TRANSFORMATION OF COASTAL COMMUNITIES: WHERE IS THE MARINE SECTOR HEADING?

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ABSTRACT Much has been said about migration to coastal areas and the consequent change in coastal community demographics. Even though coastal communities are changing they are often still colloquially referred to as 'fishing towns' which is the presumed dominant economic activity. However, the commercial fishing sector is contracting and communities are re-orienting to other marine sectors such as marine tourism and aquaculture, and some non-marine sectors often with a net loss of employment opportunities. Our aim is to examine the additional pressure of climate change on coastal communities typically referred to as 'fishing towns'. Climate change may prove to be the 'tipping point' for both the fishing fleet and coastal fishing towns. The purpose of this paper is not to examine the details of climate change -which have been documented elsewhere- but to identify the effects on fishing towns. Our approach is to consider a coastal community's vulnerability to climate change in the marine environment in the context of its size, demographics, and economic characteristics. Small coastal communities characterised by an older demographic, high unemployment, a declining commercial fishing fleet, high participation in the marine sector, and limited local sea-based or land-based employment opportunities are assumed to be especially vulnerable to the effects of climate change in the marine environment. Together with qualitative survey results from 66 community members in three typical coastal communities across Australia, we provide insight into trends and change in these coastal communities. Our results suggest that the effects of climate change such as declines in fish abundances and coastal inundations, are likely to affect small coastal communities that were previously 'fishing towns'. Moreover, transformations of structure and function of communities are likely to occur as the fishing component of communities' declines further. The future of coastal communities in Australia is likely to look very different.

KEY WORDS: fishing communities, demographic change, marine climate change, marine sector

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1. INTRODUCTION

Many Australian coastal towns are colloquially known as 'fishing towns'. These towns are generally located close to accessible fishing grounds. People who live in fishing towns often depend on fishing for a living, either directly as fishers or indirectly as suppliers of fuel, mechanical services, and victuals. Fishing towns can be in remote and isolated locations but also near larger urban centres. Both in the past and now, fishing towns conjure a romantic picture of idyllic harbours with working fishing vessels at rest at their moorings. This attracts tourists looking for an authentic seaside holiday, although this tendency is probably stronger in Europe and other parts of the world with long traditions of fishing activity (Borsay and Walton, 2011). Freshly caught fish has often been available directly "off the boat" or in local fish shops or restaurants. People who live in these coastal fishing towns often identify with the specific location (Marshall, 2001) and also with fishing (Minnegal *et al*., 2003), and will refer to the place they live and work as a 'fishing community'.

While the picture of a fishing town and community sketched above may have been accurate in the past, traditional fishing towns around Australia are undergoing a process of restructuring in response to complex social, economic and political changes. Similar to many coastal communities around the globe, fishing towns no longer have an economy that is largely dependent on harvesting and trading seafood (Ommer, 2007). Some of the restructuring is driven by fisheries governance and management requirements and changes in the productivity of marine ecosystems, but changing demographics, economic focus, urbanisation and human values (especially the 'sea change' phenomenon) also play a role. Over time, fishing towns have outgrown their commercial fishing focus and the future existence of 'fishing towns', especially in countries such as Australia, is uncertain. This uncertainty is potentially increased by the additional effect of climate change related impact on the marine environment.

In the context of climate change, there is a growing theoretical and empirical literature on community vulnerability and adaptive capacity (Adger *et al*., 2012) and the related concept of resilience (Adger, 2000; Davidson *et al*., 2013). The main focus of climate change related studies in coastal areas of Australia has been on the effects of sea level rise (Abel *et al*. 2011; Cooper and Lemckert, 2012). However, there are few studies that investigate the combined effect of demographic and economic changes in fishing communities in Australia (Groenewold, 1994; Tietze

et al., 2000) and the potential effect of climate driven changes in the marine environment.

Despite the lack of integrated research in Australia, there is anecdotal evidence suggesting that there are few coastal fishing towns where commercial fishing now constitutes the main economic activity. In Australia, the number of participants in commercial fishing has declined as a result of, amongst other things, technology improvement, management restructuring, and general corporatisation of the sector. Although technology changes may have already been happening before a management transition from largely input to output controlled fisheries, the trend towards fewer and generally larger size vessels continues. The owners of these larger vessels may be driven by different incentives and not necessarily tied to specific coastal locations (Costello and Deacon, 2007; Hamon *et al*., 2009; van Putten *et al*., 2011). Individual Transferable Quota (ITQ) systems have been criticised for leading to concentrated ownership and an erosion of critical mass in fishing communities (Arnason, 2005).

Not only has the structure of the fishing sector been impacted by changes in management but stock declines *per se*, often attributed to past overfishing (Jackson *et al*., 2001), are also having an impact. It is increasingly recognised that stock abundance is also vulnerable to the effects of climate change (Hobday *et al*., 2008; Poloczanska *et al*., 2007; Pecl *et al*., 2009). Even though there are significant uncertainties associated with predicting future timing, location, and magnitude of climate change (Hobday and Poloczansk, 2010), biological impacts are likely to include changes in marine species abundance (Simpson *et al*., 2011), distribution (Perry *et al*., 2005; Nye *et al*., 2009; Last *et al*., 2011), physiology (Somero, 2010; Neuheimer *et al*., 2011) and phenology (Dufour *et al*., 2010). These changes are likely to affect fisheries catches and profitability (Grafton, 2010) putting further pressure on the viability of the fishing sector and associated fishing communities. Both the degree of community dependency on the fishing industry and the adaptive capacity of fishers and communities will determine the longer-term future of 'fishing towns' under changing conditions, that is, their ability to be resilient (Berkes and Jolly, 2001).

The fall in the size of the fleet, attributable to, amongst other things, technology changes and past and current management, climate change, and other 'natural' factors, and the consequent decline in the economic contribution of fisheries to some local economies, has meant many fishing towns are refocussing their economic direction and activities (Pita

et al., 2010). Refocussing economic activities has in some cases been 'directed' through formal institutions while in other fishing towns this has happened in a more 'accidental' way. Some communities have refocussed on marine sectors like aquaculture or marine tourism while others refocused on non-marine industries, for instance, mining.

In this paper we attempt to fill the current gap in empirical knowledge and describe the changing economic activity in the marine sectors with a focus on the role of commercial fishing in coastal communities. In this study we are also interested in the changing economic activity in fishing and other marine sectors in the face of both predicted and existing climate driven changes occurring in the marine environment. In our study we collect case study data from three Australian states: Tasmania, Western Australia and Queensland. Fisheries in these three states make up 57 percent of the total gross value of production for Australia (Australian Bureau of Agricultural and Resource Economics and Sciences, 2013).

Fishing Communities

Australia's fishing zone is the world's third largest. Australian waters contain about 3 000 known species of fish and at least an equal number of crustaceans and molluscs (Australian Bureau of Statistics, 2012). The Australian fishing industry (commercial fishing and aquaculture) is valued at over A$2.3 billion, making fisheries products the sixth most valuable Australian rural commodity (Australian Bureau of Agricultural and Resource Economics and Sciences, 2013).

Between 2009 and 2010 the value of production for the wild fishery sector in Australia decreased by 3 percent and a further 1 percent to $1.3 billion in 2012. This contraction, however, was not experienced equally by all States particularly if considering the growth in aquaculture production. Tasmania's share in gross value of production has increased from 13 to 29 percent between 2002 and 2012, whereas Western Australia's has dropped from 25 to 16 percent over that same period. In Queensland the gross value of production has only dropped slightly from 13 percent in 2002 to 12 percent in 2012 (Australian Bureau of Agricultural and Resource Economics and Sciences, 2013).

The volume of wild catch production also decreased by 1 percent between 2009 and 2010 and a further 4 percent to 157 505 tonnes in 2012 (Australian Bureau of Agricultural and Resource Economics and Sciences, 2013). The decline in Australia-wide catches is mirrored by a decline in the number of licences, licence holders, shareholdings, and permits held. For the majority of the 17 Commonwealth fisheries for

which official information is available, the number of active vessels declined (Australian Bureau of Agricultural and Resource Economics and Sciences, 2011).

The change in commercial fishing activity has occurred in conjunction with demographic and migration changes that affected some coastal communities. The sea-change phenomenon is the term used to describe migration away from urban centres to coastal towns (Hilpern, 2004; Burnley and Murphy, 2002; Gurran *et al*., 2005). A sea-change community is an Australian term for smaller size coastal locations that provide an alternative lifestyle to the urban centres that people migrate away from. Sea-change community residents can be loosely grouped as retirees, alternative life stylers, forced re-locators (low income groups), and the so-called 'periodics' (shack owners or regular renters) (Gurran *et al*., 2005). Some booming sea-change coastal regions are characterised by high losses of youth – the 'flight to the bright city lights' (Argent, 2008) - accentuating the impact of retirees and the ageing of the population. Population growth rates of coastal areas started to accelerate in the 1970s, grew strongly in the first half of the 1990s but dropped between 1996 and 2001 (Burnley and Murphy, 2002; Gurran and Blakely, 2007). However, due to increasing house prices in capital cities and the 'baby boomer' (post-war) generation reaching retirement age the population of coastal cities grew at about 6 percent per annum between 2001 and 2006 (Garnett, 2007).

Some coastal communities are thus experiencing concurrent changes including a decline in the role of commercial fishing and the relocation of sea-changers from urban to coastal areas. These changes raise the question of how these coastal communities will survive. The decline in the role of commercial fishing has required coastal communities to refocus their economic activities. Coastal communities, particularly those further away from major urban centres, have increasingly targeted the tourist and leisure markets rather than commercial fishing income. Some communities have maintained their focus on the marine sector and reoriented to recreational fishing as well as charter fishing and marine tourism (e.g. diving and whale watching). However, income generated by marine tourism is usually seasonal and highly impacted by external factors such as the exchange rate of the Australian dollar (Coakes *et al*., 2001).

While some communities have turned to marine tourism, other coastal towns have focussed on other marine sectors, especially aquaculture. For instance, in Tasmania the aquaculture sector has expanded rapidly since

the 1990s to become one of Tasmania's major industries. Secondary industries have grown up around Tasmania's aquaculture sector, creating additional economic and employment opportunities (Department of Primary Industries, Parks, Water and Environment 2013). The aquaculture sector often offers significant part-time and full-time employment opportunities located in, or just outside, small coastal towns. Although employment is generated by aquaculture activities, the image of some aquaculture activities suffer due to environmental issues (Crawford *et al*., 2003) and the impact of its infrastructure on the aesthetic nature of coastal areas.

Coastal communities are not only experiencing changes in their fisheries activities and some refocussing on different marine sectors, but some communities are also already responding to changes in the marine environment that can be attributed to climate change (Poloczanska *et al*., 2013; Poloczanska *et al*., 2007; Cai *et al*., 2005). For instance, the southward penetration of the East Australian Current (EAC) leading to warmer waters off the north east Tasmanian coast are driving some shifts in the range of commercial species that occur in the area and an increased occurrence of some pest species (Ling *et al*., 2009b). Predictions of further climate driven marine changes are expected (Grafton, 2010) which will require ongoing adaptation.

Aside from communities dealing with a changing marine environment and intra-marine sectoral focus, livelihood diversification has in some cases led to the complete inter-sectorial reallocation of labour. In the past decade this reallocation has generally been to the mining industry. The economic benefits for coastal communities located close to onshore or offshore mining activities can be considerable both from direct employment and through the establishment of support services for the industry. Some fishers may be able to gain sea-going work on supply boats or more likely work on a ’fly-in, fly-out‘ (FIFO) basis on oil and gas rigs or at remote mine sites. In order to service the mining industry, both governments and private companies frequently increase investment in port and other transport infrastructure which can benefit fishers and other marine users - an example of what economists call positive externalities.

In summary, economic activities in coastal communities have refocussed away from fishing towards alternative activities like aquaculture, tourism and mining. The refocus is not ubiquitous for all coastal communities and in this study we will provide insight into location differences and put this in the context of marine climate change.

2. METHODS

Coastal Case Study Towns

The three coastal case study communities used in this research are: St Helens in Tasmania (around 2 000 residents), Bowen in Queensland (around 10 000 residents), and Geraldton in Western Australia (around 30 000 residents) (Figure 1). These coastal communities were selected on the basis of three criteria: a relatively large past and present contribution of the commercial fishing sector; the presence of multiple marine sectors (e.g. commercial fishing, marine tourism, aquaculture, charter, and recreational fishing); and current and future potential marine climate change impacts. The general Australia-wide trend of a decline in commercial fisheries also applies in all three coastal case study communities.

Rock lobster fishing remains a large component of the shrinking commercial fishing sector in both Geraldton and St. Helens. In Tasmania, the value of rock lobster production was worth over $63m in 2011-12. The other important fishery in St Helens is abalone with a gross value of $84m in 2011-12. Just under half of the value of Australian rock lobsters was from Western Australia in 2011-12 ($177 million) (Australian Bureau of Agricultural and Resource Economics and Sciences 2013). Geraldton has traditionally been the hub of the Western rock lobster fishery. The Houtman-Abrolhos Islands, approximately 60km offshore from Geraldton, are where most rock lobster is caught. Bowen's close proximity to the Great Barrier Reef (GBR) contributes to development of the commercial coral trout and barramundi fisheries. The gross value of production of coral trout and barramundi was approximately $24m and $14m respectively in 2011-12 (Australian Bureau of Agricultural and Resource Economics and Sciences 2013). Almost all of the rock lobster and coral trout catch is exported live to China (Australian Bureau of Agricultural and Resource Economics and Sciences, 2013).

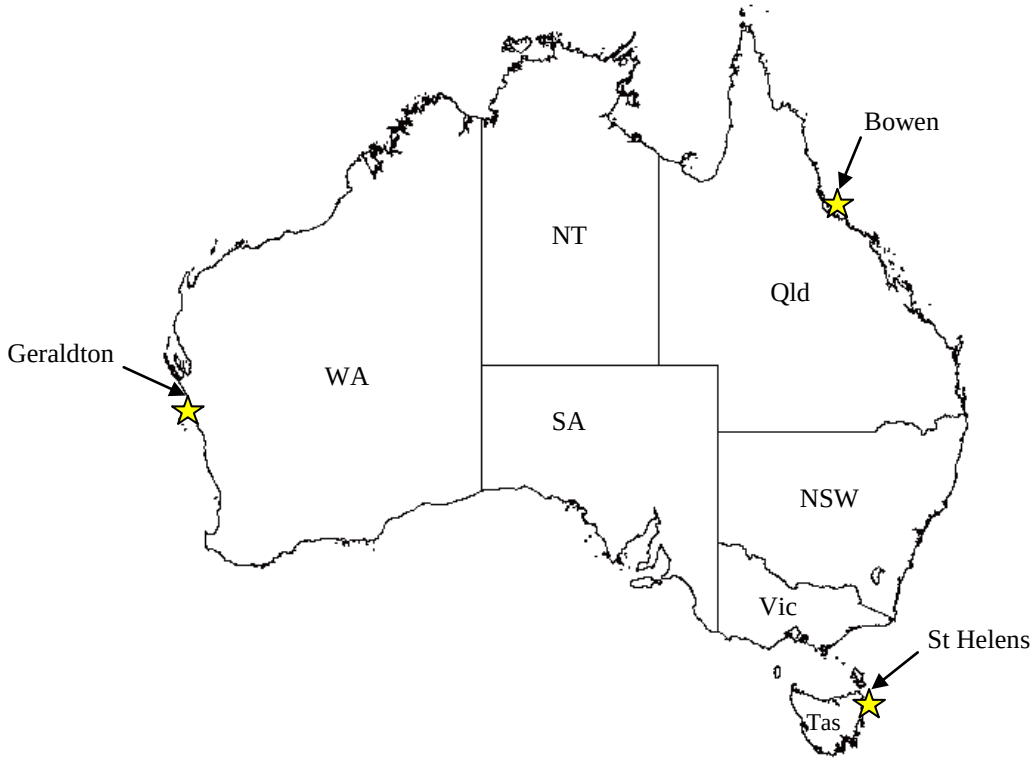

Figure 1. Coastal community case study locations in Tasmania, Queensland, and Western Australia. Source: the Authors.

Aquaculture activities took place in all three case studies. In St Helens, the rack based oyster aquaculture sector has grown over the past 15 to 20 years. Even though the sector is limited in water-based expansion opportunities, employment and economic returns from aquaculture activities are still rising. In Bowen, barramundi and prawns are farmed. In contrast to St Helens these aquaculture activities are mainly land-based. The Bowen aquaculture farms are also limited in opportunities for land-based farm expansion. Geraldton has a pearl aquaculture industry and it is unclear if there will be further planning approvals. There is small scale experimental fin fish farming within Geraldton harbour and additional water-based sites are currently being investigated by the Western Australian Department of Fisheries.

Tourism is important in Bowen and St. Helens and supports the local economy through retail sales, accommodation, and tourism related

employment. The St. Helens population increases between four- and tenfold in the summer months with an influx of temporary residents (holiday home or 'shack' owners) and tourists. Bowen also seasonally increases in size due to visiting tourists but less so from 'shack owners'. Even though there is a peak tourist season, a large component of tourists in Bowen are retired people often referred to as 'grey nomads' who tend to stay longer and whose travel is not restricted to official holiday periods. The nearby GBR is important in sustaining a tourism sector in Bowen. Even though Geraldton is also a tourist destination, particularly at the time of the wildflower blooms in spring, tourism does not have the same central economic role. Many tourists often pass through Geraldton on their way north or south. Geraldton, however, is one of Australia's fifteen most rapidly growing coastal cities, most of which are in Queensland and Western Australia, where arguably government services and infrastructure have lagged population growth (Daley and Lancy, 2011). On the other hand, Geraldton's size and diverse industrial structure probably promotes self-sustainability and social resilience (Beer *et al*., 2013), and gives it an edge over smaller and arguably more marginalised towns such as St Helens and Bowen.

Marine based tourism, for instance, charter fishing, has grown in St Helens over time. Large pelagic fish off the coast are highly valued by tourists (Mounster, 2012). Coakes *et al*. (2001) suggest that the fishing charter boat industry has been central to renewing economic confidence in St Helens. While the industry itself does not provide substantial direct employment opportunities, it does encourage the development of significant support business and employment opportunities. There is a recreational and charter fishing sector in both Bowen and Geraldton. However, neither location currently has a locally based, commercially viable charter operator, although in Bowen and Geraldton operators were active in the past. Only a small proportion of international visitors (4%) engage in recreational or charter boat fishing in Australia, and this sector is thus mostly driven by local and domestic visitors.

In 2011, around 3.4 million Australians participated in self-guided recreational fishing and the participation rate has increased over time (Recreational Fishing Advisory Committee, 2011). After the Northern Territory, participation rates in recreational fishing were the highest in Tasmania (29.3%), Western Australia (28.5%), and Queensland (24.7%). Lower participation rates are generally associated with the capital cities with high recreational fishing effort in coastal waters off coastal communities (Henry and Lyle, 2003).

Data Collection and Analysis

In this study, two sources of data were brought together. Firstly, a generic data profiling approach that sets up a community typology was developed using 2006 and 2011 Census data for three Australian States (Tasmania, Queensland, and Western Australia). Typologies are generally developed to give an overview of community make-up and can provide a basis for assessing and understanding potential changes (Fenton and Marshall, 2001). The characterisation is useful for the development of indicators that can ascribe sensitivity to change and how this sensitivity can be best managed (Fenton and Marshall, 2001). Even though no typology of Australian coastal communities exists, research has been undertaken that describes different types of coastal sea-change communities in regions around Australia (Gurran and Blakely, 2007).

This typological information was then combined with detailed information obtained by means of semi-structured interviews in a case study coastal town in Tasmania, Queensland and Western Australia. In-depth insight of climate and non-climate trends and developments were obtained from these interviews. This empirical evidence is crucial as adaptation is highly context-specific (Risbey *et al*., 1999; Wolf, 2011).

Census Data Typology

Data was gathered from the 2006 and 2011 censuses for all coastal communities of up to 30 000 people. As the definitional distinction between urban and regional communities is unclear (population thresholds vary between 10 000 and 50 000) a cut off of 30 000 was used as a guide. The census data does not provide individual towns as units and the unit that most closely resembled ‘towns’ was the postal codes (POA).

The census POA data was filtered by adjacency to the ocean. The first level descriptors for the community typology were: coastal; rural; and urban. Coastal islands were also identified but due to their heterogeneous nature were not further analysed. Any POA with more than 30 000 residents was described as urban. Any POA not adjacent to the coast and less than 30 000 was defined as rural. The second level descriptor for non urban areas was population size. The number of residents in the different coastal communities fell into three groups: less than 5 000 (small), between 5 000 and 15 000 (medium), and between 15 000 and 30 000 (large). The third level descriptor is distance from urban centres which was either more or less than 1.5 hours driving distance. Coastal

communities of less than 30 000 that were *more than* 1.5 hours drive from an urban centre could be either a small, medium, or large, coastal community. Any coastal community that had both less than 30 000 residents and was *less than* 1.5 hours driving from an urban centre was labelled a 'coastal commuter'. The typology of coastal communities developed here was partly based on Gurran *et al*. (2005) and Gurran and Blakely (2007).

Demographic data (e.g. age, dwellings, family, and educational attainment) and industry sectors (focussing particularly on the marine sector) were analysed for the different coastal community types (Australian Bureau of Statistics 2004a; 2004b; 2007). Each of the case study locations was categorised as either a small (St. Helens), medium (Bowen) or large (Geraldton) coastal community.

Case Study Survey Information

Gathering knowledge of marine user groups is integral to understanding marine sectoral development and adaptation (Goodwin, 2001). As such a semi-structured interview approach was used to evaluate observations as well as existing adaptations occurring within the specific social setting of the coastal town. In addition, detailed knowledge of social, economic, and governance changes affecting marine sectors and the broader coastal community was obtained.

Data was collected between February and September of 2012. Industry informants were interviewed, which in this context included people who are networked and have privileged access to information about specific impacts, groups of persons or decision processes in the marine sector. For the semi-structured interview format it was considered appropriate to select experts as it was not feasible to survey large samples of the population (Ruhanen and Shakeela, 2012). Regional Oceanwatch extension staff, with existing contacts to the marine industries, were used to facilitate contact with key survey respondents. A small number of individuals were attracted through snowball sampling (Goodman, 1961) where a community survey respondent recommended another person of interest who was then approached.

The survey was pre-tested in the first interview location and minor changes were made to the survey questions. A media release, a radio interview and an information sheet were available approximately one week prior to the survey to communicate the aim and focus of the study and garner interest in the community. In total 83 semi-structured

interviews held in the participant's location of choice (35 in St Helens, 23 in Bowen and 25 in Geraldton) were carried out. The majority of industry informants had connections to the marine industry and included individuals employed in fishing (around 50% of the interviews), aquaculture, charter fishing or dive sectors. The indirect impacts of change in the marine environment and the flow-on effects on the community were assessed through interviews with a broader range of individuals including those working in restaurants, newsagencies, accommodation and general retail.

The interviews were between 1 and 1.5 hours, as dictated by the participant, and were taped with the permission of each individual (n=66). The semi-structured survey questions were centred on understanding observed changes in local and marine industries and the marine environment; impacts and opportunities from these changes; perceived flow-on effect of changes throughout the wider community; and expectations of future adaptations. The authors interpreted over 80 hours of interviews and the distillation of the most important drivers of change is presented in the next section. The interview notes and recordings were analysed (but not transcribed due to funding limitations) to determine the main climate and non-climate drivers of change. The drivers of marine sectoral activities were modelled (see Metcalf *et al*. 2014; van Putten *et al*. in press) and where possible preliminary observations were verified with survey participants in the relevant communities.

3. RESULTS

Census data typology

In 2011, a total of 7.02 million people were resident in Tasmania, Queensland, and Western Australia (Table 1). From 2006 to 2011, the population in these states grew by 10 percent, but the most rapid growth was in Queensland.

Table 1. Number of residents in Tasmania, Queensland and Western Australia living in urban, rural, and coastal communities characterised by the number of residents and distance from urban centre.

Community name	Number of residents	Driving dist. from urban centre (hours)	Comm. type	TAS residents	% of total	QLD residents	% of total	WA residents	% of total
Coastal community	< 5K	> 1 ½	Small coastal comm.	45 967	9%	66 345	2%	54 902	2%
	5 to 15K	> 1 ½	Medium coastal comm.	58 961	12%	137 434	3%	80 268	4%
	15 to 30K	> 1 ½	Large coastal comm.	43 904	9%	135 373	3%	57 537	3%
Coastal *commuter* communities	< 30K	< 1 ½	Coastal *commuter* comm.	22 004	4%	525 460	12%	361 053	16%
Rural community *	< 5K	n/a	Small rural comm.	53 759	11%	270 462	6%	182 814	8%
	5 to 15K	n/a	Medium rural comm.	16 537	3%	697 187	16%	409 663	18%
	15 to 30K	n/a	Large rural comm.	16 809	3%	906 518	21%	456 588	20%
Urban centre	> 30K	n/a	Urban centre	233 874	47%	1 552 263	36%	627 115	28%
Coastal island**	< 30K			2 333	0%	6 343	0%	113	0%

* Any geographic area that is not directly adjacent to the ocean and is not an urban centre is labelled rural.
** Coastal islands are not further investigated due to the small number of observations in Western Australia.
Source: Census (2011)

In all three states the majority of people live in urban centres of over 30 000 residents. The percentage of each state's population living in coastal communities is highest in Tasmania (31%) and lower in Queensland (8%) and Western Australia (9%) although the absolute number of people varies between States. In both Queensland and Western Australia a greater proportion of people live in coastal commuting communities and rural communities than in Tasmania (Table 1).

Coastal communities differ markedly from urban areas and rural communities in a range of social, economic and demographic characteristics (summarised in Table 2). Small coastal communities are generally at the extreme end of this difference and the characteristics of coastal *commuting* communities are generally the opposite of coastal communities.

Table 2. Characteristics of coastal communities, in Tasmania, Queensland and Western Australia compared to state averages.

Characteristics of coastal communities of less than 30 000 residents and more than 1.5 hours drive from urban centres in Tasmania, Queensland, and Western Australia compared to state averages
Higher age dependency ratio
Higher proportion of population on low average household incomes
Lower average mortgages
Lower workforce participation rate
Higher unemployment rate
Lower number of new jobs created
Higher proportion of people employed in 'agriculture, forestry and fishing'
Higher proportion of people employed in 'accommodation and food services'
Higher proportion of people in 'aquaculture and fisheries'

Source: The authors based on Census 2011

Compared to the State averages, coastal communities are characterised by older populations, with an old age dependency ratio (which is the population aged 65 years and over relative to those of working age between 15 and 64 years) of 28 percent, 22 percent, and 22 percent for Tasmania, Queensland, and Western Australia respectively in 2011. The 'sea change' phenomenon of older Australians moving to small coastal towns to enjoy the lifestyle is consistent with ageing coastal communities, characterised by more families with no dependent children. In contrast, in

coastal *commuting* communities the opposite is true, with relatively more people in the 30 to 49 year age bracket and young(er) families who moved away from urban areas to take advantage of lower house prices and escape 'urban living'.

Coastal communities have below State average incomes with relatively more residents with lower incomes (less than $400 per week) and fewer with higher incomes (more than $2 000 per week). Not surprisingly, in coastal communities people tend to have lower mortgages than elsewhere. In contrast, in coastal *commuting* communities the proportion of people with higher average incomes is greater and average mortgages are correspondingly higher.

Correlated to the demographics of coastal communities, is the lower number of people in the workforce in coastal communities. In 2011 employment participation was lower than the State average for coastal communities and higher for coastal *commuter* communities. Over 325 000 jobs were created in the three States between 2006 and 2011 but only 7.9 percent of these were in coastal communities (not including coastal *commuter* communities). Unemployment was estimated at 3.0 percent, 3.0 percent and 2.4 percent respectively in Tasmania, Queensland, and Western Australia in 2011, with higher unemployment rates in coastal communities.

In terms of employed people, over 10 percent of total employment in all three states was in the 'retail trade' and 'health care and social assistance' sectors. However, the largest employment sector was not necessarily the one that grew fastest. In fact, in Western Australia 'mining' and 'construction' grew fastest (54 085 jobs). In Queensland the 'healthcare and social assistance' and 'professional scientific and technical' sectors grew fastest (85 852 jobs). While in Tasmania 'healthcare and social assistance' and 'construction' were the fastest growing sectors (5 467 jobs).

In 2011 there were 10 318 people employed in 'agriculture, forestry and fishing' in Tasmania (4.9% of the working population), 54 788 (2.8%) in Queensland, and 26 263 (2.5%) in Western Australia (Table 3). Between 2006 and 2011 there was an overall fall in employment in the 'agriculture, forestry and fishing' sector. Economic sectors of regional coastal communities traditionally have high participation in primary industries (Miller *et al*., 2012). There were significantly more people employed in 'agriculture, forestry and fishing' as a proportion of people in coastal communities: 7.7 percent in Tasmania, 7.4 percent in Queensland and 7.9 percent in Western Australia. Moreover, when

looking only at small coastal communities, around 10.7 percent of people in Tasmania and 14.8 percent of people in Western Australia were employed in 'agriculture, forestry and fishing'.

Table 3. The contribution of 'Agriculture, Forestry and Fishing' and 'Accommodation and Food Services' to employment in coastal towns (<5 000), coastal communities (<30 000) and small rural communities (<5 000) in Tasmania, Queensland and Western Australia.

	Agriculture, Forestry and Fishing				**Accommodation and Food Services**			
Census 2011	All Coastal comm.*	*Small* Coastal comm.	*Small* Rural comm.	State average	All Coastal comm.	*Small* Coastal comm.	*Small* Rural comm.	State average
TAS	7.7%	10.7%	10.8%	4.9%	7.7%	10.0%	6.7%	7.4%
QLD	7.4%	7.6%	16.1%	2.8%	10.1%	11.6%	6.2%	7.1%
WA	7.9%	14.8%	15.0%	2.5%	7.3%	7.7%	5.0%	6.0%

* Coastal communities include any POA adjacent to the coast that has fewer than 30 000 and therefore includes coastal towns. Coastal islands are not included in coastal communities due to the small number of observations in Western Australia. Source: Census (2011).

Only a small proportion of total employment in 'agriculture, forestry and fishing' is actually in fishing and aquaculture. In Tasmania only 0.73 percent of employed people (1594) work in fishing and aquaculture (excluding services to this sector), 0.05 percent in Queensland (1046) and 0.08 percent in Western Australia (829). However, the number of people employed in aquaculture and fishing increased by 234 between 2006 and 2011 in Tasmania; 84 percent of the increase was in aquaculture. In contrast, the total number of people in aquaculture and fishing fell by 163 in Queensland and 349 in Western Australia over the same time period. The majority of these job losses were in fishing with fewer jobs lost in aquaculture in both states.

Not only do more people in coastal communities rely on these sectors but in turn the fishing and aquaculture sector rely on coastal communities to provide them with people who will work in this sector. In 2011 in Tasmania, 60 percent of employment in fishing and aquaculture was filled by people who live in coastal communities (Table 4). This proportion is lower for Queensland and Western Australia, with 32 percent and 46 percent respectively of sectoral employment sourcing people from coastal communities. With respect to aquaculture, only coastal towns in Tasmania are characterised by a high number of people in this sector. A high proportion of people in Queensland who work in

aquaculture and fishing are in urban areas (37%) which may be because aquaculture is largely a land based activity in this state.
The 'accommodation and food services' sector is often associated with the tourism industry. This sector also contributes to employment in coastal communities especially in Queensland.

Table 4. Location of residence (coastal communities, coastal commuters, rural and urban areas) as a proportion of people employed in fishing and aquaculture in 2011 for Tasmania, Queensland, and Western Australia.

Proportion of employment in fishing and aquaculture	**Coastal communities (2011)***	**Coastal commuters (2011)**	**Rural (2011)**	**Urban centres (2011)**
Tasmania	60.7%	9.0%	5.4%	21.7%
Queensland	31.9%	14.2%	16.9%	36.5%
Western Australia	45.6%	16.5%	14.1%	23.8%

* Coastal communities include any POA adjacent to the coast that has fewer than 30 000 residents (but excludes coastal communities that are within 1.5 hrs drive from an urban centre). Coastal islands are not included in coastal communities due to the small number of observations in Western Australia. Source: Census 2011

In all three states the largest occupation groups are 'professionals' or 'technicians and trades workers', making up around one third of the total employment occupations. In coastal towns 'technicians and trades workers' are also in the top two occupations for all states, but Tasmania is somewhat different in that the next largest occupation is 'labourer'. In both Western Australia and Queensland 'managers' make up the next largest occupation category. Interestingly, in all three states people in the fishing sector mostly identify themselves as labourers (over 50%), a reflection of the skills required for being a fisher. In aquaculture the largest group of people (around 40%) identified themselves as managers and one third or less as labourers. This illustrates the skill base difference between the two professions.

While the characteristics of coastal communities were consistent across the three States, there were some important differences on a range of relevant indicators (Table 5). For instance, even though coastal communities are characterised by lower than average incomes, the average incomes of coastal communities households are higher in Western Australia than in the other two states. The differences between

states are indicated by the highest, middle, and lowest value for a number of indicators.

Table 5. Main differences between Tasmania, Queensland and Western Australia for a range of indicators relevant to coastal communities.

Indicators	Highest	Middle	Lowest
Proportion of State population living in coastal communities of less than 30,000 residents	TAS	WA	QLD
Proportion of State population living in coastal commuting communities (<30 000 residents and within 1½ hour drive of urban area)	WA	QLD	TAS
Workforce participation	WA	QLD	TAS
Unemployment	TAS	QLD	WA
Average incomes	WA	QLD	TAS
People employed in 'agriculture, forestry and fishing'	TAS	QLD	WA
People employed in 'accommodation and food services'	QLD	TAS	WA
Proportion of people employed in 'aquaculture and fishing'	TAS	WA	QLD
Change in number of people in fishing between 2006-2011	increase in TAS	decrease in WA	decrease in QLD
Growth in the number of people in the aquaculture sector between 2006-2011	increase in TAS	decrease in WA	decrease in QLD

Source: Census 2011

Case study results

The decline in fisheries had been explicitly noticed in all three coastal case study locations mainly as a result of the reduced number of 'working vessels' present in the harbour. The commercial fishing fleet in St Helens was estimated to have fallen from around 35 vessels some 20 years ago to around 10 vessels in 2012. The size of the Geraldton rock lobster fleet has fallen from over 300 vessels to less than 200 between 2008 and 2012, a rapid decline reflecting a puerulus (rock lobster larvae) abundance crisis in the rock lobster fishery. The commercial fleet in Bowen has fallen from over 80 in the 1960's to just over 30 about a decade ago, with less than 10 active vessels currently remaining. Remarks about the level of fishing activity included:

> "If you went back 40 years you would have had 100 plus boats, 30 years back there would have been 40 boats, 20 years 30 boats, 10 years back – 20 boats, and now you're lucky if you get 10 boats" (fisher 570002).

> "15 years ago we had probably 15 local trawler operators now we've got one. There are not many fishermen left locally now" (Processor 570037).

> "When I first got in the water there weren't that many [abalone] divers I -was lucky I guess - but before that there were heaps" (abalone diver 750015).

A decline in active commercial fishing vessels in the Geraldton harbour has occurred in conjunction with a growing role of the mining (and oil and gas) industry. The Geraldton harbour is now mainly used for the export of raw materials from mining as well as agricultural produce. Bowen has become an important port for exporting coal to Asia and new port expansion developments are the subject of ongoing discussion. In the small port of St Helens some of the empty berths have been taken up by pleasure yachts but there is much excess capacity.

Although climate and non-climate drivers for the reduction in fishing activity in each location were different (see Metcalf *et al* in press), the main reasons for the decline were attributed to fisheries management changes, and past overfishing. Three stages of fishery contraction following a fisheries management change from input to output controls were identified. In the first stage (the short term) immediately after the introduction of output controls, fishing fleets restructure and rationalisation follows. In the second phase (about 5 to 10 years after the management change) additional fishers generally decide to exit the sector as a consequence of changing operating cost. Larger and more efficient vessels gradually dominate fleet structure. In the third phase (the longer term) quota ownership characteristics in the fishery change. Increasingly quota is owned by processors, investors, or large fishing operations. Moreover, quota becomes important for retirement for an ever increasing number of ageing fishers. In 2013 the Queensland coral trout fishery and Tasmania rock lobster fishery were in the middle and last stages respectively of post management change to output controls. Management change in the rock lobster fishing sector in Geraldton is relatively recent

and fleet restructuring is still in progress. Characteristic consequences of the three staged fisheries changes are an ageing workforce; limited new entry; and high operating cost (including the value of sale and lease quota). Some other factors mentioned by interviewees were:

> "Geeez there was a lot of them [small boats] when I started, [but now] small boats have sold out to the bigger ones" (fisher 570006).

> "Succession in the industry – every one of us would love to have the family participate in the industry. But unless you have a reasonable stake in the industry [you can't get in]. If you are new to the industry the costs to get in are enormous. Now the deckies can't get into the fishery the way [we] used to." (fisher 570056).

> "Yeah – I'll sell my quota this year and get out. Young people [won't replace me because] gotta get all these licences and investment when you can get same money [income] somewhere else" (fisher 570006).

Other minor factors that contributed to the decline in participation in fisheries included: onerous administrative requirements; the lack of stakeholders representativeness on management committees; the high dependence on single export markets; and limitations in buyer and processor choices.

Aside from change in participation in fisheries, co-occurring (and in some way correlated) changes in abundance of some key species were observed. These abundance changes were attributed to both climate and non-climate drivers. An example of the latter is related to the concentration of fishing effort due to marine protected areas (MPAs). Climate change impacts on abundance changes were also recognised. The effects of climate change on commercial, charter and recreational fisheries and aquaculture were apparent in all three coastal communities and were linked to sea surface temperature (SST) increases, current changes, and the increasing occurrence and strength of wind and cyclones.

> "Changes in the environment are massive. We first noticed the first urchin barrens 15-20 years ago. The difference [regeneration] on that bottom now [after harvesting started] is incredible. The temperatures here are insane it's so much warmer some of the [commercial fishing] industries are really going to struggle" (rec diver 570027).

Even though the specific climate change drivers (SST, currents, etc.) were sometimes acknowledged, the precise impacts were not so easily separated from the effects of non-climate changes discussed earlier, particularly with respect to the commercial fishing sector. In other words, the precise attribution of reduced abundance to either non-climate or climate drivers is problematic for survey respondents.

> "I know we've had an impact with fishing – we're catching less fish. More to do with habitat not being there – don't know about the climate."(fisher 75004).

Where the effects of climate change on commercial fisheries were recognised, they were mainly perceived as negative concerning the reduced abundance of commercially valuable species.

Survey respondents were generally pessimistic about the future of their fishery as most expected still further declines. For instance, fishers who sold out or retired from the sector were not expected to be replaced by a new generation of fishers based in the town. In Geraldton this issue was not raised, possibly due to the fact that the fishery is in an earlier stage of change. The reasons given for the expected lack of new entry into the industry included: opportunities for better paying employment elsewhere; the prohibitive expense of purchasing quota, and the risks associated with fishing relative to other occupations. However, after the completion of the surveys there was an influx of fishers as the quota lease price fell due to a decline in stocks (Emery *et al.*, 2014).

> "There are always jobs in the mines if fishing gets bad." (commercial diver750013).

> "There used to be about 20 families cray fishing – that's gone … scalloping – that's gone. Kids are now not going into fishing but are going into aquaculture [or the mines]." (recreational diver 7500027).

The available alternative employment opportunities for existing fishers were different in the three locations and this had a significant impact on community structure. In the small town of St Helens fishers generally had to move away from town to find work or become FIFO workers in the interstate oil and gas and mining industry. In Bowen local employment opportunities existed for ex-fishers in agriculture and the resource industries and associated rail and port developments. In Geraldton job opportunities for ex-fishers existed locally in the gas and oil industry and port development. In Geraldton ex-fishers could remain 'at sea' as they moved across to the gas and oil industry (often with their own 'refitted' vessels) and reputedly earned more than in the past. Moreover, some fishers keep their fishing entitlements (lease them out) and use their vessel in this alternative occupation.

The attractive employment opportunities in the resource sector do not only affect ex-fishers but have led to many deckhands leaving the fishing sector. In all three case study communities, complaints were expressed that not only is it hard to find 'good and reliable' deckhands as mining offers greater rewards, but that wages have increased, further squeezing profits. In some cases fishers chose to venture out alone or with a spouse rather than rely on unpredictable and unreliable deckhands, creating some occupational safety concerns.

Directly linked to the fishing sector is the processing sector and direct fish sale outlets, which were affected by the contracting fishing sector as product throughput had fallen. As fish processing and sale is increasingly centralised in larger coastal centres and urban areas this impact was greatest in the small community of St Helens. The centralisation of fish processing and fish outlets had an unexpectedly wide-flow on effect in the small community as local restaurants also source fish outside the community due to the high cost of local fish and lack of security of supply. The irony is that this fish is often still sold as locally caught fish in the restaurants. After all, it was caught locally then transported to the processors in the urban centres, and subsequently transported back to the coastal community.

> "Fish is on the menu – [but] I couldn't afford to get my fish [locally] – I get it from Launceston. Cheaper for them to bring the boats in here, unload it, send it to Launceston and bring it back here" (restaurant owner 750016).

The situation was different in Geraldton where the local processing function has been successfully maintained.

> "Fishing is still a big employer even if now it's mostly on the processing side" (business owner 570053).

However, the processing sector's workforce requirements have changed and become more seasonal and temporary in nature as the export of mainly live product has meant that lobsters are no longer processed (cooked) prior to distribution.

The reduced size of the fleet and the reduced number of fishers and deckhands working in the fishing sector, and in the smaller communities, the loss of processing function, has had other significant flow-on effects in the local economies. These effects were most noticeable, in terms of changing fisher behaviour, in the small coastal community of St Helens. For instance, fishers who remained in the sector were increasingly fishing and landing their fish elsewhere due to declining local services and change in the location of the more abundant fishing grounds. A smaller fishing sector has resulted in the closure of many services to the fleet like the local slipway, local fish sale outlets, and availability of specialised mechanics. In larger centres such as Bowen and Geraldton services to the fishing sector (like diesel mechanics) are generally still locally available, but competition for these services from the resource sector has increased prices.

> "The boats aren't there and the fishermen aren't there – it's not that the fish aren't there. All off a sudden it's costing too much. Years ago you had people lined up for a job –all the good workers have gone to the mines – the tradesmen cost twice what they used to because they can get more money at the mines" (fisher 570039).

> "I have to go the 'north island' to buy supplies where I used to be able to get it here" (tackle shop owner 750025).

Even though many solutions to the current demise of the fishing industry were offered by survey respondents, such as changing management and reducing the impact of MPAs, there were few perceived new commercial fishing opportunities. The notable exception is the long spine sea urchin industry that is developing in St Helens. This species of urchin has extended its range into the St Helens region due to climate change (Ling *et al*., 2009a) where a local fisher has developed a small fishery against all odds. The business suffered a severe setback in September 2013 when the east coast was closed for fishing due to a toxic algal species (http://www.dpiw.tas.gov.au/inter.nsf/WebPages/SWIS-92A3LJ?open). Product is currently supplying the domestic market and exported to China. This species has sporadic recruitment events in Tasmania. Other species, such as scallops which also have sporadic recruitment and are the basis for commercial fisheries, are dependent on careful management to ensure a the long-term future and avoid the boom-bust nature that has characterised fisheries based on infrequent recruitment events (Beukers-Stewart and Brand, 2003).

Product is currently being supplied to the domestic market and exported to China. Even though the industry may have a finite lifespan it nevertheless provides a profitable industry in the intervening time.

> "If they can export something [urchin] that we don't want – how good is that? It's a new business and sort of makes up for the others that close" (shop owner 750005).

However, this industry alone, is unlikely to provide adequate employment to sustain the level of local employment previously created through commercial fishing.

In all three locations opportunities were perceived to be in other marine sectors such as charter fishing, marine tourism and aquaculture. Aquaculture was seen as a sector with much opportunity offering an attractive economic alternative in all case study areas. Although the aquaculture sector was small in Geraldton, the presence of the Batavia Coast Maritime Institute (BCMI) was perceived to form the foundations for many opportunities in the future. The aquaculture sector provides many employment opportunities particularly in smaller coastal communities. The main roadblocks to growth in the aquaculture sector were: area restrictions that apply to both on-land and at-sea fish farm culture; the high start-up costs; and public perceptions of the environmental impact of aquaculture. Climate change drivers, in the form of increased frequency and intensity of rainfall, were also affecting rack

based oyster aquaculture in particular. Excessive fresh water influxes caused by greater rainfall intensity and frequency caused more regular farm closures.

Even though aquaculture was perceived as a good alternative marine sector, there seemed to be limited labour exchange between commercial fishing and aquaculture, due to the different skill set requirements. The lack of labour exchange from fisheries to aquaculture also seemed to apply to tourism, which is often seen as a viable alternative for coastal communities when other economic sectors are in decline. There was only a smattering of evidence that fishers had gone into a 'tourism related' area, that is, a fish and chip shop outlet. This only seemed to be possible where there was availability of other family members to 'run the shop and do the cooking'. Some reasons for this lack of transfer were surprising.

> "Tours on boats – I can't see the fishermen doing it – not the fishermen I know, that would be the last thing on their mind." (business owner 570054).

However, there were some instances where ex-fishers (some retired) had moved into the charter fishing sector and to a lesser extent the dive sector. These marine sectors are also often seen as alternatives for coastal communities affected by the decline in the role of commercial fishing. Surprisingly, the charter sector was successful only in the small coastal community of St Helens and only in the peak season. In St Helens the charter and dive sectors were cross-subsided by either a second job or another family member's income. Even in the larger centre of Bowen in the GBR, operators had not been economically viable due to seasonality and competition from close by tourist centres (e.g. Airlie Beach). In Geraldton local operations were also not viable but a Perth based business runs charters to the area. Climate change had a perceived positive effect on the charter fishing sector and recreational fishing. Increased access to new 'exciting' game fish species (e.g the availability of yellow tail kingfish in areas not previously fished) carried south on the warm EAC, was attracting people to the region.

> "Snapper and whiting they are all seen here now and seem to be increasing in numbers (especially in the last 20 years or so). Most of these are from the

> warmer waters. You'd nearly have to think that way – that [the current] is bringing them further down." (fisher 750002).

Recreational fishing participation had noticeably increased in all locations, especially in the small centre of St Helens. In both Geraldton and Bowen an increasing proportion of recreational fishers were boat owners who work in the resource industry and have a higher than average disposable income. In St Helens much recreational fishing activity was undertaken by the owners of shacks who bring their own vessels for the summer season. The services to recreational fishing, like tackle shops, fuel stations and boat ramp associated services, had grown as a consequence in all three coastal communities.

> "There's definitely more people fishing recreationally now – and people are a bit better at catching the fish" (shop owner 750026).

> "The importance that fishing used to have is much lower because of the mines but more people with expendable income and they come from the mines – they are bored silly in the two weeks off - and they come and spend it in my shop" (shop owner 750049).

Aside from marine tourism *per se*, tourism is often seen as a viable alternative for coastal communities but development in this sector had stalled in the case study communities in recent years primarily due to the high value of the Australian dollar and the Global Financial Crisis. Survey respondents believed that misinformation about the aftermath of (climate change driven) extreme weather events in Bowen and St Helens had a negative impact on tourist numbers, for instance, because tourists believed that access roads were still blocked or that the environmental damage that had been done had not been repaired (or was irrecoverable).

> "The cyclones have the major impact – on tourism. The trade that we used to have, those that travel north – they are not here anymore – we also lost them coming back south" (resort manager 750032).

4. DISCUSSION

As elsewhere around the world, coastal communities have been forced to adapt to changes in economic activities associated with their operating environment (Marshall, 2001). The marine operating environment of small coastal communities in Australia is shaped by many different climate and non-climate drivers. About one third of Australia's population live in coastal communities of less than 30 000 people and any structural change or transformation (Marshall *et al*., 2012) of these communities caused by either climate or non-climate drivers or a combination of the two is an important public policy issue.

There has been a steady decline in the relative importance of traditional resourced-based industries such as agriculture, fisheries and forestry within Australia. In coastal communities the decline in commercial fishing is particularly pertinent. Since the fishing industry was rescued from its 'Cinderella' status after the Second World War, it has been the mainstay of many coastal communities around Australia (Tull, 1993). However, Australian fishing fleets have been getting progressively smaller. Today, individuals in coastal communities who were intimately linked to their environment through fishing, no longer meet the demands of the current restructured sector (Binkley, 1996). Many Australian fishers who are first or second generation members of an industry that, through its 150-year history, was characterised by innovation and mobility, see no future in the industry; for them, this is a tragedy (Minnegal *et al*., 2003). It is well known that fishers like to remain in a sea-based and preferably fishing-related occupation (e.g. Terkla *et al*., 1988). Fishers have often been attracted to fishing as a lifestyle rather than a source of profit, so the loss of the connection with the sea is deeply felt (Tull, 1992). As one fisherman said:

> "For me it's a lifetime dream to be a fisherman and now I'm my own boss – I don't want to do anything else" (net fisherman 570052).

Moreover, the aesthetic qualities of coastal towns, enhanced in the past by vistas of working fishing vessels, are being reduced with possible negative implications for tourism. As one survey participant pithily expressed it:

> "It's really just a [boring] country town except it's on the water" (diver 750036)

The reduction in the size of the commercial fishing fleet has had significant economic and demographic flow-on effects, particularly in the smaller coastal communities. Fishers who exit the industry are often not replaced by a younger generation, further accentuating the demographic ageing effect occurring as a result of the ongoing sea change phenomenon. Young fishers are exiting the industry due to the rising cost of fishing and the difficulties in remaining competitive in an increasingly industrialised fleet, or simply because more attractive employment opportunities are present elsewhere. Moreover, those ageing fishers who remain in the industry have trouble getting quality deckhand labour due to the multitude of opportunities in other industries. Even though marine climate change has directly and indirectly impacted the abundance of some commercial species, climate was not perceived to be easily separated from non-climate drivers and some respondents did not considered it relevant.

Growth in other marine sectors including aquaculture has somewhat counterbalanced the fall in employment in commercial fishing. Even though employment and economic returns from aquaculture activities are still rising, expansion is hampered by planning and environmental restrictions. Tourism related employment forms an important economic component of coastal communities and until recently was increasing. Despite growth in other marine sectors and tourism, there seems limited labour mobility between the fishing sector and these other local marine sectors (Panayotou and Panayotou, 1986; Pita *et al*., 2010). This is partly due to the perceived reluctance of fishers to change occupation, with the willingness to move reducing with age (Acheson, 1981; Almeida *et al*., 2003). In some cases it is also due to a lack of transferable skills. For instance, the Census data shows that labourers characterise the fishing sector whereas managers predominate in the aquaculture sector.

Although skill transferability is an issue, for some fishers in Western Australia, the move to the oil and gas industry, where work concerns mainly sea-based transportation, has offered a relatively painless transfer from fishing to another (non-marine) sector. This has not been the case in the smaller communities assessed in Queensland and Tasmania. In Tasmania ex-fishers have often moved away from town to seek employment, while in Bowen many have found local employment in non-sea based professions as well as some moving elsewhere. The situation in small coastal towns cannot be considered in isolation from broader

regional trends illustrated by the impact of the growth of the resource sector on employment and out migration (see also Regional Australia Institute: http://www.regionalaustralia.org.au/).

Other important consequences of fishing sector decline, besides the employment implications, are the flow-on effects into the community. Negative flow-on effects in terms of diminishing service availability, for instance, of slipways, refrigeration and diesel mechanics, and fuel stations are common place, especially in small coastal communities (Clay and Olson, 2008). Small town economies are typically made up of small independently-owned businesses that employ fewer than five employees and focus on the local market. This is why the loss of population and cuts in services and physical and social infrastructure is felt so severely in small towns (Collits, 2000).

Out migration, changing demographics and service business closures, could hit irreversible thresholds or a 'tipping point', particularly in small coastal communities far from large regional centres. When businesses fail to receive benefits from their proximity to other firms, a cascading effect can develop. On the flip side, there are economic drivers for businesses to locate in close proximity to one another, which helps explain the tipping point that can sometimes lead to exponential growth of larger centres. There has been a steady growth of major regional centres which are increasingly absorbing government and private sector services, often at the expense of surrounding smaller centres (Collits, 2000). This 'sponge city' effect has helped create regional 'cold spots' across Australia (Stimson, 2011).

It is important to consider the additional pressure exerted by climate change as it may prove to be the tipping point for both the fishing fleet and coastal fishing towns especially if economic shocks occur in conjunction with increasing environmental pressures. In St Helens, for example, the re-orientation towards aquaculture and marine tourism can be adversely affected or even reversed. The combined impact of increased rainfall frequency and intensity leading to aquaculture closures and range shifting commercial and recreational species driven by increased SST could override any economic re-orientation. The combined effect can lead to increased disparities within and between regions across a wide range of social and economic indicators. In small coastal communities out-migration and local employment might be the result. The ability of fishers, managers and marine resource-dependent communities to adapt to climate-induced change (Berkes and Jolly, 2001; Tompkins and Adger, 2004), as non-climate driven changes in the marine

sector continue, will become increasingly pertinent. It has been suggested that greater research engagement between regional universities and local councils will help build adaptive capacity (Sesne, 2012).

5. CONCLUSION

Government policies aimed at reducing and limiting fishing effort, ensuring conservation and the rehabilitation of fisheries resources have played a role in forcing fishers out of their traditional occupation. There is little incentive for young people to take on a relatively low paying, physically demanding job in the fishing sector if greater amounts of money can be made in the mining sector. Young persons who have a passion for fishing and being out on the water and want to be independent fishers face high start-up costs, especially for quota units. Many fishing families also avoid becoming tourism entrepreneurs and tend not to take up fish farming, which is riskier, entails taking on substantial debt (Boissevain and Selwyn, 2004), and requires a different skill set.

The decline of the fishing sector is particularly pertinent in small coastal communities. However, by virtue of the fact that the connection to the marine environment in coastal communities is often strong, there is an almost natural re-orientation of economic activity to other marine sectors. Maintaining a much reduced commercial fishing sector and at the same time re-orientating to aquaculture and marine tourism could be challenging not only for labour and skill reasons but also considering current and predicted future marine climate change impacts.

The socio-economic profile of coastal communities and their relatively high dependence on marine resources suggests that they may be susceptible to the consequences of climate change impacts in the marine environment in all marine sectors. With a currently declining commercial fishing sector which previously formed a central role in small coastal communities, the synergistic effects of, for instance, reduced abundance of commercial species due to SST and EAC changes and the effect of increased rainfall frequency and intensity on aquaculture may mean crucial viability thresholds are transgressed. Characterised by lower incomes, higher proportions of older people and a higher proportion of labourers and trade workers, small coastal communities are exposed to the potential cumulative effects of physical exposure, higher levels of social disadvantage and reduced capacity to adapt to change (Christensen *et al*., 2007). In fact, the flow-on effects of change in marine sectors, particularly commercial fishing, are already being felt. Unless the workforce is able to develop skills commensurate with the existing and

emerging local industries and evolve effective strategies to cope with marine climate change, small coastal communities may be at risk of terminal decline.

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