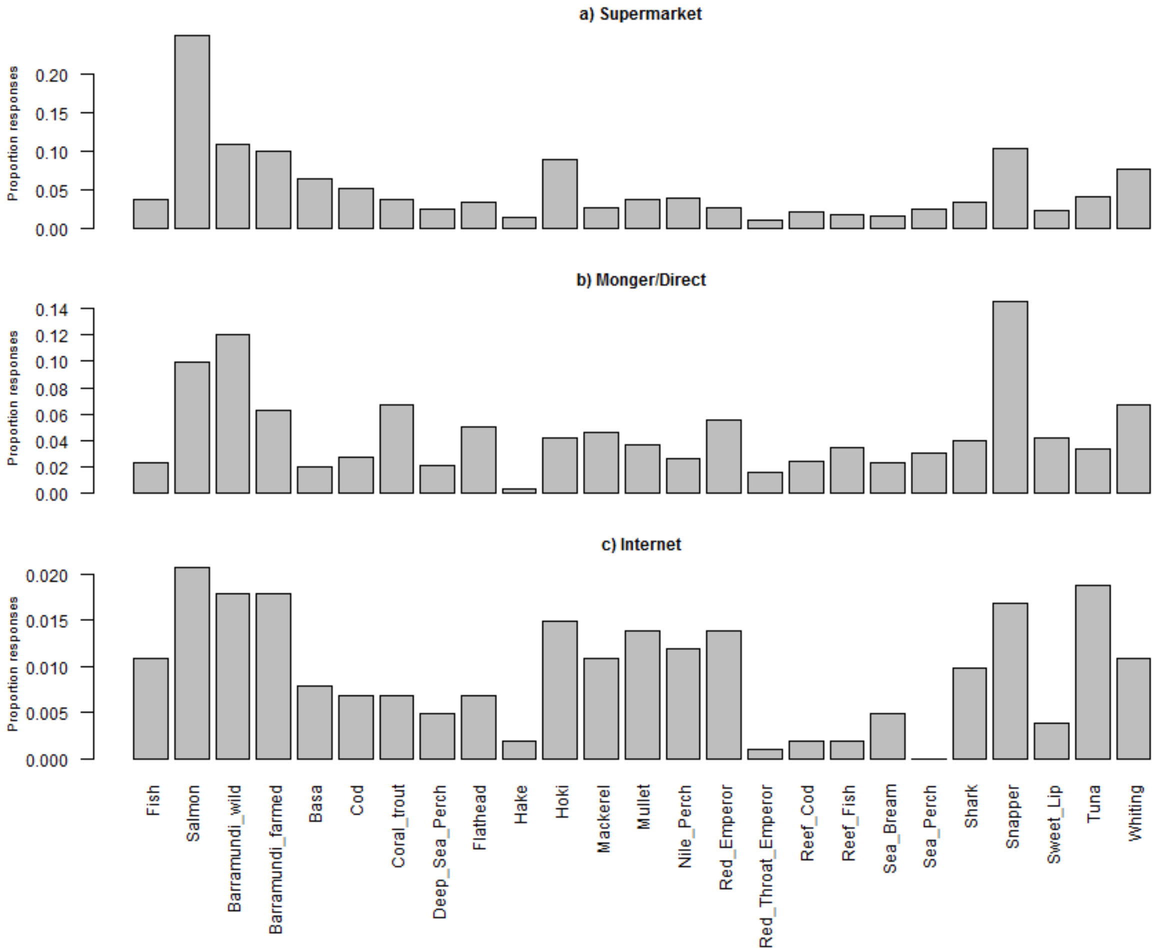

Figure 50. Key species purchased from each retail outlet

The top 10 species bought from supermarkets and fish mongers is shown in Figure 51 and summarised in Figure 52 in terms of Queensland content. As expected, respondents bought more Queensland wild caught fish from fish mongers, although around half of all fish bought from supermarkets were also sourced (or potentially sourced) from Queensland (Figure 53).

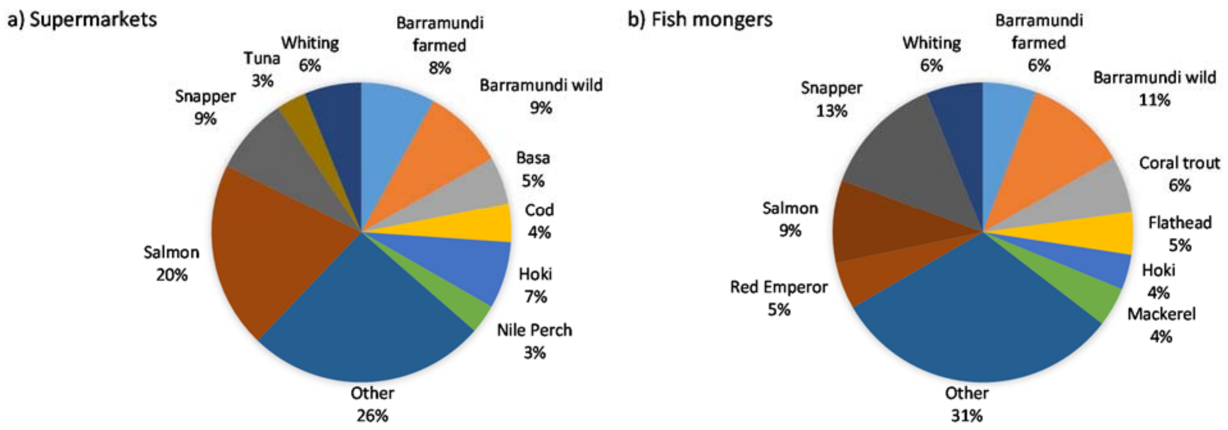

Figure 51. Top 10 species (plus 'other') bought from a) supermarkets; b) fish mongers

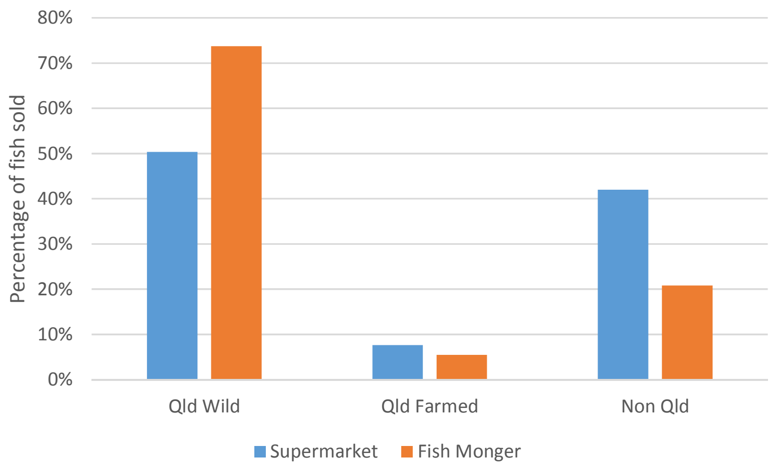

Figure 52. Queensland content of fish bought from supermarkets and fish mongers

Figure 53. Example of supermarket fish counter, Brisbane, displaying farmed and wild-caught Queensland fish

Choice model results

The underlying premise of choice experiments is that individuals will choose the option that is expected to maximise their individual utility, taking into account the cost of each option and the attributes presented. The choice can also be affected by the individuals' attributes.

Each respondent was presented with six choice sets, each containing four options with differing attributes. While the choices were labelled (i.e. with the name of the fictitious fish shop), these labels were unrelated to the attributes presented, with the exception of the fourth 'shop' that provided the same default attributes in each set (i.e. Australian product for $40/kg with no other information provided).The respondents were asked to choose one of the four shops to purchase from based on the attributes presented.

The respondents were also asked at the end of the process if they thought that the task was confusing. Eleven percent stated that they did find the process confusing. Despite this, the number of individuals that selected the same option every time (i.e. all six choice sets) was limited (Figure 54), a total of 18 out of 915 responses (i.e. people who had eaten fish). Relatively few chose the 'default' option ("Deb's fish shop"), indicating that most people were willing to pay a higher price for certain fish attributes.

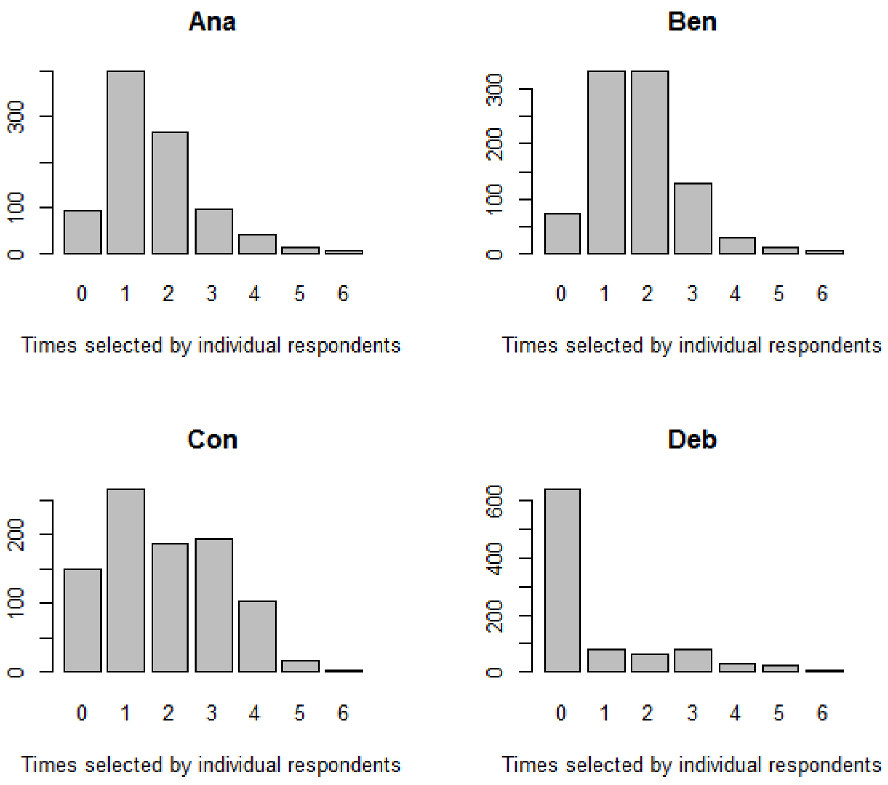

Figure 54. Distribution of the number of times a particular option was selected

Although around 10% thought the exercise was confusing, a substantially smaller proportion of individuals always chose only a single option, suggesting that 'confusing' may have more reflected difficulty in making choices rather than confusion as to the process. Consequently, all data were used in the subsequent analysis. A multinomial logit model was developed including the choice attributes (price, origin, freshness and sustainability) and individual specific characteristics (sex, age, distance living from the sea, a recreational fisher dummy variable, an urban dummy variable (i.e. lived in Brisbane), education level (included as a continuous variable from 1 to 5, with 1 being not finished high school and 5 being postgraduate qualifications), household income, commercial fisher dummy variable and a dummy variable representing membership of an environmental group (Table 22).

From Table 22, the price and alternative attributes were all highly significant. The alternative specific constants were not significantly different for alternatives 1 to 3 (i.e. Ana's, Ben's and Con's fish shops). This is as expected as, even though the choices were labelled, the attributes of the product sold were independent of the 'shop'. Despite being selected by relatively few respondents, alternative 4 (Deb's fish shop) was significantly different, this being the option with a constant low price and limited information. From the individual specific attributes, the probability of selecting alternative 4 decreased with age, income and if the respondent was female or a recreational fisher, but increased if the respondent was a commercial fisher or from Brisbane. This latter result was significant at only the 10% level, suggesting a weak at best relationship.

Table 22. Multinomial logit model results

	Original					Restricted				
	Estimate	Std. Error	t-value	Pr(>|t|)		Estimate	Std. Error	t-value	Pr(>|t|)	
2:(intercept)	0.199	0.226	0.879	0.379		0.429	0.186	2.314	0.021	*
3:(intercept)	-0.031	0.223	-0.138	0.890		0.121	0.183	0.661	0.508	
4:(intercept)	1.193	0.274	4.362	0.000	***	1.514	0.228	6.650	0.000	***
Price	-0.258	0.009	-28.891	0.000	***	-0.258	0.009	-28.881	0.000	***
Queensland	0.633	0.084	7.487	0.000	***	0.632	0.084	7.485	0.000	***
Local	1.138	0.073	15.491	0.000	***	1.135	0.073	15.463	0.000	***
Sustain	0.999	0.042	23.774	0.000	***	0.996	0.042	23.753	0.000	***
Fresh	1.542	0.043	36.272	0.000	***	1.537	0.042	36.219	0.000	***
2:sex	-0.125	0.090	-1.390	0.164		-0.151	0.089	-1.691	0.091	.
3:sex	-0.045	0.088	-0.510	0.610		-0.048	0.087	-0.551	0.582	
4:sex	-0.476	0.106	-4.499	0.000	***	-0.481	0.105	-4.582	0.000	***
2:age	-0.004	0.003	-1.479	0.139		-0.005	0.003	-1.697	0.090	.
3:age	0.000	0.003	0.062	0.951		0.000	0.003	0.051	0.959	
4:age	-0.017	0.003	-5.047	0.000	***	-0.018	0.003	-5.563	0.000	***
2:distance	0.000	0.000	-0.878	0.380						
3:distance	0.000	0.000	-1.023	0.307						
4:distance	0.000	0.000	1.108	0.268						
2:recfish	-0.041	0.092	-0.449	0.654		-0.081	0.090	-0.900	0.368	
3:recfish	-0.095	0.090	-1.052	0.293		-0.095	0.089	-1.068	0.286	
4:recfish	-0.438	0.112	-3.920	0.000	***	-0.480	0.110	-4.367	0.000	***
2:urban	0.093	0.088	1.049	0.294						
3:urban	0.018	0.086	0.213	0.831						
4:urban	0.179	0.104	1.719	0.086	*					
2:education	0.065	0.039	1.651	0.099	*					
3:education	0.062	0.039	1.621	0.105						
4:education	0.052	0.046	1.124	0.261						
2:income	-0.001	0.001	-1.044	0.296		0.000	0.001	-0.567	0.571	
3:income	-0.001	0.001	-1.623	0.105		-0.001	0.001	-1.048	0.295	
4:income	-0.003	0.001	-3.391	0.001	***	-0.003	0.001	-3.230	0.001	***
2:comfish	0.099	0.356	0.277	0.782		-0.026	0.347	-0.074	0.941	
3:comfish	-0.482	0.367	-1.313	0.189		-0.353	0.357	-0.989	0.323	
4:comfish	0.752	0.363	2.074	0.038	**	0.755	0.348	2.171	0.030	**
2:envgroup	-0.427	0.236	-1.810	0.070	*					
3:envgroup	0.262	0.214	1.223	0.221						
4:envgroup	-0.058	0.271	-0.216	0.829						
Log-Likelihood:		-5603.2					-5614.5			
McFadden R^2:		0.237					0.235			

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level

A restricted version of the model was also estimated containing only the variables which were significant at the 1% or 5% level (Table 22). However, the model was found to be significantly different than the unrestricted model using the likelihood ratio test ($\chi2$ =22.55). Hence, the original model was subsequently used for the willingness to pay analysis.

Table 23. Likelihood ratio test of restricted versus original model

	Model Degrees of freedom	Log Likelihood	Test Degrees of freedom	χ^2	$Pr(>\chi^2)$	
Original	35	-5603.2				
Restricted	23	-5614.5	-12	22.55	0.03	**

*** Significant at 1% level; ** significant at 5% level; * significant at 10% level

The willingness to pay (WTP) for each attribute was derived from $-\beta_a/\beta_p$, where β_a is the coefficient of the attributed of interest and β_p is the coefficient of the price variable. These are marginal values, and represent the additional willingness to pay for the good compared from one that has a base level of attributes, in this case Australian caught with no sustainability or freshness guarantee.

The estimated WTP for each attribute is given in Table 24. From this, Queenslanders are willing to pay around $2.45/kg more for Queensland caught barramundi, which represents a 6% increase over the base price used in the analysis. Locally produced fish attracts an additional value equivalent to 11% of the base price (or an additional 5% over the Queensland value). The greatest benefit is realised by ensuring freshness, with a freshness guarantee representing a benefit of 15% over the base price.

Table 24.Willingness to pay estimates

Attribute	WTP ($/kg)	Standard Error	% Premium
Queensland	2.45	0.33	6%
Local	4.41	0.29	11%
Sustainable certification	3.87	0.16	10%
Freshness guarantee	5.97	0.16	15%

What does this mean?

In the previous section we estimated the additional benefits generated by fisheries in the regional economy through production and consumption associated with additional income generated. We can similarly estimate the benefits to local consumers in Queensland, extrapolating the results from the above WTP estimates.

While information on GVP is available for the fishery, consumer benefits are relative to the retail price (rather than the price at first capture). Information on retail margins is limited, but are believed to be generally low for fish. Further, fishery GVP is generally based on whole fish, while retail prices are often in a different product form (e.g. fillets). Assuming that similar margins apply to all species, that all have a common conversion rate as barramundi (38%, http://www.chefs-resources.com/seafood/seafood-yields/), and comparing the base price ($40/kg) used in the study with the landed price for 2013-14 (derived from ABARES (2015)), we can derive a factor of 1.65 for landed to retail price. This factor is conservative as recovery rates from different species vary, with some higher than assumed here. Crab in particular is likely to have a high conversion rate from whole live to cleaned and cooked.[6]

We also assume that the premiums estimated in the choice experiment apply to all species equally. That is, an 11% premium for fish produced locally, and a 6% premium for fish landed in Queensland. We finally assume that all fish caught by Queensland fishers is sold in Queensland. Information collected in the fisher survey identified the proportion sold locally (Figure 39).

[6] A comparison of online retail prices for crab and the most recent landed price information suggests that an equivalent retail factor for crabs may be over 2.

Given these assumptions, and the results from the choice experiment, then total consumer benefits in Queensland from the inshore fisheries may be around $6m a year (Table 25). This figure is most likely an underestimate given the assumptions. This figure represents the additional value to Queensland from having locally or Queensland caught fish.

Table 25. Estimated benefits to consumers from the inshore fisheries ($'000), 2013-14

	Pot	Net	Line
Fishery GVP ($m)	28.8	13.6	3.4
% sold locally	40	50	50
% sold rest of Queensland	60	50	50
Retail GVP (estimated)			
• Local	19.0	11.2	2.8
• Rest of Queensland	28.5	11.2	2.8
Consumer benefits			
• Local	2.1	1.2	0.3
• Rest of Queensland	1.7	0.7	0.2
Total consumer benefits	3.8	1.9	0.5

Transferring the approaches to other fisheries

A principle objective of the study, other than assess the contribution of the Queensland inshore fisheries to the local communities, was to develop a template for a transferable method in order to assess the similar contributions in other fisheries.

To this end, the study considered several methods for assessing several different aspects of economic contribution. First, the study considered alternative methods to value the industry itself; second, the study applied methods for assessing the flow on effects of the industry to the local community and finally, the study assessed the additional non-monetary benefits associated with local production.

In this section, we review the findings more from a methodological perspective. That is, what worked well and what may be useful for future studies in other fisheries.

What is the value of the industry?

As with most resource based industries, the monetary value of production is not a good measure of the value of the resource stock or its contribution to the economy. Increased yields (and hence GVP) may arise through overexploitation in the short term, consuming natural capita (the fish stock) in the process. Conversely, decreasing yields to a more sustainable level may be seen as reducing the value of the industry, even though the discounted future value may be higher due to the enhanced sustainability.

Despite these shortfalls of GVP, some measure of industry value is often considered necessary. In fisheries and other rural industries, measures of GVP are used as the basis for both collecting research levies and allocating research funding. Relative GVP, imperfect as it is, is often used also as the basis for justifying the allocation of infrastructure expenditure between sectors.

The project considered alternative measures of industry 'value', based around finance related measures. These included the net present value of fishery profits, total capital invested in the industry and the total value of licences/quotas in the fishery. These measures also proved problematic, as they also reflected the effectiveness of management in generating economic value from the fishery. For example, low profitability may reflect management that is not focused on maximising economic returns. The overuse of input controls may impede the economic efficiency of the fishery even if enhancing resource sustainability. While this is not necessarily that case in the fisheries examined, it may arise elsewhere.

Similarly, total capital invested may be a misleading measure. A fishery that is overcapitalised may appear more 'valuable' than one which is operating at an efficient level of capital.

The total value of licences and quota ideally reflect the discounted expected flow of profits in the fishery. However, the implicit discount rate used by fishers in valuing the licences reflect confidence in the level of management as well as expectations of future returns. For example, the move to ITQs has seen a decrease in the implicit discount rate in NZ fisheries, such that licence values increased beyond that attributable to changes in profitability (Newell *et al.* 2005).

Given this, GVP is likely to remain the best of an imperfect set of measures of *direct* current fishery value, although consideration of benefits beyond GVP need to be considered in parallel to derive a measure of the overall contribution to the regional economy.

The study has also considered gross value added (GVA) as an additional measure of value. Gross value added represents the contribution of fishing to gross domestic product, and is a more appropriate measure of the contribution to the economy as a whole than GVP. This measure has not gained much interest in Australia, mainly as it requires detailed cost information as well as revenue, but is commonly used elsewhere as one of a set of measures of fishery value (which also includes GVP). For labour intensive fisheries, such as the Queensland inshore fisheries, GVA may represent a high proportion of GVP, and hence its contribution to the overall economy may be greater than fisheries (or other activities) with a larger GVP but more capital intensive operations.

The inclusion of GVA into the measure of economic performance of fisheries has potentially other benefits, such as estimating the benefits of fisheries management. A fleet reduction, for example, may result in lower levels of revenue (GVP), but potentially higher levels of income and fishery profits, and hence a higher GVA. Norman-López and Pascoe (2011) found this to be the case for several Australian fisheries that have moved to a maximum economic yield (MEY) target. Similarly, when considering resource allocation issues, GVA may be a better measure than GVP as the former better reflects the contribution of the sector to gross domestic product.

Current versus potential value?

The level of economic value produced by an industry is a function of the economic environment in which it operates. In fishing reduced costs, for example through fuel price reductions, may result in an increase in fishing effort and hence GVP even if fleet size and prices remain the same.

Fisheries often operate at less than full capacity for a large number of reasons. For example, breakdowns or adverse weather conditions may result in fishers operating less than their potential. Further, capacity utilisation is a technical measure of what could happen rather than what should – if the costs of fishing exceed the expected returns then fishers would not go fishing even if they potentially could (Tingley et al. 2003; Tingley and Pascoe 2005). In other cases, as is believed to be the case for many Queensland fishers, lifestyle choices may result in satisficing behaviour, such that fishers choose not to fish to their potential provided they achieve a given income. As a consequence, current GVP may not reflect the potential value of the fishery even at the same price and resource levels.

The study considered the use of data envelopment analysis (DEA) to estimate capacity utilisation and hence the potential GVP of the fisheries considered. DEA is usually applied at an individual vessel level. In this study, we applied DEA at the level of the fishing grid. The interpretation of efficiency and capacity utilisation in this case reflects the potential productivity of an area rather than an individual vessel. Low levels of capacity utilisation reflect either high costs of access (i.e. not near a major port) or potential low catch rates, while low levels of technical efficiency reflect more the quantity and composition of the catch in an area (reflecting the local stock abundance and composition). The 'unbiased' measure of capacity utilisation removes this latter effect, and hence provides a better estimate of how much catch could potentially increase given favourable changes in economic conditions.

The capacity utilisation measures are often reflective of the level of excess capacity in the fishery (Pascoe et al. 2003). This is not an appropriate interpretation in this case as the unit of assessment was the region rather than the individual vessel. However, it does provide an indication as to where potential gains can be made in the fishery, provided effort is available to increase in these areas if conditions become more favourable and assuming also that such catch increases would be sustainable.

Many areas in the inshore fisheries were found to be operating at a high level of capacity utilisation overall. However, the median capacity utilisation in most years was between 0.6 and 0.7 in the net fishery suggesting that there were many areas in which effort increases would be feasible. The pot fishery was operating at a much higher level of capacity utilisation, with the median capacity utilisation being around 0.8 in recent years. This suggests a low potential to expand output if economic conditions improved.

Such information is important when assessing the potential impact on fishing of other developments. For example, the economic impact of loss of fishing ground through port development may be underestimated if current production values are low due to prevailing economic conditions, rather than underlying stock productivity conditions. Changes in economic conditions (such as reduced fuel prices or higher product prices) may result in a substantially higher output in the future from these areas.

In general, an area with a high unbiased capacity utilisation but low efficiency score is unlikely to produce more output in the future. Conversely, an area with a high efficiency score but low unbiased capacity utilisation has substantial potential to increase under more favourable economic conditions. Consideration of these factors needs to be undertaken when assessing developments that may impact on areas of the fishery.

What is transferable to other fisheries?

The project analysed technical efficiency and capacity utilisation using the R software (R Core Team 2012). R was used as the main software throughout the project as it is freely available. The code, provided in Appendix D, can be readily adapted for other fisheries, provided similar spatial catch and effort information is available.

Measuring regional economic impacts

The impact of fishing on the regional community goes beyond the value of the landed product. Fishing requires inputs that are purchased either locally or from outside the region. The greater the proportion of inputs purchased locally, the greater the level of economic activity in the regional community.

Fishing also generates incomes in the region – to the skipper, owner and crew. In inshore fisheries, which are often less capital intensive than their offshore counterparts, crew payments and returns to the boat owner often comprise a substantial component of the inputs used. For example, (from Table 2), cash profits ranged from 46% to 60% of total revenue for the three inshore fleets considered. While these do not take into account non-cash costs (e.g. depreciation), capital levels in these fisheries are generally low (Table 5). While crew costs were, on average, generally low (due to a large number of vessels being operated solely by the owner), total incomes generated generally comprised over half of the total revenue generated (i.e. GVP). Much of this income is also potentially spent locally, further generating economic activity in the regional communities.

The impact of these factors on total economic activity can be estimated through production and consumption induced multipliers. These are generally estimated through input-output (I-O) analysis, which involves the generation of regional input-output models of the regional economy. A large number of such models have been generated for various Australian fisheries (Table 10), the results of which indicate that the multiplier effect varies from fishery to fishery. Studies in other industries have been based on computable general equilibrium (CGE) models. These are even more complex models that allow for the effects of changes in production in some industries to impact on prices of inputs and outputs, further impacting on production in other industries and the overall economic impact of a change. Such models do not generate multipliers as such.

The development of such models are not a trivial exercise. I-O and CGE models include all industries in a region. As the economic structure of different regions varies (some are more industrial, some are more agricultural, some are more urban etc.), a different model is required for each region. An alternative is to develop the model at a higher level (e.g. State or national level) and assume that common multipliers are applicable to all regions. Most CGE models are developed at a high level, although development of regional based CGE models (which interact with adjacent regions) has been undertaken (e.g. The Enormous Regional Model(Horridge 2012),http://www.copsmodels.com/term.htm).

Where regional models are developed, these are often based on larger national or state level models and scaled down using a series of indicators e.g. GVP of the local industries and location quotients based on relative employment rates (Flegg *et al.* 1995). Such national or State level models are developed infrequently, and many models are hence based on observed economic activity from several years previous. For example, the most recent national input-output table released by the Australian Bureau of Statistics relates to 2006-07, while the most recent Queensland specific table relates to 1996-97 – almost 20 years old! Further, the use of location quotients and other related scaling methods has also found to often result in misleading assumptions about the regional economy (Tohmo 2004).

The complexity and scale of these models also results in greater aggregation of the industries, including fisheries. While the models developed by Norman-López and Pascoe (2011) and EconSearch (2014) separate out a number of specific fisheries, most I-O models include fisheries at a much more aggregated level.

Although I-O and related models (e.g. general equilibrium models) are often considered the 'gold standard' for regional economic analysis, their complexity at (i.e. modelling the entire regional economy) means that their development is time consuming and potentially costly to develop accurate regional models. Further, the relevance to the current conditions is questionable in many cases.

The approach adopted in this study was an alternative method for approximating equivalent production and consumption induced multipliers developed by Stoeckl (2007). The approach is based on the traditional Keynesian multiplier which relates the multiplier effect to the inverse of the leakages in the economy, namely saving, imports and taxation. These can be derived for the fishing industry through a survey of expenditure, including how much of each item is purchased locally. Similarly, consumption induced effects can be estimated through collecting information on personal expenditure and how much of this was purchased locally, along with the level of income generated to crew and owner.

The approach, not previously applied to fisheries, resulted in similar estimates of multipliers as those derived in previous I-O studies in Australian fisheries, suggesting that they are reliable estimates. The approach has the additional advantage, however, in that distributions of impacts can be estimated, as expenditure patterns of fishers may differ by area, gear type and even between different fishers.

The approach does different from the traditional input-output analysis in one potentially important way, namely the assumption that local expenditure reflects local production. Where intermediate goods are imported into a region (e.g. fuel sold by the fuel retailer), then part of this expenditure is diverted out of the region. Hence, a dollar spent in a business that mostly imports its goods is considered the same as a dollar spend in a business where all the goods are produced locally.

While this difference seems theoretically significant, in practice it is less problematic. Derivation of regional input-output tables requires estimation of quantities of inputs produced locally and imported for all sectors of the economy. Deriving these estimates produces large margins for error that are generally not considered in the input-output analysis and multiplier derivation. Similarly, derivation of the interlinkages between the sectors are often derived through scaling down larger national or state based models, and their relationship with the actual interlinkages in the regions may be imprecise. Hence, while theoretically more robust at one level, input-output models may be very imprecise at an empirical level. In contrast, the method used in this study is empirically robust (as it uses actual data on purchases in the region) and has a direct link to the theory underlying the development of Keynesian multipliers.

What is transferable to other fisheries?

The analysis suggested that the production multipliers did not vary significantly between regions, with all inshore fleets having similar multipliers. Although the sample size was relatively small, the results were relatively consistent for the inshore fleets. Consumption induced multipliers were independent of gear type (all crew and owners need to eat!), and no significant difference was found between different regions.

Based on the results of this study, the lack of regional differences may mean that the multipliers can be immediately applied to other regions in the first instance. However, validation of this through additional studies in other regions would be beneficial, and would confirm whether or not the multipliers developed in this study can be generalised, or if regional specific multipliers are required.

The survey and associated R-code developed to analyse the results can be used in other States or regions to undertake similar studies. The results of this study suggest that, while the survey can be developed for an online platform, this may not be the best approach. In our study we used a combination of telephone and online platforms to obtain the information from individual fishers. Over time, as more fishers become familiar with online data collection, the online survey approach may be most cost effective.

Assessing consumer benefits

The third main component of the study was to identifying if benefits to consumers from having access to local product exist, and if so how much.

The potential for consumer benefits to exist from access to local seafood products has been identified in previous Australian studies (Calogeras et al. 2011) although these benefits were not fully quantified. Studies elsewhere also identified a general preference for local products, with consumers willing to pay more to access these products (e.g. Yue and Tong 2009; Meas et al. 2015).

In this study, we used a choice experiment approach to attempt to quantify the potential additional value that consumers place on having access to local produce, and why they have this value. Choice experiments are stated preference approaches, and rely on consumers honestly indicating their purchase decisions in a realistic, but still somewhat artificial, scenario. The alternative to stated preference approaches is to model real purchases of seafood with different characteristics and prices. However, data were not available to do this.

A limited observation based retail 'survey' of local fish mongers and supermarkets in Townsville and Brisbane and online retailers in Queensland was undertaken over a couple of weeks to determine appropriate price parameters for use in the choice experiment. This found substantially varying prices for the species of interest (in this case barramundi) with little indication as to the qualities of the product. Barramundi was chosen as the reference species as it is readily caught and available across the State, and is also produced outside of Queensland. While prices of imported and farmed fish differed from wild caught fish for potentially quantifiable reasons, the price of the wild caught barramundi also varied substantially across the State, with generally no information other than product of Australia.

The informal survey formed the bounds that were used in the choice experiment. The base price observed (mostly in Brisbane supermarkets and just labelled product of Australia) was around $40/kg; the highest prices observed were around $50/kg. While not labelled, presumably the more expensive fish had characteristics that justified their higher price, but may also reflect local supply and demand conditions (e.g. few alternative retailers, high income area etc.). Regardless of the reasons, the informal retailer survey suggested that willingness to pay for barramundi ranged generally from $40/kg to $50/kg.

As part of the study, we tried to identify what ‘local’ actually meant to most people. As would be expected, the perception of ‘local’ varied widely, from within 50km to somewhere in Australia (i.e. no imports). Regardless of the individual definition of local, most survey respondents indicated that they would prefer to buy local product if available. The response in terms of why they preferred local was also fairly equal; namely the assumption that it was fresher product, to support the local industry and also to reduce food miles. There is evidence to suggest that consumers perceive locally produced food, as food which was produced within a distance of 160km (Lim and Hu 2016).

This definition seems reasonable given our results, as a high proportion of respondents considered local to be within 100km of where the fish was sold.

The choice experiment specifically separated out the freshness attribute from the local label attribute to determine how much the preference for local product was driven by the assumption of freshness. Product source was identified as either local (undefined so implicitly reflecting the respondent’s interpretation of local), Queensland caught or product of Australia.

The results of our study suggest that a freshness guarantee attracts the highest price premium in Queensland, around 15%. Local produce attracts a price premium of around 11%. The strong preference for local produce reported elsewhere (e.g. Calogeras et al. 2011), therefore may partially reflect the assumption that local produce is likely to be fresher. However, on its own, local produce also attracts a substantial price premium, irrespective of the freshness guarantee.

Sustainability of the product was also included. Studies of sustainability labelling in seafood had been undertaken elsewhere and were often inconclusive. Those that had identified a price premium associated with sustainability certification suggested that these may be as between 14.2% (Roheim et al. 2011) and 20% (Uchida *et al.* 2014). In our study, we found that a sustainability certification only attracts a willingness to pay premium of around 10%, less than the previously cited international studies.

The study has assumed that the level of willingness to pay by consumers manifest themselves as consumer surplus – the non-monetary benefit reflecting the difference between what the consumers are willing to pay and what they are actually required to pay (the market price). However, it is also possible that retailers are extracting this additional willingness to pay in the form of higher prices for locally caught produce. In either case, additional value is generated locally – either monetary or non-monetary.

What is transferable to other fisheries?

The study used a readily identifiable species as the basis for assessing the potential consumer benefits of locally caught product being available on the market. The species was one of the most frequently bought across all retail outlets (supermarkets, fish mongers and online). The results were presented as a percentage premium assuming that they could be extrapolated to other species. In the first instance, these percentages could also be applied to fish in other regions.

Ideally, to validate the approach, a similar study could be undertaken in another region. A good candidate species may be flake (shark) in Victoria, as this is a common species purchased through fish mongers (mainly as fish and chips). The survey developed in this study can be readily modified for the Victorian (or other region) application. Similarly the R-code in the appendix would require only minimal modification if the same questionnaire was used.

Discussion

The overall aim of the project was to examine methods for assessing the economic value of commercial fisheries beyond their value of production (i.e. gross value of production or GVP). While GVP is commonly used to indicate the relative importance of an industry, this tends to ignore its impact on the regional community, and hence underestimate its true value.

From the introduction, the specific aims of the project were to:

- Determine the economic value of inshore commercial finfish and crab fisheries within Queensland east-coast regional communities;
- Model the flow-on economic value of inshore commercial fisheries;
- Determine the relative value of local seafood compared to non-local Australian or imported products; and
- Develop a transferable methodology template to measure the value of commercial fisheries to regional communities for a broader range of fisheries

This discussion section will focus on summarising the combined results under each of the first three of these objectives. A detailed discussion as to which components of the research can be transferred to other fisheries and how this was undertaken may be seen in the previous section. Similarly, methodological issues and limitations were also discussed in the previous section.

Economic value of Queensland inshore commercial fisheries

From the analysis, the combined economic value of the Queensland inshore commercial fisheries (pot, line and net fisheries) was in the order of $143m in 2012-13 (the most recent year for which data are available). The direct GVP of the inshore commercial fishery may contribute only one third of this (Figure 55).

The flow on economic impact associated with the fishery was estimated to be higher still, with production induced effects representing around $41m (29% of the overall value), and consumption induced effects contributing a further $33m (23% of the overall value). A high proportion of fishing inputs are purchased locally, while incomes generated are also mostly spent locally, contributing to the substantial additional economic flow-on effect.

The retail value added estimate is highly uncertain, and was based on comparing observed baseline retail prices for barramundi fillets with prices fishers received for their barramundi catch, taking into account average conversion factors from whole fish to fillets. From the very limited price observations (which were only undertaken to establish realistic price levels for the choice experiment), there was considerable variability in retail prices, particularly outside supermarkets. Other studies have found that about 17% of domestic, fresh seafood sales (by volume) are made through supermarkets, while around 40% of sales are through independent fishmongers (Spencer and Kneebone 2012). The remainder – 43% – is made through takeaway seafood outlets and other dining venues (e.g. cafes and restaurants) (Spencer and Kneebone 2012). Value added in these sectors is likely to be higher, although costs are also likely to correspondingly higher. While several studies on seafood value of chains in Australia have been undertaken, including one directly relating to barramundi (Howieson *et al.* 2013), these have not generally quantified the additional value added at each stage of the value chain.

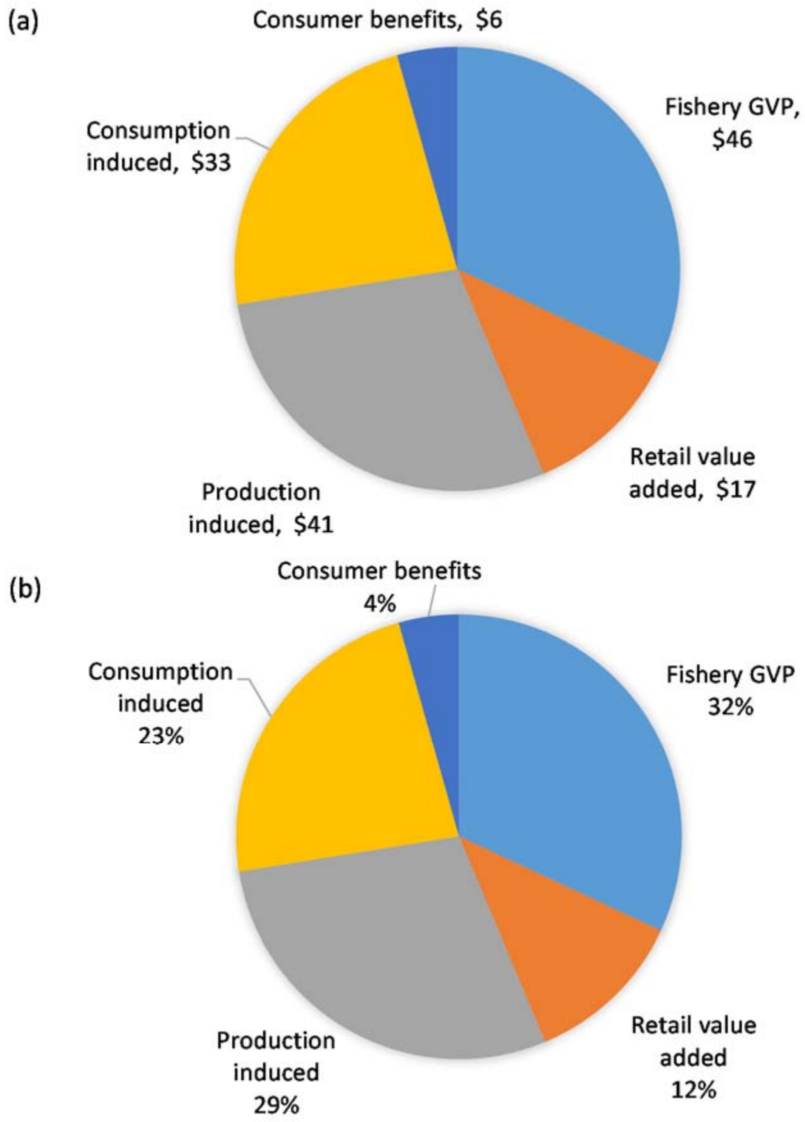

Figure 55. Sources of economic value generated by the Queensland inshore commerical fishery a) Millions of dollars (2012-13); b) percentage contribution

Based on the very limited analysis undertaken in the project, and the amount of product sold locally, the value added by the retail sectors may result in an additional $17m in economic value to the regional economies in Queensland from their sale of product from the inshore commercial fishery. As noted above, this is likely to represent an underestimate, as it was based on the lowest retail prices observed and related to supermarket prices with no origin other than product of Australia. This was used to establish the base prices for the analysis.

Our study on the value of local seafood to Queensland consumers found that people are generally willing to pay an 11% premium to have access to local product, and a 6% premium for product identified as caught in Queensland, even if not ‘local’. Based on the proportion of product identified by fishers as sold locally, with the assumption that the remainder was largely still sold in Queensland, this equates to a value of around $6m. Some of this value may have already been captured by retailers charging a higher price for local product, in which case it would add to the retail value added. As a result, the sum of the consumer benefits and retail value added represents the post-harvest benefits, although the exact share of each may be less certain.

Consumer benefits were less than originally expected, although not inconsistent with other studies in agriculture. For example, Meas et al. (2015) found price premiums in the order of 5-10% for local farm produce, and additional premiums for organic produce. The higher premiums for freshness guarantees and sustainability certification suggests that these may offer additional means to increase the value of the fishery beyond GVP (and potentially GVP if the benefits flow back to fishers).

From the capacity utilisation analysis, there is some potential for fishery GVP to increase given current stock conditions (e.g. if costs decrease), although most areas are operating at fairly high levels of capacity utilisation. From the analysis, GVP could increase by up to 10% with the existing fleet and stock conditions if all areas were operating at full capacity. This translates roughly into an additional $4.5m in direct GVP and as much as $14.3m to the regional economies as a whole, assuming similar levels of economic flow on effects.

What was not covered in the project in the end was a comparison between local, Australian and imported seafood. This was initially considered for the choice experiment, although the informal survey of retailers (predominantly supermarkets who often had barramundi sourced from several different areas on sale at the same time) demonstrated that quite substantial price differentials existed between wild caught, farmed and imported fish. These relationships would be best measured through econometric modelling provided sufficient data could be obtained. Including it into the choice experiment would have involved a much larger set of comparisons and price differentials, with an already known outcome in terms of the willingness to pay for wild caught product over farmed or imported. Consequently, the additional costs and complexity of including these would have added no additional benefits to the study.

Seafood consumption in Queensland

The survey of Queensland consumers also produced interesting results of relevance to the fishing industry, particularly in their future efforts to market their products. First, a high proportion of Queenslanders eat fish at least once a week, with many eating seafood more frequently. Further, most respondents also purchased fresh fish during the year, with most purchasing fresh fish at least once a month (many more frequently).

Most fish consumption was largely due to a preference for the taste of fish, or to add variety to the diet. Despite the often reported health benefits, few respondents suggested that was an important reason why they ate fish. Similarly, the comparatively small number of respondents who did not eat fish also suggested that the main reason was that they did not like it. Often reported reasons that it is too difficult to cook or that consumers do not know how to prepare it (e.g. McManus *et al.* 2012) did not seem relevant to Queensland consumers.

As noted above, a high proportion of respondents also expressed a preference for locally caught product. The reasons for this preference included assumption of fresher product, limiting food miles and supporting the local industry. These three reasons were considered highly important by most respondents, with fresher product and supporting the local industry slightly (but not significantly) more important than reducing food miles.

Finally, around half of all fish bought from supermarkets were species caught in Queensland. In contrast, 70% of fish bought from fish mongers were species wild-caught in Queensland. While the exact source of the fish is not known (as the survey was of the purchasers, not the suppliers), it does indicate a high preference of Queensland consumers for Queensland species, even if not locally caught.

Extending the analysis to other regions

Potentially, as noted in the previous chapter, many of the results of the study could be directly transferred to other regions. In particular, the price premiums (as a percentage) for local product are likely applicable to other regions. While estimated on the basis of premiums for local barramundi, this was only to ensure a well-recognised and commonly available species was used for the choice experiment to ensure the scenario was a realistic as possible. Potentially, the Queensland premium may also be similar to premiums for fish caught and sold within other States.

Similarly, the study estimated production and consumption multipliers for a number of different fleets. While there was some difference between different fleet types (e.g. trawlers compared with inshore boats), there was no significant difference seen between the different regions in the fishery. This also suggests that these multipliers may be more broadly applicable. Given that they were fairly similar to multipliers developed in other fisheries (using input-output analysis), this further suggests that they may be useful first approximations of value beyond GVP in other States.

The extent to which the values are actually transferable, however, cannot be known until a comparable set of values are developed elsewhere. Consequently, there is potential benefits in having a similar study conducted in another State to test the degree of transferability of the results.

Conclusion

The primary aim of the study was to assess the potential value of the Queensland inshore fishery to the regional economies in Queensland; to assess this value beyond just the gross value of landings. This was in response to growing concerns about increasing pressure on inshore fisheries as a result of coastal development, and loss of fishing area due to closures for conservation or recreational reasons.

The results suggest that total additional economic benefits to local industries and consumers in the fishery amount to almost $100m, compared to the direct GVP of around $46m. A substantial component of this arises through the additional incomes generated directly in the fishery and subsequently spent in the local communities.

A secondary objective of the project was to develop a transferable methodology that can be used on other studies. The approaches developed and applied in the study were chosen for their ease of transferability to other areas. In particular, the survey to estimate the economic flow on effects is transferable with minimal modification, while the survey to estimate the consumer benefits is also easily modified for other states or regions. Similarly, the spatial capacity utilisation analysis could be readily modified for application in other regions to help identify which areas are most critical to the fishery and which areas offer some opportunity for expansion, albeit at higher cost.

The results indicate that regional differences in multiplier effects are not significant, suggesting that, in the first instance at least, these multipliers may be used in other regions with similar vessel and regional characteristics. Further, the difference between the multipliers between the different inshore fleets were also not significant, further suggesting that they may be readily transferable to other inshore fisheries. The additional willingness to pay (as a percentage increase) may also be readily transferable to other fisheries.

Ideally, the extent to which these values can be transferred can be tested through undertaking a similar application elsewhere. If such a study yields similar results, then this would confirm the transferability of the results. If not, it will at least test the transferability of the methods.

Implications

The study has found that inshore fisheries have substantial economic benefits to the local communities beyond their immediate value of production. As mostly small businesses, the fishers purchase a high proportion of their inputs locally. Further, the role of labour is high in inshore fisheries compared with mode capital intensive offshore fisheries. The income generated is consequently high relative to the value of landings, and the effects of this on local community economic activity is considerable.

Measuring gross value added (GVA), which captures this income as well as other economic benefits generated by fishing, is generally not undertaken on a regular basis, namely as it requires information on costs of fishing that are not routinely available. Given that GVA is often high relative to GVP in inshore, labour intensive fisheries, there are benefits in particular for these sectors to provide cost data to allow such measures to be derived.

Such information are invaluable when assessing the potential impacts of coastal developments or resource allocation decisions that may result in loss of inshore fisheries production. While these may not be sufficient to necessarily stop development, the costs of the development will be better understood, and decision making can take place in a more informed environment.

Recommendations

The results of this study were focused on assessing the economic benefits to Queensland regions from the Queensland inshore fisheries. The methodologies that were developed and utilised were done so with the aim that they may be applied elsewhere. However, the transferability of these approaches cannot be confirmed without an additional study to test these approaches elsewhere.

Given this, there are merits in repeating the project elsewhere with the same methodology to:

1. Confirm that the methodology is readily transferable (with limited modification); and
2. Test the extent to which the results of this study are readily transferable (i.e. does a second study produce similar results).

Given that the methods have been developed (including analysis tools), the cost of modifying the surveys would not be substantial. From our study, however, support from the fishing industry representatives is essential in ensure sufficient response rates from industry.

Further development

This study focused only on the economic impacts of inshore commercial fisheries on the local communities. Social benefits,other than those related to consumption benefits, are not examined. Similarly, in areas where fishing has a strong link with the heritage of the area, the industry may also have heritage benefits that could potentially be measures in economic terms in a similar fashion as the benefits to consumers. Consequently, further benefits could be explored that were not considered in this study.

Extension and Adoption

The Queensland Seafood Industry Association (QSIA) and the Queensland Department of Agriculture and Fisheries (QDAF) have been represented at each of the working group meetings over the life of the project.

Conference presentations

Sean Pascoe, Samantha Paredes, Natalie Stoeckl, Renae Tobin and James Innes, Do seafood consumers value locally caught fish? IIFET 2016 Conference, Aberdeen, Scotland, July 2016.

Papers in preparation and target journals

Sean Pascoe, James Innes and Kieron Darth, Using spatial fishing data and DEA to inform spatial fisheries management, Target journal: *Asia-Pacific Journal of Operational Research: Special Issue on OR & the Environment* (submission target July 2016 http://www.worldscientific.com/page/apjor/callforpapers02)

Sean Pascoe, Natalie Stoeckl and James Innes, Estimating regional impacts of fishing based on fisher survey information. Target journal: *Regional Studies* (submission target July 2016)

Samantha Paredes, Sean Pascoe, James Innes, Renae Tobin, Natalie Stoeckl, Louisa Coglan and Carol Richards, Importance of local fish to consumers in Queensland. Target journal: *Journal of Consumer Marketing* (submitted July 2016).

Sean Pascoe, Samantha Paredes, Natalie Stoeckl, Renae Tobin, James Innes, Louisa Coglan and Carol Richards, Do seafood consumers value locally caught fish? Target journal: *Australian Journal of Agricultural and Resource Economics* (submission target July 2016)

Project coverage

The project was highlighted in the QSIA newsletter, requesting industry participation in the study.

Project materials developed

The project has developed surveys and analysis tools (written in R) which can be modified for use in other fisheries. These are included in the appendices.

Appendix A: List of researchers and project staff

CSIRO Oceans and Atmosphere	Sean Pascoe
	James Innes
James Cook University	Renae Tobin
	Natalie Stoeckl
Queensland University of Technology	Kieron Dauth (Student)
	Samantha Paredes (Research Student)
	Louisa Coglan (paper writing)
	Carol Richards (paper writing)

Appendix B: Questionnaires developed to estimate regional multipliers

1. Original online questionnaire
2. Revised telephone and online questionnaire

Beyond GVP: Economic value of Queensland commercial fisheries to local regions

This is the commercial fisheries' opportunity to demonstrate their value to the local economy.

The purpose of this survey is to estimate the flow-on effects to the local economy associated with your business. This includes the business based expenditure as well as your own private household expenditure. These types of expenditure are likely to be different, with subsequently differing regional benefits associated with fishing.

The survey is a follow up to the survey relating to the "Adapt or Fail" and "Beyond GVP" projects being run jointly by James Cook University and CSIRO. You have been contacted as you participated in this original survey and had agreed to undertake a follow up survey. The research is being funded by the Australian Fisheries Research and Development Corporation.

We will contact you in the next couple of weeks to again ask for your co-operation and record your answers over the phone. The aim of providing a paper copy of the survey is so that you are aware of the questions we will be asking, and hopefully will be able to pre-prepare your answers for when we phone.

As with the previous face-to-face and telephone survey, your responses will be confidential, and only aggregated information will be used. We will link the responses of these supplementary questions to your responses from the main survey, but will need to ask a couple of key questions similar to those you may already have answered just for clarification and validation.

The survey takes no more than20 minutes to complete and consists of 5 parts:
Section 1: We ask some basic questions about revenue, costs and fishing activities.
Section 2: We ask about your fishing business cost overview.
Section 3: We ask about your business expenditure location.
Section 4: We ask about personal income and expenditure.
Section 5: We ask about personal household expenditure location.

Please feel free to contact me (sean.pascoe@csiro.au) if you have any concerns or queries about the questions.

Section 1:Some basic questions about revenues, costs and fishing activities

In the first part of the survey, we will ask some basic questions about you and your business. We also need to estimate roughly how much of your total fishing revenue is spent as business expenditure and how much you retain as your personal income. Knowing this is important to determine regional flow on effects as business and personal expenditure patterns are likely to be different, but both contribute to the regional economy.

Some of the first couple of questions are similar to those asked in the earlier survey. This is just for clarification to ensure that both surveys are based on the same set of information.

1) Which local government area (LGA) do you live in?

This information is important to work out your local area. A key aim of the project is to determine how much economic activity is generated in your local area.

LGA: ______________________

Don't know LGA? Please tell us what town you live in

Town: ___________________________

2) What was your approximate total fishing revenue for the last financial year (2013/14)?

This information is important to know in order to understand how much total income was generated within your region from fishing and related businesses.

□ Under $20,000	□ $20,000-$39,999	□ $40,000-$59,999
□ $60,000-$79,999	□ $80,000-$99,999	□ $100,000-$124,999
□ $125,000-$149,999	□ $150,000-$174,999	□ $175,000-$199,999
□ $200,000-$249,999	□ $250,000 -$299,999	□ $300,000 -$349,999
□ $350,000 -$399,999	□ $400,000 and over	□ I would rather not say

If you are willing to provide the actual value as well (to the nearest $10,000) that would be most appreciated.

Actual value: (to nearest $10,000) _______________________

Section 2:Fishing business cost overview

Please provide a rough breakdown of your fishing business costs in 2013-14. Some of this information was collected in the earlier survey, but for completeness we wish to collect a more detailed breakdown of costs. This is important for determining the flow-on effects to the local community.

3) Running costs (to the nearest $500), 2013-14

Cost Category	Value ($)	Cost category	Value ($)
Vessel repairs and maintenance		Freight and marketing	
Gear repairs, maintenance and replacement		Packaging costs	
Fuel costs		Bait (if used)	
Crew costs		Ice (if used)	
Food costs		Other trip costs	

4) Annual costs (to the nearest $500), 2013-14

Cost Category	Value ($)	Cost category	Value ($)
Accountancy		Bank fees	
Electricity and gas		Bank interest	
Vehicle repairs and maintenance		On-shore leasing	
Wharfage		Insurance	
Brokerage fees (e.g. quota)		Fishing licence fees and levies	
Quota/licence leasing costs		Council rates (business)	
Telephone and postage		Other administrative costs	

5) Roughly how much did you pay in taxes (excluding income tax) last year? (to the nearest $500)

State Government tax (e.g. payroll tax) ____________________

Federal Government tax (e.g. GST) ____________________

Section 3:Business expenditure location

The aim of these questions is estimate what part of your business expenditure is spent locally. The information will be used to estimate flow-on impacts to the local economy resulting from your fishing activity.

6) Approximately what proportion of your running costs is spent within your local government area (LGA)?

For example, if about half of your fuel was purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular input at all (e.g. bait), you would tick the "did not use" box (rather than the 0% box, which means that all bait were purchased from outside your local government area).

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	all non-local					Around half local					All local
Fuel	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vessel repairs and maintenance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Gear repairs and maintenance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Freight and marketing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Packaging materials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bait (if used)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other running costs (Please specify below)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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7) How many of your crew live locally and non-locally?
Please provide the number of crew who live locally and those who live outside your local area

In your local government area? ________________________________

Outside your local government area? ________________________________

8) Approximately what proportion of the below annual costs is spent within your local government area?

Annual costs are those costs that are not directly related to how much you fish or how much you catch. We are after best approximate estimates, so round to the nearest 10% rather than try and estimate exact proportions.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	all non-local					Around half local					All local
Accountancy	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Banking	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Brokerage fees (e.g. quota or license leasing/purchase	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Electricity and gas	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vehicle repairs and maintenance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
On-shore leasing costs	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Insurance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

Section 4: Personal income and expenditure

The economic contribution of fishing to the region depends not only on the expenditure from your business, but also how your personal income is spent. Details on this expenditure will be collected later in the survey. On this page, we wish to find out roughly how much of your fishing income is used for personal income and how much is spent or saved.

9) Roughly what proportion of your total fishing revenue did you keep as your own personal income last financial year (2013-14)?

This is important as it provides an indication as to how much of your fishing revenue is available for personal expenditure. If you are willing to provide an actual value as well, that would also be appreciated. Please enter this in the box below otherwise indicate an approximate proportion.

5% or less	10%	15%	20%	25%	More than 25%
☐	☐	☐	☐	☐	☐

Actual value: (to nearest $10,000) ______________________

10) Roughly what percentage of your total annual personal income do you:

Save (average Australian saving rate was 9.3% in 2014) ______________

Pay in income tax (most Australians pay between 10% and 30%) ______________

Section 5: Personal household expenditure location

The aim of this set of question is to estimate what part of your personal household expenditure is spent locally (i.e. within your local government area). The information will be used to estimate flow-on impacts to the local economy from your income derived from fishing, which are likely to be different from those derived from your fishing expenditure.

11) Approximately what proportion of your own personal household expenditureon each of the following basic goods and services is spent within your local government area?

For example, if about half of your groceries were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. construction services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	all non-local ◄					Around half local					► All local
Communication (e.g. phone, post)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Education (e.g. TAFE, school fees)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Electricity, gas and water supply	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Health and community services (e.g. doctors, vets, childcare)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Retailers and wholesalers (e.g. supermarkets, petrol stations)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Transport and travel (e.g. taxi, bus, flights)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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12) Approximately what proportion of your own personal household expenditure on each of the following recreational goods and services is spent within your local government area?

For example, if about half of your groceries were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. construction services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	All non-local					Around half local					All local
Accommodation, cafes and restaurants (e.g. hotels, motels)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other recreational services (e.g. cinemas, sport, museums)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fishing industry direct purchases (e.g. seafood off the boat, bait for recreational fishing)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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13) Approximately what proportion of your own personal household expenditure on each of the following local building and trades goods and services is spent within your local government area?

For example, if about half of your groceries were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. construction services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	All non-local					Around half local					All local
Construction and trade services (e.g. builders, plumbers, electricians, mechanics)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturers (e.g. recreational boat R&M)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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14) Approximately what proportion of your own personal household expenditure on each of the following government and financial goods and services is spent within your local government area?

For example, if about half of your groceries were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. construction services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	Did not use	All non-local					Around half local					All local
Finance and insurance (e.g. bank charges and interest, insurance companies, superannuation)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Government administration (e.g. car registration, license fees etc)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Property and Business services (e.g. rent, cleaning)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mortgage repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Local government taxes (e.g. local council rates)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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Section 6: Thank you.

Thank you for participating in the survey.
The results of the survey should be available later in 2015.

If you would like to receive further information about the results of the survey, please enter an email address below, or contact (sean.pascoe@csiro.au)

15) Please add any comments you would like to make and/or your email address if you would like further information.

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THANK YOU FOR YOUR TIME.

Sean Pascoe on behalf of the project teams.

CSIRO

JAMES COOK UNIVERSITY AUSTRALIA

Beyond GVP: Economic value of Queensland commercial fisheries to local regions

This is the commercial fisheries' opportunity to demonstrate their value to the local economy.

1: Introduction

Thank you for agreeing to participate in the survey relating to the "Beyond GVP" project being run jointly by James Cook University and CSIRO. The research is being funded by the Australian Fisheries Research and Development Corporation.

The purpose in this survey is to estimate the economic benefits generated in your local economy from the flow-on effects associated with your business. As well as contribute to local employment directly, fishing can contribute to employment and income indirectly through purchasing goods (e.g. food, fuel, supplies) and services (e.g. accountants) locally. This includes the business based expenditure as well as your own private household expenditure. These types of expenditure are likely to be different, with subsequently differing regional benefits associated with fishing.

As with the previous survey, your responses will be confidential, and only aggregated information will be used. We will link the responses of these supplementary questions to your responses from the main survey, but will need to ask a couple of key questions similar to those you may already have answered just for clarification and validation.

We expect this additional survey to take around 15-20 minutes to complete. Having a copy of your last year's financial statement on hand may help you answer some of the questions.

Please feel free to contact me (sean.pascoe@csiro.au) if you have any concerns or queries about the questions.

Section 2:Some basic questions about your fishing activities

The aim of these questions is to determine what types of fishing you mostly do and what is your level of involvement in the industry.

16)Which local government area (LGA) do you live in?

This information is important to work out your local area. A key aim of the project is to determine how much economic activity is generated in your local area.

LGA: ________________________________

Don't know your LGA? Please tell us what town you live in

Town: ______________________________

17)How many years have you been fishing?

Years: __________________________

18)What fishing gears do you mostly use, and if you use more than one fishing gear roughly what proportion did you use of each over the last year?

Nets - inshore	%
Nets - offshore	%
Line - inshore	%
Line - offshore	%
Pots (crab)	%
Trawl	%
Other	%

Section 3:Some basic questions about revenues and costs

In the first part of the survey, we will ask some basic questions about you and your business. We also need to estimate roughly how much of your total fishing revenue is spent as business expenditure and how much you retain as your personal income. Knowing this is important to determine regional flow on effects as business and personal expenditure patterns are likely to be different, but both contribute to the regional economy.

Some of the first couple of questions are similar to those asked in the earlier survey. This is just for clarification to ensure that both surveys are based on the same set of information.

19)What was your approximate total fishing revenuefor the financial year 2013/14?

This information is important to know in order to understand how much total income was generated within your region from fishing and related businesses.

- ◻ Less than $50,000
- ◻ $50,000-$99,999
- ◻ $100,000-$149,999
- ◻ $150,000-$199,999
- ◻ $2000,000-$249,999
- ◻ $250,000-$299,999
- ◻ $300,000-$399,999
- ◻ $400,000-$499,999
- ◻ $500,000 or more
- ◻ Prefer not to answer

If you are willing to provide the actual value as well (to the nearest $10,000) that would be most appreciated.

Actual value: (to nearest $10,000) ___________________________

20)What was your approximate total fishing costs for the financial year 2013/14?

This information is important to know in order to understand the costs of fishing.

- ◻ Less than $50,000
- ◻ $50,000-$99,999
- ◻ $100,000-$149,999
- ◻ $150,000-$199,999
- ◻ $2000,000-$249,999
- ◻ $250,000-$299,999
- ◻ $300,000-$399,999
- ◻ $400,000-$499,999
- ◻ $500,000 or more
- ◻ Prefer not to answer

If you are willing to provide the actual value as well (to the nearest $10,000) that would be most appreciated.

Actual value: (to nearest $10,000) ___________________________

Section 4:Business expenditure location

The aim of these questions is estimate what part of your business expenditure is spent locally. The information will be used to estimate flow-on impacts to the local economy resulting from your fishing activity.Please make your best estimate of the proportion spent inside your local area. If you are uncertain about some items, please make your best estimate and add a note in the comments boxes below.

21)Approximately what proportion of your <u>running costs</u> is spent within your <u>local government area</u> (LGA)?

For example, if about half of your fuel was purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular input at all (e.g. bait), you would tick the "did not use" box (rather than the 0% box, which means that all bait were purchased from outside your local government area).

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	N/A (Did not use)	all non-local					Around half local					All local
Fuel	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vessel repairs and maintenance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Gear repairs and maintenance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Freight and marketing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Packaging materials	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bait (if used)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ice (if used)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other running costs (Please specify below)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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22) How many of your crew live locally and non-locally?

Please provide the <u>number</u> of crew who live locally and those who live outside your local area. If the answer to either (or both) is zero, please enter zero (0).

Live in your local government area? ____________________

Live outside your local government area? ____________________

23) Approximately what proportion of the below <u>annual costs</u> is spent within your <u>local government area?</u>

Annual costs are those costs that are not directly related to how much you fish or how much you catch. We are interested in determining where the main flow of expenditure goes. For example, if you most deal with your local bank branch for deposits and withdrawal, but also use internet banking (or phone banking), please choose the local branch option. As another example, if you buy all your insurance online (not through a local broker) then choose all non-local. We are after best approximate estimates, so round to the nearest 10% rather than try and estimate exact proportions.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	N/A (Did not use)	all non-local					Around half local					All local
Vehicle repairs and maintenance												
Accountancy												
Banking												
Brokerage fees (e.g. quota or license leasing/purchase)												
Electricity and gas												
On-shore leasing costs (e.g. workshops)												
Insurance												
Maritime Queensland survey costs												
Wharfage/ harbour dues												
Other administrative costs												

Comments and clarifications

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Section 5: Personal income and expenditure

The economic contribution of fishing to the region depends not only on the expenditure from your business, but also how your personal income is spent. Details on this expenditure will be collected later in the survey. On this page, we wish to find out roughly how much of your fishing income is used for personal income and how much is spent or saved.

24) Roughly what proportion of your <u>total fishing revenue</u> did you keep as your <u>own personal income</u> last financial year (2013-14)?

This is important as it provides an indication as to how much of your fishing revenue is available for personal expenditure. If you are willing to provide an actual value as well, that would also be appreciated. Please enter this in the box below otherwise indicate an approximate proportion.

5% or less	10%	15%	20%	25%	30%	35%	40%	45%	45% or more
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Actual value: (to nearest $10,000) ________________________________

25) Did you need to borrow money for personal expenditure to make ends meet in 2013-14?
The aim of this question is to determine if greater expenditure took place in your region than your income alone would account for.

No ________________

Yes ________________

If yes, would you mind telling us roughly how much?

$ ____

26) Roughly what percentage of your total annual personal income do you save and/or pay in tax?
Please enter your best estimate as a percentage. If none, please enter zero (0)

Save (average Australian saving rate was 9.3% in 2014) ________________

Pay in income tax (most Australians pay between 10% and 30%) ________________

Section 6: Personal household expenditure location

The aim of this set of question is to estimate what part of your personal household expenditure is spent locally (i.e. within your local government area). The information will be used to estimate flow-on impacts to the local economy from your income derived from fishing, which are likely to be different from those derived from your fishing expenditure.

27) Approximately what proportion of your own personal household expenditure on each of the following basic goods and services is spent within your local government area?

For example, if about half of your groceries were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. transport services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
	N/A (Did not use)	All non-local ←				Around half local				All local →			Do not know
Communication (e.g. phone, post)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Education (e.g. TAFE, school fees)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Electricity, gas and water supply	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Health and community services (e.g. doctors, vets, childcare)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Retailers and wholesalers (e.g. supermarkets, petrol stations)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Transport and travel (e.g. taxi, bus, flights purchased through local agent)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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28) Approximately what proportion of your own personal household expenditure on each of the following recreational goods and services is spent within your local government area?

For example, if about half of your expenditure in cafes were purchased locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. fishing industry), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
	N/A (Did not use)	All non-local ←					Around half local					→ All local	Do not know
Accommodation, cafes and restaurants (e.g. hotels, motels)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other recreational services (e.g. cinemas, sport, museums)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fishing industry direct purchases (e.g. seafood off the boat, bait for recreational fishing)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

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29) Approximately what proportion of your own personal household expenditure on each of the following local building and trades goods and services is spent within your local government area?

For example, if about half of the tradies you used were based locally (i.e. within your local government area), then you would tick the 50% box. If you did not use a particular service at all (e.g. manufacturing services), you would tick the "did not use" box.

		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	
	N/A (Did not use)	All non-local					Around half local					All local	Do not know
Construction and trade services (e.g. builders, plumbers, electricians, mechanics)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturers (e.g. recreational boat R&M)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Property and Business services (e.g. rent, rental property management, cleaning)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments and clarifications

30)Where are the agents, offices or brances you mostly deal with located for the following personal and financial services?

We are interested in determining where the main flow of expenditure goes. For example, if you most deal with your local bank branch for deposits and withdrawal, but also use internet banking (or phone banking), please choose the "mostly local branch" option. As another example, if you buy all your insurance online (not through a local broker) then choose the last option.

	N/A (Did not use)	Mostly use local agent or branch and some Internet/phone	Equally use Internet/phone and local agent or branch	Mostly use Internet/phone and some local agent or branch	Mostly use Internet/phone and/or Agent or branch outside my local area
Accountancy	☐	☐	☐	☐	☐
Banking (e.g. bank charges and interest)	☐	☐	☐	☐	☐
Banking – Mortgage repayments	☐	☐	☐	☐	☐
Finance and insurance (e.g. insurance companies, superannuation)	☐	☐	☐	☐	☐
State Government administration (e.g. car registration, **<u>but not</u>** council rates)	☐	☐	☐	☐	☐

Comments and clarifications

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Section 7:Who do you sell your catch to?

The aim of this question is to determine roughly how much of your catch is sold locally and how much is sold elsewhere. This also affects the level of benefits generated in the local economy.

31)Roughly what proportion of your catch do you sell to the following buyers?

	None	Some	About half my catch	Most	All of my catch	N/A
Direct to public	☐	☐	☐	☐	☐	☐
Direct to local retailers or restaurants	☐	☐	☐	☐	☐	☐
Local agents (who mostly supplies local businesses)	☐	☐	☐	☐	☐	☐
Local agents (who mostly supplies businesses in other regions)	☐	☐	☐	☐	☐	☐
Local processors	☐	☐	☐	☐	☐	☐
Agents, retailers or processors outside your local area	☐	☐	☐	☐	☐	☐

Section 8:Fishing business cost in more detail

If you are willing, please provide a rough breakdown of your fishing business costs in 2013-14. Some of this information was collected in the earlier survey, but for completeness we wish to collect a more detailed breakdown of costs. This isimportant for determining the flow-on effects to the local community.

32)Running costs (to the nearest $500), 2013-14

Cost Category	Value ($)	Cost category	Value ($)
Crew costs		Freight and marketing	
Food costs		Packaging costs	
Fuel costs		Bait (if used)	
Vessel repairs and maintenance		Ice (if used)	
Gear repairs, maintenance and replacement		Other trip costs	

33)Annual costs (to the nearest $500), 2013-14

Cost Category	Value ($)	Cost category	Value ($)
Accountancy		Quota/license leasing costs	
Telephone and postage		On-shore leasing (e.g. workshop, freezers, sheds etc.)	
Bank fees		Insurance (business related e.g. vessel, work vehicles)	
Bank interest		Fishing licence fees and levies	
Brokerage fees (e.g. quota)		Council rates (business)	
Wharfage/harbor dues		Other administrative costs	
Electricity and gas		Safe Food Queensland accreditation	
Vehicle repairs and maintenance (business related only)		Maritime Safety Queensland survey	

34) Did you set aside any business savings to meet future expenses (e.g. depreciation fund) in 2013-14?

Yes ☐ No ☐

If, YES, roughly how much (to the nearest $500) ______________________________

35) Roughly how much did you pay in business-related taxes (i.e. excluding income tax) last year? (to the nearest $500 if possible)

State Government tax (e.g. payroll tax) ______________________________

Federal Government tax (e.g. GST) ______________________________

Section 9: Thank you.

Thank you for participating in the survey.

The results of the survey will be used to estimate the benefits of the Queensland fishing industry to the local coastal communities. Individual responses will not be identifiable.

The results of the survey should be available later in 2015.

If you would like to receive further information about the results of the survey, please enter an email address below, or contact (sean.pascoe@csiro.au)

36) Please add any comments you would like to make and/or your email address if you would like further information.

____

____

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THANK YOU FOR YOUR TIME.

Sean Pascoe on behalf of the project teams.

CSIRO

JAMES COOK UNIVERSITY AUSTRALIA

Appendix C: Questionnaire developed to estimate value of fish to local consumers

Beyond GVP Survey of Fish Consumers

CSIRO and James Cook University are currently surveying people from Queensland about their consumption of fish, and whether people place importance on where and how their seafood is produced. The work is being undertaken in the broader context of examining the value of the fishing industry to regional economies.

The survey consists of 3 parts and takes around 20 minutes to complete.

Section 1: Asks some background questions about how you typically buy and consume fish.

Section 2: Asks for your opinions regarding specific attributes of fish when you are buying it.

Section 3: Asks some specific questions about you.

Section 1. Questions about your consumption of fish

37)Did you eat any fish and/or seafood over the last 12 months?

- ☐ Yes (1)
- ☐ No (2)

Note: (Q2a) is only displayed if the respondent answers "Yes" to Q1

2a) Why do you eat fish and seafood?

	Select main reason	
Health reasons	☐	(1)
Variety in diet	☐	(2)
Enjoy the taste	☐	(3)
Special occasion treat (e.g. Easter, Christmas, New Year, Birthday)	☐	(4)
Avoid eating red meat	☐	(5)
Other (please specify)	☐	(6)

Then go to Question 3.

Note: (Q2b) is only displayed if the respondent answers "No" to Q1

2b) Why do you not eat fish and seafood?

	Select main reason	
Allergies	☐	(1)
Do not like the taste	☐	(2)
Vegan/vegetarian	☐	(3)
Too expensive	☐	(4)
Prefer other protein sources	☐	(5)
I am unfamiliar with how to prepare fish and seafood	☐	(6)
I find preparing fish and seafood inconvenient or difficult	☐	(7)
Good quality fish and seafood is unavailable in my area	☐	(8)
Other (please specify)	☐	(9)

Then go to Section 3 (Question 18).

The next set of questions relates to how often you ate **fish** over the last 12 months. We are interested in fish only, not other seafood such as prawns, crabs and other shellfish. We are also interested in all types of fish, whether fresh, cooked, processed or frozen.

3) Over the last 12 months, roughly how often did you **eatfish** over the year?

	Times a year	Answer	
4-7 times a week	150-300	☐	(1)
2-3 times a week	80-149	☐	(2)
About once a week	40-79	☐	(3)
About once every 2 weeks	20-39	☐	(4)
About once a month	7-19	☐	(5)
About 4-6 times a year	4-6	☐	(6)
About 3 times per year	3	☐	(7)
About 2 times per year	2	☐	(8)
About once a year	1	☐	(9)

The next set of questions relate to your **purchases** of **fresh fish**(e.g. from a fish monger or supermarket fish counter). Fresh salmon and previously frozen fish sold on fresh fish counters are to be included.

Please **do not consider** purchases of processed fish (e.g. fish fingers, pre-packaged frozen crumbed fillets, tuna in a can, etc,.).

Please also **excludecooked** fish purchased at restaurants or fish and chip shops. Questions about purchases in these outlets will be asked later in the survey.

4) Do you ever buy fresh fish (e.g. fillets or whole)?
- ◻ Yes (1)
- ◻ No (2)

Note: If answer to (4) is No please take respondents to question 10, otherwise allow them to continue to 5

Note: Please can it be a requirement that respondents must make one entry in each column of Q5?

5) On average, how often do you buy**freshfish** (i.e. fresh fillets or whole) and from which outlets: (tick one from each column)

	Times a year	Supermarkets (1)	Local fish monger (2)	Direct from fishers (off the boat) (3)	Internet (4)
Never	0				
4-7 times a week	150-300				
2-3 times a week	80-149				
About once a week	40-79				
About once every 2 weeks	20-39				
About once a month	7-19				
About 4-6 times a year	4-6				
About 3 times per year	3				
About 2 times per year	2				
About once a year	1				

Note. Local fish mongers are retailers who sell fresh filleted or whole fresh fish. These may be specialist fish markets, or may also be fish and chip shops with a fresh fish counter. For this question, if you purchase fresh fish fillets from a fish and chip shop then we consider them a fish monger.

Note: Please can it be a requirement that respondents must make one entry in each row of Q6

6) Thinking of the fresh fish you buy from these outlets, how important (on a scale of 0 to 10) is to you where the fish werecaught or farmed (i.e. where it came from)?

	0	1	2	3	4	5	6	7	8	9	10	
	Do not purchase	Not at all important									Very Important	
Supermarkets												(1)
Local fish monger												(2)
Direct from fishers (off the boat)												(4)
Internet												(5)

Note: Please only allow one response in Q7

7) If you saw fresh fish labelled as 'local', how far away would you expect it to have come from?

	Tick one	
Somewhere within 50km of retail outlet		(1)
Somewhere within 100km of retail outlet		(2)
Somewhere within 200km of retail outlet		(3)
Somewhere within 500km of retail outlet		(4)
Anywhere in Queensland		(5)
Anywhere in Australia		(6)

8) Given the option, would you prefer to buy locally caught or farmed fish over fish from further away?
- □ Yes (1)
- □ No (2)

Note: (Q8a) is only displayed if the respondent answers "Yes" to Q8

8a) How important are these reasons for your preference to buy locally caught or farmed fish? Rate the reason 1 if not important, 10 if very important, or some value in between depending on how important you think the reason is.

	1	2	3	4	5	6	7	8	9	10	
	Not at all important									Very Important	
I believe that it is fresher											(1)
It has lower 'food miles' so better for the environment (i.e. less distance travelled and therefore lower levels of greenhouse gas emissions produced in its transport)											(2)
I like to support the local seafood industry											(3)
Other (specify)											(4)

9) When buying fresh fish (fillets or whole) from a fish market, supermarket fish counter or internet, what are the main types of fish you tend to buy? Choose up to three in each column. If you do not buy fish from the outlet leave the column blank

	Supermarket fresh fish counter (1)	Fishmonger/boat (uncooked) (2)	Internet (3)
"Fish" (unspecified species)			
Atlantic Salmon (farmed)			
Barramundi (wild caught)			
Barramundi (farmed)			
Basa			
Cod (generic fish name)			
Coral trout			
Deep Sea Perch			
Flathead			
Hake (generic fish name)			
Hoki			
Mackerel (Grey or Spanish)			
Mullet			
Nile Perch			
Red Emperor			
Red Throat Emperor			
Reef Cod			
Reef Fish (generic fish name)			
Sea Bream			
Sea Perch/Ocean Perch			
Shark/Flake			
Snapper			
Sweet Lip			
Tuna			
Whiting			
Other:			

Note: need individual cell identified for the purposes of the online survey

10) Do you ever buy cooked fish from a fish and chip shop, restaurant or café?

- ☐ Yes (1)
- ☐ No (2)

Note: If answer to (10) is "No", then go to Section 2, otherwise continue to 11

Note: Please require one (and only one) response in each column

11) On average, how often do you eatout over a year, and how often do you eat fish when eating out?

	Times a year	Eat out (any type of meal) (1)	Eat fish at a restaurant or café (2)	Buy cooked fish from a fish and chip shop (3)
Never	0			
4-7 times a week	150-300			
2-3 times a week	80-149			
About once a week	40-79			
About once every 2 weeks	20-39			
About once a month	7-19			
About 4-6 times a year	4-6			
About 3 times per year	3			
About 2 times per year	2			
About once a year	1			

Note: Please only allow one answer per row

12)How important are these reasons when you buy locally caught/farmed fish when eating out? Rate the reason 1 if not important, 10 if very important, or some value in between depending on how important you think the reason is

	1	2	3	4	5	6	7	8	9	10	
	Not at all important									Very Important	
I believe that it is fresher											(1)
It has lower 'food miles' so better for the environment (i.e. less distance travelled and therefore lower levels of greenhouse gas emissions produced in its transport)											(2)
I like to support the local fishing industry											(3)
Other (specify)											(4)

Note: Please only allow one answer here

13)Are you more likely (on a 1-10 scale) to purchase fish in a restaurant, café or fish and chip shop if it is identified as locally caught/farmed?

1	2	3	4	5	6	7	8	9	10	
Not more likely									Very likely	
										(1)

Note: Please require the sum of these to equal 100%

14)When you have eaten fish in a restaurant, café or from a fish and chip shop, to the best of your knowledge what proportion of your meals have been:

	%	
Salmon		(1)
Imported fish		(2)
Australian farmed fish other than salmon		(3)
Fish landed locally to the area you are in		(4)
Fish landed elsewhere in Queensland		(5)
Fish landed elsewhere in Australia		(6)
Unknown origin		(7)

Section 2. Your opinions regarding the attributes of wild caught fish you buy

Background information

More detailed labelling of seafood can provide information relating to a range of factors, such as: whether it is from a sustainable source, how recently it was caught, or where the fish has come from.

This type of labelling helps consumers make better informed decision about the seafood they are buying, and consequently the industries or practices they are ultimately supporting.

In this section we will ask you a series of questions set in the context of a labelling scheme that is designed to provide you with more information on the wild caught fish that you buy. The aim of this is to help us get a better understanding of how much you value specific attributes of the fish you buy.

The table below provides a summary of the information that could be supplied in relation to each attribute being considered.

Table 1. Information that can be provided in relation to

Attribute	**Information labelling could potentially provide**
Price	$/kg
Sustainability:	from a source accredited to be sustainable
	not specified
Freshness:	Guaranteed fresh
	not specified
Origin:	Produced locally
	Product of Queensland
	Product of Australia

Please read the following instructions before proceeding to the scenarios in the next section:

- You will be presented with 6 separate scenarios (one set per page). Each scenario has a different combination of information about fish available from a number of hypothetical retailers. A blank attribute represents “not specified”. It does not mean that the fish comes from an unsustainable fishery or is not fresh – it just indicates that this attribute is not specified.
- In each of the 6 scenarios, you will be presented with 4possible options,each with an associated cost
- In each scenario, you will be asked to choose the one option that you most prefer.
- You must choose one of the options each time (there is no “none of these” option available).
- Each scenario should be considered independently. That is, the attributes of the fish from one retailer in one scenario has no relation to the attributes of the same retailer in another scenario. For example, if one retailer provides sustainably caught fish in one scenario, but unspecified in the next, there is no guarantee that the fish in the next scenario is from a sustainable fishery.
- We will be surveying a large number of people to work out the preferences held across a range of Queenslanders.
- There are no right or wrong answers – this is your opinion.

Scenario

You have friends coming for dinner and you have found a good recipe requiring fresh Barramundi fillets. We have chosen barramundi for the scenarios as it is widely available in Queensland, is both farmed and wild caught in Australia, and is also imported. It is also very tasty. In the scenario, however, <u>we are only considering Australian wild caught Barramundi</u>, as we are most concerned about differences due to sustainability, freshness and distance from where caught.

You have four local fish retailers who each stock fresh Barramundi fillets sourced from a wild fishery. The retailers are all located side by side allowing you to see what is on offer in each before you purchase.

The fish shops all source their fish from different suppliers, who also get their fish from different fisheries (or fish farms). Ana, Ben and Con all display the key characteristics of the fish they are selling, Deb does not. The prices in each shop may also vary. You are able to see what each is offering before deciding where you will buy your fillets.

Example scenario:
On this page is an example of the type of scenario you will be presented with (you don't need to answer this one). When answering, please do not forget to:

- Consider the full set of attributes of each option before making your decision.
- Choose the **one**option you most prefer **on each page**based on the assumption that these are the only options available to you.
- Keep your financial circumstances in mind while answering.
- A blank cell indicates that no information is provided.

Treat each scenario independently. You do not need to remember or anticipate the choices you make across the series of scenarios. For an explanation of each option, please place your curser over an option below:

	Ana's	Ben's	Con's	Deb's
Origin	Local	Queensland	Queensland	Australia
Sustainability certified	Yes	Yes		
Freshness guarantee	Yes			
Price ($/kg)	$48.00	$44.00	$42.00	$40.00
I would buy (select one)	☐	☐	☐	☐

Please note:

- *The above sample question is to be a screen shot of a choice scenario*
- *When the curser is placed over the relevant radio button they will see the following text in a pop up window*

When the curser is placed over the button for Ana's fresh fish

By choosing this option, it would mean that ***you prefer Option 1*:**Fish fillets that have been wild caught locally from a fishery certified as sustainable and they are less than 24hrs old. These fillets cost $48/kg.

When the curser is placed over the button for Ben's fresh fish

By choosing this option, it would mean that ***you prefer Option 2*:**Fish fillets that have been wild caught in Queensland from a fishery certified as sustainable and no information is provided with respect to freshness. These fillets cost $44./kg.

When the curser is placed over the button for Con's fresh fish

By choosing this option, it would mean that you prefer ***Option 3***: Fish fillets that have been wild caught in Queensland. No information is provided about the sustainability of the fishery or the freshness of the fillets. These fillets cost $42/kg.

When the curser is placed over the button for Deb's fresh fish

By choosing this option, it would mean that you prefer ***Option 4***: Fish fillets that have no information provided, other than that they are a product of Australia. These fillets cost $40/kg.

Notes regarding choice scenarios:

- *The choice scenarios will be displayed here*
- *Please note there are a total of 24 choice scenarios.*
- *The 24 choice scenarios have been split into 4 blocks, such that each participant will only receive 6 choice scenarios*
- *The 6 choice scenarios will be displayed here. Each choice scenario will be displayed on a different screen.*

The following text will be displayed above each choice scenario:

The following displays options for fresh Barramundi fillets offered by fish retailers near you. Please consider each option below (looking at each one to see the proposed level of information provided) and choose your most preferred option.Each scenario should be considered independently. That is, the attributes of the fish from one retailer in one scenario has no relation to the attributes of the same retailer in another scenario. For example, if Ana provides sustainably caught fish in one scenario, but this is unspecified in the next, there is no guarantee that Ana's fish in the next scenario is from a sustainable fishery.

We would now like to ask you some questions regarding the choices you have made

Note: [This question is displayed only if the Option 4 is chosen on every occasion]
You chose the Option 4 (Deb) as your most preferred option for every choice *set. Please choose an option below which best represents your reason for doing so:*
□ I preferred the Option 4(Deb's Fresh Fish) option to all others (1)
□ I could not afford other options based on my financial circumstances (2)
□ Other, please specify:____ (3)

15)Did you think the presentation of the choices was confusing?
- □ Yes (1)
- □ No (2)

Note: (Q15a) is only displayed if the respondent answers "Yes" to Q15
15a) If YES, please explain why_______________________________________

Note: please only allow one answer in each row
16)How important were the different attributes of the fish to you when making your choices?

	1	2	3	4	5	6	7	8	9	10	
	Not at all important									Very Important	
Sustainability											(1)
Freshness											(2)
Origin											(3)
Price											(4)

17) In real life when purchasing fresh fish, have you ever have inquired about any of these attributes with the retailer if the information is not already provided through labelling?

	Yes	No	
Sustainability			(1)
Freshness			(2)
Origin			(3)

Section 3: Some general questions about you

The purpose of these questions is to see if your answers to the previous questions are influenced by your own personal characteristics. This will allow us to make better estimates at the regional level given information on the demographic structure of each region.

18) Gender?
- ◻ Male (1)
- ◻ Female (2)

19) Age? ____________________

20) Number of people in your household?
   Over 18 years old (including yourself) ____ (1)
   Less than 18 years old _____ (2)

21) What is your level of education?
- ◻ Not completed high school/year 12 (education to 18 years old) (1)
- ◻ Completed high school/year 12 (education to 18 years old) (2)
- ◻ TAFE qualification/Trade/Technical Certificate technical (trade) college (3)
- ◻ University graduate (4)
- ◻ University postgraduate (5)

22) What is your employment status?
- ◻ Unemployed (1)
- ◻ Student (2)
- ◻ Employee (3)
- ◻ Self-employed (4)
- ◻ Retired(5)
- ◻ Other, please specify _____________ (6)

23) Which of the following gross (before tax) annual household income group applies to you in 2014-15?
- ◻ Under $20,000 (1)
- ◻ $20,000-$39,999 (2)
- ◻ $40,000-$59,999 (3)
- ◻ $60,000-$79,999 (4)
- ◻ $80,000-$99,999 (5)
- ◻ $100,000-$124,999 (6)
- ◻ $125,000-$149,999 (7)
- ◻ $150,000-$174,999 (8)
- ◻ $175,000-$199,999 (9)
- ◻ $200,000-$249,999 (10)
- ◻ $250,000 -$299,999 (11)
- ◻ $300,000 -$349,999 (12)
- ◻ $350,000 -$399,999 (13)
- ◻ $400,000 and over (14)
- ◻ I would rather not say (15)

24) What is your post code? ____

25) Approximately how far from the sea do you live?____________________________________ (km)

26) Do you go fishing for recreation?

- □ Yes (1)
- □ No (2)

27) Do you work in a commercial fishing industry?

- □ Yes (1)
- □ No (2)

28) Are you a member of an environmental conservation society or organization?

- □ Yes (1)
- □ No (2)

If you have an comments you want to make about the survey, or the issues raised in it, please add them here

____

THANK YOU FOR YOUR TIME.

Appendix D: R-code developed for assessing spatial capacity utilisation

```
## call the Benchmarking package
library("Benchmarking")

###############  USING ANNUAL DATA (TIME SERIES) ################

## read in the data from a csv file
#Data <- read.csv("Net.csv",header=T)
Data <- read.csv("pots.csv",header=T)

# insert average prices for the key species being considered. These species will also need to be specified
# in the sets of outputs below

# nets, lines prices
WhitingP <- 3.715
ThreadfinP <- 4.348
SharkP <- 3.001
MulletP <- 2.50
MackerelP <- 5.55
BarramundiP <- 9.172
OtherP <- 4.348

# pots
Blueswimp <- 5.5
Mudp <- 16.0
Spannerp <- 5.5
Otherp <-5.5

## drop any missing data
Data <- na.omit(Data)

Data$Daysperboat <- Data$Days/Data$Boats

##### OUTPUT ORIENTATION DEA

#### defining the components of the DEA model
Ifix <- as.matrix(subset(Data, select=c(Boats)))       ## fixed inputs
Iall <- as.matrix(subset(Data, select=c(Boats,Daysperboat)))  ## all inputs, Days are variable

## outputs for the net and line analyses
#outputs <- as.matrix(subset(Data,select=c(Whiting,Threadfin,Shark,Mullet,Mackerel,Barramundi,Other)))
## outputs for the pot analysis
outputs <- as.matrix(subset(Data,select=c(Blueswim,Mud,Spanner,Other)))  ## outputs

### simple plot of the frontier
dea.plot.frontier(Data$Boats,outputs,txt=FALSE,xlab="Number of fishers",ylab="Catch",main="Fishery capacity
frontier")

## estimate technical efficiency VRS
allinvrs <- dea(Iall,outputs,RTS="vrs",ORIENTATION="out")
```

```
summary(allinvrs)  ## produces summary output
Data$TEvrs <- 1/(allinvrs$eff)

## estimate technical efficiency CRS
allincrs <- dea(Iall,outputs,RTS="crs",ORIENTATION="out")
summary(allincrs)
Data$TEcrs <- 1/(allincrs$eff)

## estimate scale efficiency
Data$Scale <- Data$TEcrs/Data$TEvrs

## estimate capacity utilisation VRS
fixinvrs <- dea(Ifix,outputs,RTS="vrs",ORIENTATION="out")
summary(fixinvrs)
Data$CUvrs <- 1/(fixinvrs$eff)

## estimate unbiased capacity utilisation
Data$UCU <- Data$CUvrs/Data$TEvrs

### lets look at some of the results

par(mfrow=c(1,2),cex=0.7)
hist(Data$TEvrs,main="(a) Technical efficiency",xlab="Technical efficiency",ylab="Frequency")
hist(Data$UCU,main="(b) (unbiased) Capacity utilisation", xlab="(unbiased) Capacity
utilisation",ylab="Frequency")

par(mfrow=c(2,1),cex=0.7)
boxplot(Data$UCU~Data$Year,type="l",xlab="Year",ylab="Unbiased capacity utilisation")
boxplot(Data$CUvrs~Data$Year,type="l",xlab="Year",ylab="Technical efficiency")

#Data$Revenue <- (Data$Whiting*WhitingP+Data$Threadfin*ThreadfinP+Data$Shark*SharkP+
#              Data$Mullet*MulletP+Data$Mackerel*MackerelP+Data$Barramundi+BarramundiP+
#             Data$Other+OtherP)/1000000

Data$Revenue <- Data$Blueswim*Blueswimp+Data$Mud*Mudp+Data$Spanner*Spannerp+Data$Other*Otherp

Data$CapRev <- Data$Revenue/Data$UCU

Data$BCapRev <- Data$Revenue/Data$CUvrs

Revperyear <- tapply(Data$Revenue,Data$Year,sum)
CRevperyear <- tapply(Data$CapRev,Data$Year,sum)
BCaprevyear <- tapply(Data$BCapRev,Data$Year,sum)

par(mfrow=c(1,1),cex=1)
plot(Revperyear, ylim=c(0,30),ylab="Revenue ($m)",xlab="Year")
lines(CRevperyear,type="l",col="blue")
#lines(BCaprevyear,type="l",col="red")

plot(Data$UCU~Data$Revenue)

Revperyear

par(mfrow=c(2,1))
boxplot(Data$Boats~Data$Grid)
```

```
boxplot(Data$TEvrs~Data$Grid)
plot(Data$TEvrs~Data$Boats)
par(mfrow=c(3,1))
with(subset(Data,Year==1990),plot(TEvrs~Boats))
with(subset(Data,Year==2000),plot(TEvrs~Boats))
with(subset(Data,Year==2010),plot(TEvrs~Boats))

totboat <- with(Data,tapply(Boats,Year,sum))
totboat


################ MALMQUIST INDEX #####################

library(nonparaeff)

#balanced <- read.csv("Netpanel.csv",header=T)
balanced <- read.csv("Crabpanel.csv",header=T)

data <- subset(balanced,Year>1990)

#data <- subset(data,select=c("Grid","Year","Whiting","Threadfin","Shark","Mullet","Mackerel",
#           "Barramundi","Other","Days","Boats"))
data <- subset(data,select=c("Grid","Year","Blueswim","Mud","Spanner","Other","Days","Boats"))

malmq <- faremalm2(data, noutput = 4, id = "Grid", year = "Year")

#malm.re1
par(mfrow=c(2,1))
boxplot((malmq$tc-1)*100~malmq$Year,ylim=c(-100,100))
boxplot((malmq$ec-1)*100~malmq$Year,ylim=c(-100,100))

Year <- c(1992:2014)
Year

tcav <- tapply(malmq$tc, malmq$Year, geometric.mean)
tech <- cumprod(tcav)
plot(tech~Year,type="l",col="blue", main="(a) Cumulative technical change (1991=1)",
   ylab="Cumulative technical change", ylim=c(0.6,1.8))
abline(h=1,col="red")

ecav <- tapply(malmq$ec, malmq$Year, geometric.mean)
eff <- cumprod(ecav)
plot(eff~Year,type="l",col="blue", main="(b) Cumulative efficiency change (1991=1)",
   ylab="Cumulative efficiency change", ylim=c(0.6,1.8))
abline(h=1,col="red")

Year <- c(1992:2014)
Year

CTC <- cbind(Year,tech)
CTC

CTC1 <- c(1991,1.0)
names(CTC1) <- c("Year","tech")
CTC1
```

```
CTC <- as.data.frame(rbind(CTC1,CTC))
CTC
plot(CTC,type="l")

maxtech <- subset(CTC,Year==2014,select=c("tech"))
maxtech <- as.numeric(maxtech)

CTC$tech <- CTC$tech/maxtech
CTC

Data2 <- merge(Data,CTC,by.x="Year",by.y="Year")
head(Data2)

Data2$Blueswim <- Data2$Blueswim/Data2$tech
Data2$Mud <- Data2$Mud/Data2$tech
Data2$Spanner <- Data2$Spanner/Data2$tech
Data2$Other <- Data2$Other/Data2$tech

##### OUTPUT ORIENTATION DEA
detach("package:nonparaeff")

library("Benchmarking")

#### defining the components of the DEA model
Ifix <- as.matrix(subset(Data2, select=c(Boats)))      ## fixed inputs
Iall <- as.matrix(subset(Data2, select=c(Boats,Daysperboat)))  ## all inputs, Days are variable
outputs <- as.matrix(subset(Data2,select=c(Blueswim,Mud,Spanner,Other)))  ## outputs

## estimate technical efficiency VRS
allinvrs <- dea(Iall,outputs,RTS="vrs",ORIENTATION="out")
summary(allinvrs)  ## produces summary output
Data2$TEvrs <- 1/(allinvrs$eff)

## estimate technical efficiency CRS
allincrs <- dea(Iall,outputs,RTS="crs",ORIENTATION="out")
summary(allincrs)
Data2$TEcrs <- 1/(allincrs$eff)

## estimate scale efficiency
Data2$Scale <- Data2$TEcrs/Data2$TEvrs

## estimate capacity utilisation VRS
fixinvrs <- dea(Ifix,outputs,RTS="vrs",ORIENTATION="out")
summary(fixinvrs)
Data2$CUvrs <- 1/(fixinvrs$eff)

## estimate unbiased capacity utilisation
Data2$UCU <- Data2$CUvrs/Data2$TEvrs

highCU <- (with(Data2,tapply(UCU,Grid,median)))

par(mfrow=c(1,1))
boxplot(UCU~Grid, data=Data2)
```

```
### lets look at some of the results

par(mfrow=c(1,2),cex=0.7)
hist(Data2$TEvrs,main="(a) Technical efficiency",xlab="Technical efficiency",ylab="Frequency")
#hist(Data$Scale,main="",xlab="Scale efficiency",ylab="Frequency")
#hist(Data$CUvrs,main="",xlab="Capacity utilisation",ylab="Frequency")
hist(Data2$UCU,main="(b) (unbiased) Capacity utilisation", xlab="(unbiased) Capacity
utilisation",ylab="Frequency")

par(mfrow=c(2,1),cex=0.7)
boxplot(Data2$UCU~Data2$Year,type="l",main="(a) Unbiased capacity utilisation",
     xlab="Year",ylab="Unbiased capacity utilisation")
#abline(lm(UCU~Year,data=Data),col="red")
boxplot(Data2$CUvrs~Data2$Year,type="l",main="(b) Technical efficiency",
     xlab="Year",ylab="Technical efficiency")

#Data2$Revenue <-  (Data2$Whiting*WhitingP+Data2$Threadfin*ThreadfinP+Data2$Shark*SharkP+
#  Data2$Mullet*MulletP+Data2$Mackerel*MackerelP+Data2$Barramundi+
#     BarramundiP+Data2$Other+OtherP)/1000000

Data2$Revenue <-
(Data2$Blueswim*Blueswimp+Data2$Mud*Mudp+Data2$Spanner*Spannerp+Data2$Other*Otherp)/1000

Data2$CapRev <- Data2$Revenue/Data2$UCU

Data2$BCapRev <- Data2$Revenue/Data2$CUvrs

Revperyear <- (tapply(Data2$Revenue,Data2$Year,sum))
CRevperyear <- tapply(Data2$CapRev,Data2$Year,sum)
BCaprevyear <- tapply(Data2$BCapRev,Data2$Year,sum)
#Boatyears <- tapply(Data2$Boats,Data2$Year,mean)
BoatYears <- read.csv("PotBoats.csv",header=T)

Year <- c(1991:2014)

par(mfrow=c(1,1),cex=1,mar=c(5,4,4,5)+.1)
plot(Revperyear, ylim=c(0,100),type="l",col="green",ylab="Revenue ($m)",xlab="Year", col.axis="white")
axis(2,at=c(10,20,30,40,50,60,70,80,90,100),labels=c(10,20,30,40,50,50,70,80,90,100))
lines(CRevperyear,type="l",col="blue")

par(new=TRUE)
plot(BoatYears,type="l",col="red",yaxt="n",ylab="",xlab="",col.axis="black",ylim=c(0,1000))
axis(4)
mtext("Licence numbers",side=4, line=3)
legend("topright",col=c("green","blue","red"),lty=1,legend=c("Observed revenue","Capacity revenue","Licence
numbers"))

#lines(BCaprevyear,type="l",col="red")

data3 <- cbind(Revperyear,CRevperyear,BoatYears)
data3
```

Appendix E: R-code developed for assessing regional economic impacts

```
library(MASS)

data <- read.csv("BGVPdata.csv",header=T)  ## read in the data
names(data)

regions <- data$region

################# SOME BASIC INFO ABOUT THE DATA ###############
par(cex=0.6)
plot(regions, xlab="Region", ylab="Useful responses")

par(cex=0.9)
hist(data$yearsfish, xlab="Years fished", ylab="Number of skippers", main="")
par(cex=1)
boxplot(yearsfish~maingear, data=data, xlab="Main gear type", ylab="Number of years fished")


############# CALCULATE COST SHARES ###############

# create sub set of full data
costshare <- subset(data,select=c(crewcost,foodcost,fuelcost,vesselRMcost,
                    gearcost,freightcost,packcost,baitcost,
                    icecost,otripcost,accountcost,commscost,
                    bankcost,interestcost,brokercost,wharfcost,
                    electcost,vehiclecost,quotacost,onshorelasecost,
                    insurancecost,licencecost,ratescost,otheradmincost,
                    safefoodcost,surveycost))

#sum the costs to get consistent total
costshare$newtotal <- with(costshare,crewcost+foodcost+fuelcost+vesselRMcost+
                gearcost+freightcost+packcost+baitcost+
                icecost+otripcost+accountcost+commscost+
                bankcost+interestcost+brokercost+wharfcost+
                electcost+vehiclecost+quotacost+onshorelasecost+
                insurancecost+licencecost+ratescost+otheradmincost+
                safefoodcost+surveycost)

data$newcost <- costshare$newtotal

# estimate costs as share of total
costshare$crewcost <- costshare$crewcost/costshare$newtotal
costshare$foodcost <- costshare$foodcost/costshare$newtotal
costshare$fuelcost <- costshare$fuelcost/costshare$newtotal
costshare$vesselRMcost <- costshare$vesselRMcost/costshare$newtotal
costshare$gearcost <- costshare$gearcost/costshare$newtotal
costshare$freightcost <- costshare$freightcost/costshare$newtotal
costshare$packcost <- costshare$packcost/costshare$newtotal
costshare$baitcost <- costshare$baitcost/costshare$newtotal
costshare$icecost <- costshare$icecost/costshare$newtotal
```

```
costshare$otripcost <- costshare$otripcost/costshare$newtotal
costshare$accountcost <- costshare$accountcost/costshare$newtotal
costshare$commscost <- costshare$commscost/costshare$newtotal
costshare$bankcost <- costshare$bankcost/costshare$newtotal
costshare$interestcost <- costshare$interestcost/costshare$newtotal
costshare$brokercost <- costshare$brokercost/costshare$newtotal
costshare$wharfcost <- costshare$wharfcost/costshare$newtotal
costshare$electcost <- costshare$electcost/costshare$newtotal
costshare$vehiclecost <- costshare$vehiclecost/costshare$newtotal
costshare$quotacost <- costshare$quotacost/costshare$newtotal
costshare$onshorelasecost <- costshare$onshorelasecost/costshare$newtotal
costshare$insurancecost <- costshare$insurancecost/costshare$newtotal
costshare$licencecost <- costshare$licencecost/costshare$newtotal
costshare$ratescost <- costshare$ratescost/costshare$newtotal
costshare$otheradmincost <- costshare$otheradmincost/costshare$newtotal
costshare$safefoodcost <- costshare$safefoodcost/costshare$newtotal
costshare$surveycost <- costshare$surveycost/costshare$newtotal

costshare = subset(costshare,select=-c(newtotal))
costshare <- as.matrix(costshare)
par(cex=0.9,las=2)
par(mar=c(8,4,2,2))
boxplot(x = as.list(as.data.frame(costshare)),outline=FALSE,ylab="Cost share")  ## puts all the data into the
boxplot

####################### LOCAL EXPENDITURE SHARES ##############

spendshare <-  subset(data,select=c(crewcost,foodcost,fuelcost,vesselRMcost,
                    gearcost,freightcost,packcost,baitcost,
                    icecost,otripcost,accountcost,commscost,
                    bankcost,interestcost,brokercost,wharfcost,
                    electcost,vehiclecost,quotacost,onshorelasecost,
                    insurancecost,licencecost,ratescost,otheradmincost,
                    safefoodcost,surveycost))

spendshare$crewcost <- ifelse(data$crewlocal>0,data$crewlocal/(data$crewlocal+data$crewnotlocal),0)
spendshare$foodcost <- data$retailspend  ## assume same as private expenditure
spendshare$fuelcost <- data$fuelshare
spendshare$vesselRMcost <- data$VRMshare
spendshare$gearcost <- data$GearRshare
spendshare$freightcost <- data$Freightshare
spendshare$packcost <- data$packshare
spendshare$baitcost <- data$baitshare
spendshare$icecost <- data$iceshare
spendshare$otripcost <- data$othrunshare
spendshare$accountcost <- data$accountshare
spendshare$commscost <- data$comsspend  ## assume it is the same as private expenditure
spendshare$bankcost <- data$bankshare
spendshare$interestcost <- data$bankshare
spendshare$brokercost <- data$brokershare
spendshare$wharfcost <- data$wharfshare
spendshare$electcost <- data$electshare
spendshare$vehiclecost <- data$vehicleshare
spendshare$quotacost <- data$brokershare
spendshare$onshorelasecost <-data$onshoreleaseshare
```

```
spendshare$insurancecost <- data$insuranceshare
spendshare$licencecost <- 0 ### paid to QDAF - none local
spendshare$ratescost <- 1  ### assume all local as paid to local council
spendshare$otheradmincost <- data$othadminshare
spendshare$safefoodcost <- data$surveyshare
spendshare$surveycost <- data$surveyshare

spendshare <- as.matrix(spendshare)
par(cex=0.9,las=2)
par(mar=c(8,4,2,2))
boxplot(x = as.list(as.data.frame(spendshare)),outline=FALSE,ylab="Proportion spent locally")  ## puts all the data into the boxplot


######### PROPORTION TOTAL COSTS SPENT IN AREA ###########


crossprod <- costshare * spendshare ## just want the cross product of the two matrixes
prop1 <- rowSums(crossprod)
prop1

#adjust prop for cost share of revenue so that multiplier is on a revenue rather than cost basis
adjust <- ifelse(data$costs>data$revenue,1,data$costs/data$revenue) #assume that making a loss is unsustainable, or that costs overinflated
prop <- prop1*adjust
prop


#########   SAVINGS AND TAXES  ########

### leakages: "busavingamount","statetax",  "fedtax"

leakdata <- subset(data,select=c(revenue,busavingamount,statetax,fedtax))
leakdata

leak <- (data$busavingamount+data$statetax + data$fedtax)/data$revenue
leak


################  CALCULATE VESSEL MULTIPLIERS ############
multdata <- as.data.frame(cbind(prop,leak))
multdata

mult <- with(multdata, 1/(1-(1-leak)*prop))
mult

data$mult <- mult
par(cex=0.5)
par(cex=0.9,las=2)
par(mar=c(8,4,2,2))
boxplot(data$mult~data$region)
par(cex=1)

boxplot(data$mult~data$bussavings,ylab="Multiplier",xlab="Business savings")
```

```
plot(data$mult~data$revenue,ylab="Multiplier",xlab="Vessel Revenue")

#################  LOOK AT MAIN GEAR TYPES  #############
data$maingear <- with(data,ifelse(netsin>=50,"Nets inshore",
                      ifelse(netsoff>=50,"Nets offshore",
                          ifelse(linein>=50,"Line inshore",
                              ifelse(linoff>=50,"Line offshore",
                                  ifelse(pots>=50,"Pots",
                                      ifelse(trawl>=50,"Trawl","Other")))))))

data$inshore <- with(data,ifelse(netsin>=50,1,
                      ifelse(netsoff>=50,0,
                          ifelse(linein>=50,1,
                              ifelse(linoff>=50,0,
                                  ifelse(pots>=50,1,
                                      ifelse(trawl>=50,0,3)))))))

data$gearcode <- with(data,ifelse(netsin>=50,1,
                     ifelse(netsoff>=50,2,
                         ifelse(linein>=50,3,
                             ifelse(linoff>=50,4,
                                 ifelse(pots>=50,5,
                                     ifelse(trawl>=50,6,7)))))))

par(cex=1,las=1)
par(mar=c(4,4,2,2))

par(mfrow=c(1,2))
boxplot(revenue/1000~maingear, data=subset(data,inshore==1), ylab="Revenue ($'000)",xlab="Main Gear",
outline=FALSE,ylim=c(0,200))
boxplot(costs/1000~maingear, data=subset(data,inshore==1), ylab="Total costs ($'000)",xlab="Main Gear",
outline=FALSE,ylim=c(0,200))

par(mfrow=c(1,2))
boxplot(revenue/1000~maingear, data=subset(data,inshore==0), ylab="Revenue ($'000)",xlab="Main Gear",
outline=FALSE)
boxplot(costs/1000~maingear, data=subset(data,inshore==0), ylab="Total costs ($'000)",xlab="Main Gear",
outline=FALSE,ylim=c(0,1000))

par(mfrow=c(1,1))
boxplot(data$mult~data$maingear, ylab="Multiplier",xlab="Main Gear", outline=FALSE)

hist(mult,main="",xlab="Multiplier")
par(mfrow=c(2,1))
hist(data$revenue/1000000,main="",xlab="Fishing Revenue ($m)")
hist(data$mult*data$revenue/1000000,main="",xlab="Multiplied Revenue ($m)")

par(mfrow=c(1,1))
plot((data$revenue/1000000),((data$mult-1)*data$revenue/1000000),xlab="Fishing revenue ($m)",
ylab="Additional regional revenue ($m)",xlim=c(0,1),ylim=c(0,3))

par(mfrow=c(1,1))
boxplot(data$mult*data$revenue/1000000~data$maingear, ylab="Multiplied Revenue ($m)",xlab="Main Gear")
par(cex=.5)
boxplot(data$mult*data$revenue/1000000~data$region, ylab="Multiplied Revenue ($m)",xlab="Region")
```

```
#################################################################
############### PERSONAL EXPENDITURE  ##########################
#################################################################

perspend <- subset(data,select=c(comsspend,educatespend,electspend,healthspend,
  retailspend,transportspend,accomspend,recspend,fishspend,
  buildpsend,manufspend,propertyspend,accountspend,bankspend,
  mortgagespend,insurancespend,stategovspend))
perspend <- as.data.frame(perspend)
perspendm <- as.matrix(perspend)

par(cex=0.9,las=2)
par(mar=c(8,4,2,2))
boxplot(x = as.list(as.data.frame(perspendm)),outline=FALSE,ylab="Proportion consumed locally")  ## puts all
the data into the boxplot

##### read in personal expenditure averages
spenddata <- read.csv("personalexpenditure.csv",header=F) # derived from ABS data
spenddata <- as.data.frame(spenddata)
spenddatam <- as.matrix(spenddata)

##### expenditure multipliers

spendprop <- t(spenddatam)%*%t(perspendm)
spendprop <- as.vector(spendprop)


### leakages: "saving", "taxrate"

spendleak <- (data$saving+ data$taxrate)
spendleak <- as.vector(spendleak/100)


################  CALCULATE PERSONAL EXPENDITURE MULTIPLIERS ############
spendmultdata <- as.data.frame(cbind(spendprop,spendleak))
spendmultdata

spendmult <- with(spendmultdata, 1/(1-(1-spendleak)*spendprop))
spendmult

data$spendmult <- spendmult

par(cex=1,las=1)
par(mar=c(4,4,2,2))
boxplot(data$spendmult~data$Zone, outline=FALSE, names=c("North Qld","Central Qld","Southern Qld"),
ylab="Consumption multiplier")

### t-tests to see if there are significant differences between the zones

t.test(subset(data,Zone==1)$spendmult,subset(data,Zone==2)$spendmult)
t.test(subset(data,Zone==1)$spendmult,subset(data,Zone==3)$spendmult)
t.test(subset(data,Zone==2)$spendmult,subset(data,Zone==3)$spendmult)
```

```
hist(data$spendmult,main="",xlab="Personal expenditure
multiplier",ylab="Frequency",breaks=c(0,1,2,3,4,20),xlim=c(0,5))
summary(subset(data, spendmult<10)$spendmult)
m <- mean(subset(data, spendmult<10)$spendmult)
se <- sd(subset(data, spendmult<10)$spendmult)/length(subset(data, spendmult<10)$spendmult)**0.5
CIup <- m+1.96*se
CIlo <- m-1.96*se
m
se
CIup
CIlo

##################### INCOMES ##########################
data$income <- ifelse(data$skipperincome>0,data$skipperincome,data$revenue-data$costs)
data$income <- ifelse(data$income<0,0,data$income)
data$totcrew <- data$crewlocal+data$crewnotlocal

data$crewincome <- ifelse(data$totcrew>0,(data$crewlocal/data$totcrew)*data$crewcost,0)

par(cex=1)
plot(data$spendmult~data$income)

boxplot(data$spendmult~data$maingear, ylab="Multiplier",xlab="Main Gear")

par(mfrow=c(1,1))
boxplot(income/1000+crewincome/1000~inshore,data=subset(data,inshore<2),names=c("Offshore","Inshore"),
ylab="Income ($'000)",outline=FALSE)

par(cex=0.5)
boxplot(data$spendmult*(data$income+data$crewincome)/1000~data$region, ylab="Multiplied incomes
($'000)",xlab="Region")

data$incomeshare <- with(data,(income+crewincome)/data$revenue)
tapply(data$incomeshare,data$maingear,mean)

################################### MULTIPLIER MODEL ############
## estimation of model using regression analysis. Several different functional forms applied below

data$lnmult <- log(mult)
data$lnpop <- log(data$Population)
data$lnrev <- log(data$revenue)
data$lnSEIFA <- log(data$SEIFA-850)
data$innet <- ifelse(data$gearcode==1,1,0)
data$offnet <- ifelse(data$gearcode==2,1,0)
data$inline <- ifelse(data$gearcode==3,1,0)
data$offline <- ifelse(data$gearcode==4,1,0)
data$inpot <- ifelse(data$gearcode==5,1,0)
data$intrawl <- ifelse(data$gearcode==6,1,0)

model<-lm(lnmult~lnpop+lnSEIFA+lnrev+innet+offnet+inline+offline+inpot+intrawl, data=data)
summary(model)
AIC(model)

model<-lm(lnmult~lnpop+innet+offnet+inline+offline+inpot+intrawl, data=data)
summary(model)
```

```
AIC(model)

model<-lm(mult~Population+SEIFA+revenue+innet+offnet+inline+offline+inpot+intrawl, data=data)
summary(model)
AIC(model)

model<-lm(lnmult~lnpop+innet+offline+inpot+intrawl, data=data)
summary(model)
AIC(model)

model<-lm(lnmult~innet+offline+inpot+intrawl, data=data)
summary(model)
AIC(model)

data$Zone<-factor(data$Zone)

model<-lm(lnmult~lnpop+maingear*Zone, data=data)
summary(model)
AIC(model)

model<-
lm(lnmult~I(netsin/100)+I(netsoff/100)+I(linein/100)+I(linoff/100)+I(pots/100)+I(trawl/100)+I(other/100)+Zone,
data=data)
summary(model)
AIC(model)

model<- lm(lnmult~+I(netsoff/100)+I(linoff/100)+I(trawl/100)+Zone, data=data)
summary(model)
AIC(model)

model<- lm(lnmult~I(linoff/100)+I(trawl/100)+Zone, data=data)
summary(model)
AIC(model)

model<- lm(lnmult~I(trawl/100)+Zone, data=data)
summary(model)
AIC(model)

# dropping some of the extreme values (>5) as possibly spurious
model<- lm(lnmult~I(trawl/100)+Zone, data=subset(data, mult<5))
summary(model)
AIC(model)

model<-
lm(lnmult~I(netsin/100)+I(netsoff/100)+I(linein/100)+I(linoff/100)+I(pots/100)+I(trawl/100)+I(other/100)+Zone,
data=subset(data, mult<5))
summary(model)
AIC(model)

model<-lm(lnmult~lnpop+lnSEIFA+lnrev+innet+offnet+inline+offline+inpot+intrawl+Zone, data=subset(data,
mult<5))
summary(model)
AIC(model)

step <- stepAIC(model, direction="both")
```

```
step$anova # display results

model <- lm(lnmult ~ innet + offnet + offline + inpot + intrawl, data=subset(data, mult<5))
summary(model)
AIC(model)

model<-
lm(lnmult~lnpop+lnSEIFA+lnrev+I(netsin/100)+I(netsoff/100)+I(linein/100)+I(linoff/100)+I(pots/100)+I(trawl/100
)+I(other/100)+Zone, data=subset(data, mult<5))
summary(model)
AIC(model)
step <- stepAIC(model, direction="both")
step$anova # display results

model<- lm(lnmult ~ I(linoff/100) + I(trawl/100) + I(other/100), data=subset(data, mult<5))
summary(model)
AIC(model)


## derive average multipliers and st error from the model
linoff <- c(0,100,0,0)
trawl <- c(0,0,100,0)
other <- c(0,0,0,100)

preddata <- as.data.frame(cbind(linoff,trawl,other))
preddata

predict(model,preddata,se.fit=TRUE)

## linear model

model<-
lm(mult~Population+SEIFA+revenue+I(netsin/100)+I(netsoff/100)+I(linein/100)+I(linoff/100)+I(pots/100)+I(trawl
/100)+I(other/100)+Zone, data=subset(data, mult<5))
summary(model)
AIC(model)
step <- stepAIC(model, direction="both")
step$anova # display results

model<- lm(mult~I(linoff/100) + I(trawl/100) + I(other/100), data=subset(data, mult<5))
summary(model)
AIC(model)

predict(model,preddata,se.fit=TRUE)



##############   LOCAL SUPPLY OF SEAFOOD ###########

sellshare <- NULL
sellshare$Public <- data$publicsell/data$totsell  ## sell direct to public
sellshare$Local_Retail <- data$localsell/data$totsell ## sell to local retailer
sellshare$Local_Agent <- data$agentlocalsell/data$totsell ## sell to local agent
sellshare$Local_Agent_sell_elsewhere <- data$agentelsewheresell/data$totsell ## sell to local agent who sells
outside the region
```

```
sellshare$Non_Local_Processor <- data$processsell/data$totsell ## sell to non-local processor
sellshare$Non_Local_Agent <- data$outagentsell/data$totsell ## sell to non-local agent

spendshare <- as.matrix(sellshare)
par(cex=0.9,las=2)
par(mar=c(8,4,2,2))
boxplot(x = as.list(as.data.frame(sellshare)),outline=FALSE,ylab="Proportion sold locally")  ## puts all the data into the boxplot

data$Local <- (data$publicsell+data$localsell+data$agentlocalsell)/data$totsell
boxplot(Local~maingear,data=data)
data$Non_Local <- 1-data$Local

Local <- tapply(data$Local,data$maingear,mean)
Non_local <- 1-Local

dotchart(as.matrix(Local),pch=19,cex=1.25,xlab="Proportion of catch sold locally")

selldata <- cbind(Local, Non_local)

dotchart(as.matrix(selldata),pch=19,cex=1.25,xlab="Proportion of catch sold")
```

Appendix F: R-code developed for assessing consumer benefits

```
library(foreign)
library(mlogit)
library(tidyr)

data <- read.spss("Interimdata.sav", to.data.frame = TRUE)  ## read the SPSS file
freq <- read.csv("Frequency.csv", header=TRUE)

head(data)
names(data)

dim(data)[1]

trialdata <- subset(data, select=c(respid,b1s1:b4s6)) # extract the respondent ID and the response to each choice
set
trialdata2 <- gather(trialdata,key=respid,choice,na.rm=TRUE)
names(trialdata2) <- c("respid","set","choicetext")

ChoiceSets <- read.csv("ChoiceSets.csv",header=TRUE)

sets <- c("b1s1","b1s2","b1s3","b1s4","b1s5","b1s6",
        "b2s1","b2s2","b2s3","b2s4","b2s5","b2s6",
        "b3s1","b3s2","b3s3","b3s4","b3s5","b3s6",
        "b4s1","b4s2","b4s3","b4s4","b4s5","b4s6")
choiceset1 =c(1.1,1.2,1.3,1.4,1.5,1.6,
          2.1,2.2,2.3,2.4,2.5,2.6,
          3.1,3.2,3.3,3.4,3.5,3.6,
          4.1,4.2,4.3,4.4,4.5,4.6)

choiceset <- cbind(sets,choiceset1)

newdata <- merge(trialdata2,choiceset,by.x="set",by.y="sets")

choicedata <- subset(data,select=c(respid,s1,s2_1,location,q21,q22,q23,q25_1,q3,q10,q26,q27,q28))

combine <- merge(choicedata,newdata,by.x="respid",by.y="respid")

finaldata <- merge(combine,ChoiceSets,by.x="choiceset1",by.y="Blocksen")

finaldata$ChoiceValue <- with(finaldata,
                    ifelse(choicetext == "Option 1: Ana's Fresh Fish",1,
                        ifelse(choicetext == "Option 2: Ben's Fresh Fish",2,
                            ifelse(choicetext == "Option 3: Con's Fresh Fish",3,4))))

finaldata$choice <- with(finaldata,ifelse(ChoiceValue==alt,1,0))

##### DEVELOP THE MULTINOMIAL LOGIT MODELS #######

Fish <- mlogit.data(finaldata, shape = "long",choice = "choice",alt.var="alt",id = "respid")
```

```r
f1 <- mFormula(choice~ Price+Qld+Local+Sustain+Fresh | s2_1+q25_1+q26+s1)
f2 <- mFormula(choice~ Price+Qld+Local+Sustain+Fresh)

m1 <- (mlogit(f1,data=Fish))
m2 <- (mlogit(f2,data=Fish))

summary(m1)
summary(m2)
lrtest(m1,m2)# test to see if the two models are significantly different

z <- with(Fish,data.frame(Price=tapply(Price,index(m2)$alt,mean),
                Qld=tapply(Qld,index(m2)$alt,mean),
                Local=tapply(Local,index(m2)$alt,mean),
                Sustain=tapply(Sustain,index(m2)$alt,mean),
                Fresh=tapply(Fresh,index(m2)$alt,mean)))

vcov(m2)  ## covariance matrix

######### CALCULATE WTP ###########
Qldpremium <- -round(coefficients(m2)[5]/coefficients(m2)[4],3)
Localpremium <- -round(coefficients(m2)[6]/coefficients(m2)[4],3)
Sustainpremium <- -round(coefficients(m2)[7]/coefficients(m2)[4],3)
Freshpremium <- -round(coefficients(m2)[8]/coefficients(m2)[4],3)
Premium <- rbind(Qldpremium,Localpremium,Sustainpremium,Freshpremium)

Qldstd <- -round(sqrt(vcov(m2)[5,5])/coefficients(m2)[4],3)
Localstd <- -round(sqrt(vcov(m2)[6,6])/coefficients(m2)[4],3)
Sustainstd <- -round(sqrt(vcov(m2)[7,7])/coefficients(m2)[4],3)
Freshstd <- -round(sqrt(vcov(m2)[7,7])/coefficients(m2)[4],3)
Premiumstd <- rbind(Qldstd,Localstd,Sustainstd,Freshstd)

results <- as.data.frame(cbind(Premium, Premiumstd))
names(results) <- c("Premium","std")
results
```

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