



**Adapt or Fail:
Risk management and business resilience in Queensland
commercial fisheries**

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Abbreviations

AMSA	Australian Maritime Safety Authority
ATO	Australian Tax Office
DAF	Department of Agriculture and Fisheries (Queensland)
FRDC	Fisheries Research and Development Corporation
GBRMPA	Great Barrier Reef Marine Park Authority
LGA	Local Government Area
MBSIA	Moreton Bay Seafood Industry Association
MSQ	Maritime Safety Queensland
NRM	Natural Resource Management area
QBFP	Queensland Boating and Fisheries Patrol
QSIA	Queensland Seafood Industry Association
QSMA	Queensland Seafood Marketers Association
RBA	Reserve Bank of Australia

Executive Summary

A collaborative team from James Cook University (JCU), the CSIRO, Fisheries Queensland (within the Department of Agriculture and Fisheries, DAF), and the Queensland Seafood Industry Association (QSIA) worked together to explore how different types of fishing businesses adapted to different types of change within Queensland's east coast fisheries. Led by PI Dr Renae Tobin from JCU, the team first sought to classify fishing businesses into 'types', exploring the industry structure in a new and innovative way, given the diversity of business capacity and mobility, and the overlap between fishery types on Queensland's east coast. Through surveys of just over 200 fishing businesses, they then explored what types of change and challenges different business types were exposed to and / or constrained by, whether businesses were able to successfully adapt to these changes or challenges, and if there were any specific driving characteristics that improved the likelihood of success. The aim was to identify common challenges and constraints, and ideally to lead to recommendations of what different fishing business types could do to adapt their business in the face of ongoing environmental, economic and management change.

Background

The idea for the project stems from the fact that change in the commercial fishing industry is inevitable, ongoing and cumulative; whether that be gradual or rapid change, or whether it be environmental (e.g. cyclones), economic (e.g. global financial crisis), or management (e.g. marine parks) related change. Given the continued reduction of outside assistance for commercial fisheries, it becomes increasingly important for fishers to be able to self-organise. We know from previous research that individual fishers have varying degrees of capacity to adapt to change. In part this relates to an individual's inherent capacity to cope with risk, but also to how individuals operate within and structure their business, and utilise opportunities. To improve adaptive capacity across the industry, we first need to understand if there are key characteristics that assist in ensuring successful adaptation to different types of change. Further, opportunities may be available for shared learning, where successful businesses can share their experiences and help improve the adaptive capacity of the industry as a whole.

Aims

The objectives of this project were to firstly document the current diversity of Queensland east coast commercial fishing businesses, and develop innovative typologies of business models. We then wanted to explore whether there were key characteristics within these business types that improved access to adaptation options, and whether there were common challenges or constraints to adaptation across the industry and between business types. We aimed to provide findings from this exploration back to the industry in the form of an information 'tool' that businesses could use to assist in future decision making (although this objective later changed to communicating common constraints and success stories).

Methods

The typologies for different business models were developed via 'clustering' based on licence, capacity, effort and harvest data available through DAF. A stratified sample of commercial fishing business across typologies were then surveyed through a combination of face-to-face, phone, email and posted surveys. Survey questions were based on a framework (Figure 1) designed to explore the contribution of individual and business characteristics to the ability to uptake various adaptation options, and to document common externalities and constraints that may affect implementation of options under a given type of change or challenge. Survey questions also explored actual adaptation behaviour, and whether that behaviour led to perceived success of the business in the short and long-term.

In total, 206 respondents (including those who operated their own licence, some who leased off others, and 'investors' who owned licences but did not fish themselves) completed the survey, with the sample spread along the Queensland east coast.

Initially, data were analysed descriptively to provide an outline of the findings, and hence a more in-depth understanding of the industry. Data were then analysed more formally to explore if there were any

relationships between individual characteristics, business characteristics, business types, and fishery types with the types of change they experienced or felt constrained by, the adaptation behaviour they displayed, and the perceived success of their business and their adaptation behaviour.

Key findings

Typology

We classified Queensland east coast fishing businesses into 11 ‘types’ (see Table 1) based on their key fishing characteristics. There was strong agreement from the fishers surveyed that they ‘fitted’ within the types they were placed. The typology was well received by fishery managers as a new way to think about the industry structure, particularly for those where there is high overlap between fisheries (e.g. net and pot), or where there is high diversity in capacity or mobility within a fishery. For example, when considering the potential impact of making changes to one specific fishery (e.g. the inshore net fishery), managers could more clearly envisage the potential flow on consequences in other fisheries where there is high overlap; or if there are proposed to management changes to one specific area (e.g. via area closures), managers may be able to explore the proportion of the fishers in the region that are likely to be most affected because the fish within a smaller region (i.e. they are ‘homing’) rather than ‘roaming’.

Table 1. Typology output of the 11 business ‘types’ A–L (missing ‘I’) within the Queensland east coast commercial fishery.

Label	Name	Description
A	Roaming trawlers	Larger boats and high GVP, fishing many regions – mainly trawlers
B	Homing trawlers	Like A but smaller boats and GVP, preferring the south
C	Big reef-liners	High GVP, quota holdings and landings and large number of dories – mainly line fishers
D	Small reef-liners	Like C but with smaller boats, and smaller GVP, quota holdings and landings
E	Roaming specialists	Medium boats fishing many regions but focussing mainly on a single method – a diverse group covering all methods
F	Homing specialists	Like E but also staying in a single region and little quota holdings – all methods except line and pot
G	Homing quota generalists	Very diverse methods yielding moderate quota landings while staying in a single region – a diverse group tending to pot and net
H	Homing non-quota generalists	Like G but focussing on non-quota species only – almost exclusively potters and netters
J	Roaming generalists	Uniquely diverse in methods and regions and tending to hold a large number of licences – like E, a diverse group covering all methods
K	Non-quota specialists	Single method landing non-quota species – almost exclusively pot, net and harvest fisheries including all worm licences
L	Sleepers	Inactive businesses

Enabling / constraining characteristics

Personal demographic characteristics can have implications for fishers’ ability to cope with and adapt to change, and to perceive success. As such, we included specific demographic traits within the enabling / constraining characteristics. Survey participants were primarily male, older (median 57 years), married / with a partner, but without dependent children. Few had education beyond high school, but many had experience or training in other work that they could rely on now (particularly investors). Respondents had many years of experience in the industry, and were highly attached to it as an occupation and lifestyle (though investors were less attached than operators). Most operators were heavily dependent on the industry for their individual and household income, while most investors were less dependent. Inherent

resilience (ability to cope, plan, learn and manage risk) was skewed to the positive (i.e. more respondents showed some level of positive inherent resilience), though most had ‘medium’ resilience to change. This was not correlated with business type.

When it came to networks, few fishers trusted any information source (though DAF, other fishers and QSIA were the most trusted), and many would not seek advice from others if they needed to make a change to their business. Most (60%) were not a member of any industry association.

Fishing business types with the largest capital investment (A: *Roaming trawlers*, B: *Homing trawlers*, and C: *Big reef-liners*; primarily in vessels, followed by licences/ symbols/quota) also had the highest costs (primarily fuel) and the highest proportion of loss-making businesses. These types were also more likely to have vessel insurance. The average age of vessels across all types was >23 years, with older vessels being owned by those dependent on trawl fisheries primarily (types A and B). Most respondents across all types, particularly operators, held only 1 licence (which was active at the time of survey), and most owned quota or effort units of some sort. Most operators had some sort of turnover of licences/symbols/quota in the previous financial year, whether that be buying/selling, or leasing in/out.

Most operators across all types received all of their fishing income from harvesting alone, while some also did some processing, or had a retail/wholesale business/outlet. Surveyed operators primarily were active in only one main fishery: however this varied according to the main fishery operators were dependent on – those dependent on line, trawl and harvest fisheries were more likely to rely solely on those fisheries for harvest income, while those dependent on net and pot fisheries usually relied on at least two main fisheries.

Most businesses stated they maintained a financial buffer in case of emergencies. However, most did not have any income insurance for their business, and less than half of the operators had vessel insurance.

Adaptive capacity

We explored operators’ (not investors’) ability to uptake specific potential practical / behavioural adaptation options based on their current fishing behaviour and business practices. These options included stopping fishing temporarily, changing fisheries, species, product type or markets, moving to unfamiliar grounds, or grounds further away from their current home port, or moving home ports. We found that if a sudden change occurred most operators would find it very difficult to take up these adaptation options. Using these options as indicators, we developed an ‘adaptive capacity’ measure: adaptive capacity was skewed to the negative (though most fit within the ‘medium’ adaptive capacity rank). As with ‘inherent resilience’ (above), this was not correlated with business type, though there were some weak positive associations with other characteristics such as education, quota ownership, financial buffer, vessel insurance, access to other fisheries, dependency on fishing for individual income and more experience relative to age.

Common changes, constraints and challenges

When we asked respondents about the types of **changes** that businesses experienced previously, **constraints** they were affected by currently, and **challenges** they were concerned about in the future, we found responses primarily related to issues within the Political, Legal and Governance category of the modified PESTEL framework¹ we incorporated to categorise responses. There was a particular focus on area restrictions and fisheries regulations within this category.

¹The PESTEL framework (first developed by Aguilar (1967)) is designed to provide researchers or managers with an analytical tool to identify different factors that may affect business strategies, and to assess how different environmental factors may influence business performance now and in the future. The categories within the framework were adapted by members of the steering committee in collaboration with researchers from CSIRO and the GBRMPA who were utilising our data in a concurrent study. The PESTEL Framework includes six types of important influences, which we modified to: Political, Legal and Governance, Economic, Social, Cultural and Functional Business, Fleet and Technological, Ecological and Environmental

By typology, type E (*Roaming specialists*) and K (*Non-quota specialists*) most commonly cited area restrictions as the biggest previous change that affected their business, while type H (*Homing non-quota generalists*) considered this their main current constraint. Regulation or overregulation were of greatest previous impact to type C (*Big reef liners*), and the most common current constraint for type E (*Roaming specialists*). *Big reef liners* (C) were concerned about economic change previously and currently, while *Small reef liners* (D) were concerned about ecological and social constraints currently. Interestingly, when comparing operators and investors, most operators were concerned about area restrictions as an upcoming challenge, while most investors were concerned about regulations or regulation change.

Importantly, the third most common constraint and upcoming challenge was uncertainty, and lack of security, respectively: this also relates to the first two constraints and challenges, and highlights the common issue of lack of security in the one type of change where there should be more certainty: i.e. governance (as opposed to environmental change or external economic change where there is less certainty and little control).

Adaptation behaviour

A majority of respondents were maintaining business as usual, but many were also increasing the size of their business and/or diversifying their operations. Most intended to remain in the industry, and operate as they are now.

Actual responses to previous change were influenced by different factors, but unfortunately were not consistent by typology. Given area restrictions or regulation changes, businesses were more likely to take some action rather than have ‘no response’. The likelihood of moving ports or fishing grounds was a response to area restrictions more than other changes, and was influenced by the number of licences held and active, and whether fishers had an alternative income (if they did, they were more likely to make ‘no response’ in their fishing business). Businesses were more likely to change their fishing practices if they had access to other fisheries, or had income insurance. Interestingly, those with higher inherent resilience were less likely to make changes to their fishing, and more likely to ‘stick it out’. Businesses made changes to their vessel if they had access to fewer fisheries, had vessel insurance, and had a higher individual income dependence than household income dependence on fishing.

Success

About half of the operators (but fewer investors) were satisfied with their current profitability and agreed they earn enough money to support the style of life they prefer. For both operators and investors there was strong feeling that the success of their business was determined by factors outside of their control, and many felt their business was in a worse position than it was 5 years earlier and they felt less secure than they did 5 years prior to the survey. Respondents were not overly optimistic about the future of their business or the fishing industry. Using this information as indicators to develop a measure of perceived ‘success’ of a business, the distribution is fairly balanced between high and low success, and most businesses fit within the ‘medium’ success rank. Comparing business types, we found a wide range of success outcomes, and no distinction between the types. Hence, there is no one type that we could consider to be more successful than the others, according to our measure. There is a weak but inconsistent correlation of some characteristics (e.g. existence of a financial buffer, age, higher individual income dependency) with success, but in general success or otherwise appears mainly due to unknown factors within each business.

In terms of success of actual adaptation behaviour in response to change, unfortunately most of those who did make a response to a change felt their response put their business in a worse position in the short and long-term. Some specific examples, particularly for more common changes and responses, are included in the results and help to highlight potential causes of these perceptions.

Implications

The findings of this report highlight the complexity of the industry and the generally individual nature of responses to change. We find there is no clear ‘recipe for success’, or predictor of failure. Consistencies in

the types of change and constraints that different business types experience may help in future planning, however the lack of consistency in characteristics that determine adaptation behaviour and success makes it difficult to develop a clear plan to assist in improving adaptation to change.

What we can do is learn from success stories – of which some are outlined in the results of this report. To do that, these and other stories need to be shared within the industry and with managers. Communication and shared learning is critical, and the onus is on managers as well as representative bodies and industry leaders to develop communication mechanisms that are currently lacking. The apparent lack of security fishers feel within in the industry seems to stem from uncertainty in future management plans (whether that be related to area restrictions or fisheries regulations), and this lack of security likely leads to an incapacity to plan and experiment and, hence, to adapt successfully to change in the long term.

Keywords

Adaptive capacity, resilience, typology, fisheries management, commercial fisheries

Introduction

Change is inevitable; whether it be management, environmental, social, or economic change. Improving how industries cope with, and adapt to, change becomes increasingly important as rates and cumulative impacts of change escalate. With decreasing opportunities for government assistance, it is increasingly recognised that to ensure the ongoing viability of the fishing industry, fishers will need to be able to self-organise in the face of change (Grafton 2010; Lane 2011).

Within the commercial fishing industry, some businesses and individuals are better able to cope with, and adapt to, change than others (Tobin et al. 2010b; Marshall and Tobin 2012; Sutton and Tobin 2012). In part this is due to the inherent capabilities of some individuals to cope with change, learn, plan, and manage risk – elements we can measure through resilience frameworks (Marshall and Marshall 2007). We know from previous research that more resilient fishers are better able to cope with change and adapt to it, and that these operators are less likely to seek compensation when change occurs (Sutton and Tobin 2012). Other differences that may influence adaptation relate to access to adaptation options, which may rely on factors such as business structure, business location, primary fishery, diversity of operation (within and outside of fishing), geographical mobility, access to information and financial capacity, or even historical experience (Badjeck et al. 2010; Grafton 2010; Holbrook and Johnson 2014).

Recent research into Queensland fisheries specifically provided some insight into what may contribute to resilience within commercial fishing businesses, but also produced surprises and raised further questions. For example, surveys of commercial line fishers in the Great Barrier Reef following Cyclone Hamish showed diversification of operations (in terms of species harvested or the number of fisheries utilised) may be advantageous to improve access to adaptation options (Tobin et al. 2010a). This is supported by other studies which have found that fishing businesses with more diversity – whether that be in species harvested, regions fished, or occupations employed – can better adapt to change (Allison and Ellis 2001; Badjeck et al. 2010). However, diverse and flexible business structures require diverse and adaptable institutions and policies (Badjeck et al. 2010). Typically, in developed countries, fisheries tend to become more rigid and specialised over time, targeting a few high value species, and being managed at a specific fishery (rather than cross-fishery) level. In the post-Cyclone Hamish example, the more specialised fishers were expected to be able to adapt due to their greater financial capacity and larger vessels, but there were unexpected constraints: fishers were highly site attached due to familiarity with fishing grounds and markets as well as social factors such as family connections, and those with larger businesses also had greater financial burden which meant they could not stop fishing while the system recovered. Further, when management flexibility was exercised by changing processing laws, fishers lacked the experience, skills and markets to take up the opportunity to diversify their product (Tobin et al. 2010a).

Two years later, when Cyclone Yasi impacted northern Queensland, it was expected that the diverse fishers prominent in that region would adapt well; however, Cyclone Yasi affected most fisheries (in contrast to Cyclone Hamish which impacted the Reef line fishery only), reducing access to the adaptation option of changing between fisheries. In this case those fishers who were more mobile or who had diverse sources of income were more able to adapt (Marshall and Tobin 2012; Marshall et al. 2013). Both of these studies highlighted the need to better understand the complexity of drivers and constraints affecting adaptive capacity and resilience.

Previous research investigating change has tended to focus on a single change event (e.g. a cyclone, or a management change such as marine park implementation). However, change can be cumulative, which may influence the ultimate impact of change, and how fishers respond to it. Further, research and management tends to focus on single fisheries, to gain an understanding of what change is likely to occur, and how businesses within those fisheries may respond. While this makes sense from an ecological management standpoint, in Queensland (as in many other areas), commercial fishing businesses may access one or more fisheries (as outlined in (Tobin et al. 2010b; Marshall and Tobin

2012; Marshall et al. 2013). For those businesses accessing multiple fisheries, it doesn't make sense to assess likely change impacts and adaptive capacity by single fishery type. Further, even within fisheries, businesses vary according to factors such as their 'size', related to vessel size and number, number of licences held, dependency of crew, financial investment, and revenue. These characteristics may influence what options are available, and their capacity to uptake adaptation options. Hence, it is important to identify factors or resources that improve access to and uptake of adaptation options (van Putten et al. 2013), across fisheries, and between different types of businesses, whether they are large or small, specialized or diverse, mobile or immobile.

We also need to develop educational awareness and communication strategies that promote the implementation of best practices appropriate to the nature of risks faced by fishing operations (Pecl et al. 2009), which may or may not depend on their current behaviour and business structure. Given a well-informed industry can be more proactive in managing impacts of change (Pecl et al. 2009), we need to communicate and share options for change, and identify possible management options which could reduce some constraints on adaptation and hence increase resilience.

This project sought to build on the learnings of, and address many of the questions raised through, previous research and strategies. It sought to do this by focusing on all types of change, rather than specific change events, and exploring change and adaptation responses across all fisheries and types of fishing business on Queensland's east coast. This project evolved with input from fishery and management stakeholders as well as other researchers in this field over the past few years. We aimed to explore the key individual fisher and business traits and options that contribute to adaptive capacity, as well as traits of individual fishers, businesses and management strategies that constrain access to or uptake of those options. We also aimed to improve uptake of knowledge of adaptation options for different fishing business types.

Objectives

The objectives of this report, as agreed in the original contract, were to:

1. Document the current diversity and develop a typology of business models and operation types employed across all commercial fisheries on Queensland's east coast;
2. Explore the current adaptation options for different business model types regarding risks associated with economic, management and environmental changes;
3. Document the common constraints affecting uptake of adaptation options between and across business model types;
4. Provide information tools regarding adaptation options for different business model types to fishers and managers, to enable the improvement of adaptive capacity and hence resilience.

The first three objectives were achieved. However the 4th objective (develop an information tool) was not possible given the results. This objective is adjusted to:

4. Provide information on common constraints and successful adaptation examples to fishers and managers.

Methods

First, a note: This project ran concurrently with a number of other related research projects and a management review.

- 1) In particular, economic data collected from the surveys of this project contributed directly to FRDC project 2013/301 “Beyond GVP: The value of inshore commercial fisheries to fishers and consumers in regional communities on Queensland’s east coast”, led by Dr Sean Pascoe of the CSIRO. The two projects were developed together, with the express intention of combining sampling efforts and steering committee meetings.

During the project, a number of other synergies became apparent:

- 2) GBRMPA and the CSIRO were undertaking a ‘situation analysis’ of adaptation within Queensland commercial fisheries. The timing of these projects allowed the direct contribution of data from our surveys to the Bayesian Belief Network analyses of the GBRMPA-CSIRO project, and influenced our methods of analysis regarding coding of changes, challenges and constraints.
- 3) JCU PhD student Rebekah Boynton was studying factors that influence adaptive capacity in commercial fisheries in Queensland, and had intended to interview fishers at the same time as the surveys for this project. To reduce overlap and survey fatigue, it was agreed that we would include some additional questions for Ms Boynton in the fisher surveys for this project. These questions are not analysed in this report, but will be presented in Ms Boynton’s thesis and resulting scientific publications (credit will be given to FRDC for finding).
- 4) The Queensland government commissioned an independent review of Queensland’s fisheries management (the ‘Queensland Fisheries Review’), which commenced just prior to the surveys for this project. In consultation with the review team (MRAG Asia Pacific), we developed questions specifically to explore fishers’ opinions about future management needs. This information was supplied to MRAG consultants.

1) Typology development

To explore adaptive capacity across Queensland fisheries, and impacts and constraints affecting them, we first need to understand the structure of the industry. To break this diverse industry into quantifiable ‘groups’ we first developed a ‘typology’ of the Queensland east coast fishing industry via stratification. We aimed to assess adaptive capacity across different types of fishing businesses on Queensland’s east coast, rather than focusing solely on single fishery types. The typology was developed in part to guide sampling for the surveys to follow, but also to identify businesses with similar characteristics across fishery types. The stratification of businesses should be such that: 1) different strata capture the full range of business behaviour and characteristics, and 2) businesses within each stratum should be broadly similar so that a random sample from each can represent the stratum as a whole.

The resulting stratification is also referred to as a *typology*; other terminology to describe the process of arriving at a typology are *clustering* and *partitioning*. The typology implied that businesses were assembled on a continuum whereby partitions along the continuum separated businesses into crude homogeneous groups or clusters. The term clustering implies a search for well-defined groupings among the businesses, with a clear number of clusters emerging from the analysis; on the other hand, partitioning implies that the businesses lie on a continuum and the purpose is to find a reasonable separation into a number of partitions, the number being governed by design considerations. The

analysis presented here is closer to partitioning than clustering. However, we use the word cluster when referring to the groups arising from the analysis, since this is commonly used terminology.

Data types

The Queensland fishery licence holder data were extracted from three raw data sets, provided under a Data Agreement with Queensland's DAF. These data are readily available to fisheries managers, and hence the method is repeatable over time to explore changes in business structure within the fishery. These data sets outlined details of a) licence, b) harvest and c) quota held for each business, and are detailed as follows.

a) Licence data

Licence data included the name and address of the business, the licences held (as per Authority Chain Number, ACN), and the symbols and vessel length attached to each licence. Businesses with similar name and address were considered to be one business and hence given the same unique identifier. Symbols held by each business (e.g. 'L') were extracted, along with the associated number of dories (e.g. where 'L(1)' means 1 dory is permitted), where appropriate. Note, possession of a symbol does not necessarily mean it is used, and the permissible number of dories is not necessarily utilised.

b) Harvest data

Harvest data included all commercial fisheries/methods for licences that were actively fished in the 2013/14 financial year. Some businesses (82) did not appear in the harvest database, likely due to inactivity at the time. Data included effort (days), landings (kg), and GVP (\$) at a fishery and regional level. Regions were, from north to south, Far Northern, Northern, Wet Tropics, Burdekin, Mackay-Whitsunday, Fitzroy, Burnett-Mary and South East Queensland.

Note, GVP was not provided by most 'harvest' fisheries (i.e. those fisheries where harvest is by hand, including eel, aquarium fish, beche-de-mer, coral, rocklobster, beachworm and yabby): We therefore estimated the GVP from estimates of beach price and their landings data. For the coral/aquarium fish harvesters we assumed a combined GVP of \$12M, which we split 50:50 in order to estimate separate unit prices to be consistent with a total of \$6M in each fishery. For the worm and yabby harvest we assumed all landings were worm numbers, as this is the main component of this fishery.

c) Quota data

Quota data consisted of the amount of quota (kg) held under a business name. Business names in the quota database were unfortunately not consistent with those in the licence database. Although many names did match, some further effort was required to match up similar names. In all, 574 businesses that occurred in the licence data base also appeared in the quota data base. In the quota data base, 310 businesses could not be matched to a business name holding a licence. It is not possible to include these businesses in the typology analysis because of the very limited information about them.

The types of quota are: Coral Trout†, Other Beche-de-mer*, Other Coral, Other Species†, Red Throat Emperor†, Spanish Mackerel, Spanner Crab, Specialty Coral*, Trawl – Concessional‡, Trawl – East Coast‡, Trochus*, Tropical Rock Lobster*, Zone 1 White Teat Fish, Zone 2 White Teat Fish.

There were two problems with the quota data:

1. The values were potentially sensitive to the timing of the data request. For the reef species (marked †) quota information was available at both the start and end of the 2012 season, so that landings could be computed. For the remaining species, some (marked *) had quota values at the start of the 2013 season, whereas the others were for remaining quota at 19-11-2013.
2. Unlike other quotas which use units of weight, the units of trawl quotas (marked ‡) relate to effort and vessel size. This was accommodated approximately by converting the quota to weight equivalents using a regression of catch on quota for the relevant businesses.

The following statistics were computed from the raw data sets for each business:

- Measures of diversity:

- number of licences held (nacr),
 - number of symbols held (nsym),
 - number of fisheries/methods (nfm),
 - number of regions fished (nrgn).

The first two of these measure potential diversity whereas the second two measure actual diversity as seen in the harvest data base.

- Measures of capacity:

- maximum dories per licence (mxdr),
 - average boat length (avgl).

The average boat length is the average of the boat lengths under each licence. Maximum dories is the largest number of dories a business is permitted to fish under any symbol.

- Measures of activity and investment:

- total GVP (tgvp),
 - fraction of total GVP in primary region (frg),
 - fraction of total GVP by primary fishery/method (frfm),
 - total days fished (tday),
 - landed quota species (lanq),
 - refined landed quota species (†) (refq),
 - total quota held (tquo).

See measures of preference (below) for meaning of ‘primary’. These numbers will be missing if the primary case is based on landings. The fractional GVP measures, which are often close to 1, can also be regarded as (inverted) diversity measures. The landed quota species is a very rough estimate from the harvest data. We assume that all landings were quota species except for the following fishery/methods: Net, Pot, Adult Eel, Aquarium, Beachworm, Bloodworm and Yabby, and Juvenile Eel. In the case of Pot, however, the landings were assumed to be quota if the licence held a spanner crab symbol (C2–3). The refined version of the landed quota uses the species-level landings from the quota data base for the Coral Reef Finfish Fishery (RQ) species. This may be an underestimate in some cases because Spanish mackerel are not included. We therefore included both variables in the analysis, since neither is ideal.

- Measures of preference (categorical)

- primary fishery/method used,
 - primary region fished,
 - biggest quota species.

The ‘primary’ cases are those for which GVP (or landings, if GVP is missing) was highest.

Partitioning

Partitioning was performed by characterising businesses by 13 numerical variables (nanc–tquo) and three categorical preference measures (see above). We can imagine the businesses as a cloud of points in a 13-dimensional space. As this is impossible to visualize, we use principal components analysis to reduce the data to a manageable number of dimensions.

An approach called partitioning about medoids or PAM (Kaufman and Rousseeuw 1990) was used to search for a partitioning that minimizes the sums of the distances of all points (businesses) to their group medoid. The medoid of a group is the most representative member in the sense that it has the smallest average distance to all other members. PAM tends to result in fairly even partitions (no very small or very large clusters). The evenness of PAM’s clusters is a highly desirable property in the stratification of a survey.

Clustering methods define a distance between businesses. Here, as with Thébaud et al. (2014), we used Euclidean distance, which is natural for continuous data. Euclidean distance requires that the 13 variables be on comparable scales, so we centred and scaled the variables to unit variance. Also, to avoid the creation of small groups with extreme values, we \log_{10} -transformed the skew variables (tday, tgv, lanq, refq, tquo, nactn) before scaling. The assumption here was that all variables had equal importance in determining distance.

The PAM method had a further advantage in that it provided each cluster's silhouette width, which is a measure of cohesiveness from 0 to 1. Values close to 1 imply well-defined clusters whereas values close to 0 imply greater ambiguity in cluster membership. By taking into account average silhouette width under different numbers of clusters, we arrived at a more objective choice for the number of clusters.

2) Assessing adaptive capacity

The methodological framework

Before beginning the survey design, a methodological framework was developed in consultation with the steering committee, in order to ensure we explored all types of change (here also called 'impacts' or 'challenges') that might affect fishing businesses, business characteristics that might influence adaptive capacity, influences or externalities that affect businesses' ability to adapt, practical adaptation behaviour, and whether businesses were successful in adapting to change. The final framework is shown in Figure 1.

Following the framework, **IMPACTS / CHALLENGES** include anything that has in the past, or may in the future, affect a fishing business. This could be environmental (e.g. a cyclone), management (e.g. a new management plan or regulation; marine parks), financial (e.g. market price), or personal (e.g. health) change. There are likely various **OPTIONS** businesses can utilise in response to these changes, such as stopping fishing temporarily if there is sudden but short term change, moving areas, investing in another licence or a new vessel, diversifying their businesses either within the fishery (e.g. harvesting more species) or outside of the fishery (e.g. adding a point of sale business). A business's **CAPACITY** to implement any given option may be affected by various **individual CHARACTERISTICS** such as their age and knowledge, or their inherent resilience to change, plus **business CHARACTERISTICS** or traits such as their current level of diversity or specialisation, their business size, fishery type, or region they fish. Each of these characteristics, and the ability to translate capacity to actual behaviour, is affected by various **EXTERNALITIES**, such as fisheries and marine park regulations, competition with other fishers or sectors, or markets. Given all of these elements, we then want to understand the response of businesses, or their **ADAPTATION BEHAVIOUR**, and whether this leads to success (measured as perceived success, by the businesses, rather than an absolute measure of profit or business size – a 'successful' business may be of any 'size').

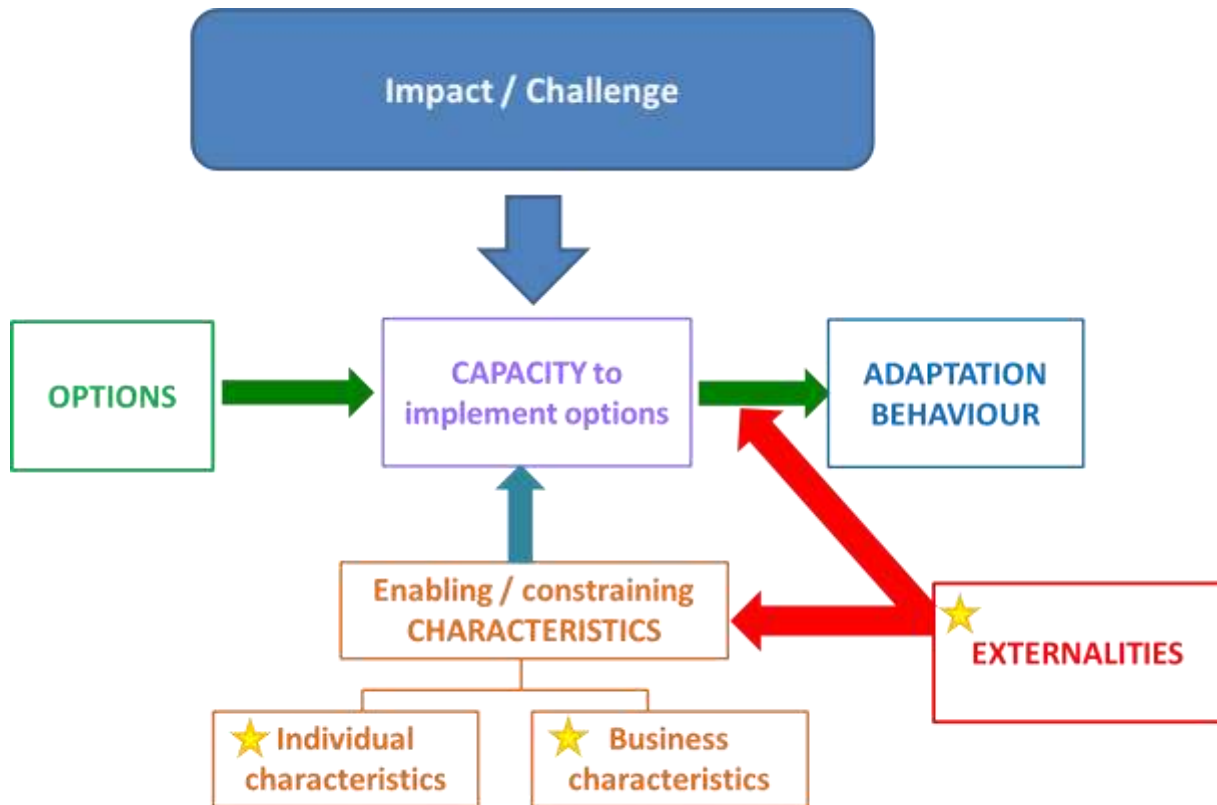


Figure 1. Methodological framework to explore adaptation behaviour to multiple change types. Stars indicate areas of potential influence (i.e. elements that could be changed to improve capacity or allow adaptation behaviour)

Survey development

Surveys were developed based on the framework above, substantial review of the literature, previous surveys from within and outside of the project team, and input from multiple sources (the steering committee, the ‘Beyond GVP’ project team, GBRMPA staff, MRAG’s Duncan Souter, and JCU PhD student Rebekah Boynton).

Separate surveys were designed for those businesses considered as ‘Operators’ (i.e. those who own a lease a licence and actively fish) versus ‘Investors’ (i.e. those who own at least one licence, but do not fish themselves). Most information collected was the same for both groups, however some questions for operators were not relevant for investors, and vice versa. Draft surveys were pilot tested with a small selection of fishers before being finalised. The final survey took at least 30 minutes to complete, with final times being highly dependent on the level of detail and discussion provided by the respondent. The final surveys are shown in Appendix B-D.

Human ethics approval for the survey was covered under JCU permit H7511.

Survey deployment

A random selection of fishers was chosen from the businesses identified in the Queensland fishery licence holder data used for the typology. The random list was stratified by business type (according to their type or cluster as below) and region.

All businesses selected on the random list were sent a letter inviting them to participate (see Appendix E), and asking them to please call the researchers listed. This was accompanied by a media release, an

article in QSIA's 'Queensland Seafood' magazine, and as part of a profile article in FRDC's Fish magazine. Contact details for some licence holders were available from lists maintained by the PI, which included phone numbers for those who had participated in previous research and explicitly given permission to be contacted again. Other phone numbers were sourced via the white pages, internet searches and via snowballing with survey respondents. Snowballing also allowed access to those fishers who were leasing licences from others. Fishers were also approached in person at wharves by survey staff.

Surveys were completed between June and November 2014. Multiple survey staff were deployed along the coast from Cairns to the Gold Coast, with the aim of completing surveys face-to-face. For those fishers not available when survey staff were in their area, or those living in areas not visited, surveys were completed over the phone. A few fishers requested paper copies to complete themselves – these were sent by post, and accompanied by a reply-paid envelope.

In total, 374 businesses were contacted. Of these, 63 were not business owners within the Queensland East Coast fisheries, had stopped fishing, or were not available / contactable. Of the active people contacted (311), 206 completed the survey (188 'operators' who actively fish; and 18 'investors' who own licences but do not fish themselves), giving a response rate of 66%.

Analysis

Results were initially subject to basic descriptive analysis, describing the sample and overall findings for each of the framework elements.

Open-ended questions were coded into 'categories' including 2-3 levels of internal sub-categories, to allow the identification of trends among businesses. For the types of **change**, upcoming **challenges**, types of **responses** undertaken or desired, and main **constraints** on businesses, responses were placed into categories within Microsoft Excel by two independent coders, to enable investigation of trends. Level 1 categories followed modified PESTEL categories (first developed by Aguilar (1967), and modified by multiple others since (Fernandez et al. 2011)). The categories were adapted by members of the steering committee in collaboration with researchers from CSIRO and the GBRMPA who were developing a situational analysis of adaptation of commercial fisheries in Queensland (this CSIRO-GBRMPA project was running concurrently with the present study, utilising data from the fisher surveys collected here). The PESTEL framework is designed to provide researchers or managers with an analytical tool to identify different macro-environmental factors that may affect business strategies, and to assess how different environmental factors may influence business performance now and in the future. The PESTEL Framework includes six types of important environmental influences: **political**, **economic**, **social**, **technological**, **environmental** and **legal**. The modified categories are described in Table 2.

Table 2. Description of the PESTEL categories modified for coding open-ended responses related to the types of change, challenges and constraints businesses experienced, plus their responses to these.

Label	Name	Description
P	<i>Political, Legal and Governance</i>	This category includes the political framework (e.g. environment credentials of the Queensland State or Commonwealth governments) within which management decisions are made, the legal framework (e.g. the EPBC Act, Queensland Fisheries Act) and the overall governance system (GBRMPA, DAF) that applies to Queensland fisheries.
E	<i>Economic</i>	This category relates to external or ‘macro-economics’, rather than economics within the Business. It includes aspects that relate to fisheries, but are generally outside of the control of a fisheries business, such as the exchange rate, fuel prices, tax system and unemployment rate
S	<i>Social, Cultural and Functional</i>	This category include aspects such as equity, social capital, minimise conflicts, and personal traits (e.g. health, family).
T	<i>Business, Fleet and Technological</i>	Technological and business-scale economic decisions are intertwined and as such placed together in these modified categories. This category includes ‘micro-economics’ in the context of business scale economics (e.g. size of a business loan), technological (e.g. gear types) and other decisions (e.g. which suite of fisheries licences to own, where and when to fish) that a business is able to influence directly.
EL	<i>Ecological and Environmental</i>	This category includes all aspects of the environment that relate to fisheries, including the inshore, offshore and the coastal ecosystem. This category also includes environmental factors such as rainfall and cyclones.

The PESTEL categories were on the whole too generic, so some categories were split into finer sub-categories that were more directly relevant to the Queensland fishery. Some of these level 2 categories turned out to be too fine, having only a few respondents, so an intermediate *lumped* grouping was created in which some of these categories were lumped together. Some cases of lumping from level 2, though not immediately obvious, arose from going back to the detailed answer and finding common ground there (see the results section for the final categories).

Following the presentation of descriptive results, more complex analyses were completed to explore the influence of different individual and business characteristics on various key findings (See Table 3 for a list of variables). While some detail of these analyses are provided here, specific analyses are described in the results where appropriate.

Table 3. Individual and business characteristics used in analyses exploring the influence of variables on measures such as adaptive capacity, type of change experiences, response to change, and success. These variables consist of: numerical responses (age, experience, indiv_income, house_income, nport, nlicence, nactive, nbuyer_local, nbuyer_other); binary (yes/no) response (education, quota_owned, buffer, insure_income, insure_vessel, network_assoc); and categorical responses (optype, type, home, port, quota_type, fishery, fisheries, network_trust, network_advisor). *Scores were developed by combining sets of relevant questions. See Table 4. The three questions constraint, change, and response were open-ended: see text below for how they were coded for analysis.

Code	Survey question
type	Business type (A, B, C, D, E, F, G, H, J, K, L)
home	Home NRM
port	Home port NRM
age	Age
education	Do you have university or tafe education (beyond high school)? Y / N
experience	How many years commercial fishing (or investing)?
indiv_income	What percentage of your <i>individual</i> income comes from fishing?
house_income	What percentage of your <i>household</i> income comes from fishing?
nport	Number of <i>ports</i> used
nllicence	Number of <i>licences</i> owned
nactive	Number of <i>active</i> licences
quota_owned	Did you own any <i>quota/effort units</i> in 2013/14?
quota_type	Quota type owned
fishery	Main <i>fishery</i> dependency (Combination, Harvest, Line, Net, Pot, Trawl)
fisheries	Fishery types accessed (one or more of Harvest, Line, Net, Pot, Trawl)
nbuyer_local	How many buyers do you sell to: In your <i>local</i> region?
nbuyer_other	— <i>Elsewhere</i> ?
resil_score*	F-Score for <i>inherent resilience</i>
buffer	Do you actively maintain a <i>financial buffer</i> in case of emergency?
insure_income	Do you have <i>income protection insurance</i> for your business?
insure_vessel	Do you have <i>vessel insurance</i> ?
option_score*	F-Score for <i>adaptive capacity</i>
constraint	What is the main <i>constraint</i> on your ability to adapt to changes?
change	What was the most significant <i>change</i> in the past 10 years?
response	What changes did you make in <i>response</i> to that change?
change_positive	Was the change positive?
success_short	What position did these changes put your business: In the <i>short</i> term? (Worse, Same, Better)
success_long	—In the <i>long</i> term? (Worse, Same, Better)
success_secure	How <i>secure</i> do you feel in your fishing business? (1–5)
success_score*	F-Score for <i>success</i>

For some framework elements, multiple questions were asked to give an overall measure of the element (i.e. inherent resilience, adaptive capacity, and success; see Table 4). For these elements, combined questions were subjected to reliability analysis within SPSS based on a calculation of the correlation among statements, using Cronbach's α (Chen and Popovich 2002). A value of 0.7 or greater was accepted as indicating a reliable scale (Nunnally 1978; Marshall and Marshall 2007). Dimension reduction was then applied within SPSS, to give an 'F-Score' via factor analysis for each respondent. These F-Scores were converted to low, medium and high 'ranks'. Distribution of scores / ranks between business types were graphed and statistically tested (e.g. using *t*-tests to test for differences between types) where appropriate. Regression analyses tested for relationships between

adaptive capacity, resilience and success scores with various individual and business characteristics (See Table 3 for a list of characteristics included). See the results for more detail of specific analyses used for each score type.

Table 4. Survey questions used to develop scores of ‘resilience’, ‘adaptive capacity’, and ‘success’.
Variables include ordinal responses (*success_short*, *success_long* and most codes beginning *network_*) including 5- and 10-points qualitative scales for resilience, (*resil_...*) adaptive capacity (*option_...*) and success (*success_...*).

Code	Survey question
Resilience	
<i>resil_decisions</i>	I am happy to make <i>decisions</i> when faced with uncertainty (1–10)
<i>resil_plan</i>	I am sure of how to <i>plan</i> for changes (1–10)
<i>resil_risks</i>	I am willing to take higher <i>risks</i> (1–10)
<i>resil_future</i>	I am good at planning for the <i>future</i> (1–10)
<i>resil_discuss</i>	I <i>discuss</i> new ways of solving problems with others (1–10)
<i>resil_adapting</i>	I am more likely to <i>adapt</i> compared to others (1–10)
<i>resil_learning</i>	I am interested in <i>learning</i> how to prepare (1–10)
<i>resil_options</i>	I have many job <i>options</i> available (1–10)
<i>resil_age</i>	I am not too young or too old... (1–10)
<i>resil_trying</i>	I would not be nervous <i>trying</i> something else (1–10)
<i>resil_financial</i>	I have <i>planned</i> for my financial security (1–10)
<i>resil_skills</i>	I am interested in learning <i>new skills</i> (1–10)
Adaptive Capacity	
<i>option_stop</i>	If a sudden change occurred, how easy it would it be to: <i>stop</i> fishing temporarily? (1–10)
<i>option_fishery</i>	—Change <i>fisheries</i> ?
<i>option_species</i>	—Change target <i>species</i> ?
<i>option_product</i>	—Change <i>product</i> ?
<i>option_market</i>	—Change <i>market</i> ?
<i>option_further</i>	—Move to fishing grounds <i>further away</i> ?
<i>option_new</i>	—Move to <i>new</i> fishing grounds?
<i>option_port</i>	—Move home <i>ports</i> ?
<i>option_score</i>	F-Score for <i>adaptive capacity</i>
<i>change_positive</i>	Was the change positive?
Success	
<i>success_profit</i>	How satisfied are you with your current <i>profitability</i> ? (1–10)
<i>success_earning</i>	I currently <i>earn enough</i> money to support lifestyle (1–10)
<i>success_1year</i>	Improvement compared with position <i>1 year ago</i> (1–5)
<i>success_5year</i>	Improvement compared with position <i>5 years ago</i> (1–5)
<i>success_secure</i>	How <i>secure</i> do you feel in your fishing business? (1–5)

For these more detailed analyses, to reduce the number of ‘lost’ cases due to missing responses some values were imputed using various techniques. For example, a few respondents failed to provide one of age or experience, so this was imputed one from the other by adding or subtracting 28, the mean difference between age and experience. This was justified because age and experience were reasonably correlated (53%). There were a moderate number of missing answers to the resilience, adaptive capacity and success scores. To improve the number of useable records, for these elements,

we applied an imputation method to predict the missing values from other related characteristics. We used *median polish*, which is a simple method for data in tabular form that takes its name by analogy with polishing along and across a wooden table top. First, the table is swept down the columns, replacing missing values by the column (raw score) medians; next, the table is swept across the rows, replacing the originally missing values by the current row (business) medians. The process is repeated until the replaced values no longer change. Since median polish was originally designed for continuous data on a spatial grid, we needed to make two adjustments to make it applicable. First, the integer values were jittered by a random amount up to 0.5 either side of the actual value, and the final imputed values rounded back to integers. Second, the jittered 5-point scale values were adjusted to align with the jittered 10-point scale, so that medians across rows made sense. On repetition, the randomness produced occasional 1-point differences in a few cases, which we considered acceptable. Because the missing values occurred sporadically, this method worked well for imputing all resilience and success scores and most adaptive capacity scores. The exceptions were the 18 cases where no option_... scores were recorded, for which the adaptive capacity score could not be imputed.

We framed the analysis by assuming a flow of causation as follows, starting from the bottom of the methodological framework (Figure 1): **business type** or **characteristics** may influence **adaptive capacity** and **resilience**, which in turn may affect or be affected by the **constraints** and principal **change type**. All of these variables may affect how the business **responds** to a change. Finally, everything in this chain of causation affects the **success** of the outcome. Our objectives for the analyses can be listed in increasing order of priority as:

1. What variables influence a business' **adaptive capacity** and **inherent resilience**? These may include business type and other individual fisher characteristics.
2. What variables influence the main **change** and **constraints** nominated by a business? These may include adaptive capacity, resilience, business type, and other individual business characteristics.
3. What variables influence the type of **response** to a change? These may include the change and constraint types, adaptive capacity, resilience, business type, and other individual business characteristics.
4. What variables influence the degree of **success** of a response to a change? These variables may include the response type itself, the change and constraint types, adaptive capacity, resilience, business type, and other individual business characteristics.

All results are displayed following the framework described above (Figure 1) working from the bottom up towards the top right of the framework; i.e. starting with the **individual** and **business characteristics**, outlining potential adaptation **options** for any change, describing business **capacity** to adapt or implement options, and exploring common **constraints** and **barriers**, before exploring specific **change types**, **businesses responses** to those changes, and whether those changes were successful. Results for each element of the framework are first described, before more detailed analyses tested for variables of influence.

3) Information Tool development

The original intention was to provide an information tool that fishers could follow to help guide decision making under future change situations. However, this section changed due to the project findings. Please see the results for more detail here, now under the heading 'Learning from success':

'Success' stories within the sample were identified, by highlighting businesses that had a 'high' success rank (developed from indicators relating to satisfaction with profit and earnings for lifestyle, improvements in business position in short and long term in response to change, and security in their business, see Table 4). From these businesses, respondents who listed detailed information about what change they experienced and how they responded to it, were selected as 'case studies' to present.

Results

To assist in interpretation each section of the results is precluded with a ‘Key Findings’ box which outlines the key findings of the section in plain language.

1) Typology

Key Findings

- We identified 1035 individual businesses holding 1 or more licences in Queensland east coast fisheries (based on 2013 DAF data)
- We summarised the key business characteristics of these businesses (e.g. type and number of fisheries accessed, licence holdings, quota holdings, key fishing regions, mobility)
- The data were explored to identify for ‘clusters’ or groupings of different business types
- The final typology revealed 11 business ‘types’ (see Table 5 and Table 6).

From the Queensland fishery licence holder data which consisted of three data sets (a) licence, b) harvest and c) quota), 1035 individual businesses were identified (labelled 1–1035). In all, 574 businesses that occurred in the licence database also appeared in the quota database. In the quota database, 310 businesses could not be matched to a business name holding a licence.

The structure of the businesses is seen in the heat map of Figure 2. Some businesses (groups a–e) are specialist in certain quota species, whereas others (group f) are generalists across a range of species. Although this figure shows the structure of the quota holders in the fishery, this is only one aspect of the businesses’ characteristics; we should not expect the typology to align with the groups seen here. The spread of other characteristics measured are shown in Figure 3, Figure 4 and Figure 5.

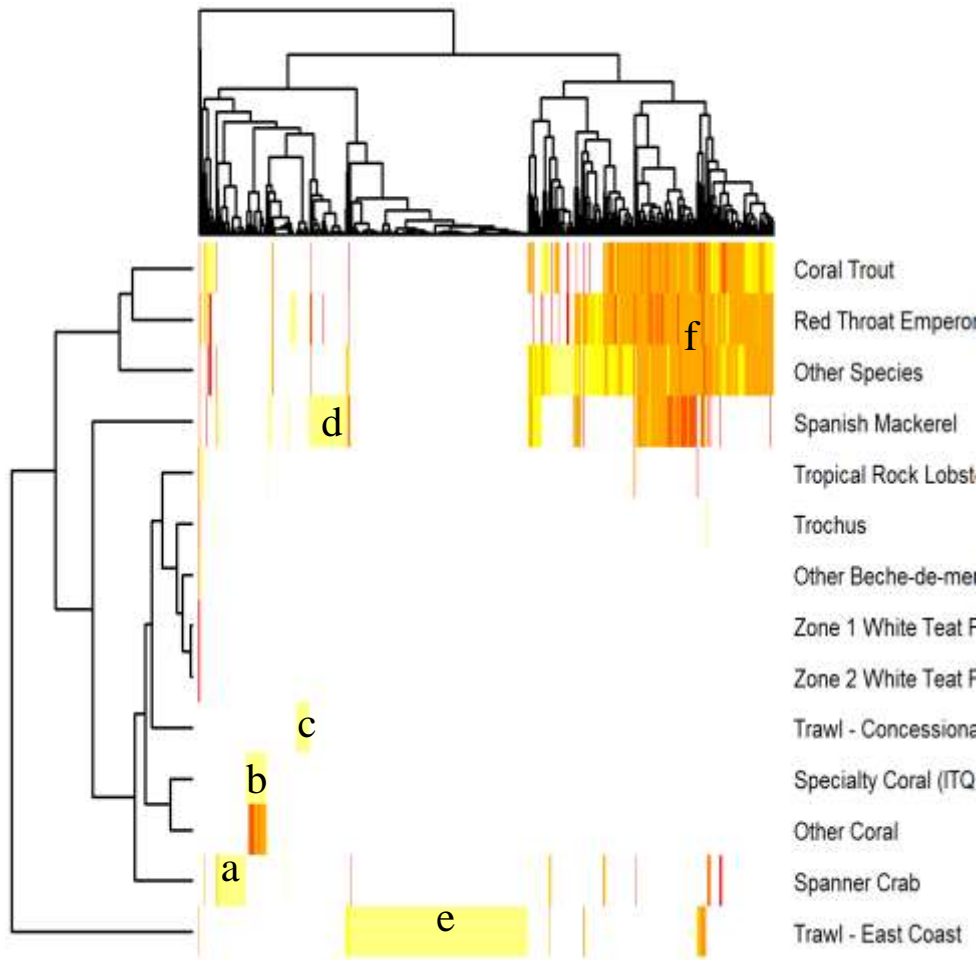


Figure 2. Heat map of the quota data showing the structure of the fishery. Rows denote quota species, columns denote businesses. Colour (red – low, yellow – high) represents quota amount. The species and businesses have been sorted (according to the dendrograms at left and top) so that neighbouring species attract similar businesses and neighbouring businesses fish for similar species. Clear groupings are: a – spanner crabbers, b – coral specialists, c – concession trawl operators, d – Spanish mackerel specialists, e – trawlers. The large group f represents the reef line fishers.

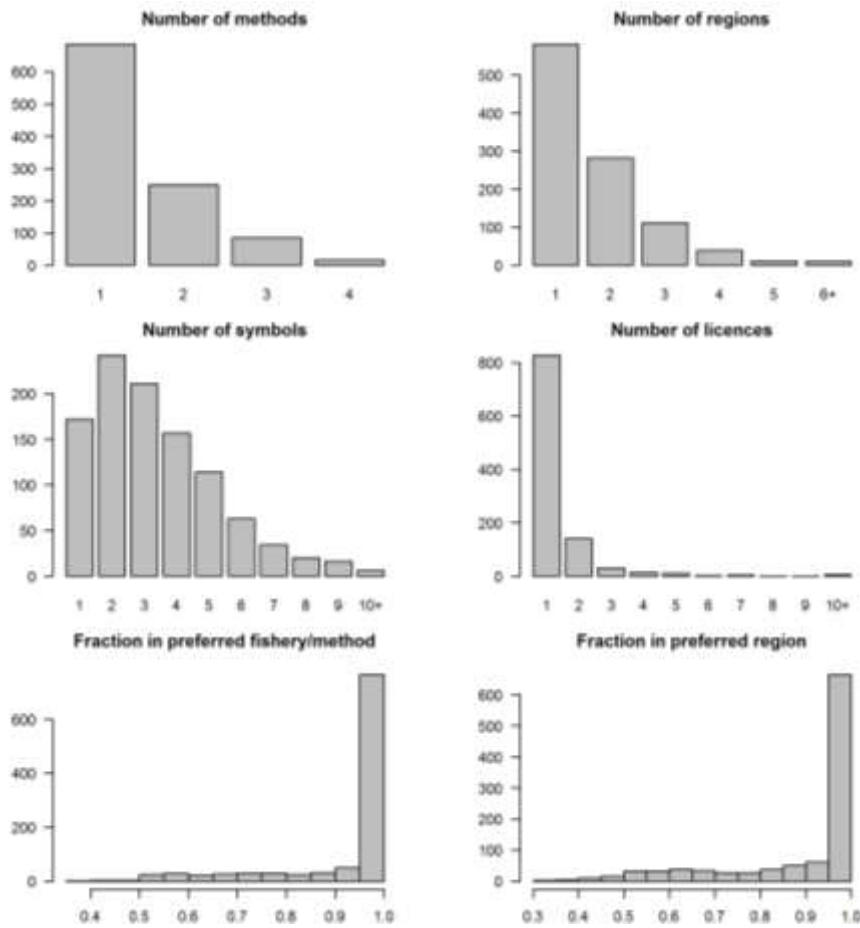


Figure 3. Histograms of diversity measures

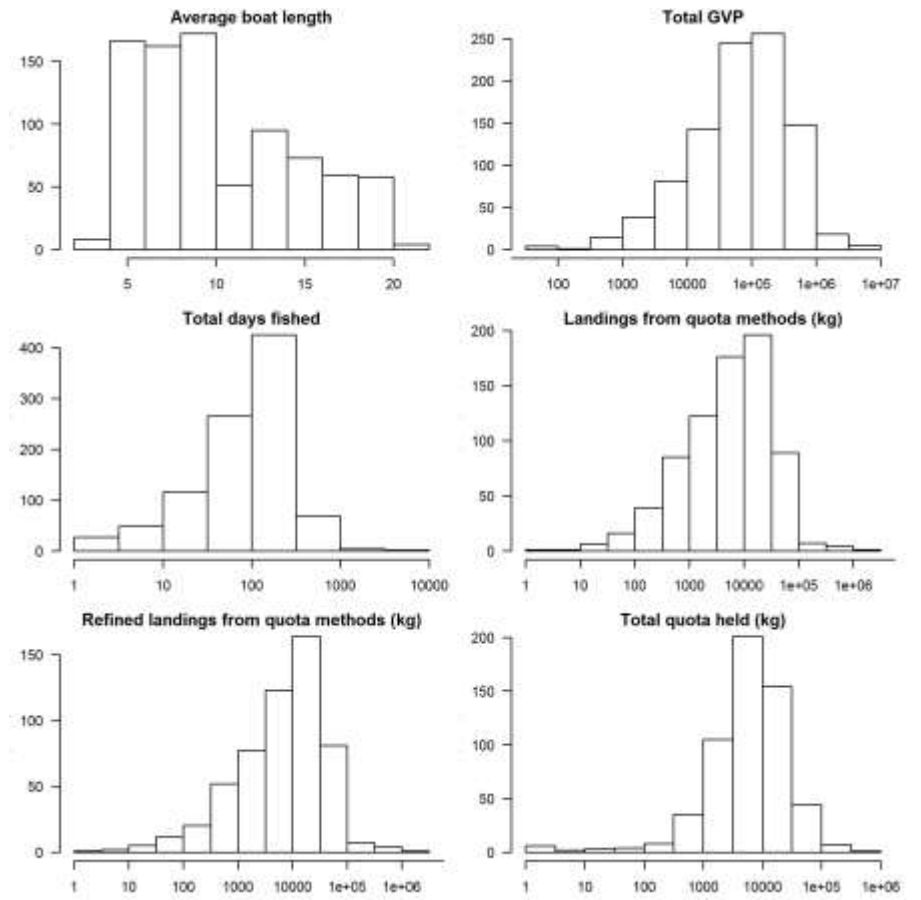


Figure 4. Histograms of activity and investment measures (and boat length). Note most measures are on a \log_{10} scale.

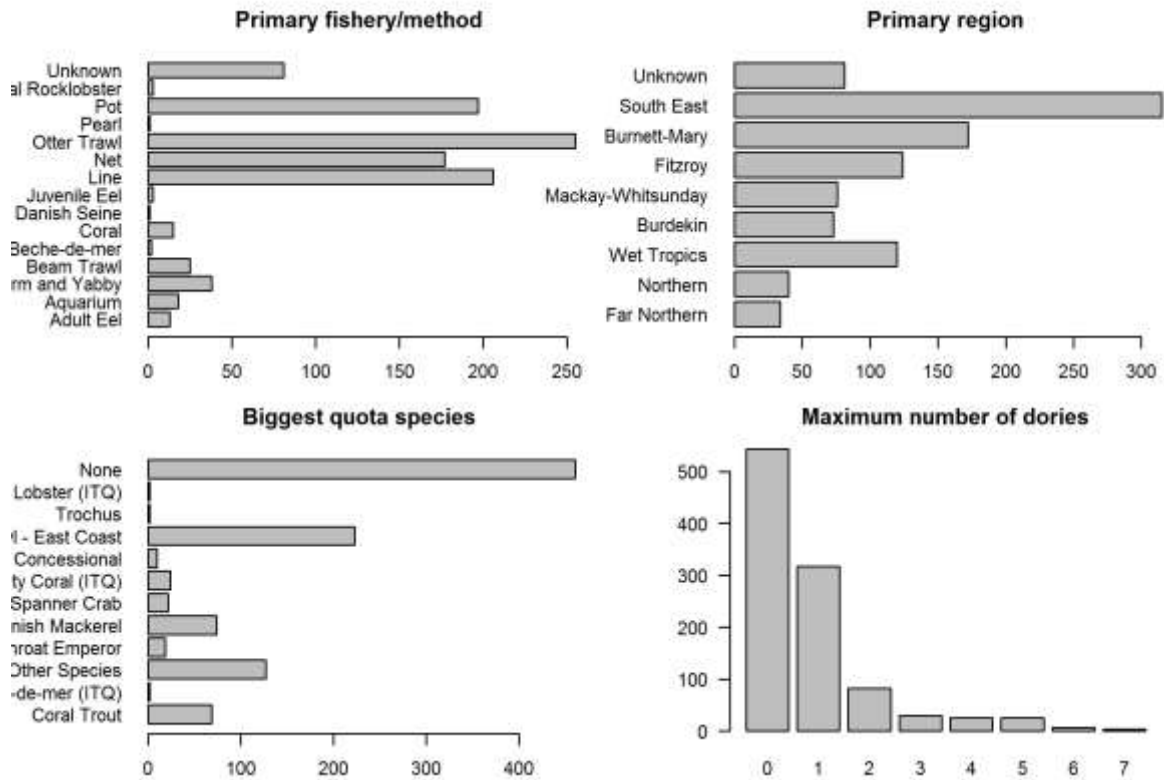


Figure 5. Histograms of preference measures (and dories).

The unknown ‘primary’ cases arise from businesses that do not appear in the harvest data base. There are a large number of businesses that apparently do not deal in quota.

The 1035 businesses identified were to be separated using approximately 15 clusters according to the previous work of Thébaud et al. (2014) which was utilised as a guide. However a local maximum in the silhouette width at 11 clusters was found. We erred on the lower side of 15 to allow for the possibility of further splitting of some clusters using the preference measures, which otherwise did not contribute to the partitioning.

The partitioning as a result of the principal components analysis (PCA) can be seen in Figure 6. Pair-wise scatter plots of the first four principal components are shown. There were five businesses that stood apart from the rest – these had very high diversity and included a business with 38 licences. These outlying businesses have been placed in a rather diffuse cluster J. The remaining majority of businesses lay in the main cloud near the centre of the panels. The first four PCAs roughly spread the businesses out along activity, roaming behaviour, diversity, and capacity directions, respectively. This spreading out allowed us to arrive at a rational partitioning of the businesses that can be described as a typology.

Note that the 11 clusters indeed separate out the businesses in the 13-dimensional space; though it may seem they overlap in some projections, they can be seen to be separate in others (e.g. cluster C is clearly seen in components 3 and 4, but not in 1 and 2). Clusters A, B and C (first panel) contain businesses with larger boats (avgl) and higher landed quota (lanq); G, H and J (also first panel) contain businesses engaged in diverse operations (high nsym, nfm, low frfm); A, E and J (second panel) businesses roam over more regions (nrgn, low frfg); K and L have similar properties, as do G and H, and each pair is distinguished by the amount of activity (less for L and H along component 1).

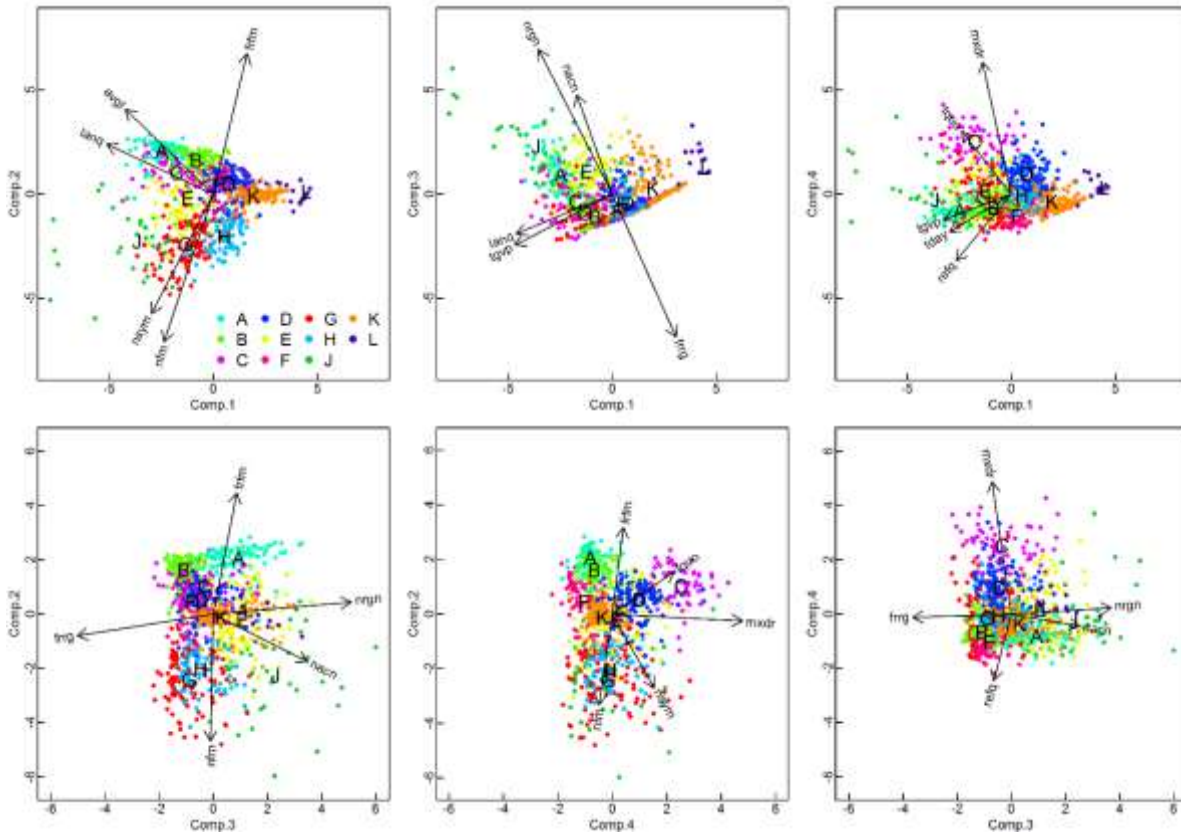


Figure 6. Projections of the 13 business measures in the first 4 principal components (PCs), with businesses coloured by cluster number. Each panel is a projection on a different pair of PCs. The large letters denote the mean value of each cluster. The arrows show the axes of the continuous variables with the 5 biggest components in each projection. Roughly speaking, the first PC is aligned with activity measures (tgvp, tday, lanq), the second with diversity (nfm, frfm), the third with roaming behaviour (nrgn, frg) and the fourth with capacity (mxdr).

It is more intuitive, however, to understand each cluster's contents by looking at their properties with respect to the original 13 variables. This is shown in Figure 7 for the count variables and Figure 8 for the continuous variables. The stand-out features of **Error! Reference source not found.** are: the large number of licences in J, larger number of regions in J, A, E and C, larger number of methods and symbols for G, H, J and E and large number of dories for C. From Figure 8 the stand-out features are: low or zero values for L, an apparently inactive group; large boats in A, B and C (and generally high activity) and small boats in K; low quota for H and K; low fraction in primary region for J, A and E (the roamers); low fraction in primary method for G, H and J (the generalists); lower activity in D.

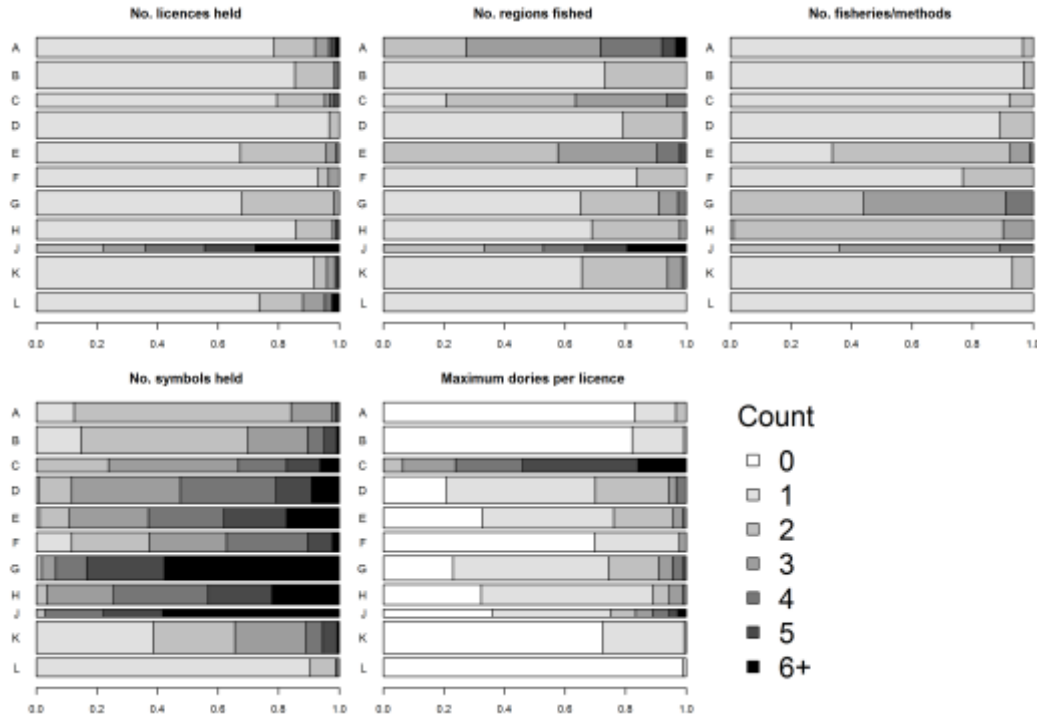


Figure 7. Bar plots of the count variables separated by cluster. The width of the bars is proportional to the size of the cluster. The length of each grey segment indicates the proportion of the businesses in the cluster with the corresponding value (0–5 or 6+).

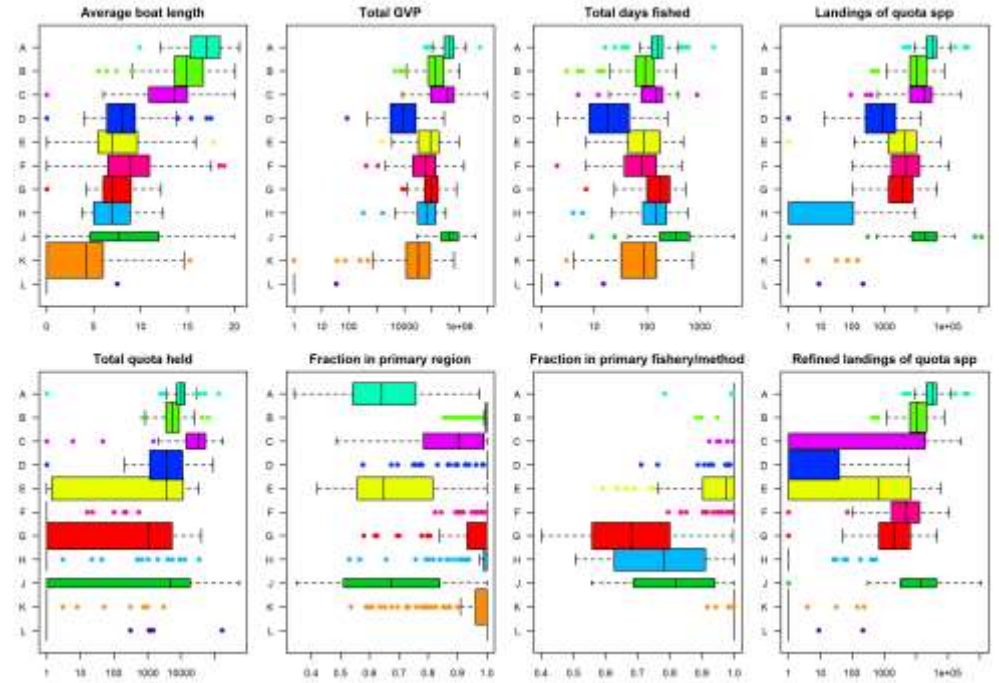


Figure 8. Box-and-whisker plots of the numerical variables for each cluster. The skew variables are on the log₁₀ scale. The same colouring is used as for Figure 6. The width of the bars is proportional to the size of the cluster. Boxes mark the 1st and 3rd quartiles. ‘Whiskers’ extend to the furthest point inside 1.5 times the box width and points beyond are drawn individually. Values of 1 on the log scale in fact indicate zero or missing values. In several cases the box collapses to this value.

The preference variables help to clarify the clusters further (Table 5). A and B are mainly trawlers, C and D are mainly reef line fishers, and E–K are a mixture of operators in all fisheries with roughly comparable levels of activity. A and B are distinguished by operators in A generally having larger capacity, activity, revenue and quota, and importantly tending to roam over several regions. The distinction between C and D runs along similar lines, with C being the larger operators also using many dories. The remaining groups can be split according to whether they are generalists (G, H, J) or specialists (E, F, K), roamers (E, J) or ‘homers’ (F, G, H, K), and quota (E, G, J) or non-quota fishers (H, K). The status of F with respect to quota is unclear since the operators landed quota without apparently holding any. This may be a deficiency of the data itself.

Table 5. Tabulation of cluster against primary method, biggest quota species and primary region. The clusters have been ordered to create a natural ordering in Method. Here fishery/methods other than Otter Trawl, Line, Pot and Net are classified ‘Other’. Quota species coral trout, red-throat emperor and other species are classified under ‘Reef Fin Fish’; then quota species other than Reef Fin Fish, ‘Trawl – East Coast’ and Spanish Mackerel are classified ‘Other’.

Method	Cluster										
	A	B	C	D	E	F	G	H	J	K	L
Otter Trawl	83	114	0	5	11	28	5	0	9	0	0
Line	1	1	58	96	33	1	14	0	1	1	0
Pot	0	1	2	9	19	5	28	54	3	56	0
Net	3	7	1	6	21	32	54	34	14	24	1
Other	1	0	2	4	8	20	8	2	9	64	1
Unknown	0	0	0	0	0	0	0	0	0	0	81
Quota											
Trawl - EC	82	104	0	8	10	0	8	1	9	1	0
Reef Fin Fish	1	3	53	69	32	4	35	7	8	3	0
Spanish Mackerel	0	0	5	26	18	1	14	5	1	2	2
Other	2	16	4	6	9	4	7	1	9	1	3
None	3	0	1	11	23	77	45	76	9	138	78
Region											
Far Northern	9	5	10	3	4	1	1	0	0	0	1
Northern	14	1	5	4	4	2	1	3	4	2	0
Wet Tropics	6	9	10	28	16	4	21	11	5	10	0
Burdekin	5	5	10	11	12	1	7	14	0	8	0
Mackay-W'sunday	8	3	13	3	10	2	9	14	2	12	0
Fitzroy	13	7	12	14	15	10	21	6	10	16	0
Burnett-Mary	16	17	1	24	18	11	16	20	8	41	0
South East	17	76	2	33	13	55	33	22	7	56	1
Unknown	0	0	0	0	0	0	0	0	0	0	81
Total	88	123	63	120	92	86	109	90	36	145	83

Taking into account all these considerations we can arrive at the descriptive typology as seen in Table 60. The trawlers were either roamers (A) that operated over several regions or homers (B) that stayed in a single region, the latter tended to predominate in the south. The reef liners were separated into big (C) and small (D) operations, reflecting differences in earnings, effort and capacity; operators in C tended to have some roaming behaviour too. The specialists also split into roamers (E) and homers (F, K); the main difference between F and K is that F landed quota and K did not. The generalists split into roamers (J) and homers (G, H), which once again were distinguished by the greater amount of quota in G; within these two groups, most of the spanner crab symbols were held in G. The sleepers (L) represented operators with low or no activity. (For an alternative way to visualise the typology, that also helps to see the relationship between clusters is the self-organising map (Kohonen 1995) (see Appendix A)).

Table 6. Typology description for the 11 clusters A–L (missing ‘I’).

Label	Number of businesses	Name	Description
A	88	Roaming trawlers	Larger boats and high GVP, fishing many regions – mainly trawlers
B	123	Homing trawlers	Like A but smaller boats and GVP, preferring the south
C	63	Big reef-liners	High GVP, quota holdings and landings and large number of dories – mainly line fishers
D	120	Small reef-liners	Like C but with smaller boats, and smaller GVP, quota holdings and landings
E	92	Roaming specialists	Medium boats fishing many regions but focussing mainly on a single method – a diverse group covering all methods
F	86	Homing specialists	Like E but also staying in a single region and little quota holdings – all methods except line and pot
G	109	Homing quota generalists	Very diverse methods yielding moderate quota landings while staying in a single region – a diverse group tending to pot and net
H	90	Homing non-quota generalists	Like G but focussing on non-quota species only – almost exclusively potters and netters
J	36	Roaming generalists	Uniquely diverse in methods and regions and tending to hold a large number of licences – like E, a diverse group covering all methods
K	145	Non-quota specialists	Single method landing non-quota species – almost exclusively pot, net and harvest fisheries including all worm licences
L	83	Sleepers	Inactive businesses

A final note: The method here has taken into account a large number of business characteristics to group them into roughly homogeneous clusters. These clusters are all of a reasonable size (36–145 businesses) that they can all be sampled from. The clustering is not overly distorted towards any one characteristic such as fishery licence or quota holdings. Some of the businesses in cluster J had a large number of licences. This may allow us to identify the lessees of those licences, since it is unlikely the business owners are operating those licences themselves. The quota data may be problematic, because of the difficulties of obtaining contemporaneous data. If necessary, the distinctions on quota could be ignored, leading to a merging of F and K and of G and H, resulting in 9 clusters. Alternatively, the clustering could be repeated without the quota variables, although this is not desirable. If further stratification is required, this could be done by splitting the clusters on the preference variables, in particular the primary region.

2) Adaptive capacity surveys

Key Findings

- 206 businesses operating along the Queensland east coast fisheries were surveyed.
- Most of these businesses matched the business type they were allocated via the typology above.
- Of those that didn't, they were 're-typed' according to their characteristics before further analysis.

Surveys achieved 206 responses, including 188 'operators' and 18 'investors'. The stratified sampling resulted in surveys of fishers from a range of business types (according to their typology as above), particularly for operators. Investors were dominated by types C and D (*big* and *small reef liners*, respectively), followed by K (*non-quota specialists*). Most respondents (82% of operators and 83% of investors; 82% overall, not including lessees) matched the original type they were allocated. There were multiple explanations for those that did not fit their original typology allocation (n=35), including (with >1 explanation possible per respondent):

- incorrect identification of fishery type (n=10)
- 'homing' vs 'roaming' identified incorrectly (n=8)
- 'generalist' vs 'specialist' identified incorrectly (n=8)
- quota holdings being mis-judged or missing (n=6)
- sale of licences, or reactivation of 'sleeper' licences prior to the survey (n=6)
- mis-judgement of boat size (n=3); and
- mis-judgement of GVP size (n=2)

When those respondents who did not match their original type allocation were re-typed, there was still a spread of diverse types surveyed within the operators, and a close match to the original spread of business types determined by the typology process (explained above), except perhaps for *homing specialists* (F) and *sleepers* (L) (Figure 9). For investors, there was a dominance of *small reef-liners* (D) (n=6) (Figure 9). Lessees were spread thinly across multiple business types.

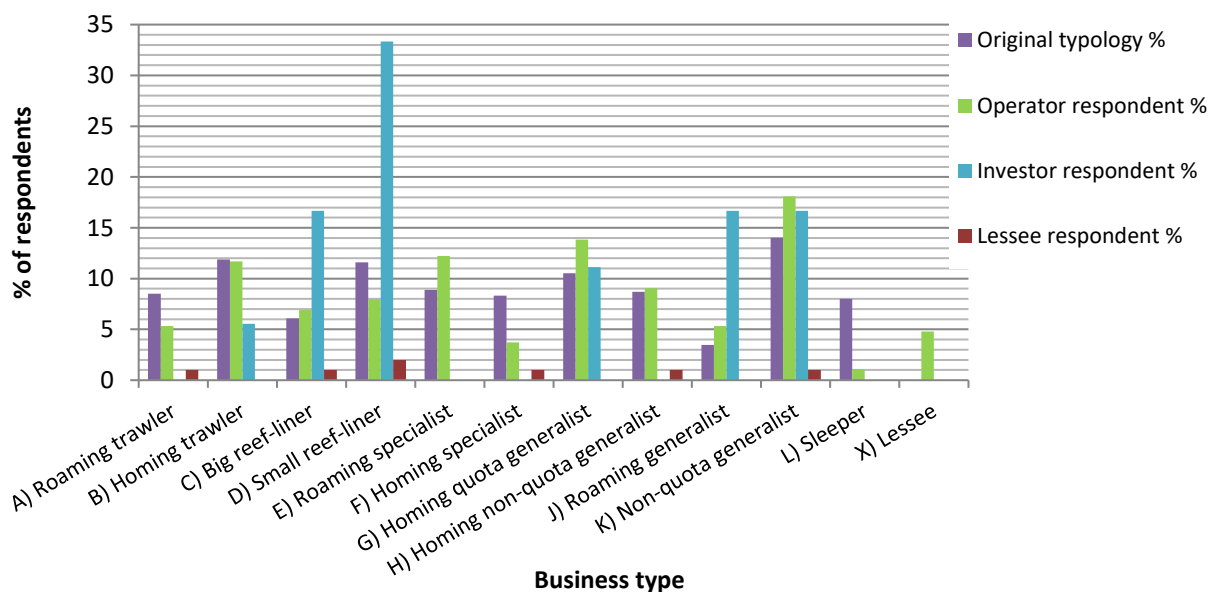


Figure 9, Proportion of operator and investor survey respondents within each business 'type' (as well as the proportion within the original typologies for comparison), determined by agreement with original typology, and/or business characteristics listed during the survey.

NB. Lessees are included twice in this figure, as lessees in general, plus grouped with the appropriate type according to their fishing characteristics.

One of the hopes of the study was that the business types themselves would be useful for predicting adaptability and success. If this were the case then the findings and recommendations arising from this study would be particularly simple to communicate: e.g. 'big reef-liners (type C) subject to a change X should take action Y for greatest chance of success.' However, we found considerable divergence of behaviours and degrees of success within each business type, such that broad-brush conclusions like the above cannot be made. Instead, a more detailed analysis based on characteristics was necessary to capture individual traits leading to success. These more detailed analyses are outlined within the sections below, following the basic description of findings.

Enabling / Constraining characteristics

Individual characteristics

Key Findings

- Surveyed business holders were primarily male, and were dominated by those in the ages of 50s and 60s (though ages ranged from 25 to >80). Most had a partner or were married, without dependent children. While lacking in education beyond high school, many did have experience or training in other work they could rely on.
- Respondents were highly attached to their occupation of fishing, which they have been involved in for many years. Most operators (but not investors) did not want to be in any other industry.
- Operators had a high individual income dependency on fishing (though less so for their household income), while many investors did not.
- Income dependence appears to also have varied by business type: Operators in type A (*roaming trawlers*), B (*homing trawlers*) and C (*big reef liners*) businesses were the most dependent on commercial fishing for individual and household income. Type D (*small reef liners*) operators appeared less dependent than the other types.
- Respondents were asked to rank their level of agreement with a number of statements related to their ability to manage RISK, 2) ability to PLAN, learn, experiment and reorganise, 3) ability to COPE with change, and 4) INTEREST in adapting to change. These were used as indicators to develop an 'inherent resilience' score and rank:
 - Overall, a slight majority showed positive resilience, though most respondents fitted within the medium resilience rank. There was no significant difference between business types regarding inherent resilience.
- Respondents do not appear to rely on external networks, with few trusting other information sources (although ~30% stated DAF was their most trusted information source), and most not seeking advice from others at times of change. 60% were not members of any association.

Demography

Most respondents were male (96% of operators, 89% of investors surveyed), although we also surveyed couples (n=3 operators, n=1 investors). Operators were on average 56 years (+/- 0.8 SE) of age, while investors were 63 years (+/- 2.02 SE) (ranging from 25-84, median 57 years for operators; and from 47-74, median 66 years for investors). Figure 10 shows the age distribution of the sample.

85% of operators and 56% of investors were married or had a partner, and most (70% and 72%, respectively), did not have any dependent children. Most did not have an education beyond high school (66%

of operators, 72% of investors), but a slight majority of operators (58%) and most investors (89%) did have experience and/or training in other work that they could rely on now.

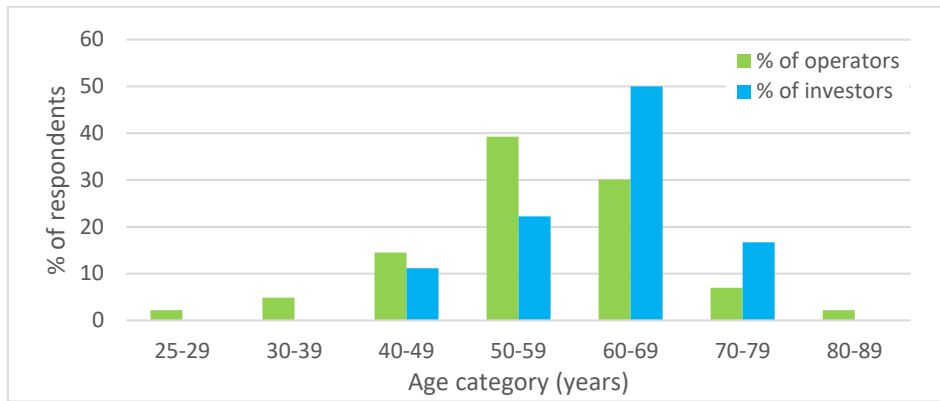


Figure 10. Frequency histogram showing the age distribution of the respondents.

Attachment to occupation

Survey respondents had primarily been involved in the industry for a long time (see Figure 11 for the distribution of experience). Operators had been fishing between 1 and 60 years, with an average and median of 30 years (+/- 0.94 SE for the average), while investors had been investing in the industry for 6-54 years (average 23 years +/- 3.62; median 19 years). Most (76%) investors had also been active fishers in the past, on average for 20 years (+/- 3.32; ranging from 6 - 40 years, median 15 years), but had stopped fishing themselves on average 8 years (+/- 2.02) prior to being surveyed (range 1.5-19 years, median 6 years). Various reasons were given for why they stopped fishing themselves, with 62% (n=8) stating personal constraints such as age or health, 23% claiming economic reasons (e.g. “it wasn’t viable full-time”, or “rising costs”) and 15% stating they had business opportunities elsewhere.

Most respondents had a high reliance on the fishing industry for their income (Figure 11). Operators had a greater individual and household reliance on the industry for their income than investors: 65% of operators relied on fishing for all of their individual income (average 79% +/- 2.58; median 100% of individual income from fishing), and 43% relied on fishing for all of their household income (average 70% +/- 2.70; median 90% of household income). For investors, only 17% relied on the industry for all of their individual income (average 31% +/- 9.41 income; median 10% of individual income from fishing), and 12% relied on it for all of their household income (average 24% +/- 8.39; median 5% of household income).

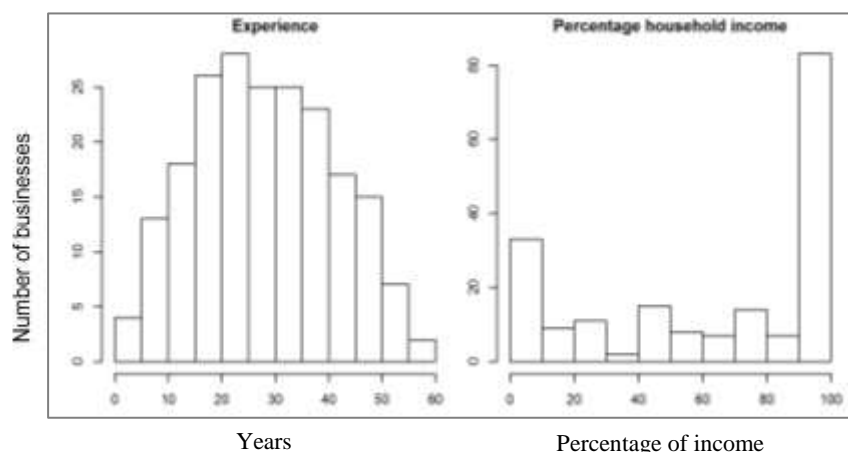


Figure 11. Frequency histogram of ‘attachment to occupation’ related variables: experience in the fishing industry, and household income dependence.

The extent to which the operators surveyed relied on their commercial fishing businesses for income also varied between types (though these differences were not tested for significance) (Figure 12). On average,

type A (*roaming trawlers*), B (*homing trawlers*) and C (*big reef liners*) businesses were the most dependent on commercial fishing as a source of both their individual and household income (see Table 29 in Appendix F for more detail), obtaining a minimum average of 88% of household income in this way. Group D (*small reef liners*), had by far the lowest levels of dependence on commercial fishing income, with more than 50% of their individual and household income coming from other sources on average. Dependency for investors was substantially lower for all types surveyed (Figure 13).

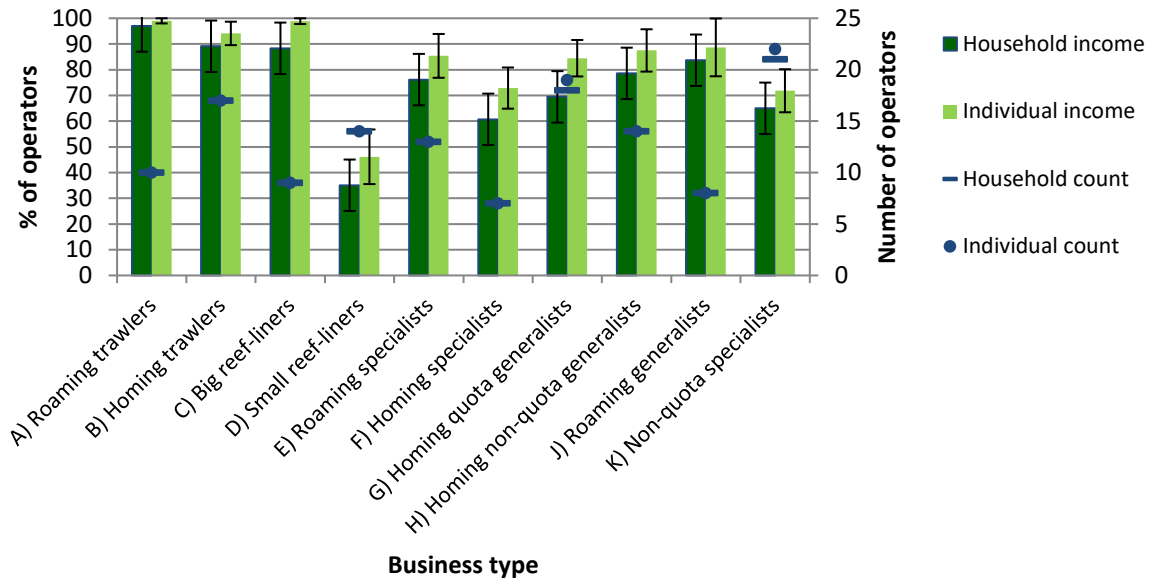


Figure 12. Mean proportional contribution of fishing business income to both household and individual income for Operators (error bars denote associated standard errors). Please see Table 29 in appendix for numbers of observations (n), mean, standard deviation (sd), standard error (se).

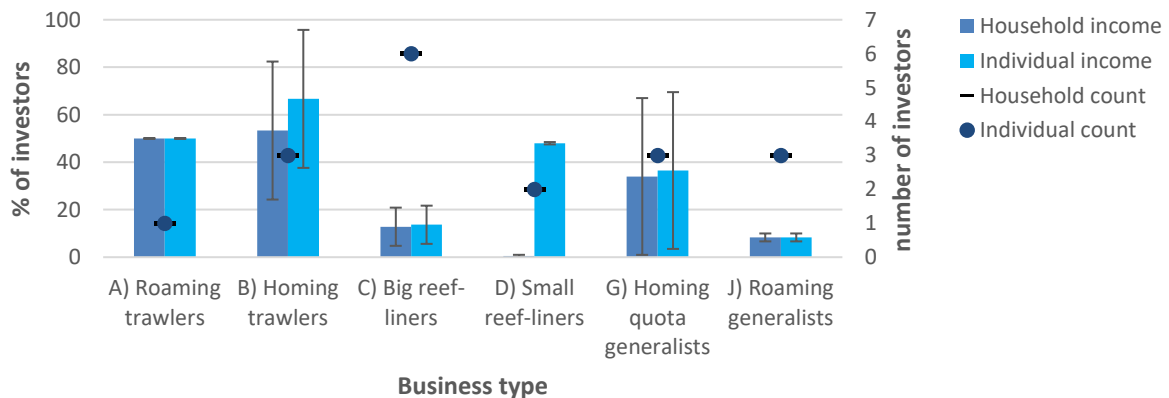


Figure 13. Mean proportional contribution of fishing business income to both household and individual income for Investors (error bars denote associated standard errors). Please see Table 29 in appendix for numbers of observations (n), mean, standard deviation (sd), standard error (se).

The majority of operators were also very attached to commercial fishing, with 75% agreeing they wouldn't want to be anything other than a commercial fisher, 89% viewing commercial fishing as a lifestyle, and not just a job, 87% stating they plan to remain in the industry until they retire, and 86% agreeing that working in the commercial fishing industry contributes to their quality of life and well-being (Figure 14).

For investors, attachment was more mixed: Only 24% agreed they wouldn't want to be involved in any other industry, and 35% stated that investing in the industry contributes to their quality of life and well-being. However most (65% and 67%, respectively) stated the fishing industry is part of their life, rather than just an investment, and that they plan to remain invested in the industry (Figure 15).

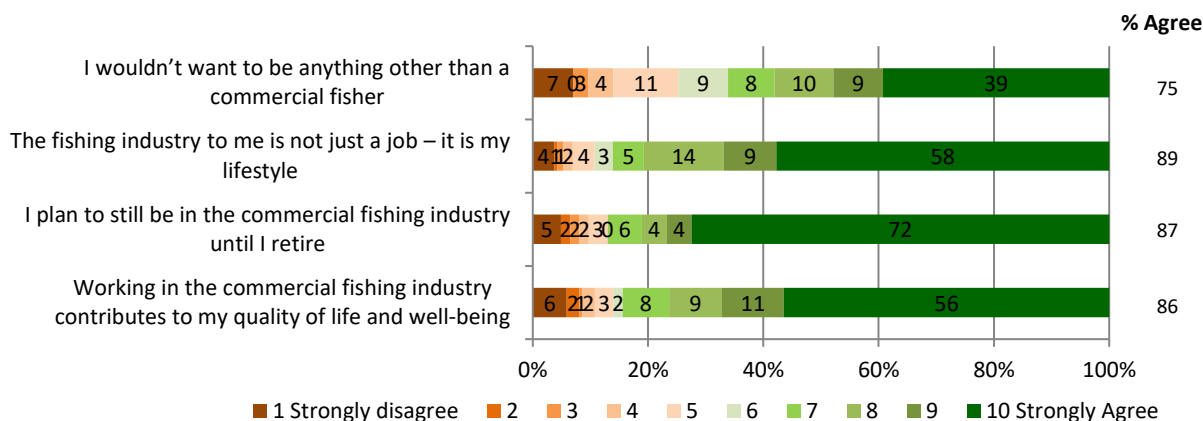


Figure 14. Operators' level of agreement with statements related to attachment to commercial fishing. Proportions of respondents are shown within the bars for each level of agreement score.

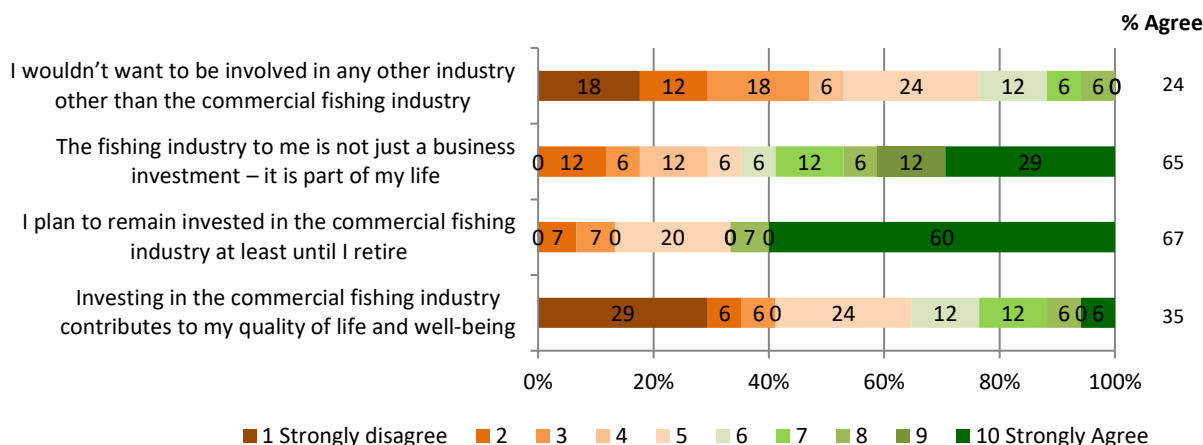


Figure 15. Investors' level of agreement with statements related to their attachment to the commercial fishing industry as an investment. Proportions of respondents are shown within the bars for each level of agreement score.

Inherent resilience (adaptive capacity)

Respondents were asked to state their level of agreement with a series of statements relating to their perceived personal ability to adapt to change (here called 'inherent resilience', given we later explore more 'practical' adaptive capacity). These statements were adapted from the resilience framework developed by Marshall and Marshall (2007), and relate to an individual's 1) ability to manage RISK, 2) ability to PLAN, learn, experiment and reorganise, 3) ability to COPE with change (related to psychological and financial buffers), and 4) INTEREST in adapting to change (each capitalised term is included in figures below to aid interpretation).

Operators and investors showed variable responses to questions related to RISK: while most were happy to make decisions when faced with uncertainty, less than half of the operators (but 67% of investors) were willing to take higher than average risks in order to get higher financial returns. Further, few operators, and half of the investors felt they had many job options available to them if they left the industry. Ability to PLAN appeared much more positive for operators and investors (except for investors' surety of how to plan for changes in the industry that may affect them). COPING showed a mixed result again: while most operators felt they were more likely to adapt compared to others in the industry, only half of the investors agreed with this statement. Unfortunately most operators did agree that they were too young to retire or too

old to find work elsewhere, meaning they may feel ‘stuck’ in their current occupation. In terms of INTEREST, while operators and investors were interested in learning ways to better prepare their business for change, most would be nervous trying something else outside of fishing, and few operators were interested in learning new skills outside of the industry. See Figure 16 for more detail regarding the spread of responses and Figure 17 for the comparison of responses between operators and investors.

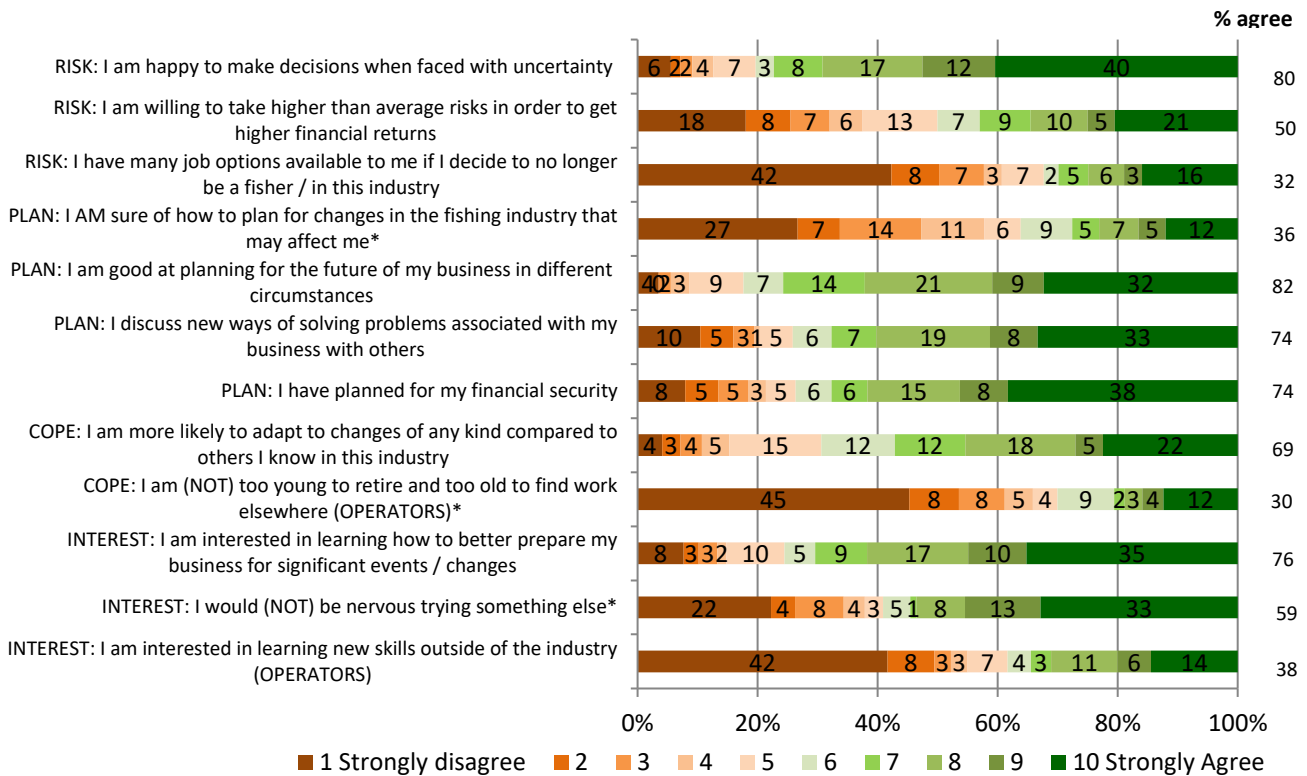


Figure 16, Respondents’ level of agreement with, and average score for, a series of statements relating to their individual perceived ability to adapt to change.

*These questions were negatively oriented in the survey, but were reversed in analysis to derive a positively oriented scale comparable to other variables.

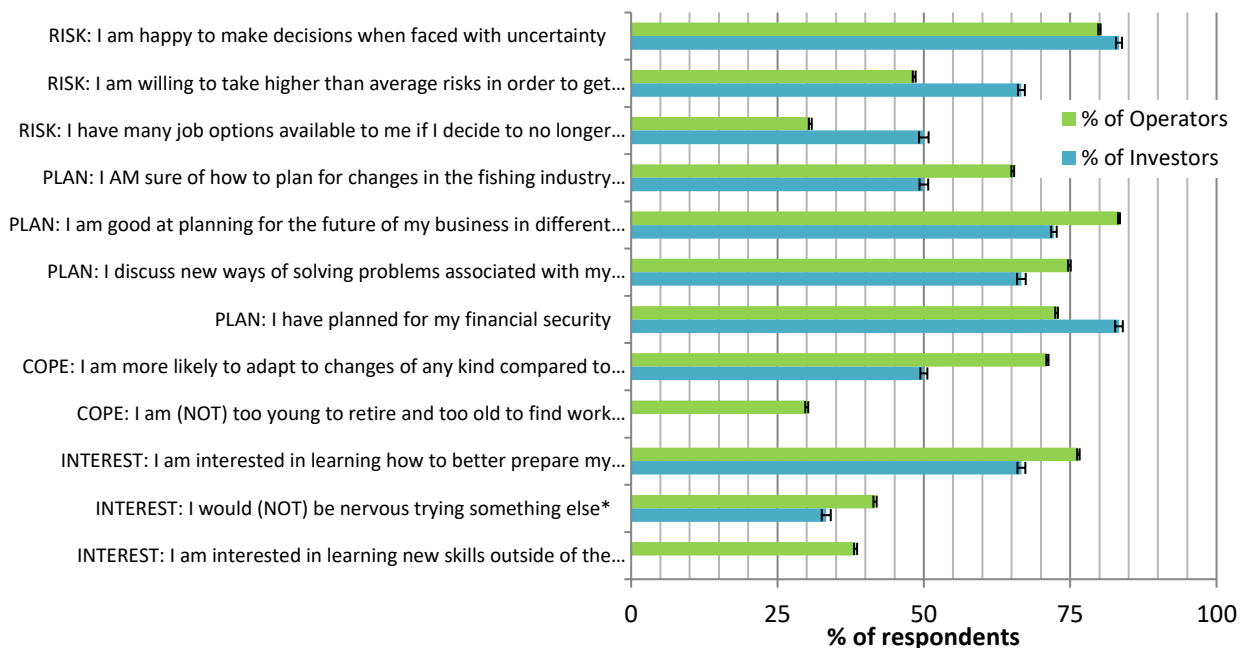


Figure 17, Differences in the average score for operators vs investors, for a series of statements relating to their individual perceived ability to adapt to change.

*These questions were negatively oriented in the survey, but were reversed in analysis to derive a positively oriented scale comparable to other variables.

Unfortunately, the reliability across questions within each of the four dimensions was not consistent enough to provide an overall score for each dimension. When all questions for inherent resilience for operators and investors were combined and tested for reliability within SPSS, we achieved a Chronbach's α of 0.599 (reliability would require a score of 0.7, as explained in the methods). There was a moderate number of missing answers to some questions, and any respondent with at least one missing response was omitted from this reliability analysis. Given this then removed a substantial number of records, we applied the median polish imputation method described in the methods above. Following imputation, reliability analysis revealed a Chronbach's α of 0.629, which we considered useful enough to use for correlations with other dimensions. Hence, dimension reduction was applied within SPSS, to give an 'F-Score' via factor analysis for each respondent. These scores were then converted to an inherent resilience 'rank' (where an F-Score of -5 to -1 = 'low' resilience; >-1 to 1 = 'medium' resilience; and >1 to 5 = 'high' resilience). On the whole, businesses were inclined to resilience, according to the resilience score (Figure 18a) whose distribution is skewed to the right (though most respondents fitted within the medium resilience rank (Figure 18b)). The differences, if any, between business types are shown in Figure 18c. There is a suggestion that *homing trawlers* have lower resilience, however no differences prove significant in *t* tests of the underlying scores.

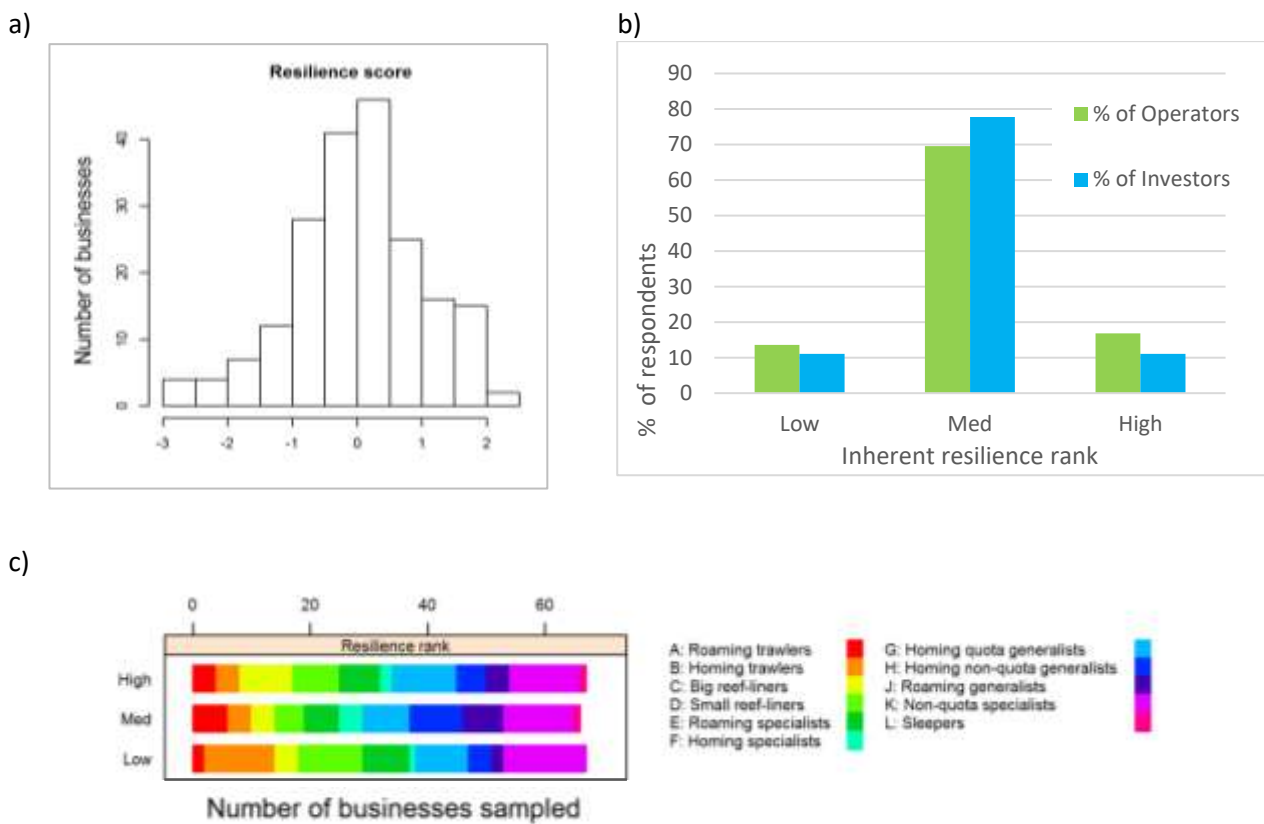


Figure 18. Inherent resilience (a) score for all respondents, (b) ranks for Operators and Investors, and (c) ranks for different business types, based on a combined score for all resilience questions developed via dimension reduction.

Step-wise linear regression analysis revealed weak associations of the resilience score with the maintenance of a financial buffer, dependence for individual income, and presence of external buyers (Table 7). The fits were poor, however, explaining only about 15% of the variation.

Table 7. Estimated coefficients from the stepwise linear regression for inherent resilience.
The adjusted R^2 and residual standard errors (R^2_{adj}, σ) were (0.13, 0.95) for resilience.

Response	Variable	Estimate	Std. Error	t value	Pr(> t)
Resilience score	(Intercept)	0.293	0.236	1.242	0.216
	option_score	0.211	0.077	2.756	0.007
	bufferY	0.253	0.176	1.436	0.153
	indiv_income	-0.008	0.002	-3.456	0.001
	nbuyer_other	0.036	0.012	2.949	0.004

Other statements related to inherent resilience, but not included in the framework, related to opportunities to develop their business or seek work elsewhere: Most investors (67%) stated they do not have any formal skills to develop a business plan (operators were not asked this question), but most (89%) did have experience or training in other work that they could rely on now. Just over half of the operators (58%) stated they had experience or training they could rely on now.

Networks

When respondents were asked who their most trusted source of information was regarding fisheries in Queensland, the most common responses were Queensland’s DAF² (29% of respondents), other fishers (25%), QSIA (21%) and ‘no-one’ (16%) (see Figure 19). Similar responses were found when we asked who respondents would go to for advice if they needed to make changes to their business in response to an upcoming change, except that the majority stated they would go to ‘no-one’ or take their own advice (42% of respondents).

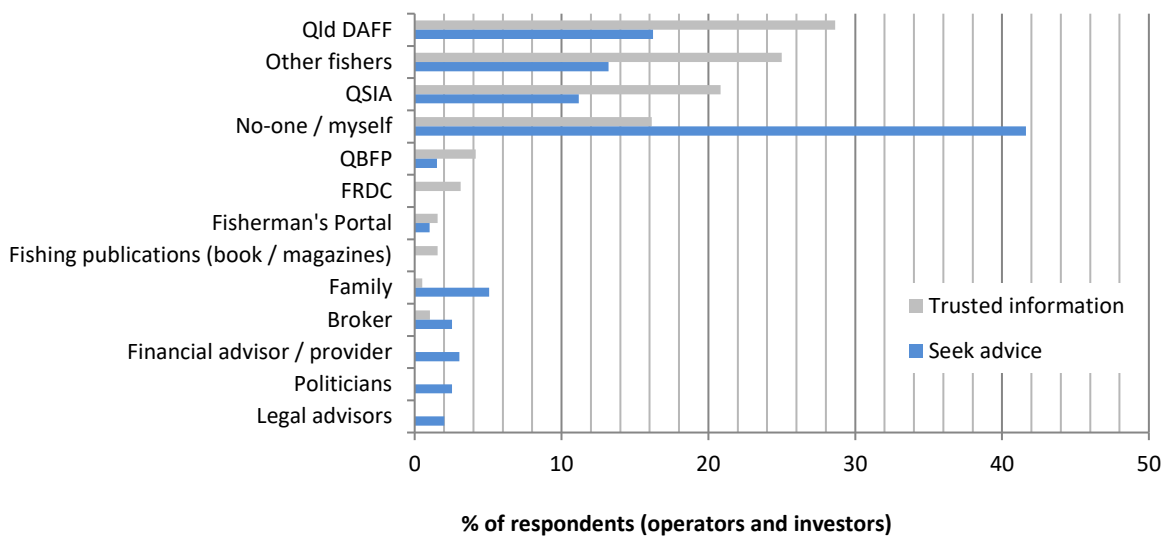


Figure 19. Respondents’ trusted information sources about fisheries in Queensland; and who respondents would first go to for advice if they decided they needed to make changes to their business due to an upcoming change (Only those listed by >1% of respondents are shown here. More than one response was possible).

Most respondents (59% of operators and 78% of investors; 60% overall) stated they were not members of any industry association. Of those that were members, most were members of QSIA (73% of those who were members of an association). Others listed by >1 respondent were Moreton Bay Seafood Industry Association (MBSIA; 9% of association members), the Fisherman’s Portal (9%), the East Coast Crabbers Association

² Queensland’s Department of Agriculture and Fisheries (DAF) was called the Department of Agriculture, Forestry and Fisheries (DAFF) at the time of the survey.

(6%) and the Queensland Seafood Marketers Association (QSMA; 3%). A number of other associations were listed by individual respondents.

When asked how frequently they sourced or received information from a number of sources, results revealed a heavy reliance on ‘other commercial fishers’ for regular information (>5 times a year), plus DAF, the QBFP, researchers and the public media for occasional information (1-5 times a year; see Figure 20). Most respondents did not receive or source any information from GBRMPA in the previous year (noting that many respondents operated south of the Great Barrier Reef), and approximately half received / sourced no information from QSIA or the public media in the previous year. Other information sources respondents listed included FRDC (particularly via the ‘FISH’ magazine), internet sites, forums and social media, the Fisherman’s Portal, MBSIA, the Australian Maritime Safety Authority (AMSA) / MSQ, and political sources (such as local councillors or the Minister).

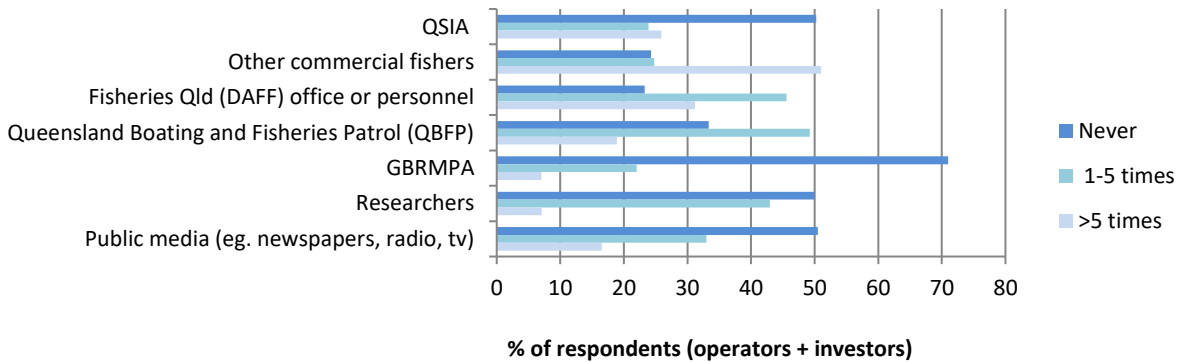


Figure 20. Broad frequency of how often respondents sourced or received fisheries related information from various sources in the previous 12 months prior to survey.

Business characteristics

Although many business characteristics (e.g. fishery type, licence and quota ownership) had been used in the typology analysis, they had been based on preliminary information from DAF. At times it was difficult to match these data to specific businesses, or to get more in-depth information. There are also some characteristics (e.g. vessel information, economic data) that are not available through DAFs compulsory reporting systems. It was therefore valuable to obtain more reliable and detailed information through this survey. The following figure (Figure 21) provides a summary of the spread of some categorical characteristics between business types, which are explained further in the following subsections.

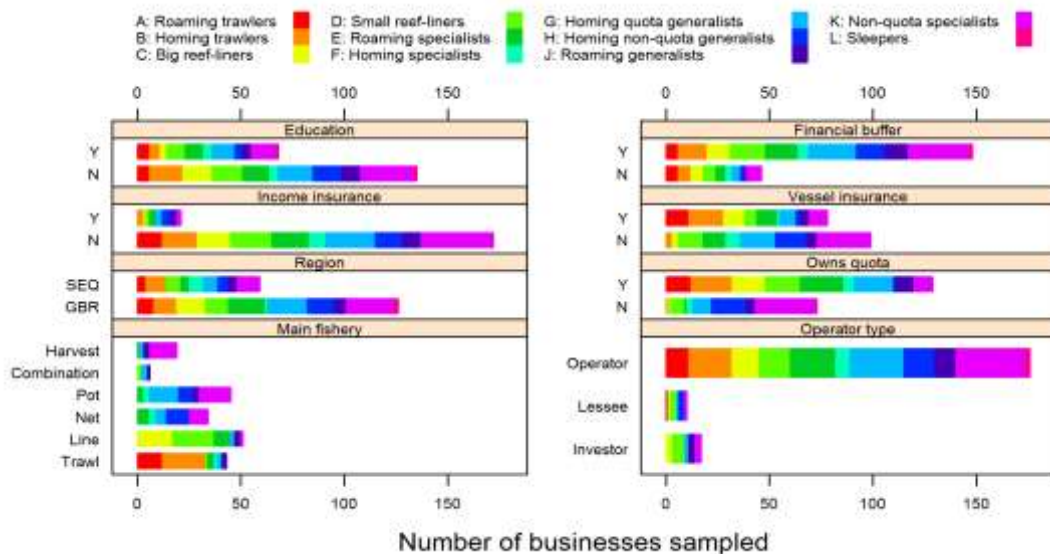


Figure 21. Barplots of key business categorical characteristics, subdivided by business type. Length of the bars represents the number of respondents.

Key Findings

- Economic characteristics were highly variable within some business types
- Assets:
 - Types A (*roaming trawlers*), B (*homing trawlers*) and C (*big reef-liners*) had the greatest investment in primary vessels. Licenses/quota/symbols were their second largest investment.
 - The total level of investment in primary vessels was on average substantially lower in all other business types (D–K), and in these cases always came second to licenses/quota/symbols
 - The mean level of investment in licenses was generally higher in the *roaming generalists* (J) than in any other business type.
 - The average age of primary vessels was relatively high (average 23.5 yrs) in all business types (operators only). Businesses oriented around trawling operated the oldest vessels.
 - Most respondents (61% of operators, 53% of investors) held only one licence.
 - Most operators (61%) and investors (84%) owned quota or effort units of some sort at the end of the 2013/14 financial year
 - Most operators (54%) had some kind of turnover of licences, symbols or quota during the previous financial year
- Costs:
 - For operators, as with investment in capital assets, total business costs were also generally highest in the *trawler* (both A and B) and *big reef-liner* (C) typologies
 - Fuel is the largest cost of operation for over half of the operator types.
- Revenues, profit and return on capital
 - The revenues reported for investors were highly bimodal (most fell within the category “under \$50,000” and the remainder exceeded \$500,000).
 - For operators, mean revenues were highest in the *roaming generalists* (J) and *big reef-liners* (C), however, the level of variation was high in the *roaming generalists*.
 - The majority of businesses in the survey had revenues and costs of under \$500,000 and all but a few fell below the \$2m revenue threshold used to define small businesses by the Australian Taxation Office (ATO) at the time of the surveys.
 - There was no obvious relationship between business types and revenues/costs, however costs are seen to exceed revenues for a number of operators.

Key Findings contd.

- Income and market diversity:
 - Harvesting was most frequently the primary component of income, although some level of retail or wholesale was also seen to be present in all business types.
 - Leasing out of quota or effort units as a source of income was only really relevant for the *homing trawlers* (Type B) surveyed whereas the leasing out of licenses was seen to predominantly be a source of income for *roaming specialists* (E) and some *roaming generalists* (J).
 - Most operators had one local buyer (51% of operators), including selling direct to the public (which ~37% of operators did).
- Most operators and investors (76% of both groups) stated that they maintain a financial buffer in case of emergencies. However, most (89%) do not have any income insurance for their business. Less than half of the operators (44%) have vessel insurance
- Fishery type:
 - Surveyed operators primarily were active in only one main fishery type (60% of operators), followed by two types (26%), three types (12%) or 4 types (3%). This varied according to the main fishery operators were dependent on – those dependent on line, trawl and harvest fisheries were more likely to rely solely on those fisheries for income, while those dependent on net and pot fisheries usually relied on at least 2 main fishery types.
 - Just over half of the operators (55%) stated the fishery they depended on did not vary among years. Annual variation was most common for those operators dependent on net and pot fisheries.
 - There is substantial overlap among net, pot and line fisheries and also with the trawl sector.
- Regarding regions and mobility: Respondents were spread along the east coast. Most operators (92%) stated their home port was also their home region. A slight majority (54%) of operators used only one home port.
- All business types (other than the *homing specialists* (F)) reported employing and paying some additional non-family workers or crew. Family members were also employed to some extent (except for *non-quota specialists* (K)), and they were generally paid. Family employees are of greatest relative importance to the *homing quota generalists* (G) where on average 44% of labour is obtained from family members.

Economic characteristics

While we did not judge the overall ‘size’ of the business as a category, we collected information on a number of indicators, particularly economic ones. Many of the questions related to business economics were intended for use in the associated ‘Beyond GVP’ project. However a summary of many of the characteristics are also provided here and in Appendix F and G.

Unfortunately respondents did not always answer every question asked in relation to the economic aspects of their businesses, and it was not possible to include some of them in the data presented throughout this section. For example, of the 188 operators surveyed, 26 did not provide any information relating to total revenue earned in the 2013–14 financial year. However, most of the incompleteness of the economic data was a consequence of cost figures not being provided, which was the main reason for exclusion in 43 cases (the remaining 8 omissions had partial cost data or no revenue data). The economic characteristics reported here are subsequently based upon the figures reported by 137 operators and 18 investors. The final numbers of businesses included in each business type for the economic component are reported in Table 28, Appendix F.

Relatively high levels of variability were observed in the data collected within some business types, as illustrated by the standard deviations (sd) and standard errors (se) reported in each of the tables presented throughout this section. Whilst some degree of heterogeneity between individual businesses was expected,

the relatively low numbers of complete observations should be taken into consideration. As the data reported here relates to a single year of operation for each of the businesses surveyed (2013/14), it represents a snapshot of their economic situation and performance during that period, and, as a consequence, may not reflect longer term performance at the individual business level.

Given the difference in day-to-day business operation between operators and investors, they are described separately here for economic metrics. For investors, while each of the 18 investor businesses interviewed were also assigned to one of the 11 typological groups based on their characteristics, the low number of businesses in each type generally prevents their economic results being reported at such a detailed level.

Capital Assets

Operators were asked a series of questions to determine their level of investment and the mix of capital assets associated with operating their businesses (0, Appendix F). Operators' investment in primary vessels was greatest in both absolute and relative terms in the *roaming trawlers*, *homing trawlers* and *big reef-liners* (Types A, B and C, respectively) (Figure 22). For these types, licenses/quota/symbols were their second largest investment in all cases. The number of dories owned and the level of investment in each dory was greatest in the *big reef-liners* (C), an observation in line with their typical mode of operation. The total level of investment in primary vessels was on average substantially lower in all other types (D–K), and in these cases always came second to licenses/quota/symbols. The mean level of investment in licenses was generally higher in the *roaming generalists* (J) than in any other business type, accounting for 88% of asset value on average. However, the relatively large standard deviation associated with licences also demonstrates there is a high level of variation around this mean in absolute terms.

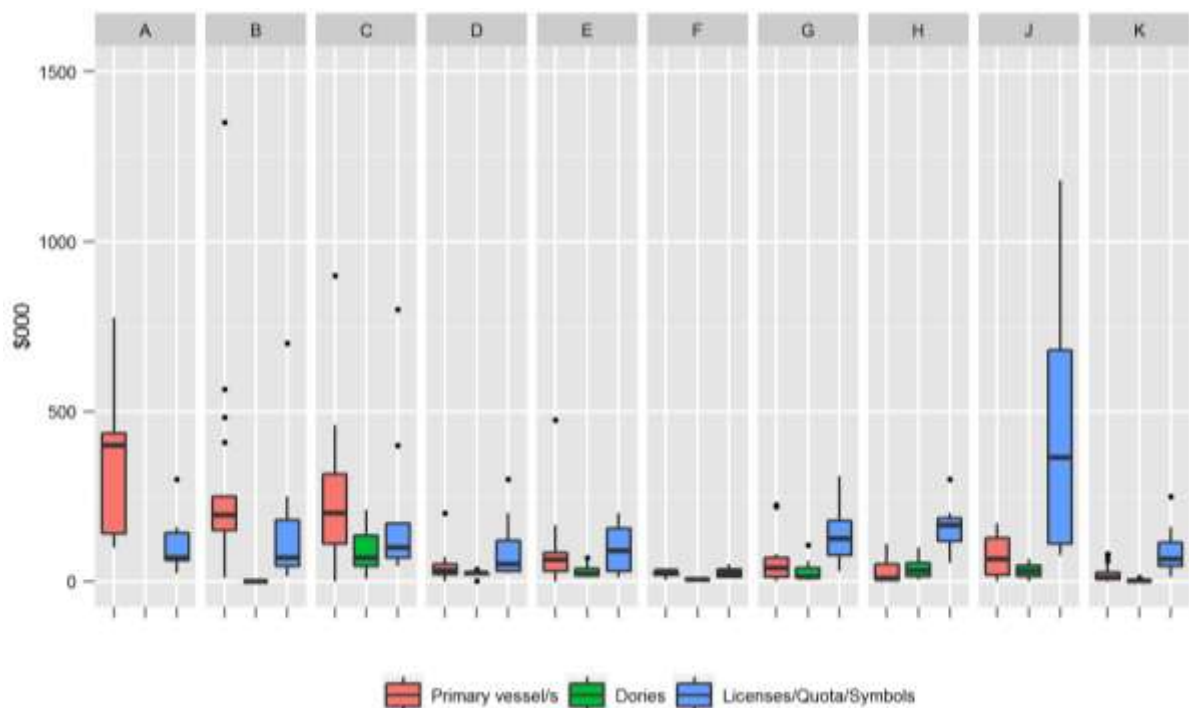


Figure 22. Mean absolute value and mix of capital assets for operators by business typology (Y axis is constrained at \$1.5 million resulting in the exclusion of two outliers which exceeded this amount). Data behind this figure are reported in Appendix F.

The average age of primary vessels was relatively high in all types of operators, the average across all types being 23.5 years (vessel details were not asked of investors). The youngest average age within a group was 15.9 years in the *homing quota generalists* (G). In addition to investing the most in vessels, businesses oriented around trawling also operated the oldest vessels on average at 34.1 and 39.5 years old for A and B respectively. Average vessel ages at the typology level are presented in Figure 23.

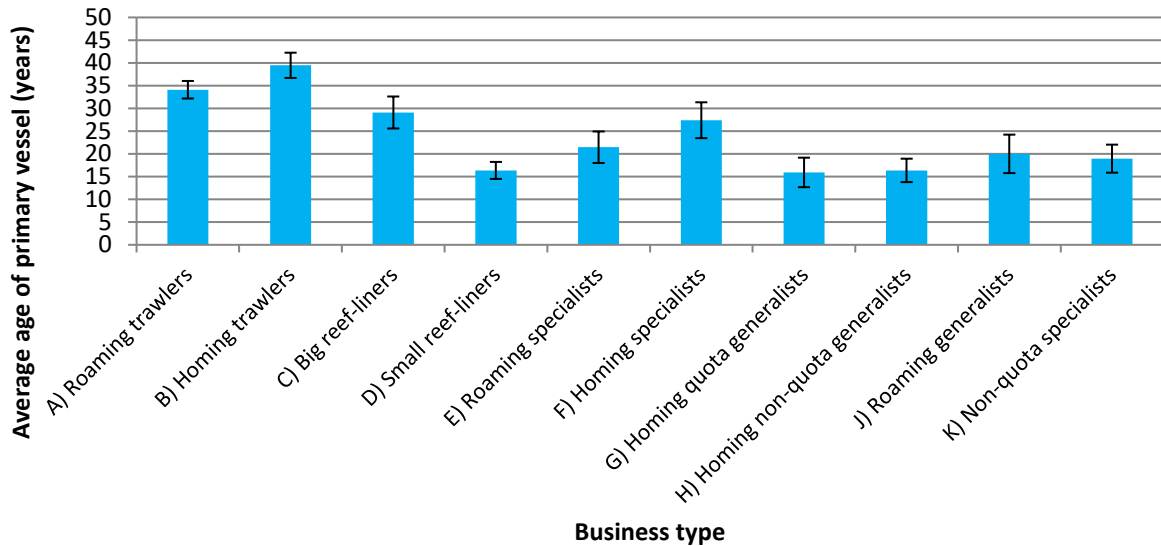


Figure 23. Average ages of primary vessel by business type.

In terms of licence characteristics, most respondents (61% of operators, 53% of investors), held only one licence (Figure 24). Most respondents (85% of operators, 82% of investors) stated all of their owned licences were active in 2013/14. Most operators had active licences they operated themselves in the previous financial year (96% of operators), however some also had licences they leased for at least part of the year (13%), and /or had a skipper operating (9%). Most investors (82%) leased their licences to others, rather than managing the licence with a skipper (18%). On investigation of the licence data, it appears 2 of the operators, and 2 of the investors, perhaps should have completed the alternate survey – however we decided it would be best to let respondents self-define their role.

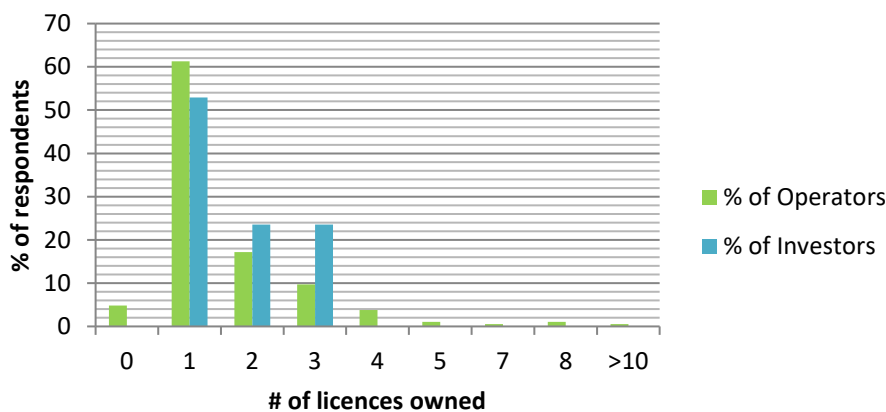


Figure 24. Number of licences owned by operator and investor respondents.

Most operators (61%) and investors (84%) owned quota or effort units of some sort at the end of the 2013/14 financial year. The majority of business types A–E and G are quota-owners, and, as expected, the non-quota types H and K mostly are not. For operators, quota types included Reef Quota (RQ, held by 26% of respondents), Spanish mackerel (SM, 23%), trawl effort days (23%), spanner crab (8%), coral harvest (3%), shark (0.5%) and tailor (0.5%). Figure 25 shows the combinations of quota ownership. There is a substantial overlap between RQ and Spanish mackerel (38%).

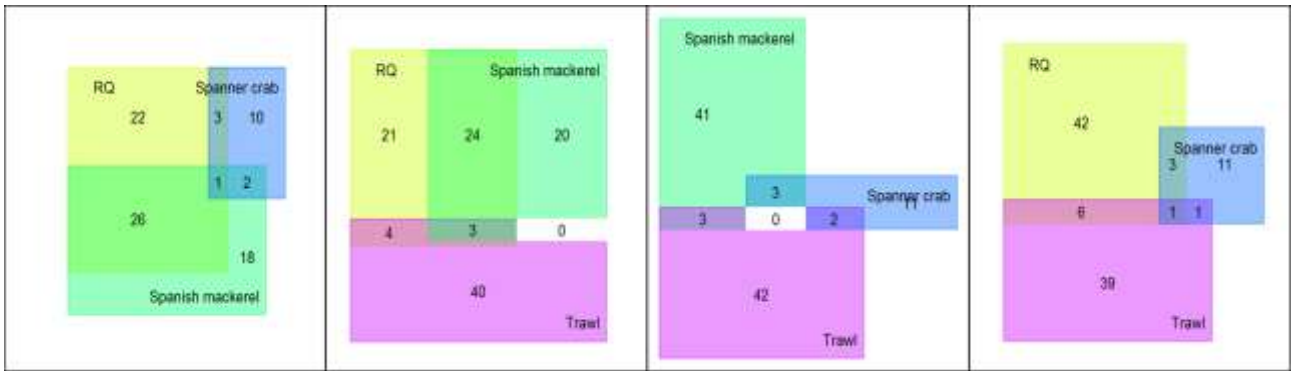


Figure 25. Three-way Venn diagrams for quota and effort days association. The area in each rectangle is proportional to the number of businesses using that quota / effort type or combination of types, and is also labelled by this number. Regions with no overlap are drawn in white.

For investors, 12 of those who owned quota (80% of all) held RQ quota (owning some combination of CT, RTE or OS quota). Eight investors owned SM quota, one business owned Trochus quota (in addition to RQ), and one owned Spanner crab (in addition to RQ and SM). The estimated current resale value of the licenses quota owned by businesses was also provided by 12 of the investors interviewed (Figure 26). A similar breakdown of value is not available for operators.

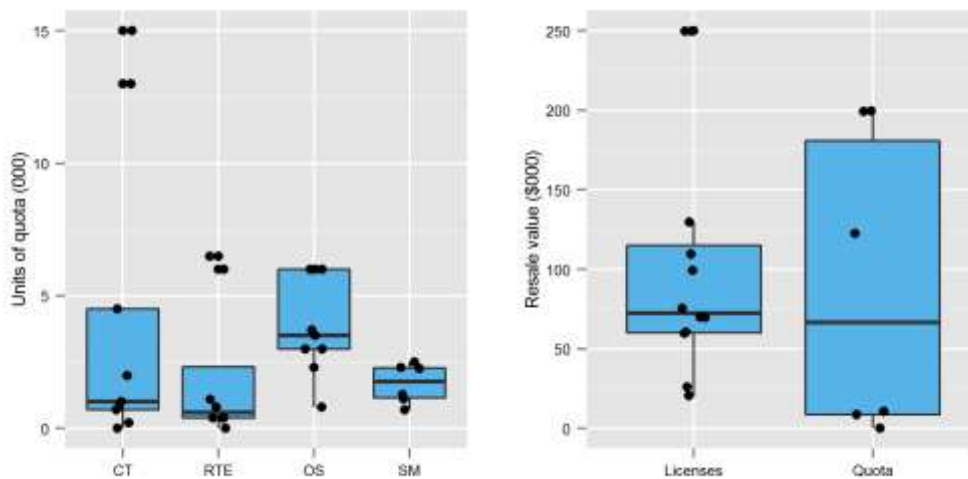


Figure 26. Units of quota owned (left panel), and value of licenses and quota held (right panel) by investors. All data points are plotted to better illustrate the spread of values.

Most operators (54%) had some kind of turnover of licences, symbols or quota during the previous financial year. Of those, 40% bought or leased in, while 42% sold or leased out one or more licences, symbols or quota types (or any combination of these). All investors leased in or out licences, symbols or quota, with 94% of investors leasing out any or all of these types of ownership (12%, n=2, leased in quota for their licences). More detail is shown in Figure 27, which shows that it was most common for operators surveyed to lease in quota, while investors most commonly leased out licence packages.

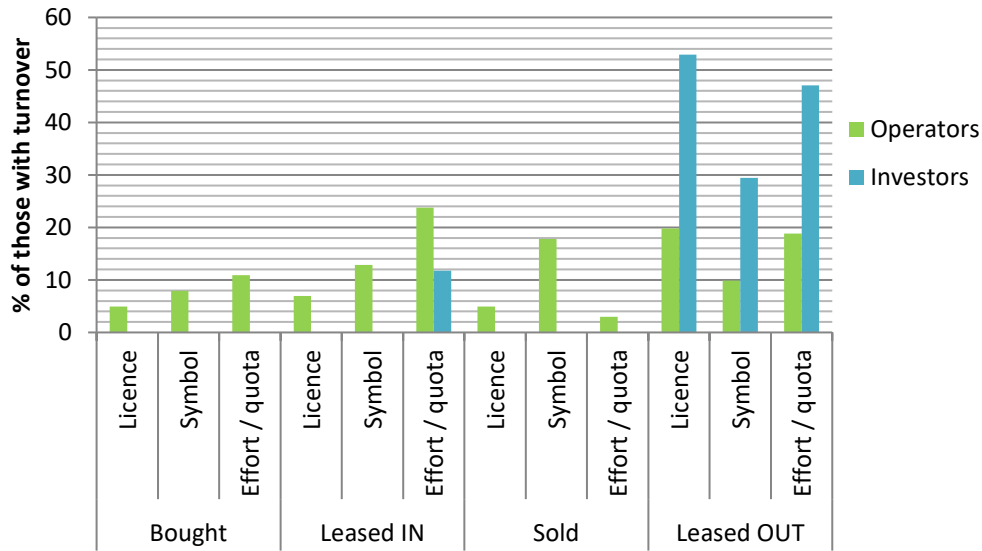


Figure 27. Proportion of operators and investors who stated they had some form of licence / symbol / quota turnover in the 2013/14 financial year, displayed by turnover type.

Business costs

Investors did not provide sufficient data related to costs, and therefore are not included here. Where costs were reported in any amount of detail, they were typically associated with the leasing of licenses, quota and/or symbols.

For operators, as with investment in capital assets, total business costs were also generally highest in the *trawler* (both A and B) and *big reef-liner* (C) types (Table 31, Appendix F, and Figure 28). Average total costs for the *roaming generalists* (J) are also relatively high at approximately \$491K but this figure is inflated by the total reported costs of one survey respondent (as reflected in the sd), and when the data for this business is omitted average total costs fall to ~\$318K. There is a similar situation in group C, where the average reported cost of land staff (~\$312K) exceeds that of crew (~\$309K) (Figure 29). However, when the figures reported by one business are omitted, mean land staff costs fall to \$17.5K, whereas crew costs only fall to ~\$267K. These situations illustrate how significant differences in the magnitude and structure of businesses within a business type have the potential to substantially affect the reported means, and that aspects with few observations must be treated with a degree of caution (e.g. 3 data points for land-based staff in type C).

Fuel is the largest cost of operation for over half of the operator types (Figure 29). For the *trawlers* (A, B) and the *roaming generalists* (J) fuel and crew/skipper costs combined represent the majority of their total costs at the annual level.

The proportion of total costs attributable to labour (i.e. crew/skipper/land staff) varies markedly by operator type, with a number of types not paying either land staff or skippers. The values for skipper payments are potentially underrepresented in some cases, as there were instances where the figures provided for crew actually included skipper costs but a more detailed breakdown was not available. The relative magnitude of costs for crew and fuel reported by respondents in group C, the *big reef-liners*, are also broadly in line with those reported by large (>15m) reef-line vessels in the recent ELFSim economic survey (Little et al. 2015).

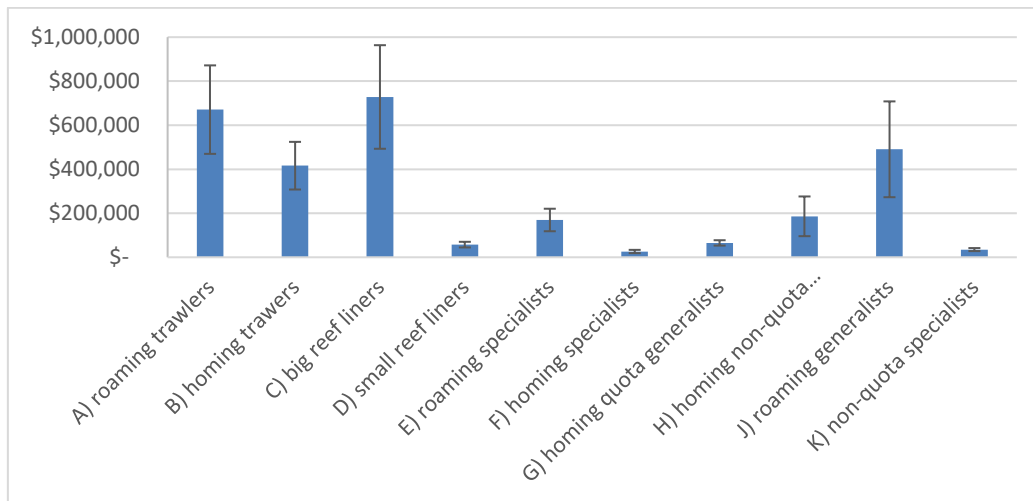


Figure 28. Average total business costs across operator business types.

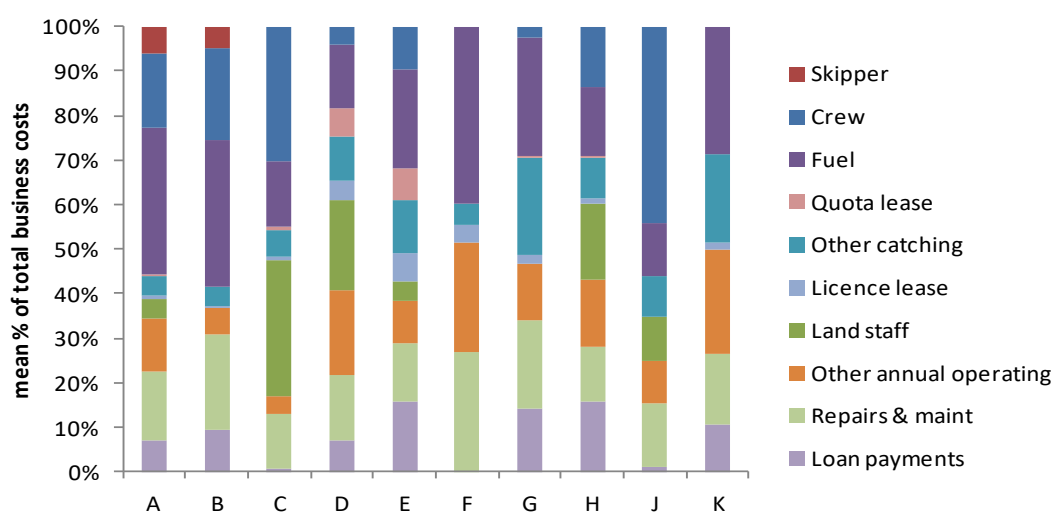


Figure 29. Average costs as a proportion of the annual total by operator type

Revenues, profit, return on capital 2013/14

For investors, only 4 respondents provided exact figures in relation to total business revenues; the remaining 14 either selected a category from a series of levels (12) or did not provide an answer (2). The revenues reported were highly bimodal, with the majority (13) falling within the category “under \$50,000” and the remainder exceeding \$500,000. The low levels of data obtained in relation to costs, combined with primarily categorical earnings data, prevent meaningful estimates of indicators such as profit or returns on capital.

For operators, mean revenues were highest in the *roaming generalists* (J) and *big reef-liners* (C), however, the level of variation was again seen to be high in the *roaming generalists* (Table 8) (Figure 30). In the absence of information on costs or investment, measures of revenue provide a relatively limited amount of information on how well a business is performing. As a consequence, measures of profitability, return on capital, and profit as a share of revenue were also estimated from the survey data (Table 8). Given these data are not explored further in analyses, they are discussed in greater detail in Appendix G rather than here. The majority of businesses in the survey had revenues and costs of under \$500,000 and all but a few fell below the \$2m revenue threshold used to define small businesses by the Australian Taxation Office (ATO) at the time of the surveys. There was no obvious relationship between types and revenues/costs, however costs are seen to exceed revenues for a number of operators (Figure 31).

Table 8. Revenue, full equity profits, return on capital and profit as a share of revenue for each business typology (operators only); number of observations (n), mean, standard deviation (sd), standard error (se).

		Business Type									
		A	B	C	D	E	F	G	H	J	K
(n)		7	15	11	14	13	7	19	14	8	24
TOTAL business revenue	mean	422,857	343,533	670,091	91,786	286,538	57,143	171,842	245,257	744,332	60,125
	sd	369,796	258,532	598,105	102,218	398,494	31,339	282,278	367,735	843,382	49,294
	se	139,770	66,753	180,336	27,319	110,522	11,845	64,759	98,281	298,181	10,062
Full equity profits	mean	-46,500	-5,346	-51,810	39,396	124,059	31,254	107,490	60,157	254,241	25,560
	sd	207,697	202,748	254,196	96,349	265,563	16,440	238,215	59,715	357,046	27,414
	se	78,502	52,349	76,643	25,750	73,654	6,214	54,650	15,960	126,235	5,596
Economic Profits	mean	-66,857	-22,170	-77,651	33,786	114,713	28,677	97,663	50,312	211,122	21,055
	sd	217,319	218,036	265,515	95,971	268,543	16,559	233,469	58,866	337,924	26,013
	se	82,139	56,297	80,056	25,649	74,480	6,259	53,562	15,733	119,474	5,310
Return on capital	mean	-0.01	0.21	0.05	0.66	0.49	0.69	0.48	0.75	0.25	0.63
	sd	0.5	0.4	0.4	1.6	0.7	0.4	0.5	1.5	0.3	1.5
	se	0.2	0.1	0.1	0.4	0.2	0.2	0.1	0.4	0.1	0.3
Profit as share of revenue	mean	-0.28	0.08	0.10	-0.03	0.35	0.57	0.39	0.40	0.36	0.45
	sd	0.7	0.4	0.3	1.1	0.2	0.2	0.6	0.3	0.3	0.3
	se	0.3	0.1	0.1	0.3	0.1	0.1	0.1	0.1	0.1	0.1

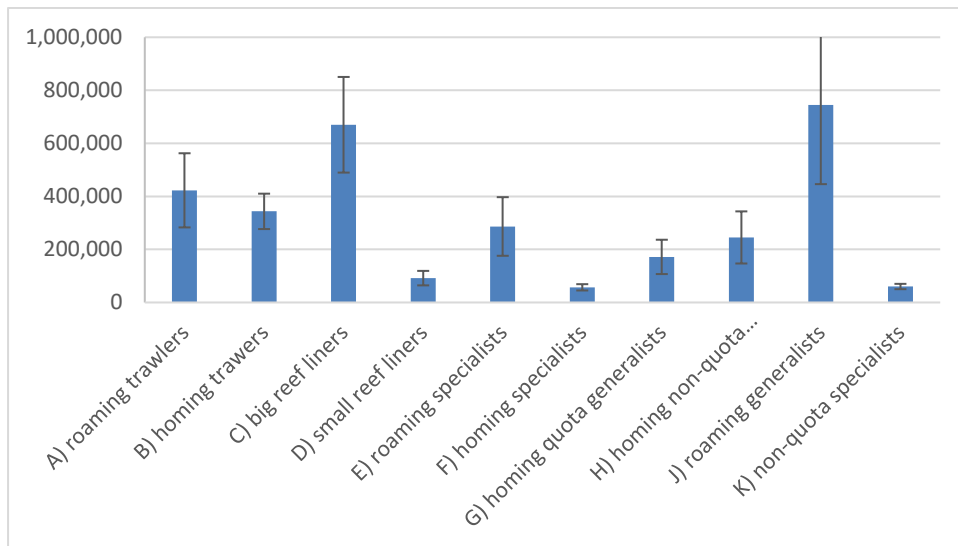


Figure 30. Mean total business revenue across business types (operators only).

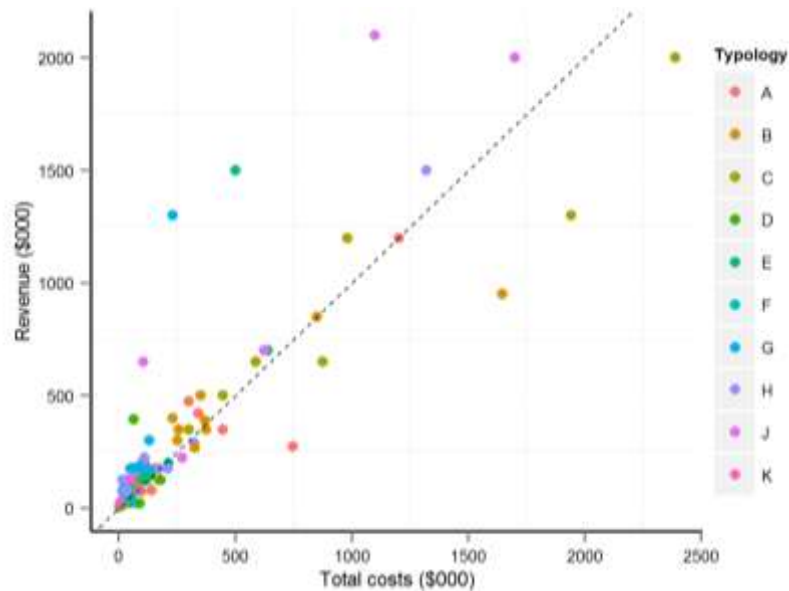


Figure 31. Business revenue against total costs of operating for operators; dashed line indicates the point at which revenues equal costs

Attempts were made to also calculate the finance costs associated with each business type, but insufficient data was available. In the majority of cases, two or fewer businesses reported the rate of interest associated with their loan payments, preventing estimates of the debt owed being made. This also prevented the calculation of reliable estimates of equity being calculated.

Income and market diversity (within fishing business)

Most operators (66%) received 100% of their fishing income from harvesting alone (overall 86% (+/- 2.16) of fishing income was from harvest, median 100%), while others received some income from processing (7% of operators; overall average 2% +/- 0.83), retail/wholesale (20% of operators; overall average 7% +/- 1.48) or other (overall average 5% +/- 1.32). By business type, harvesting was most frequently the primary component of income, although some level of retail or wholesale was also seen to be present in all business types (Figure 32). Leasing out of quota or effort units was only really relevant for the *homing trawlers* (B) surveyed whereas the leasing out of licenses was seen to predominantly be a source of income for *roaming specialists* (E) and some *roaming generalists* (J).

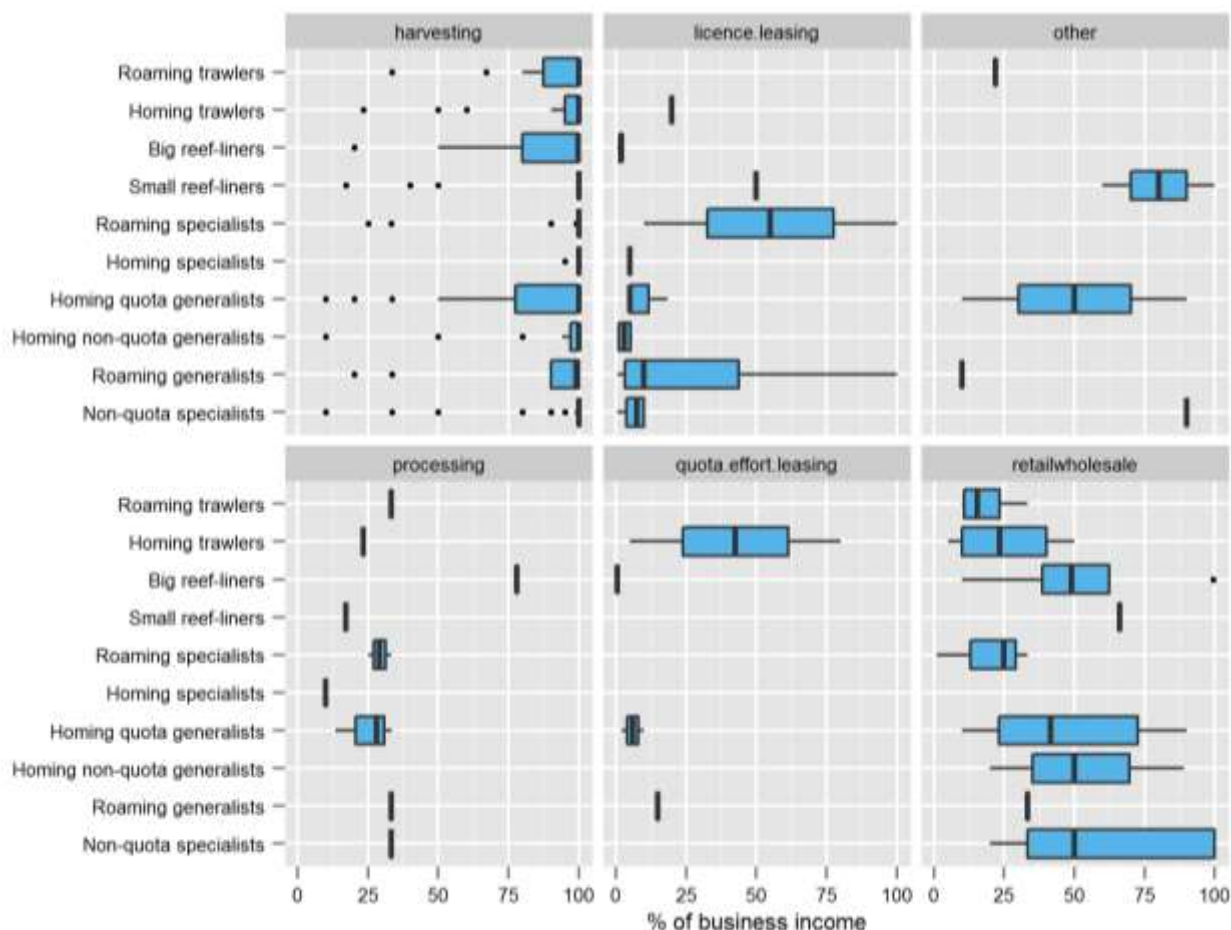


Figure 32. Sources of revenue by business type, as a percentage of business income.

Some operators (37%) also sold at least some of their harvest directly to the public. Most operators had one local buyer (51% of operators), including selling direct to the public. Many also sold to buyers in other locations outside their home port. Many operators (39%) sold only to local buyers, with about a quarter (26%) of operators selling to one local buyer and no others elsewhere. In contrast, 14% sold all their product outside of their local area (Table 9).

Table 9. The number of buyers that operators sold to in their local home port region and elsewhere, by proportion of operators.

% of operators	# of local buyers					TOTAL %
	0	1	2	3	>3	
# of buyers elsewhere	0	1	2	3	>3	TOTAL %
0	-	26	8	3	1	39
1	5	13	4	2	2	27
2	2	5	3	0.5	2	13
3	1	2	1	1	0.5	6
>3	4	4	4	2	0.5	15
TOTAL %	13	51	21	9	6	

Financial buffer

Most operators and investors (76% of both groups) stated that they maintain a financial buffer in case of emergencies. However, most (89%) do not have any income insurance for their business. Less than half of the operators (44%) have vessel insurance (Figure 33). These characteristics varied slightly by business type, with the lowest proportion of businesses having a financial buffer within the *roaming trawlers* (A) type, and those with the highest value vessels (A-C) more likely to have vessel insurance (Figure 34). Only 15% of

operators stated they could afford to hire a skipper, although again there was some variation at the typology level (Figure 34).

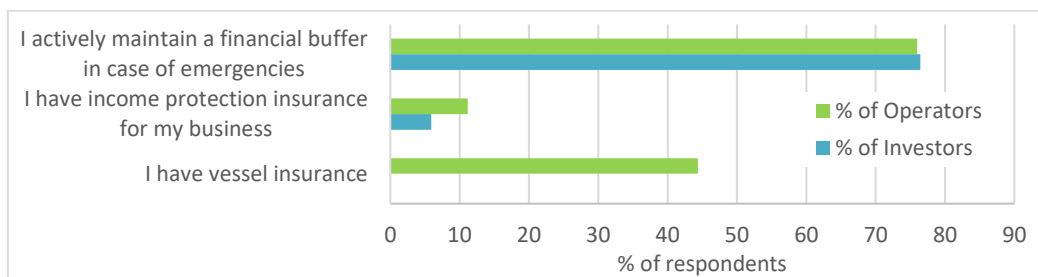


Figure 33. Proportion of operators and investors with a financial buffer or insurance.

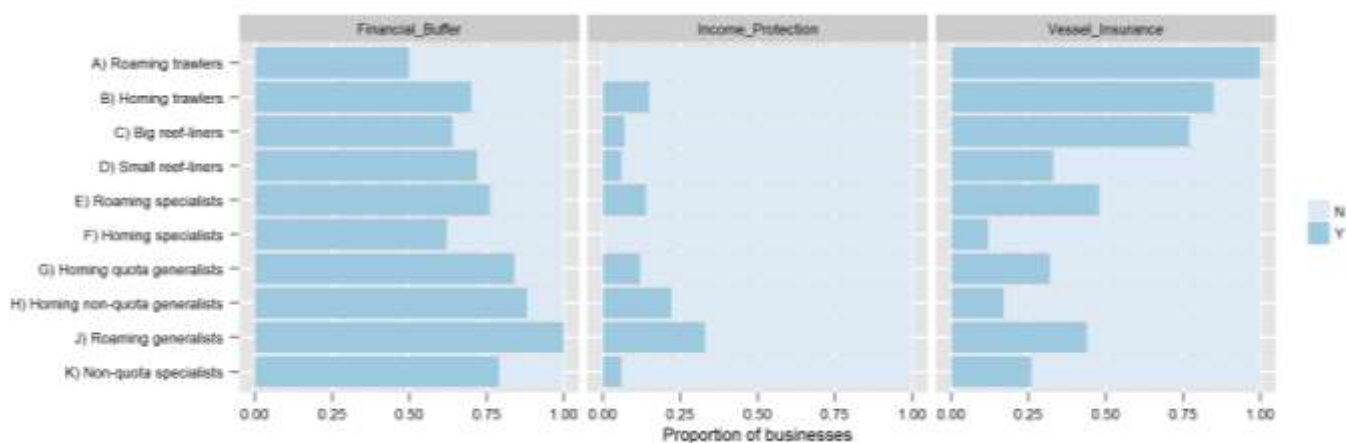


Figure 34. Proportion of operators by business type who stated they maintain a financial buffer, and have income protection insurance and vessel insurance.

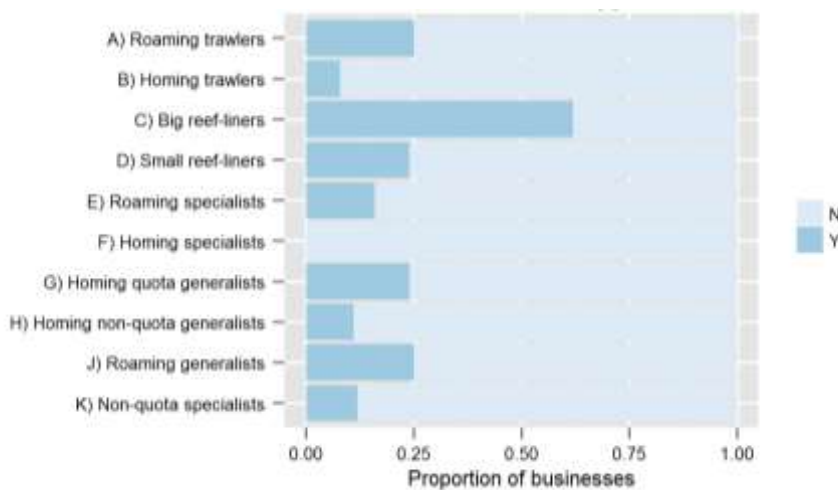


Figure 35. The proportion of operators in each business type that could afford to hire a skipper if they chose to hire one.

Fishery type

Surveys covered operators dependent on all main fishery types (20% were primarily dependent on line fisheries, 19% on net, 25% on pot, 23% on trawl, 19% on harvest, and 6% on a combination of fisheries – i.e. they could not state primary dependency on one fishery alone) (Figure 36). There was also diversity within each main fishery type (e.g. ‘line’ included reef line, rocky reef, Spanish mackerel, spotty mackerel,

deepwater and pelagic line fishing; ‘pot’ includes mudcrab, blue swimmer crab and spanner crab). Just over half of the operators (55%) stated the fishery they depended on did not vary among years. Annual variation was most common for those operators dependent on net and pot fisheries (53% of net fishers, and 67% of pot fishers stated their fishery dependency varied among years). Most fishers who stated their fishery varied (61%) explained that this was due to weather or seasonality, with statements such as “Seasonal weather patterns”; “Wet season = good banana prawn season”; “Weather - wrong wind direction early means you don’t get Spanish mackerel”; “Rainfall or floods affects crab - depends on the weather”. Other common reasons for fishery variability related to: market price (12% of those who stated their fishery dependence varied); management change (11%), including zoning and removal of licences; competition with other fishers (recreational and/or commercial) (8%); product availability (7%), with statements such as “If prawns are good, I’ll concentrate on that”; Sale of access (symbol / licence), (4%), and ocean currents which affect fish movement (3%).

Surveyed operators primarily were active in only one main fishery type (60% of operators), followed by two types (26%), three types (12%) or 4 types (3%). As expected, this varied according to the main fishery operators were dependent on – those dependent on line, trawl and harvest fisheries were more likely to rely solely on those fisheries for harvest income, while those dependent on net and pot fisheries usually relied on at least 2 main fishery types (Figure 36). There is substantial overlap among net, pot and line fisheries and also with the trawl sector. This is seen more intuitively in Venn diagram form (Figure 37), which shows net and pot are most closely aligned (38% of businesses in net or pot fisheries access both).

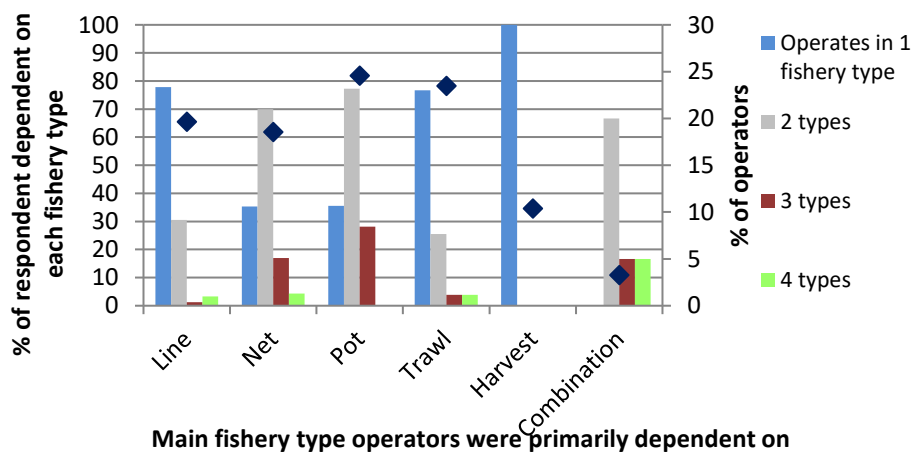


Figure 36. Spread of main fishery types which operators primarily rely on for their income (see dots, linked to right-hand axis), and the proportion of fishers reliant on each fishery type who operated in 1 or more fishery types (bars, and left-hand axis).

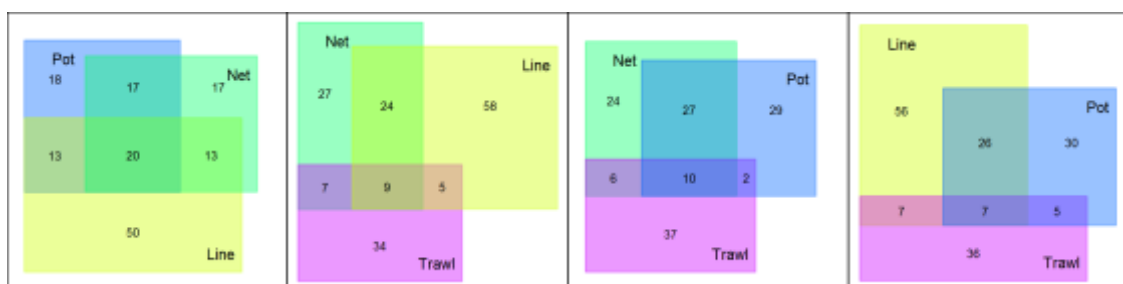


Figure 37. Three-way Venn diagrams for fishery type association. The area in each rectangle is proportional to the number of businesses involved with that fishery or combination of fisheries, and is also labelled by this number. For example, line is the biggest sector in our sample (13+20+13+50=96 businesses) and, of these, 20 businesses are also involved in the net and pot fisheries. There is very little overlap between harvest and the other fisheries (not shown).

Region and mobility

The regional distribution of the home address of survey respondents and home port of operators closely matched that of all licences listed along the Queensland east coast (Figure 38), at least at the Natural Resource Management (NRM) area level. Most operators (92%) stated their home port was also their home NRM (Table 10). A slight majority (54%) of operators used only one home port, while 20% used 2 ports, 14% used 3 ports, and 6% used more than 3 ports in the previous financial year.

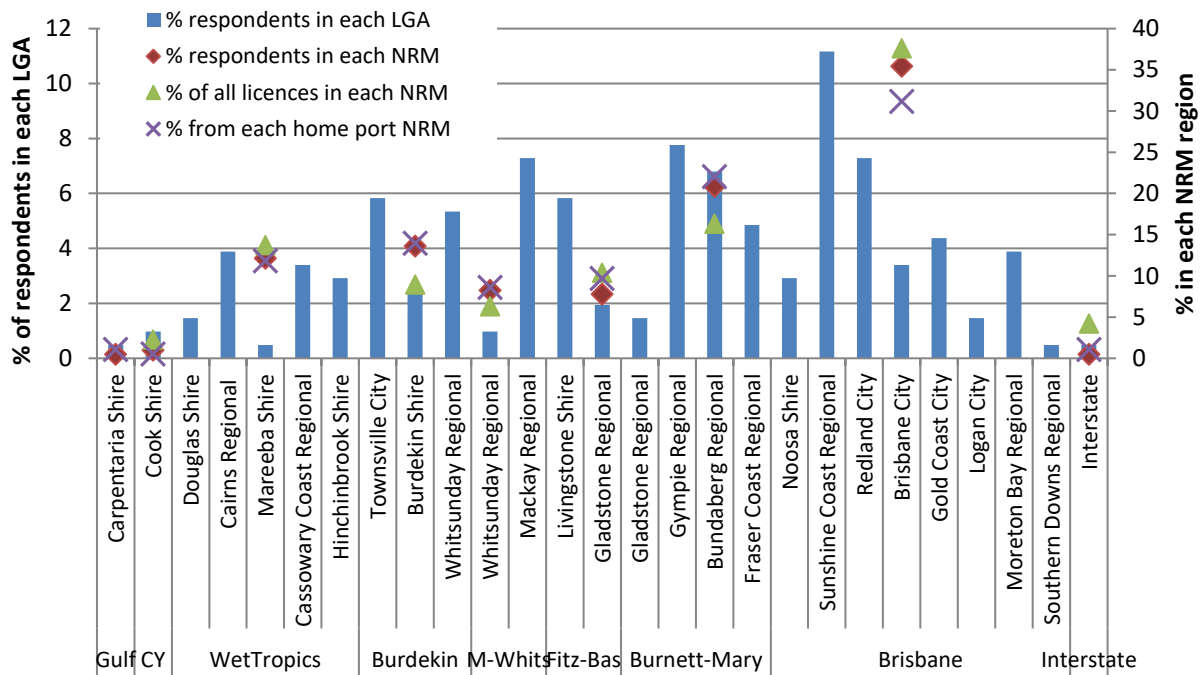


Figure 38. Distribution of survey respondents by local government area (LGA) and Natural Resource Management (NRM) region (plus proportion of all licences within each NRM). Note some LGAs overlap two NRM regions. Groupings are based on postcode and home town or port name.

Table 10. The proportion of operators who stated their home port is within their listed home NRM region.

NRM	% of operators with their home port within their home NRM
Gulf	100
Cape York	50
Wet Tropics	95
Burdekin Dry Tropics	93
Mackay Whitsundays	94
Fitzroy Basin	100
Burnett-Mary	95
Brisbane	89
Interstate	0
TOTAL	92

Staff dependency

On average, all business types other than the *homing specialists* (F) reported employing some additional workers or crew. In all cases this labour was most often paid and supplied by non-family members on either a full- or part-time basis (Table 32, Appendix F). Workers or crew that are family members are also employed to some extent in all businesses other than the *non-quota specialists* (K), where family labour was not used by the businesses surveyed. Where family labour was used it was primarily on a paid basis,

however there were cases where family labour was more unpaid than paid (D – *small reef-liners*, J – *roaming generalists*). Family employees are of greatest relative importance to the *homing quota generalists* (G) where on average 44% of labour is obtained from family members (33% paid, 11% unpaid) (Figure 39).

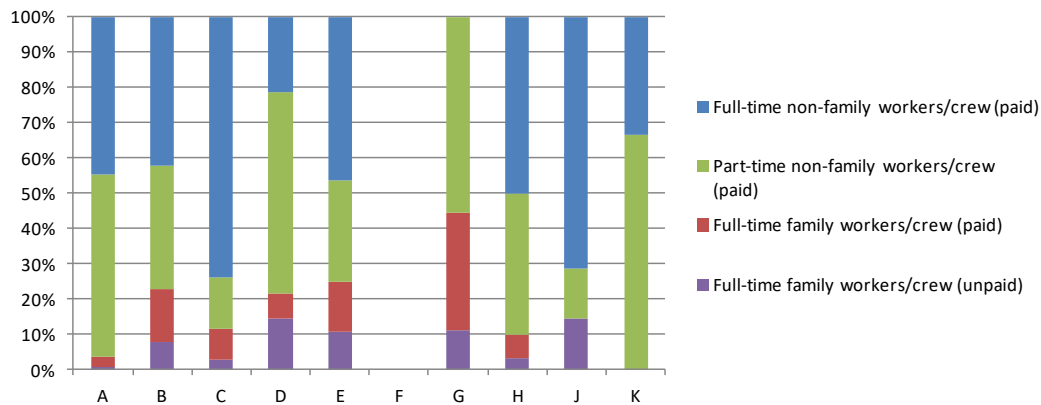


Figure 39. Relative importance of different labour sources by business type.

Adaptation Options

Operators were asked to state how easy or difficult it would be to make practical behaviour changes such as stopping fishing temporarily; changing fisheries, species, product type or markets; moving to unfamiliar grounds, or grounds further away from their current home port; or moving home ports, if a sudden change occurred. We refer to these as ‘practical adaptation options’. Operators’ ability to take up these options relates to their capacity to adapt, and hence the responses are included under the next subtitle.

Capacity to adapt / implement options

Key Findings

- Current practice:
 - most respondents (39%) were maintaining business as usual, but many were also increasing the size of their business (21%), or diversifying their operations (20%) (some fishers were doing both).
 - About half of the operators but a quarter of the investors were satisfied with the current profitability of their fishing business.
 - Similarly, 58% of operators, but no investors agreed that they currently earn enough money to support the style of life they prefer.
 - There was also a strong feeling among respondents that the success of their business was determined by factors outside of their control.
 - While the majority of respondents felt their business was in the same financial position as it was at the same time last year, fewer felt the same when comparing to 5 years ago. Most also felt less secure in their fishing business than they did 5 years ago.

Key Findings contd.

- Future options:
 - When asked about their perceptions of the future, respondents were not overly optimistic about the future of their business or the future of the Queensland east coast fishing industry.
 - When considering potential practical adaptation options for operators, based on their current fishing behaviour and business practices, if a sudden change occurred most operators would find it very difficult to take up various behavioural adaptation options.
 - The responses to the adaptation options questions were combined to create an overall score and rank of adaptation 'options': the 'options' score suggests only a few businesses have a large number of options available. Most businesses fit within the 'medium' options rank. The differences between business types are not marked.
 - We found education, quota ownership, financial buffer, vessel insurance, access to other fisheries, dependency for individual income and more experience relative to age were all associated with higher adaptive capacity.
 - The adaptive capacity score was also associated with the inherent resilience score.
 - When asked what they see themselves doing in the next 3 years, most operators (63%) selected the statement: "still in the industry, operating the same as now".

Current practice

First, we explored what fishers (operators and investors) were currently doing, in terms of their business plans: i.e. were they maintaining business as usual, or planning/making changes. We found most respondents (39%) were maintaining business as usual, but many were also increasing the size of their business (21%), or diversifying their operations (20%) (some fishers were doing both) (see Figure 40). About 10% of fishers were downsizing, and 10% were waiting for a good time to sell or retire. In contrast, 6% of operators were specialising (including value-adding) and 6% of investors were 'trying new things'. 'Other' responses included those who had recently sold their licence, had stopped fishing at least temporarily due to environmental or health issues, or were waiting for the right time to re-enter the fishery actively.

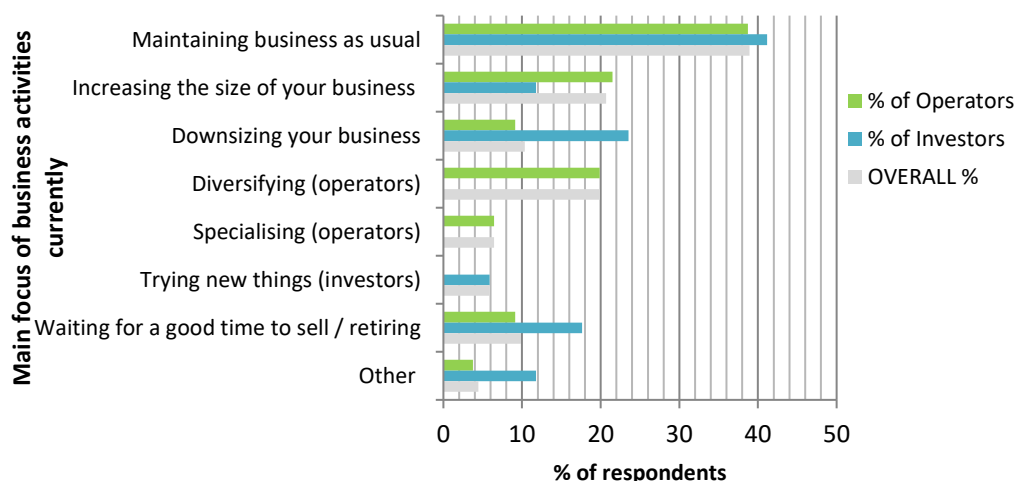


Figure 40. Current focus of business activities of operators and investors.

Respondents were asked to state their level of agreement with a series of statements related to how satisfied they are with their current profit, their perception of how much control they have over the success of their business, and their optimism for the future of their business and the industry. About half of the operators (51%) but a quarter of the investors (28%) (49% overall) agreed that they were satisfied with the current profitability of their fishing business. Similarly, 58% of operators, but no investors (overall 53% given the larger sample size of operators) agreed that they currently earn enough money to support the style of life they

prefer (interestingly, 83% of investors chose an agreement score of ‘1, strongly disagree’ for this statement). There was also a strong feeling that the success of their business was determined by factors outside of their control (81% of operators, 78% of investors; 81% overall) – more than half of the respondents strongly agreed (score of 9 or 10) with this statement. See Figure 41 for more detail showing the spread of responses among respondents, and the average scores.

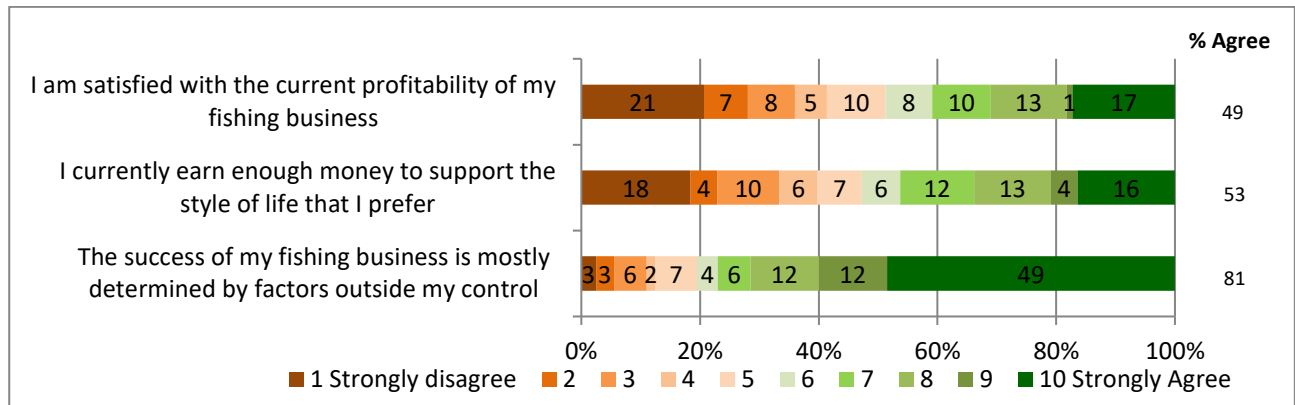


Figure 41. Respondents’ level of agreement with statements related to current satisfaction with profit, and their perception of control over their business success.

Operators were positive about the state of the habitats they fish the most, and the sustainability of their main target species (65% and 91% agreed with the related statements, respectively) – see Figure 42 for more detail of the spread of responses and the average scores.

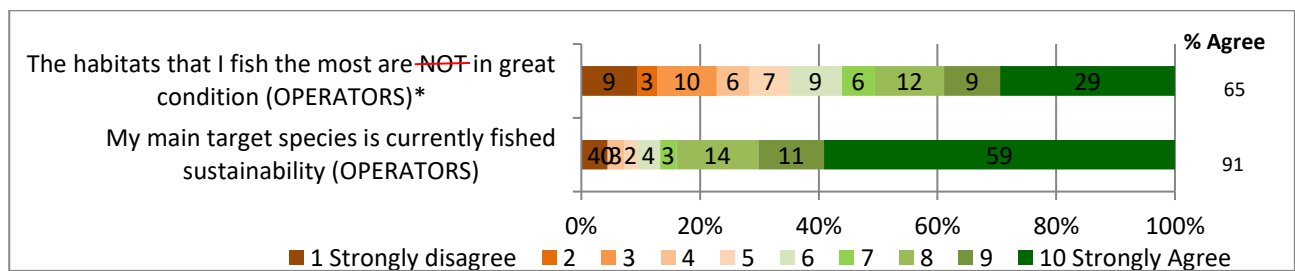


Figure 42. Operators’ level of agreement with statements related to the status of habitats and target species they utilise. *Negatively worded questions have been reversed to be positively stated for analysis.

While the majority of respondents (41%, overall: 38% of operators and 67% of investors) felt their business was in the same financial position as it was at the same time last year, fewer felt the same when comparing to 5 years ago (Figure 43) – more (45% overall: 43% of operators; 61% of investors) felt their business was now in a worse financial position.

Most respondents also felt less secure in their fishing business than they did 5 years ago (Figure 44).

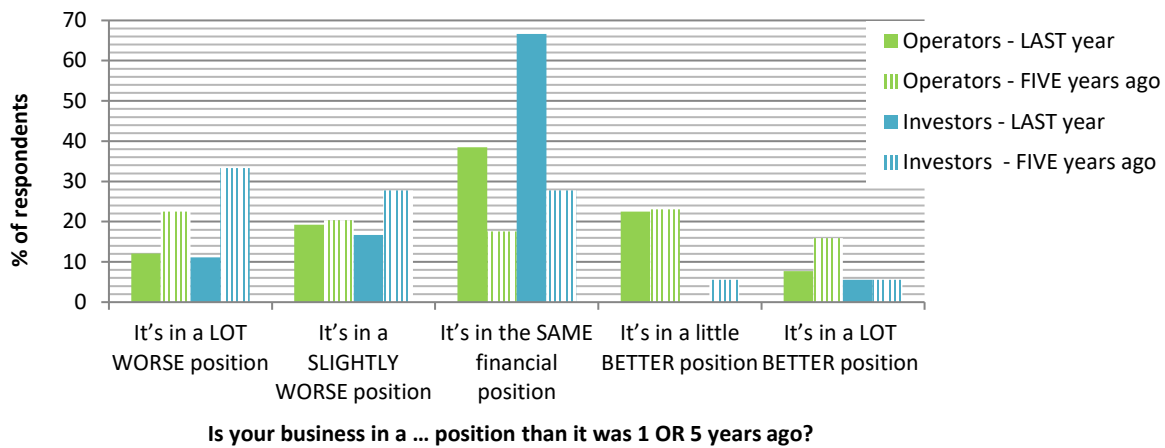


Figure 43. Respondents' perceptions regarding whether their business was in a better, same or worse financial position at the time of the survey, compared to the same time a year ago, and 5 years ago.

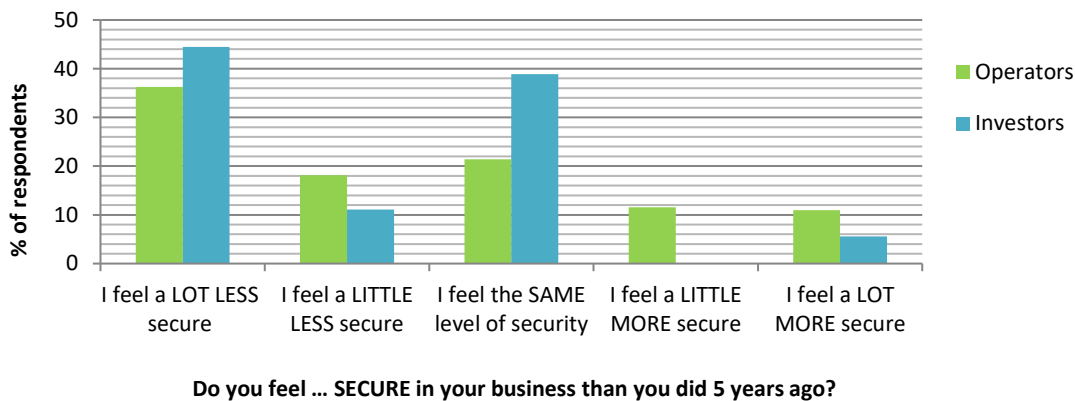


Figure 44. Respondents' perceptions regarding whether they feel more or less secure in their business than they did 5 years ago.

Future options

When asked about their perceptions of the future, respondents were not overly optimistic about the future of their business (57% of operators, and 22% of investors; 54% overall, were at least slightly optimistic) or the future of the Queensland east coast fishing industry (44% of operators and 17% of investors; 42% overall, agreed with this statement). See Figure 45 for more detail showing the spread of responses among respondents, and the average scores.

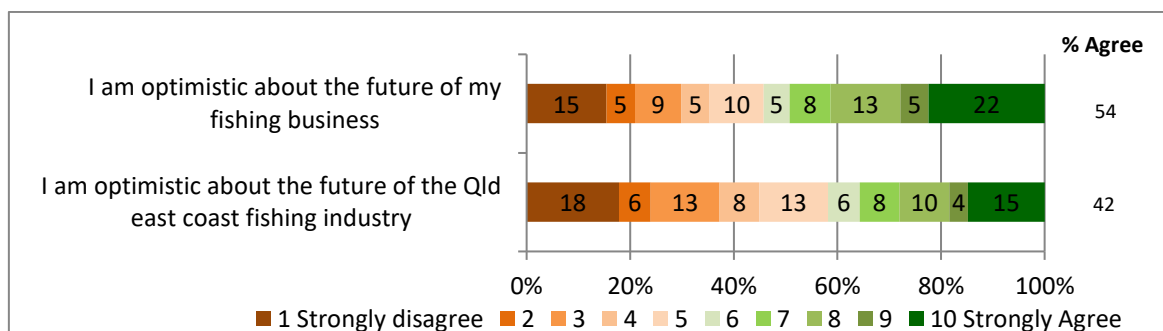


Figure 45. Respondents' level of agreement with statements related to optimism for the future of their business and the industry.

When considering potential practical adaptation options for operators (not investors), based on their current fishing behaviour and business practices, if a sudden change occurred most operators would find it very difficult to take up various behavioural adaptation options such as stopping fishing temporarily, changing

fisheries, species, product type or markets, moving to unfamiliar grounds, or grounds further away from their current home port, or moving home ports (Figure 46).

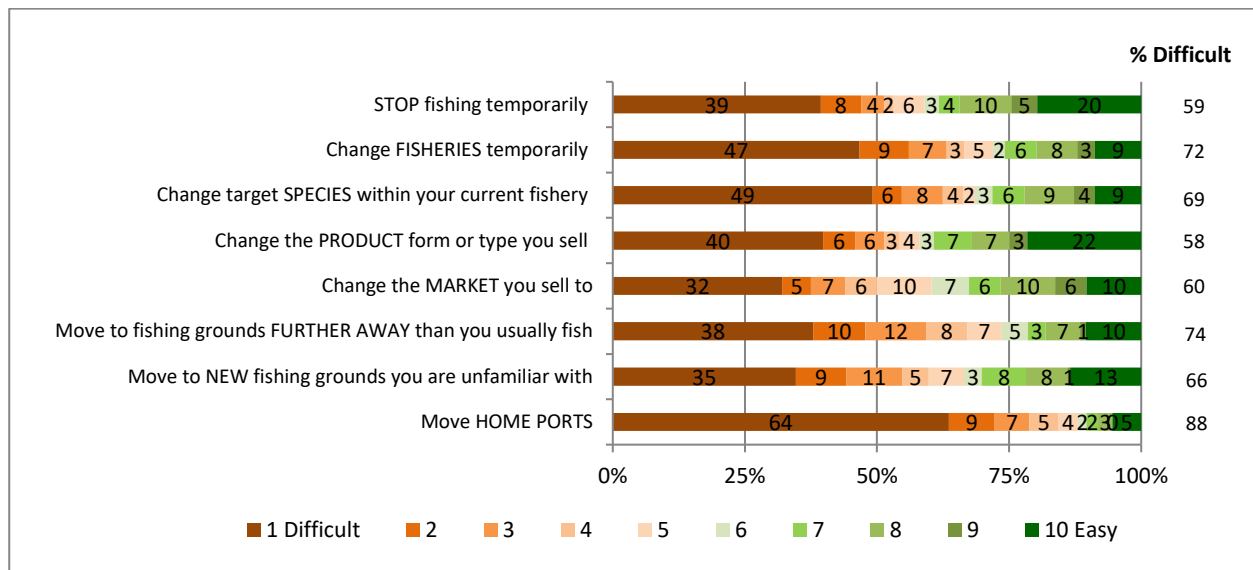


Figure 46. Operators’ perceptions regarding how difficult or easy it would be for them currently to make behavioural adaptation changes if a sudden change occurred.

As with the inherent resilience questions, the responses to the adaptation options questions (see Table 4 for the questions included) were combined to create an overall score of ‘adaptation options’. First, missing values were imputed using median polish, then all cases were tested for reliability across the questions. Reliability analysis revealed a Cronbach’s α value of 0.69, which was considered acceptable. Dimension reduction was then applied to create a score of adaptation options for each respondent. As suggested in Figure 46, the ‘options’ score is skewed to the left (Figure 47a), with only a few businesses having a large number of options available. This score was converted to an ‘adaptive capacity’ rank of low, medium or high, with most businesses fitting within the ‘medium’ rank (Figure 47b). The differences between business types are not marked (Figure 47c); there is a suggestion that more *roaming trawlers* have a high adaptive capacity rank, but the difference does not prove significant in *t* tests of the underlying scores.

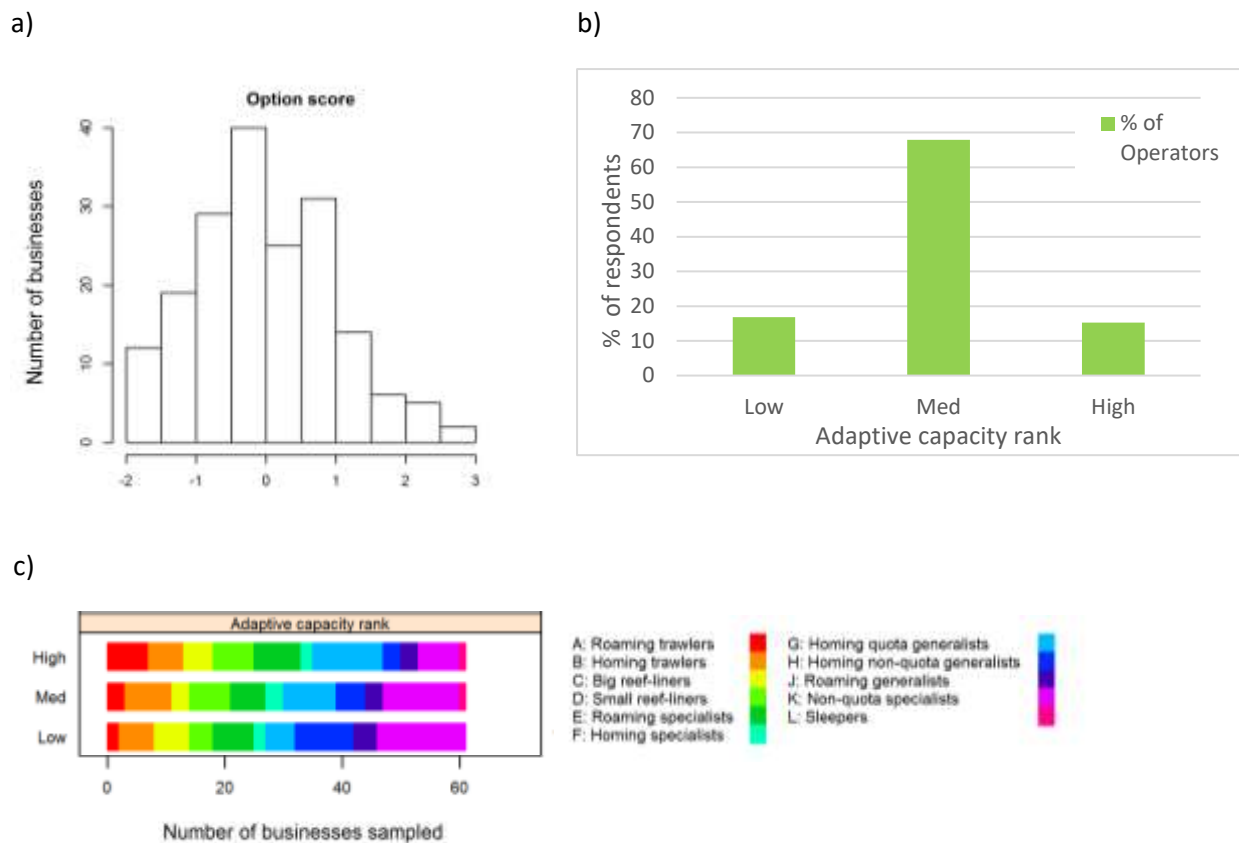


Figure 47. (a) Distribution of ‘adaptation options’ scores among all operators, (b) the spread of ‘adaptive capacity’ scores between business types

While commonly stated reasons for difficulty in taking up adaptation options related to experience, financial buffer, licence and vessel restrictions, step-wise linear regression analysis against various individual and business characteristics (see Table 3 for the complete list of characteristics tested) we found education, quota ownership, financial buffer, vessel insurance, access to other fisheries, dependency for individual income and more experience relative to age were all associated with higher adaptive capacity (Table 11). The excess of individual over household income percentage from fishing can perhaps be understood as a measure of incentive, which is therefore associated positively with adaptive capacity (i.e. higher dependency may force fishers to adapt within the fishery). The adaptive capacity score was also associated with the inherent resilience score. Note, however, as with the resilience score regressions, the fits were poor, explaining only about 15% of the variation.

Table 11. Estimated coefficients from the stepwise linear regression for adaptive capacity.

The adjusted R² and residual standard errors (R_{adj}^2, σ) were (0.15,0.91) for adaptive capacity, (0.13,0.95).

‘Y’ after the variable/attribute denotes ‘Yes’.

Response	Variable / attribute	Estimate	Std. Error	t value	Pr(> t)
Adaptive capacity score	(Intercept)	-0.585	0.309	-1.890	0.061
	educationY	0.402	0.156	2.584	0.011
	quota_ownedY	0.266	0.161	1.653	0.100
	resil_score	0.113	0.073	1.554	0.122
	nfishery	0.184	0.088	2.093	0.038
	bufferY	0.252	0.173	1.460	0.146
	insure_vessely	0.276	0.160	1.722	0.087
	l(indiv_income – house_income)	0.007	0.004	1.848	0.066
	l(age – experience)	-0.015	0.007	-2.116	0.036

When asked to choose the most appropriate statement that reflects what they see themselves doing in the next 3 years, most operators (63%) selected the statement: “still in the industry, operating the same as now”. A quarter (24%) chose “still in the industry, but will make substantial changes”, 9% would be “retired”, and 4% would be “out of the industry, doing something else”. Of those who intended to remain in the industry but make substantial changes, these changes most commonly included diversifying their fishing, decreasing their effort, changing / upgrading their vessel, changing fishing area, upgrading gear, or involving family. We did not ask the investors these questions.

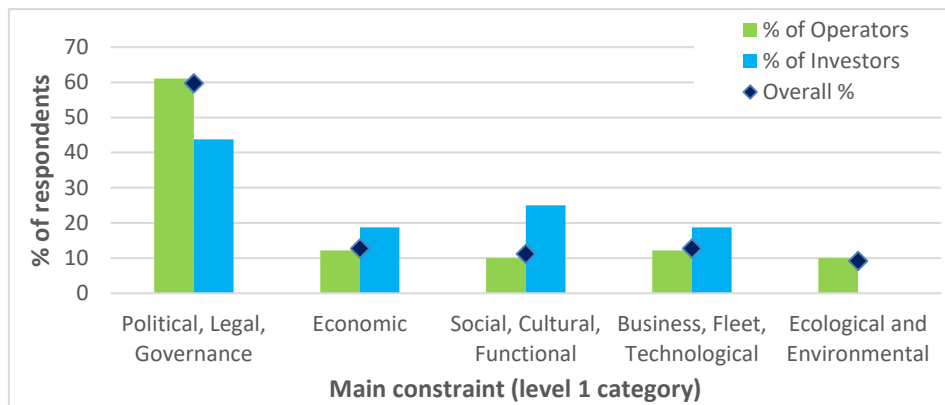
Barriers and constraints (including Externalities)

Key Findings

- Responses in this section were coded to modified PESTEL categories, as explained in the methods
- Main constraint:
 - Most businesses listed constraints within the *Political, legal and governance* category. Within this category most answers related to regulation or over-regulation, area restrictions, or feelings of uncertainty / lack of security.
 - There were some strong relationships between business type or fishery with constraint category: *Homing trawlers* (B) are associated with economic constraints, *homing non-quota generalists* (H) with area restrictions, *roaming specialists* (E) with regulation, and *small liners* (D) with both ecological and social constraints.
 - When relating to individual and business characteristics to constraints, we found a more experienced business is less likely to be constrained by uncertainty.
 - At the time of the surveys the Queensland Fisheries review was underway. We asked fishers what one management change they would like to see. Despite the request to focus on a State fisheries rather than a Federal Marine Park issue, changes to area restrictions (including green and yellow zones) were most commonly stated.

We asked fishers what the main constraint was on their ability to maintain a viable business, or to grow. Responses were coded to two levels, by two independent coders, into the PESTEL categories listed above (0). Most businesses (60%), particularly operators (61%), listed constraints within the *Political, legal and governance* category (Figure 48a). This category mostly contained answers related to regulation or over-regulation, area restrictions, or feelings of uncertainty / lack of security (Figure 48b).

a)



b)

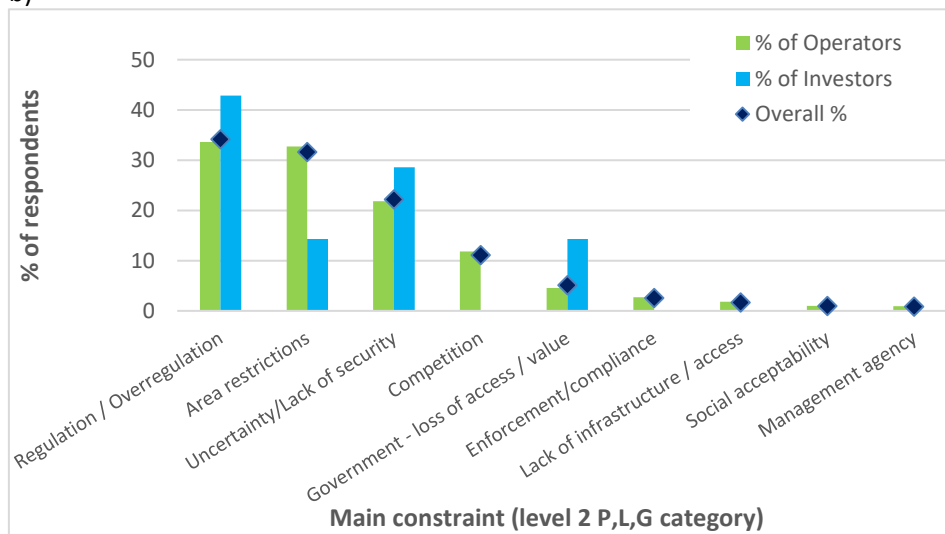


Figure 48. Main constraints businesses face, coded to (a) level 1 modified PESTEL categories; and (b) level 2 sub-categories for the *Political, Legal and Governance* category.

For correlation analyses, level 1 was too coarse, but many of the level 2 categories were too infrequently mentioned, meaning we needed to ‘lump’ some categories together in a way that made sense and meant numbers were sufficient for analysis (see Table 12 for the list, and Figure 49 for the frequency each category was listed).

Table 12. Categories for the open-ended questions on **constraint** to allow further analysis.

Level 1 consists of the PESTEL categories and level 2 are more detailed sub-categories within these. The lumped categories are a compromise between the two, chosen to provide an adequate number of samples per category. Level 1 categories that have been split at level 2 are shown in *italic*. Sub-categories at level 2 that have been lumped together are indicated by the same superscript number; e.g. ‘Competition’ is lumped with ‘Enforcement/compliance’ and others as an ‘Other Political, Legal, Governance’ category.

Level	Categories
Level 1	Business, Fleet, Technological; Ecological & Environmental; Economic; No constraint; <i>Political, Legal, Governance</i> ; Social, Cultural, Functional
Level 2	Area restrictions; ¹ Competition; ¹ Enforcement/compliance; ¹ Government—loss of access/value; ¹ Lack of infrastructure/access; ¹ Management agency; Regulation/Overregulation; ² Social acceptability; Uncertainty/Lack of security
Lumped	Area restrictions; Business, Fleet, Technological; Ecological & Environmental; Economic; No constraint; ¹ Other Political, Legal, Governance; Regulation/Overregulation; ² Social, Cultural, Functional; Uncertainty/Lack of security

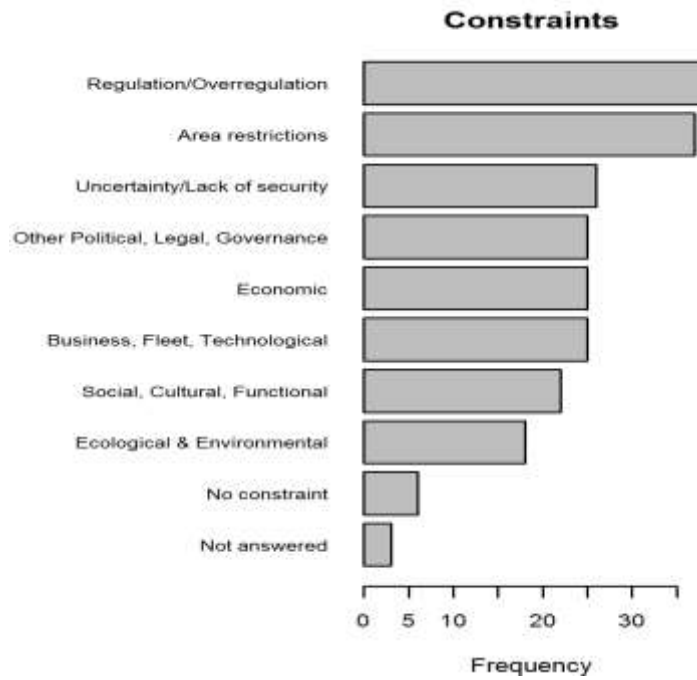


Figure 49. Frequency of the ‘lumped’ categories used for analysis of influences on **constraints**.
 Note, ‘not answered’ does not mean there was no constraint.

The contingency tables show some strong relationships between business type (Table 13) or fishery (Table 14) with constraint category. The canonical correspondence analysis biplots (Figure 50) help to highlight these associations. *Homing trawlers* (B) are associated with economic constraints, *homing non-quota generalists* (H) with area restrictions, *roaming specialists* (E) with regulation, and *small liners* (D) with both ecological and social constraints. The proximity of constraints (e.g. ecological and social) indicates they have a similar profile of consideration across businesses. Also, the proximity of types (e.g. G, *homing quota generalists* and K, *non-quota specialists*) indicates the two types have similar considerations with respect to constraints.

Table 13. Contingency tables of constraint with business type.
 Where respondents gave more than one constraint, the count has been split equally across categories.

Constraint / Typology	A	B	C	D	E	F	G	H	J	K	L
Area restrictions	2.5		5	1.5	1.0	1.0	5	8.5	2	6.0	
Business Fleet Technological	0.5	2.5	5	1.5	1.0	2.0	3		1	4.0	
Ecological & Environmental	0.5		2	7.0	2.0	0.5	1	1.0		3.0	
Economic	1.5	8.5	2	0.5	4.0	0.5	1		2	1.0	
No constraint					1.0	2.0	1		1	1.0	
Other Political Legal Governance		2.0	2	1.0	2.5		3	4.0	2	7.5	
Regulation / Overregulation	0.5	4.0		4.5	7.0	2.0	6	1.5	2	7.0	1
Social Cultural Functional	1.5			6.0	1.0		3	1.5	2	5.0	1
Uncertainty / Lack of security	5.0	3.0	1	1.0	1.5		5	1.5	1	3.5	

Table 14. Contingency tables of constraint with main fishery type.
Where respondents gave more than one constraint, the count has been split equally across categories

Constraint / Main Fishery	Trawl	Line	Net	Pot	Comb.	Harvest
Area restrictions	2.5	6.5	11.0	7.0	2.0	3.5
Business Fleet Technological	4.5	6.5	2.0	5.5		2.0
Ecological & Environmental	0.5	8.0	3.0	1.5	1.0	3.0
Economic	12.5	4.5	1.0	2.0		1.0
No constraint	1.0	1.0	2.0			2.0
Other Political Legal Governance	2.0	4.5	4.5	10.0		3.0
Regulation / Overregulation	8.5	8.5	3.5	8.5	1.5	2.0
Social Cultural Functional	2.5	8.0	4.0	3.5		2.0
Uncertainty / Lack of security	8.0	2.5	3.0	7.0	1.5	0.5

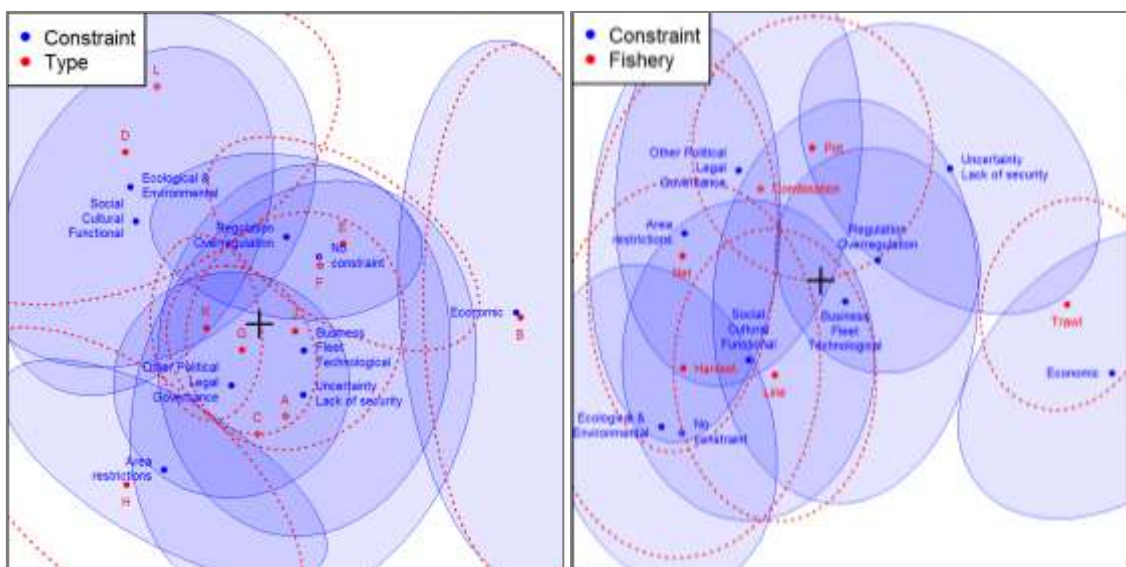


Figure 50. Canonical correspondence analysis plots for association between **constraint** variables (*blue*) and **type** (*red*, left), or **fishery** (*red*, right).

The cross indicates the origin of the first two canonical dimensions. For categories indicated by a filled circle, the 80% confidence ellipse is also drawn centred on the circle. Points indicated by open circles have larger confidence ellipses, which have been suppressed for clarity. To prevent excessive busyness, the ellipses for the row variables have been drawn with a lighter touch (dotted red line).

In addition to the contingency tables, we performed a logistic analysis with the various individual and business characteristics (0). The results are intriguing and mostly unexpected / unexplainable: For example the finding that political, legal and governance constraints are related to vessel insurance is an unexplainable result. The one result that does make sense is for the *uncertainty* constraint: a more experienced business is less likely to be constrained by uncertainty. One notable absence is *regulation/overregulation*, which despite being frequently reported as a constraint, shows no relationship to business characteristics. It may be helpful to see the data behind some of these models: for the constraint *Business, Fleet, Technological*, 14/21 of businesses had vessel insurance compared to 64/156 citing a different constraint; and for *Other Political, Legal, Governance*, only 5/23 of businesses had vessel insurance compared to 73/154 under other constraints.

Table 15. Estimated coefficients from the stepwise logistic regression for each level of constraint, treated as a binary variable.

The number of ‘yes’ cases n and the total number of cases N are shown in the format (n/N). The coefficient represents the change in log-odds when switching from ‘no’ to ‘yes’. Only constraints with a non-trivial model are shown; intercepts have been suppressed

Constraint	Variable	Estimate	Std. Error	z value	Pr(> z)
Area restrictions (37/195)	quota_ownedY	-0.968	0.386	-2.51	0.012
	resil_score	0.386	0.198	1.95	0.051
	nfishery	0.380	0.212	1.80	0.072
Business, Fleet, Technological (21/173)	insure_vessely	1.039	0.491	2.11	0.035
Ecological and Environmental (18/195)	experience	-0.057	0.022	-2.58	0.010
Other Political, Legal, Governance (23/173)	insure_vessely	-1.201	0.531	-2.26	0.024
Social, Cultural, Functional (17/174)	l(nbuyer_local – nbuyer_other)	0.215	0.101	2.13	0.033
	experience	-0.054	0.019	-2.80	0.005
Uncertainty/Lack of security (26/184)	house_income	0.012	0.007	1.88	0.060

One particular factor related to barriers and constraints relates to management. During the survey period, Queensland fisheries management was undergoing an independent review – this provided an opportunity to ask fishers what one management change they would like to see, which would help their business adapt to change and remain viable or grow. This relates to potential to remove a given constraint, if possible. Note, given this was during the time of the Queensland Fisheries review, respondents were asked to focus on a State fisheries rather than a Federal Marine Park issue, if possible. Despite this, changes to area restrictions (including green and yellow zones) were most commonly requested (see Table 16 for the coded responses). Most of the statements within the ‘area restriction changes’ category related to requests to reopen areas (green or yellow zones) (see Table 17 for examples of responses within this and other more common categories).

Table 16. Frequency of coded responses to the question “What ONE management change would you like to see, that would allow your business to adapt to change and remain viable or grow?”
Only those listed by >1% of respondents are included here

What one management change would you like to see?	% of Operators	% of Investors
Area restriction changes	24	44
Communication / inclusion in management (incl. co-management)	7	6
Quota related changes	6	13
Gear restriction changes	6	
Temporal closure revisions	6	
Licence / symbol related changes	5	6
Improve security / certainty	5	
Longevity of management plans	4	6
Don't make any changes	4	
Bycatch retention changes	4	
Effort management	4	
Harvest restriction changes	4	
Management agency related changes	4	
Reduce overregulation	2	19
Reporting requirement changes	2	6
Licence zoning	2	
Vessel / dory related issues	2	
Imported seafood related issues	2	
Coastal development / growth management	2	
Flexible management	2	
Improved market prices (government led)		6
Number of respondents (n)	171	16

Table 17. Examples of responses given within the most common management change categories.

Category	Example statements from respondents
Area restriction changes	<p>“Open up or review some of the closures of current areas”</p> <p>“No more new green zones”</p> <p>“Don’t leave the green zones permanent. Move opening and closures of the green zones”</p> <p>“Get rid of closures. We can’t work but charter boats can still operate there”</p> <p>“Less green zones. I don’t believe they work. Haven’t reduced effort – just moved it”</p> <p>“Open the green zones and close other reefs that are overfished. Manage the zones so they work”</p> <p>“Open up some yellow zones in State zoning plan”</p> <p>“Need security of access to fishing grounds. Revisit yellow zones”</p> <p>“Restructure of yellow zones – not having areas totally closed to one group or another”</p>
Communication / inclusion in management	<p>“Government to consult with fishermen and scientific research regarding decisions to regulations and rules”</p> <p>“Whole new management team in the fisheries that talk to commercial fishermen and not just recreational fishers”</p> <p>“Implement regional management”</p> <p>“Co-management. That is fishers on the ground talking to managers about how we’re fishing - 'live'. e.g. when catches are low, have immediate decisions of what to do”</p>
Quota related changes	<p>“Introduction of quota in C1 fishery”</p> <p>“Effective quota management by managing and policing quota effectively”</p> <p>“Unitisation - security of days, quota etc”</p> <p>“Remove the RQ quota. Not because it is a limit to catch levels but because of the associated costs and stress for a non-constraining rule as the quotas are currently not being met in this fishery”</p> <p>Investors: “Value of quota needs to increase”</p>
Reduce overregulation	<p>“Fewer restrictions and more flexibility”</p> <p>“Less regulations - to get rid of those regulations that make fishery harder to be in”</p>

Challenge types

Key Findings

- Previous change:
 - When asked to list the most important change affecting their business in the last 10 years, respondents most commonly listed changes that fitted within the *Political, Legal and Governance* category.
 - Responses in this category mainly related to area restrictions (just under a third of all respondents reported area restrictions as the main previous change) and regulation changes (especially for investors).
 - Contingency tables showed some relationships between change type and business type: *Homing trawlers* (B) are again associated with economic changes, *big reef liners* (C) with regulation, *roaming specialists* (E) with area restrictions, and *non-quota specialists* (K) with area restrictions and other political, legal or governance categories.
 - As for fishery type, there appears to be some association between Trawl with area restrictions and economic change; Line with area restrictions and regulations; Net with area restrictions; and Pot with area restrictions and other political, legal or governance categories

Key Findings contd.

- Upcoming challenge
 - When asked to list the one biggest upcoming challenge that would affect their ability to remain viable respondents again most commonly listed changes that fitted within the *Political, Legal and Governance* category.
 - As per the previous change, the upcoming challenge responses in this category mainly related to area restrictions and regulation changes (especially for investors).
 - Given the consistency in responses compared to previous changes and main constraints, we did not test further for relationships with type, fishery or business characteristics.

Previous change

Respondents were asked to list the most important change affecting them in the last 10 years. This was an open ended question, and data were coded into modified PESTEL categories as above. As per the current barriers and constraints listed above, the most common category was *Political, Legal and Governance* (Figure 51). Within this level 1 category, the most common level 2 category was *area restrictions*, as well as *regulation/overregulation*, for investors particularly (Figure 52). Most (91%) of respondents stated this change was negative. See Table 18 for examples of common statements provided by respondents within the more common categories.

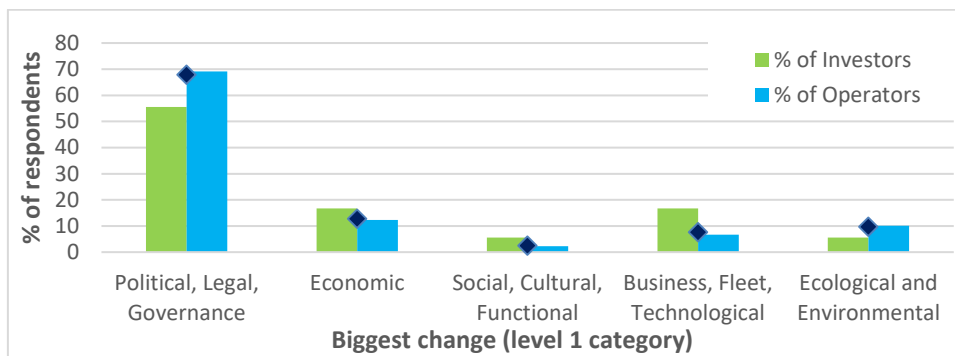


Figure 51. Level 1 PESTEL categories for the one most significant change that affected fishers in the 10 years prior to survey.

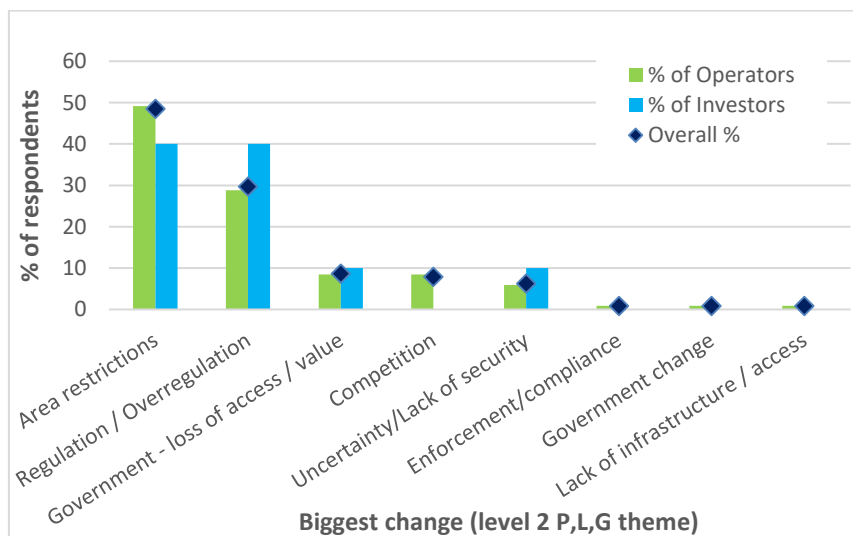


Figure 52. Level 2 categories with the Political, Legal and Governance category, for the one most significant change that affected fishers in the 10 years prior to survey.

Table 18. Examples of responses given regarding the one most significant change that affected respondents' businesses in the previous 10 years.

Category	Example statements from respondents
Area restrictions	<p>"GBRMPA zoning restricted where you could fish - loss of fishing grounds"</p> <p>"RAP and associated displaced effort and loss of grounds"</p> <p>"Green zones restrict access, so there's lots of people in smaller area"</p> <p>"Federal government green zones then the Queensland government mirrored with inshore zoning which meant that it forced fishermen into smaller areas"</p> <p>"Rezoning. Specifically the reef. The government approach was pathetic. Should be dealing with fishers on an individual basis"</p> <p>"Marine Park zoning. Closed down area and effectively took half of our income source"</p> <p>"Zoning plan. The balance between fishing area and licence numbers is not as good as it was in this area. The picture is not clear with complementary zoning. There should have been more information and transparency before we were invited to tender"</p> <p>"Rezoning of Moreton Bay Marine Park - loss of previous fishing areas to green zones and yellow zones"</p> <p>"Moreton Bay closures and the failure to reduce effort adequately. The result was that effort was pushed into remaining areas"</p>
Regulation / Overregulation	<p>"Allocation of fishing rights. Distribution wasn't done fairly. Falsified logs got more quota"</p> <p>"The introduction of reef quota. It increased the price of fish, and made it unaffordable for locals to buy (or decreased profit margin due to increased costs). This increased influx of imported product. All this has flow on effects..."</p> <p>"Quota system introduced and made things hard. Interfered with operations and caused insecure feelings. Made us feel like criminals"</p> <p>"Quota is a major burden mentally and physically. Fisheries regulations too e.g. If you book a landing time you can't change it, which is too inflexible. If you hit fish on the way back to port, you can't stop to catch them and lose money as a result"</p> <p>"The government is not reviewing input controls"</p> <p>"Fisheries regulations. There are ongoing changes against the fisheries"</p> <p>"The offshore netting attendance requirement"</p> <p>"The introduction of the safe seafood accreditation that enables sale of product to the public was positive"</p>
Government – loss of access / value	<p>"Made it hard with lost symbols L1, N8, N11, etc. Can't take scalefish now. Reduced bycatch take allowance. Always thought we had reef fishing to rely on, but now it's gone. Now, illegal to have fishing line on board. Wastage of scale fish not being able to be kept when caught as bycatch"</p> <p>"Theft by DAFF of N1 fishing endorsement which was a property right that was bought and stamp duty paid"</p> <p>"When fisheries changed endorsements or took them off us. It restricted our options"</p>
Economic (level 1)	<p>"Economic downturn and imported product pushing your prices down"</p> <p>"Aquaculture and imported prawns meant prawn price dropped. Business didn't feel viable"</p> <p>"The cost of fuel skyrocketed, and rebate has stayed the same. This ruined profitability"</p> <p>"Fuel prices increasing over time is negative. Product is not increasing in value in line with other costs and services, license costs, etc."</p> <p>"Increases in fees. E.g. quota"</p>

As was the case for ‘constraints’, when we attempted to explore the previous change data further, we found the level 1 PESTEL categories were too coarse, but many of the level 2 categories were too infrequently mentioned, meaning we needed to ‘lump’ some categories together in a way that made sense and meant numbers were sufficient for analysis (see Table 19 for the list, and Figure 53 for the frequency each category was listed).

Table 19. Categories for the open-ended questions on previous **change** used to allow further analysis.

Level 1 consists of the PESTEL categories and level 2 are more detailed sub-categories within these. The lumped categories are a compromise between the two, chosen to provide an adequate number of samples per category. Level 1 categories that have been split at level 2 are shown in *italic*. Sub-categories at level 2 that have been lumped together are indicated by the same superscript number; e.g. ‘Competition’ is lumped with ‘Enforcement/compliance’, ‘Government change’ and others as an ‘Other Political, Legal, Governance’ category.

Level	Categories
Level 1	Business, Fleet, Technological; Ecological & Environmental; Economic; No change; <i>Political, Legal, Governance</i> ; Social, Cultural, Functional
Level 2	Area restrictions; ¹ Competition; ¹ Enforcement/compliance; ¹ Government—loss of access/value; ¹ Government change; ¹ Lack of infrastructure/access; Regulation/Overregulation; ¹ Uncertainty/Lack of security
Lumped	Area restrictions; Business, Fleet, Technological; Ecological & Environmental; Economic; No change; ¹ Other Political, Legal, Governance; Regulation/Overregulation; Social, Cultural, Functional

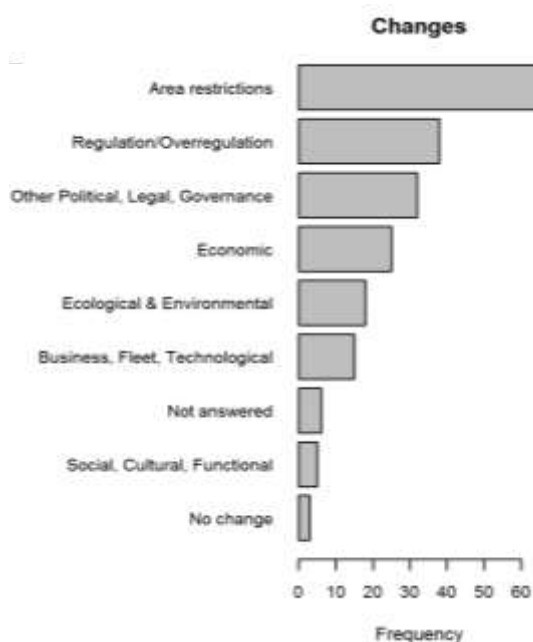


Figure 53. Frequency of the ‘lumped’ categories used for analysis of influences on previous **change**. Note, ‘not answered’ does not mean there was no change.

The contingency tables show some strong relationships between business type (Table 20) and fishery (Table 21) with **change** categories. As per ‘constraints’, the canonical correspondence analysis biplots (Figure 54) help to highlight these associations. The interpretation here is less obviously about the businesses themselves, but more an amalgamation of the businesses with the fishery as a whole. One major thing to note is that just under a third of businesses reported *area restrictions* as the main previous change, and this with *regulation* and *other political, legal or governance* accounted for just over two thirds of businesses. *Homing trawlers* (B) are again associated with economic changes, *Big reef liners* (C) with regulation, *Roaming specialists* (E) with area restrictions, and *Non-quota specialists* (K) with area restrictions and other political, legal or governance categories.

Table 20. Contingency tables of previous change with business type.

Where respondents gave more than one change, the count has been split equally across categories. This table helps to identify which changes were most frequently cited as being important for a given business type (higher number = greater relative frequency).

Change / Typology	A	B	C	D	E	F	G	H	J	K	L
Area restrictions	5	6.5	5	6	9.5	2	5.0	10	4	11	
Business Fleet Technological	1	2.0		2	1.0		1.5	2	1	4	
Ecological & Environmental		1.0	3	3		3	4.0		1	3	
Economic	3	8.0		6	2.0	1	1.5	1	1	1	
No change							1.0			2	
Other Political Legal Governance	2	1.0		2	5.0		5.0	4	3	10	
Regulation / Overregulation		1.5	9	4	3.5	1	8.0	1	3	4	1
Social Cultural Functional	1						2.0			2	

Table 21. Contingency tables of previous change with main fishery type.

Where respondents gave more than one change, the count has been split equally across categories. This table helps to identify which changes were most frequently cited as being important for a given fishery type (higher number = greater relative frequency).

Constraint / Main Fishery	Trawl	Line	Net	Pot	Comb.	Harvest
Area restrictions	11.5	16.5	17	10.0	1	8
Business Fleet Technological	4.0	3.0		5.5		1
Ecological & Environmental	2.0	5.0	4	5.0	1	1
Economic	12.0	6.0	1	2.5		3
No change	1.0			2.0		
Other Political Legal Governance	4.0	5.0	7	13.0	2	1
Regulation / Overregulation	5.5	15.5	4	4.0	1	4
Social Cultural Functional	1.0		1	2.0	1	

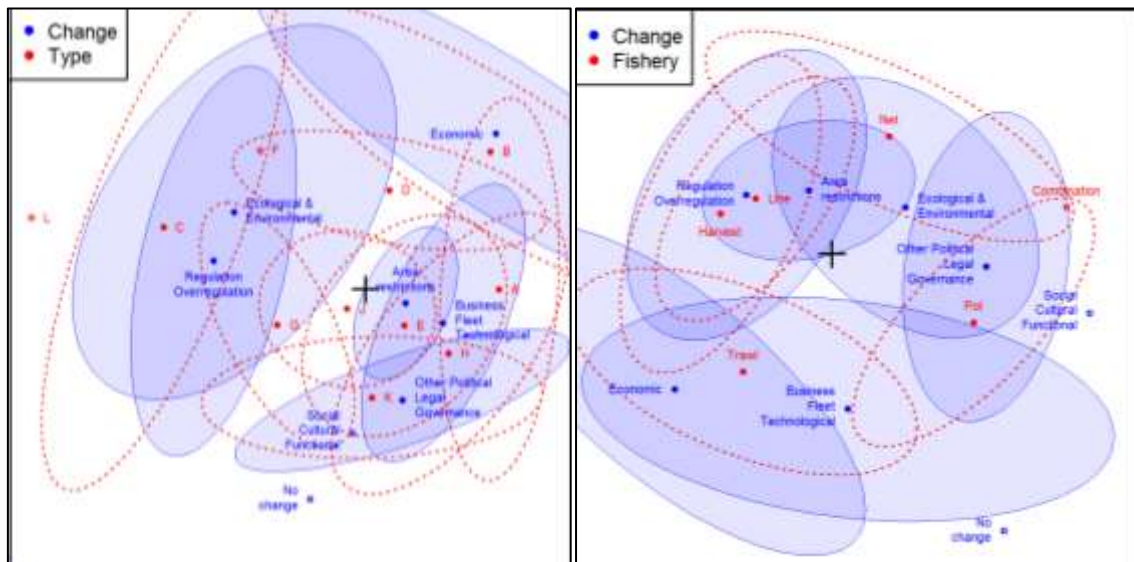


Figure 54. Canonical correspondence analysis plots for association between **change** variables (*blue*) and **type** (*red*, left), or **fishery** (*red*, right). The cross indicates the origin of the first two canonical dimensions. For categories indicated by a filled circle, the 80% confidence ellipse is also drawn centred on the circle. Points indicated by open circles have larger confidence ellipses, which have been suppressed for clarity. To prevent excessive busyness, the ellipses for the row variables have been drawn with a lighter touch (dotted red line). The actual position of the point for *No change* is 50% further from the origin in the direction of the arrow; the point was drawn here to prevent crowding of the labels.

We performed a logistic analysis to explore any potential relationships between previous change categories and various individual and business characteristics (Table 22). As per the same test regarding constraints, the results are somewhat counterintuitive. As per the constraints analysis, one notable absence is *regulation/overregulation*, which despite being frequently reported as a change, shows no relationship to business characteristics.

Table 22. Estimated coefficients from the stepwise logistic regression for each level of change, treated as a binary variable. The number of ‘yes’ cases *n* and the total number of cases *N* are shown in the format (*n/N*). The coefficient represents the change in log-odds when switching from ‘no’ to ‘yes’. Only change categories with a non-trivial model are shown; intercepts have been suppressed.

Change	Variable	Estimate	Std. Error	z value	Pr(> z)
Area restrictions (66/197)	age	-0.027	0.015	-1.86	0.063
	resil_score	0.268	0.157	1.71	0.088
Business, Fleet, Technological (15/190)	bufferY	1.578	1.049	1.50	0.133
Ecological and Environmental (18/190)	educationY	-1.529	0.778	-1.97	0.049
	bufferY	-1.376	0.517	-2.66	0.008
Other Political, Legal, Governance (29/166)	resil_score	-0.686	0.226	-3.03	0.002
	insure_vessely	-0.902	0.484	-1.86	0.062
	house_income	0.015	0.008	2.03	0.043
	l(age - experience)	0.042	0.022	1.88	0.060

Upcoming challenge

Respondents were asked to list what they considered to be the one biggest upcoming challenge that would affect their ability to remain viable within the fishing industry. Responses were again grouped into PESTEL categories, which was dominated by the *Political, Legal and Governance* category (Figure 55a). Looking at this category alone, when split into level 2 sub-categories, the most common upcoming challenge related to *area restrictions* for Operators, and *regulation / overregulation* for Investors (Figure 55b). Regarding area

closures, fishers commonly stated that if there were more closures of areas, it would be the biggest upcoming challenge due to further loss of fishing grounds. Investors were concerned with the potential for further regulations being introduced or regulations being continually changed.

Given the consistency of responses with upcoming challenges to the previous change and main constraints, these data were not analysed further to test for relationships with individual or business characteristics.

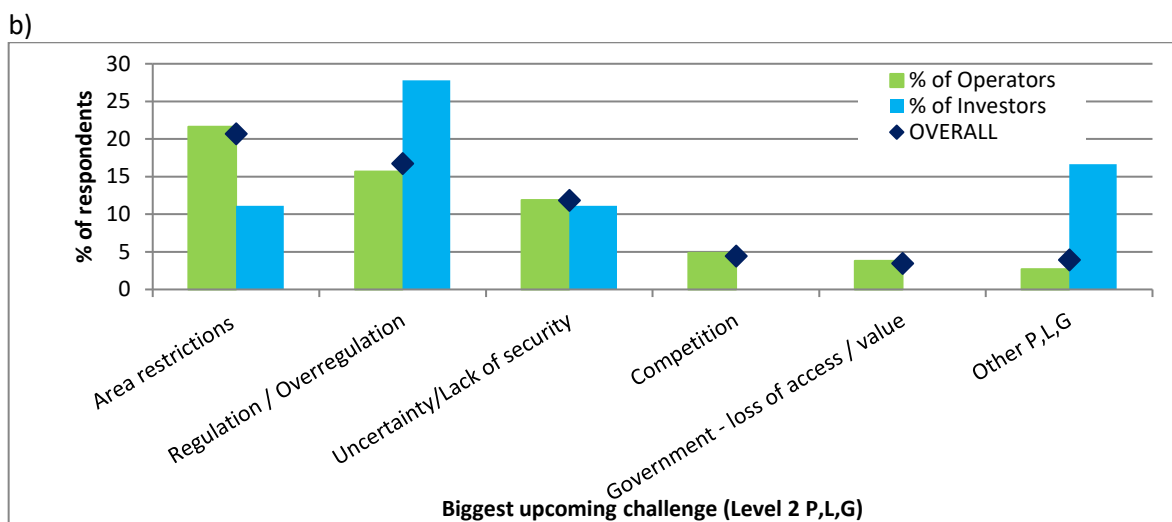
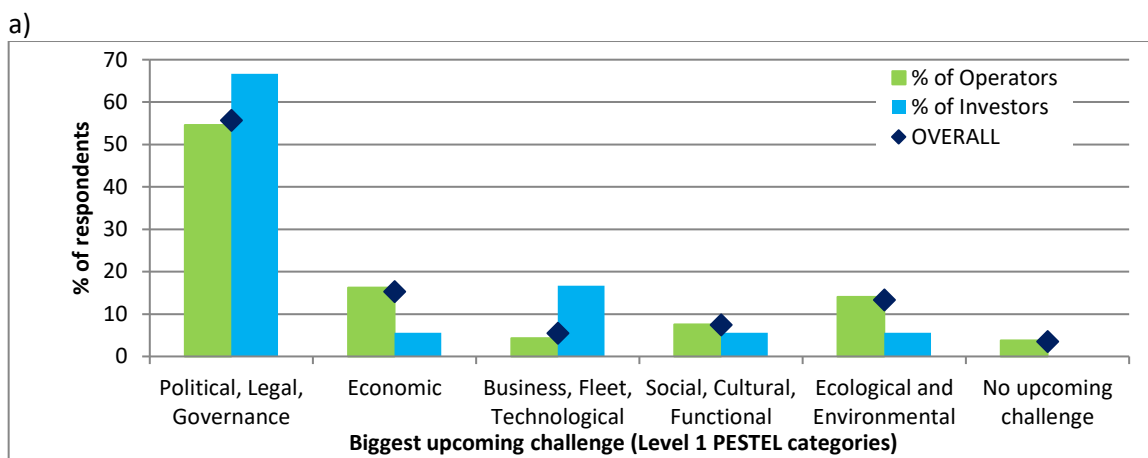


Figure 55. Upcoming challenges that may affect respondents' ability to remain viable, coded to (a) level 1 modified PESTEL categories; and (b) level 2 sub-categories for the *Political, Legal and Governance* category.

Adaptation Behaviour

Key Findings

- When asked how they responded to the main change that affected their businesses in the past 10 years, most responses fitted into the *Business, Fleet and Technological* level 1 PESTEL category. *No response* was the 2nd likeliest action.
- At a finer level, responses were most commonly (in decreasing order of frequency), *Moved, No response, Changed fishing* and *Vessel changes* (many businesses did >1 of these things). Analysing these changes one by one, we found:
 - Businesses were more likely to move if they relatively fewer latent licences relative to active ones, or if they listed *area restrictions* as the biggest change affecting their business.
 - Businesses were more likely to make no response when their percentage of household income due to fishing was smaller. They were most likely to make some response if impacted by *area restrictions* and *regulation/overregulation*.
 - Businesses were more likely to change fishing if they had income insurance or had access to more fisheries, but more resilient businesses were less inclined to change fishing.
 - Businesses were more likely to make vessel changes if they had access to fewer fisheries, had insured their vessel or the individual percentage of income from fishing exceeded the household percentage
- Using a multinomial framework, we found (consistent with the above analyses) that low resilience is associated with moving and changing fishing, and *area restrictions* are strongly associated with moving.
- A slight majority overall (but 70% of investors) felt their response to change put their business in a worse position in the short term. This result was similar for the long-term perspective, although more investors (80%) felt their business was in a worse position in the long term due to their response.
- Success scores and ranks were developed using related questions as indicators (see Table 4), as per the resilience and adaptive capacity scores and ranks above:
 - The distribution is fairly balanced between high and low success scores, and most businesses fit within the 'medium' success rank.
 - When compared between business types, there was a wide range of success outcomes, and no clear distinction between the types.
 - The same is true when we split by main fishery, although long-term success (as an indicator within the score) appears to be better for *roaming trawlers*.
 - When tested against individual and business characteristics, results suggest that having a financial buffer confers about half a point's advantage. Being younger by 30 years or depending on fishing for 100% of individual income compared to 20%, or being constrained by area restrictions instead of business or fleet technology all confer roughly the same advantage.
 - However, given diversity within our sample, the model fit is very poor. Most of the variation in success has gone unexplained, and therefore the main message is that success or otherwise is mainly due to unknown factors within each business.

All respondents who listed a change that affected their business in the past 10 years, were asked to describe how they responded to that change: i.e. did they make any changes to their business or practices as a result of that change. Many responses were listed, often with more than one response per fisher. Almost all (96%) responses fitted within the *Business, Fleet and Technological* level 1 PESTEL category. The PESTEL categories for response were too broad for further analysis, so they were split into 8 lumped categories (Table 23). Some cases of lumping from level 2, though not immediately obvious, arose from going back to the detailed answer and finding common ground there: e.g. *Government restructure* involved the business

owner making *Vessel changes* after receiving a government rebate. The frequencies of each answer for the lumped categories is shown in Figure 56. Note that *Not answered* indicates respondents who did not provide an answer; this is not to be confused with the answer *No response*, which indicates that the individual took no action in response to a change. Indeed *No response* was the 2nd likeliest action (see Figure 56).

Table 23. Categories for the open-ended questions on **response** to change used to allow further analysis. Level 1 consists of the PESTEL categories and level 2 are more detailed sub-categories within these. The lumped categories are a compromise between the two, chosen to provide an adequate number of samples per category. Level 1 categories that have been split at level 2 are shown in *italic*. Sub-categories at level 2 that have been lumped together are indicated by the same superscript number.

Level	Categories
Level 1	<i>Business, Fleet, Technological</i> ; No response; <i>Political, Legal, Governance</i>
Level 2	¹ Business finance; ⁵ Business involvement; ⁵ Business management; ² Changed fishery; ² Changed market; ² Changed product; ² Changed species; ³ Communication; ⁴ Diversified business; ⁴ Diversified externally; ⁵ Effort change; ¹ Financial change; ⁶ Government restructure; Investment/lease/sale; Moved; ³ Regulation change; ⁵ Specialised business; ⁵ Staff; ⁵ Stopped fishing temporarily; ⁶ Technology; ⁶ Vessel changes
Lumped	¹ Business finance; ² Changed fishing; ³ Communication; ⁴ Diversified business; ⁵ Effort change; Investment/lease/sale; Moved; No response; ⁶ Vessel changes

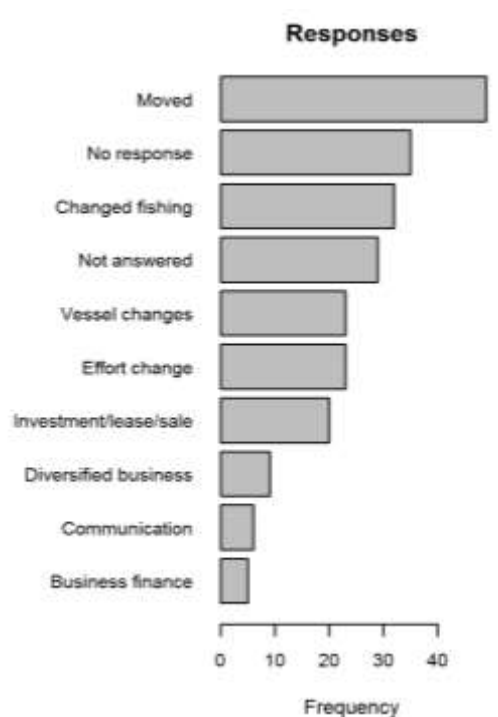


Figure 56. Frequencies of the lumped categories for the **response** variables.

To test for correlations between response and various individual and business characteristics, plus the type of change that businesses experienced, we analysed the most common responses one at a time using logistic regression (results for the less common responses are unreliable, so we do not report them here). In decreasing order of frequency, the responses were *Moved*, *No response*, *Changed fishing* and *Vessel changes*. Note that 25 businesses answered ‘yes’ to more than one of the above responses. The estimates of the regression coefficients is given in 0. The intercept terms, which contribute only to the overall prevalence of the response, have been suppressed in favour of the more informative proportion of ‘yes’ responses (n/N). Note that the changes in N across the four models is because of differing degrees of missingness of the explanatory variables.

Table 24. Estimated coefficients from the stepwise logistic regression for each of the binary **responses** *Moved*, *No response*, *Changed fishing* and *Vessel changes*.

The number of ‘yes’ cases n and the total number of cases N are shown in the format (n/N) . The coefficient represents the change in log-odds when switching from ‘no’ to ‘yes’. The factor coding for **change** is such that the coefficients represent the contrast with the reference level, *Area restrictions*. Intercept terms are not shown.

Response	Variable	Estimate	Std. Error	z value	Pr(> z)
Moved (47/164)	nlicence	-0.908	0.481	-1.89	0.059
	nactive	1.227	0.546	2.25	0.025
	changes_fEconomic	-2.287	0.793	-2.88	0.004
	changes_fOther Political,Legal,Governance	-1.273	0.584	-2.18	0.029
	changes_fRegulation/Overregulation	-2.097	0.689	-3.04	0.002
No response (32/169)	changes_fEcologicalandEnvironmental	0.889	0.652	1.36	0.173
	changes_fEconomic	1.038	0.595	1.75	0.081
	changes_fOther Political,Legal,Governance	1.505	0.576	2.61	0.009
	changes_fRegulation/Overregulation	-1.661	1.088	-1.53	0.127
	house_income_alt	-0.012	0.006	-2.08	0.037
Changed fishing (31/168)	resil_score	-0.362	0.202	-1.79	0.073
	nfishery	0.577	0.227	2.54	0.011
	insure_incomeY	1.078	0.530	2.03	0.042
Vessel changes (22/154)	nfishery	-0.545	0.377	-1.45	0.148
	insure_vessely	1.108	0.521	2.13	0.033
	l(indiv_income – house_income)	0.024	0.011	2.23	0.026

The results in Table 23 are explained in more detail here:

- 1) *Moved*. Both *nlicence* and *nactive* were influential with coefficients close to -1 and $+1$ respectively. A simple interpretation of this is that every extra latent licence increases the log-odds of *not* moving by roughly 1. The contrast of *Area restrictions* with *Economic*, *Other Political*, *Legal*, *Governance* and *Regulation/Overregulation* changes was significant, meaning businesses were more likely to move under the former change than any of the latter 3. This is consistent with their separation in the correspondence analysis (Figure 57).
- 2) *No response*. Businesses were more likely to make no response when their percentage of household income due to fishing was smaller; this accords with common sense, since the incentive to take action is presumably less if there is an alternative source of income. (Because four *No response* cases were missing on variable *house_income*, we replaced them by the values for *indiv_income* and called the resulting variable *house_income_alt*.) The contrast of *Area restrictions* with *Other Political*, *Legal*, *Governance* changes was significant, meaning businesses were more likely to take some action under the former change than the latter. In fact, using *Other Political*, *Legal*, *Governance* as the reference level, both *Area restrictions* and *Regulation/Overregulation* were significantly different from it, leading to a higher probability of making some action.
- 3) *Changed fishing*. Businesses were more likely to change fishing if they had income insurance or had access to more fisheries, but more resilient businesses were less inclined to change. If we compare the effect of insurance to a unit change in resilience or access to an additional fishery, insurance has about twice the effect of fishery access and three times that of resilience. The associations make sense: access to other fisheries enables some of the *Changed fishing* options, and possession of insurance may indicate a willingness to try something different, whereas more resilient owners may try to ‘stick things out’, or may feel they had adapted already or in different ways.
- 4) *Vessel changes*. The strongest effect was with *indiv_income*, but there was a conflicting opposite effect with *house_income* having almost the same coefficient. A likelihood ratio test suggested we could replace the two terms by their difference. Businesses were more likely to make vessel changes if they had access to fewer fisheries, had insured their vessel or the individual percentage of income from fishing exceeded the household percentage. (Note there were only 22 cases from which to

estimate the probability). The effect of access to an extra fishery is about the same as a 25% change in income percentage and about half that of having vessel insurance.

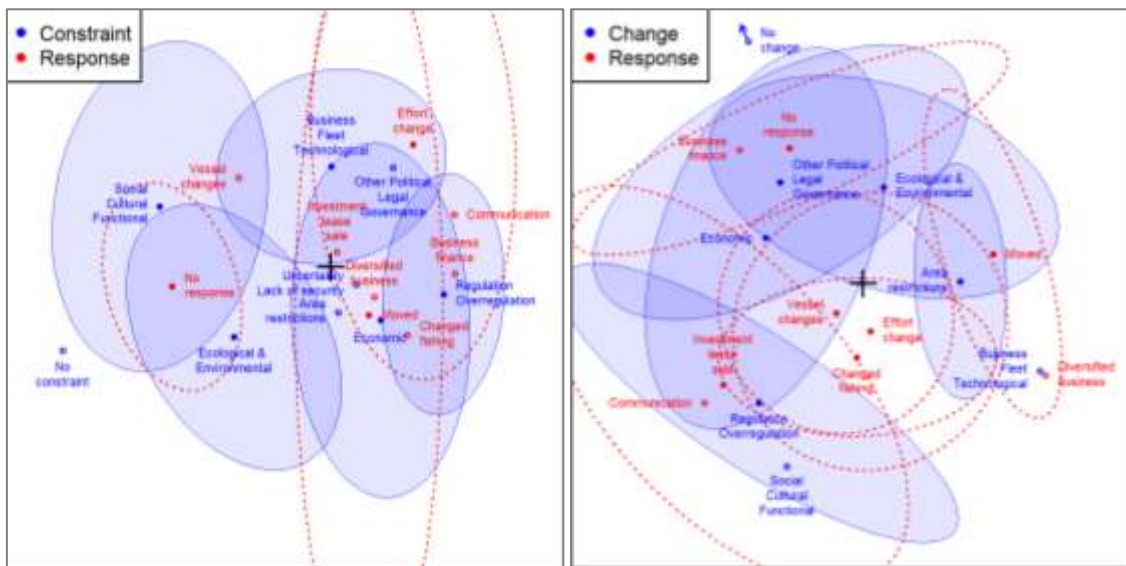


Figure 57. Canonical correspondence analysis plots for association between **response** variables (*red*) and **constraint** (*blue*, left), or **change** (*blue*, right).

The cross indicates the origin of the first two canonical dimensions. For categories indicated by a filled circle, the 80% confidence ellipse is also drawn centred on the circle. Points indicated by open circles have larger confidence ellipses, which have been suppressed for clarity. To prevent excessive busyness, the ellipses for the row variables have been drawn with a lighter touch (dotted red line).

We also analysed the responses in a multinomial framework. The advantage of this is that it deals with the responses collectively, taking into account the inevitable (anti-)correlation between responses, since usually one type of response precludes any others. (The logistic analysis above did allow the same business to have more than one response; but in the multinomial case, each business must have a unique response. For the small number of cases where this issue had to be resolved, we assigned to the commonest response: for instance, several businesses reported to have both moved and made vessel changes, these business were placed under response *Moved*). It would not be sensible to attempt to model all 9 possible responses, so we stopped at 4 responses (*Moved*, *No response*, *Changed fishing*, and *Effort change*) and lumped the remainder into a catch-all response *Other*. Note that *Effort change* was more common than *Vessel changes* because of the unique assignment mentioned above. Backwards stepwise regression was performed, and the final model included terms for resilience and three of the changes (*Area restrictions*, *Ecological and environmental* and *Other Political, Legal, Governance*). The estimates are given in Table 25. We found (consistent with the above analyses) that low resilience is associated with moving and changing fishing, and area restrictions are strongly associated with moving.

Table 25. Estimated coefficients from the stepwise multinomial regression for multinomial response (*Moved*, *No response*, *Changed fishing*, *Effort change*, *Other*). Only the relevant terms (interactions with response level) are shown.

Variable	Estimate	Std. Error	z value	Pr(> z)
respNoresponse:changes.EcologicalandEnvironmental	2.383	1.156	2.06	0.039
respMoved:changes.EcologicalandEnvironmental	2.632	1.177	2.24	0.025
respChangedfishing:changes.EcologicalandEnvironmental	1.606	1.220	1.32	0.188
respEffortchange:changes.EcologicalandEnvironmental	1.763	1.210	1.46	0.145
respMoved:changes.Arearestrictions	2.365	0.558	4.24	0.000
respNoresponse:changes.Other.Political.Legal.Governance	1.234	0.642	1.92	0.055
respMoved:resil_score	-0.597	0.248	-2.41	0.016
respChangedfishing:resil_score	-0.799	0.277	-2.88	0.004

The raw estimates are perhaps difficult to interpret, so we show the predictions of these models in graphical form in Figure 58. Each panel represents a different main change, with the lower right being the remaining changes lumped together. The points above the grey line are the actual observations: there are many cases for *Area restrictions* and *Other change*, and somewhat fewer for the other two. Under *Area restrictions*, many businesses opted to move (blue), and so the blue line is higher than for the other choices. Moreover, among the less resilient businesses, the proportion opting to move was higher, which is also the case for the *Changed fishing* choice (purple), although this was chosen less frequently. Therefore the blue and purple lines have a negative slope. Because the choices have been constrained to be mutually exclusive, the probability of the other choices tends to be greater for more resilient businesses. This agrees reasonably well with the observations in the *Other Political, Legal, Governance* panel and the *Other change* panel for *Other response*. The fit is not as convincing in the *Ecological and environmental* panel, especially for *No response*. The identification of this constraint as significant may be an artefact of the very low incidence of the *Other response*.

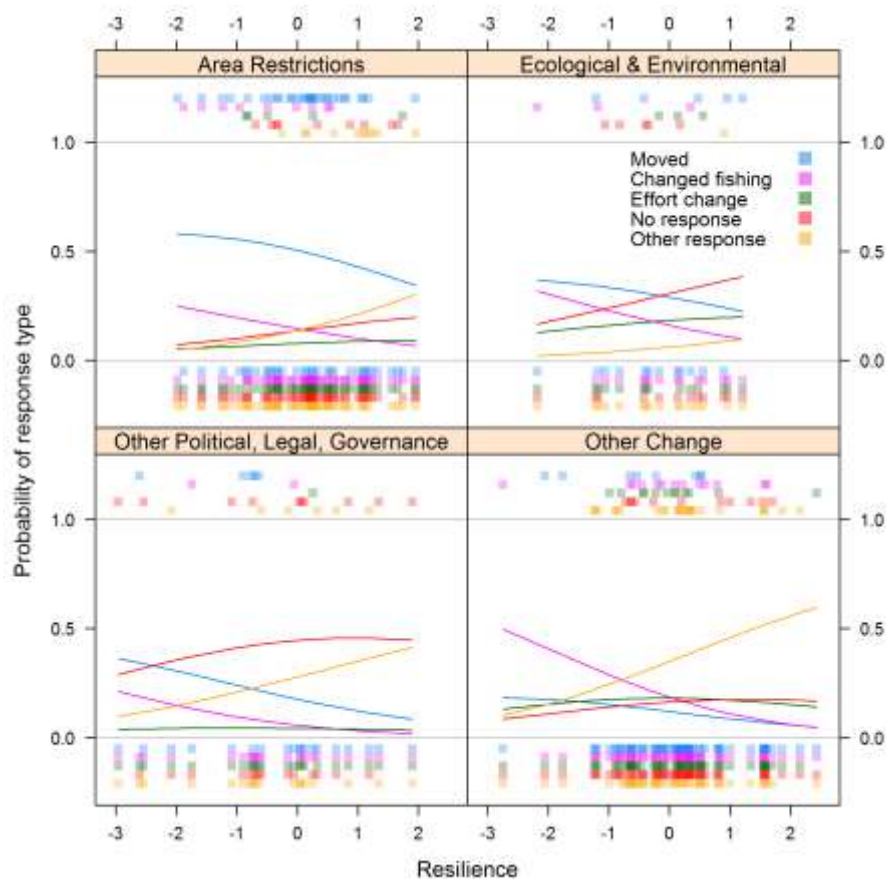


Figure 58. Estimated probability (bold line) of each of 5 responses (given by blue to yellow key) as a function of **resil_score**, for each of 4 main changes.

Each (possibly overlapping) square above the plot denotes a business that made the response corresponding to the square's colour; points below represent businesses that did *not* make the response corresponding to the given colour; hence, each point 'above the line' has four corresponding points below. Note that overlapping squares show darker so that their distribution can be assessed.

Success / Failure

Importantly, we wanted to explore whether respondents felt their response to a change that impacted their business was successful in the short and long term. A slight majority overall (but 70% of investors) felt their response put their business in a worse position in the short term. This result was similar for the long-term perspective, although more investors (80%) felt their business was in a worse position due to their response (Figure 59).

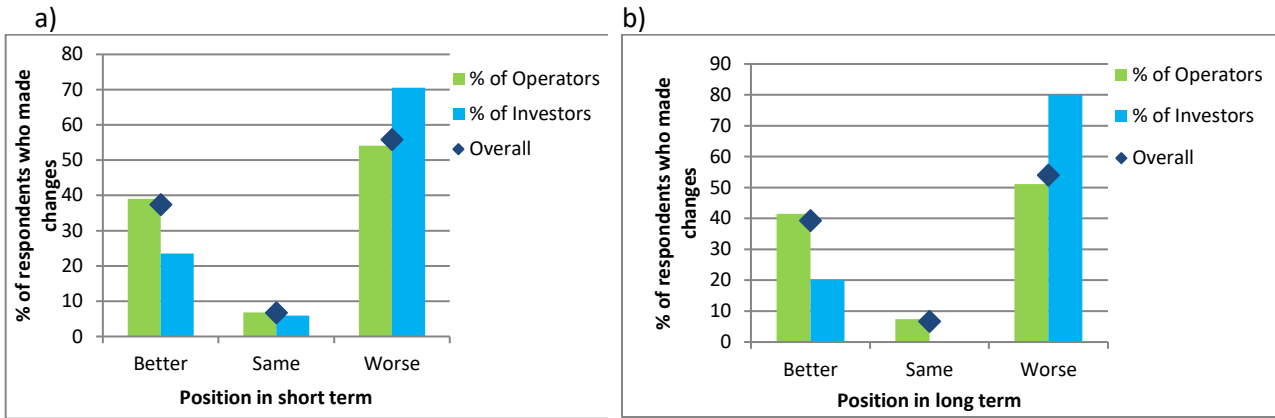


Figure 59. The proportion of operators and investors who felt their response to previous change put their business in a better or worse position in the a) short and b) long term.

Given the complexity of combinations of change types, responses and reasons for short and long-term success (or otherwise), we did not analyse these data further formally. Some specific examples, particularly for more common change types and responses, may help to highlight potential causes of these perceptions, however. We also added respondents' statements regarding what they would do differently next time, where possible. Table 26 outlines some specific examples from respondents. Specific details were very respondent-specific, but these examples highlight that some responses were successful for some but not others (long term success / failure is case specific); measures of what is 'better' or 'worse' are specific to individuals (e.g. one individual here who stated that the business was not better off financially, but was better in terms of family); and perhaps those who made a combination of responses may be more successful (although this is difficult to measure statistically).

Table 26. Examples of responses to change types, where information was provided regarding short and long-term success for specific businesses.
 Note, investors are not included here due to a lack of detail of what contributed to short and long-term success of common responses.

Change category	Response	Position in short term	Position in long term	Business type	Explanation	What did you want to do, but couldn't?	Would you do anything differently next time?
Area restrictions	Moved	Better	Better	Operator, Type E (<i>Roaming specialist</i>)	Moved in combination with vessel changes (downsized, trailerable), reduced crew and became more specialised regarding species. Was more efficient and cost effective in the short term and long term		Maybe, depending on proximity of closures to home.
			Better	Operator, Type K (<i>Non-quota specialist</i>)	Became more mobile, in combination with buying a second vessel. Better in short and long term because they were able to "maintain more stock (aquarium) and therefore increase sales"		No
			Worse	Operator, Type J (<i>Roaming generalist</i>)	Moved to other regions, spreading effort over wider area. This helped to remain viable in the short term, but fisher didn't think this will help in the long run - Less viable.		Would relocate, or sell licence and exit.
		Worse	Better	Operator, Type B (<i>Homing trawler</i>)	Chose to move grounds to a new area. Worse in short term as didn't have access to usual fishing grounds. Had to rethink operations, change gear, in a new location not familiar with. In long term is the same financially, but better for family given not as much time away from home.	Wanted to buy a bigger vessel but there was lack of security of access and tenure.	No
				Operator, Type E (<i>Roaming specialist</i>)	'Moved' in combination with vessel changes (downsized), travelled less, reduced staff, changed and trialled gear. In short term had less catch due to weather restrictions with a smaller boat. Improved in long term as got used to it and had fewer bills to pay.	Was thinking about getting another symbol and diversifying. But already other fishers with that symbol in the area.	No
			Worse	Operator, Type H (<i>Homing non-quota generalist</i>)	Shifted to new areas, though these were already being fished by others. In short term, with more fishers in smaller areas there was a loss of income to some extent. In long term, found there are still more fishers in areas where they're allowed. This causes conflict amongst fishers, with more fishers vying for the same product.	Move to a new area out of the region. Couldn't due to family commitments.	No

Change category	Response	Position in short term	Position in long term	Business type	Explanation	What did you want to do, but couldn't?	Would you do anything differently next time?
Area restrictions	Moved	Worse	Worse	Operator, Type C (<i>Big reef-liner</i>)	Left home port, in combination with increasing vessel size and buying more dories. In short term increased costs including fuel. Financial loss in short and long term.	Limited finances so had to refit an existing vessel.	Take the buyout and exit.
Regulation / overregulation	Diversified business	Better	Better	Operator, Type D (<i>Small reef-liner</i>)	Frustration with lack of review into input controls which restricted business. Diversified business by value adding product with in-house processing and upgraded facilities with a wholesale/retail option. In short term provided more appropriate value of product. In long term it allowed fisher to invest and maximise returns.		Ensure capital available before starting commercial fishing.
	Changed fishing		Worse	Operator, Type J (<i>Roaming generalist</i>)	Loss of symbol on purchased licence due to lack of history, in combination with restrictions on quota and fishing grounds. Purchased another (different) symbol, which provided income in the short term. In the long term, would have been better off in the fishery where the symbol was lost.	Wanted to diversify, but symbols were too expensive.	Ensure sufficient history.
	Reduced effort	Worse	Worse	Operator, Type K (<i>Non-quota specialist</i>)	Quota system introduced. Reduced fishing effort in response. Short term impact of lost incentive to work due to addition of barrier to fishing. Reduced fishing's contribution to quality of life. This flowed on in long term.	Need to improve processes (e.g. reporting systems) to meet management requirements more efficiently	Sell licence earlier.
Economic	Vessel changes	Better	Better	Operator, Type G (<i>Homing quota generalist</i>)	Bought more efficient motors in response to fuel price increases. Was a large initial cost, but saved costs in the long term.	Would like subsidy on other vehicles' fuel, not just boat fuel. Government also needs to buy back more licences to reduce competition	No

Change category	Response	Position in short term	Position in long term	Business type	Explanation	What did you want to do, but couldn't?	Would you do anything differently next time?
Economic	Travelled less	Better	Worse	Operator, Type B (<i>Homing trawler</i>)	Became more home based and travelled less in response to fuel cost increases. Better in short term – staying local and getting to know grounds such that they can fish all year round without changing areas. Worse in long term due to targeting limited areas more intensely.		Increase the value of the product, and reduce product thrown overboard that could be kept.

To develop a measure of perceived success of a fishing business, we combined five questions regarding current and relative profit and security to develop a 'success score' and 'success rank' as per the resilience and adaptive capacity scores and ranks above. These questions related to whether fishers felt satisfied with their current profitability, whether their earnings supported the style of life they prefer, whether their business was in a better, same or worse position than 12 months earlier, or 5 years earlier, and whether they felt more secure in their business than 5 years earlier (see Table 4). Data for each of these questions are shown above (See Figure 41, Figure 43 and Figure 44). Reliability analysis across the five questions revealed a Cronbach's α of 0.768, which is considered acceptable. After median polish was applied to impute missing values, Cronbach's α was 0.774. As above, a combined dimension reduction was applied within SPSS, to give an 'F-Score' via factor analysis for each respondent. These scores were then converted to success 'rank' (where an F-Score of -5 to -1 = 'low' success; >-1 to 1 = 'medium' success; and >1 to 5 = 'high' success).

The distribution is fairly balanced between high and low success (Figure 60a), and most businesses fit within the 'medium' success rank (Figure 60b). When compared between business types, there was a wide range of success outcomes. There is no clear distinction between the types (Figure 60c), and indeed a formal t test adjusted for multiple comparisons yields no significant differences. The same is true when we split by main fishery (not shown here). Long-term success appears to be better for roaming trawlers (Figure 60d), and this is borne out by t tests on the underlying values (worse=-1, same=0, better=+1) which show the only significant difference is between types A (*Roaming trawlers*) and K (*Non-quota specialists*).

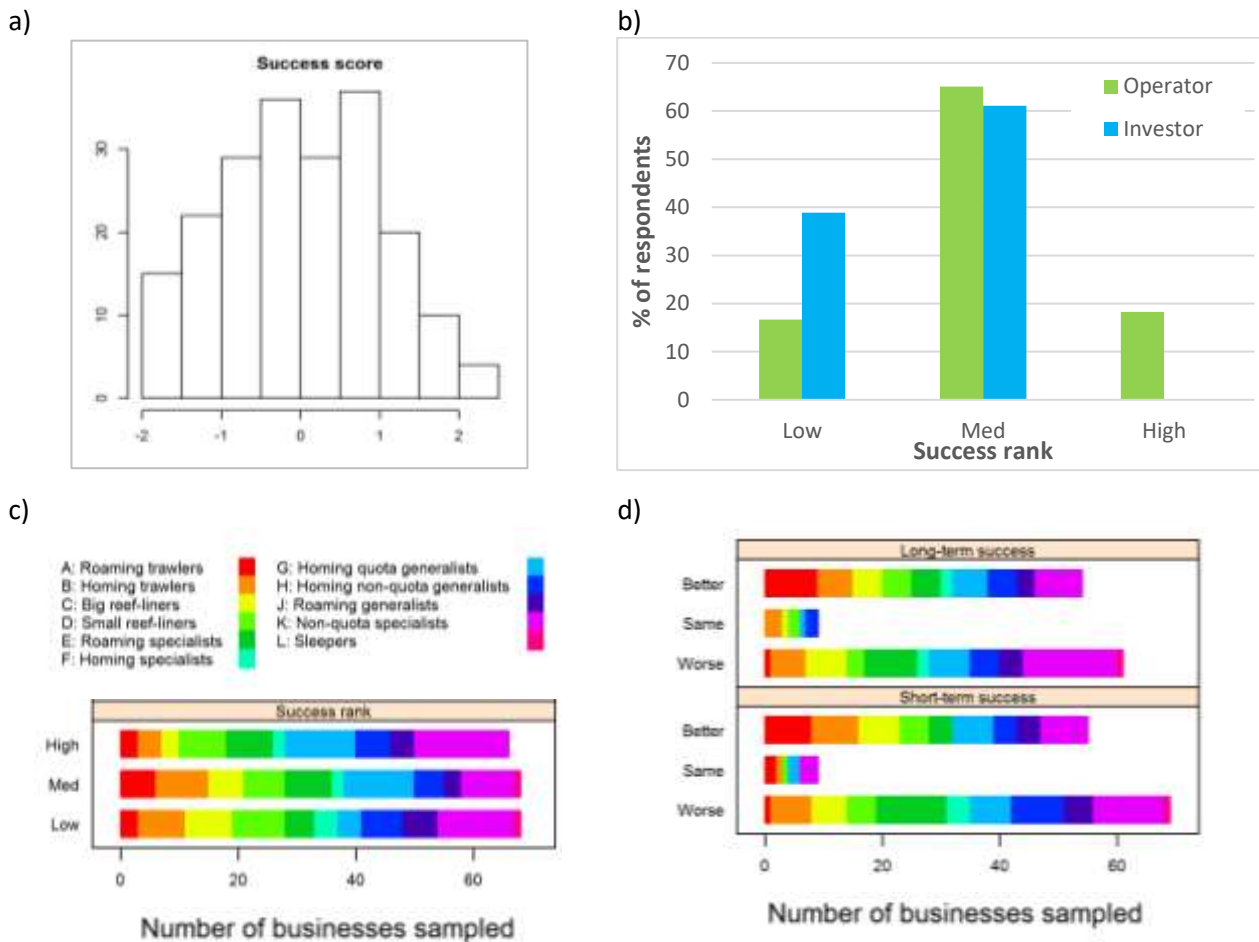


Figure 6f. Success (a) score for all respondents, (b) ranks for Operators and Investors, (c) ranks for different business types, based on a combined score for all success questions developed via dimension reduction, and (d) a comparison of perceptions of short and long-term success for different business types.

A more detailed analysis was completed using the various business and individual characteristics. We fit a series of linear models starting with all variables including the constraints, changes, response and the interaction of changes with response. Because of ‘missingness’ in some of the variables (e.g. the 29 cases where response was not answered), the initial fit was based on only 151 records. However the backwards stepwise procedure eliminated most variables, including response and change, so that the final model used 189 records. The coefficients are shown in Table 27.

The results suggest that having a financial buffer confers about half a point’s advantage. Being younger by 30 years or depending on fishing for 100% of individual income compared to 20%, or being constrained by area restrictions instead of business or fleet technology all confer roughly the same advantage. The effect due to having no constraints is probably spurious, being based on only 5 businesses.

However this is not the main message. The success score by design has a standard deviation of 1, but the residual standard error is only slightly less than this. Therefore most of the variation has gone unexplained, which is confirmed by the adjusted R^2 value of 15%: the model fit is very poor. Although the regression tells part of the story, the main message is that success or otherwise is mainly due to unknown factors within each business.

Table 27. Estimated coefficients from the stepwise linear regression for success.

The adjusted R^2 and residual standard errors (R_{adj}^2, σ) were (0.15, 0.92) for success.

Response	Variable	Estimate	Std. Error	t value	Pr(> t)
Success score	(Intercept)	0.341	0.516	0.662	0.509
	age	-0.017	0.007	-2.388	0.018
	bufferY	0.462	0.160	2.883	0.004
	indiv_income	0.006	0.002	3.065	0.003
	constraints_fBusiness,Fleet,Technological	-0.641	0.249	-2.580	0.011
	constraints_fNoconstraint	0.830	0.412	2.017	0.045

We also applied random forest analysis to the success score. The models were very poor, with an R^2 of only 10%. Some variables were identified as important, including financial buffer and resilience, which were both positively associated with success, and age (or youth) which showed a positive effect for ages below 40 (based on about 15 cases). This analysis confirms the main message that most of the variation is unknown. Whatever effects can be seen are not inconsistent with other results.

3) Learning from success

Information tool

The initial goal of the project was to develop an ‘information tool’ that fishers of different business types or in different fisheries, could use to help choose potential adaptation responses given a specific type of change. However, given the data outlined above, and the main message that success was not related to business type, fishery, any specific business attribute, change type, or response, it is no possible to develop such a tool. Instead, we choose to highlight specific success stories discovered during the fisher surveys, in the hope that fishers may be able to learn tools from others that they may be able to apply to their own business, if relevant.

Success stories

Of the businesses that had a ‘high’ success rank based on the above questions (see Table 4 for the questions included in developing the rank, and Figure 60 for results), all were Operators, rather than Investors. ‘Successful’ businesses we surveyed accessed all types of fisheries, and were from all business types. Some of these businesses provided enough detail to gain an understanding of how they operate, and what makes them appear to be successful (noting that these traits do not necessarily apply to others). Examples are provided here from a variety of business types (noting, again, that business type was not a determinant of success):

Example 1) Type A. *Roaming trawler*

Individual characteristics: This fisher been fishing for >30 years and has a very high attachment to fishing. 100% of their personal income, 80% of household income comes from the fishing business. He is ~60 years old and has a partner and dependent children to support with the business. This fisher has medium inherent resilience according to our measures. He doesn’t have a trusted source of information about fisheries in Queensland, though does regularly source or receive information from other commercial fishers, plus sometimes from QBFP and the public media.

Business characteristics: Dependent on 1 fishery (T), though harvests multiple species within that fishery. Accesses 2 ports. Owns and operates 1 licence + quota. Nothing leased. Sells to 1 local buyer. Doesn’t maintain a financial buffer for emergencies, but does have vessel insurance.

Capacity to implement options: Has high practical adaptive capacity as he feels he could change fisheries and species given previous experience of doing so. However, while he could move ports, he would prefer not to, and he couldn’t stop fishing, move to grounds further away, or change markets.

Challenges: The biggest previous change in the past 10 years was the removal of unused symbols which he thought he could sell for some value in the future, and the removal of ability to take line caught fish and specific bycatch species from trawler. As he states, that removed something he thought they could rely on, and resulted in wasted fish that is now discarded.

Main current constraint is the weather, combined with age (he states he is ‘taking fewer risks’).

Main upcoming challenge is potential fuel cost increase.

Externalities: Weather; fuel; input controls.

Adaptation behaviour to change: In response to the previous change, he stayed with the trawl fishery, but tried new things with his fishing gear to increase catches.

Success: Business is better than it was 5 years ago (though is about the same as it was 1 year ago) due to increased catches in the past couple of years. He also has improved feelings of security in his business. These increased catches provided enough financial buffer to be able to experiment with gear and improve efficiencies. He is currently maintaining business as usual as he is satisfied with the current situation. ‘Business is good’.

Example 2) Type C. *Big reef-liner*

Individual characteristics: This fisher has been fishing for >40 years, and has a very high attachment to fishing. All of his personal and household income is from the fishing business. He is in his 60s with a partner but no dependent children. He has medium inherent resilience. QBFP is his most trusted source of information regarding fisheries. He does source/receive fisheries related information from other commercial fishers, DAF and QBFP, but not Industry groups, GBRMPA, researchers, or the public media. He states he would seek legal advice if he needed to make more changes to the business.

Business characteristics: He is dependent on 1 fishery and species (SM), and accesses 2 ports. He owns 1 licence and some quota, but also leases in quota, stating that it was more economical at the time than buying it. He sells to multiple buyers within and outside of the local area. He maintains a financial buffer for emergencies, but does not have vessel insurance.

Capacity to implement options: This fisher has a low practical adaptive capacity due to current specialisation, costs of change and current age and health.

Challenges: The biggest previous change in the past 10 years was the introduction of quota to his fishery.

The main current constraint is imported products and larger companies that sell sliced fish rather than whole / quarters.

The main upcoming challenge relates to his own health rather than external factors.

Externalities: Output controls; markets.

Adaptation behaviour to change: In response to the previous change (quota introduction), he improved his product, and marketed over the internet to received premium (but fair) price for his product.

Success: Business is better than 12 months ago and better than 5 years earlier as he believes the stocks are increasing and catches improving. He is satisfied with his current profit and income, and feels the success of his business is relatively in his own control rather than in the control of outside factors. He is optimistic about his own business but not about the future of the Industry. He feels secure in business due to experience and knowledge. He intends to maintain business as usual, due to age.

Example 3) Lessee, Type D. *Small reef-liner*

Individual characteristics: This lessee has been fishing for 13 years and has a medium to high attachment to fishing. He receives all of his individual income, but 60% of his household income, from the fishing business. He is in his 40's, with a partner and dependent children. He has a medium inherent resilience according to our scores. He considers DAF a trusted source of fisheries information but wouldn't go to anyone for advice if needed to make changes to business. He sources / receives information from DAF, QBFP and researchers, but not GBRMPA, other fishers or any Industry groups.

Business characteristics: This fisher accesses multiple ports, line fishing for multiple species, but especially Spanish mackerel. He leases 1 licence, with associated symbols and quota, after selling his licence and quota in recent years due to uncertainty in licence prices. He used to finance from the sale to buy a retail van (i.e. added a point of sale business). He also sells to multiple buyers outside of the local area. He does maintain a financial buffer for emergencies, but has no vessel insurance.

Capacity to implement options: This fisher ranked 'high' in the adaptive capacity scores – he couldn't stop fishing due to the need for income, but could change species, fisheries, products, ports or grounds (but not further away), given current practice and experience.

Challenges: The biggest previous change in the past 10 years was green zone increases in the GBR and Moreton Bay Marine Parks.

The main current constraint is green zones, plus 'duplication' of regulation (e.g. '[temporal] spawning closures that are no longer needed given green zones now cover the spawning grounds').

The main upcoming challenge relates to input regulations (however nothing specific was outlined in the survey).

Externalities: Input controls; Area restrictions.

Adaptation behaviour to change: While this fisher stated they didn't feel like they could do anything given the previous challenge of green zone application, the more recent sale of his licence allowed diversification via adding a retail business, allowing him to value-add product.

Success: While he is not currently satisfied with profitability of business, he agrees it does support the style of life he prefers. He feels the success of his business is mostly determined by factors outside of his control, and is not optimistic about the future of his fishing business or the Industry. However, he is more optimistic and secure regarding the retail business. This is the main focus currently, and he intends to continue diversifying his business in this way, as this has put his business in a better financial position than 12 months and 5 years earlier.

Example 4) Type F. *Homing specialist*

Individual characteristics: Fishing for 30 years, this fisher is highly attached to fishing. In his 50's and living solo, all of his individual and household income is from fishing. He has a medium inherent resilience, like most fishers. His most trusted information source is QSIA (although he is not a member). He occasionally seeks / receives information from each of the sources listed in the survey, but would ask no one for advice if he needed to make changes to fishing business.

Business characteristics: He owns and operates 1 licence from 2 ports, with a dependency primarily on inshore net fishing (he also fishes for spotty mackerel). He sells to 2 local buyers and another elsewhere. He does keep a financial buffer, but doesn't have insurance for income / vessel.

Capacity to implement options: Adaptive capacity was ranked as medium. He can change species easily, would find it easy to change markets (has multiple markets now), and could change grounds further away as he does explore further currently. He couldn't move ports due to extended family needs.

Challenges: The biggest previous change in the past 10 years was increased area restrictions. He stated he has no current constraints affecting his ability to maintain a viable business or grow

The main upcoming challenge listed was concern about pressure from the recreational sector to close more areas to commercial fishing.

Externalities: Area restrictions; Social pressure.

Adaptation behaviour to change: In response to the area restrictions, he simply stopped fishing the closed area and fished further afield. Since then, he has reduced the number of vessels and hence costs. If further closures were introduced due to recreational pressure, he would adapt by moving fishing grounds.

Success: This fisher is currently maintaining business as usual as he feels 'all set'. He has a high level of optimism for his own business and the Industry. The business is in a slightly better position than year before due to improved catches and prices, and a much better position than 5 years ago due to having fewer vessels (reduced costs). Feelings of security were intermediate due to pressure from recreational fishing groups to remove commercial fishing.

Example 5) **Type H. *Homing non-quota generalist***

Individual characteristics: This fisher has been fishing for more than 30yrs, was in his late 40s at the time of survey, and is highly attached to fishing. All of his individual income and 60% of their household income comes from fishing, which supports his partner and dependent children. He has a medium inherent resilience. His most trusted source of information relating to fishing is QSIA, and he does source / receive information from multiple sources including other fishers, QSIA, management agencies and researchers (but not public media). He stated he would go to other fishers for advice if he needed to make changes to his business in the future.

Business characteristics: This business owns 2 licences – 1 of which this respondent operates himself in multiple ports, and the other of which is operated by a skipper. He is most dependent on mudcrab, but also accesses the inshore net fishery. He has multiple buyers, primarily in his local area. He does keep a financial buffer, but doesn't have insurance for income / vessel.

Capacity to implement options: According to our score, he has a low practical adaptive capacity. Further investigation reveals he would find it difficult to change most things given he is highly specialised and invested in what he does now.

Challenges: The biggest previous change in the past 10 years was more crabbers coming into the area he fishes.

The main current constraint is still too many fishers coming into industry (he believes licences should be zoned to prevent this from happening).

The main upcoming challenge is more fishers potentially coming into the area. This would cause 'stress, decreased income, loss of gear due to other fishers'.

Externalities: Competition.

Adaptation behaviour to change: In response to the increased number of crabbers, he bought an extra symbol (in the year prior to survey) to reduce the number of fishers and get more of his own pots in the water. He invested in bigger boats, crab boats, and improved the efficiency of the process.

Success: The changes he made put his business in a worse position in the short term due to costs, but better in the long term. He states the business is in better position than 1 year ago due to favourable weather (wet seasons) which improved catches, and better than 5 years ago because he 'owns everything' now. However, he feels much less secure than 5 years ago because of insecurity in entitlements and the potential for buyouts. This fisher is currently maintaining business as usual.

Discussion

This project aimed to provide a new way of investigating adaptive capacity within multiple Queensland commercial fisheries to multiple types of change. We aimed to understand, given the multiple environmental, management and economic changes that the industry has been exposed to over time, the most significant previous, current and upcoming challenges that the industry was facing. We also wanted to understand how these challenges, and the responses to those challenges, varied between different types of businesses.

Typology

Queensland fisheries, like many others, include a diverse array of business types. Some businesses access only one type of fishery – at which point it may be appropriate to understand the challenges faced and adaptation options at a fishery level. However, many businesses access more than one fishery type; meaning when you explore change at the level of one fishery, and apply management strategies at the fishery level, this likely misses important elements / features of the business, and may have flow on effects for other linked fisheries. Further, even within fisheries, businesses are often structured in different ways: e.g. some are highly specialised to target a single species or fishing areas, while others might be more diverse and more mobile along the coast. Some also have higher levels of investment and capacity than others. These features likely influence how certain types of change affect them, and how they choose to adapt (or not) to a given change (Tobin et al. 2010a; Tobin et al. 2010b; Marshall et al. 2013; van Putten et al. 2013)

Given this, we aimed to develop a ‘typology’ of all fishing business types operating along Queensland’s east coast. We included as many business characteristics as we could access through available records. These included measures of diversity or specialisation, such as the number of licences a business held, symbols held, fisheries accessed, and regions fished; measures of capacity such as vessel size and dory number available; and measures of activity and investment such as number of days fished in a given year, and harvest and GVP for that year. These data are readily available to fisheries managers, and hence the method is repeatable over time to explore changes in business structure within the fishery.

We found the typology very useful for describing such a diverse industry, and they were well received by fishers and managers. They provided a useful breakdown of the east coast fisheries in Queensland, which have some overlap between fishery types, and high diversity in terms of capacity, diversity/specialisation, and mobility. Many of the final groupings still focused on a key fishery type (most are dependent on 1 fishery type) but there is delineation between those with different levels of capacity, diversity and mobility. The typology is particularly useful to describe those who access multiple fisheries, and as might be expected, we found a high overlap between the net and pot fisheries, with many of these fishers also accessing line fisheries, and some accessing the trawl fishery. Managers may be able to use the typology when considering the potential impact of making changes to specific fishery (e.g. managers could more clearly envisage the potential flow on consequences in other fisheries where there is high overlap); or if there are proposed to management changes to one specific area (e.g. managers may be able to explore the proportion of the fishers in the region that are likely to be most affected because the fish within a smaller region (i.e. they are ‘homing’) rather than those who have high mobility (i.e. ‘roaming’)).

There were some useful correlations related to business type, which may help describe and understand the industry better. For instance, we found that economic dependence on fishing varied by type: Those with a larger investment and capacity (A. *Roaming trawlers*, B. *Homing trawlers*, and C. *Big reef liners*) had a greater dependence on the industry. These types were also more likely to have vessel insurance. They had the highest costs compared to other types (fuel was the highest cost for most typologies, but especially the trawl types, A and B), and while there was no relationship between basic revenues-costs by typology, various profit measures seemed to consistently show that these three types had more businesses with negative profit than the other typology groups. Types E (*Roaming specialists*) and F (*Homing specialists*) were devoid of any loss making businesses when measured via full equity profit. The types with the highest rates of return on capital were generally those which had the lowest investment in capital (noting there are multiple elements missing in this measure, including licence value; hence it should be treated with caution).

Changes, Constraints and Challenges

The types of changes that businesses experienced previously, constraints they were affected by currently, and challenges they were concerned about in the future, were primarily related to issues within the Political, Legal and Governance category of the PESTEL framework, with particular focus on area restrictions and fisheries regulations. By business type, type E (*Roaming specialists*) and K (*Non-quota specialists*) were most commonly associated with area restrictions as the biggest previous change that affected their business, while H (*Homing non-quota generalists*) considered this their main current constraint. Regulation or overregulation were of greatest previous impact to type C (*Big reef liners*), and the most common current constraint for type E (*Roaming specialists*). *Big reef liners* (C) were concerned about economic change previously and currently, while *Small reef liners* (D) were concerned about ecological and social constraints currently. Interestingly, when comparing Operators and Investors, most Operators were concerned about area restrictions as an upcoming challenge, while most Investors were concerned about regulations or regulation change (or lack of).

Concern about area restrictions has been an issue for Queensland commercial fishers for a long time (e.g. Hundloe et al. 2003; Lédée et al. 2012), and is typical of many fisheries (Chang et al. 2012): e.g. Chen et al. (2014) found that urchin fishers in California felt most constrained by the loss of fishing area due to closures, highlighting issues with displacement of fishing effort (as was common in this case study), increased risk due to loss of safely accessible areas, and a reduced ‘portfolio’ of available areas which previously allowed adaptation to changing environmental conditions. It is also common for fishers to feel constrained by regulations, which may be seen as obstacles that restrict their activities or their inherent flexibility and ability to adapt to change (Hovelsrud et al. 2010; Tokotch et al. 2012). In this case study, some fishers listed particular regulations that they felt constrained their business (e.g. quotas, input controls, reporting requirements), but in many cases respondents outlined the uncertainty surrounding regulations (e.g. draft management plans not implemented after numerous years, potential changes in quota value). This uncertainty also related to area restrictions: many fishers were concerned about further closures being implemented through management or political processes. Feelings of lack of security and certainty are common in the industry (this was the third most common category within current constraints and upcoming challenges), as are feelings that the success of their business is determined by factors outside of their control. Some respondents highlighted the importance of inclusion of fishers in decision making processes – while efforts have been made in this regard, given the significance of uncertainty and lack of security as a constraint, clearly more needs to be done.

Adaptation to change

While most businesses we surveyed were maintaining business as usual, and intended to remain doing so, some were making changes including growing and/or diversifying their business in some way. For those who were maintaining business as usual, it is not clear whether this is because they are generally satisfied with their current business, or because they felt they could not make changes at the moment and hence were maintaining the ‘status quo’. Given the general lack of satisfaction with current profit and earnings, and feelings of uncertainty, perhaps it is primarily the latter for most.

When we explored whether fishers felt they could uptake various practical adaptation options within fishing, such as moving or diversifying given a sudden change, we found practical adaptive capacity was skewed to the negative (in contrast to inherent resilience (i.e. the resilience tested at an individual, personality level) which was skewed to the positive). Most would find it difficult to adopt many of the practical options listed, based on their current practice and previous experience. Interestingly, we found adaptive capacity scores positively related to education levels and experience relative to age, suggesting greater knowledge and experience may lead to greater adaptive capacity, as in other studies (e.g. Boon 2014). Those with greater individual income dependency had higher adaptive capacity, perhaps out of necessity. Further, existence of a financial buffer and vessel insurance enabled greater adaptive capacity, similar to other studies which found that access to capital can contribute to greater adaptive capacity (e.g. Chen et al. 2014). Access to more than one fishery logically allowed greater practical adaptive capacity, as did ownership of quota, similar to van Putten et al. (2013) who suggested that fishers who rely on leasing quota in the Tasmanian rock lobster fishery may be less profitable during times of declined catch rates, and hence less resilient to change.

Actual responses to previous change were influenced by different factors, but unfortunately were not consistent by business type. Given area restrictions or regulation changes, businesses were more likely to

take some action rather than have ‘no response’. The likelihood of moving (whether that be ports or fishing grounds) was a response to area restrictions more than other changes (logically), and was influenced by the number of licences held and active, and whether fishers had an alternative income (if they did, they were more likely to make ‘no response’ in their fishing business). Businesses were more likely to change their fishing practices if they had access to other fisheries (again, logically), or had income insurance. Interestingly, those with higher inherent resilience were less likely to make changes to their fishing, and more likely to ‘stick it out’. Businesses made changes to their vessel if they had access to fewer fisheries, had vessel insurance, and had a higher individual income dependence than household income dependence on fishing.

While these findings are interesting, it is difficult to find ‘recommendations’ of responses businesses can make with a given type of change. It seems the responses to change are chosen at an individual level, rather than based on a business type or key characteristics.

The only feature that seemed to consistently stand out in multiple statistical tests as being influential for adaptive capacity, was the existence of a financial buffer. This relates to previous research on Queensland’s fisheries following Cyclone Yasi, where operators’ recommendations to new fishers were to ensure they had a financial and/or business plan as well as a financial buffer (Marshall and Tobin 2012). Fortunately we did find that a majority of businesses did maintain a financial buffer in case of emergencies.

Success

Unfortunately, when considering success of specific adaptation responses, our sample was dominated by businesses who thought their response to a change had put their business in a worse position in the short and long term. i.e. they had not successfully adapted to change.

This study explored success at the scale of the business itself, measured as perceived success rather than actual levels of profitability (financial success itself is not always the most appropriate measure for businesses driven by social motivations and with high social attachment (Toledo-López et al. 2012), such is the case with these fisheries). When looking at measures of perceived success of a business, the distribution is fairly balanced between high and low success, and most businesses fit within the ‘medium’ success rank. Comparing between business types, we found a wide range of success outcomes, and no distinction between the types. Hence, there is no one business type that we could consider to be more successful than the others, according to our measure.

Importantly, as touched on above, most businesses do believe that their success is determined by factors outside of their control. This is reflected somewhat in some of the constraints and success stories outlined in the results. Most constraints were related to regulations of some sort (marine park or fisheries), and success stories sometimes showed improved catches provided the financial boost needed to make changes to their business (though improved catches may in part be due to changed fishing practices, some fishers stated the stocks had improved or the weather was favourable). Also related to this is that they feel less secure in their business than 5 years earlier, likely due to constraints they consider as outside of their control. Again, some respondents outlined the importance of inclusion during implementation of regulation changes – perhaps this would improve feelings of control and security, and encourage positive adaptation behaviour. There is clear need for empowerment of the industry (Jentoft 2005; Nutters and Pinto da Silva 2012) to take control of, and feel secure in their own businesses and the industry.

Communication needs

Given the variation between successful and unsuccessful businesses is due to unknown factors, we were unable to develop the information tool as we had hoped. The initial idea was that businesses of a certain type could explore how other businesses of their type had successfully adapted to a given change, and consider whether the same adaptation responses were appropriate for their business. Given the lack of consistency, and clearly individual responses to change, this is not possible. There appears to be no specific ‘recipe for success’ or predictor of failure.

However, given the findings surrounding lack of security and certainty, and the feeling that external factors, particularly related to area and fisheries management, influence business success improved communication is a likely a key starting point for improvements in the industry. Businesses can still learn from each other, and

managers can take learnings from this work to apply to their day-to-day management tasks. We know from numerous studies that inclusion of fishers in management and communication between fishers and managers is key to developing mutual trust, understanding and confidence, and improving not just effectiveness of management but also the resilience of the fishing industry (Marshall 2007; Pita et al. 2010; Nutters and Pinto da Silva 2012; Sutton and Tobin 2012; Yates 2014).

What we have learned is that fishing businesses tend to rarely seek information from others, and if they do, it is primarily from other fishers. This is consistent with findings from other studies in this industry (e.g. see Tobin et al. 2014). Some businesses do source or receive information from government agencies, particularly DAF and QBFP. However few trust other information sources apart from other commercial fishers. This highlights the importance of developing good leadership and communication within the industry to improve connectedness, which is important in promoting adaptive capacity and resilience (Boon 2014). If fishers are going to other fishing businesses for information and advice, there is an opportunity to ensure key industry leaders are equipped with appropriate information to pass on, both from fishers to managers, and from managers to other fishers. Programs such as GBRMPA's Reef Guardian Program (<http://www.gbrmpa.gov.au/our-partners/reef-guardians/reef-guardian-fishers>), and FRDC's National Seafood Industry Leadership program (<http://www.ruraltraininginitiatives.com.au/home/programs/seafood>) provide positive steps forward in this regard.

Industry representative groups provide one method of improving two-way communication and involvement of fishers in management (Young et al. 1996; Karadzic et al. 2013); however we found less than half of the respondents were members of any industry group. Further, the industry groups themselves have splintered in recent years, with multiple groups claiming to represent their members' interests and voice. This can only reduce the effectiveness of communication between a diverse industry and fishery and marine park managers.

However, even if there was good leadership and representation, opportunities for two-way communication are limited in Queensland given the current lack of formal consultative mechanisms (such as management advisory groups, extension officers) and other formal opportunities for involvement (e.g. Fishcare) which existed previously. The Queensland Fisheries Review, which included multiple industry meetings and port visits along the Queensland coast, provided an opportunity for fishers to voice their concerns and needs of management. It appeared industry participation was high, and there was some hope for change in current management processes to allow greater transparency and certainty. However this review was stalled due to political change.

Conclusion

Examining the Queensland commercial fishery via a typology of businesses provided some useful insights into the structure of the industry, which may assist both fishery and marine park managers in exploring likely impacts and flow on consequences of change across this diverse industry. There were some consistencies in the types of challenges or constraints experienced by business type, which may help inform future communication and consultation when it comes to management of and adaptation to change.

Unfortunately, there were no consistencies within business types in terms of responses to change and success of those responses, and there were no specific business or individual characteristics that contributed to success of a fishing businesses (except perhaps existence of a financial buffer): That is there was no 'recipe for success' or predictor of failure. These findings highlight the complexity of the industry and the generally individual nature of responses to change.

Related to this individualism, we found that commercial fishing businesses generally do not seek information or advice from others, and when they do, it is primarily from other fishers rather than external organisations. Lack of communication within the industry, and between fishers and management agencies is a particular issue of concern. This paucity in communication and engagement likely contributes to fishers' clear feelings of uncertainty and lack of security, particularly in relation to what regulation or area restriction changes may occur in the future. This in turn, likely affects fishers' ability to plan, experiment, and feel confident in their own ability to control the success of their business, and hence their capacity to adapt successfully to change, whatever that change may be.

Implications

The typology developed in this study may improve management understanding of the structure and complexity of industry. The structure of the industry may change over time, and it is up to the fishery managers to update the typology with data they already hold. To make this task simpler, some improvements are needed in how the contributing data is stored (e.g. connecting quota ownership to the Authority Chain Number, easy identification of businesses that hold multiple licences, better recording of lease transactions). More discussion is required to move forward with this if it proves useful.

The main past change, current constraint and future challenges affecting the Queensland east coast commercial fishing industry relate to externalities from management, including area restrictions and fisheries regulations, particularly the future uncertainty surrounding them. Fishers feel that the success of their business is related to factors that outside for their control. This lack of control and security may relate to issues of communication (or lack thereof) between fishers and managers in terms of ongoing and future management change. There may be a cascade effect from a lack of communication to a lack of security and certainty, and hence reduced ability to adapt to change and ensure future success.

This has important implications for fisheries and marine park managers, who have the responsibility of improving communication and consultation with fishers, to build trust and understanding, and improve confidence and security of the fishers regarding the future of the industry. Improved communication requires a commitment from managers and budget from governments to improve this situation and reinstate or replace former formal consultation mechanisms such as management advisory groups, and on the ground extension efforts. This is not easy in the current financial and political climate, but its importance cannot be underestimated. Improved communication also requires a commitment from industry representative groups to take on more of a leadership role and improve communication with members. Again, this requires financial commitment, partly from the organisations themselves, but perhaps with assistance from government given the importance of functional representation. Representative organisations also need to encourage non-members to become involved, and splintered groups need to find commonalities and work together.

It appeared that the existence of a financial buffer may contribute to successful adaptation. Therefore, fishers should be encouraged to continue to maintain a buffer, and it may be important to provide financial assistance when needed in the face of change to allow businesses to plan and experiment.

Further research may help to reveal other influences on adaptive capacity and success. In particular, surveys of more businesses than included here (i.e. a greater participation rate across the industry), with increased focus on fewer topics, may help improve the 'power' of the data to detect consistencies or trends.

Recommendations

Broad recommendations from this project are:

- 1) Managers explore and understand the usefulness of considering the industry as a collection of business types rather than fishery types. Managers can continue to improve the ease with which to explore the industry structure in this way by improving the way specific characteristics (e.g. quota) are stored and linked to businesses and licences.
- 2) Improve communication and trust between fishers and management agencies, and ensure transparent and clear inclusion of fishers in fisheries and marine park management decisions. This may be achieved by funding and reinstating formal processes such as management advisory committees and extension officers. This should be explored as a matter of priority.
- 3) Improve the effectiveness of industry representative bodies by improving leadership and communication between managers, representatives and members, increasing membership, and improving relationships between each of the industry groups. Ideally there should be one representative group; however, if this is not possible, each group needs to find common ground to work together.
- 4) Continue to foster industry leaders to help build the strength of the industry as a whole, and improve communication within the industry.

These recommendations are broad, and not easily achievable. They do not come with a specific path of how to achieve these, but are more ultimate ‘goals’ aimed to improve communication, improve transparency of management, improve industry input into management, and hence increase certainty and security of fisheries into the future. The achievement of these ‘goals’ will lead to a more secure and confident industry that can work together within the industry and with management agencies, to be better placed to collectively adapt to change, whether that be management, environmental, or economic change.

Further development

While there were no consistent characteristics or business types investigated by this study that could be shown to contribute specifically to success, ‘success stories’, or examples of successful businesses in this diverse industry should still be understood and shared, in the interest of building the adaptive capacity and strength of this industry in the face of ongoing change.

Improvement of communication and relationships within such a diverse industry and between industry and management agencies is essential, but is not an easy task. Substantial research has explored different ways of fostering relationships and building trust, and how best to include fishers in management processes (see, for example: Berkes 2009; de Vos and van Tatenhove 2011; Flannery and Ó Cinnéide 2011; Nutters and Pinto da Silva 2012; Dedual et al. 2013). However, there is no single path that is ‘correct’ for all situations. More efforts are needed to guide this process, and this needs ongoing funding support; both to explore the best way forward, and to implement communication mechanisms. At a time when funding for research and natural resource management is at an all-time low, this is more than challenging. Its importance, however, cannot be understated. Management agencies need to take a lead role in this task, with assistance from scientific and communication experts in this field.

Extension and communication of the project occurred primarily via steering committee and other opportunistic face-to-face meetings (particularly with DAF, GBRMPA, the QSIA board and MRAG). The steering committee comprised of researchers from JCU and the CSIRO, managers from GBRMPA and DAF, and representatives from QSIA. Other invited members attended at times: for example researchers from the University of Queensland (Ruth Thurston and Sarah Buckley) who were also studying commercial fisheries in Queensland. Meetings were held near the beginning of the project to discuss the typology, following the main analysis of the fisher surveys, and near project completion, to ensure input from managers, fishing representatives, and relevant researchers throughout the project.

The fisher surveys provided an essential communication point with fishers themselves. Further, we have developed a brochure summarising the project findings, to return to all survey participants. This will also be provided to DAF and GBRMPA managers, QSIA, MBSIA and the Fisherman's Portal for dissemination to members, and publication in the Queensland Seafood magazine.

During the project a number of articles were published to alert industry and the public to the project, in particular to the fisher surveys. Specific articles are listed below in 'Project coverage'.

Importantly, this project was able to link directly with the 'situation analysis' project being completed by researchers from CSIRO and managers from GBRMPA. The data from our surveys contributed directly to that project, being incorporated into their Bayesian Belief Network analyses exploring future adaptation to climate change scenarios based on current sensitivity and adaptive capacity of different business types.

Project coverage

JCU Media release, 11th August 2014: 'Understanding the value of commercial fishers and how they survive'. Resulted in:

- Articles in the Townsville Bulletin, the Cairns Post, Bowen Independent Newspaper, The Australian Marine Environment Protection Association website, Baird Marine website, and Biz Community website
- Television interview with WIN News
- Article on DAF newsletter

QSIA Queensland Seafood magazine article, 2014, Volume 32, No. 3: 'How do you cope with change?'

FRDC's FISH Magazine article, September 2014, Volume 22, No. 3: 'A people-focused approach'. This article outlined my research in general, including this project.

Project materials developed

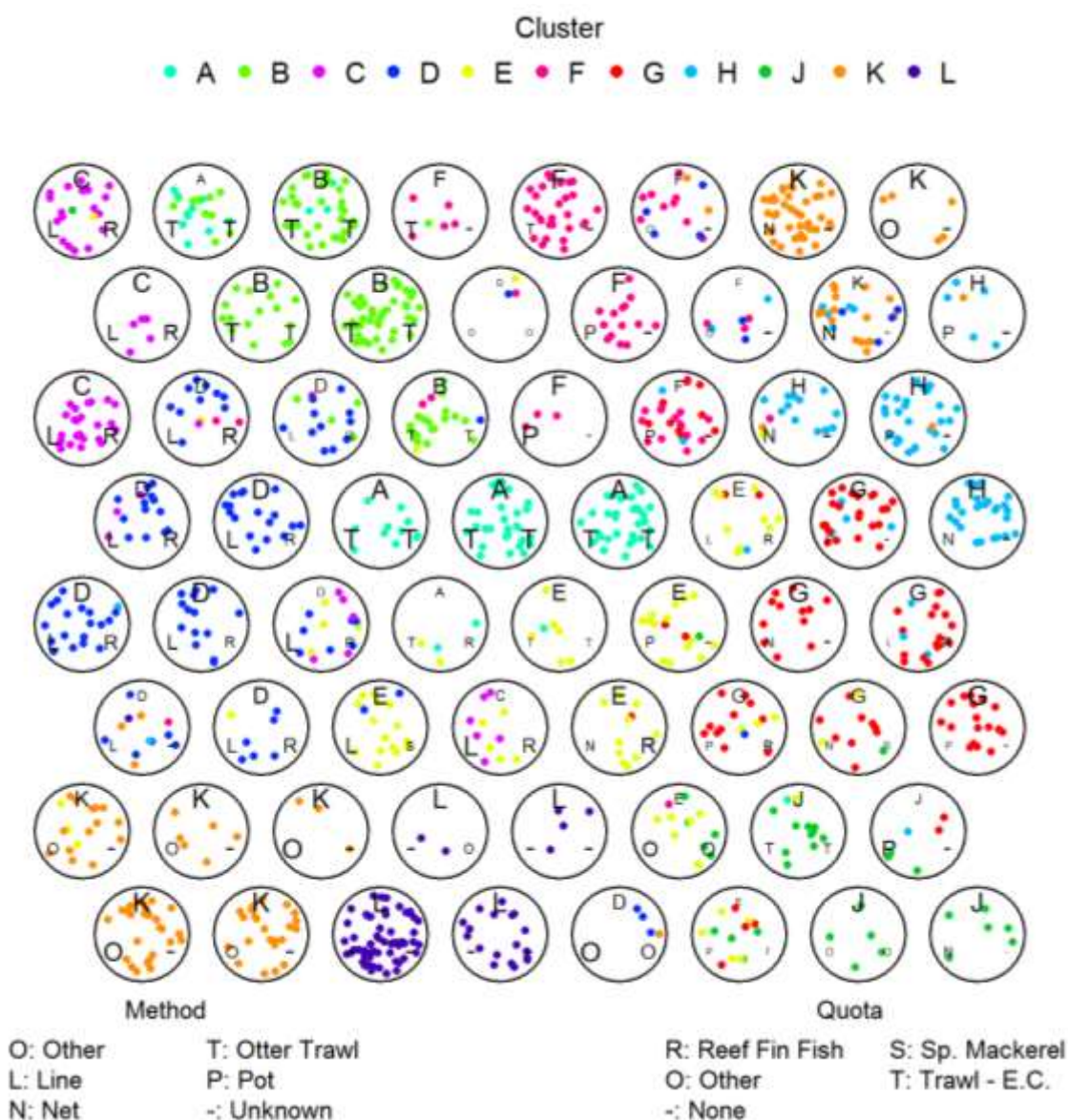
A 'glossy' summary brochure has been produced, to provide a summary of project findings to industry and managers.

Scientific papers outlining the typology development, and the project findings, are in progress and ongoing.

Appendices

Appendix A: Visualisation of clustering using self-organizing map

Visualisation of the clustering using a self-organizing map (SOM). The map can be imagined as a 2-dimensional quilt with an 8x8 hexagonal pattern (the big circles) that has been folded around in the 13-dimensional variable space so that the quilt lies close to the points. The points (coloured by cluster) lying closest to each circle have been placed (randomly) inside it. The majority cluster is printed at the top of each circle, the majority method to lower left and majority quota species to lower right. The size of the label indicates the size of the majority: e.g. the top-left circle contains a majority of businesses in cluster C using mainly line methods fishing for reef fin fish quota, whereas the 3rd circle from the right in the bottom row is a mixture of clusters with a marginally more in E and marginally preferring pot method and trawl quota. Circles that are nearby on the map are also nearby in the 13-dimensional variable space.



Appendix B: Classification form for fishing business surveys

This form was used to determine if the respondent was an ‘Operator’, or an ‘Investor’ in the Queensland East Coast fishing industry.

Adapt or Fail Commercial Fisher Survey – INITIAL CLASSIFICATION

Date: / / 2014	Time:	Interviewer:
ID: <i>If this is a NEW fisher (no ID), please ask for:</i> ACN _____ Or Boat mark _____ Or Licence # _____	Type:	Region:

INTRODUCTION

Hi, my name is _____. I’m from James Cook University in Townsville, and I’m talking to commercial fishers and licence holders on Qld’s east coast about how they adapt to change – whether that is management change, economic or market change, or environment change or events. We’re also trying to get a better estimate of the true value of commercial fisheries to regional communities. You may have received a letter from us already, or read about these surveys in your local paper or industry magazine?

To explain, we’re talking to as many different fishers as we can, to try to get a handle on how different types of fishing businesses have adapted to change in the past, and how well they are prepared for the future. We want to be able to learn from different types of fishing businesses, in the hope that we can improve the ability of the industry as a whole to cope with and better adapt change. We’re also asking fishers about their finances and how they spend their fishing income, to improve our understanding of the value of commercial fisheries, beyond a simple GVP estimate.

We’d really like to talk with you. Would that be ok? Your name is not written on the survey so you can’t be identified – everything you say is completely confidential

Yes (= consent given, continue)

No (Try to convince it is worth their time, and in the interests of the industry as a whole. If not, this is a non-response. Thank them for their time, and offer contact details should they change their mind. END.)

First, we’d like to know what type of fisher / licence holder you are.

1. a) Are you a:

- 1 Licence owner non-operator (‘investor’)
- 2 Owner-operator (*though may own >1 licence*)
- 3 Operator leasing a licence from someone else
- 4 Contract skipper
- 5 Other _____

2. Do you consider yourself the ‘DECISION MAKER’ for this fishing business?

Yes – continue to appropriate survey

No – are you able to put me in contact with someone who is?

Name: _____ Ph: _____

We really need to the decision maker in the business. Thank you for your time today! END

Appendix C: Final fishing business ‘Operator’ survey

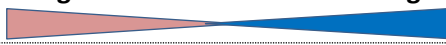
Adapt or Fail Commercial Fisher OPERATOR Survey

Date:	Time:	Interviewer:	ID: Leasing from ID:
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Rather than have a general conversation, I have a lot of specific questions so we can collect similar information from lots of different fishers.

*First, we’d like to get an understanding of how **important** the commercial fishing industry is to you.*

3. In what year did you start commercial fishing (or for how many years)? _____ Year / _____ Yrs
4. I’m going to read out a set of statements, and I need to you tell me your level of agreement with these statements on a scale of 1-10, where **1** = Very Strongly **Disagree** and **10** = Very Strongly **Agree**. Please note that there is no mid-point on this scale, so a 5 would be a slight disagreement, and a 6 would be a slight agreement.

	Disagree											Agree
a) I wouldn’t want to be anything other than a commercial fisher	1	2	3	4	5	6	7	8	9	10		
b) The fishing industry to me is not just a job – it is my lifestyle	1	2	3	4	5	6	7	8	9	10		
c) I plan to still be in the commercial fishing industry until I retire	1	2	3	4	5	6	7	8	9	10		
d) Working in the commercial fishing industry contributes to my quality of life and well-being	1	2	3	4	5	6	7	8	9	10		

*Thanks for that. Now we’d like to get a better idea about the **type of fishing business** you have.*

5. **Type:** Using basic information available from DAFF about licences and fishing activity, we have placed what we could determine as ‘licence holders’ into broad, simplified, business ‘types’, based on how many licences you hold, symbols held, quota/ effort units held, what fisheries and regions you operate in (including diversity and range), harvest, and vessel size. **SEE TYPOLOGY SHEET**. For your business, we have placed you in the ‘type’ labelled simply as (type for this ID).... which is described as (read out description)

- a) Knowing these are quite simplified descriptions, would you say your business fits this type?
Y **N** : b) If you don’t fit where we had you placed (or if we have not placed you in a category – e.g. for lessees), which type do you think fits you best? _____

c) What characteristics does your business have that make this the best fit for you?
(Surveyor – focus on # licences, diversity of fisheries, regions fished in, as above)

6. a) How many **LICENCES** did you own by end of 2013/14? _____
- b) How many of those licences were ‘active’ in 2013/14 (i.e. had a primary vessel in operation) _____
- c) How many of these licences do you operate/manage vs lease out to others?

_____ operated by myself VS _____ operated by a skipper VS _____ leased out to others
(Surveyor – ask for lessee name, phone number and town)

7. a) By the end of the 2013/14 financial year did you own any **QUOTA / EFFORT UNITS** for any east coast Qld fisheries?

Not applicable to my fishery **No** **Yes :**

b) What type/fishery (*circle*): **CT** **RTE** **OS** **SM** **Trawl** **Spanner Crab** **Other** ____

c) Number of units (*if known*): ____ ____ ____ ____ ____ ____ ____

8. a) Did you **buy, sell or lease (in or out)** any licences, symbols and quota / effort units for the 2013/14 financial year? **N** **Y : Details in table**

	Licence packages (#)	Symbols (which, #)	Quota / Effort (which fishery, # units)
Bought			
Leased IN			
Sold to others			
Sold in buyout			
Leased OUT			

b) Can you explain what made you decided to buy / sell / lease these licences / symbols / quota at the time?

Bought because _____

Leased because (*Surveyor – include why leased instead of bought/sold*): _____

Sold because _____

9. a) Could you describe how you make your **income** at a fishing BUSINESS level?

% of income		% of income		% of income	
Harvesting	_____ %	Licence leasing	_____ %	Licence sales	_____ %
Processing	_____ %	Symbol leasing	_____ %	Symbol sales	_____ %
Wholesale /retail	_____ %	Quota / effort leasing	_____ %	Quota / effort sales	_____ %
OTHER	_____ %				

b) Do you sell your own product directly from your home / boat? **N** **Y**

10. a) In terms of fisheries specifically, which **fisheries** does your business income come from (*Tick all that apply, add others if needed. Show fisher to check all are included*):

- Inshore Net 'Offshore' Net Otter Trawl Beam trawl
- Reef Line Rocky Reef Spanish mac Spotty mac
- Mudcrab Blue Swimmer crab Spanner crab
- Aquarium fish Coral harvest Rocklobster

Others _____

b) Which fishery contributed the **most** to your income in 2013/14? (*Circle above, or list*) _____

c) Does this vary among years? **N** **Y :** d) Can you explain why it varies? _____

11. a) Where is your main **home port** (i.e. where you typically unload your product)?

b) How many other ports have you used in the past year (*can be 0 other ports*)? _____

12. How many **buyers** do you sell to in:

a) Your local region (*i.e. town of main home port, include yourself as 1 if you sell directly*): _____

b) Elsewhere: _____

We'd like to know a little about how you feel you are going at the moment, somewhat compared previous years.

13. a) How would you describe the main focus of your business activities at the moment?

Are you (*many be doing >1*):

- 1 Maintaining business as usual?
- 2 Increasing the size of your business?
- 3 Downsizing?
- 4 Diversifying (e.g. species / fisheries / markets, fishing grounds)?
- 5 Specialising (e.g. species / fisheries / markets, fishing grounds)?
- 6 Waiting for a good time to sell?
- 7 Other: _____

b) Why? _____

14. What is the main constraint on your ability to maintain a viable business, or to grow? (*what gets in your way?*) _____

Now I am going to read a series of statements again, like before, with the 1-10 scale, and I need you to tell me your level of agreement with the statements. Some of these are about your business, some about your main fishery, and some about you personally. Some are based on social science theories and may seem a bit strange! Remember there are no right or wrong answers – everyone is different 😊

15. On a scale of 1 – 10, where 1 = Strongly disagree, 10 = Strongly agree, please state your level of agreement with the following statements:	Disagree	Agree								
a) I am satisfied with the current profitability of my fishing business	1	2	3	4	5	6	7	8	9	10
b) I currently earn enough money to support the style of life that I prefer	1	2	3	4	5	6	7	8	9	10
c) The habitats that I fish the most are NOT in great condition	1	2	3	4	5	6	7	8	9	10
d) My main target species is currently fished sustainability	1	2	3	4	5	6	7	8	9	10
e) The success of my fishing business is mostly determined by factors outside my control	1	2	3	4	5	6	7	8	9	10
f) I am optimistic about the future of my fishing business	1	2	3	4	5	6	7	8	9	10
g) I am optimistic about the future of the Qld east coast fishing industry	1	2	3	4	5	6	7	8	9	10
h) In most ways my life is close to ideal	1	2	3	4	5	6	7	8	9	10
i) So far, I have gotten the important things I want in life	1	2	3	4	5	6	7	8	9	10
j) If I could live my life over, I would change almost nothing	1	2	3	4	5	6	7	8	9	10

The next series of statements we have been asking fishers for a few years now, relating to your own thoughts on how you **adapt to change personally**. Again, there are no right or wrong answers 😊

16. Again, I'll read out a list of statements, and I'd like you to rate your agreement or disagreement with each statement; where 1 = Very Strongly Disagree and 10 = Very Strongly Agree .	Disagree	Agree
a) I am happy to make decisions when faced with uncertainty	1 2 3 4 5 6 7 8 9 10	
b) I am unsure of how to plan for changes in the fishing industry that may affect me	1 2 3 4 5 6 7 8 9 10	
c) I am willing to take higher than average risks in order to get higher financial returns	1 2 3 4 5 6 7 8 9 10	
d) I am good at planning for the future of my business in different circumstances	1 2 3 4 5 6 7 8 9 10	
e) I discuss new ways of solving problems associated with my business with others	1 2 3 4 5 6 7 8 9 10	
f) I am more likely to adapt to changes of any kind compared to other fishers I know	1 2 3 4 5 6 7 8 9 10	
g) I am interested in learning how to better prepare my business for significant events / changes	1 2 3 4 5 6 7 8 9 10	
h) I have many job options available to me if I decide to no longer be a fisher	1 2 3 4 5 6 7 8 9 10	
i) I am too young to retire and too old to find work elsewhere	1 2 3 4 5 6 7 8 9 10	
j) I would be nervous trying something else	1 2 3 4 5 6 7 8 9 10	
k) I have planned for my financial security	1 2 3 4 5 6 7 8 9 10	
l) I am interested in learning new skills outside of the industry	1 2 3 4 5 6 7 8 9 10	

17. a) Do you think your fishing business is in a worse, same or better financial position than it was this time last year?

- 1 It's in a LOT WORSE position 2 It's in a SLIGHTLY WORSE position
- 3 It's in the SAME financial position
- 4 It's in a little BETTER position 5 It's in a LOT BETTER position

b) Why? _____

18. a) Do you think your fishing business is in a worse, same or better financial position than it was this time 5 years ago?

- 1 It's in a LOT WORSE position 2 It's in a SLIGHTLY WORSE position
- 3 It's in the SAME financial position
- 4 It's in a little BETTER position 5 It's in a LOT BETTER position
- 9 N/A (not in business)

b) Why? _____

19. a) Do you feel more or less secure in your fishing business than you did 5 years ago?

- 1 I feel a LOT LESS secure 2 I feel a LITTLE LESS secure
- 3 I feel the SAME level of security
- 4 I feel a LITTLE MORE secure 5 I feel a LOT MORE secure
- 9 N/A (not in business)

b) Why? _____

20. a) Thinking about everything that has happened in the past 10 years, can you list **the ONE most significant** either positive or negative **change that has affected your business**? *Change can include specific management, environmental, market or financial changes, personal change, or a combination of any of these. (Surveyor – if they list >1, ask and circle what they think is the ONE biggest)*

b) What changes (*if any*) did you make in response? _____

c) Did these changes put your business in a better or worse position in the short term (*than if you had done nothing*)? And in what way?


d) What about the long term? _____

e) What else did you want to do but couldn't? (*e.g. in an 'ideal world', with no barriers. Could be a 'pie in the sky' idea*) _____

f) What stopped you? _____

g) Would you do anything differently next time, if a similar change happens again? (*if yes, what?*)

We've come up with a list of more 'practical' behavioural **adaptation options** businesses could/couldn't take based in previous surveys. Some of these will be more difficult for some businesses, and easier for others. We're trying to understand that, and what **barriers** get in the way of being able to take these options.

21. On a scale of 1 – 10, where 1 = extremely difficult, 10 = extremely easy, if a sudden change occurred, how difficult or easy it would be for you to...	Difficult Easy 
a) STOP fishing temporarily (e.g. until impact of event has passed)	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
b) Change FISHERIES temporarily	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
c) Change target SPECIES within your current fishery	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
d) Change the PRODUCT form or type you sell (e.g. fillet instead of whole / cooked instead of raw, etc...)	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
e) Change the MARKET you sell to	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
f) Move to fishing grounds FURTHER AWAY than you usually fish (<i>but still from your current home port</i>)	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	

g) Move to NEW fishing grounds you are <u>unfamiliar</u> with (not necessarily further away)	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	
h) Move HOME PORTS	1 2 3 4 5 6 7 8 9 10
What makes it difficult / easy?	

22. What other types of behaviour changes could you do? (*i.e. have we missed anything?*)

Now, we want to contemplate the future...

23. What do you see yourself doing in the next 3 years

- 1 Out of the fishing industry, doing something else 2 Retired
 3 Still in the industry, operating the same as now
 4 Still in the industry, but will make substantial changes: (*explain here*)

such as _____

because _____

24. a) What do you see as the ONE biggest UPCOMING challenge that would affect your ability to remain viable within the fishing industry? (*i.e. what gets in your way?*) (*Surveyor – if they list >1, ask for and circle the ONE biggest*)

b) On a scale of 1-10 (*1 = not at all likely; 10 = extremely likely*), how likely do you think this 'challenge' / event is to occur? (*circle*) 1 2 3 4 5 6 7 8 9 10

c) On a scale of 1-10 (*1 = not at all severe; 10 = extremely severe*), how severe do you think the impacts of this challenge will be for you? (*circle*) 1 2 3 4 5 6 7 8 9 10

d) Can you explain how it will affect you? _____

e) Do you plan to make changes to your business in response to this challenge?

N Y : f) What will you do? _____

g) How do you feel about that? _____

25. What **ONE management change** would you like to see, that would allow your business to adapt to change and remain viable or grow? (*Surveyor, if they list marine park regulations, ask again in relation to Qld fishery management, in context of current review. Include both answers here but make it clear MPAs were #1*)

The next questions relate to how you receive **information** about fisheries issues.

26. What or who is your most trusted source of information about fisheries in Queensland?

27. If you decided you needed to make changes to your fishing business due to an upcoming change, who (person or organisation) would you first go to for advice? (Can be 'No-one') _____

28. a) Are you a member of an industry association **N** **Y**: b) Which one? _____

29. How often have you sourced or received **fisheries related information** from the following sources in the previous 12 months?

a) QSIA	Never	1-5 times	> 5 times
b) Other commercial fishers	Never	1-5 times	> 5 times
c) Fisheries Qld (DAFF) office or personnel (NOT QBFP)	Never	1-5 times	> 5 times
d) Queensland Boating and Fisheries Patrol (QBFP)	Never	1-5 times	> 5 times
e) GBRMPA	Never	1-5 times	> 5 times
f) Researchers	Never	1-5 times	> 5 times
g) Public media (eg. newspapers, radio, tv)	Never	1-5 times	> 5 times
h) Other _____	Never	1-5 times	> 5 times

The next set of questions relate to your **income, capital, costs and debt** – many of these questions relate to the “Beyond GVP” project, where we are trying to get a better idea of the value of commercial fishing to regional communities. Please remember everything is **CONFIDENTIAL**. It’s important that we get answers that are as **accurate** as possible. **If there is anything you would prefer to look up and answer later, we can call you in a few days to complete your answers.**

30. Can you please tell me your approximate business **revenue** for the last financial year (2013/14)?

Preferably **ACTUAL** value (to nearest \$10k) \$ _____

OR Range:	1	Under \$50,000	6	\$250,000 to \$299,999
	2	\$50,000 to \$99,999	7	\$300,000 to \$399,999
	3	\$100,000 to \$149,999	8	\$400,000 to \$499,999
	4	\$150,000 to \$199,999	9	>\$500K
	5	\$200,000 to \$249,999	98	Prefer not to answer

31. **Capital: a)** When did you buy your current **primary vessel** (If you have >1 primary vessel, please include details of **EACH**)? _____(year)

b) How much did you pay for it then? \$ _____

c) Did this value include attached: (Circle all included) **symbols, quota, effort units or licences**

d) How old was it when you bought it? _____ (years)

e) How much is it worth now (use insured value if uncertain)? \$ _____

f) Does this value include attached: (Circle all included) **symbols, quota, effort units or licences**

g) How many tenders / dories do you have? (i.e. other vessels attached to the same licence as the primary vessel) _____

h) What is their approximate value? \$ _____ each / total (circle)

i) How much do you think your licence(s) is/are worth now? \$ _____

j) Does this include attached: (*Circle all included*): **symbols, quota or effort units**

32. a) What were your TOTAL business **costs** in 2013/14: \$ _____

Please can you break this down into:

b) Crew/staff costs: Crew \$ _____
 Skipper (*if you employ one*) \$ _____
 Land based staff \$ _____

c) Vessel repairs and maintenance costs \$ _____

d) Fuel costs \$ _____ e) Other catching costs \$ _____ (gear, bait, food etc.)

f) Licence lease costs \$ _____ g) Quota lease costs \$ _____

h) Other annual operating costs \$ _____ (insurance, administration, licence fees, business vehicle etc.)

33. a) In 2013/14, what were your total **repayments** on loans relating to your fishing business?

Total \$ _____ Month/Annual (*circle*)

b) How much of this was **interest**: \$ _____ and **principle** \$ _____

c) What was the **interest rate** you were charged? _____%

34. a) Do you actively maintain a financial buffer in case of emergencies? **N** **Y**

b) Do you have income protection insurance for your business? **N** **Y**

c) Do you have vessel insurance? **N** **Y**

35. a) How many workers / **crew** do you directly employ to work in your business?

	Full time	Part time	
	Number	Number	Hrs/week
Non-family			
Family (paid)			
Family (unpaid)			

b) *If you don't already*, could you afford to hire a skipper to run your operation?

Y **N** **N/A** (*already have one*)

Finally, we would like to know a little bit **about you and your family** situation – this relates to your level of dependency on the fishing industry. It is of course confidential, as with the rest of the survey.

36. In what year were you born? 19 _____

37. Are you currently married or have a partner? Y N

38. Do you have any dependent children? Y N

39. Do you have university or tafe education (i.e. beyond highschool)? Y N

40. a) Do you have experience / training in other work that you could rely on now?
N Y : b) what sort?

- | | | | |
|---|-------------|---|-----------|
| 1 | Trade | 2 | Transport |
| 3 | Farming | 4 | Business |
| 5 | Other _____ | | |

41. What percentage of your individual income comes from the fishing industry? _____ %

42. What percentage of your household income comes from the fishing industry? _____ %

43. Gender (Surveyor - don't ask!) M F

44. When we put the findings of these surveys together, we are hoping to develop 'options' for different business types, that fishers can go to for advice. Do you have any ideas of how you would like to receive this so it is useful to you? Be creative 😊

45. We have a series of questions relating to **where you spend your income**, to get a better idea of contributions to local communities. To get an accurate measure of economic value of the industry, we need as many fishers as possible to complete these. You have a few options regarding filling this in..

- 1 Complete it at the end of this survey on paper, and give to us straight away
- 2 Keep a paper version, and complete with one of us over the phone (*ensure phone is correct*)
- 3 Online survey monkey (*need email address*)

46. Is there anything else that you'd like to add?

47. Is there another fisher that you think we really should talk to?

Name: _____

48. Finally – would we be able to contact you again for future surveys?

N Y: (*Please confirm contact details on separate sheet (Name, phone and email)*)

Thank respondent for their time! Pass on our details for questions – ensure they have an information sheet.

END

Appendix D: Final fishing business survey for ‘Investors’

Adapt or Fail Commercial Fisher INVESTOR survey

Date: / / 2014	Time:	Interviewer:	ID:
----------------	-------	--------------	-----

Rather than have a general conversation, I have a lot of specific questions so we can collect similar information from lots of different fishers.

First, we’d like to get an understanding of how **important** the commercial fishing industry is to you.

3. In what year did you start investing in the commercial fishing industry (or for how many years)?
 _____ Year / _____ Yrs

4. What made you choose to invest in the commercial fishing industry?

5. a) Were you ever an active commercial fisher yourself?

N Y : b) For how many years? _____ c) When did you stop fishing? _____

d) What made you stop? _____

6. For the next group of questions, I’ll read out a list of statements, and I’d like you to rate your agreement or disagreement with each statement, using a ten-point scale; where **1 = Very Strongly Disagree** and **10 = Very Strongly Agree**. Please note that there is no mid-point on this scale, so a 5 would be a slight disagreement, and a 6 would be a slight agreement.

	Disagree	Agree
a) I wouldn’t want to be involved in any other industry other than the commercial fishing industry		
b) The fishing industry to me is not just a business investment – it is part of my life	1 2 3 4 5 6 7 8 9 10	
c) I plan to remain invested in the commercial fishing industry at least until I retire	1 2 3 4 5 6 7 8 9 10	
d) Investing in the commercial fishing industry contributes to my quality of life and well-being	1 2 3 4 5 6 7 8 9 10	

Thanks for that. Now we’d like to get a better idea about the **type of fishery business** you have.

7. **Type:** Using basic information available from DAFF about licences and fishing activity, we have placed what we could determine as ‘licence holders’ into broad, simplified, business ‘types’, based how many licences you hold, symbols held, quota/ effort units held, what fisheries and regions your licences operate in (including diversity and range), harvest, and vessel size attached to licences. **SEE TYPOLOGY SHEET**. For your business, we have placed you in the ‘type’ labelled simply as (type for this ID).... which is described as (read out description)

a) Knowing these are quite simplified descriptions, would you say your business fits this type?

Y N : b) Which type do you think fits you best? _____

c) What characteristics does your business have that make this the best fit for you?

(Surveyor – focus on # licences, diversity of fisheries, regions fished in, as above)

8. a) How many **LICENCES** did you own by end of 2013/14? _____

b) How many of those licences were ‘active’ in 2013/14 (i.e. have a primary vessel in operation) _____

c) How many of these licences did you actively manage vs lease out to others?

_____ managed by myself with hired skipper VS _____ leased out to others (Ask for lessee details)

OR other structure _____

9. a) By the end of the 2013/14 financial year did you own any **QUOTA / EFFORT UNITS** for any east coast Qld fisheries?

Not applicable to my fishery **No** **Yes :**

b) What type/fishery (*circle*): **CT** **RTE** **OS** **SM** **Trawl** **Spanner Crab** **Other** ____

c) Number of units (*if known*): ____ ____ ____ ____ ____ ____ ____

10.a) Did you **buy, sell, or lease (in or out)** any **licences, symbols and quota / effort units** for the 2013/14 financial year?

	Licence packages (#)	Symbols (which, #)	Quota / Effort (which fishery, # units)
Bought			
Leased IN			
Sold to others			
Sold in buyout			
Leased OUT			

b) Can you explain what made you decided to buy / sell / lease these licences / symbols / quota at the time?

Bought because _____

Leased because (*Surveyor – include why leased instead of bought/sold*): _____

Sold because _____

11. Could you describe where / how you made your **income** at a fishing BUSINESS level in 2013/14?

	% of income	% of income	% of income
Harvesting	_____%	Licence leasing	_____%
Processing	_____%	Licence sales	_____%
Wholesale / retail	_____%	Symbol leasing	_____%
OTHER	_____ %	Symbol sales	_____%
		Quota / effort leasing	_____%
		Quota / effort sales	_____%

*We'd like to know a little about how you feel you are going **at the moment**, somewhat compared previous years.*

12. How would you describe the main focus of your business activities at the moment?

Are you (*many be doing >1*):

- 8 Maintaining business as usual?
- 9 Increasing the size of your enterprise?
- 10 Trying new things?
- 11 Downsizing?
- 12 Waiting for a good time to sell?
- 13 Other: _____

13. What is the main constraint on your ability to adapt to changes, to maintain a viable business, or to grow? (*what gets in your way?*)

Now I am going to read a series of statements again, like before, with the 1-10 scale, and I need you to tell me your level of agreement with the statements. Some of these are about your business, some about your main fishery, and some about you personally. Some are based on social science theories and may seem a bit strange! Remember there are no right or wrong answers – everyone is different 😊

14. On a scale of 1 – 10, where 1 = Strongly disagree, 10 = Strongly agree, please state your level of agreement with the following statements:	Disagree	Agree								
a) I am satisfied with the current profitability of my fishery investment business	1	2	3	4	5	6	7	8	9	10
b) I currently earn enough money from my business to support to style of life that I prefer	1	2	3	4	5	6	7	8	9	10
c) The success of my fishing business is mostly determined by factors outside my control	1	2	3	4	5	6	7	8	9	10
d) I am optimistic about the future of my fishery business	1	2	3	4	5	6	7	8	9	10
e) I am optimistic about the future of the Qld east coast fishing industry	1	2	3	4	5	6	7	8	9	10
f) In most ways my life is close to ideal	1	2	3	4	5	6	7	8	9	10
g) So far, I have gotten the important things I want in life	1	2	3	4	5	6	7	8	9	10
h) If I could live my life over, I would change almost nothing	1	2	3	4	5	6	7	8	9	10

We have a series of statements we have been asking fishers for a few years now, relating to your own thoughts on how you **adapt to change personally**. Again, there are no right or wrong answers...

15. Again, I'll read out a list of statements, and I'd like you to rate your agreement or disagreement with each statement on 1-10 scale	Disagree	Agree								
m) I am happy to make decisions when faced with uncertainty	1	2	3	4	5	6	7	8	9	10
n) I am unsure of how to plan for changes in the fishing industry that may affect me	1	2	3	4	5	6	7	8	9	10
o) I am willing to take higher than average risks in order to get higher financial returns	1	2	3	4	5	6	7	8	9	10
p) I am good at planning for the future of my business in different circumstances	1	2	3	4	5	6	7	8	9	10
q) I discuss new ways of solving problems associated with my business with others	1	2	3	4	5	6	7	8	9	10
r) I am more likely to adapt to changes of any kind compared to others I know in this industry	1	2	3	4	5	6	7	8	9	10
s) I am interested in learning how to better prepare my business for significant events / changes	1	2	3	4	5	6	7	8	9	10
t) I have many other options available to me if I decide to no longer remain involved in this industry	1	2	3	4	5	6	7	8	9	10
u) I would be nervous investing in something else	1	2	3	4	5	6	7	8	9	10
v) I have planned for my future financial security	1	2	3	4	5	6	7	8	9	10

16. a) Do you think your business is in a worse, same or better financial position than it was this time last year?

- | | | | |
|---|-------------------------------------|---|-----------------------------------|
| 1 | It's in a LOT WORSE position | 2 | It's in a SLIGHTLY WORSE position |
| 3 | It's in the SAME financial position | | |
| 4 | It's in a little BETTER position | 5 | It's in a LOT BETTER position |

b) Why? _____

17. a) Do you think your fishing business is in a worse, same or better financial position than it was this time 5 years ago?

- | | | | |
|---|-------------------------------------|---|-----------------------------------|
| 1 | It's in a LOT WORSE position | 2 | It's in a SLIGHTLY WORSE position |
| 3 | It's in the SAME financial position | | |
| 4 | It's in a little BETTER position | 5 | It's in a LOT BETTER position |
| 9 | N/A (not in business) | | |

b) Why? _____

18. a) Do you feel more or less secure in your fishery business than you did 5 years ago?

- | | | | |
|---|-----------------------|---|----------------------|
| 1 | A lot LESS secure | 2 | A LITTLE LESS secure |
| 3 | About the same | | |
| 4 | A LITTLE MORE secure | 5 | A LOT MORE secure |
| 9 | N/A (not in business) | | |

b) Why? _____

19. a) Thinking about everything that has happened in the past 10 years, can you list **the ONE most significant** either positive or negative **change that has affected your business**? *Change can include management change, environmental change, market or financial change, personal change, or a combination of any of these.*

(Surveyor – if they list >1, ask and circle what they think is the ONE biggest)

c) Did these changes put your business in a better or worse position in the short term (*than if you had done nothing*)? And in what way?

d) What about the long term? _____

e) What else did you want to do but couldn't? (*e.g. in an 'ideal world', with no barriers. Could be a 'pie in the sky' idea*)

f) What stopped you? _____

g) Would you do anything differently next time? (*if yes, what?*) _____

Now, we want to contemplate the **future...**

20. a) What do you see as the ONE biggest UPCOMING challenge that would affect your ability to remain viable within the fishing industry? (i.e. what gets in your way?) (Surveyor – if they list >1, ask and circle what they think is the ONE biggest)

b) On a scale of 1-10 (10 = extremely likely), how likely do you think this ‘challenge’ / event is to occur?

(circle) 1 2 3 4 5 6 7 8 9 10

c) On a scale of 1-10 (10 = extremely severe), how severe do you think the impacts of this challenge will be for you?(circle) 1 2 3 4 5 6 7 8 9 10

d) Can you explain how it will affect you? _____

e) Do you plan to make changes to your business in response to this challenge?

N Y : f) What will you do? _____

21. What **ONE management change** would you like to see, that would allow your business to adapt to change and remain viable or grow? (Surveyor, if they list marine park regulations, ask again in relation to Qld fishery management, in context of current review. Include both answers here but make it clear marine parks were #1)

The next questions relate to how you receive **information** about fisheries issues.

22. What or who is your most trusted source of information about fisheries in Queensland?

23. If you decided you needed to make changes to your fishing business due to an upcoming change, who (person or organisation) would you first go to for advice? (Can be ‘No-one’) _____

24. a) Are you a member of an industry association N Y : b) Which one? _____

25. How often have you sourced or received fisheries related information from the following sources in the previous 12 months?

i) QSIA	Never	1-5 times	> 5 times
j) Other commercial fishers	Never	1-5 times	> 5 times
k) Fisheries Qld (DAFF) office or personnel (NOT QBFP)	Never	1-5 times	> 5 times
l) Queensland Boating and Fisheries Patrol (QBFP)	Never	1-5 times	> 5 times
m) GBRMPA	Never	1-5 times	> 5 times
n) Researchers	Never	1-5 times	> 5 times
o) Public media (eg. newspapers, radio, tv)	Never	1-5 times	> 5 times
p) Other _____	Never	1-5 times	> 5 times

The next set of questions relate to your **income, capital, costs and debt** – many of these questions relate to the “Beyond GVP” project, where we are trying to get a better idea of the value of commercial fishing to regional communities. Please remember everything is **CONFIDENTIAL** – we do not share individual fisher information with others. It’s important that we get answers that are as **accurate** as possible. **If there is anything you would prefer to look up and answer later, we can call you in a few days to complete your answers.**

26. Can you please tell me your approximate **business revenue** for the last financial year (2013/14)?

Preferably **ACTUAL value** (to nearest \$10k) \$ _____

OR Range:	1	Under \$50,000	6	\$250,000 to \$299,999
	2	\$50,000 to \$99,999	7	\$300,000 to \$399,999
	3	\$100,000 to \$149,999	8	\$400,000 to \$499,999
	4	\$150,000 to \$199,999	9	>\$500K
	5	\$200,000 to \$249,999	98	Prefer not to answer

27. Please can indicate the current anticipated **resale value** of your:

a) Licenses: \$ _____ b) Endorsements \$ _____

c) Quota/effort units: \$ _____

28. a) What were your TOTAL business **costs** (specifically relating to fishing) in 2013/14: \$ _____

Please can you break this down into:

a) Staff costs: \$ _____

b) Lease costs:

Licenses \$ _____ Symbols \$ _____ Quota/effort units \$ _____

c) Other annual operating costs \$ _____ (insurance, administration, business vehicle etc.)

4. a) In 2013/14, what were your total **repayments** on loans relating to your fishing business?

Total \$ _____ Month/Annual (*circle*)

b) How much of this was **interest**: \$ _____ and **principle** \$ _____

c) What was the **interest rate** you were charged? _____%

29. a) Do you actively maintain a financial buffer in case of emergencies? **Y** **N**

b) Do you have income protection insurance for your business? **Y** **N**

We would like to know a little bit about you and your family situation – this relates to your level of dependency on the fishing industry. It is of course confidential.

30. In what year were you born? 19 _____

31. Are you currently married or have a partner? **Y** **N**

32. Do you have any dependent children? **Y** **N**

33. Do you have university or tafe education (i.e. beyond highschool)? **Y** **N**

34. Do you have any formal skills to develop your own business plan? **Y** **N**

35. a) Do you have experience / training in other work that you could rely on now?

N **Y** : b) what sort?

1	Trade	2	Transport
3	Farming	4	Business
5	Other _____		

36. What percentage of your individual income comes from the fishing industry? _____ %

37. What percentage of your household income comes from the fishing industry? _____ %

38. Gender (*Surveyor – don't ask!*) **M** **F**

39. When we put the findings of these surveys together, we are hoping to develop 'options' for different business types, that fishers can go to for advice. Do you have any ideas of how you would like to receive this so it is useful to you? Be creative 😊

40. Is there anything you'd like to add?

41. Is there another licence holder that you think we really should talk to?

Name: _____

42. IF LEASING OUT LICENCE: We'd really like to talk to people who LEASE licences out from others. Would we be able to speak to your lessee(s)? **N** **Y** :

43. Finally – would we be able to contact you again for future surveys?

N **Y:** (*Please confirm contact details on separate sheet (Name, phone and email)*)

Thank respondent for their time! Pass on our details for questions – ensure they have an information sheet.

END

Appendix E: Letter sent to fishers alerting them to the upcoming surveys

XXth of July, 2013



«First_name» «Surname»
«Business_Name»
«AddrLine1»
«AddrLine2»
«Suburb»
«State» «Postcode»

«GreetingLine»

We are about to ‘hit the road’ to talk directly to commercial fishers and licence holders on Queensland’s east coast about how they deal with change – whether that be management, environmental, or economic change – as well as how they contribute economically to local communities. We’d really like to talk to you personally! You may have read a little about this upcoming visit in the recent QSI magazine, newspaper or heard it on the radio. I will explain more here.

This ‘road trip’ is part of a two research projects funded by the Fisheries Research and Development Corporation (FRDC). The first project, titled “*Adapt or Fail: Risk management and business resilience in Queensland commercial fisheries*” is being led by Dr Renae Tobin at the Centre for Sustainable Tropical Fisheries and Aquaculture (CSTFA), at James Cook University (JCU), Townsville. The second project, titled “*Beyond GVP: The value of inshore commercial fisheries to fishers and consumers in regional communities on Queensland’s east coast*” is being led by CSIRO’s Dr Sean Pascoe. Both projects aim to meet industry research priorities, and are highly collaborative, including other researchers from JCU and the CSIRO, managers from the Department of Agriculture, Fisheries and Forestry (DAFF), and representatives from the Queensland Seafood Industry Association (QSI).

Over the next couple of months, researchers from JCU will be talking to fishers from all fishery and business types on Queensland’s east coast to get a better understanding of how fishers cope with different types of change, what steps they have taken to adapt in the past, whether these steps have been successful, and what ‘got in the way’ of them taking steps they would have liked to take. We’re also asking fishers about what money they spend in their community, to get a better idea of the value of commercial fisheries to regional areas. We also want to explore the best way to communicate this information back to you.

Why should you participate?

Change is inevitable, apparently increasing, and can build up. Change can negatively impact fishing operations, or provide opportunities for growth. Previous surveys and events have highlighted that individual fishers have varying abilities to cope with, or to adapt to change. This relates to an individual’s personal ability, but also to how individuals operate within and structure their business. There are complex drivers and constraints affecting fishers’ ability to adapt to change.

By talking to fishers and/or licence holders like yourself, we hope to increase the understanding of how different types of fishing operations respond to changes – what is successful, what is not, and importantly, what are the barriers to adaptation options. This will hopefully help guide successful adaptation and improve viability industry-wide. This project hopes to be able to provide fishers with a ‘toolkit’ of options for different business types, and to address some of the common obstacles / barriers.

In terms of value, we know that the Gross Value of Production (GVP) is a poor measure of the true value of commercial fishing to local communities. So we are trying to develop methods to better estimate the value to regional areas, particularly where there is high demand for local seafood. By asking you how much of your fishing income you spend in the local region, we can start to get a better picture of the contribution of fisheries to communities.

Further, by combining the data collection for 2 projects into 1 survey, we hope to relieve the time burden on participating fishers, and really make it worth your while.

What information are we collecting?

We'll be asking basic questions about your fishing business – i.e. how you operate, how long you've been involved, how much of your income comes from the fishing industry, information about revenue, investment and costs, and where you spend your income. We'll also be asking about what you think the biggest changes have been in the industry that have affected you, and what (if any) changes you made to your business in response. Importantly, we also want to know what (if anything) got in the way of you making the changes you wanted to make.

What will we do with the information?

Your name will not be written on the survey – all data will be treated confidentially and results grouped so that individuals cannot be recognised. The Centre for Sustainable Tropical Fisheries and Aquaculture (previously the Fishing and Fisheries Research Centre) has a long history of collecting sensitive commercial fishing data, and has upheld a good reputation with fishers throughout Queensland. The information will be summarised and presented to relevant Queensland fishery stakeholders – i.e. commercial fishers and managers – with the hope of improving adaptation across the industry, and working to remove key obstacles / barriers.

How long are the surveys?

Each survey will take about 30 minutes, depending on the length of your answers. We can make an appointment at a time that suits you. We would prefer to do these surveys face-to-face, but if we're unable to catch you when we're near you, we will aim to do the survey over the phone.

What do you need to do?

As you can understand, it is difficult to come by phone numbers for commercial fishers. So, if we have not called you soon, PLEASE give us a call so that you can be included! Bernadette will be running the surveys – her office number is **07 4781 5251**, or send her an email at bernadette.nicotra@jcu.edu.au so we can arrange a time and place to meet.

I am hoping you will be keen to take part in this research by telling us about your experiences and how you contribute to your community. This is a good step forward in working to ensure fishers have the tools to adapt to change, we all have a better understanding of the value of commercial fisheries, and that fishers are better considered in future management changes.

Yours sincerely,



Renae Tobin

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Appendix F: Detailed economic data tables

Table 28. Numbers of operators and investors by business type, numbers in parenthesis denote those ultimately included in the economic figures reported.

Label	Name	Operators	Investors
A	Roaming trawlers	12 (10)	–
B	Homing trawlers	22 (17)	1
C	Big reef-liners	14 (11)	3
D	Small reef-liners	18 (14)	6
E	Roaming specialists	22 (13)	–
F	Homing specialists	8 (7)	–
G	Homing quota generalists	26 (19)	2
H	Homing non-quota generalists	19 (14)	–
J	Roaming generalists	10 (8)	3
K	Non-quota specialists	35 (24)	3
L	Sleepers	2 (–)	–
		188 (137)	18

Table 29. Proportional contribution of fishing business income to both household and individual income; number of observations (n), mean, standard deviation (sd), standard error (se).

% INCOME FROM FISHING INDUSTRY		Typology									
		A	B	C	D	E	F	G	H	J	K
OPERATORS											
Household income	(n)	10	17	9	14	13	7	18	14	8	21
	Mean	97.00	89.12	88.33	35.07	76.15	60.71	69.44	78.57	83.69	65.00
	sd	6.75	19.22	19.36	32.32	32.73	31.94	33.38	29.77	31.56	40.84
	se	2.13	4.66	6.45	8.64	9.08	12.07	7.87	7.96	11.16	8.91
Individual income	(n)	10	17	9	14	13	7	19	14	8	22
	mean	99.00	94.12	98.89	46.14	85.38	72.86	84.47	87.50	88.69	71.82
	sd	3.16	18.81	3.33	39.73	30.72	21.19	30.91	30.81	31.80	39.27
	se	1.00	4.56	1.11	10.62	8.52	8.01	7.09	8.23	11.24	8.37
INVESTORS											
Household income	(n)	0	1	3	6	0	0	2	0	3	3
	Mean	-	50.00	53.33	12.83	-	-	0.50	-	34.00	8.33
	sd	-	-	50.33	19.70	-	-	0.71	-	57.17	2.89
	se	-	-	29.06	8.04	-	-	0.50	-	33.01	1.67
Individual income	(n)	0	1	3	6	0	0	2	0	3	3
	Mean	-	50.00	66.67	13.67	-	-	48.00	-	36.50	8.33
	sd	-	-	57.74	19.15	-	-	66.47	-	55.06	2.89
	se	-	-	33.33	7.82	-	-	47.00	-	31.79	1.67

Table 30. Volume and value of capital assets by business type; number of observations (n), mean, standard deviation (sd), standard error (se).

CAPITAL ASSETS		Typology									
		A	B	C	D	E	F	G	H	J	K
Number of vessels	(n)	10	17	10	14	13	7	19	14	8	22
	mean	1.30	1.35	1.20	1.07	1.15	1.00	1.16	1.14	1.13	1.09
	sd	0.95	0.61	0.42	0.27	0.38	0.00	0.37	0.53	0.35	0.43
	se	0.30	0.15	0.13	0.07	0.10	0.00	0.09	0.14	0.13	0.09
Vessel age (yrs)	(n)	10	17	10	14	13	5	18	11	7	19
	mean	34.10	39.47	29.10	16.36	21.46	27.40	15.92	16.36	20.00	18.95
	sd	6.10	11.44	11.12	7.00	12.49	8.82	13.76	8.54	11.20	13.44
	se	1.93	2.77	3.52	1.87	3.47	3.94	3.24	2.57	4.23	3.08
Value of primary vessel/s	(n)	10	17	11	14	13	7	19	14	8	24
	mean	592,500	242,059	281,818	44,179	88,308	23,286	51,184	21,500	78,938	19,833
	sd	561,829	198,739	279,743	49,278	124,896	11,280	56,377	30,611	47,717	23,655
	se	177,666	48,201	84,346	13,170	34,640	4,263	12,934	8,181	16,870	4,828
No. dories	(n)	10	17	10	14	13	7	19	14	8	22
	mean	0	0	4.20	0.71	1.62	0.57	1.63	3.50	1.00	0.41
	sd	0	0	2.15	1.20	1.76	0.79	1.21	2.74	1.93	0.73
	se	0	0	0.68	0.32	0.49	0.30	0.28	0.73	0.68	0.16
Ave. dory value	(n)	0	1	4	3	5	2	11	3	1	6
	Mean	–	–	22,500	13,333	16,800	2,650	13,182	16,833	–	2,417
	sd	–	–	8,660	9,866	11,122	3,323	14,070	15,332	–	3,878
	se	–	–	4,330	5,696	4,974	2,350	4,242	8,852	–	1,583
Value of all dories	(n)	0	1	9	5	8	3	15	12	3	6
	mean	–	–	92,556	21,400	29,750	4,433	27,000	39,125	31,667	2,700
	sd	–	–	64,653	12,361	22,814	3,881	28,571	31,051	32,532	3,707
	se	–	–	21,551	5,528	8,066	2,241	7,377	8,964	18,782	1,513
Value of license/s	(n)	7	12	10	9	11	7	16	12	8	19
	mean	115,143	148,583	199,200	93,889	94,546	26,357	141,344	156,250	775,313	87,158
	sd	93,114	189,623	235,213	96,494	68,061	15,206	87,872	666,10	986,129	70,591
	se	35,194	54,739	74,381	32,165	20,521	5,747	219,68	19,229	348,649	16,195

Table 31. Operator business costs by business type; number of observations (n), mean, standard deviation (sd), standard error (se).

COSTS		Typology									
		A	B	C	D	E	F	G	H	J	K
TOTAL costs	(n)	10	17	11	14	13	7	19	14	8	24
	mean	670,800	416,108	728,227	57,575	169,441	26,246	65,251	186,079	490,542	34,932
	Sd	635,621	446,386	780,158	47,841	184,459	19,687	53,131	337,444	615,651	34,061
	se	201,001	108,265	235,227	12,786	51,160	7,441	12,189	90,186	217,665	6,953
Crew	(n)	9	14	8	5	7	1	12	8	4	12
	mean	130,833	74,918	308,750	3,200	13,143	0	1,667	16,803	142,993	0
	sd	182,053	104,630	235,944	7,155	15,497	0	4,438	19,965	198,437	0
	se	60,684	27,963	83,419	3,200	5,857	0	1,281	7,059	99,219	0
Skipper	(n)	7	7	2	5	5	0	11	6	2	12
	mean	45,429	16,657	0	0	0	0	0	0	0	0
	sd	61,316	23,992	0	0	0	0	0	0	0	0
	se	23,175	9,068	0	0	0	0	0	0	0	0
Land staff	(n)	6	7	3	6	5	1	11	7	3	12
	mean	33,667	0	311,667	16,667	6,000	0	0	21,135	32,660	0
	sd	82,466	0	509,812	40,825	13,416	0	0	52,498	15,051	0
	se	33,667	0	294,340	16,667	6,000	0	0	19,842	8,690	0
Fuel	(n)	8	15	8	10	8	3	15	12	7	14
	mean	258,006	118,400	147,500	12,150	30,813	12,700	17,407	18,857	38,299	10,900
	sd	203,873	96,217	135,093	11,078	32,291	15,001	14,061	14,144	36,956	10,559
	se	72,080	24,843	47,762	3,503	11,417	8,661	3,631	4,083	13,968	2,822
Other catching costs	(n)	7	9	7	8	7	3	12	11	7	15
	mean	32,824	14,667	60,071	8,366	15,929	1,533	14,453	11,357	29,046	7,659
	sd	29,307	14,133	43,744	10,007	17,899	1,050	22,871	10,129	20,232	13,119
	se	11,077	4,711	16,534	3,538	6,765	606	6,602	3,054	7,647	3,387
Licence lease	(n)	3	7	4	7	6	2	11	4	1	14
	mean	6,667	2,286	6,125	3,614	9,000	1,250	1,300	1,125	0	607

Quota lease	sd	5,774	6,047	7,075	3,573	11,675	1,768	2,514	2,250	0	1,689
	se	3,333	2,286	3,538	1,351	4,766	1,250	758	1,125	0	451
	(n)	3	6	4	4	3	1	10	4	1	12
	mean	2,933	0	10,500	5,125	10,000	0	157	625	0	0
	sd	3,495	0	7,506	6,713	17,321	0	472	1,250	0	0
Other operating costs	se	2,018	0	3,753	3,356	10,000	0	149	625	0	0
	(n)	8	13	7	9	6	3	14	11	5	13
	mean	92,285	21,484	40,214	15,925	13,063	7,840	8,276	18,498	31,150	8,902
	sd	109,116	14,816	32,540	20,210	9,100	7,701	6,135	17,627	29,118	10,020
Vessel repairs & maint.	se	38,578	4,109	12,299	6,737	3,715	4,446	1,640	5,315	13,022	2,779
	(n)	8	13	7	10	8	2	14	11	6	17
	mean	120,333	75,692	125,714	12,010	18,250	8,500	13,071	15,380	45,945	6,206
	sd	98,565	111,400	133,555	10,066	15,944	9,192	11,026	9,952	33,093	8,736
Loan payments	se	34,848	30,897	50,479	3,183	5,637	6,500	2,947	3,001	13,510	2,119
	(n)	10	12	10	8	13	6	14	11	7	14
	mean	55,096	33,950	7,450	5,950	21,554	0	9,161	19,324	3,086	3,971
	sd	87,840	29,700	11,744	11,080	49,198	0	18,675	40,691	6,712	13,857
	se	27,777	8,574	3,714	3,917	13,645	0	4,991	12,269	2,537	3,703

Table 32. Numbers of workers/crew employed by business type; number of observations (n), mean, standard deviation (sd), standard error (se).

EMPLOYMENT	Typology										
		A	B	C	D	E	F	G	H	J	K
Full-time non-family workers/crew (paid)	(n)	10	17	11	14	13	7	19	14	8	24
	mean	5.20	1.35	4.64	0.21	1.00	0.00	0.00	1.07	1.25	0.04
	sd	10.60	1.54	4.95	0.80	1.68	0.00	0.00	3.73	2.05	0.20
	se	3.35	0.37	1.49	0.21	0.47	0.00	0.00	1.00	0.73	0.04
Full-time family workers/crew (paid)	(n)	10	17	11	14	13	7	19	14	8	24
	mean	0.30	0.47	0.55	0.07	0.31	0.00	0.16	0.14	0	0
	sd	0.67	0.80	0.82	0.27	0.63	0.00	0.50	0.53	0	0
	se	0.21	0.19	0.25	0.07	0.17	0.00	0.12	0.14	0	0
Part-time non-family workers/crew (paid)	(n)	9	17	11	14	13	7	19	14	8	24
	mean	6.00	1.12	0.91	0.57	0.62	0.00	0.26	0.86	0.25	0.08
	Sd	14.73	1.93	1.51	1.02	1.04	0.00	0.73	2.21	0.46	0.41
	Se	4.91	0.47	0.46	0.27	0.29	0.00	0.17	0.59	0.16	0.08
Full-time family workers/crew (unpaid)	(n)	10	16	11	14	13	7	19	14	8	24
	mean	0.10	0.25	0.18	0.14	0.23	0.00	0.05	0.07	0.25	0
	sd	0.32	0.58	0.40	0.36	0.44	0.00	0.23	0.27	0.71	0
	se	0.10	0.14	0.12	0.10	0.12	0.00	0.05	0.07	0.25	0

Appendix G: Measures of profit

Full equity profit

Full equity profit provides a measure of business performance under the assumption that a business fully owns all of its capital inputs. It is calculated as total business revenue minus total business costs, less any interest payments and lease costs. This is an accounting (as opposed to economic) measure of profit, as it does not account for the opportunity cost of capital and labour, which has the potential to be applied in other fisheries sectors or elsewhere in the economy. Full equity profits were calculated for a total of 132 businesses and 17% of these (22) were estimated to not be covering their cash costs for the period surveyed (2013-14) (Figure 61a). This proportion of loss makers is comparable to, but slightly higher than, those observed in similar assessments of other fisheries (e.g. 15% in Whitmarsh et al., (2002) and 11% in Pascoe et al., (1996)). It is also slightly worse than the 15% reported by the Reserve Bank of Australia (RBA) for Australian small businesses as a whole in the year 2009/10 (Connolly et al. 2012). Failure to cover cash costs generally indicates that a business is performing poorly and is likely to be unviable if the situation is representative of its true year-on-year performance.

When considered by business type, the majority of businesses in each group returned positive full-equity profits in the 2013/14 financial year (Figure 61b). However, the proportion of profitable businesses was lowest in Types A–D, and average levels of profit were negative for the *trawlers* (A and B) and *big reef-liners* (C) (Table 8). Whilst most types had positive average profits, only the *roaming specialists* (E) and *homing specialists* (F) were totally devoid of loss-making businesses in the year for which data was collected (Figure 61b).

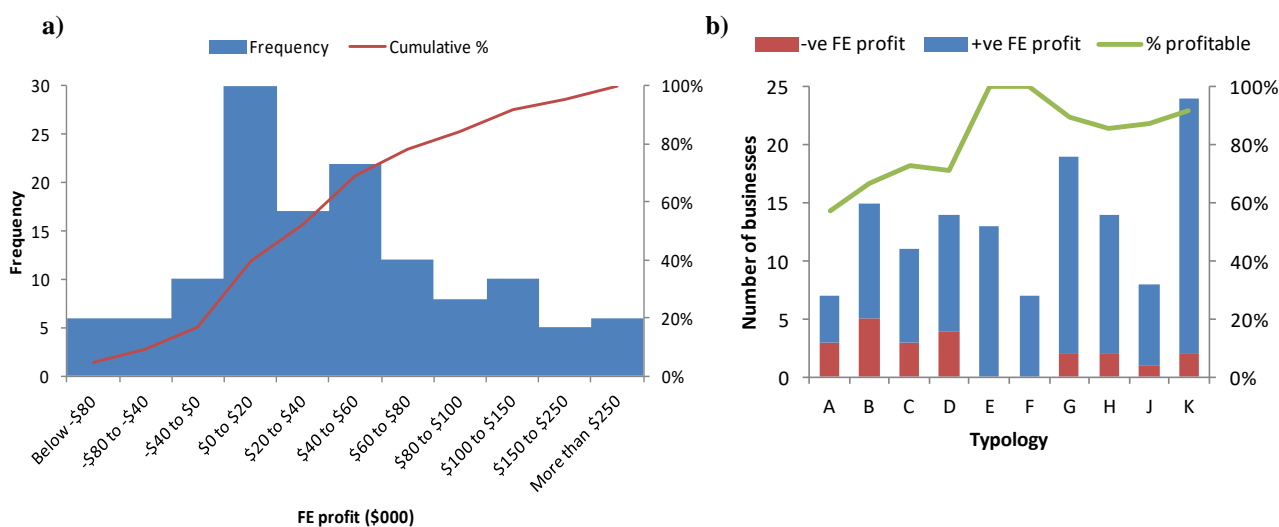


Figure 61. a) Distribution of full equity profits for all 132 businesses. b) Number of surveyed businesses calculated as making either positive or negative full equity profits by business type.

Economic profit

Economic profits were estimated at the business level by assuming a 5% opportunity cost of capital. This is an industry-accepted rate, previously applied to account for opportunity cost in fisheries such as the northern prawn fishery (e.g. Punt et al. 2010). When economic profitability is considered, even fewer businesses were seen to be making positive returns, with 22% of the respondents making negative levels of economic profit (Table 8). This suggests that just over one fifth of the businesses surveyed could potentially be earning higher returns on their investment if they were applied elsewhere in the economy. At the typology level it is still only types A, B and C that are seen to have negative average returns when economic profits are assessed. Economic profitability is typically considered to be an indicator of longer-run trends in an industry, with negative economic profitability implying that capital will flow out of the industry over time. Despite this, commercial fisheries have often been observed to go against these expectations, with capital remaining in the industry for far longer than would be considered economically rational. A number of potential reasons have been put forward to explain this, such as a failure to account for unpriced benefits of remaining in the industry (e.g. utility gained from the lifestyle). The non-malleability of fisheries capital assets is also known

to result in the potential for substantial lags in changes in investment, resulting in activity persisting in sectors for longer than might otherwise be expected (Clark et al. 1979).

Return on capital

Return on capital is the ratio of full equity profit to capital invested in the operation (in this instance vessels, licences, quota and symbols). This metric is commonly estimated for fisheries and is also used to infer how sectors (both within fishing and the broader economy as a whole) are likely to evolve into the future, with investment being assumed to gravitate to fleets or business models that generate the highest rates of return.

Mean rates of return for the business types assessed here range between -1% and 75% but are generally relatively high (Table 8). The *small reef-liners* (D), *homing specialists* (F), *homing non-quota generalists* (H) and *non-quota specialists* (K) have the highest average rates of return on capital (all >60%), however these types also typically have relatively high levels of variability around these measures (Figure 62). The business types with highest mean rates of return are also typically those with lower mean reported levels of capital investment in absolute terms, and it is possible that such high average rates of return are an indication that the full value of capital inputs of production were not completely captured in all cases. Whilst the reported results are broadly comparable with rates of return reported in studies of other multi-sector fisheries – e.g. 0%–40% for vessels (both UK and French) operating in the English Channel (Boncoeur et al. 2000) – these estimates did not factor in the value of quota or licenses. More comparably estimated rates of return on capital are those recently calculated for fisheries in South Australia (2012/13) which range between 0.4% and 11.4% (Econsearch 2014), indicating that the rates calculated for some of the business in this study are relatively high. So, whilst the observed results might be taken to imply that over time (and if licensing permits) capital investment might be expected to reduce in the business types with lower rates or return (e.g. A, B, C and J) and increase in those with higher rates (e.g. E, F, G, H and K), it is likely that this will not occur in practice.

An additional factor for consideration is that differences in the level of dependence upon unpaid labour between alternative groups has previously been cited as one reason for metrics such as rate of return on capital being unreliable indicators of how capital investment may change in fisheries (Boncoeur et al. 2000). This is because unpriced labour inputs inflate the rate of return for businesses that use relatively greater levels of unpaid labour and gives the appearance that they are performing better when compared to groups that are less reliant on unpaid labour. Businesses operating smaller vessels are more commonly reliant on unpaid labour (both crew and/or skipper). As a consequence this is potentially contributing to the observed differences in rates of return reported in this study (Figure 62). For example, types D, F, H and K do not report paying skippers and D has highest relative level of dependence on unpaid labour of any business type. As a consequence these measures might be better used as indicators of how specific business types perform over time, rather than for direct comparisons between alternative types at any given point in time.

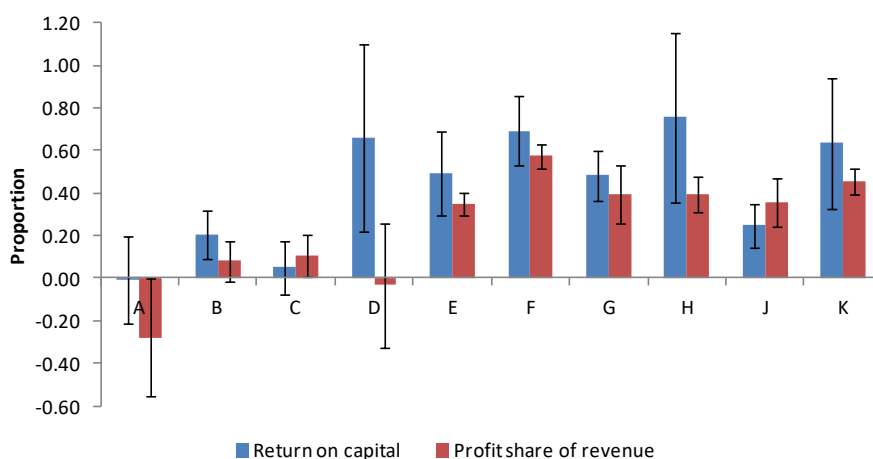


Figure 62. Mean return on capital and mean profit as a share of revenue (error bars denote associated standard errors) (operators only).

Profit as a share of revenue

Finally, profit as a share of revenue was also calculated. This is the net profit margin of a business (not accounting for taxes in this instance) and measures the amount of net income (i.e. profit) generated for every

dollar or revenue earned. It provides a measure of the proportion of revenue that remains after all other costs are accounted for and is a useful metric for determining how effectively a business turns sales into profit. Profit as a share of revenue is one way of assessing efficiency, with low profit margins suggesting that costs are excessively high within a business. Average profit ratios vary across sectors in the economy, so the survey results were compared with the latest (2012–13) ATO data on net profit ratios for the Australian fishing industry as a whole (industry group 0413). In general, the levels of profit as a share of revenue in survey data are slightly lower than those reported by the ATO, but slightly above when only the profitable businesses are considered (Table 33, Figure 62). This suggests that the loss-making businesses in the survey were making proportionally greater losses on average than reported at the national level in the previous year. The figures are all also broadly comparable to mean profit ratios previously reported in the fisheries literature (54.7% and 7.2%) (Whitmarsh et al. 2003). When all businesses are included, the survey data indicates that those with total revenues of between \$50,000 and \$500,000 had the highest net profit ratios. If only profitable businesses are considered, those with the lowest revenues have the highest net profit ratios (revenues of \$10,000 < \$50,000 and \$50,000 < \$100,000).

Table 33. Net profit ratios at the whole of survey level and net profit ratios for the whole Australian fishing industry as reported by the ATO.
Values in parenthesis indicate number of usable survey responses in each category.

Total revenue (\$000)	Net profit ratio			
	ATO (2012-13)		Survey (2013-14)	
	All	Profitable	All	Profitable
10<50	0.44	0.58	0.16 (28)	0.50 (23)
50<100	0.45	0.50	0.39 (24)	0.54 (20)
100<300	0.34	0.38	0.32 (48)	0.43 (42)
300<500	0.21	0.24	0.25 (12)	0.33 (10)
500<1,000	0.19	0.24	0.06 (9)	0.23 (7)
1,000<5,000	0.04	0.00	0.20 (9)	0.35 (7)

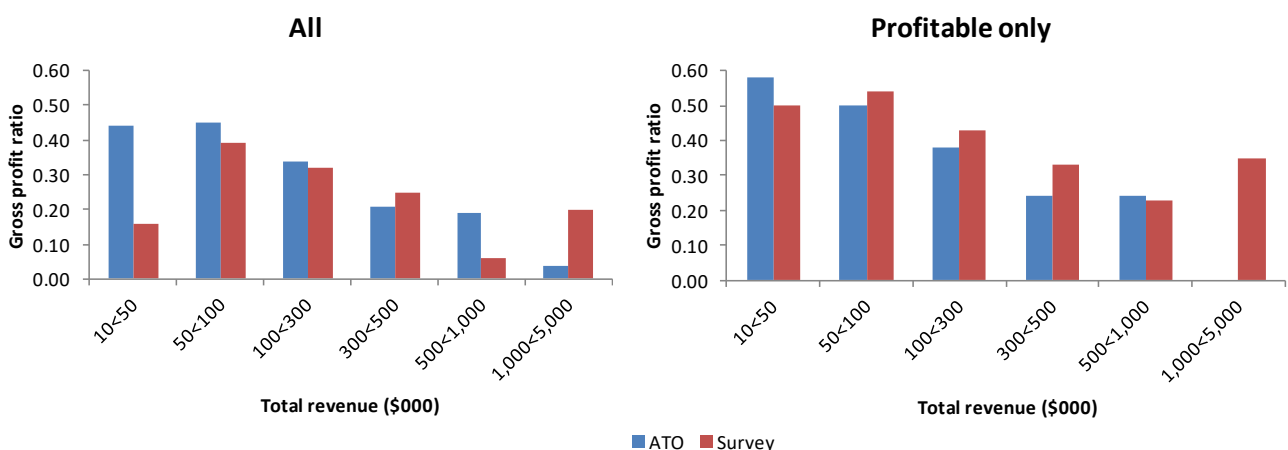


Figure 63. Levels of profit as a share of revenue: survey results (financial year 2013/14) compared to ATO national results for fishing (financial year 2012/13)

³ <https://www.ato.gov.au/About-ATO/Research-and-statistics/In-detail/Tax-statistics/Taxation-statistics-2012-13/?anchor=Industrybenchmarks1#Industrybenchmarks1>

Appendix H: References

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