Fishing communities and climate change: impacts and the co-production of knowledge

Jenny Lauren Shaw

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Doctor of Philosophy

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Jenny Lauren Shaw

28th September 2016
Abstract
Australia’s fisheries have experienced significant change in recent years. This PhD addresses two research questions. The first is, ‘how has climate change affected an Australian fishing community?’ The geographic focus was the Houtman Abrolhos Islands, a group of low-lying islands off the midwest coast of Western Australia (WA) and the centre of the WA Rock Lobster Managed Fishery. From 2006 to 2013 there was a very low rate of settlement of post-larval rock lobsters (*Panulirus cygnus*), which appeared to be climate-driven. To protect the stocks of this valuable fishery, the WA Department of Fisheries imposed significant catch reductions across the entire fishery. These management changes resulted in almost half of the boats and fishers leaving the WA lobster fishery, including at the Abrolhos Islands. An additional management strategy extended the length of the fishing season which in turn changed patterns of fishing. As a result there are now few people on the islands at any one time: all schools, clubs and sporting events have shut down. The present study uses an ethnographic action research approach to document this cascade of climate and environmental changes, management responses and economic outcomes which in turn led to social decline and community collapse.

The management intervention saved the lobster stocks and the fishery; however the social implications of the management changes were not considered in the decision-making process as required under Ecosystems Based Fisheries Management (EBFM). I suggest this was an unintended consequence of the invisibility of women and families who make up the fishing communities in general and the Abrolhos Islands in particular.

The second research question is, ‘what methodologies are effective in working with fishing communities to understand the role of climate change? Working within the ethnographic action research approach, I developed and built on the methodology known as ‘Photovoice.’ I modified and improved it by: sharing information between fishers and scientists, engaging fishers collectively and individually on their home Islands, and using their photos and stories combined with scientific observations, visualisations and artworks to co-produce an exhibition. This multi-award winning exhibition was shown in three coastal fishing towns in WA and viewed by
approximately 30 000 people. The exhibition documented changes to the fishing community and was also successful in building a shared understanding of climate change impacts in both the fishing and wider communities.

The research has theoretical significance in that it builds on ‘coastal cultural models’ theory by showing that the keys to the enactment of a ‘sustainability model’ of coastal management are the use of a bioregional framework and the development of knowledge partnerships among stakeholders who hold and enact divergent cultural understandings of the coast. The research also uses and extends boundary organisation and boundary spanning theory to show that the co-production of knowledge can occur not just between policy-makers and scientists but with the broader community. In this action research project the input of each of the collaborators - the fishing community, scientists, managers, creatives and the researchers - all played important roles in the effectiveness of the process and the outcome.
Acknowledgements

At almost the end of this PhD journey I would like to acknowledge the incredible support and encouragement I received from so many colleagues, friends and family. It has been a wonderful period of learning, growth and reflection.

Throughout my PhD I felt very privileged to have been given the opportunity and financial assistance to be immersed in a research topic of my choosing. The Australian fishing industry and global climate change are two areas close to my heart. To better understand the complexities of climate change knowledge uptake while engaging with a generous and supportive fishing community has been a huge honour.

I wish to very gratefully acknowledge my Supervisor, Associate Professor Laura Stocker, Curtin University Sustainability Policy Institute. Laura’s outstanding support, guidance, wisdom, patience, optimism and input into this PhD made it the wonderful experience it was. Without Laura’s initial enthusiasm for the topic and constant guidance, this PhD would not have been achievable.

My Mum and Dad fostered the importance of a lifetime of learning and I thank them for believing I could achieve this goal. My partner Francis encouraged me to take time out and ‘do something I really wanted to do’. I certainly couldn’t have done this PhD without his support and understanding. To be studying at the same time as our daughter Katie – possibly made this journey additionally stressful – but I hope it has been worth it. Thank you all!

The extremely generous financial and in-kind support from multiple organisations is very gratefully acknowledged. The advice and research input from many colleagues for various aspects of this research project has been immense. I acknowledge and thank you all. This project was truly a collaborative research effort.
List of Publications included as part of the thesis
I warrant that I have obtained, where necessary, permission from the publishers / copyright owners to use any third-party copyright material reproduced in the thesis, or to use any of my own published work in which the copyright is held by another party. See Appendices 1-7. Every reasonable effort has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

Where papers are ‘in press’ I have provided evidence that the papers have been referred by established scholars and specialists in relevant fields. See Appendices 1-7.

The publications listed below are reproduced in full in the Section: Published Papers (pages 107 – 263).

Paper 1

This paper has been double-blind peer reviewed by established scholars in relevant fields.

Paper 2

Paper 3
This paper has been double-blind peer reviewed by established scholars in relevant fields. Copies of this publication will be available in the coming month.

Paper 4
Western Australia Northern Agriculture Catchments Council.

The text in this book was reviewed by multiple specialists in this area.

Paper 5
[http://dx.doi.org/10.1016/j.ocecoaman.2013.02.009](http://dx.doi.org/10.1016/j.ocecoaman.2013.02.009)

Paper 6
[http://dx.doi.org/10.1016/j.ocecoaman.2012.11.008](http://dx.doi.org/10.1016/j.ocecoaman.2012.11.008)

Paper 7

The text in this report was read and reviewed by established industry experts.
Statement of contribution

I warrant that I have authored and co-authored the following publications. The level of my intellectual input is indicated in brackets following each paper below. Signed verification statements from each of my co-authors are provided in Appendices 1-7.


List of additional publications

Publications


Shaw, J., Caputi, N., & Stocker, L. (2013). Climate adaptation in the Abrolhos Islands fishing community: a cascade of environment, management, economic and


**Exhibitions**


Exhibition Albany: Western Australian Museum. 26 June - 21 July 2013.


**Conferences, presentations, videos, TV & radio**


**Shaw, J.** (2011). Knowledge and Adaptation in Coastal Fishing Communities.
*Meeting Coastal Challenges*, CSIRO Coastal Cluster Conference. Wollongong NSW. 3 - 5 October 2011.


Shaw, J. (2012). Social change and adaptive responses by fishers in a changing climate. *Coastal Planning and Management in WA: The good, the bad and the ideal*. Curtin University, Perth Western Australia. 30 - 31 August 2012.


Shaw, J. and Noble, L. (2013). Seafood, Seaweed and Science: there’s more to South Korea than Kimchee! *Promoting all the benefits of seafood sustainably harvested and distributed by resilient Australasian fishers and their families*. Women’s Industry Network Seafood Community Conference, Port Lincoln South Australia, 26 - 27 October 2013.


Awards


MAGNA 2013. Museums and Galleries National Awards

Winner - Best Temporary Exhibition under $20,000


Western Australian Coastal Awards for Excellence 2013.

Winner - Coastal Heritage Preservation Award


Goodness Awards for Sustainability and Innovation 2013.

Winner - Science Award


Overall winner Postgraduate Presentation Award. NCCARF Conference *Climate Adaptation in Action 2013: Knowledge and Partnership*. Sydney NSW. June 2013.

For the presentation and poster - **Shaw, J.**, Caputi, N., and Stocker, L. (2013). Climate adaptation in the Abrolhos Islands fishing community: a cascade of environment, management, economic and social changes.
WA Seafood Industry Awards 2013.

Commendation - Seafood Industry Promotion Award: **Jenny Shaw**

Western Australian LANDCARE AWARDS 2013.

Finalist – Coastcare Award: **Jenny Shaw**

Curtin University, Faculty of Humanities.

Research Through Your Lens Photography Competition 2015.

People’s Choice Award: **Jenny Shaw** ‘Gloves and Fishers’

Curtin University, Faculty of Humanities.

Research Through Your Lens Photography Competition 2015.

Highly Commended: **Jenny Shaw** ‘Gloves and Fishers’
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A. Introduction

Aims

The present doctoral research aims to investigate and document the impacts of climate change on a fishing community in Western Australia. The research also aims to develop an effective methodology for improving the dialogue about climate change in fishing communities and to thereby improve their sustainability.

Significance

Whilst there is extensive literature on the likely impacts of climate change on the marine environment, there is less literature on methods to increase the uptake of this knowledge, and even less literature on methods to engage and increase knowledge within fishing communities. At the time this doctoral research began, anecdotal evidence suggested that fishers were reluctant to engage in climate change discussions (Pecl et al., 2009; Shaw, 2014), and the political discourse at the time had further polarised opinion about climate change.

The present doctoral research makes a significant contribution to new knowledge in three ways:

1. **Empirical.** Bringing together both qualitative and quantitative evidence, the present research is able to document for the first time a cascade of change from climate and environmental changes through management intervention by the State, to economic responses and socio-cultural impacts including the demise of the fishing community. The research explores the implications of unintended management consequences resulting from gender-blind fishery management to the collapse of the fishing community.

2. **Methodological.** The thesis develops for the first time the application of Photovoice for use in a coastal fishing community both to analyse the complex impacts of climate change and to improve community understanding of climate change. Significant methodological development of Photovoice includes: provision of opportunity for detailed scientific and fisher exchange; engagement and re-engagement of the fishing community;
and co-production of a community exhibition illustrating both scientific and fisher perspectives on change. The research demonstrates and extends the methodological role of boundary organisations in creating a space for a meaningful dialogue between scientists, decision-makers and the community.

3. **Theoretical.** Finally, the research builds on ‘coastal cultural models’ theory by arguing that key to the enactment of a ‘sustainability model’ are the use of a bioregional framework and the development of knowledge partnerships among stakeholders who hold and enact divergent cultural models.

A schema of the exegesis (Figure 1) summarises the content. The three sections that form my literature review are the: Background (Section B); Theoretical framework (Section C); and Policy, fishery & community framework (Section D). There are two research questions (Section E), a summary of the Research design (Section F), and the Overview of findings (Section G) relating to each research question. The publications used for my doctoral research are reprinted in full in the Published Papers section (pages 107 – 263). All other publications completed during my research are in the List of additional publications, exhibitions, conferences, awards etc (pages x – xviii).
Figure 1. Schema of exegesis
B. Background

Climate change in the marine environment, fisheries and fishing communities

The concept of climate change is complex, cognitively challenging, and often polarising within the community (Garnaut, 2011; Moser & Dilling, 2007; Oreskes, 2004; Oreskes & Conway, 2010a). Climate change is considered a ‘wicked’ issue (Brown et al., 2010; Hulme, 2009; Moser, 2011; Moser et al., 2012). It is wicked in the sense that climate change defies a simple understanding, and because of the inherent and evolving complexity and uncertainty in the system, a clear solution does not exist (Jentoft & Chuenpagdee, 2009; Moser, 2011; Moser et al., 2012).

Despite the complexities and scale of the issues, the science of climate change is well documented (Garnaut, 2011; IPCC, 2014) and the vast majority of scientists (Goot, 2011a; b, c; Oreskes, 2004) especially climate scientists (Anderegg et al., 2010; Goot, 2011c) accept that anthropogenic climate change is real and a serious threat.

Climate change impacts on the terrestrial and marine environments have been recorded and observed (IPCC, 2014). The oceans of the world are acting as a heat sink for the planet; an estimated 90% of this heat is currently going into the upper layers of the oceans (Domingues et al., 2008; IPCC, 2014). This warming is not homogenous across the surface of the ocean: some areas are being impacted at a greater rate than others. Hotspots or regions where the ocean’s surface temperature has changed most rapidly over the past 50 years have been identified (Hobday & Pecl, 2013; Pecl et al., 2014). One of the 25 marine global hotspots is in southern Western Australia where this study is located.

Increasing sea temperature is one of the primary physical drivers of biological change; however sea level rise, salinity, acidification, changing currents, upwelling, nutrient supply, stratification and oxygen depletion (Brander, 2010; Hobday & Pecl, 2014; IPCC, 2014) all contribute to the complex relationships between the physical responses to a changing climate and the biological impacts. The complexity of climate change and the gaps in knowledge about many aspects of marine species lifecycles can only increase the uncertainty of exact impacts. This is particularly true.
of species with complex lifecycles such as the western rock lobster (*Panulirus cygnus*), with a larval phase that occurs up to 1 500 kms off the WA coast (Phillips et al., 1979).

There has been extensive research on the physical drivers of climate change summarised in the IPCC (2014). However there is less research on the consequences of climate change in marine ecosystems (Abdo et al., 2012; Hoegh-Guldberg & Bruno, 2010; Jennings & Brander, 2010; Pearce & Feng, 2007; Pearce et al., 2011; Selig et al., 2010; Wernberg et al., 2013) including fish and commercial fishery impacts (Allison et al., 2009; Barange et al., 2011; Brander, 2007, 2008, 2010; Hobday et al., 2008; Pinsky & Fogarty, 2012), notably poleward species shifts (McCay, 2012; Pecl et al., 2014). Recreational fishing impacts (Kerr et al., 2009), social and economic implications of climate change on fisheries (Allison et al., 2009; Barange et al., 2011; Coulthard et al., 2011; Hobday et al., 2008; McCoy et al., 2011; Pinsky & Fogarty, 2012), as well as research on the policy and management directions for fisheries (Brander, 2007, 2010; Galland et al., 2012; Grafton, 2010; Hodgkinson et al., 2014; Jennings & Brander, 2010; Johnson & Welch, 2009; McCoy et al., 2011; McIlgorm et al., 2010; Pinsky & Fogarty, 2012), are in their early stages and there is little or no indication of how all these issues will interact in a climate changed future.

Small and large scale changes to the marine environment in addition to rising sea levels and extreme weather events (IPCC, 2014) already appear to be impacting coastal communities (Kenchington et al., 2012a). However assessing the vulnerability of these communities is difficult for a number of reasons including: the multiple stressors already affecting fish and fisheries; the difficulty of downscaling climate models to bioregional scales; and understanding how communities will react to these changes (Barange et al., 2011). Assessments undertaken on the vulnerability of coastal and island communities (Adger, 1999; Allison et al., 2009; Barange, 2011; Ford et al., 2010; Lazrus, 2012; Moser et al., 2012) indicate that the poorer and those most reliant on fish in the less-developed countries are likely to be the most vulnerable (Allison et al., 2009). Adaptation options for these communities and more developed coastal communities are still in early phases of
research (Grafton, 2010; Hobday & Pecl, 2014; Stafford-Smith et al., 2011). Adaptation mechanisms specifically for fisheries associated with coastal communities have been described in relation to vulnerability and impacts on livelihoods (Badjeck et al., 2010; Ford et al., 2010; van Putten et al., 2014a; Sievanen, 2014). Means of sharing knowledge about climate change and understanding of adaptation pathways in coastal communities are also a current focus of research (Kenchington et al., 2012b; Khan et al., 2012; Nursey-Bray et al., 2015).

In Australia where coastal communities are often characterised as ‘fishing towns’ (van Putten et al., 2014a) there has been some focus on climate adaptation approaches (Leith et al., 2014; Metcalf et al., 2015; van Putten et al., 2014b). Several factors have been considered in these analyses; however knowledge of climate change drivers is seen as an important factor in successful community adaptation (Metcalf et al., 2015) and in building capacity for more informed decisions about community futures (Nursey-Bray et al., 2012; Pecl et al., 2009; van Putten et al., 2014b).

Despite the information available and research undertaken on marine climate change, fisheries impacts, coastal community vulnerability and adaptation pathways, there appears to be:

- No previous investigation that documents community collapse as a result of climate and environmental change
- Very little research on the impacts or future predictions for fishing communities (but see Coulthard et al., 2011)
- No previous account of a community’s response to marine climate drivers including community collapse.

**Fishers’ knowledge of the marine environment and their resistance to climate change uptake**

Given the documented changes (see above) to marine systems, fisheries, and coastal communities, it is likely that fishers and fishing communities will be
significantly impacted by climate change. An understanding of what these changes might be, how they could impact fishers and their communities and possible adaptation options available will be important for the long term future of these communities. Knowledge and understanding of climate change science is seen as important for adaptation success (Section B).

In my professional experience as a fisheries manager and scientist for almost 30 years I have observed that fishers are usually cognisant of many changes that occur in the marine environment. This includes changes to fish abundance, species distributions, current shifts and sea surface temperature fluctuations. I have also observed that fishers have a comprehensive understanding of weather patterns, as their personal safety and fish catches depend heavily on their ability to adapt their daily fishing strategies to particular weather scenarios. Fishers can talk knowledgeably about changes they see in the marine environment. Some fishers record data meticulously and make acute observations (R. Lenanton, personal communication).

Fishers also appear to have a strong attachment to their industry, despite the difficult aspects: fishing conditions can be harsh; fishers are subject to weather, tides and swells; the hours worked are long and the boats often small. The overall danger level is high. Even with these issues, it seems that most fishers are in the industry for life; some fishing families are multi-generational. The term ‘lifestylers’ has been coined (Department of Fisheries, 2000) to account for the reluctance among those fishers with low economic returns to move out of the industry. Attachment to lifestyle and place appears strong. For many fishers, there is no better place to be than out on the water, close to nature, reading the weather, the wind and the waves (Author’s observation).

This strong attachment to lifestyle and place raises questions about fishers’ vulnerability (Marshall & Marshall, 2007) and their capacity to adapt to issues such as climate change. Fishers believe they are adaptable (A. Whalley, personal communication). While they may indeed have a strong tactical flexibility on a daily and seasonal basis because they deal continuously with weather and market
changes, they may not necessarily be able to respond with effective long term adaptation strategies in a changing climate (Adger et al., 2008, 2013; Marshall, 2010; Marshall et al., 2012, 2013).

In my experience I also noticed that fishers generally were largely resistant to the traditional delivery of science, and prior to this study had been disengaged with climate change science (Pecl et al., 2009). It appeared that fishers tended to be climate change ‘sceptics’ or even ‘deniers’ (Chivers, 2011). Fisher engagement in general can be challenging for a range of reasons (Frusher et al., 2014, Nursey-Bray et al., 2012), including that fishers are often not available onshore as they spend considerable time at sea.

That fishers have been reluctant to engage, particularly in climate change science, is not surprising as there is extensive academic literature detailing the tension between scientific evidence of climate change and community acceptance of its factual basis (Climate Commission, 2011; Groot, 2011a, b, c; Hulme 2009; Moser & Dilling, 2007; Oreskes & Conway, 2010a). Despite this tension in the wider community and the political polarisation of the topic at the time (Hulme 2009; Oreskes, 2004; Oreskes & Conway 2010a, b), it was not clear whether fishers were: observing changes to the marine environment and not connecting the changes to climate change models and predictions; not noticing the small-scale and often incremental changes in their work environment; enacting cultural models or values (Kahan, 2012; Stocker & Kennedy, 2009) that meant they interpreted the climate information in a different way to fisheries scientists; or experiencing a suite of interacting barriers such as a lack of trust (Hulme, 2009; Hulme, 2011; Lucas et al., 2014) which inhibited their engagement in climate change discussions. Whatever the reasons, it appeared that increasing fisher engagement in and knowledge exchange about climate change science could be beneficial for the fishers’ long-term sustainability.
C. Theoretical framework
Climate change has been framed in many different ways (Hulme, 2009; Moser & Dilling, 2007; Nisbet et al., 2010; Nisbet & Mooney, 2007; O’Neill & Nicholson-Cole, 2009) including in terms of: scientific uncertainty; fear-inducing catastrophe; unfairly distributed economic burden; and evangelism (Nisbet & Mooney, 2007; Pettinger, 2007). The framing of issues is important as frames focus attention on a central idea and summarise complex issues with particular emphasis. Using frames, people can readily identify what matters, where responsibility lies and how the possible outcomes will impact them (Nisbet & Mooney, 2007).

Although most scientists come from a positivist\(^1\) worldview, they also frame issues. Deliberate or not, this framing is reflected in the way that climate change information is analysed, interpreted and communicated. With successive reports, the IPCC view of climate change has steadily increased confidence around projections of the anthropogenic warming of the planet. Even within this huge body of work the framing of the issues is clearly evident (Hulme, 2011). O’Neill and Nicholson-Cole (2009) demonstrated that: climate change information has been produced in just a few regions of the world, although the impacts are world-wide; there is an ‘epistemological hierarchy’ promoting certain types of climate change knowledge over others with biases toward the physical and economic sciences; and a negative gender bias exists in climate change presentations.

In the fifth IPCC assessment report (2014), the analysis of climate change continues to be framed by positivist disciplines at the expense of interpretive ones (Hulme, 2011; Nisbet & Mooney, 2007; O’Neill & Nicholson-Cole, 2009).

\(^1\)Positivism ‘assumes that facts exist outside of the observer who remains impartial in the process, and that all results can be subject to testing, leading to a systematic and reliable progression of knowledge’ (Pettinger, 2007).
There exists a disconnect between the relatively cohesive scientific position on climate change on one hand, and the divergent positions of the general public on the other (Goot, M, 2011a; Leviston et al., 2011; Levitson & Walker, 2012). Twin reasons for this may be the inaccessibility of the scientific discourse to the broader community and the insufficient involvement of the arts and cultural discourses (Hulme, 2009) in enabling community engagement. This suggestion arises because it is understood that the humanities disciplines are better at engaging with and articulating deeper human values, purpose and meaning than are the physical sciences (Hulme, 2011). As many disciplines are important to the understanding and resolution of wicked issues such as climate change, bringing them together under more trans-disciplinary approaches may be more effective than drawing on and disseminating positivist science alone (Brandt et al., 2013; Pereira & Funtowicz, 2006). Commentary from Nisbet et al. (2010), calls for truly transdisciplinary collaborations across academic and other institutions to create and foster new synergies for engaging society on climate change. This could result in better political and social outcomes than have been achieved so far with the traditional deficit model of science communication (Pereira & Funtowicz, 2006). Knowledge is still seen as important in people’s attitudes towards science; however the nature of the knowledge-attitude interface is complex (Sturgus & Allum, 2004) and likely to be more effective with transdisciplinary and multidisciplinary approaches.

As no particular sector has the necessary and sufficient knowledge to address the current problems with climate change and fisheries, we need new and more innovative ways of coming together to create knowledge and resilience. Therefore this doctoral research project is located within social constructivism with an emphasis on relationality (Bryman, 2008; Mannheim, 1936; Powell, 2014; Slife, 2004).

To inform the social constructivist approach and provide a theoretical frame for this research, three key bodies of theory were applied:

- Cultural models
- Boundary organisation theory
Knowledge production and partnerships. These higher order theories are developed more fully in my published papers, and below is a short summary.

Cultural models

Cultural models describe different ways people can understand the world and their behaviour in it (Quinn & Holland, 1987; Shore, 1996; Stocker & Kennedy, 2009; Thompson, 2007). It reflects the fact that different sections of society have different beliefs and cultural knowledges and these play an important role in their understanding of others as well as their own behaviour (Quinn & Holland, 1987). For example fishers, scientists and managers have different models of how they understand a fishery and the community that surrounds the fishery. In this research a fishery is defined as a stock or part of a stock of fish (Fisheries Department, 1994). These models are generally considered presupposed, taken for granted and widely shared (Quinn & Holland, 1987; Thompson, 2007). It is acknowledged that understanding and recognising when people are using different cultural models can improve communication between parties particularly in management and dispute situations (Thompson, 2007). In this thesis it is understood that an actor’s cultural model (Quinn & Holland, 1987) strongly influences his or her framing of climate change (Nisbet & Mooney, 2007).

Boundary organisations

The existence of cultural models creates boundaries between groups of people. These boundaries are often hard to cross or span because of poor engagement and dialogue (McNie et al., 2008; Moser & Ekstrom, 2010). Because of this, there is a need for boundary organisations and boundary spanners whose explicit job is to create a dialogical framework that enables engagement across those boundaries. Boundary spanners are individuals who facilitate linkages between knowledge and action (McNie et al., 2008); they can be agents located within a boundary organisation, or within other agencies. The role of boundary organisations as identified in the existing literature is to enable knowledge exchange between scientists and decision-makers, sometimes in the climate change space (Aldrich &
Herker, 1977; Cash et al., 2002, 2003, 2006a, b; Jasanoff, 2004; Moser & Ekstrom, 2010). Boundary organisations must be seen as neutral and credible to all parties. They can be specifically formed (McNie et al., 2008) to undertake boundary work. They may also be existing organisations such as local government associations or universities that effectively function as boundary organisations. Boundary organisations typically use the institutional processes described by Cash et al. (2006b) as: convening stakeholders, translating information, mediating conflict and collaborating to coproduce knowledge. Boundary work ‘enables multiple knowledges and values to be shared and co-produced while maintaining the legitimacy of all stakeholders involved’ (McNie et al., 2008).

Knowledge production and partnerships

Traditionally science, science communication and public education have come from a positivist, deficit model whereby knowledge flows from scientists to the broader community. Under this model, the sharing of knowledge, multi-way communication and the co-production of knowledge and pathways forward are not sought and are therefore unlikely to occur.

While certainly important, science communication, in implicitly adopting a deficit model, also accepts a knowledge hierarchy (Hilgartner, 1990), often referring to experts (scientists) communicating with recipients (for example fishers). As described above, despite the comprehensive and widespread presentation of high quality climate science, a significant section of the public remains sceptical or denies the science (Chivers, 2011; Feygina et al., 2010; Leviston et al., 2013; Leviston & Walker, 2012; McCright & Dunlap 2011a ,b; Moser & Dilling, 2007; Oreskes & Conway 2010a, b; Poortinga et al., 2011).

It is clear that science alone is not adequate to enhance the public understanding of climate change. Indeed, it is well documented that exposure to knowledge about climate change in itself does not lead to changed behaviour and decision-making. The communication of knowledge, its contextualisation and links to communities’ affective meanings and personal understandings of climate change are also important. The deliberate development of knowledge partnerships in which
knowledge types are seen as equal, though different partners (Asian Development Bank, 2011; Dodson, 1995a), is one means of creating a socially constructed understanding of climate change. In a knowledge partnership, formal, informal and tacit knowledges can be brought together to create a new co-produced climate knowledge (Asian Development Bank, 2011).

Innovative avenues for developing knowledge partnerships (Asian Development Bank, 2011; Dodson, 1995a) for the purposes of increasing awareness of climate science include story-telling and visual art. The field of cultural geography demonstrates how stories and art can give meaning to complex situations and tells us that art can help support cognitive change and make groups aware of others’ different perceptions (DeSilvey, 2012; Hawkins, 2013; Nettley et al., 2014).

Allied to cultural geography, Photovoice is one specific technique that has a creative component and has been demonstrated to be useful in terms of documenting and sharing knowledge and perceptions (Baldwin & Chandler, 2010; Catalini & Minkler, 2010; Chandler & Baldwin 2010, Wang & Burris, 1997). In this research project the Photovoice method was developed and expanded to include the sharing of knowledge and stories with the wider community through a large collaborative and co-produced exhibition. This is described below in the Research Design (Section F).
D. Policy, fishery and community background
This section complements the above theoretical framework by presenting aspects of the extensive fisheries technical, policy and management background to the current research. While not a central focus of the primary research, it is highly relevant to an understanding of the context in which the primary research occurred.

EBFM: key policies and management practices

Ecological Sustainable Development (ESD) and the management of fisheries using these principles became an important part of Australian public policy in the 1990s and early 2000s (Commonwealth of Australia, 1992, 1998, 2001). This was a fundamental shift in public policy in Australia as it affected the operations of all Government Departments and industry (Productivity Commission, 1999). Fisheries management approaches based on sustainable development principles have been adopted in Australia (Department of Environment & Water Resources, 2007; Fletcher, 2002, 2006; Fletcher et al., 2002a, b, 2005) as well as overseas (FAO, 1999a, b, 2003; Garcia & Cochrane, 2005; Garcia & Staples, 2000; Garcia et al., 2003) for many decades. The basic tenet of ESD as applied to fisheries management is that short and long-term environment, economic and social considerations should be integrated in all decision-making (Fletcher et al., 2005). However, the principles of ESD remain difficult to implement and demonstrate in a way that is transparent and easily understood by managers, fishers and the general public. It represents a challenge to conventionally siloed approaches to management and the dominant cultural model of productivism.

Fisheries management is recognised as one of the most contentious areas of public policy (Fletcher et al., 2005). There are myriad reasons for this, including the importance of seafood in the sustenance and livelihoods of billions of people (FAO, 1999a, 2009, 2014). This marine resource, as with all natural resources, is not finite and is often considered ‘common property.’ It has multiple users including extractive users who harvest commercially, recreationally or for subsistence, and non-extractive users who engage in marine activities or simply enjoy the marine environment vicariously. This last group may not interact with the marine
environment directly but place a high existence value on the resource and want to know that it is being managed sustainably for themselves and future generations. These multiple overlapping interests and associated economic, social, cultural and environmental values make for complex public policy challenges.

The development of an ESD process which recognises and considers these issues in fisheries management decision-making was a positive step. Australia was quick to develop a framework for implementing ESD for fisheries (Fletcher, 2002; Fletcher et al., 2002a, b, 2005) with WA taking a lead role.

More recently there was an understanding that a regional and ecosystem based approach was necessary in demonstrating and undertaking sustainable fisheries management (Bianchi & Skjoldal, 2008; Fletcher et al., 2010; Rice, 2005). The subsequent adoption of Ecosystems Based Fisheries Management (EBFM) in effect changes the order of fisheries management priorities to start with the ecosystem rather than the fishery or target species (Pikitch et al., 2004). It was also understood in EBFM, that a greater focus on the social and economic considerations of fisheries management decisions was required (Fletcher et al., 2010).

The three aspects of sustainability (environment, social and economic) were understood to have equal weighting (Barclay, 2012) and one of the four guiding principles of ESD states that ‘No objective or principle should predominate over the other’ (Commonwealth of Australia, 1992; McGregor, 2003).

Although the social objectives of ESD in fisheries were considered to have equal weighting they were generally broad, somewhat vaguely defined and in practice often fell a long way behind the environmental and economic objectives, if they were considered at all (Fletcher et al., 2002a, b). There remain a number of reasons for this including: a lack of understanding of the social metrics required; complexity of the issues; a lack of data; methodological confusion; and the high cost of data collection. Work was done to address this in Australia with the development of a social assessment handbook (Schirmer, 2005), case studies (Schirmer & Pickworth, 2005), a review of social and economic evaluation methods that could be used in a
fisheries context (Brooks et al., 2010; Viera et al., 2009) and the development and testing of a number of specific social objectives (Triantafillos, 2014).

This social focus is also reflected internationally (FAO, 2009). For example, in the USA, the National Oceanic & Atmospheric Administration and National Marine Fisheries Service has provided policy guidance for the assessment of the social impact of fishery management, noting that it is an ‘essential part of the fishery management process, and improves fishery conservation and management decision-making.’ The policy statement goes on to state that fishery management plans or amendments will not be considered complete without it (NOAA NMFS, 2007).

Despite the increased social focus, there has been limited material progress made in the assessment of social factors in accordance with EBFM (Begg et al., 2014; Brooks et al., 2010, 2015; Schirmer, 2005; Schirmer & Pickworth, 2005; Viera et al., 2009) and the defining of consistent social policy objectives for fisheries management decisions (Symes & Phillipson, 2009). The high level objectives written for the early ESD assessments and for EBFM (Fletcher et al., 2010; Triantafillos, 2014) are reasonable; however there is little focus on the sustainability of fishing communities, rather a focus on economic criteria and data it is possible to collect by fisheries departments (L. Triantafillos, personal communication).

In Australia and globally, coastal fisheries are inextricably linked with coastal communities (Van Putten et al., 2014a) and yet there is little research or policy analysis about the value of these towns and how management decisions will affect them (Huddleston, 2009). Despite fisheries being profoundly social and economic enterprises, Voss et al. (2014) note that in the EU in particular, integration of existing social-ecological knowledge and ecological-economic modelling is missing and not used in any decision-making processes (Voss et al., 2014).

In exploring the social and economic risk factors for the West Coast bioregion (Figure 2) as part of the development of the EBFM process in WA (Fletcher et al., 2010), the social risk and amenity was determined, as is often normal for risk assessment, from a group of stakeholders sitting around a table (Author’s
comment). That is despite the resources developed for this very exercise (Vieira et al., 2009).

More rigorous social research and assessment methods, while more costly and time consuming (Halpern et al., 2013; Voss et al., 2014), may have produced more comprehensive results. However, social impacts are not generally considered to be core business of fisheries management agencies, despite ESD principles, and as a result they are often given a low priority or left out of management consideration, giving rise to unintended consequences of fishery management decisions.

Rock lobster fishery

The Western Australian Rock Lobster fishery is Australia’s most valuable single species fishery (de Lestang et al., 2013). The fishery extends between Shark Bay and Cape Leeuwin, primarily in the West Coast Bioregion (Figure 2). The fishery has a long history of management, with protection (minimum size) instigated as early as 1887 (Bowen & Hancock as cited in Penn et al., 2015, p. 3). In 1963 it was one of the first fisheries in the world to restrict the number of licences available in the fishery (de Lestang et al., 2013). It was also the first fishery in the world to obtain Marine Stewardship Council accreditation: the gold standard for ecological sustainability. After 15 years of continuous certification and re-certification, this achievement was recently recognised internationally (http://www.wafic.org.au/what-we-do/community-support/msc).
Figure 2. Western Australia showing the approximate extent of the western rock lobster (semi-circle), the West Coast Bioregion, Abrolhos Islands and Geraldton.

(Figure modified from Fletcher & Santoro, 2015, p. 9)
In the 2014 season there were 235 vessels fishing commercially with a catch of almost 6,000t valued at approximately $360 million. The recreational fishery has a 5% allocation of the catch and in the 2013/14 season, 16,500 fishers caught approximately 250t of lobster (de Lestang et al., 2015).

The research on this species is considered extensive and a large number of long term data sets have been generated. For example, the Department of Fisheries and CSIRO have been collecting data for the past 60 years on the settlement of lobster larvae (puerulus) and ocean currents along the WA coast (Caputi, 2008). The length of this data set is unusual and underpins the extensive knowledge of this species and subsequent management measures for the fishery. Over this time a strong positive correlation has been found between the numbers of lobster larvae (puerulus) settling along the coast and the strength of the warm, low nutrient, southward flowing Leeuwin current (Caputi, 2008; Caputi et al., 2009; Phillips, 1986; Phillips et al., 1979). There are also extensive research data that reliably predict the catch of adult lobster four years in advance by counting the number puerulus settling along the coast (Caputi, 2008).

There is little information on the social aspects of the fishery including the number of people involved in the fishery over time. The Department of Fisheries has information on the number of boats actively fishing since 1963 and estimates approximately 2.5 fishers per boat (N. Caputi, personal communication). In 1963 when the fishery became limited entry, there were 836 vessels. This equates to approximately 2,090 people (skippers and crew) actively fishing for lobster during the season. By 2014 this had fallen to 235 vessels (588 people), a further 6% decline from the 251 vessels that fished during the previous season (de Lestang et al., 2014) (Figure 3).
Figure 3. The number of commercial rock lobster boats actively fishing since 1963/64.

(Figure modified from de Lestang et al., (2012). Additional data supplied by the Department of Fisheries, Research Division)

The decrease in the number of vessels reflects the national trend with a decline in employment in the Australian fishing sector (ABARES, 2015). Huddleston and Tonts (2007a) followed the number of lobster boats and people employed between 1989 and 2005 noting the decline in vessels. It was thought the decline was from the selling of Entitlements to other Licensees and amalgamation of Licences for the purchase of bigger boats (Huddleston & Tonts, 2007a). However the reduction in the WA lobster fishing fleet in the period between 2006 and 2012 was much more significant (Figure 3).

It is difficult to gauge the actual numbers of people associated with the lobster fishery and allied industries, including processors, engineers, chandlers, boat builders, transportation, other marine services as well as the associated port facilities. The 2011 census data indicated 443 people employed in the lobster and
crab fisheries in WA (ABARES, 2015). This figure is significantly lower than crew numbers estimated using the number of boats in the lobster fishery only, i.e. 279 boats equating to 698 people (Department of Fisheries, 2011; Fletcher & Santoro, 2013). This discrepancy may be a result of timing, with the fishing season not coinciding with the census data collection, and/or fishers not recording fishing as their employment at that time.

Many coastal Australian towns are considered ‘fishing towns’ (Van Putten et al., 2014a) and this is the case in WA, particularly in the West Coast Bioregion where the lobster fishing activities have often been the genesis of the communities and remain an intrinsic part of the social fabric of these coastal towns.

While examining the socio-cultural characteristics of fishing towns along the WA coast, Huddleston and Tonts (2007a, b) reported that the fishers’ participation in the lobster industry was linked as much to lifestyle choices as to economic objectives, and they had a strong engagement in local social institutions and networks. The report found that ‘there was a strong desire on the part of most fishers to remain in their communities if possible and that the level of attachment to both the physical location and the social networks therein were very high.’ The fishery was understood to be ‘...more than simply an economic activity.’

Following on from this, Huddleston (2009) notes in her PhD: ‘...the need for a holistic view of fishery management that takes into consideration not only biological sustainability, but also promotes an understanding of fishers’ behaviours and fishing patterns and the consequent effects on specific communities.’

Huddleston’s (2009) comments followed her research project (2002-04) investigating the impacts of restructuring and adjustment in the lobster fishery, primarily to gauge whether management of the fishery should move from input (restricting fishing effort) to output (limiting catch) controls, known as quota management. A ballot across the fishery was held and the outcome was overwhelmingly to remain with input controls (Author’s comment).
However, 2006 heralded a significant change to the WA Rock Lobster Managed Fishery. The number of puerulus settling along the coast declined significantly and in 2008 was the lowest on record (Caputi et al., 2010a; de Lestang et al., 2014). The initial concern was that the fishery was being overfished. To protect the breeding stock, the Western Australian Department of Fisheries intervened rapidly with a massive 50% catch reduction from the long term average catch, that is: approximately 11 000t to 5 500t in the 2009/10 season (de Lestang et al., 2014; Fletcher & Santoro 2008; Tull et al., 2015).

In the 2010/11 season the style of fisheries management also changed from input to output controls or quota management (de Lestang et al., 2014). This gave fishers an individual unit entitlement and increased the fishing season over time to the current 12 months. (http://www.fish.wa.gov.au/Fishing-and-Aquaculture/Commercial-Fishing/Commercial-Fishing-Management/Pages/Industry-Notice-Board.aspx).

There was much uncertainty about the future economic viability of the fishery and many fishers left the industry. In the space of a few years the fleet was reduced by about a half (Figure 3).

As a result, the fishery approached maximum economic yield (Reid, 2009) with the number of lobsters per pot increasing from approximately 2kg/pot lift to around 6kg/pot lift. The price of lobsters went from an average of $28.50/kg in 2006 to $48.02/kg in 2014 (de Lestang et al., 2014).

Research since 2006 has investigated a number of explanations of the reduction of puerulus numbers along the coast. Given the record high breeding stock numbers, the overfishing explanation has been dismissed. Rather it appears to be some environmental issue(s) linked to climate change. The increased water temperatures have resulted in an earlier spawning time causing them to be “out of sync” with some other necessary environmental parameters (Caputi et al., 2010a, b; de Lestang et al., 2014; Melville-Smith & de Lestang, 2006). As the lobster larvae can move up to 1 500km offshore (Phillips et al., 1979), the well-documented reduction in storms and associated south-westerly winds in southwest WA may inhibit the
return of the larvae to the coast (de Lestang et al., 2014). Other biological changes of the western rock lobster that are linked to climate change trends include: changes in their growth pattern; smaller size of migrating lobsters; and smaller size animals at maturity (de Lestang et al., 2014).

The environmental changes including increased sea water temperatures (Pearce & Feng, 2007) and decreased rain-bearing winter lows are consistent with climate change predictions (Caputi et al., 2010a, b).

**Marine impacts of climate change in southwest WA**

The southwest of Western Australia is considered ‘particularly vulnerable to climate change with sea levels rising at more than double the global average’ (Climate Commission, 2011) and an increasing sea temperature of between 0.6 and 1 degrees over the past 50 years (Pearce & Feng, 2007). It has recently been recognised as one of 24 ‘global hot spots’ (Hobday et al., 2016; Hobday & Pecl, 2014; Pecl et al., 2014).

The marine environment and coastal climate of southwest WA is dominated by the Leeuwin Current; a warm water, low nutrient southward flowing current which has traditionally been strongest in autumn and winter (Pearce & Walker, 1991).

In 2011 there was a ‘marine heat wave’ off the mid-west coast of WA (Bureau of Meteorology, 2012; Caputi et al., 2014; Feng et al., 2013; Pearce et al, 2011; Pearce & Feng, 2013) with water temperatures between 4 and 5 degrees higher than normal (Feng et al, 2013; Hobday et al., 2016; Pearce et al., 2011) for an extended period (10 weeks) along an extensive length of coastline (> 2 000km) (Wernberg et al., 2013). This unusual event resulted in widespread fish and invertebrate kills and impacts on corals, seaweeds and seagrasses (Abdo et al., 2012; Moore et al., 2012; Smale & Wernberg 2011, 2013; Wernberg et al., 2013, 2016), and also in little penguins (Cannell et al., 2012; Caputi et al., 2014). The impacts on fisheries in the Gascoyne and West Coast Bioregions were extensive; the scallop and abalone fisheries remain closed (Fletcher & Santoro, 2015). There is evidence that there has been a shift in marine community structure with a reduction in habitat-forming
seaweeds and tropicalisation of fish communities (Cheung et al., 2012; Wernberg et al., 2013).

The marine ecosystems of WA are biodiversity and endemism hotspots (Kerswell, 2006; Tittensor et al., 2010; Wernberg et al., 2012). Given the highest magnitude warming event on record in 2011 (Wernberg et al., 2013) and subsequent anomalous high summer temperatures for the three years following 2011 (N.Caputi, personal communication) and predictive models for climate change indicating ongoing changes to water temperature, salinity, acidification, currents and storms (IPCC, 2014), it is likely that changes to the marine environment of the southwest of WA will be significant and ongoing. These may manifest as a state-wide cascade of impacts on the fisheries, fishers and coastal fishing communities.

Abrolhos Islands

The Houtman Abrolhos Islands are better known as ‘the Abrolhos.’ They are a group of over 120 low-lying coral and limestone islands situated about 70km off the coast of Geraldton in the West Coast Bioregion. They are part of the most southerly located coral reef systems in the Indian Ocean and also one of the highest latitude coral reefs in the world (Abdo et al., 2012; Harris et al., 2008; Webster et al., 2002).

The coral reefs exist primarily because of the Leeuwin current which transports warm waters from the north. However the Abrolhos Islands are considered a transition zone (Abdo, 2012; Commonwealth of Australia, 2006; Wilson & Marsh, 1979) with a mix of tropical waters from the north and cooler temperate waters from the south. This gives rise to a unique assemblage of both tropical and temperate species of marine flora and fauna (Hatcher et al., 1987; Hutchins, 1997a,b; Watson et al., 2007; Webster et al., 2002), and most notable is the association of tropical coral reefs and temperate macro-algae (Wells, 1997).

The impact of the weather on these low-lying Islands and the marine environment is profound. Persistent strong winds (>32km/hr for 44% of the time), large swells and winter storms have been important factors in causing significant physical
disturbance of the reef system (Webster et al., 2002), the terrestrial environment and shaping the community.

The Islands are an internationally recognised seabird breeding area, and it is worth noting that the first industry on the Islands was for mining guano, with tens of thousands of tons removed over about 20 years from 1882 (Gray, 1999).

Although there is mention of fishing and the abundance of ‘crayfish’ at the Abrolhos Islands much earlier than the guano industry (1843), it was not until the second world war and the canning of lobster tails, followed by a strong market for lobsters in the USA that fishing for lobsters really developed at the Abrolhos (Gray, 1999; Tull et al., 2015). This was the start of the long lobster fishing history at the Islands. In some cases, fishing licences have now been handed down over three and four generations.

The Abrolhos Islands are considered to be the ‘heart’ of Australia’s largest and most valuable single species fishery, contributing an estimated 50% of the eggs for the entire fishery. The Abrolhos, known as the ‘A zone’ for fishery management purposes, produces approximately 15% of the State’s lobster catch (de Lestang et al., 2012).

There is a range of other fishing activities on the Islands including commercial (fin fish, and saucer scallops), charter (fishing and diving), recreational fishing and aquaculture (pearling and coral grow-out) (Fletcher & Santoro, 2014). However the main industry is the lobster fishery which targets the western rock lobster.

Most of the Islands are uninhabited; however approximately 20 of the Islands have fisher’s camps or dwellings on them. The Islands are divided roughly into four groups and until recently had strong communities on each.
E. Research questions

My research project responded to two questions.

1. How has climate change affected an Australian fishing community?

The research contribution was the first documentation of the collapse of a fishing community in a changing climate.

2. What are effective methodologies in working with fishing communities to understand the role of climate change?

The research contribution was to innovate methodologies to enhance engagement with fishing communities and develop shared understandings of climate change.
F. Research design
This doctoral research project was planned to investigate ways to increase fishers’ knowledge and understanding of climate change. I had substantial ‘insider knowledge’ as a long standing fisheries scientist and manager. As a regular visitor to the Abrolhos Islands over a number of decades and earlier participant in lobster fishery management, I was shocked at the beginning of the project to discover the declining state of the Abrolhos communities and hear the often emotional comments from the fishers about their sense of loss. It quickly became apparent that this project would also record the cascade of changes fishers had observed in the marine environment and their community.

In line with the social constructionist approach described in the theoretical framework, I applied a research design that was deeply interpretive and used methods that enabled the social construction of knowledge rather than seeking to present or define a positivist view or single scientific truth.

The present research can be termed ‘Ethnographic Action Research’ (Tacchi et al., 2003). Ethnography is typically used to understand different cultures (Dick, 2000; Kemmis, 2009; Tacchi et al., 2003). Action research ‘is used to bring about new activities through new understandings of situations’ (Tacchi et al., 2003). Taken together, ‘ethnography is used to guide the research process and action research is used to link the research back to the projects plans and activities’ (Tacchi et al., 2003).

This research project was ethnographic, recording in detail the culture and stories of a small island fishing community off the midwest coast of WA while sharing information on the changes being observed and recorded in the marine environment. The process of ethnographic research can be described in simple terms as ‘... joining a group, watching what goes on, making some notes and writing it all up’ (Bryman, 2008). However, the techniques used for the present research go far beyond Bryman’s description and are better represented by Tacchi et al., (2003) who comment: ‘An ethnographer looks for patterns, describes local relationships, understandings and meanings. Ethnography takes a holistic approach
to the subject of study, that is, the ethnographer looks at the whole social setting and all social relationships. S/he also seeks to contextualise these in wider contexts (e.g., the wider economy, government policies, politics, etc’). Such an approach is thus able to generate rich understandings that enable effective use of knowledge (Tacchi et al., 2003). An ethnographic approach to research can yield a range of relevant grounded information and can produce rich understandings and allow for the more effective use of knowledge and information (Tacchi et al., 2003).

The present research can also be characterised as action research in the sense that it had both action outcomes and research outcomes (Dick, 2000; Kemmis, 2009). It was participatory, largely qualitative and followed the phases of: plan, act, observe, reflect; and then plan for the next cycle (Dick, 2000; Kemmis, 2009) in a responsive and adaptive process. During the ‘act’ phases, several ‘interventions’, designed to enable change through community dialogue and reflection, were introduced. These interventions and their results were then documented as part of the research (observe and reflect). Several techniques were innovatively and uniquely combined for data collection and intervention including:

- Photovoice
- Interviews, surveys and workshops
- Participant observation
- A collaborative, co-produced exhibition.

In summary, bringing ethnography and action research together, ‘ethnographic action research involves the production of knowledge through rigorous, well-planned, structured and self-aware methods. All participants in a project can contribute to the research, feeding back their thoughts and observations and actively engaging with the research process’ (Tacchi et al., 2003).

The specific methods used in the present study are fully described by Shaw, Stocker and Noble (2015); Shaw (2014), and Shaw and Stocker (in press). Following are brief descriptions of the methods used.
Photovoice

Photovoice is a social science technique that gives people a voice through the lens of a camera. Since its development in the mid-1990s by Caroline Wang and colleagues, this community-based participatory method has received growing attention in health education and related fields (Catalini & Minkler, 2010; Wang, 1999; Wang & Burris, 1994, 1997, 2001). In a seminal article (Wang & Burris, 1997), Photovoice was described as having the three main goals:

- ‘To enable people to record and reflect their community’s strengths and concerns
- To promote critical dialogue and knowledge about important issues through large and small group discussion of photographs, and
- To reach policy makers.’

More recently Photovoice has also been used to ‘build consensus about adaptation to climate change’ (Baldwin & Chandler, 2010) and create visual narratives (Blackman & Fairey, 2007; Chandler & Baldwin, 2010). As this research project was aiming to share knowledge about climate change and create new cultural narratives, the technique was seen as an effective tool to record changes and tell the fishers’ stories.

The Photovoice method also enables groups, who may be socially marginalised or disadvantaged, to have a conversation and convey their perspectives on significant issues affecting their lives and communities (Baldwin & Chandler, 2010). Fishers in Australia are not socially marginalised or necessarily disadvantaged; however many fishers are uncomfortable speaking out in formal workshop settings or writing responses to surveys. As Photovoice enables people to speak through their photographic images, it was not perceived as intimidating. There was also familiarity with the photographic process: given everyone has access to a camera or smart phone, most fishers and their families at the Abrolhos Islands regularly take photos of their island and marine environment.
Structured and semi-structured: interviews, surveys and workshops

Surveys (both qualitative and quantitative), interviews (structured and semi-structured) and workshops (on each Island group and on the mainland) (Patton, 1990) were used to enhance the Photovoice method. To maximise participation in the project and at the workshops, a local fisher who was a well-known, trusted community leader was engaged to invite participants and liaise with fishers throughout the project.

Surveys were conducted with fishers at the start of the project in order to identify any recent environmental changes they had observed and understand their views on climate change.

Workshops on each of the Island groups were held to share knowledge between scientists and fishers and introduce the project. After photographs had been collected, a workshop was held on the mainland to select the best photographs for the exhibition and discuss the cascade of changes.

One-on-one interviews (semi-structured) were conducted after the initial workshops to re-engage fishers in the project and better understand their views and values. At the end of the project, interviews were again conducted with fishers to gauge the success of the method used, their sense of attachment to place and their views on climate change after the project. Interviews were held with Museum staff in Geraldton and Fremantle involved with the project or working on the floor of the exhibition to gauge their reaction to the exhibition and the responses of visitors to the exhibition.

Participant observation

Participant observation has become a ‘common feature of qualitative research in a number of disciplines’ (DeWalt & DeWalt, 2010). It is used to gain a greater understanding of the issues from the participants’ viewpoints (DeWalt & DeWalt, 2010). In this study, participant observation complemented the interviews and Photovoice method, providing depth and understanding of the issues brought up by the community.
A collaborative, co-produced exhibition

A large collaborative, co-produced exhibition was held at the WA Museum in Geraldton. The story was told with a complex of mixed media including: fishers’ photographs, quotes taken from interviews, animations of currents and larval movement offshore, text boxes with information on the fishery, environmental changes the fishers and scientists had observed, local art works, video vignettes of fishers and their stories, modified documentaries of the Abrolhos Islands and published information on climate change. The exhibition was designed to represent the perspectives of both the scientists and the fishers rather than trying to define a single scientific truth.

The exhibition was also shown in Albany and Fremantle, Western Australia and a book of the exhibition produced.
G. Overview of findings
The Overview of Findings is in two parts. The first focuses on the research question: *How has climate change affected an Australian fishing community?* This was addressed by documenting the collapse of a community in a changing climate and investigating the reasons underpinning the collapse.

Four publications contributed to answering this research question:

**Paper 1**  

**Paper 2**  
[http://dx.doi.org/10.1080/18366503.2015.1014016](http://dx.doi.org/10.1080/18366503.2015.1014016)

**Paper 3**  

**Paper 4**  

The second research question is: *What are effective methodologies in working with fishing communities to understand the role of climate change?* The research contribution was to identify and develop methods that increase the understanding of climate change in fishing communities.
The above four and following three publications contributed to answering this research question:

**Paper 5**  
[http://dx.doi.org/10.1016/j.ocecoaman.2013.02.009](http://dx.doi.org/10.1016/j.ocecoaman.2013.02.009)

**Paper 6**  
[http://dx.10.1016/j.ocecoaman.2012.11.008](http://dx.10.1016/j.ocecoaman.2012.11.008)

**Paper 7**  
Photovoice: an innovative method for the uptake of climate change science. Methods, p. 87-90.
1. How has climate change affected an Australian fishing community?

Climate and environmental changes leading to the loss of a fishing community

In 2006, the Abrolhos fishing community was thriving with approximately 1,000 people on the islands at any one time during the intense 3.5 month fishing season. Around the Easter period this number would swell to about 4,000 people (G. Finlay, personal communication). Five schools were open and the community halls and associated social clubs in each Island group were successful and profitable (Paper 1- Shaw & Stocker, in press; Paper 2- Shaw, Stocker, & Noble, 2015). The WA Rock Lobster Managed Fishery was the largest and most valuable fishery in Australia, and lobster breeding stocks were at high levels (Section D).

However six years later the fishery and the Abrolhos community had altered significantly. This was the result of a cascade of changes including: climate and environmental changes, management intervention, economic responses, and social outcomes (Figure 4).

This story was told by fishers and scientists; qualitative data were collected from workshops, surveys, interviews, participant observations and photographs (Section F).
Climate-related changes

In 2006, climate scientists were reporting changes to the ocean currents, rising sea levels and increased sea temperatures. In WA there was a reduction in winter storms and corresponding rainfall in the southwest (Sections B & D) (Figure 4).

Figure 4. Flow diagram illustrating the cascade of events affecting the Abrolhos Islands fishing community.
Environmental changes

In 2006, fisheries scientists reported a significant environmental change: unusually low numbers of lobster larval (puerulus) had settled along the WA Coast. In 2008 the lowest puerulus settlement on record occurred (Paper 1- Shaw & Stocker, in press; Paper 3- Stocker & Shaw, 2016) (Section D). In 2011 a ‘marine heatwave’ had significant impacts on the Gascoyne and West Coast bioregions and scientists recorded the first-ever coral bleaching at the Abrolhos Islands (Paper 4- Shaw, 2013) (Section D).

Fishers had also observed changes to the marine environment. When asked, all fishers could give material examples of changes they had observed (Paper 4- Shaw, 2013; Paper 1- Shaw & Stocker, in press) including Islands disappearing and rising sea levels, changes to marine plants, changes to coral growth, coral bleaching and some unusual tropical fish and invertebrate species taking up residence. In a formal survey (49 fishers), 71% indicated they had noticed changes in the weather or other marine-related areas. However, when asked if the climate was changing, only 58% indicated ‘yes’. This result supported anecdotal information that fishers were observing changes to the marine environment but not necessarily linking those changes to climate change.

Management intervention

With the reduction in puerulus settlement, the Department of Fisheries intervened rapidly to protect the breeding stock and reduced the catch by 50%. Two years later the Department of Fisheries adopted a quota management system for the Abrolhos Islands lobster fishery (Section D). Under quota management, the season was extended to eight months in 2012 and 12 months in 2013 (Paper 2- Shaw, Stocker & Noble, 2015).

Between 2006 and 2012 the number of active fishing licences approximately halved (Figure 3).
Economic responses

However, these management changes which protected the lobster stock also had a significant impact on the economics of the fishery (Paper 2- Shaw, Stocker & Noble, 2015; Paper 3- Stocker & Shaw, 2016). At the Abrolhos Islands, the number of fishers operating fell by about 50% (G. Finlay, personal communication).

Many leaving the industry tried to sell their vessels. Others, particularly family members, amalgamated their licences to give them access to larger unit entitlements. To remain viable, many fishers leased additional pots. Other fishers took up additional employment, particularly in the oil and gas industry (Paper 4- Shaw, 2013). Some locked up their camps and waited to see if the situation would improve (Paper 4- Shaw, 2013; Paper 2- Shaw, Stocker & Noble, 2015; Paper 3- Stocker & Shaw, 2016).

The economic outcomes for the fishers remaining in the industry have varied; however pot prices, pot lease prices, catches per pot and lobster prices have all increased. Fishers’ tactics altered because the newly introduced quota management allowed fishing over an extended period (12 months) rather than the previously compressed season (3.5 months). This resulted in fishers changing their tactic to ‘fishing to price’ that is; catching their allocated quota when the price was high. It was common to hear ‘… we won’t go out [fishing] unless the price is at least $35/kg … (2013)’. In 2015 the price reached $90/kg. As the as the pot prices and lease price of pots has increased, so has the fishers’ ‘break-even’ price. Abrolhos fishers now (2016) maintain that the lobster price has to be $50/kg for them to break even (L. Noble, personal communication).

Over the life of the project, the price per kilogram of lobster increased, as did the fishing efficiency, which is the average number of lobsters caught in each pot. The lobster breeding stocks reached record high levels (Paper 3- Stocker & Shaw, 2016). Thus for the lobster population and those fishers remaining in the industry, the results of management interventions have had positive economic impacts. However for fishers who had to exit the community, the economic impacts were largely negative.
Community collapse

The above events cascaded through to the Abrolhos Islands community, having a negative social impact.

During interviews, surveys and discussions, fishers spoke about their values: their social, cultural, economic and environmental values. They commented on the changes they had observed in the marine environment, their industry and fishery. Mostly they spoke about changes to their community, the loss of social values, and the loss of their community (Paper 4- Shaw, 2013; Paper 2- Shaw, Stocker & Noble, 2015; Paper 3- Stocker & Shaw, 2016).

A Photovoice exhibition successfully told the fishers’ story through their photographs and quotes. It recorded and documented the collapse of a community and illustrated the linkages between climate and environmental changes, management responses, economic outputs and social changes (Paper 4- Shaw, 2013; Paper 1- Shaw & Stocker, in press; Paper 2- Shaw, Stocker & Noble, 2015). See below RQ2.

The community as it was

In 2006, five schools were open, community halls were thriving and sporting and other community events were commonplace. There were five carrier boats operating, multiple air services, emergency medi-vac helicopter facilities and Silver Chain Nursing post for the season (Paper 4- Shaw, 2013; Paper 1- Shaw & Stocker, in press; Paper 2- Shaw, Stocker & Noble, 2015; Paper 3- Stocker & Shaw, 2016).

Fishers spoke about their proud history in the fishery and the fishing licences that had been handed down over generations; the way that knowledge was learned, fishing in the ‘old days,’ the strength of their communities and the social life (Paper 3- Stocker & Shaw, 2016). They referred to themselves as ‘Abrolhos fishers born and bred’ and that their kids ‘grew-up’ and ‘went the school’ at the Abrolhos, even if they also fished elsewhere and spent more time attending school in Geraldton than at the Abrolhos Islands (L. Noble, personal communication).
Fishers talked about their strong sense of community and their environmental stewardship of the islands. They had a strong attachment to place and their industry. This was evident from their interviews, comments (Paper 3- Stocker & Shaw, 2016), photos and stories (Paper 4- Shaw, 2013, Paper 1- Shaw & Stocker, in press).

The community now

The closed schools and community halls, locked camps, empty jetties and overgrown sporting fields are very different from the vibrant community recalled from the recent past. There is only one air charter service functioning and Silver Chain operates a reduced nursing post. There is no emergency heli-vac support and the supply/carrier boats have been reduced from five to two vessels (Paper 4- Shaw, 2013; Paper 1- Shaw & Stocker, in press; Paper 2- Shaw, Stocker & Noble, 2015; Paper 3- Stocker & Shaw, 2016).

The material changes described have had a profound effect on the social fabric of the community. More difficult to measure are the flow-on effects that resulted in increased levels of stress, depression and suicide (Paper 2- Shaw, Stocker & Noble, 2015).

The cascade of changes: climate and environmental changes, management intervention and economic responses, resulted in the collapse of an iconic Australian fishing community.

This cascade was represented in the exhibition (see RQ2). The following comment written on a comment card at the exhibition in Geraldton summed up the view of many: ‘Quite an eye-opener. The exhibition, showing how much impact the changes have regarding community life and so on. All that in such a short amount of time. Very sad.’

Could this situation have been averted?

The changes to the marine environment as a result of anthropogenic climate change are understood and well documented (Section B). Less well known are the biological impacts from the complex physical responses to the changing climate.
This is particularly evident with existing biological knowledge gaps and especially those species with complex life cycles such as the western rock lobster (Section B). Fisheries scientists linked the 2006 decline in the number of lobster puerulus to environmental factors rather than overfishing. These environmental factors were consistent with climate change predictions (Section D).

If the focus of the fisheries management decisions was the status of the stocks alone, the decisions made after the decline in puerulus settlement were justified and successful: the fishery was protected and the puerulus settlement has increased.

If however the social impacts were important and community collapse to be averted, other issues should have been considered. Shaw, Stocker & Noble (Paper 3-2015) argue that the social implications of the management decisions were not evident and in fact this may have been an unintended consequence of the invisibility of women and families who make up fishing communities generally and the Abrolhos Islands in particular.

WA is also considered a leader in the practical implementation of EBFM and under this process social consequences should be considered as part of all management decision-making (Section D). It appears that the social implications and the collapse of this fishing community were not fully considered in the management decisions. Community collapse was thus an unintended consequence of protecting the lobster stocks and maintaining Australia’s most valuable single species fishery after climate and environmental changes.

Spangenberg (2011) describes two approaches to sustainability science i) sustainability for science and ii) sustainability of science. These two branches of sustainability science have distinctive features with one branch (science for sustainability) being monodisciplinary and academic in nature, whereas the sustainability of science, described as a process necessary to achieve sustainability, is transdisciplinary, academic and social with an extended stakeholder community (Spangenberg, 2011).
The State of Western Australian has an international reputation for managing fisheries sustainably, including the rock lobster fishery (Fletcher & Santoro, 2015). The agency responsible undertakes the science that underpins the sustainable management of the fisheries, which is the science for sustainability. In this doctoral research I have focused on the science of sustainability which addresses the ‘complex dynamics that arise from interactions between human and environmental systems’ (Clark, 2007). If this model was enacted by the State it could be argued that the outcome for both the fishery and the fishing community may have been sustainable.
2. **What are effective methodologies in working with fishing communities to understand the role of climate change?**

**Innovative methods**

A premise of this research was that the impact of climate change on fishing communities is complex and subject to multiple interpretations. Because of this, and as discussed in the theoretical framework (Section C) this research has taken a socially constructivist approach.

Innovative methods were initially investigated as part of the collaborative research program undertaken by the CSIRO Flagship Coastal Collaboration Cluster (Paper 5- Clarke et al., 2013). This research, early in my PhD, provided a strong background and early uptake of new processes, tools and techniques for knowledge sharing, knowledge uptake, and collaboration (Paper 5- Clarke et al., 2013).

**Boundary organisations**

With my long family history in the commercial fishing industry and extensive professional background as a fisheries research scientist, fisheries manager and marine science communicator, I was aware of the boundaries between science research, policy, and fishers and the difficulties in moving across these boundaries.

One key approach in spanning the science policy boundary is the use of boundary organisations and boundary (agents) spanners (Paper 5- Clarke et al., 2013; Paper 6- Shaw, Danese, & Stocker, 2013). In my research I developed an understanding of this approach through a case study in Tasmania where I worked with a small national environment organisation with strong links to the fishing industry (Paper 6- Shaw, Danese & Stocker, 2013). The organisation, OceanWatch Australia (OWA), appeared to outwardly fulfil the criteria of a functioning boundary organisation relevant to climate change science and the fishing industry. The OWA officers were acting as boundary spanners. This research identified that the officers presented with high levels of credibility and legitimacy: two prerequisites for successful knowledge uptake (Paper 6- Shaw, Danese & Stocker, 2013). A third criterion, ‘salience’, was more difficult to achieve. In terms of boundary organisations and
knowledge, salience responds to the question: ‘is the science answering the right question?’ In some cases the data available were not seen to be relevant to the particular fishery: the models not of a fine enough scale, and the projections beyond the life expectancy of the fishers (Paper 6- Shaw, Danese & Stocker, 2013).

This perception of the OWA Officers and their belief that fishers were not interested in engaging in climate change science combined with their close personal links to the industry and local community may have limited their capacity to deliver technical information on climate change. It appeared that a number of the officers believed their credibility in the community would be diminished if they raised this complex and contentious topic (Paper 6- Shaw, Danese & Stocker, 2013).

In summary what I learnt from this research was:

- Boundary organisations and boundary agents can be important in moving complex technical information such as climate change information between scientists and decision-makers, in this case fishers.
- The salience of the information can be improved by down-scaling climate change data to more relevant geographic and temporal scales.
- The nature of the boundary spanner’s relationship to the fishing community and the scientists is important. It is possible to be too close or too removed from either.
- Other more innovative methods, organisations and processes may be necessary to engage fishing communities in climate change (Paper 4- Shaw, 2014, Paper 6- Shaw, Danese & Stocker, 2013).

I adopted the learnings from this initial case study when approaching the Abrolhos project. In this major action research project, I played the role of a boundary spanner working between the fisheries researchers, oceanographers, climate change specialists and commercial fishers. Curtin University was used as the boundary organisation because of its credibility with stakeholders. In this capacity as a boundary spanner working within a boundary organisation, I deployed the institutional processes of convening, translating, mediating and co-producing
knowledge. These processors did not occur in a simple linear sequence but rather at different times, places and ways throughout the project.

The salience of the climate change knowledge shared with fishers was enhanced by the scientists presenting at workshops covering issues directly relevant to the Abrolhos Islands environment and lobster fishery (Paper 5 - Clarke et al., 2013; Paper 7 - Shaw, 2014; Paper 6 - Shaw, Danese & Stocker, 2013). Visualisations and animations were powerful tools used to explain complex climate data such as ocean currents and offshore larval movement (Paper 5 - Clarke et al., 2013; Paper 1 - Shaw & Stocker, in press). Word clouds summarising interviews from fishers compared with interviews with the scientists were important in graphically portraying the different frames of these two groups (Paper 4 - Shaw, 2013; Paper 1 - Shaw & Stocker, in press).

The nature of my role as project lead, researcher and boundary spanner was managed carefully to build trust and credibility with both the fishing community and the scientists. A local ‘insider,’ and community leader was part of the Project Steering Group (Paper 2 - Shaw, Stocker & Noble, 2015). By introducing me to the fishing community as a trusted colleague with a family and work history in the fishing industry, I gained a level of trust and credibility via the respected ‘insider.’ Legitimacy came from being a researcher at Curtin University and having previously worked in fisheries research and rock lobster management. This extensive fisheries and marine research experience afforded close collegial connections with the scientists.

Following the comprehensive knowledge paper (Paper 5 - Clarke et al., 2013), the case study described in Shaw, Danese & Stocker (Paper 6 - 2013) and lessons learned above, it was evident that for a complex issue such as climate change, innovative methods were necessary to effectively engage fishing communities.

Cultural models

As outlined in the theoretical discussion (Section C), one of the challenges in climate change dialogues is that different groups in society enact different cultural models
about the coast. These cultural models which also point to different worldviews and ways of framing information reflect different understandings of the natural world, the nature of knowledge and the role of communities.

As outlined in Stocker and Shaw (Paper 3- 2016) the fishing community at the Abrolhos Islands have a combination of productivist and community cultural models of the coast. The community aspect is demonstrated in their living together as a tight-knit community with a strong sense of belonging and identity. This lifestyle is central to the meaning that these fishing families have made from their lives over generations: it includes the significance given to the social interaction in the Abrolhos Islands clubs, schools, and sporting events and the cultural development that occurs as fishers make and express meaning through their shared sense of place. However the fishers are there to fish and their livelihood depends on harvesting lobsters. Their stories also talk of the economic impact of the changes at the Abrolhos Islands and this aspect points to the productivity model of the coast (Paper 3- Stocker & Shaw, 2016).

By contrast, fisheries managers and fisheries scientists enact solely a productivist cultural model of the coast in which industry and science unite to utilise coastal resources for the betterment of the wider community. In the long term this is primarily served by maintaining stock numbers. Fisheries managers do not necessarily understand or prioritise the significance of a community lifestyle for the Abrolhos fishers. In this case the stock numbers were maintained with prompt intervention by the managers and the productivity model enacted. Although these actions were arguably protecting the fishing community by ensuring the fishery did not fail or become commercially extinct, the actions had serious ramifications for the livelihoods of the fishers who had to exit the industry. This productivist management action also impacted on the fishers’ ability to enact the community cultural model and devastated the fishing community life (Paper 3- Stocker & Shaw, 2016).

Fishers and scientists also have differing views of epistemology. Fisheries managers and scientists rely primarily on their own empirical scientific results (Section C)
whereas fishers hold substantial tacit and informal knowledge about the marine environment and they frame it in different ways (Section C). Fishers’ ability to operate successfully in the marine environment is largely based on knowledge derived from experience, observations and often inter-generational exchange. There is little training and few formal qualifications for commercial fishers.

**Knowledge production and partnerships**

These differences in cultural models and epistemology lie at the heart of the challenge of creating meaningful dialogue about climate change and they are the kinds of differences that can be best resolved through sophisticated boundary spanning and engagement processes. Where these boundary spanning and engagement processes are successful they can lead to the development of significant knowledge partnerships whereby different types of knowledge generated under different cultural models can be brought together to tell a more complete story than any of the groups could tell alone (Asian Development Bank, 2011; Dodson, 1995; Paper 3 - Stocker & Shaw, 2016).

**Photovoice**

Applying the higher order theories of: boundary organisations, cultural models, knowledge production and partnerships (Section C Theoretical framework), I chose to develop and expand a little known methodology: Photovoice (Section F Research Design). The theories above are all strongly linked to the social construction of knowledge. Expanding and developing the theory of the Photovoice method (Figure 5), I was able to demonstrate that it could be enacted with a better result than Wang ‘s approach (2005) would have done in the context of the Abrolhos Islands fishing community.

The method was modified and further developed given the particular community and the research objectives (Figure 6). Some of the concerns before embarking on the project included: fishers’ reluctance about engaging in climate change discussions, the perception they were suspicious of researchers, lacked trust in Government officials, their fluidity and lack of availability given they are often at sea
or working elsewhere, the isolation of the community and distance of the Abrolhos Islands from the mainland, restrictions in visiting and staying on the Islands, and awareness that fishers could lack enthusiasm to participate in a research project. For these reasons I further developed and enhanced the theory of the Photovoice method outlined by Wang and Burris (1997) (Figures 5 and 6).

Figure 5. Wang’s stages of Photovoice.

(Figure taken from Castleden et al., 2008 pg 1402, adapted from Wang 2005)
Figure 6. Theory building for Abrolhos Photovoice method

Keen to understand the fishers’ views on climate change and their local observations, I invited fishers to workshops on each of the Abrolhos Island groups for discussion and information exchange. Scientists specialising in the lobster fishery, ocean currents and coral reef ecology were also invited to share their local knowledge. These were described as the ‘information exchange workshops’ (Figure 6). Particular attention was given to the knowledge and delivery being credible,
salient and legitimate (Paper 7- Shaw, 2014; Paper 6- Shaw, Danese & Stocker, 2013; Paper 1- Shaw & Stocker, in press).

After the information exchange, we proceeded into the ‘recruitment and training workshop’ phase explaining the project and ‘photographic assignment’ (Paper 7- Shaw, 2014) (Figure 6). Because of the issues outlined above, it was important to go back to the Islands and re-engage the fishers, answering any questions about the project and the ‘photographic assignment’ (Figure 6). This was achieved with ‘one-on-one’ semi-structured interviews designed to gain a better sense of fishers’ values and unpack some of their observations in relation to changes to their community and the marine environment. The ‘Interviews 1: 1 and re-engagement’ (Figure 6) was an important development of the method for this community and occurred with individuals on their home Islands and in their houses (Figure 6).

The surveys were analysed, interviews transcribed and photos collected. With over 1 000 photographs received, multiple interviews and stories, and the difficulty bringing the large number of fishers together for a workshop, we proceeded to the ‘codification of issues and themes’ (Figure 6) and undertook this phase with the project steering group. This small group included researchers, a fisher, an exhibition specialist and an Abrolhos Islands community member. The group linked the photos to themes generated by the researchers.

Fishers available on the mainland were then invited to discuss the themes and select the ‘best photos’ i.e. those that best described their stories (Figure 6). The images selected were then curated into a large exhibition (Paper 4- Shaw, 2013, 2014, Paper 1- Shaw & Stocker, in press). The ‘co-produced exhibition’ then enabled us to ‘reach others to create change’ (Figure 6).

In the exhibition, fishers’ quotes associated with the themes were used to give additional voice and meaning to the photos taken by the fishers. Pictures taken over time were used to compare existing and previous images, for example: jetties covered in water, disappearing islands, bleached corals and unusual tropical species. Video vignettes of fishers told their stories, described their industry, and the changes to their community. The science of climate change was woven
throughout the exhibition with animations of the Leeuwin current and puerulus, text boxes and published information (Paper 4 - Shaw, 2013; Paper 1 - Shaw & Stocker, in press).

The co-produced exhibition was significant in the phase ‘reach others to create change (Figure 6).’ The additional phases built from the Wang and Burris Photovoice methodology (1997) engaged a large number of fishers from different Island groups to speak as one community and use their photos to tell their story of environment and community change to the greater community of Geraldton.

The power and popularity of the exhibition resulted in an invitation to tour the exhibition in other coastal towns in WA (Albany and Fremantle). ‘Evaluation (participant and community)’ (Figure 6) was enabled by visitor surveys and comment cards. Fishers and museum staff were interviewed following the exhibition to evaluate the success of the Photovoice method, exhibition and climate change knowledge exchange. Each of the methods used to rate the success of the exhibition and project was very positive (Paper 1 - Shaw & Stocker, in press).

The methodological development of Photovoice from Wang and Burris (1977) (Figure 5) to that described in Figure 6 enabled the engagement of a reluctant community on the complex, difficult and contentious topic of climate change. The additional phases: information exchange workshops, re-engagement interviews, co-production of exhibition and evaluation of both participants and the community, were keys to the success of the project.

**Structured and semi-structured interviews, surveys and workshops**

Surveys (both qualitative and quantitative), interviews (structured and semi-structured) and workshops (on each Island group and on the mainland) were used to enhance the Photovoice method and were conducted with women and men from the Abrolhos Islands fishing community to gain greater insights into the changes being experienced as well as their community perspective and values. During workshops, interviews and surveys, language was important and efforts were made to keep any information local and relevant. When interviewing and
talking to participants, I was aware of the setting and the way I dressed, being careful not to be mistaken for a representative of a government management agency or department.

To maximize participation in the project and at the workshops, a local fisher who was a well-known, trusted community leader was engaged to invite participants and liaise with fishers throughout the project (Paper 2 - Shaw, Stocker & Noble, 2015). When describing the project, the term ‘climate change’ was not emphasised. The exhibition was titled ‘Seeing Change’ (Paper 4 - Shaw, 2013; Paper 1 - Shaw & Stocker, in press).

**Participant observation**

Participant observation has become a common feature of qualitative research in a number of disciplines. It is used to gain a greater understanding of the issues from the participant’s viewpoint and in this study, participant observation complemented the interviews and Photovoice methods providing depth and understanding of the issues brought up by the community (Paper 2 - Shaw, Stocker & Noble, 2015).

**Photovoice exhibition**

Linking the three quite different stories from the climate scientists, fisheries scientists and fishers into an exhibition was complex and risky. However it was the same story, just different sides of the same story. The exhibition was structured in multiple layers, with multiple entry points and levels of complexity (Papers 4 & 7 - Shaw, 2013, 2014, Paper 1 - Shaw & Stocker, in press). The exhibition resonated with fishers past and present, those who had visited the Islands and those who had not (Paper 1 - Shaw & Stocker, in press).

In surveys following the exhibition, Abrolhos fishers believed that the exhibition represented their views very well (56%) and well (44%). (Likert scale 1-5: not at all – very much). All fishers surveyed indicated they were pleased they had participated in the exhibition; 78% were very pleased. Several fishers commented that ‘...they wished they had been more involved...’ (Paper 1 - Shaw & Stocker, in press). The fishers found the photos the most interesting aspect of the exhibition. Also popular
were the video interviews of fishers and the fishers’ quotes. The fishers were overwhelmingly in support of ‘Photovoice’ as an excellent method to tell their story. The different stories had been successfully woven together, socially constructed in a way that reflected the value of socially constructed knowledge compared with the usual positivist approaches used in climate change science communication (Section C).

Of the approximately 30 000 visitors to the exhibition, the WA Museum in Fremantle estimated over 80% were first time visitors. Comments from the Geraldton, Albany and Fremantle Museum staff backed this up and indicated that visitors had come to the Museum primarily to see the ‘Seeing Change’ exhibition. Of the visitors who completed survey forms (197), most had never visited the Abrolhos (70%), and few worked in a commercial fishery or the seafood industry (4%). However most visitors selected environmental and climate changes, as well as fisheries management, as the main causes of the changes experienced at the Abrolhos Islands. Visitors enjoyed all aspects of the exhibition, however their favourite components of the exhibition were the photos, fisher quotes and Information about the Abrolhos Islands.

Both fishers (62%) and visitors (56%) reported increased awareness of climate change issues.

The reaction of both fishers and visitors and to the exhibition was very positive measured by interviews, surveys and comment cards from fishers, visitors and museum staff. The level of interest by first time visitors and their interest in the components of the exhibition demonstrated the success of the methods used in the exhibition: the layering of the information, the linking of the different stories, the rawness of the images, the scientific and management information and the unsanitised depiction of a proud fishing community in social decline. The exhibition documented a sad story, overwhelming to some visitors. Museum staff spoke of people returning three and four times and spending hours at the exhibition (Paper 1- Shaw & Stocker, in press).
The sense of attachment of fishers to the Abrolhos Islands was very strong (82%) compared with their sense of attachment to Geraldton (18%) where the fishers officially reside. This sense of attachment to their industry and place was palpable in the exhibition and demonstrated strongly in the surveys and interviews.

Developing the theory of the Photovoice methodology, I created a collaborative and co-produced exhibition and powerfully demonstrated the value of socially constructed knowledge in the climate change debate.
H. Conclusions

Research question 1
The first research question was, ‘How has climate change affected an Australian fishing community?’ It is usually very challenging to attribute social impacts directly to climate change as these impacts may be diffuse, spread over a range of time frames, not accurately monitored, have a range of interpretations and be confounded by other changes. In this study there was a cascade of impacts starting from climate and environmental change leading to the collapse of the Abrolhos Islands fishing community. This cascade of change was documented and analysed.

There were two main drivers causal to the collapse. The primary driver was environmental change consistent with climate change forecasts. Higher sea temperature led to earlier lobster spawning and consequently to lobster larvae (puerulus) missing some as yet unknown but critical environmental cues. Combined with the reduction of SW winter storms which normally aid the return of the larvae to the coast, this altered pattern caused a crash in puerulus settlement along the coast.

The secondary driver was the management intervention put in place to protect the lobster stocks, in response to the dramatic decline in puerulus settlement. The decision to reduce the lobster catch also had the effect of reducing the number of fishers. As the fishery is largely composed of owner-operated small businesses working out of the coastal communities in the southwest of WA, the reduction in fishers had an impact on these communities. This was particularly evident at the Abrolhos Islands where only licenced fishers can reside, and only when they are actively fishing. Under Ecosystem Based Fisheries Management, social outcomes, not just environmental and economic outcomes, should be considered in all management decision-making.

Further management changes came about with the subsequent introduction of a ‘quota system’. This system gives each fisher a unit entitlement or total weight of lobster they can catch in a year. It also allows a freeing up of some of the regulations that govern fishing practices. In this case it was decided to increase the
fishing season to 12 months. At the Abrolhos Islands, the implications were evident as the fewer fishers then spread their fishing throughout the year – fishing whenever the price was high. The result was a wider temporal distribution of fishing families on the islands over the year. The services (schools) and community events could no longer be sustained and came to an end. This eventuality was of great concern to members of the Abrolhos Islands community; however it appeared not to have been an important consideration by fisheries management.

I argue that had there been a greater representation of women in the decision-making process, these potential social impacts issues may have received greater attention, and community collapse may have been averted. The EBFM process should consider the social impacts of management decisions, including the risk of community collapse. However, I suggest the invisibility of women in the process made the consideration of social issues less likely. Conversely, the inclusion of women could have reduced the extent of unintended consequences in two ways. Women could have presented a positive value on community and social wellbeing and could have contributed to improved environmental resource stewardship.

This doctoral research has also shown that the sustainability of science, compliments and enhances the sustainability for science. Without the sustainability of science, sustainability is difficult to achieve.

In conclusion, the collapse of this iconic fishing community resulted from unintended management consequences because several key issues were overlooked. Although there appear to be no specific fisheries objectives that focus on the collapse of a community, it is an important possibility which needs to be addressed in future if full sustainability is to be achieved through the interaction of socio-cultural, environmental and economic dimensions of fisheries.
Research question 2
The second research question is, ‘What methodologies are effective in working with fishing communities to understand the role of climate change?’ Working within the ethnographic action research approach, I developed and built on the methodology of Photovoice. I modified and improved it by: sharing information between fishers and scientists; engaging fishers collectively and individually on their home Islands; and using their photos and stories combined with scientific observations, visualisations and artworks to co-produce an exhibition. This multi-award winning exhibition was shown in three coastal fishing towns in WA and viewed by approximately 30,000 people. The exhibition documented changes to the fishing community and was also successful in building a shared understanding of climate change impacts in both the fishing and wider communities.

In elaborating this innovative methodology, I was informed strongly by key bodies of theory, and I also contributed significantly to theory building. I developed coastal cultural models theory by showing that the keys to the enactment of a sustainability model of coastal management are the use of a bioregional framework and the development of knowledge partnerships among stakeholders who hold and enact divergent cultural understandings of the coast. The research also uses and extends boundary organisation and boundary spanning theory to show that the co-production of knowledge can occur not just between policy-makers and scientists but with the broader community.
Figure 7. Contributors to an effective research process and outcome using a collaborative, co-produced transdisciplinary approach.

In this research the input of each of the collaborators, namely the fishing community, scientists, managers, creatives and the researchers all partially determine the outcome and play an important role in the success of the process (Figure 7). They each bring their own capability, knowledge and particular cultural model. The doctoral researcher is a boundary spanner located within the boundary
organisation, and enables boundary processes across multiple disciplines and agencies in order to maximise the effectiveness of the process and the co-produced outcome.

In seeking to apply my findings to other cases, other researchers may also benefit from engaging these actors in any collaboration and considering their respective capabilities, knowledge types and cultural models.
I. Limitations of research and future directions

Limitations
My long history with the fishing industry and professional knowledge meant I was very close to the commercial fishing community and this proximity could have arguably generated a bias. However, the purpose of an ethnographic study is precisely to present a story from the perspective of the community, so this possible weakness became a strength of the present study. Nevertheless, in order to balance my perspective on the fishing community, I also spoke to other researchers, scientists and academics who were not closely associated or aligned with the community. I acknowledge other commentators’ criticisms of the Abrolhos Islands fishing community’s early record of stewardship of the Islands and am cognisant of other critical accounts of the community.

Extensive interviews were done with fishers, museum staff and each of the project group members. This material will be used in future research publications.

Future directions
The present socially constructivist, collaborative research that enabled a co-produced exhibition to be created with fishers and scientists took place in only one fishing community. It is important to attempt to reproduce this methodology in other locations to explore its broader relevance and applicability. This would allow the model shown in Figure 7, which illustrates the importance of each type of contributor, to be theorised more fully.

During my doctoral research, I fulfilled the functions of a boundary spanner within a boundary organisation. As shown in Shaw, Danese and Stocker (Paper 6- 2013), when these functions are not met, sharing and building knowledge such as climate change science is more challenging. Trust, credibility and salience were all found to be important and without these approaches future projects could be hampered.

The establishment of clear and succinct criteria for the effective engagement of communities with complex issues such as climate change would be of benefit for the reproduction of this type of action research project. For example, how can the quality of collaboration be assessed? What sort of sensitivities do boundary spanners need with respect to socio-cultural contexts and cultural models?
The EBFM framework is set up to consider the social, environmental and economic outcomes of fishery management decisions. This process may require strengthening to take into account major social impacts such as the collapse of a fishing community.

Given that many coastal towns in Australia are considered ‘fishing towns’ and likely to be impacted by climate change, it is timely to have much more extensive dialogue and discussion about the value of these coastal communities and associated fisheries to the fabric of our society.
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Seeing Change:
An influential exhibition about climate change impacts on a WA fishing community

Jenny Shaw and Laura Stocker

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Chapter 5

Seeing Change:
An influential exhibition about climate change impacts on a WA fishing community

Jenny Shaw and Laura Stocker

Abstract
Innovative methods are required to address some of the barriers to climate change knowledge and uptake, particularly in coastal fishing communities where there appears to be resistance to the uptake of climate change science. This chapter explores the use of ‘Photovoice’, a social science methodology that uses visual images taken by participants, to help rock lobster fishers of the Abrolhos Islands (Western Australia) deepen their understanding of environmental and social change. The fishers’ photos were incorporated into a large community exhibition to illustrate the changes observed and explain the cascade of environmental change through to social decline. This participatory methodology and resulting community exhibition was very successful in the fishers’ regional community of Geraldton. As a result, the exhibition ‘Seeing Change: a photographic story from Abrolhos fishers’ has also been shown in two other centres, Albany and Fremantle, with high visitation rates. Using structured and semi-structured interviews, surveys and comment cards, we unpacked the responses from project participants, exhibition visitors and exhibition staff to understand better the value and influence of the exhibition. We found the exhibition enhanced the uptake of climate change knowledge and improved linkages among climate, environment, governance and social change in this iconic Australian fishing community.

Background
Knowledge and uptake of climate change science is important in coastal communities in the south west of Western Australia (SWWA) as they are considered particularly vulnerable to climate change. The sea level in SWWA is rising at more than double the global average, and an increasing sea temperature of between 0.6 and 1 degrees has been recorded over the past 50 years. These trends, combined with a recent ‘marine heat wave’ that caused extensive fish and invertebrate kills along the Western Australian coast, have focused the attention of the fishing industry, research scientists, fishery managers and the community on the impacts of climate change on the marine environment.

Fishers are cognisant of the many changes that occur in the marine environment perhaps because of the long hours spent on the water. Changes have been observed in: fish abundance, species distributions, current shifts and sea surface temperature fluctuations. Fishers also have an intimate knowledge of weather patterns, as personal safety and fish catches depend heavily on the ability to adapt their fishing tactics to the daily weather.

However, anecdotal evidence suggests that fishers are resistant to the traditional delivery of science, and it is well known that many of them are currently not engaging in the uptake of climate change science. For these reasons: Fisheries Research and Development Corporation (FRDC), Western Australian Marine Sciences Institution
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(WAMSII) and the CSIRO Coastal Collaboration Cluster, contributed to this research project. This knowledge is considered complex, however it is important for many industries reliant on the environment for primary production. It enables them to adapt to a changing environment and ‘future proof’ their businesses. Museums around the world have been discussing their role in complex and contentious topics such as climate change. Cameron contends that museums are predominantly “framed as places for circulating normative views around nature, culture and technology, progress and the market as a solution to climate change.” This researcher goes on to assert that there is potential for the roles of museums in Australia to change and to develop the capacity of citizens to live creatively with climate change and the challenges it poses. Cameron suggests a re-framing of museum practices from that of “a problem to be solved, to (generating) complex reflexivity and creative imaginaries.”

This debate lies at the heart of the role and function of museums in topics such as climate change. In dealing with these highly politicised topics cultural institutions can be exposed to attack from climate sceptics with vested interests. Despite this risk, there are changes to the way museums do business with a greater emphasis on collective action, networking and building critical information on complex issues such as climate change. Participatory and co-produced exhibitions can offer opportunities for museums to engage with the community more meaningfully in a topic which includes complex science as well as important cultural and social considerations. A relatively new and innovative method such as Photovoice is an example of a community-based participatory research approach which can provide an opportunity for fishers to have a voice and share their knowledge through their photographs.

Both of the present authors have a background in marine science and have experienced barriers when trying to communicate marine science to fishers and members of the fishing community. This research focuses on exploring new ways to communicate climate change science with stakeholders in ways that are meaningful and have enduring value. The research question the authors addressed was:

To what extent and in what ways can Photovoice be effective in promoting climate change dialogue in a coastal fishing community?

Objectives

The research project had a number of objectives, both practical and academic, including:

- Improving fisher and community understanding of climate change science.
- Encouraging a shared understanding of the values and issues affecting the local environment, the fishery and the community.
- Giving voice to fishers’ strong community values and sense of place.
- Evaluating whether the Photovoice methodology and resulting community exhibition is a useful method to increase understanding and knowledge uptake of climate change.

Methods

Our study area was the Abrolhos Islands, groups of 122 low lying coral islands approximately 70 kms west of Geraldton, on the Midwest coast of Western Australia (Figure 1, overleaf). These islands are considered ‘the heart’ of Australia’s largest and most valuable single species fishery, the rock lobster fishery, which has been fished for generations.

We used a visual research method called ‘Photovoice’ to give voice to this well established fishing community. Photovoice enables participants to use their own photographs and personal narratives to share knowledge and views. This method has been used previously to explore climate change impacts in a coastal community in Queensland and is considered a powerful communications tool for illustrating change in a number of research domains.
Figure 1: Map of the Abrolhos Islands (Shaw 2013)
Seeing Change

In summary the technique can:

- illustrate change
- generate insights not normally accessible
- help build a shared understanding
- be inexpensive and relatively quick
- be persuasive in communicating ideas
- identify and represent strong community values
- be interesting and fun.  

This method was chosen as it seemed likely to be a creative and effective way for fishers to express their collective views and knowledge about changes they are currently experiencing in their fishing community, and to share these with the wider community in a large exhibition at the local museum.

An Abrolhos fisher was engaged as the regional coordinator to liaise with the fishers and invite them to participate in workshops, surveys and interviews. We held initial informal workshops on each of the four main island groups, in which we tried to engage as many fishers as possible. At these workshops, fishers had the opportunity to share their own views and knowledge of climate and environmental changes and to hear scientists speak on the latest climate change science relevant to the Abrolhos Rock Lobster fishery. One of the authors (Shaw) introduced the project and methodology with a presentation titled 'Photovoice: the Abrolhos project.' Two other scientists, considered expert in their respective fields, presented on management implications of climate change effects on fisheries in WA and on coral reefs in a changing environment. A professional videographer gave a presentation on tips and tricks when taking photographs and encouraged people to take photographs using a range of cameras, including their mobile phones.

These informal workshops were designed to assess fishers’ initial views and also to begin a conversation about climate change impacts. Fishers were then asked to take photos of what they valued about their industry and community and any changes they had seen over the previous 5-10 years.

To gain a deeper understanding of the fishers’ views we made subsequent trips to the islands. We interviewed fishers about changes they had observed around the islands and their attitudes to climate change. We used these follow-up visits to further engage fishers in the project and collect photographs.

Over 1,000 images were collected from the fishers, including older photos as well as photos taken specifically for our research project. A final workshop was held with the fishing community to select the most appropriate images for the exhibition. Photos were enlarged to A4 size, laminated, and sorted into subject themes. Everyone was given a number of ‘voting dots’ and after discussion with other members of the community, selections were made: photos were selected for their narrative value rather than their photographic merit. Fishers chose photographs that expressed meaning and highlighted critical issues.

The community exhibition ‘Seeing Change: a photographic story from Abrolhos fishers’ was produced and opened at the WA Museum in Geraldton. The exhibition was designed to reflect the stories, views and values of the Abrolhos Islands fishing community while illustrating the linkages among climatic, environmental, management, economic and social changes.

The exhibition was jointly curated by the Author and the Director of the WA Museum Geraldton drawing on a selection of over 1,000 photographs taken by the Abrolhos Islands fishing community. The exhibition combined approximately 100 photographic images of varying sizes, 10 text panels, 26 fisher quotes, two ‘word clouds’, a map of the Islands and two posters of island names. TV monitors were located around the exhibition: a large monitor screened the ABC Open interviews with fishers and the project team, another monitor showed the photos submitted but not incorporated into the exhibition, and a large screen displayed ocean current
**THE RITES OF SPRING**

animations, sea temperature increases, visualisations of the Leeuwin Current and graphical models of the rock lobster larval movement thousands of kilometres offshore. Local artwork, island artefacts and couches gave the exhibition a relaxed feel. In the Deckies’ Lounge (Figure 2), visitors sat on the comfy couches and watched the videos at a kitchen table and completed the visitor surveys and comment cards. It enabled contemplation and reflection on the exhibition photographs, the climate change information that had been presented and the changes being experienced at the Abrolhos Islands. A large amount of published climate change information was taken away for further information.

![Figure 2: Deckies’ Lounge](image)

The title of the exhibition ‘Seeing Change: a photographic story from Abrolhos fishers’ was chosen for a number of reasons. Earlier work by Shaw,9 indicated that the fishing community was less likely to engage if the words ‘climate change’ were used. We wanted to indicate what the exhibition was about, but were mindful of the work by Leder and others that elaborative titles can increase understanding but not necessarily appreciation of art works.20

The exhibition title was descriptive detailing ‘a photographic story from Abrolhos fishers’ but not elaborative in that it did not mention climate change.21 ‘Seeing Change’ referred to fishers seeing and observing things through their own eyes and their own photographs. The ‘change’ referred to a range of issues including social, cultural and environmental values and not necessarily climate change. This allowed visitors to reach their own conclusions by viewing the exhibition.

The association of the words ‘seeing change’ with ‘climate change’ may have helped establish a linkage; however the relationship was designed to be subtle.
A range of techniques was utilised in the exhibition to convey the story and increase knowledge and understanding of this complex information. We had the fishers' interviews transcribed and from these created a collection of quotes and anecdotes that were printed onto story boards in order to personalise the exhibition (Figure 3). These quotes were displayed anonymously throughout the exhibition. We also analysed interview transcripts of fishers and scientists (the expert speakers at the workshops) and used these to produce word clouds (Figures 4 and 5) to illustrate the different views of these two groups.
A series of video vignettes (Stories from the Abrolhos Islands) was created by the Midwest Producer for the Australian Broadcasting Corporation: ABC Open. The vignettes included interviews with fishers and members of the fishing community. They also showed scenes of the Abrolhos Islands and underwater footage of the coral reefs. The ABC Landline video of the Abrolhos (Out to Sea by reporter Sean Murphy) was edited to focus on the historical background to the Abrolhos Islands and describe the special marine and ecological features of the group. These videos were spooled continuously throughout the exhibition in the ‘Deckies’ Lounge’ (Figure 2).

The ‘Deckies’ Lounge’ was a room separated from the main exhibition hall and designed to resemble a fisher’s camp. The room had Abrolhos art, lobster designed wallpaper, family and community snaps, retro linoleum and comfy couches. Visitors could sit back on the couches, watch the videos, and in their minds be transported to the Abrolhos Islands. Visitors were invited to comment on the exhibition by writing on ‘Seeing Change’ postcards and then hanging them on a peg board. We also used an anonymous survey to collect information about the visitor demographic, exhibition impact and attitudes and awareness related to climate change (Figure 6).

Figure 5: Word Cloud generated from fishers’ interviews

Figure 6: Visitor survey table and TV monitor with animations of ocean currents and rock lobster larval dispersal
The exhibition was launched in the WA Museum in Geraldton, Western Australia (29 November 2012–24 February 2013) and in response to popular demand was then shown at the WA Museum Albany (26 June 2013–21 July 2013), and at the WA Maritime Museum in Fremantle (Figure 7), (7 September–24 November 2013).

**Figure 7: Invitation to the Seeing Change Exhibition, WA Maritime Museum Fremantle**

Staff from the WA Museum Geraldton and the Maritime Museum in Fremantle were interviewed to gauge their views on the exhibition and to better understand the visitor response. Fishers were also re-interviewed and this research is ongoing.

**Findings**

Below we present the results from the various types of evidence we collected through our research project. We also include supporting research information that was published while this project was underway. Although we did not collect the material it is central to the narrative told by the exhibition. These research findings were:

**Fishers observing change**

From the workshops, surveys and interviews it was clear that fishers had observed changes to the environment and particularly the marine environment at the Abrolhos Islands. Key changes included:

- increased water temperatures
- significant fish and rock lobster kills during the marine heat wave (February 2011)
- coral bleaching; the first ever recorded coral bleaching occurred during the 2011 marine heat wave
- increased coral growth of some species, particularly staghorns
- species changes; greater numbers of tropical fish and invertebrate species
- species changes; more rock lobster and sharks, no cuttlefish
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- increased numbers of birds on some islands
- differences in plant growth for seaweed and seagrasses; some species growing faster, others disappearing
- reduction in the mangrove coverage
- higher tides; one of the fishers has had to raise the height of his jetty
- changing weather patterns including reduced storms and swells and later seasons
- reduced rainfall and more extreme weather events.

Scientists recording change, fisheries management responses and economic outcomes for fishers

From the scientists’ presentations and interviews, it was clear that they have also recorded and monitored changes in the marine environment. Many of these changes are consistent with long-term climate forecasts. During the workshops, marine scientists showed graphs of long-term data collected by the Department of Fisheries and CSIRO describing the settlement of rock lobster larvae (pueruli) along the Western Australian Coast. Historically this settlement has been correlated with the strength of the Leeuwin current. A strong Leeuwin current resulted in a high number of larvae which was predictive of high rock lobster numbers in four years. In 2006, there was a significant decline in the number of rock lobster larvae settling along the coast.22 As the numbers of larvae are used to predict rock lobster catches, there was an immediate management response to protect the breeding stock. This intervention reduced the catch of lobsters by about half. The number of fishers that could be sustained in the fishery consequently also declined by approximately one half. Although originally thought to be caused by over-fishing, it appears the reduction in larvae numbers was due to long-term climate and environmental changes.23

There were economic winners and losers resulting from the management changes.24 Many fishers decided to sell their licences; others combined licences or bought and leased more rock lobster pots.

Social changes

Despite all of the environmental, management and economic changes observed and discussed in the workshops, surveys and interviews, the observation most emphasised by fishers was the social change experienced from a reduced community on the Islands. For example in 2006 it was estimated there were about 1,000 people at the Abrolhos during the fishing season and this could swell to 4,000 people over the Easter period. In 2012 there were an estimated 150 people. In 2006 there were five schools at the Abrolhos Islands; in 2012 all schools were closed. Most of the community halls, bars and restaurants also closed as they were no longer viable. Sporting and community events, once ‘not to be missed’ events on the Abrolhos calendar were no longer held. The brightly painted spectator chairs around the football fields made from craypots, have fallen into disrepair (Figure 8, overleaf).

The Exhibition

The exhibition wove a story of the Abrolhos Islands, the rock lobster fishery and island community. It described the environmental changes observed by fishers and the changes recorded by scientists. The exhibition illustrated the strong social values of the island community, the significant changes the community is experiencing and how they are adapting.

The exhibition was subtle in its use of `climate change’ as a theme, and complex in the techniques utilised to enable visitors to deepen their understanding of climate change.

Having this range of climate change information available for visitors to access in different formats and at different levels offered multiple avenues for engagement. It gave visitors the opportunity to access this complex and somewhat contentious information in a place where they felt comfortable (couches and island artworks), in a trusted environment (the museum). For some people the Deckies’ Lounge created the feeling of home.
Figure 8 Spectator chairs for football matches have fallen into disrepair.
The Rites of Spring

Publicity and awards

The exhibition received an excellent response in Geraldton (over 8,000 visitors), drawing in a large number of people who had not previously visited the museum. Although intended for the local community of Geraldton, it resonated with the Abrolhos community, the wider regional community and visitors from around Australia and overseas. As a result of its success, the exhibition in its entirety was requested by other coastal museums in Western Australia – Albany and Fremantle. It is estimated that about 30,000 people viewed the exhibition in total. This number is based on museum visitor data. The exhibition was highly acclaimed, winning both State and National awards.25

The project and exhibition were extensively publicised in local and national media (print, TV and radio), numerous websites (WA Museum, WAMSI, NACC, ABC Open), newsletters, magazine articles, large billboards (Figure 9) and by invitation for the exhibition launches.

Figure 9 Large billboard in Fremantle advertising the Seeing Change exhibition

Surveys and interviews of fishers

Initial data from a follow-up survey and interviews indicate that the reaction from the fishing community was very positive. Fishers believed that their industry, community, lifestyle and views had been fairly represented in the exhibition. Many of the fishers went to see the exhibition two or three times and spent hours listening to the video interviews and going over the photos, text and fisher quotes. The exhibition had been inclusive and inviting to a demographic not perceived as high-frequency museum users. A number of fishers appreciated that the climate change message “wasn’t in their face.” By contrast, it was the power of seeing their own photos of a jetty underwater, bleached coral or invasive species, enlarged and displayed in a formal setting, which changed fishers’ understanding and perceptions of the cascading effects of climate change.

Further communication work is clearly necessary. However rather than avoiding the topic of ‘climate change science’ as they had in the past, some of the fishing community surveyed in follow-up interviews now appear to be more accepting and open to receiving information on this complex and contentious subject. If this outcome holds across the fishing community, it will likely increase their opportunities for adaptation.26
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Of the fishers (10) interviewed in follow-up surveys, the vast majority (9) indicated with the highest positive ranking that the Photovoice method was a good technique for telling their story and giving people a voice through their own photographs.

Fisher comments taken from the follow-up interviews included:

- “... the talk that it generated with the fishermen, it has been outstanding really ...”
- “... I wish I had been more involved ...”
- “... the story connected and flowed ...”
- “... fishermen have gone to see the exhibition 2 and 3 times ...”
- “... fishermen are reluctant to talk about themselves, but happy to talk about the photos, and in doing so, are talking about themselves ...”
- “... to see it in photos (our photos) ... really makes it sink in ...”
- “... it opened up conversation about climate change ... definitely made a difference ...”27

Surveys and interviews of museum staff

Museum staff were interviewed following the Geraldton exhibition as they are on the floor mixing with exhibition visitors and are privy to a range of visitor reactions and interviews. Their responses to the exhibition and visitor feedback were all very positive.

The museum staff in a large regional centre such as Geraldton are well aware of the demographic of people who visit the museum. One of their most consistent comments was that many local people who visited the exhibition had not previously visited the museum in Geraldton. They also noted that people visited the exhibition on numerous occasions and were there for hours, sometimes becoming emotional after viewing the exhibition. The exhibition was thus successful in increasing the social diversity of museum visitors by providing an opportunity that was perceived as interesting and relevant enough for people to visit. The fact that people returned for multiple visits is a reflection of the interest that the exhibition generated and a manifestation of its ability to represent a complex topic in an attractive, personal and respectful way.

Museum staff comments taken from follow-up interviews included:

- “... this exhibition gave people space to express their own opinions and their own ideological arguments ... so it wasn’t dictating to people ... so that was for me ... that was the strength of it ...”
- “... a lot of people came in to see the exhibition that you wouldn’t normally see in here ...”
- “... the exhibition had all those different sections in it...which was great ...”
- “... it’s a risky format if the content doesn’t come together ... complex ... because of the threads of science, the environment the community and fisheries ...”
- “... it kick started the climate change conversation ...”28

Surveys and interviews of exhibition visitors

In a review of results from 201 visitor surveys (Geraldton, Albany and Fremantle), most people were positive with their reactions to the exhibition. When asked question about the exhibition and climate change, the majority of respondents indicated (with a circle on a Likert scale) that the exhibition had:
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- stimulated their curiosity or interest to find out more about climate change
- raised their awareness about climate change issues
- encourage them to think about adapting to climate change, and
- encouraged them to take action about climate change.

The overall positive ratings from visitors are a significant outcome for this innovative methodology for building community knowledge on climate change and adaptation.

Discussion

The Photovoice methodology formed the basis of a project which resulted in community exhibitions in a number of important coastal fishing centres in Western Australia: Geraldton, Albany and Fremantle. This highly acclaimed exhibition ‘Seeing Change: a photographic story from Abrolhos Fishers’ shared the values and issues affecting the iconic fishing community of the Abrolhos Islands in Western Australia. It also documented the linkages between climate and environmental changes, management responses, economic outputs and social changes.

Fishers were invited to participate in workshops, surveys and interviews, provide photographs and select images for the exhibition. Their participation throughout the life of the project enabled an ownership of the exhibition by the entire fishing community. It allowed identification and recognition of the strong community values, the attachment to the fishing industry and the strong attachment to place. The strong place attachment appeared to be understood and recognised not only by the fishers and local community, but by visitors from around Australia and overseas.

By presenting the fishers’ photographs in a formal exhibition setting, we were able to increase the wider community understanding of their lives, their values and strong environmental linkages. The photographs also enabled fishers to reflect on island scenes they had seen regularly over an extended period and, complemented by other accounts of change in the marine environment, pointed to environmental and climate changes consistent with climate predictions.

In the exhibition, we wove fishers’ photographs and comments together into a powerful narrative about how the climate and environmental changes have in turn led to social decline. This experience allowed fishers and visitors alike to access and uptake knowledge and information. As one fisher stated “it was a bit like a light going on.” It became apparent that the fishers’ and the climate scientists’ stories were different sides of the same story rather than being different stories.

Although the climate change message was subtle, various communication techniques were used to illustrate what is generally considered a complex and controversial subject area. We presented material through a variety of means, and at layered levels of difficulty. This approach allowed each viewer to access knowledge individually and to reach their own conclusions in their own time.

Approximately 30,000 people visited the exhibition; some visited on multiple occasions and stayed for long periods of time. The feedback from fishers, exhibition visitors, exhibition staff and project collaborators was positive. A lot of evidence was generated that indicates increased uptake on climate change issues by fishers and visitors. Museum staff and fishers in Geraldton indicated the exhibition had opened up the climate conversation in the community.

The exhibition received widespread publicity and appears to have increased dialogue among fishers, scientists and the community. Several Ministers, politicians and agency CEOs were interested enough to have private viewings of the exhibition.

In addition to the benefits previously recorded for the Photovoice methodology,\textsuperscript{29} we have identified several
more. Many of them arise because, unusually for a Photovoice project, the images were exhibited in major museums and so received a substantial profile with the press, politicians and the general public.

First, Photovoice can play a conversation-opening role about a controversial topic, as identified by both fishers and museum staff. Because Photovoice was used in this project in a non-threatening, supportive style and in a culturally sensitive manner, the exhibition created a space that was sufficiently safe for the community to discuss a previously controversial and somewhat taboo subject. Importantly, the exhibition was not designed to generate fear, but rather understanding. As the use of fear and sensationalism in the climate change discourse is known not to be effective in actively engaging communities with the issues of sustainability, this new approach generated a very positive outcome.

Second, the Seeing Change exhibition addressed some of the issues currently being debated in museum circles particularly with regard to complex and contentious topics such as climate change. It illustrated that museums can be agents of transformation and play a greater role in communities confronted by climate change. This is an important achievement considering the challenges faced by the scientific community in getting climate science on the public and policy agenda in a coastal context.

Third, because of the participatory and personal nature of the Photovoice project, it resulted in a highly inclusive museum exhibition in terms of community visitation. This finding goes towards addressing the issue of the exclusion from museums of individuals or social groups. Museums are often perceived as exclusive and indeed may unintentionally reproduce exclusionary relationships with certain sectors of the population unless their staff deliberately challenge these established norms by seeking out and embracing diverse narratives and presentation styles.

Conclusion

Photovoice was a powerful method to build understanding and knowledge of climate science as well as a shared understanding of the values and issues of the Abrolhos Islands fishing community. It gave a voice to fishers while demonstrating with their own photographs their strong attachment to the fishing industry and the island community. The exhibition at the museum enabled participation on many levels and ownership across the community. It increased understanding and knowledge of climate change and the changes currently being experienced by the Abrolhos Island’s community. The results from this project also allowed us to build theory around the methodological capacity of Photovoice, especially through the presentation of community generated images in the form of a museum exhibition.

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SEEING CHANGE


Caputi, Pearce, and Lenanton, "Fisheries-Dependent Indicators of Climate Change in Western Australia."

Finlay, "Personal Communication."

A number of awards and commendations were received as a result of the Photovoice project and Seeing Change exhibition:

**MAGNA 2013 Museums and Galleries National Awards**
Winner - Best Temporary Exhibition under $20,000

**Western Australian Coastal Awards for Excellence 2013**
Winner - Coastal Heritage Preservation Award

**Goodness Awards for Sustainability and Innovation 2013**
Winner - Science Award

**Overall winner Postgraduate Presentation Award.** NCCARF Conference Climate Adaptation in Action 2013: Knowledge and Partnership. Sydney NSW, June 2013. For the presentation and poster – Jenny Shaw, Nick Caputi, and Laura Stocker, Climate adaptation in the Abrolhos Islands fishing community: a cascade of environment, management, economic and social changes (2013).

**WA Seafood Industry Awards 2013**
Commendation - Seafood Industry Promotion Award

**Western Australian LANDCARE AWARDS 2013**
Finalist – Coastcare Award

**Winner Postgraduate Presentation Award.** Jenny Shaw and Laura Stocker, A photographic exploration of attitudes to climate change and adaptation. NCCARF Postgraduate Workshop, Climate Adaptation in Action 2012: Sharing Knowledge to Adapt. Sebel Hotel Albert Park, Melbourne Victoria. 25 June 2012.


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Paper 2


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Climate change and social impacts: women’s perspectives from a fishing community in Western Australia
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Conditions of access and use can be found at http://www.tandfonline.com/page/terms-and-conditions
Climate change and social impacts: women’s perspectives from a fishing community in Western Australia

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A cascade of climate and environmental changes, government intervention and economic responses has led to major social impacts on the Western Australian fishing community of the Abrolhos Islands. In 2006, a significant decline in the number of settling lobster larvae was met with major changes to the management of the fishery. The decline in larval settlement appears to be climate driven. Stocks were protected by reducing the overall catch, but these measures also led to a decrease in the number of fishers operating in the fishery. The management changes have resulted in the decline of this well-established fishing community. From the perspectives of fishing women, this paper explores the tension between the contribution that women make to fishing and their well-documented ‘invisibility’ in this industry. The authors suggest that the lack of management focus on social outcomes and subsequent community impacts are related to the invisibility of women in the fishing industry.

Introduction

Stories of fishing communities are conventionally about the role of men in economic production. Women’s contribution to the fishing industry is often underestimated, unrecognised or confined to traditional domains such as community well-being, health and education. Furthermore, women have not been welcome in leadership positions historically and can face hostility when they step into this male domain.

In this present story of the Abrolhos Islands rock lobster fishery, the aim is to provide a narrative that is complementary to the traditional stories about men and economics, and this paper not only analyses the roles women have played in the industry but also the difficulties they face in achieving recognition for their participation. This paper explores the impact of climate and environment change on the Abrolhos Islands rock lobster fishing community and the ways in which the ‘invisibility’ of women in the industry may have exacerbated impacts on the community.

Women in fishing

Fishing has traditionally been considered a male domain in which the role of women remains largely invisible to their own communities, to the broader public gaze and to policy and management settings.1

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However, there has been much international research to suggest that women in fishing make vital contributions despite their lack of formal recognition within this industry. In the case of Japan, Lim et al.\textsuperscript{5} assert that although women have important on-water roles in fishing communities, using rapid diving techniques without scuba gear or compressed air to collect seafood, their position ‘… affirms the long standing social problem of their low status in society, especially compared to that of men’. Lim goes on to say that this situation is a ‘reflection of the traditional idea of women as mothers and wives, while men are breadwinners and leaders’.\textsuperscript{4} A similar situation is reflected with fishing women divers in Korea although it is compounded by the separation of gender roles along religious and philosophical grounds.\textsuperscript{5}

In Australian fisheries too, women play an important role in the industry especially in off-water activities and where fishing is characterised by family businesses operating in the wild catch sector.\textsuperscript{6} This is despite it being an industry traditionally seen as a male domain.\textsuperscript{7} Schirmer found that many women who work in Australian fishing businesses do so unpaid and may not be formally recognised as employees.\textsuperscript{8} Although not directly researching the role of women in fishing, Schirmer goes on to cite the example of ‘… a partner of a fisher (who) may spend up to 20 hours a week undertaking correspondence and managing financial aspects of the fishing business, without being formally documented as a partner in the fishing business’. Schirmer observes that ‘… these participants in fishing businesses may be highly impacted by changes to management of fisheries, but these impacts may be hard to document due to the “invisible” nature of their work in fishing’.

A complex of sociocultural issues reinforces the invisibility and low status of women in the fishing industry. The first issue is about the perception of what constitutes the fishing industry. Williams et al. acknowledge that ‘… because few women go out in large boats to fish, they are often not considered fishers and marginalised in fisheries sector analysis’.\textsuperscript{9} This position reflects the traditional perception of the fishing industry in Australia as comprising only ‘blokes in boats’.\textsuperscript{10} By contrast, the Australian fishing industry is diverse in sector, methodology, location and management arrangements. Recently Australia’s Fisheries Research and Development Corporation (FRDC) recognised this with a broad definition that the ‘fishing industry’ comprises a range of activities and includes ‘… any industry or activity carried on in or from Australia concerned with: taking, culturing, processing, preserving, storing, transporting, marketing, or selling fish or fish products’.\textsuperscript{11} However, this more inclusive definition has not yet permeated the attitudes of the fishing industry itself.

Thus, a second issue concerns how the traditional gendered perceptions of the fishing industry are perpetuated within it. In Australia, the dominant position of men in the fishing industry has been fiercely protected by men in the industry.\textsuperscript{12} However, it has also been validated by women in fishing communities who suggest that fishing is an undesirable occupation for women, including their daughters, or who assert their identity as a ‘fisherman’s wife’.\textsuperscript{13} This may be because women are comfortable with, and value more highly, the familiar social role of caring for family and community and/or the support roles of off-water aspects of the business such as book-keeping. Even if they are not comfortable with these roles, they may not want to risk the impacts to family and community that a challenge to male dominance inevitably involves. This is likely to be especially true in a small remote community where there is no possibility of external support for women if a bid to change power relationships goes awry.\textsuperscript{15} In early surveys, Aslin et al.\textsuperscript{16} found that barriers in industry generally fell into two main categories: practical (time, commitments, childcare and boat conditions) and overt (discrimination/prejudice from men). Despite this, over half of the fishing women surveyed wanted better status or recognition for their role in the industry which would likely facilitate easier access into industry decision-making roles.\textsuperscript{17}
A third issue concerns how the traditional gendered perceptions of the fishing industry are perpetuated within fisheries management and the advancement of women blocked. Although the fishing industry is made up of women and men, management organisations and fishing associations feature few, if any, women representatives. In Australia, the ways in which women have been excluded from industry decision-making are both structural and cultural, including explicit constitutional membership criteria, the pervasiveness of the dominant masculine industry discourse and the fallacy of women’s lack of knowledge.  

Given the above issues, it is not surprising that ‘… women and gender topics are still “not on the agenda” in aquaculture and fisheries’.  

The twin failures, both to acknowledge the existing roles played by women in the fishing industry and to promote women in fisheries management, have not only created gender distortion in the fishing industry but also in some cases have resulted in misplaced policy interventions.

Changes to fisheries management and the role of Western Australia (WA) women in leadership

The mid-1990s seemed to herald a new era in women’s status in Australia. WA had its first female State Premier, Dr Carmen Lawrence. There was a Federal and State policy to increase female representation, particularly on councils and boards. A new Fisheries Act: the Fish Resources Management Act, 1994 addressed not only habitat and environment issues but also, importantly for the fishing community, embedded community consultation in the legislation. These changes were significant for the environment, the fishing industry and particularly for women, as community and social issues were traditionally recognised more as ‘women’s domain’. The changes effectively gave women’s priorities higher profile.

During this period, a number of State and Federal fisheries jurisdictions set up representative committees to provide advice and information on the fishing sector. These committees were generally referred to as Ministerial Advisory Committees. The Western Australian rock lobster fishery was no exception, and the Rock Lobster Industry Advisory Committee (RLIAC) reported directly to the State Minister for Fisheries on ‘all things to do with rock lobster’. However, the committee operated for many years without any women on the Board, until two of the present authors were nominated to RLIAC (see below).

This move to a more participatory management style coincided with a greater consideration of Ecological Sustainable Development principles in fisheries as laid out in the National Strategy for Ecologically Sustainable Development and later in an Ecological-Based Fisheries Management (EBFM) approach. The EBFM approach made a greater attempt to deal with the social outcomes of fisheries.

Rock lobster fishery

The Western Australian rock lobster fishery is economically important for the region and the State of Western Australia. It remains the largest and most valuable single-species commercial fishery in Australia, worth between $A200 and $A400 million annually. In 2000, it was the first fishery in the world to achieve Marine Stewardship Council certification, a highly regarded eco-labelling certification. The fishery has continued to maintain this certification after two further assessments.

The rock lobster fishery provides the basis for the economies of a number of coastal towns and communities in WA including the community at the Abrolhos Islands. The strong fishing community at the Abrolhos has been built up over many generations, and in some cases rock lobster fishing licences have been handed down to three or four generations.

The number of settling rock lobster larvae (puerulus) is used as a predictor of future catch. Seven years ago, there was a significant drop in larval settlement along the coast. This gave
rise to substantial management changes designed to reduce the catch and protect the stocks.\textsuperscript{31} There are several theories regarding the reduction in puerulus settlement; however, given the current high breeding stock levels, the cause is likely to be some long-term environmental change consistent with climate change predictions.\textsuperscript{32} Higher water temperatures and earlier spawning times likely give rise to some mismatch in environmental factors such as peaks in oceanic productively and/or reduced storms which assist larval return to the coast.\textsuperscript{33} Further long-term verification of these relationships is required; however, currently they are considered consistent with climate change models.

The rock lobster catch and number of active fishing licences have approximately been halved between 2006 and 2012 as a result of fisheries management decisions to protect the stock.\textsuperscript{34} For a more comprehensive story of the rock lobster fishery and the fishing industry, see Gray\textsuperscript{35} and de Lestang et al.\textsuperscript{36}

\textbf{Significance of this study}

Fisheries management focuses on the management of stocks, environmental impacts and economic outcomes, with little consideration given to social implications of decisions. The authors suggest that this practice reflects the invisibility of women and families who make up fishing communities in general and the fishing community of the Abrolhos Islands in particular. The present paper uniquely documents attempts to empower women in the Abrolhos Islands, records the impacts of climate change on their community and lives, and examines fisheries management implications of these findings. The paper thus has academic, policy and practical significance.

\textbf{Methodology}

The overall approach of this study is ethnographic: recording in detail the culture and stories of a small island fishing community off the Midwest coast of WA from the point of view of the women. Bryman\textsuperscript{37} discusses many features of ethnography and ethnographic studies and in simple terms describes the process as ‘... joining a group, watching what goes on, making some notes and writing it all up’. Or as Hoey puts it, ‘Ethnographic writing is a means of expressing a shared interest and telling stories of what it means to be human’.\textsuperscript{38}

This research is also multidisciplinary. It brings together two researchers from multiple academic disciplines and one insider-researcher from the Abrolhos Islands fishing industry and community.\textsuperscript{39} This approach is important as Williams et al. advocate that in order to advance both gender and fisheries issues, truly multidisciplinary research is required:\textsuperscript{40}

...Fisheries biologists realise they need to understand about the people who are engaged in fish production, hence focus more on gender division of labour in fish production. Social scientists are concerned with social relations and structures as well as livelihood systems but often lack knowledge of fisheries/aquaculture system and technologies and fish species that people are engaged with. In order to advance the field we need to combine both perspectives.\textsuperscript{41}

\textbf{Positioning of authors}

The authors involved in the study took up different roles and responsibilities throughout the project. Their backgrounds are varied and their successful collaboration addresses one of the gaps suggested for the lack of progress in gender and fisheries research.

Author 1 (AI) has worked in fisheries and marine-related areas for over 30 years as a biologist, fisheries manager and more recently as a multidisciplinary and mixed-methodology researcher. Her long involvement in the fishing industry, research sector, fisheries management
and policy areas has enabled deep and well-established insights into the structure, function and culture of the Western Australian fishing industry.

Author 2 (A2) is a university academic with a background in marine ecology and contemporary expertise in sustainability policy, social science and action research. She was the research supervisor for the project.

Author 3 (A3) has lived, worked and raised a family at the Abrolhos Islands fishing community for 35 years. She has represented the Island community and rock lobster fishery in numerous positions over the years, providing leadership and support to women and men in the community. More recently she has mentored younger members of the fishing community to take up leadership roles and participate in decision-making. A3 has worked to give voice to the community in fisheries management processes and build recognition and understanding of the environmental and social issues affecting the rock lobster fishery and Island community. She brings direct experience and deep understanding of the Abrolhos Islands fishing community. Some ethnographic studies objectify the lives of community members as data. In this project, however, A3 plays a role as a researcher collaborating with academics to tell a story, and not as a research object.

The collaboration of three authors provides a three-dimensional perspective on the role of, and impacts on, women in the Abrolhos Islands fishing community through shared photography and story-telling. However, the study also aimed to create change and even transformation through action research.

Techniques

The present ethnographic study used three techniques for data collection: Photovoice, participant observation and interviews.

Photovoice

Photovoice is a social science technique that gives people a voice through the lens of a camera. Wang and Burris describe the main goals of Photovoice as ‘enabling people to record and reflect their community’s strengths and concerns; promotion of critical dialogue and knowledge; and reaching policy makers’.

The Photovoice method enables groups, who may be socially marginalised or disadvantaged, to have a conversation and convey their perspectives on significant issues affecting their lives and communities. It also has the potential to reduce the inherent bias of a male fishing culture, as women are able to take photographs of specific issues and values important to them. In Australia, Photovoice has been used to build consensus about adaptation to climate change and create visual narratives. In this study, Photovoice is an effective tool for participatory research as participants are able to record data using their cameras in their own communities.

At four workshops on different Islands of the Abrolhos, the authors explained the project, the Photovoice method and the aim to use fishers’ photos in an exhibition at the Museum on the mainland. We asked the fishing community to take photos of what they valued in their industry and community and also of any changes they had seen in their community and the environment over the previous 10 years.

Participant observation

Participant observation has become a common feature of qualitative research in a number of disciplines. It is used to gain a greater understanding of the issues from the participant’s viewpoint.
In this study, participant observation complemented the interviews and photovoice methods providing depth and understanding of the issues brought up by the community.

The authors’ roles as participants in the community varied. A3 has lived and fished with her husband in the Abrolhos Islands community for over 30 years. A3 has participated in all aspects of community life at the Abrolhos as a willing worker, industry representative, friend and confidant. In this project, A3 is very much an ‘insider’, having been immersed in the community for over three decades.

Over many years, A3 and A1 have participated in a wide range of fisheries-related meetings and sat on fishing industry Boards and councils. For this study, the authors visited the Abrolhos Islands on several occasions to hold workshops and conduct interviews. They also conducted interviews in Geraldton, the coastal town closest to the Abrolhos Islands.

In a summary of ethnographers’ roles, Bryman draws on multiple authors to describe a continuum of roles of ethnographers from involvement to detachment. In our study, A3 was a ‘complete participant’, and a community insider before the project. However, after joining the research team A3 became a ‘participant-as-observer’ in an overt role, recognised by the fishing community as part of the project team. A1 and A2 filled ‘observer-as-participant’ roles, with little community participation, mostly obtaining information by observation in workshops and by interview (see below). Although there is a risk of the ‘observer-as-participant’ role making incorrect inferences from not sufficiently understanding the community, this risk was minimised by always checking back with A3 as the community insider. Conversely, A1 and A2 were able to provide ‘observer’ perspectives that might not have been available to someone fully embedded in sets of existing relationships in the community.

*Semi-structured interviews*

Structured and semi-structured interviews were conducted with women and men from the Abrolhos fishing community to gain greater insights into the changes being experienced as well as their community perspective and values. When interviewing and talking to participants, the authors were aware of the setting and the way they dressed, being careful not to be mistaken for representatives of a government management agency or department.

*Study area*

The project study area is the Houtman Abrolhos Islands, referred to as the Abrolhos. The Islands comprise four main groups of about 120 low-lying coral and limestone islands, approximately 70 km off Geraldton in the mid-west of WA. There have been fishing settlements on the Abrolhos Islands for nearly 100 years. Early photos and diary entries indicate that conditions were rough, and isolation appeared to be an issue for selling fish product. In the early photos there do not appear to be many, if any, women. Now there are fishing ‘camps’ (simple houses and sheds) on 22 Islands and, until recently, thriving fishing communities.

*Findings: a story of fishing women in Australia*

*Women’s Industry Network Seafood Community*

A national organisation was established in Australia in 1998 to promote women in the fishing industry and also raise community awareness that the industry is made up of both women and men. The Women’s Industry Network Seafood Community (WINSC) gained significant prominence in a relatively short time frame by promoting women in the industry, building the capacity...
of women and undertaking action to further the industry generally. A1 was a founding member of the organisation, State Director and on the National Board for many years. A3 is currently the WA Director and National President.

On a daily basis, the organisation provides an extensive electronic networking facility, enabling women from all sectors of the industry to share information via email and come together to network at an annual Conference.

The role of WINSC is to encourage women in the industry to participate in industry decision-making and take up leadership roles wherever possible. This is often a daunting prospect in the face of the well-entrenched invisibility of women in the industry and the historical lack of women in management or industry representative roles.

Friends of the Abrolhos

At around the same time WINSC was being established, A3 was working on empowering women at the Abrolhos Islands and gaining political recognition for the existence and value of the community on the Abrolhos Islands. At the time, there was no consultation by the fisheries management agency with the Abrolhos Islands community, nor was there any real understanding of how policies impacted on the industry and community. In response to these inadequacies, A3 invited a group of women living at the Abrolhos to discuss a strategy to improve understanding and raise awareness of the needs of the Island community.

The emergent group of women called themselves the ‘Friends of the Abrolhos’. Membership was predominantly but not exclusively female. Their priority was to focus on environmental and community well-being, and they wrote submissions on these subjects to government on behalf of the whole fishing industry. Friends of the Abrolhos quickly became an incorporated and politically powerful organisation on the Islands. Friends of the Abrolhos effectively became a gatekeeping committee through which proposals for any development or action on the Abrolhos Islands had to be directed.

We suggest here that the largely female Friends of the Abrolhos group was accepted in such a significant role because the ambit of their concerns was seen by men in the community as compatible with the traditionally acceptable roles for women: health, environment, communication, cleaning up, education and other aspects of community well-being. Furthermore, their objectives were to benefit the whole community not just to advance women’s power.

The key achievements of the Friends of the Abrolhos group were:

- increased mainstream community understanding through education programs;
- publications including the development and printing of the Abrolhos Islands Visitor guide;
- input into Industry stakeholder Codes of Conduct;
- annual clean-up programs;
- improved telecommunication services;
- additional health and emergency evacuation services;
- coordinated fundraising through community events to improve services to industry;
- support for researchers and
- representation by women on both State and National Boards.

While this last achievement was a big step forward for women, perhaps the most valuable achievement was its capacity-building opportunities for women and giving voice to the Abrolhos community.
Rock Lobster Industry Advisory Committee

One of the boards established under the new Fisheries Act in 1994\textsuperscript{51} was the RLIAC. The Board reported directly to the Minister for Fisheries and dealt with ‘all things rock lobster’. The advancement of women into this Board was more confronting to men than was the Friends of the Abrolhos group. The Board was exclusively male and remained that way until 2003 when two women were appointed to RLIAC for the first time. A number of members appeared hostile at the inclusion of what they saw as the appointment of not one, but two token females! A3 and A1 were the women appointed. The first meeting was not pleasant for either woman. One of the Board members asked if they ‘were there to make the cups of tea?’ At the first meeting, A3 spoke about representing the Abrolhos fishery, and the fishing community and A1 spoke about the value of diversity on Boards, including gender diversity and environmental considerations.

Including women on the Board changed the way business was done and how decisions were made. Over the next five years, the focus of RLIAC expanded from a sustainability and economic focus to include social issues and impacts on fishers and fishing communities when making decisions for industry. Myriad issues were dealt with. Examples included crew health and safety, equity for small operators and time restrictions that would benefit crews and their families. The change in the way issues were viewed was eventually embraced by both the board and industry.

Impacts of change on the Abrolhos Islands

Management perspectives

Many achievements were made by and for women of the Abrolhos Islands community through the avenues described above. In the last seven years, however, many of those achievements have been lost. As discussed, a reduction in the number of rock lobster larvae, likely attributable to climate change impacts,\textsuperscript{52} caused fisheries management to intervene to protect the stocks. This reduced the total catch by about half and in turn caused a reduction in numbers of fishers by about half.

The reduction in catch and other management changes appear beneficial to the environment, the breeding stocks and the efficiency of the fishery, which is now operating at almost maximum sustainable yield.\textsuperscript{53} Despite this, the government’s process caused deep concern among many of the fishers.

As a result of the management intervention, many fishers had to make the decision to sell or lease their licences (unit entitlement) or buy units from other fishers. The fishers who remained have altered their patterns of fishing so that they ‘fish to price’ (coming to the Islands to fish only when the price is high) and often supplement their income with alternative livelihoods.

A change in government saw all consultative measures either removed or reduced. Fishers no longer feel heard by policy-makers. Participatory and consultative decision-making were abandoned in favour of a ‘top-down’ approach which disregards social issues. For example, when management changes including Quota (unit entitlement per fisher) and a longer fishing season were introduced, fishers were concerned about the possible reduction of people on the Islands at any one time. However, submissions by the fishers (via the Abrolhos Islands Management Advisory Committee, known as AICMAC, and the Body Corporate) to the State Department and Minister responsible for fisheries management to maintain shorter season length did not appear to be heeded.

An industry that was largely made up of inter-generational and small family businesses is becoming increasingly investor-driven, although it is worth noting that fishers are predominantly the investors, leasing their entitlement to other operators.
Community perspectives

During interviews, the fishing community reported changes and documented many of these changes with photographs. Over 1000 photographs were received from the fishing community. The community was invited to help select the images for an exhibition titled ‘Seeing Change: a photographic story from Abrolhos fishers’. This emotive story was told powerfully yet sensitively in a major community exhibition in the Western Australian Museum in Geraldton, the closest mainland town to the Abrolhos Islands. The multi-award winning exhibition was also shown in the coastal fishing towns of Albany and Fremantle. Approximately 30,000 people viewed the exhibition.

Although the fishers had observed environmental changes over the preceding years, by far the most significant changes represented in the Photovoice exhibition and explained through interviews were the social changes in the community.

Prior to 2006, the Abrolhos Islands fishing community was strong, healthy and supportive. Although the fishing season was short, families lived and worked together. Weddings, christenings and birthdays were celebrated along with traditional festivals. The five schools were full and well-supported, fundraising events were enjoyed and museums created. Inter-island sporting rivalry was intense, and the three community halls were always open, hosting events and providing a space for socialising. The community was relatively prosperous with good health services and air transport. The carrier boats were the lifeline of the Abrolhos community delivering supplies from the mainland and taking live lobsters back to the processors. People’s ‘homes were their castles’ and they took pride in them, often painting them vibrant colours (Figure 1).

There was good community stewardship of infrastructure and the surrounding environment and good cooperation with local management agencies.

By 2012, the community had changed significantly (Table 1). Over six years, the number of fishers had reduced by almost half. With the new management arrangements, the fishing season increased from three and a half months to almost the entire year. Fishers now fish to price and only go to the Islands for short periods at any time of the year. This change has dramatically reduced the number of people on the Islands at any one time to a level that is too low to sustain viable community life on most of the Islands. Very few women or families now live at the Abrolhos.

The number of active fishing camps has declined significantly (Table 1). In the harsh environment, infrastructure weakens rapidly when not maintained and some of the camps and jetties have deteriorated and are unusable. Community halls and bars are no longer viable and have closed down. There are no sporting events. The sporting fields are overgrown, and the spectator chairs have decayed. All the schools have closed, the school yards unkempt and abandoned. The community structure has changed significantly and on some Islands the communities have collapsed.

Figure 1. Roma, a small Island in the Easter Group, Abrolhos Islands. Photo: L. Noble.


Table 1. Changes in community structure between 2006 and 2012.

<table>
<thead>
<tr>
<th>Fishing season</th>
<th>Active camps</th>
<th>No. of people</th>
<th>Season length (months)</th>
<th>Community halls</th>
<th>Sporting events</th>
<th>Supply/ carrier boats</th>
<th>Air services</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>128</td>
<td>~1000 increasing to over ~4000 at Easter ~150 (12 in 2013)</td>
<td>3.5</td>
<td>5</td>
<td>3</td>
<td>Many</td>
<td>5</td>
</tr>
<tr>
<td>2012</td>
<td>74</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>1 (part-time)</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

There are increased levels of mental- and stress-related health issues, including incidences of suicide. It appears that the community of the Abrolhos Islands is decimated in terms of numbers of people, structure and function. Wives, partners and children no longer stay on the Islands. Many wives and partners supplement the family income by working on the mainland.

**Overall effect on women**

The flow-on effects of climate change on women in the Abrolhos islands is dramatic and all the community gains created by their input above have been lost. Furthermore, due to broader political change, women’s input and voice are declining and in many cases have disappeared. The representative boards and organisations mentioned previously (RLIAC, AIMAC and Friends of the Abrolhos) no longer exist.

Women have lost the community in which they lived. Families are no longer raised on the Abrolhos but are based on the mainland in Geraldton. In many cases, because men now have to work away from the Islands or have picked up additional work in the fly-in fly-out mining industry, women are in effect single parents in Geraldton. Many inter-generational fishing families are leaving the industry.

Women have to deal with the consequences which include:

- stress and depression
- domestic violence and abuse
- suicide
- alcohol and drug abuse

These are all problems that occur widely in society, and indeed have also occurred at the Abrolhos throughout the history of the industry, but women are now experiencing higher levels.

The level of environmental stewardship on the Islands is decreasing. This is because the women took a lead role in looking after the environment and passing these values onto their children and are no longer able to do so.

Oral histories passed down through families from grandmothers through mothers to daughters are becoming lost, and the time for community and ‘yarning’ or telling stories has reduced.

**Discussion and conclusions**

Contextual understanding of the cascade of changes to the Abrolhos Islands community resulting from climate and environmental change is provided by the many decades in which two of the
authors have promoted women’s interest in the fishing industry in general and in the Abrolhos Islands rock lobster fishery in particular. Building on this understanding, the Photovoice method, observations and interviews enabled us to construct a narrative that told the story of climate and environmental change, management intervention, economic response and social impact. The story formed the basis of a highly acclaimed exhibition ‘Seeing Change: a photographic story from Abrolhos fishers’ that was shown in three coastal communities around WA.54

This paper argues that women are not widely recognised as fishers or as members of the fishing industry, despite their very significant contributions and the recent, broad FRDC definition. Women’s invisibility as fishers is well documented.55 There is also a closely related gender imbalance in industry representative bodies and in management, policy and decision-making positions. In the current research, we concur with feminist critiques of the fishing industry56 and others who have contributed to the gender critique57 by acknowledging the invisibility of women in the fishing industry in Australia and overseas.

In this paper, we reported that climate change created environmental effects to which fisheries management responded to protect the rock lobster stocks. This intervention was considered timely and prudent as without this intervention the stocks may have been impacted causing fishery collapse. However, there were also unintended consequences on the economic and social life of the Abrolhos Island fishers. The changes disproportionately affected the women and families of the Islands, impacting heavily on the social fabric of their community.

The strong values that had been photographed, observed and discussed throughout the study have been diminished and in some cases lost altogether. These social, cultural, economic and environmental values included raising families on the Islands, the strong, supportive and social community, schools, clubs and sporting events, generating valuable livelihoods and enjoyment of the Island environment. Each of the values influenced the strong fisher attachment to the industry and Island community. The investment in these values by the women in the community was high. As there are very few women and families now living on the Islands, the entire community is reduced and on some Islands has disappeared.

Could this situation have been averted? It is possible that greater visibility of women in the industry and on decision-making and advisory committees could have created a greater focus on the likely outcomes of management decisions on the Abrolhos Islands community. This in turn may have led to a different result. For example, some women advocated for a fishing season that concentrated fishers into a shorter time frame that would have maintained community structure and vibrancy. Their recommendation was ignored.

In WA, the move to EBFM and a more participatory management style which included at least some women in advisory and management roles gave rise to a greater focus on social issues which benefited the whole of the fishing industry. The subsequent reversion to limited community consultation and the lack of women inputting into management decisions has eroded the previous gains and limited the consideration of social outcomes in management decisions. The authors conclude that a return to this participatory model would benefit all fishing communities, particularly the Abrolhos fishing community.

Furthermore, the authors would like to reinforce the FRDC definition58 of the fishing industry to make explicit the roles of maintaining the off-boat aspects of fishing businesses, which include organising crews and their payments, provisioning, business accounting, logistics and the bureaucracy interface. By this definition, the fishing industry is made up of men and women in diverse roles, not just ‘blokes in boats’.59 A fisher in this industry is not just the on-boat operator but also any active partner in the family business both on- and off-boat.

In summary, the present study has uniquely documented the story of the Abrolhos Islands fishing community, the attempts to empower women in the community, the climate change impacts on their fishery, their community and their lives. We conclude that Fisheries management
is focused on management of the stocks, the environmental impacts and economic outcomes. The social implications were not evident, and in fact this reflected the invisibility of women and families who make up fishing communities generally and in particular the fishing community of the Abrolhos Islands.

The varied roles, including off-boat activities, which women play in fishing, should enable them to be recognised as part of the industry. Women’s leadership, activity and knowledge within the fishing industry should be better recognised, and women’s leadership, decision-making and activity in all sectors should be encouraged. The authors believe that this argument can be extended across the fishing community more broadly.

Acknowledgements

This paper draws on years of experience by the authors as participants in the WA fishing industry. It also uses data from the ‘Photovoice Project’ with seed funding provided by Coastwest in partnership with Caring for Our Country, and in kind funding from the Coastal Collaboration Cluster. The authors would like to acknowledge and sincerely thank the rock lobster fishers of the Abrolhos Islands and all those who participated in this project.

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44. Baldwin & Chandler, ‘At the Water’s Edge’.
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Paper 3

CHAPTER FIVE

CULTURAL MODELS ON THE WESTERN AUSTRALIAN COAST: IMPROVING SUSTAINABILITY OUTCOMES

LAURA STOCKER AND JENNY SHAW

The coastal zone of the Indian Ocean has been subject to dramatic anthropogenic and natural changes over millennia, both over short and long time frames. These changes, including climate change, have been understood from diverse human perspectives which are highly influenced by culture. Quinn & Holland use the term “cultural models” to suggest “presupposed, taken-for-granted models of the world that are widely shared (although not necessarily to the exclusion of other, alternative models) by members of a society and that play an enormous role in their understanding of that world and their behavior in it.” Cultural models of the coast in Australia include Indigenous, productivity, community and sustainability, among others.

The Indigenous “model” begins by recognising the cultural diversity of perspectives that exists among the multiplicity of Australian Aboriginal and Torres Strait Islander peoples in the conduct of their cultural practices. Nevertheless, there are also some common perspectives among Indigenous coastal groups, including: use of marine resources for subsistence, culture and exchange; an understanding of the land and ocean as continuous sea country; the weaving together of features of sea country, place names and sacred sites into cultural stories; and group identity closely related to the sea. Coastal groups manage their estates through cultural ceremonies such as song and dance and can also restrict access to the sea according to season, status of group member, totem and presence of sacred sites.

A community model characterises the coast as a place for social interaction, for the development of a sense of place and for group activity according to social norms of the day. We take “community” to mean “that web of personal relationships, group networks, traditions and patterns of behaviour that develop against a backdrop of the physical neighbourhood and its socio-economic situation”, although the term is highly contested. A productivity model of the coast is about putting coastal resources to use for the betterment of society; it is the secular union of industry and science. It constructs the coast as a standing stock of resources to be owned and used with explicit technological control and is represented prominently in the marine environment by fisheries. It is central to public policy and is often the dominant model or “master narrative” in relation to the coast, while the other models are typically alternative or counter narratives.

A sustainability model seeks to integrate community, ecological and economic aspects. It also reflects critically on itself and other models and explores synergies among other them. Sustainability is the overarching conceptual framework within which our study resides. We also explore bioregionalism as a framework within which sustainability can and has been applied. For management purposes, a bioregion can be considered a regional landscape that is an integration of human governance with ecological systems. Giblett uses the term bioregion slightly differently to mean a “geomorphological and biological area.... where or on which humans live and work, and which sustains our life.” Climate change is now a key agent of change in all coastal bioregions; it has affected and will continue to affect the sustainability of bioregions over multiple time frames. Examples include changes to sea temperature, sea levels and the movement of currents.

We argue below that key to the enactment of a sustainability model is the development of knowledge partnerships among stakeholders who hold and enact divergent cultural models. Knowledge partnerships have been defined as “associations and networks of individuals or organizations that share a purpose or goal and whose members contribute knowledge, experience, resources, and connections, and participate in two-way communications.”

In this chapter we present two Western Australian (WA) case studies, one on Derbal Nara (also known as Cockburn Sound) and the other on the Abrolhos Islands. The case studies are both located in the southwest of Western Australia, in the ‘West Coast Bioregion’ as described by Fletcher (Figure 5.1). The West Coast Bioregion is strongly influenced by the Leeuwin Current, a southward flowing, warm, low nutrient current. This current affects the marine flora and fauna of the west coast of Western Australia as well as the weather patterns of the adjacent terrestrial region. The West Coast Bioregion (Figure 5.1) is also considered a global marine climate change hotspot with sea levels rising by more than double the global average and sea temperatures increasing by point six to one degrees over the past fifty years. A recent marine heat wave with water temperatures between four and five degrees higher than normal in some places.

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In the first case study of Derbal Nara/Cockburn Sound, we compare a Whadjuk Nyungar account with a geomorphological scientific account about origins of that coastscape over time and a changing climate. Both accounts span the ending of the last ice age and the inundation of the coastal lands with water. In the second case study of the Abrolhos Islands, we compare fisheries scientists’ account with the rock lobster fishers’ account of recent changes to the rock lobster fishery, the environment, climate and community. We compare these accounts by exploring the respective stories, perceptions of the significance of the environment and people, and knowledge systems deployed. Each account relates to a different cultural model of the coast. A comparative analysis of the cases is developed in the Discussion section below.

We aim to show that while the cultural models of the coast are divergent in each case study, a sustainability model could be better enacted if a bioregional framework was used as a space for creating collaborative knowledge partnerships and the consequent synergising of community, economic and environmental values of the bioregion.

Case Studies

The present chapter draws on two separate social research projects. The original two studies are reported more fully elsewhere. Both original studies are ethnographic, drawing on insider knowledge, new and existing images and in depth interviews. The Derbal Nara/Cockburn Sound research project generated a public website, while the Abrolhos Islands research project generated a community exhibition of photographic images and comments by the fishers woven together with research data and comments by fisheries scientists.

The case studies are set out below. Each case study follows the same structure: we first compare the stories as told by two different cultural subgroups. We then detail the contrasting perspectives on environment and people as seen by these subgroups. Finally we present an account of the contrasting knowledge systems. Our use of the structure “environment, people and knowledge” is designed to parallel the Nyungar trilogy of belief: “boodjar (country), moort (family) and kattijin (knowledge).”

Case One: Derbal Nara/Cockburn Sound, Western Australia

The first case study is of the ancient history of Derbal Nara or Cockburn Sound. Two accounts are presented: a Whadjuk Nyungar account and a geomorphological scientific account. The nature of the stories, the understanding of the environment, the perception of people and the knowledge systems are set out below.

The Stories

Nyungar

Cockburn Sound is known to the traditional owners, the Whadjuk Nyungar, as Derbal Nara. The Whadjuk Nyungar word for the “coast” is warden boodjar which literally means “sea country”; warden means “the sea” and boodjar means “country.” The coast is of great practical and spiritual significance to the Whadjuk Nyungar.
The Walnyup (Fremantle) Dreaming story tells of Yondock, an ancestral crocodile that travelled down from the north, causing floods and disturbances, creating Wadjemup (Rottnest Island), Ngooloomnyaup (Carnac Island), Derbal Nara (Cockburn Sound), and flooding the Derbal Yaragan (Swan River) with salt water. The Waagle or Rainbow Serpent, guardian of the fresh water, smells the salt and travels down Derbal Yaragan to see what’s happening. With advice from Woorrji (a lizard) in a cave in North Fremantle and strength gained from a freshwater spring at the East Street Jetty, the Waagle fights the crocodile, bites off his tail and places the tail across the mouth of the river to prevent salt water coming up stream. The tail is secured with hair from the armpits of the Waagle on the southern side of the river, and with toenails from the crocodile on the north side of the river. The rest of the crocodile’s body remains as Meeanup (or Garden Island...) and dingoes watch from Cantonment Hill to make sure the body of the crocodile is not reunited with its tail.40

The inundation of coastal lands by the sea, as described in the above story, impacted on Nyungar ability to access their traditional sites including the island of Wadjemup or Rottnest which was a “high point and used for ceremonial and spiritual purposes.”41 In particular, Nyungar were concerned about the buried dead whose spirits were trapped beneath the sea. Dr Noel Nannup, pre-eminent Nyungar story-teller provides an account of “When the Sea Levels Rose”42 and the spirits of people were trapped under the rapidly rising sea.43

It is said that whenever a whale calf is born, one of these spirits attaches itself to the whale calf. After 80 or 90 years swimming around the ocean, Mamong returns to this coast. Mamong, the whale beaches itself to return the spirit being carried by the whale back into the land where it belongs.44

Figure 5.2. A digital elevation model of the Rottnest Shelf and Perth Coastal Plain showing the major geomorphic features of Cockburn Sound and the adjacent coast.45
Geomorphological Science

Around 120,000 to 12,000 years ago, during the Pleistocene epoch, the sea level in the East Indian Ocean was much lower than today due to an ice age. At 10,000 years ago, the sea level was still around twenty metres lower than today’s level.\(^{50}\) A coastal plain with dunes lay exposed between Perth and Rottnest, and the Swan River at that time discharged into a wide bay about eight kilometers east-north-east of Rottnest.\(^{49}\)

However, following the last glacial minimum around 18,000 years ago, sea levels had begun to rise.\(^{50}\) The sea flooded and drowned the Rotnest Shelf and the coastal plain situated between Perth and Rottnest,\(^{31}\) reaching its current level around 6,500 years ago.\(^{52}\) The sea also inundated the Cockburn-Warnbro Depression, a low-lying swale or interdunal lake\(^{53}\) that had formed between the Garden Island and Spearwood Ridges in the Late Pleistocene.\(^{54}\) Garden Island became separated from the mainland.

In the current Cockburn Sound area, a series of subtidal ridges parallel to the coast and submerged reefs mark this lower sea level.\(^{55}\) Cockburn Sound now contains a variety of terrestrial and marine deposits as well as the Pleistocene dune ridges.\(^{56}\) Digital elevation models illustrate the existence of former coastlines beneath the coastal sea including the current line of remnant islands and submerged reefs that extend from Point Peron to Rottnest Island (Figure 5.2).\(^{57}\)

Since sea level became relatively stable in the middle Holocene 6,500 years ago, large volumes of sediment have been transported across the shallow shelf and thick sand accumulations such as Success and Parmelia Banks have begun to develop (Figure 5.2).\(^{58}\)

Figure 5.3 shows schematically the relationship between today’s coastline and that of 9,000 years ago when the area now known as Fremantle was connected to Rottnest Island by a broad land bridge.

Environment/Boodjar

Nyangar

For Nyangar, the environment or “boodjar,” the people or “moort,” and their knowledge systems or “katitjin,” are an interconnected seamless web, a trilogy of belief that underpins their entire worldview.\(^{59}\) In Nyangar cosmology, the “Waagle” is the pre-eminent creative ancestral spirit who made the trilogy.\(^{60}\) For Nyangar, the environment or boodjar is the mother.\(^{61}\) It is not an empty environment: it is full of human culture. There is another dimension that invests the land with meaning and significance—that transforms the land and environment into landscape and “country”. That other dimension is “culture”. “Country” is an Australian Aboriginal term that has come to be used widely to convey this sense of a fully cultural-spiritual landscape. In a Nyangar worldview, relationship to country is primary.\(^{62}\) Whadjuk Nyangar refer to the coast as “wardan boodjar” or “sea country”.\(^{55}\) Traditionally, the Whadjuk exercise rights and have responsibilities over wardan boodjar; using resources for subsistence, culture and exchange. Throughout the entire Boodjar, the sea, rivers, wetlands, hills, stars, coastal
lakes and other features of the landscape are the “Dreaming tracks” made by the Waagle and other ancestral spirits who travelled across country having encounters with each other. The Dreaming tracks are held to be sacred by Nyungar. Cultural stories describe these ancestral encounters, the consequent features of country and the placenames that reflect them. In the story told by Trevor Walley, it was the interaction between Yondock and Waagle that created Derbal Nara.

Geomorphological Science

The scientific account of the Cockburn environment during the Pleistocene and its evolution during the Holocene, as presented above, is a geomorphological account. Under this account, the environment is understood through a detailed study of the physical features of the area, their relation to its geology and oceanography, and the impact of long term climatic change on these. In this sense the study is interdisciplinary, though only within the physical sciences rather than fully holistic across a wider range of human understandings and experience. The biological environment is considered only with respect to the contribution of shells to sediment or in some cases the fossil remains of plants and pollen. Although beyond the scope of their study, Skene et al. highlight the need to compare the distributions of trace metals in the surface sediments with maps of changes in the extent of benthic habitats in Cockburn Sound “to help identify any long-term ecological impacts of the sediment contamination, as well as their impacts on benthic habitat composition.”

Moort/People

Nyungar

Nyungar understanding of the role of people in the environment is highly relational. Traditionally, kinship systems are determined by relationship to various aspects of country, and these in turn determine the obligations that people have to each other. Environmental care can be practiced through the system of totems which are the ancestral forms of animals, plants or other objects: a person or family has an obligation to care for that totem. Relationships between people and the greater-than-human world are reciprocal. In the above story about Derbal Nara told by Dr Noel Nannup, humans were trapped by rapidly rising sea levels and the spirits were helped ashore by “namong” or whales. Humans then help release the spirits.

The Nyungar men knew when the whales were coming and would prepare a ceremonial knife called a Dap. When the whale washed ashore, the Dap was used to cut open the whale and when the blood from the whale ran into the land, the people would be satisfied that the spirit had returned.

Geomorphological Science

There is no reference to the Aboriginal culture of the Pleistocene nor the Holocene, nor is there any reference to the numinous dimension of the coast in Skene et al. Place names describe the physical features of the environment—ridge, bank, shelf—in combination with significant European references: Success, Rottnest. There is, however, considerable reference to recent anthropogenic change or the “human alteration of Cockburn Sound that has occurred since European settlement of the area during the 1800s.” Humans thus become relevant to the scientific account when they are seen to have influenced its physical development. Their experience of it, and the meaning they make from it, is not the content of conventional science.

Knowledge system

Nyungar

In Nyungar, “katijin” means knowledge, understanding or information. Nyungar katijin is holistic. “Yarn” is a common term for a story in Nyungar discourse and it is the foundation of katijin. Over the long history of the Nyungar, yarns were transmitted orally and were also performed through song and dance. Yarning is a powerful social means of reinforcing knowledge. The data of the stories are qualitative. Cultural memories of the origin of Derbal Nara have been handed down without writing for thousands of years.

The word “nyitting” means cold times. Nyitting yarn is a term used to mean cosmological or “Dreaming stories.” Its use suggests that a climatic epoch, probably the ice age, was a cosmological turning point in Nyungar history. Nyitting yarns or Dreaming stories account for significant events lying within and beyond the living memories of the Nyungar people. As mentioned above, Dreaming stories relate to tracks made by the Waagle and other creative spirits as they interacted. Placenames refer to phenomena depicted in these stories. Thus places, names, stories and creative ancestors form a single integrated cultural whole. In the case of Trevor Walley’s story of Derbal Nara, it is clear how the storyline matches the activities of the creative spirits,
Waagle and Yoddock; both places and placenames reflect these stories. For example, the body of Yoddock the crocodile has become Meendip or Garden Island, meaning wounded or bloodied, referring to the beating he got from the Waagle.80

Other features of the Nyungar knowledge system include the importance of talking to Elders to verify information, as Trevor Walley did in researching the Derbal Nara story.81 While yarning about yarning,82 Trevor Walley reflects extensively on the role he has taken on in cultural development, highlighting the reflexivity found in the Nyungar knowledge system.83

Geomorphological Science

The scientific geomorphological account of the history of Cockburn Sound is also empirical. The geomorphological account is based on sediment samples grabbed from the surface of the seafloor and 3–6 m long cores taken by drilling beneath the seafloor.84 The samples were then described lithologically and subsampled for measurements of grain size and calcium carbonate in the laboratory.85 Geochemical analysis was also conducted.86 The account is largely quantitative though qualitative and highly visual representations of Cockburn Sound are also provided (Figure 5.2). The nature of the modern scientific endeavour, and indeed broader Western culture, is that it tends to be reductionist rather than holistic. In the present case the primarily geomorphological account represents one, albeit large, discipline. Nevertheless, the scientific geomorphological account of Skene et al. is in some ways a social enterprise in that it draws together the knowledge of a wide range authors, a common feature of scientific teamwork.87 Naturally there are other scientific accounts from other disciplines. Taken together they provide a broader understanding of Cockburn Sound, but they do not provide an integrated whole that links human experience with the evolution of landscape and fauna.

Case Two: Abrolhos Islands, Western Australia

In this second case study of the Abrolhos Islands, we compare fisheries scientists’ account with the rock lobster fishers’ account of recent changes to the fishery.

The stories

Fisheries Science

The 122 low-lying islands of the Abrolhos Islands, seventy kilometres off the Midwest coast of Western Australia with a diverse mixture of tropical and temperate marine species88 are in a transition zone between warmer waters from the north and cooler waters from the south.89 They are home to a number of fisheries, notably the highly productive and valuable rock lobster fishery.90

Over sixty years of monitoring, a strong correlation has been found between the numbers of rock lobster larvae (puerulus) settling along the coast and the strength of the warm, low nutrient, southward flowing Leeuwin Current.91 There is also extensive research data that reliably predicts the catch of adult rock lobsters four years in advance by counting the number of puerulus settling along the coast.92 In 2006 the number of puerulus declined significantly. The initial concern was that the fishery was being overfished. To protect the breeding stock, the Western Australian Department of Fisheries intervened rapidly by reducing the State catch by about one half.93

Around this time the style of fisheries management also changed from input control to output controls, generally referred to as quota management.94 This gave fishers an individual unit entitlement and increased the fishing season over time to the current twelve months.95 As a result, the fishery is now close to maximum economic yield with the number of lobsters per pot increasing from approximately 2 kilos per pot lift to around 6 kilos per pot lift.96 The price of rock lobsters has gone from an average of $28.50 per kilo in 2006 to $48.02 per kilo in 2014.97

Research since 2006 has investigated a number of explanations of the reduction of puerulus numbers along the coast. Given the record high breeding stock numbers, the overfishing explanation has been dismissed. Rather it appears to be some environmental issue possibly linked to the increased water temperatures bringing on an earlier spawning and causing them to be “out of sync” with some other necessary environmental parameters.98 As the larvae can move up to up to 1,500 kilometres offshore,99 the well-documented reduction in storms and associated south-westerly winds in south-west WA may inhibit the return of larvae to the coast.100 The increased sea water temperature101 and decreased rain-bearing winter lows are consistent with climate change predictions.102
The rock lobster fishers of the Abrolhos Islands have a long history of fishing the waters around this archipelago, sometimes three and four generations. The fishers set up thriving communities on four main groups of islands, comprising brightly coloured camps or small houses, schools and community halls (Figure 5.4). These communities were active during the three and a half month rock lobster fishing season; whole families lived, worked and played on the islands. People strongly identified as being from the Abrolhos Islands. Even though they were not there the whole year, they had a strong sense of belonging place. When the fishery scientists reported the decline in puerulus larvae and the fishery managers responded by halving the catch, many of the fishers were concerned that the Department of Fisheries had their science and analyses wrong, thinking perhaps the larvae had settled in deeper waters or elsewhere. Alternatively, the fishers concluded, the decline was a small aberration that would self-correct; the system would to return to “normal.” At the Abrolhos Islands the catch reductions were halved and as a consequence, the number of fishers on the Islands was also halved. Many fishers exited the industry, selling or leasing their licences, while others amalgamated or bought additional units. The actions described above, the introduction of quota management and the extended fishing season had a number of impacts including on the way people fish. A longer fishing season means that fishers only fish when the price is high; they have become “price-makers” rather than “price-takers.” The decline of their community is of great significance to the fishers. As fishers now come and go throughout the whole year, families no longer live on the Islands, schools are closed, sporting events no longer occur and community halls and clubs are no longer viable. On some of the Islands the community has collapsed completely.

Figure 5.4: Brightly coloured camps on one of the Islands of the Abrolhos.

Environment

Fisheries Science

From the perspective of fisheries science, the marine environment has traditionally been viewed as a standing stock of resources. In the nineteenth century, a secular and productivist union of science and industry formed the basis of fisheries science and management with which we are familiar today. The fishery stock and its environment must be managed in order to keep the fishery productive. In relation to the present case study, this means that when puerulus numbers dropped in 2006, the primary concern was the protection of breeding stock and understanding the drivers of that change.

The “environment” of the rock lobster is considered very broadly by fisheries scientists. It includes the seasonal Leeuwin Current flowing the entire length of WA and the extensive eddies (Figure 5.1). It includes the impacts of climate on the oceanic currents and the environmental changes which affect the biological community on which the rock lobster depends throughout its whole life cycle.

This environment has also been monitored over a long time scale (sixty years). During this time, there has been a strong association between the numbers of settling rock lobster larvae and the strength of the Leeuwin Current. This correlation weakened in 2006 and it appeared that some other long term environmental factor or factors was implicated in the reduction of puerulus. Further research about the impact of environmental factors on the lobster life cycle points to a number of environmental changes consistent with long-term climate change predictions.
Fisheries management has been successful on its own terms, with evidence that the breeding stock is protected and juvenile settlement increasing.112

Fishers

Fishers spend much of their working life on the ocean and are keenly tuned to changes in it. They are observant of the marine environment and weather because their catches and safety depend upon it. When asked in interviews if they have observed any changes to the marine environment, fishers had no hesitation in talking about the increases in water temperature, decreases in storm frequency and swell height, combined with increases in storm intensity. They have also noticed changes in marine plant and animal species, namely more tropical species frequenting the Abrolhos Islands, some coral species growing faster and others disappearing.114 In 2011 there was a “marine heat wave” and the first coral bleaching at the Abrolhos Islands was noticed.115 Fishers observed the unusually warm water temperatures:

...The water temperature on the 10th March last year [2011] was two degrees warmer than it was on the 10th March this year [2012].116

There were also comments on the large number of lobster, fishes and other invertebrate deaths during this period. Some islands have disappeared and a number of jetties are covered in water during high tides:

...I’ve noticed two Islands gone, from what I can remember... The Second Sister and Sandy Island. There used to be camps on Sandy Island which are not there anymore. The actual Island’s disappeared. And Second Sister’s been washed away...117

Although 71% of surveyed fishers observed changes to the marine environment, fewer (57%) were initially prepared to link these to a changing climate. One fisher echoed a common sentiment: “I don’t believe in global warming, no, I think it’s more of a natural thing.”118 However, after participating in the research project and community exhibition, the proportion of fishers who believed the climate was changing increased to 90%.119 A number of fishers commented that seeing their photos and quotes in a formal setting alongside scientific accounts of climate change made them reconsider their attitude to climate change:

...it opened the fisherman up to listening [and] being engaged in the [climate change] conversation... now they are more aware and they are more open...120

Within the fishing community the action-research project also promoted talk about climate change:

[Initially when you]... asked me about climate change I said it was a load of cobblers, whereas now you talk to people and I get different... aspects of what other people think, so it’s brought my thinking [around] too, that there is... global warming...121

...Climate change, yeah... [seeing the photos] opens your eyes up a little bit more... we experience it over [at the Abrolhos]... all the time, but we never really let it sink in and have a good think about it... [seeing our photos in a formal exhibition]... it was like a light going on...122

People

Fisheries Science

As described above, the basis of fisheries science and management developed from a productivity model. Fisheries management theory has shifted since the advent of Ecologically Sustainable Development and Ecosystem Based Fisheries Management123 which consider the environmental, economic and social outcomes of fisheries. This substantial shift for most fisheries management agencies and Ecosystem Based Fisheries Management has had varying levels of implementation success.124 However, the concern of fisheries science and management has remained focused largely on the fish stocks and not on fishers’ experiences or on the impacts of management at an individual or community level. Indeed in the current context, the fisheries science and management approach showed little consideration of the social implications of decision making.125 Although it could be argued that the changes successfully protected the breeding stocks and consequently the fishery, there appeared little understanding or concern that the changes would lead to significant community decline and, on some Islands, community collapse. In a recent paper, Shaw, Stocker and Noble argue that the lack of management focus on social outcomes and subsequent community impacts may be related to the well documented “invisibility” of women in the fishing industry.126
Fishers

The Abrolhos Islands are significant to fishers in many ways. It is the source of their livelihood and until recently was where their families lived, went to school and socialised. The sense of community is at the heart of fishers’ perspectives of the Abrolhos story. Before recent changes, the fishing was intense and whole families lived on the Abrolhos during the fishing season.

... one of the enduring memories of living at the Abrolhos for me was the strength of the community and the “one in all in” support mentality... The community supported each other, the school and many fundraising events were held at the [community] hall...\textsuperscript{123}

... well I started in the North Island and it was just full on social community up there. Every camp was full—wives, kids, schools, bloody volley ball every afternoon, piano, social club going every night, there was dart tournaments, pool comps, just out of control stuff, it was like living in a town...\textsuperscript{128}

There was a strong sense of community and environmental stewardship, particularly in more recent years.

... I’m very proud of what the fishing community have achieved out there, we’ve done clean up days, there’s a lot of community events that happen there that don’t happen in ... larger regional town[s] for fisherman. That sense of pride...\textsuperscript{129}

Families have fished the Islands for three and four generations, catching both rock lobsters and fish. One fisher who had fished at the islands for over 30 years described himself as “one of the newcomers here.”\textsuperscript{130} The fishers identify strongly as “Abrolhos fishers” and have a strong attachment to place:

Love it. [I'm] born and bred [at the Abrolhos]. Couldn’t give it up for the world, nor would my kids, nor would my wife...\textsuperscript{131}

Many talked about the changes to the way people lived on the islands in their lifetime and also the hardships their parents endured:

... back then ... water was really hard to get. If it didn’t rain, that was it, we didn't have any water ... It was hard, it was a hard life and that’s from what I remember ... And Dad’s stories, if he was alive, he used to tell me the stories [of] how hard he had it ... they didn’t have these fancy jetties; they use to have to get out there... in little boats and get to the pontoons and it’d be slippery at night to load trays. It was very, very hard the way they did it.\textsuperscript{132}

Knowledge System

Fisheries Science

The Fisheries Department of WA has a long history of fisheries management, underpinned by extensive knowledge in fisheries research, stock assessment and associated modelling. Scientists from the Department of Fisheries and CSIRO have been collecting extensive data for the past sixty years on the settlement of rock lobster larvae (puculus) and ocean currents along the WA coast.\textsuperscript{133} The length of this data set is unusual and underpins the extensive knowledge of this species and subsequent management measures for the fishery. WA rock lobsters were protected as early as 1887 with a minimum size, initially a weight and later a carapace length. In 1899 spawning (egg carrying) females were protected. Closed seasons were introduced in 1962 and entry was limited to the fishery in 1963.\textsuperscript{134} In 2000 the WA rock lobster fishery was the first fishery in the world to obtain Marine Stewardship Council accreditation for ecological sustainability. It has since been re-certified twice, giving it fifteen years of continuous certification. This achievement was recently recognised internationally (Brussels, April 2015).\textsuperscript{135} The fishery remains Australia’s most valuable single species fishery.\textsuperscript{136}

The science that formed the basis of the policy and management decisions sustaining this fishery has been systematic, objective and quantitative. Numerous written reports are available from the Department of Fisheries\textsuperscript{137} explaining the science, predicting the catch and setting out the management plans and regulations for the fishery.

Every year a team of research scientists and managers travel to coastal fishing towns to present the latest data and talk about any changes to the management of the fishery. More recently this has included changes to the climate and environment including: water temperature, storm patterns and ocean currents that are likely impacting on the larval settlement. However, as with most fisheries science, it is designed to be an objective inquiry into the state of the fishery and its biophysical context. It occurs without explicit reference to the scientists’ relationship to the environment or to the fishers themselves. Communication with fishers generally
focuses on updating them with the latest relevant fisheries information, following a deficit model which assumes that fishers have little or no knowledge.

Fishers

Fishers’ ability to operate in the marine environment is based largely on tacit knowledge derived from experience, observations and often intergenerational exchange. Some families at the Abrolhos have fished for four generations with a fifth still at school but working on the boats during their school holidays. There are no formal qualifications or training available for commercial fishing, although the Technical and Further Education system offers courses for maritime operations.

Technology on fishing boats has changed significantly over the past 20 years with the advent of Global Positioning Systems (GPS), marine navigating systems, radio and satellite communications, and high-resolution echo sounders. Most fishing boats have on-board computers that can transmit real time information on sea temperatures, weather conditions as well as recording fishing catch data including the marking of fishing spots, catch history etc. This computerised technological change is a shift in the way people fish but the tacit, often oral exchanges of fishing knowledge are still important:

… [fishers] learn on the ground from their fathers, their mates and other skippers… Fishers talk, especially [the] young guys, so where the crays [lobsters] are is known quickly.158

A lot of people write fishermen off, but a lot of them are pretty switched on…. Because they live in the environment, they are out there all day, they notice when things are changing.159

Fishers see themselves as adaptable; responding to changes in the weather, fisheries management, technology and the movement of fish. However, they seem resistant to the uptake of climate change knowledge.160 It may be that the formal or explicit system of this knowledge is at odds with fishers’ own local knowledge system. Many also refer to a cyclical nature of change and historical environmental changes that their father or grandfathers experienced and passed down orally, such as extreme temperatures “back in the 1800s—all [these] cycles happened before”.161

Discussion

Two case studies were presented in the West Coast Bioregion to illustrate how several differing cultural models are enacted on the coast by comparing the stories, the people, their perceptions of the environment and their knowledge systems.

The first case study focuses on long term natural climatic and geomorphological change. It demonstrates a radical difference between the scientific and indigenous accounts of the creation of Derbal Nara/Cockburn Sound, consistent with an indigenous model of sustainability.162 Certainly, the weaving together of features of sea country, place names and sacred phenomena into coherent, integrated cultural accounts is clearly visible in Trevor Walley’s story of the struggle between Yondock and the Waaagle and the consequent creation of Derbal Nara and the barrier islands such as Meeandip meaning wounded or bloodied. The management of coastal estates through cultural ceremonies is demonstrated by Noel Nannup’s account of the cutting open of beached whales to release human spirits trapped under the floodwaters. Humans and greater-than-human life forms have a close relationship in the management of sea country. Knowledge is based on a holistic understanding of country and its relationship to people. Information is stored and passed down orally through stories or yams. Dreaming stories occur during Nyitting or the cold times, and the Derbal Nara stories clearly span an era of dramatic and culturally profound coastal inundation. Putting these facets together we infer that the account is consistent with the geomorphological account of rising sea levels at the end of the last ice age.163

The geomorphological account corresponds to a productivity model of the coast:164 it is the scientific basis for better understanding the use of Cockburn Sound for shipping, fishing and other industry. It is underpinned by the written dissemination of knowledge. This is the dominant or “master narrative”.165 Clearly the cause-and-effect relationships of the two worldviews are divergent,166 although the symbolism of Yondock the crocodile swimming from the north arguably relates to a flow of warmer waters from the north, possibly a more southward movement of the Leeuwin current (Figure 5.1). We suggest that both accounts show an understanding of changing climate and sea levels over the long course of history, even if the account of proximal causation and the cultural meanings made are different. We argue here that while the radically different accounts would seem to derive from different worldviews, when taken together they form a fascinating and far more complete understanding of the Pleistocene/Holocene/Nyitting times. A third space opens up in which the two cultural accounts can co-exist, creating opportunities to underpin managing for coastal sustainability in the present time.167 We suggest that by considering the Indigenous and productivity models together we move towards a cultural model of sustainability that should be underpinned by a respectful sharing
of knowledge and an integrated understanding of community, economic and environmental values of the Sound. Examples of working principles for sustainable coastal management in the third space have been developed by Stocker, Collard and Rooney. The context of the second case study is contemporary anthropogenic change. We compare scientific accounts with fishers’ accounts of recent changes to the rock lobster fishery at the Abrolhos Islands. The two accounts are more similar than are the Indigenous and scientific accounts in the first case study; however there are still many differences.

The scientists’ account of the changes at the Abrolhos can be described fully by a productivity model of the coast, in which industry and science unite in order to utilise coastal resources for the betterment of society. The betterment of society over the long term is primarily served, in the view of fisheries managers and scientists, by maintaining stock numbers. In our case, stock numbers were maintained through prompt action by fisheries management, and the productivity model enacted. Under this logic, the long-term interests of both the fishery and broader society would be met. Although the management actions were arguably protecting the rock lobster fishing community by ensuring that the rock lobster population did not become commercially extinct, these actions certainly had serious ramifications for the livelihoods of individual fishers who had to exit the industry.

The fishers’ account can be described by a mixed cultural model of coastal use which includes both community and productivity aspects. The community aspect is demonstrated by the significance given to social interaction in the Abrolhos Island clubs, schools and sporting events; and the cultural development that occurs as the fishers make and express meaning together through their shared sense of place. However, the fishers are there to fish. Their livelihoods depend on catching rock lobster. Thus their stories also talk of the economic impact of the changes at the Abrolhos. This aspect points to the productivity model of the coast. A tension exists, however, between attempts to enact the community and productivity models. The government’s productivist management action impacted on the ability of fishers to enact the community model and devastated Island community life.

We suggest that had knowledge been shared in such a way that both models could have been considered together, both productivity and community values may have been protected. After all, through the hindsight offered by the exhibition, taking the two accounts of scientists and fishers together shows that they represent different facets of the same story. The scientists’ story tells us more about the biophysical and management changes while the fishers’ story tells us more about the community and economic impacts. The scientists’ story is based on data collected through technology and creates a big picture of the impacts of changing climate on the fishery. The fishers’ knowledge is based on direct daily observation and experience. These forms of knowledge are also complementary. The exhibition provided a third space in which a framework was provided for considering both knowledge systems and information sets together.

A sustainability model requires the interaction of community, economic and environmental dimensions of the coast. This is also recognised by state government strategies and by fisheries managers. However the extent to which the three aspects are allowed to synergise is limited in practice. This limitation and its impacts on sustainability can be seen in our case studies above.

All activity occurs in a place and a bioregion is often a suitable scale for considering how to enhance sustainability. Both case studies occur in the West Coast Bioregion as defined for current fisheries management purposes. This management area was modified from a large-scale Commonwealth technical study grouping purely biophysical areas of similarity, including geomorphology, marine habitat, marine flora and fauna. However, it is important to remember that bioregions are social constructs so government agency boundaries do not always align exactly with each other, with Aboriginal understandings or even ecological boundaries which tend to be dynamic and fuzzy. The West Coast Bioregion for example does not align neatly with all fisheries zones and boundaries nor with Aboriginal country borders; Perth lies within Whadjuk Nyungar country while the Abrolhos and Geraldton lie just inside Yamatji country.

Notwithstanding this non-alignment, Giblett remarks that “indigenous peoples ... have actually shaped and produced the bioregion,” presumably through their active management processes. In contemporary times Aboriginal people, fishing communities and fisheries scientists all continue to shape and be shaped by the bioregion. The bioregion sustains these groups. Each type of group has a relationship with the marine and coastal environment which has provided different types of livelihood and sustenance including, in some cases, spiritual and cultural connectedness experienced as a deep sense of belonging to place. Giblett argues that this is especially true for Aboriginal people. However, while some relationships between people and place are mutually favourable, others can be damaging; many are both. Both Aboriginal and non-Aboriginal people can interact complexly with a place; neither are essentially carers of the land, and the Aboriginal commentator Mick Dodson has warned us against romanticising Aboriginal relationships to the land. Nevertheless, a bioregional perspective on the coast helps us to plan and manage it better with respect to key impacts such as coastal adaptation to climate change and fishing. The coast in particular needs to be considered at this scale since the sea and its margins are strongly influenced by currents that disperse sediment and marine life and alter...
water temperatures. Significantly, a bioregion represents an explicit area within which communities, government, industry and Aboriginal owners can come together and build shared knowledge and understandings about how to manage the coast sustainably.

Both case studies in this paper raise the possibility, but also the challenges, of bringing together different knowledge types for the purposes of sustainability. Both point to the possibility of knowledge partnerships. Knowledge that can be used in developing a knowledge partnership for sustainable management includes: explicit (formal, codified), tacit (an understanding of how to do things) and implicit (values and cultural considerations that shape perceptions of knowledge holders). Often scientific information is considered formal, being written and abstract, whilst community and Aboriginal knowledge is often seen as tacit, being oral and practical. However, Aboriginal knowledge can also be formally codified in cultural stories, performance and art. Knowledge in the fishing community is largely considered tacit because of the oral traditions of intergeneration learning and sharing among fishers. All groups bring implicit knowledge to the table; that is, all groups have values and cultures that frame their knowledge formation.

Where there are mixed levels of explicit knowledge and divergent tacit and implicit knowledge, as represented by different cultural models, the exchange of knowledge is best achieved through direct engagement, for example among scientists, community, Traditional Owners, managers and governance bodies such as through community exhibitions, and website production. We suggest that the development of knowledge partnerships would enable a fuller model of sustainability to be enacted and management to be improved. Importantly, it is the process of engagement that is as important as the knowledge itself, as demonstrated in our second case study. Science communication and knowledge sharing does not occur automatically but needs to be enabled through careful, deliberate design. On a warning note, it is important that Aboriginal people are not overrun by a western sustainability model. Critically, diverse Aboriginal knowledges should not be seen as inferior epistemologically but as equal to scientific knowledge in a knowledge partnership even if this is a political and epistemological challenge for managers.

Towards a fuller understanding

Three issues draw our two cases together and also demonstrate points of differentiation. Both cases belong in a shared bioregion which has maintained and sustained livelihoods of all groups. Both case studies occur in the context of a changing climate and the consequences to immediate environmental and social change, though the time frame of change differs between the cases. Both case studies demonstrate the potential of combining explicit, tacit and implicit knowledge types together to create a fuller understanding of the nearshore social ecological coastal system and better support sustainable management.

The case studies illustrate how different cultural models are enacted on the coast. We contend that in both case studies, the “master narrative” is underpinned by a productivity model of the coast. However, we argue that the “counter-stories” represented by the Whadjuk Nyungar and fishing community respectively help to create a fuller understanding of the case and support the development of a sustainability model. We conclude that a bioregional scale may be appropriate for the sustainable management of coasts. We also conclude that the development of knowledge partnerships can bring together community, economic and environmental values and dimensions of the coast and support the development of a sustainability model. It is important, however, that the process of engagement and communication in building a knowledge partnership is equitable, deliberate and well designed.

Notes

1 Funding for the first case study came from Coastwest – a State Government initiative aimed at providing opportunities for Western Australians to learn about, conserve and protect our coast. Additional funding came from CSIRO’s Flagship program via the Coastal Collaboration Cluster. The City of Cockburn also contributed funds and in-kind support. Thank you to Gary Burke for critical insights, and to Sam Blight and Declan Burke for the figures. Funding and support for the second case study came from a number of organisations and agencies including: Curtin University Sustainability Policy Institute, Coastwest in partnership with Caring for our Country, Western Australian Marine Science Institution, Department of Fisheries Government of WA, Fisheries Research and Development Corporation, Western Australian Museum Geraldtown. The authors would particularly like to thank the following for their personal involvement and contribution to the second case study: Leonie Noble (Abrolhos fisher), Greg Finlay (Abrolhos Manager Department of Fisheries), Catherine Belcher (Director, WA Museum). Special acknowledgement and thanks to the rock lobster fishers and the Abrolhos Islands community who participated in the case study. As a requirement of Curtin University’s research ethics approval (RGS-01-11), written project information was given out prior to all interviews being undertaken and written research consents obtained from participants.
We take "fishery" to mean the whole combination of species taken, people involved, area of water, means of fishing, type of boat and aim of the activities.


Nannup, Noel. Interpretive signage, Rottnest Island.

This account suggests that sea level rise was experienced as a sudden flood(s), perhaps a storm surge(s), rather than gradual inundation. This interpretation is consistent with extreme events being important expressions of climate change.

Nannup, Interpretive signage.


Ibid.

Colder sea temperatures result in lower sea levels because more water is locked up in ice sheets and glaciers, and also because water occupies a smaller volume when it is colder.

Churchill, "Late Quaternary Eustatic Changes in the Swan River District".


Churchill, "Late Quaternary Eustatic Changes in the Swan River District".


Ibid. Also see Collins, "Sediments and History of the Rottnest Shelf, Southwest Australia: a Swell Dominated, Non-tropical Carbonate Margin."

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Collard, et. al. Nidja Beeliar Boodjar Noonookart Nyininy: a Nyungar Interpretive History of the Use of Boodjar (Country) in the Vicinity of Murdoch University.

"Kaya ... Welcome!" Nyungar Wardan Kaitijin Bidi-Derbal Nara.


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Paper 4


Western Australia Northern Agriculture Catchments Council.
Introduction

Rock lobster fishing is at the centre of social and economic life of the Abrolhos Islands community and has played a major role in other Western Australian coastal communities. Recently the fishery has changed dramatically. We were inspired to understand and share the Abrolhos fishing community’s observations and views on changes in their environment, climate and lives. We invited the fishing community to take photographs and participate in workshops and conversations about change and how they have experienced it. The result was the photographic exhibition ‘Seeing Change’, which generated considerable interest and resonated strongly with the Abrolhos community, past and present, the wider regional community, and visitors from around Australia and overseas. First displayed at the Western Australian Museum – Geraldton, the highly acclaimed exhibition was awarded a 2013 Museums and Galleries National Award for excellence in museum practice.

‘Seeing Change’ was created from over 1,000 of fishers’ photographs, stories and quotes from every Island group. Photos were selected at a workshop for the power of their story, not just their photographic qualities. The locations, and in some cases the photographer’s name were not identified for a couple of reasons. Some of the fishers wanted to remain anonymous and importantly, the exhibition was about the fishing community as a whole rather than individuals and specific Island groups. Identifying the locality would detract from the story of the overall Abrolhos community. Although the communities may vary, the issues that resonated through the exhibition were similar.

When any exhibition is dismantled this small snapshot in time is lost forever. Creating a catalogue or book can act as a record or memento of the exhibition and its deeper meaning. Seeing Change reflects the experiences of some of the many people who have lived and worked at the Abrolhos. A strong community has developed here over generations. The fishers and their families have a strong sense of place and community at the Islands, as reflected by their photographs and interviews. Many others, who may not have lived at or even visited the islands, also share this sense of attachment to this place.

The Abrolhos Islands fishing community has similar challenges to many regional and rural communities in Australia and overseas, dealing with significant environmental, climatic, economic and social change. In this fishing community, however, the changes have been significant and relatively fast. How communities respond and adapt to these changes is critical to their sustainability. Consideration of climate and environmental changes, management responses and social impacts remains important and a discussion
point for policy and decision makers. Much can be learnt from the Abrolhos Island experience.

The ‘Seeing Change’ exhibition, this book, and the underlying research project have been made possible by support and contributions from a large number of people and organisations (see page 56) which are very gratefully acknowledged.

The other project team members, Leonie Noble, Greg Finlay and Catherine Belcher, provided invaluable oversight through-out the project and Laura Stocker gave timely research insights and great advice. Thank you all.

To the team at the Northern Agricultural Catchments Council (NACC), thank you for having the vision and confidence to support the project and then fund the production of this book. Without your backing, this small piece of collective history would be lost.

I would also like to sincerely thank the rock lobster fishers and Abrolhos Islands community who participated in the project; freely giving of their photographs, their time, knowledge and expertise in workshops, surveys and interviews. I hope the exhibition and this small book resonates in some part with the Abrolhos Islands community past and present, and the book will be treasured long after the exhibition has finished.

Jenny Shaw
The Abrolhos

The Houtman Abrolhos Islands are better known as the ‘Abrolhos’. They are a group of over 120 islands about 70 kilometres off the coast of Geraldton. They are part of the most southerly located coral reef in the Indian Ocean which is also one of the highest latitude (furthest from the equator) coral reefs in the world. The coral reef can exist here because it is bathed by warm waters which come from the northern tropics via the Leeuwin Current. This current flows south along the Western Australian coastline and is strongest in autumn and winter. Around the Abrolhos this warm tropical current meets cooler temperate waters resulting in an unusual mix of both tropical and temperate marine animals and plants.

The Abrolhos Islands are divided into three main groups, separated by deep channels. The groups are known as:

- North Island and Wallabi Group
- Easter Group
- Pelseart (Southern) Group
"I don’t believe in global warming no, I think it’s a more natural thing."
Changing marine environments

World wide, marine environments are undergoing significant changes including rising sea levels and water temperatures. This is particularly true for south western Australia which is considered a global ‘hot-spot’ for sea water temperature rise.

In south-west WA, scientists have recorded a rise in sea level of more than double the global average. In the last 50 years they have also recorded an increase in sea surface temperatures of 0.6° to 1° Celsius.

In 2011 there was a ‘marine heat wave’ in the mid-west of WA and water temperatures were between 4° and 5° Celsius higher than normal.

This unusual event resulted in the death of large numbers of fish, rock lobster, abalone and other marine life along the coast. For the first time ever, widespread bleaching of corals was recorded at the Abrolhos Islands. There were also observations of tropical fish species occurring much further south.
Fishing at the Abrolhos

The rock lobster fishery is the main fishery at the Abrolhos. Fishing for rock lobster, often called crays, started at the islands in the 1880s. Many of the families have fished at the Abrolhos for generations. Fishers, crews and their families live on the islands during the fishing season and have built small houses known as camps. Until recently there were approximately 350 camps and at times, 650 fisher families during the three to four month fishing season. The Island groups grew into distinct communities with schools, community halls and sporting fields.
Changes in the rock lobster fishery

For over 40 years the WA Department of Fisheries and CSIRO have collected large amounts of information which has been used to successfully predict the catch of rock lobster and better understand what affects the fishery.

Water temperature, the strength of the Leeuwin Current and the strength of the westerly winds such as those associated with storms, are the main environmental factors that influence the fishery.

Catches of rock lobster can be predicted four years in advance by counting the number of settling larvae (puerulus). Approximately six years ago there was a significant drop in the number of puerulus counted along the coast. As a result, strong management measures to
reduce the catch were put in place to protect the rock lobster breeding stocks. There were other changes to management and the fishery is now managed under a Total Allowable Catch (TAC). This gives fishers an ‘allocation’ or an amount they can catch over the year.

With the large reduction in catch and introduction of catch quota, the number of active fishers at the Abrolhos Islands has been reduced by about half in the last six years.

The economic outcomes for the remaining fishers have varied. There are now more lobsters caught per pot, however pot prices and pot lease rates have increased and catches reduced.

There has been much research to try and understand what caused the drop in puerulus numbers. As the number of breeding females is now at a record high level because of the management measures, the decline in puerulus is thought to be the result of some long term environmental change, rather than overfishing. Likely factors being investigated are an increase in the water temperature affecting the spawning cycle of the lobster and a reduction in the winter storms.
"If the water gets too warm and the lobsters move further south or that it wipes them out or something well we’re all buggered."

J. Shaw Doctoral Candidate 2016: Fishing Communities & Climate Change
These days crayfish are treated like royalty from the moment they board the boat. They are put into oxygenated water then transferred to these crates very carefully so they are kept in pristine condition for market. These crates have plastic mesh all around the inside because when cray legs stick out of the crates they get eaten by groper or any other passing fish. They need to hang in deeper water in order to gain quality water flow.
“This is our livelihood. We’re not going to wreck it because it’s our livelihood.”
What fishers value about the Abrolhos

Fishers have a very strong sense of identity with the industry and a strong sense of place at the Abrolhos. Through interviews, workshops and surveys, the communities talked about many values. These can be grouped into the following:

**Social:** The Island communities, supportive community structures, community and sporting events, family gatherings and holidays, schools, festivals, inter-island sporting rivalry, ANZAC day commemoration.

**Cultural:** Inter-generational fishing families, historical stewardship, sense of belonging, historic shipwreck sites, ‘camp’ heritage, art and sculptural pieces, lifestyle and identity.

**Economic:** Industry support for families and crews in the Geraldton and Midwest region. Economic support for marine industries such as boat builders, processors, chandlery, bait and fuel suppliers.

**Environmental:** Animals and plants that live on the islands and in the sea, weather and environmental stewardship.
**This chair was given to us by John Grosse who was a friend of Andrew's father, Vic Basile. When Vic was alive he and John would take a tipple to the back of the Island to toast the sunset. After Vic passed away it has become a bit of a ritual to 'toast the sunset.'**
“When you’re living out in a small community in the middle of the ocean it’s a lot easier lifestyle if you get on with each other.”
“The Abrolhos Football League was in place years before the current AFL made the brand well known. Annual inter-island games were hotly contested and seriously celebrated. The Abrolhos as a whole was family, foes on the field and friends indeed.”
“ANZAC Day is commemorated by each Island group with a dawn service, listening to the last post in silence with heads bowed. As the sun is rising over the ocean, the service is spine tingling. Then fishers get together from all over the Abrolhos to celebrate another Australian tradition, ‘Two-Up’.”
“Jettyes are the life lines at the Abrohos:
Many an hour is spent either working or socialising on
a jetty. I always feel like I am at home on a jetty.

Sitting on this jetty, in the early morning sun,
is probably as close to heaven, as I will ever come.
The sound of lapping water, the wind warm on my face.
A coffee right beside me. This is a wonderful place.”
How has community life changed?

Although fishers have observed environmental changes, it is the social changes that have occurred at the Islands that are seen as the most significant, with a strong view that there has been a loss of community. In five years the number of active fishers on the islands has reduced by about 50 percent. Very few wives and children now live on the Islands during the season. There were five schools open in 2006. In 2012 all schools were closed.

Inter-island sporting events, once ‘not to be missed’ events on the Abrohlos calendar, are no longer held, the football fields and spectator chairs are overgrown and idle. Community halls are no longer viable and not operating.

There were four carrier boats for the different Island groups which brought over supplies and took lobsters back to Geraldton. In 2012 there were only two carrier boats operating in total.
"...three years on and the sense of community has diminished dramatically with the changes to fishery management policy, the Abrolhos season is longer and Fishers come and go at the Abrolhos in tune with the ‘price’. This has seen many community events cease as there are not enough fishers to support them at any given time."
“Our foofy field is now overgrown and abandoned. Here is the old Abrolhos made seating. A big difference from its heyday.”
"Because the old fishermen are the ones that have got all the really good stories and that because there were so many characters amongst them. Now it’s all too business-like and there’s only a few characters left, they’ve all sort of gone."
Environmental changes seen by fishers

Fishers on the Abrolhos Islands have noticed many environmental changes over the past five to ten years. Observations have varied from island to island but include:

- Warmer water
- Higher tides
- Disappearing Islands such as ‘Second Sister’ and ‘Sandy Island’ in the Wallabi group
- Increased coral growth; particularly staghorn and plate corals
- Dead marine life such as fish, lobsters and eels after the marine heat wave
- Coral bleaching
- Changes to the weed species (both seagrass and seaweeds)
- More tropical fish species
- Different sea urchin species
- Tropical octopus
- Changing weather patterns
- Reduced storms and swells
- Significant sand movement on North Island over a period of years
- Increase in lobster catch rates
“Well the island’s definitely changed. Where you’re sitting now, 10 years ago we could see every boat in their jetty. Whereas now we can’t even see down our jetty. The island’s definitely grown, I think grown eastwards.”
Science and the changes linked to climate

Scientists agree that the climate is changing and some of the predicted changes are already apparent. In the south-west of WA these changes include:

- A gradual increase in the sea surface temperature
- A trend of rising sea level
- Changes in the wind direction and strength
- Decline in the amount of rainfall
- Likelihood of more cyclones further south
- Increase in extreme weather events
- Changes in ocean currents such as the Leeuwin current
- Some species ranges extending further south

See DVD insert at the back of this book.
How is the community adapting?

Fishers are adapting to the changes in a variety of ways.

Fishers generally had to make a decision to sell or lease their licences (unit entitlement) or buy units from other fishers. Many fishers have sold their boats and licences and left the industry. Others have leased their licences and are waiting to see what happens in the coming years. Most fishers no longer work every day, but wait for higher prices before fishing.

Smaller vessel operators may fish to coincide with the carrier boats going back to Geraldton to maximise the quality of the lobsters. Other operators transport their lobsters back to Geraldton themselves.

Some fishers have changed their work, moving into aquaculture and tourism. Others have taken up additional work, particularly driving boats in the oil and gas industry.
"In 2010 when starting our coral farm we were faced with so many decisions – what do we grow coral on? how many? where? what size? how to hold it to the ocean floor and most importantly, which ones?

We love the colour size and shape of the coral in this photo so we started with these."
"The way people are getting out of the industry I just don't think there's going to be much future on this island really, unless you've got a big boat and you can cart your own crayfish."

J. Shaw Doctoral Candidate 2016: Fishing Communities & Climate Change

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Can any conclusions be drawn?

Fishers have observed changes to the marine environment and climate of the Abrolhos. Scientists have also recorded environmental and climate change throughout the region. In response to the decline in recorded puerulus numbers, the State Government has reduced the rock lobster catch quota. This management change has in turn reduced the number of fishers at the Abrolhos. Other economic pressures have also impacted the fishers.

The flow on effect has been a loss of community and social values at the Abrolhos Islands.

Drivers of the changes being experienced by the Abrolhos Islands community include:

- Management changes such as reduced pots (units) and catch quota management
- Economic factors including lobster prices, fuel and bait prices, crew costs, and the exchange rate for the Australian dollar
- Ecological factors, such as changes in the abundance of certain marine plants and animals, e.g. fewer lobster larvae and more tropical species
- Weather cycles, such as reduced storms and swells
- Climate change including sea level rise, sea surface temperature increases and changing water currents
The future

The project was an exploration of the values of the Abrolhos fishers and the changes they are experiencing using photographic images to give voice to their observations. The project also examined the drivers of these changes.

Given the long term climate forecasts, all the types of changes observed are likely to continue. The Abrolhos community and decision makers will be in a better position to make future decisions when the linkages among environmental, economic, climate and social changes are understood better.

Some future questions to be resolved:
- Are the current catches likely to improve?
- How can we better understand the cause of the low rock lobster larval (puerulus) settlement?
- What are the best management arrangements for the industry?
- What are the likely long-term impacts on the Abrolhos Islands marine habitat and the effects on the rock lobster and other marine species?
- Can management settings take into account their impact on important social values?
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See DVD: Enter/Videos/Stories from the Abrolhos Islands/ABC open/

Jenny Shaw is a PhD Candidate at Curtin University.
Rock lobster fishing is at the centre of social and economic life of the Abrolhos Islands community. In recent years there have been changes experienced by the community, including environmental and climate changes, management responses and significant social impacts.

This book is a result of the exhibition ‘Seeing Change: a photographic story from Abrolhos fishers’. It is a snapshot of the highly valued island community and industry which have built up over generations. It also reflects some of the major changes the community is responding to.

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Paper 5


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Enhancing the knowledge–governance interface: Coasts, climate and collaboration

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ABSTRACT

Conventional systems of government have not been very successful in resolving coastal management problems. This lack of progress is partially attributable to inadequate representation in governance processes of the variety of knowledges present on the coast. In particular there has been a struggle to engage effectively with climate science and its implications. There has also been a broader failure to capture the complexity of voices, interests, values, and discourses of coastal users. We argue here that coastal governance challenges are not likely to be resolved by singular solutions; rather, interaction and collaboration will generate improvements. We suggest that a co-requisite for progress in coastal management is the development of institutions and processes that enable different knowledges to have a bearing on governance processes. This paper examines a selection of the many opportunities available to broaden and enhance the use of knowledge in decision-making for the coast. A description is provided of emerging elements of coastal governance from an Australian perspective, together with new types of institutions, processes, tools and techniques that may help to achieve an improved coastal knowledge–governance interaction.

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1. Introduction

Despite considerable effort over several decades effective governance of the coastal zone remains a considerable challenge in many parts of the world (Sorensen, 1997; Agardy and Alder, 2005), including Australia (Harvey and Caton, 2003; State of the Environment, 2011 Committee, 2011; Stocker et al., 2012a). Given the complexity and dynamism of the biophysical processes shaping the coast, the variety of administrative processes for managing the coast, and the diversity of stakeholders with an interest in matters related to the coast (Green and Penning-Rossell, 1999; Cicin-Sain and Knecht, 1998; Kay and Alder, 2005) this should not be a surprise. Under circumstances such as these it is clearly imperative, and yet a considerable challenge, to make the best use of the rapidly expanding information and knowledge that is available. However, as we will explore, achieving effective knowledge uptake requires both receptive governance processes and accessible knowledge systems. Accordingly, we analyse Australia’s coastal governance system in relation to knowledge generation, exchange and uptake, and suggest foci for improvement within an uncertain and complex coastal system, especially in the face of climate change. Both formal and informal institutions of governance are considered within our discussion.

In Australia, as elsewhere, effective governance of coastal areas is challenged by: complexity of natural coastal systems; diverse uses of coastal areas; diverse jurisdictions (e.g., international, Commonwealth, state, local) and administrative bodies with coastal responsibilities (e.g., shipping and ports, planning, biodiversity management, fishing, recreation); diverse ways of understanding and appreciating coasts (Stocker and Kennedy, 2009); and diverse perspectives on how it should be governed, managed, and used (Harvey and Caton, 2003; Stocker et al., 2012a). Reliance on linear or ‘loading dock’ approaches to transferring knowledge to governance is likely to be ineffective (Cash et al., 2006). Rather, there is much to be gained from bringing different disciplinary perspectives to bear on coastal governance, expanding institutional capacity and enabling varied stakeholder engagement approaches, notwithstanding the considerable challenge that this represents.

We argue here that:

- conventional systems of government have not adequately responded to, or represented, the variety of voices and knowledges present on the coast
- more collaborative approaches to governance that incorporate these voices and knowledges are required
- processes, tools and techniques are available that can help support the adoption of more collaborative approaches.

We expand upon these arguments by first considering some of the conceptual underpinnings to enhanced knowledge uptake in coastal governance. Second, we discuss aspects of Australian coastal governance and governance (and its shortcomings). Third, we consider some of key challenges which limit the effective use of knowledge in coastal governance, with a particular focus on knowledge uptake in relation to climate change. Finally, emerging elements of Australian coastal governance are described and some newer processes tools and technologies for an improved knowledge–governance interface are presented and illustrated through case examples. While the focus of our analysis is on coastal governance in Australia, we expect that the insights provided may have relevance for other jurisdictions.

2. Conceptual background

This section considers some of the conceptual underpinnings associated with the use of knowledge in coastal governance, and how knowledge uptake may be enhanced.

2.1. Epistemological bases

The challenges for coastal governance presented by issues such as climate change require epistemologies capable of dealing with complex social ecological systems and ramifying relationships. First, Funtowicz and Ravetz (1993), in their work on post-normal science, highlight that particular kinds of research may be appropriate for answering particular questions in particular situations, and not others. For example, in the case of coastal adaptation to climate change, where decision stakes are high and system uncertainty great, applied science and technical consultations alone may be of limited value. By contrast, research that is participatory, acknowledges local knowledge and recognizes the importance of values may be more effective, or may complement any technical studies. Second, a broader perspective on coastal knowledge and the practice of science is evident in the guiding principles of sustainability science, which emphasizes: an issue-driven agenda; co-production of knowledge; interdisciplinary and transdisciplinary approaches; acknowledging earth system complexity; focussing communication and research activities at the local level; and focussing on social learning rather than definitive answers (Cummins and McSena, 2010). Third, in contrast to the traditional ‘science-first model’ approach which elevates ‘science’ above other knowledge systems (Kelsey, 2003), there is benefit to be gained by adopting broad and more engaged and interactive forms of coastal inquiry (Leith et al., 2012) producing outputs from a variety of sources and perspectives. This approach can also lead to better sharing and communication of lay, managerial, Indigenous and scientific knowledge about the coast.

2.2. Cognitive and psychological bases

Transformation of coastal governance systems to account for knowledges such as climate science will require a greater awareness of how this knowledge is received, interpreted and socially constructed. From a transactional psychology perspective (Altman and Rogoff, 1987; Gergen, 2000; Harré and van Langenhove, 1999), any interaction between coastal knowledge-makers and decision-makers will be situated in a particular social context: it will be guided by the cognitive and affective states of the stakeholders, and will reflect the rules and norms of social behaviour. As such these interactions are dynamic, emergent and unique (Altman and Rogoff, 1987 p.28). They are in turn shaped by deeper social-cultural forces including worldviews, as defined above (Clayton and Myers, 2009; Dunlap et al., 2000; Kolstoe-Rivera, 2004).

2.3. Cultural bases

Thus, society’s consideration of issues like coastal adaptation does not arise simply from the scientific evidence of its urgency. Rather, consideration is influenced by phenomena such as worldviews, cultural symbols and metaphors of coasts and climate change, and the historical, cultural and political context that determines which particular account is considered as the ‘truth’ (Hajer and Versteeg, 2005). Cultural meaning and context are therefore central to the discourse and narratives that develop around coastal adaptation. Discourse in turn has important implications for governance. The discourse around coastal adaptation
should encourage the ability, indeed the responsibility, to reflect critically on itself and consider other discourses inviting a sustainable governance model that is reflexive and open to new ideas and ‘truths’ (Stocker and Kennedy, 2009).

2.4. Indigenous knowledge bases

A specific example of the impact of worldviews on knowledge production and application can be found in a comparison between Indigenous and Western perspectives. Western knowledge systems tend to be linear, sequential, and scientific, whereas Indigenous people’s knowledge is more circular; their knowledge systems operate concurrently and loop/feed back to the community (Sillitoe et al., 2002). In the Western world, science is a ‘common pool’ resource open to all (Ostrom, 1999); by contrast, in an Indigenous context, knowledge is distributed, held and maintained by different members of society, strictly adhering to various delineations that prescribe specific responsibilities in relation to that knowledge. For example, within fisheries, certain Indigenous people have knowledge of specific fish, rules and norms for which they are partly responsible (Haggan et al., 2007).

2.5. New modes of coastal governance: collaboration and networks

We noted above the complexity of coastal systems and the benefits of considering diverse information sources and perspectives. However, a challenge of considering complexity (in issues such as coastal adaptation) is that associated knowledge tends to be emergent, dispersed, fragmented, diverse, uncertain and with unexpected interactions (Dryzek, 2005; Duit and Galaz, 2008; Snowdon, 2002). An effective governance model for responding to this knowledge is likely to require, in combination with institutional stability, capacities for flexibility, collaborative action and learning (Duit and Galaz, 2008). These capacities may be achieved through ‘networked governance’ which features multiple nodes and complex pathways of participant interactions including private-public-partnerships and voluntary collaborations between government, businesses and not-for-profit organizations (Dryzek, 2005 pp. 108–109).

Effective knowledge exchange and information flows within a governance network require a high diversity of competencies in communication, policy analysis and subject knowledge, and high connectivity among actors in the network (Snowdon, 2002). When governance networks function effectively the collaborative development of policy between diverse and dispersed participants is possible. Deliberative processes leading to adaptive learning can support such policy development (see below). This approach involves ‘a dynamic play of problem solving and relational activities’ within the network (Bouwen and Tailieu, 2004, p.142). Although there is some scepticism about the level of critical analysis and empirical support for collaborative modes of governance (Backstrand et al., 2010), there are examples from natural resource management in Australia where collaborative governance is becoming the norm, often involving several government agencies, community groups and industry in decision-making (Head, 2009).

3. Coastal governance in Australia

The 36,000 km of the mainland Australian coast makes it one of the longest in the world (Short and Woodward, 2009); it spans temperate and tropical waters and gives rise to a vast array of coastal landscapes, habitats and unique life forms. The coast also signifies Australian culture (Lazarow et al., 2008); the majority of the population (85%) lives in coastal cities and towns, most of it heavily concentrated along the east and south–east of the continent. Australia’s population will grow in coastal settlements, especially in high amenity locations (ABS, 2010). The Australian coast is also vital for the economy. Commercial fishing and coastal tourism contribute significantly to the country’s income; estuaries of Australia’s major river systems and their surrounds support port facilities serving industry and trade, and a productive agricultural sector (State of the Environment, 2011 Committee, 2011).

The pressures placed upon Australia’s coastal environment correspond to broad international trends. Continued urban development in the coastal zone and agricultural expansion in water catchments bring many threatening processes. For example, there is a reduction and decline of habitat in settled coastal areas as a consequence of vegetation clearance, near-shore water pollution, and engineering works; and fluvial introduction of chemicals and sediments. Australian coasts are also vulnerable to invasive pests, introduced by the ballast water of visiting vessels. Climate change is an emerging threat for Australia’s coasts and sea level rise is on the agenda for planning around the country.

Dealing effectively with these existing and emerging pressures is paramount because this response will shape the future of Australia’s coast.

3.1. Australia’s coastal governance system

This section outlines Australia’s coastal governance system, in order to provide a context for later sections. A multi-level system of governance has emerged in Australia to manage competing interests and enduring challenges on the coast (Lazarow et al., 2008; Stocker et al., 2012b). This coastal governance system comprises a diverse array of formal and informal institutions, organisations and stakeholders, but as we shall argue below, it has not proved to be effective.

Legislation is the most formal of the institutions shaping coastal governance processes, authoritatively codifying rules which legally bind all stakeholders. Australian coastal legislation includes statutes governing: coastal policy and planning; development assessment and approval mechanisms; and the statutory bodies entrusted with these, and other, coastal management tasks (see Baird, 2011 for an overview of Australian coastal legislation).

Responsibility for governing the coast is shared unevenly across three tiers of government (Commonwealth, state and local) involving multiple interacting government agencies and other stakeholders. Governance of coasts and seas in Australia is in accordance with the United Nations Convention on the Law of the Sea (UNCLOS). Following the development of the law of the sea, Australia needed to align its international law obligations with its Constitution (Commonwealth of Australia, 2002; Harvey et al., 2012a,b; Kenchington et al., 2012). The alignment was achieved through the Seas and Submerged Lands Act 1973, followed by the Offshore Constitutional Settlement in 1979 and the related legislation that implemented it (Commonwealth of Australia, 2002). This Settlement surrendered to the States jurisdiction over the sea and seabed within 3 nautical miles of the shoreline. The Commonwealth retains sole responsibility for Australia’s Exclusive Economic Zone (EEZ) from three to 200 nautical miles off the mainland coast (Commonwealth of Australia, 2002; Harvey et al., 2012a,b; Kenchington et al., 2012).

The Commonwealth’s Environment Protection and Biodiversity Conservation Act 1999 also provides substantial powers with respect to matters that affect Commonwealth waters (Harvey et al., 2012b; Kenchington et al., 2012), imposing an environmental

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2 Coastal Waters (State Title) Act 1980 (Cth) and Coastal Waters (State Powers) Act 1980 (Cth).
assessment and approval regime on actions with national environmental significance, which includes impacts on Commonwealth marine areas; it also establishes regimes for marine protected areas in its waters (Commonwealth of Australia, 2002).

The Commonwealth exerts its influence on coastal management principally through indirect funding powers, policy development and research. The Commonwealth has funded important environmental initiatives (the Natural Heritage Trust and Caring for Our Country); some of these funds have been diverted to coasts. The Commonwealth has not produced a dedicated coastal policy since 1995 (Commonwealth of Australia, 1995). A National Framework for Integrated Coastal Zone Management followed in 2006 but it is described as a ‘policy without implementation’ (Wescott, 2011).

Coastal lands and waters (including the seabed) out to three nautical miles in Australia are the responsibility of state and territory governments which have legislation, policies and agencies to regulate use of this zone. Table 1 provides a summary of the various legislation, policies and agencies for each of the states and the Northern Territory.

Local government is broadly responsible for strategic land use planning, development approval, management of public land, coastal protection and preparation of plans for specific coastal areas (Harvey and Caton, 2003).

There are many other stakeholders, besides government, who influence decisions that affect coasts. For example, advocacy groups serve to agitate a wider community of interest, raising awareness and promoting coastal health (Wescott and Fitzsimons, 2010). Such groups have the potential to use knowledge and information in powerful and targeted ways to influence political agenda and disseminate ideas. Advocacy groups therefore play an important intermediary role between formal institutions and a wider public. Two important examples of such groups presently active in Australia include: the National Sea Change Taskforce, a national body representing the interests of coastal councils and communities experiencing the effects of rapid population and tourism growth; and, the Australian Coastal Society, another national body seeking to: promote knowledge and understanding of the values of Australian coast; provide a forum for discussion and debate; and build capacity of coastal managers. Both of these groups effectively lobby and contribute ideas and solutions to existing contemporary coastal management challenges (Wescott, 2011).

Universities, whilst without formal responsibility for governing coastal areas, often contain coastal scientists and policy analysts who influence coastal governance, sometimes through their formal individual roles on planning commissions or boards.

Indigenous Australians have rights over some coastal lands and are often directly involved in coastal management: 90% of the Northern Territory coast is owned by Indigenous peoples. Indigenous Land and Sea Councils typically work on natural resource management projects, often in close cooperation with catchment councils and coastal community groups. Traditional owners more generally have special rights and responsibilities in relation to the coast, including the maintenance and transmission of intangible cultural heritage, such as language, stories and ceremonies about the coast (Stockler and Kennedy, 2009).

The media have the potential to increase public and political understanding and acceptance of coastal management issues. However, largely inadequate or biased media commentaries shape Australia’s unwillingness to act on critical information about, for example, sea level rise (Lambert, 2011; Manne, 2011).

Some individuals have attained high public profile through their effective communication of coastal knowledge to decision-makers. Such ‘champions’ are variously referred to as agents of change, advocates, emergent leaders or opinion leaders (Markham et al., 1991; Ottaway, 1983; Schon, 1963). Champions possess a high level of innovativeness, use their networks and powers of persuasion to informally exert influence on the activities conducted within organizations, aiding their success in promoting causes (Thompson et al., 2006). Two Ministerial champions are identified by Wescott (2011): Senator Robert Hill who progressed Australia’s National Oceans Policy in a short time frame in the late 1990s and David Kemp who achieved a sixfold increase in ‘no-take’ marine zones in the Great Barrier Reef marine park in early 2000s.

The activities of coastal volunteers have been inspirational, and therefore, significant in raising awareness and contributing to knowledge of the coast (see Clarke, 2008 who analyses CoastsCare, a high profile Australian coastal volunteer program, and Harvey and Caton, 2003 pp.240–243). Volunteer groups and individuals have shown their capacity to raise the profile and maintain the focus on coastal matters of local significance when these might otherwise fall away from organizational interests which are diverted by competing pressures (such as budgets and other political agendas).

Individuals within their own locales and communities arguably have a heightened awareness of and affinity for their coast, i.e. a sense of place, and are therefore able to provide important insights (local knowledge and values) otherwise absent from policy development (Lazarow et al., 2008).

Informal networks exist among many of the above stakeholders, where channels of communication often depend on personal relationships involving trust, reciprocity and a shared history in the field. Significantly, some voices have greater sway on decision-making than others, such as the coastal scientist Professor Bruce Thom in Australia who, through his informal networking and roles on the think-tank Wentworth Group of Concerned Scientists and the Coasts and Climate Change Council which advises the federal government, has exerted significant influence (Stockler et al., 2012b).

Within the gamut of institutions and organisations described above, many forms of knowledge exist such as lay, Indigenous and managerial knowledge, that can constructively complement traditional ‘scientific’ knowledge as a basis for decision-making. The different worldviews held by the various coastal stakeholders within the coastal governance system and the ways that knowledge is generated, constructed and transmitted have profound implications for coastal management. In this context a worldview can be thought of as “An integrated set of beliefs about what is real, what is knowable, what is valuable, and what it means to be human” (Clayton and Myers, 2009 p.20). One of Australia’s challenges as a coastal society is to develop skills and processes that enable the better understanding of diverse worldviews, and to enhance the democratization of coastal decision-making and knowledge co-production through an expanded approach to governance.

3.2. Governance rather than government for Australia’s coasts

Australia’s coasts face continued environmental, cultural, economic and social challenges (Stockler et al., 2012a) and governments have not been able to solve enduring, well-documented problems (Stockler et al., 2012b). This lack of progress is argued here to be partially attributable to inadequate representation in governance processes of the variety of voices and knowledge present on the coast. This paper therefore recognizes and supports a shift in focus from a hierarchical, government-based style of governance to a more collaborative or networked approach to governance which recognises that decisions affecting the coast are often a reflection of the shared, collective effort of networks of government, private business, civic organizations, communities, political parties, universities, the media and the general public operating (Ansell and Gash, 2008; Bouwen and Taliiou, 2004; Hofmeester et al., 2012). A collaborative or networked approach to governance can also
<table>
<thead>
<tr>
<th>State</th>
<th>Lead agency or body</th>
<th>Coastal act</th>
<th>Coastal responsibility (non-coastal act)</th>
<th>Specific coastal zone policy</th>
<th>State or territory department and minister</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>SA Coast Protection Board (CPB) Primary authority on managing coast protection issues and providing advice on coastal development</td>
<td>Coast Protection Act 1912 (This Act was to be replaced by a Coast and Marine Act)</td>
<td>Development Act 1993 Natural Resources Management (NRM), Act 2004</td>
<td>(Policy on coast protection and new coastal development 1991) (CPB Policy Document, 2002) (South Australia’s Living Coast Strategy, 2004)</td>
<td>Department of Environment and Conservation &lt;br&gt; Minister for Environment and Conservation &lt;br&gt; Department of Planning and Local Government (for planning) &lt;br&gt; Minister for Urban Development and Planning</td>
</tr>
<tr>
<td>WA</td>
<td>Western Australian Planning Commission (WAPC) the peak body for land use, planning and development in WA, Coastal Planning Coordinating Committee is the statutory sub-committee WAPC.</td>
<td>No dedicated legislation particular to management of the Coast or Marine Environment</td>
<td>Planning and Development Act 2005</td>
<td>(WA Draft coastal policy 2001)</td>
<td>Department of Planning and Infrastructure is responsible for planning and development of coastal infrastructure &lt;br&gt; Minister for Planning and Transport &lt;br&gt; Minister for Regional Development; Lands: Minister Assisting &lt;br&gt; Minister for State Development; Minister Assisting the Minister for Transport</td>
</tr>
<tr>
<td>TAS</td>
<td>Number of lead agencies (Integrated systems) State Coastal Advisory Committee formed in 1992/98 but since 2002 there has been no effective coordinating body</td>
<td>No dedicated legislation particular to management of the Coast or Marine Environment</td>
<td>State Policies and Projects Act 1993 Land Use Policy and Approvals Act 1993 Climate Change (State Action) Act 2008</td>
<td>(Tasmanian State Coastal Policy, 1996). Binding on all spheres of government</td>
<td>Dept Primary Industries, Parks, Water and Environment (DPIPWE) &lt;br&gt; Minister for Environment, Parks, Heritage and the Arts</td>
</tr>
<tr>
<td>NT</td>
<td>RIS coastline under Aboriginal ownership No co-coordinating body for coastal matters</td>
<td>No dedicated legislation particular to management of the Coast or Marine Environment</td>
<td>Planning Act 2009. NT Local Government Act</td>
<td>(Northern Territory Coastal Policy, 2001). Main objective to enable integrated approach to management of coastal and marine zones but never endorsed</td>
<td>The Department of Infrastructure, Housing and Environment (DPIE) &lt;br&gt; Landcare Council of NT</td>
</tr>
</tbody>
</table>

(Source: Clarke, 2010)
include the deliberation and determination of goals, including the values, norms and principles underpinning them (Jentoft and Chuenpenapree, 2009, p. 554). Thus the concept of collaborative or networked governance offers a more holistic and dynamic approach to decision-making than is provided by reliance on government alone (see Section 2.5 below for further details). However, to date, although the movement from hierarchical governance to a more broad-based approach to coastal governance has begun, Australia’s current system is far from fully collaborative.

4. Challenges to knowledge use in current coastal governance

Having outlined Australia’s approach to coastal governance, we now consider some challenges raised in light of the issues discussed in Section 2. We do so through exploring several of the challenges for coastal governance related specifically to knowledge uptake with regards to climate change. This is because existing coastal issues are compounded by climate change; as a result, super-wicked problems and social messes are emerging (Stocker et al., 2012b); and central to responding to such challenges are the ability to uptake diverse knowledges including climate science, into coastal decisions.

4.1. Timing of decision making and knowledge making

One of the most confounding challenges to coastal governance relates to time. Physical coastlines are affected by natural processes on time scales ranging from minutes (wave movements) to centuries (sea level). Management responses might be reactive, for example, the repair of localized storm damage; or responses might be proactive, such as planning for long-term sea level rise. Coastal governance is therefore necessarily predicated upon varying time scales. There is an additional challenge for timeliness and governance: the mismatch between first, the processes of government, which by following formal rules and patterns, need timely information through which to inform decisions affecting the coast (through policy making); and second, the generation of detailed knowledge about natural systems (through scientific research). Scientific monitoring of coastal environments frequently takes longer than most political cycles which are fixed to a regular, half-decadal rhythm. Widespread engagement and consequent decision-making for the coast requires long-term, visionary thinking (Lazarow et al., 2008). Collaborative governance, discussed above, is not straightforward or cheap, and requires (among other things) commitment to long-term engaged dialogue and development of trusting relationships among those involved.

These requirements do not match the immediacy of governments’ needs to demonstrate tangible outputs and quick solutions that will influence electorates at the right point in the election cycle.

4.2. Agency policy and planning

Common processes used to enhance understanding between knowledge-makers and decision-makers in agency policy and planning are through workshops and committees. Advisory committees such as the Coastal Climate Change Advisory Committee (Victoria) or the Great Barrier Reef Marine Park Authority’s Catchment and Reef Advisory Committee are key examples here. A common form of knowledge transfer is through “sector representation” on such committees. While this approach can draw together various perspectives, a key challenge is to manage sectoral interests in the context of longer term priorities such as coastal environmental health, adaptation to climate change and community wellbeing. There is a requirement for better knowledge solutions that give clear options and associated risks (Cross et al., 1994; Evans and Shaw, 1986; Shaw, 2008, 2010).

Another challenge to informed decision-making is the lack of explicit environmental objectives found in coastal plans and policy (e.g., see Shaw, 2010 for an Eastern Victorian case study). Glazewski and Howard (2005) highlight the tension between local government’s desire to increase overall rate revenue consistent with coastal development and environmental management. Explicitly addressing environmental objectives and increasing agency expertise in relation to assessment of such objectives can help resolve this tension.

4.3. Litigation and case law

Most responsibility for planning and developmental control is delegated to local government authorities who are becoming increasingly exposed to litigation in cases where they have approved poorly planned developments, including with respect to climate change impacts on the coast. The courts in Australia have become de facto policy makers in relation to coastal adaptation, where controversy exists around climate change risks to the coast. This trend has created high levels of certainty for decision-making on new coastal development in specific cases, but has created uncertainty in general because of the diverse outcomes of cases. Harvey et al. (2012a) illustrate this with case studies showing how council decisions can be either upheld as in Marion Bay, South Australia or overturned, as in Gippsland Lakes, Victoria depending on the extent to which the scientific knowledge on climate change and coastal erosion has been taken into account. Elsewhere, it has proved difficult to reject private coastal protection works initiated in response erosion and climate change, as in Byron Bay, New South Wales, where previous council actions confounded the application of climate science. The courts’ role in filling the vacuum where uncertainty exists in the knowledge—governance interface illustrates the need for climate-related policies such as planned retreat to be enshrined in legislation (Harvey et al., 2012a).

4.4. Insurance industry

Risk levels for existing and new coastal development are only partly incorporated into the knowledge—governance interface by government zoning regulations, planning guidelines and decisions. Scientific knowledge on climate change and coastal erosion is also needed by the insurance industry for risk assessment of potential damage to coastal properties and facilities. The Insurance Council of Australia (ICA) commissioned its own risk study for Australian properties (Chen and McAuley, 2006) the results of which have become incorporated into the knowledge—governance interface at the intergovernmental level (Hennessy et al., 2007) and the national level (HORSCC/WEA, 2009) where the ICA estimated the number of coastal addresses at risk of coastal damage. The insurance industry has thus taken action to fill perceived gaps in the knowledge—governance interface. The Insurance Australia Group (IAG) has also expressed concern about potential climate-change related changes to insurance cover in coastal areas noting that land value which is not currently insured, forms a high proportion of the overall property value at the coast (IAG, 2008).

The four examples above, by no means an exclusive list, serve to illustrate how there are significant challenges in the availability and application of appropriate knowledge to coastal decision-making, and how these challenges or gaps are sometimes bridged by ad hoc or male-do processes. There are opportunities for new approaches to governance that may address the challenges of short-term versus futurist thinking by improving engagement at the knowledge—governance interface. The following section introduces a range of possibilities.
5. Towards an improved coastal governance in Australia

This section outlines some of the practical possibilities and processes designed to support the enhanced knowledge–
governance interface suggested by this paper as necessary for
progressing decision making at the coast. Tools and techniques that
offer means of putting theory into practice are also described.

5.1. Linking knowledge systems and new governance

Organizations and individuals can be effective agents (go-between)
in creating dialogue, negotiating, mediating, and representing viewpoints working between knowledge-makers and
decision-makers. Organizations and individuals use a range of
processes to enhance understanding between knowledge-makers and
decision-makers.

5.1.1. Boundary organizations

Over the past two decades, interest has grown in boundary or-
ganizations as a way of dealing with wicked problems such as climate
change adaptation that necessarily transcend scientific responses.
Boundary organizations play an intermediary role between knowl-
edge production and decision-making (in different domains and
levels), with a view to achieving co-operation in relation to a shared
objective (Lorenzoni et al., 2007; Guston, 2001; Cash et al., 2004).
They can be organizations specifically created to provide this func-
tion or can exist within larger organizations (Cash et al., 2004).

Successful boundary organizations are institutionally set up to be
accountable to at least two groups of stakeholders and are thus
are able to maintain a bridging position, despite external pressures,
and meet the requirements of the various parties (Guston, 2001).
The boundary will, however, be continually renegotiated and will
shape the organization itself (Guston, 2001). According to Cash
et al. (2006), boundary organizations can help increase the
salience, credibility and legitimacy across boundaries through four
institutional processes, set out below.

Convening commotes the process of bringing parties together for
face-to-face contact. Translation can be literal and/or metaphorical
in order to provide information across boundaries of culture, lan-
guage, assumptions and experiences for example. Collaboration is
the process of co-producing knowledge by experts and decision-
makers. Mediation represents and evaluates the different inter-
ests in such a way that the parties involved perceive fairness and
procedural justice. These functions will be present in different
mixes in different systems. With the appropriate institutional
design, leadership and capacity, universities and NGOs can play the
role of boundary organizations whether intentionally designed in
the first instance or not.

An example of a successful boundary organization in Australia is
the National Sea Change Taskforce (NSCT), a body representing the
interests of coastal councils and communities experiencing the
effects of rapid population and tourism growth (NSCT, 2010). This
coalition involves over 68 councils with the aim of providing
leadership and influencing policy development for coastal areas
(NSCT, 2010). The NSCT engages with three tiers of government,
industry, community groups, and research institutions. The NSCT’s
aim of collaboration and direct linkages between research and
governance institutions helps enable sustainability learning and
build adaptive capacity. As a part of a very well attended annual
conference convened by the Taskforce, the Coastal Research Forum
brings together coastal researchers and coastal decision-makers to
share insights and strengthen communication and networking. The
Taskforce supports the roles of convening, translating, mediating
and collaborating to create more informed decision-making for
local governments in coastal Australia. The efforts of the NSCT also
inform other strategic planning processes.

5.1.2. Boundary agents

Boundary agents, or knowledge brokers, play a central role
operating in the knowledge–governance space by developing
influential relationships, building trust, communicating informa-
tion needs and facilitating bridging the gaps among various
stakeholders (McNie et al., 2008).

Boundary agents, or knowledge brokers, can be found within
a variety of contexts and their roles may be formal or informal
(Pettitt et al., 2011). An example of an effective boundary agent in
the Australian coastal scene is the Executive Director of the Na-
tional Sea Change Taskforce, Alan Stokes. His goal and capacity
to enable communication and build relationships among a wide range
of decision-makers, researchers and other stakeholders make him
highly credible and respected as a boundary agent.

Consultants can also play the role of boundary agent, commonly
in relation to the representation of expert information. The format
of scientific information is not always suitable for policy-makers and
planners, so boundary spanning consultants are often employed by
government to collect, collate and translate scientific information
into an accessible locally relevant form, typically working with their
existing relationships and networks. Consultants who play this
boundary agent role advising local or state governments include
lawyers, coastal scientists or coastal engineers. However, by no
means are all consultants genuine boundary agents in the relational
sense; some play purely technical role as intermediaries.

Complex scientific knowledge can be “re-presented” to be
broadly appealing or better understood through the use of visual-
izations, graphics, informatics and the many other visual interactive
media now available. The role of a designer in this context is to
ensure that science communication is accurate and has integrity
(Tufte, 2000 p. 9). As such designers can function as boundary
agents, although this role is poorly understood (but see Fernandez
et al., 2009). Innovative visuals require careful design because of
their power to affect consequent behaviours of the target audience
(Juyle, 2008). The relational role of the designer, as boundary agent,
in understanding and drawing out the intent of the scientist is as
important as the designer’s technical skills.

5.1.3. Deliberation

Deliberation is a term that implies deep and careful consider-
ation, often of scientific information and societal values together. In
the context of community and stakeholder engagement it empha-
sizes “participation, cooperation, and discourse characterized by
reason-giving” (Hartz-Karp and Briand, 2009 p. 4). If well facili-
tated, it can enable a group to span boundaries, learn in a social and
trusting setting and respond adaptively to emerging challenges and
phenomena. Deliberation can employ a wide variety of techniques
and approaches, including many of those described in the sections
below. Quality deliberation aims to build new relationships among
stakeholders and even between citizens and democratic political
institutions (Hartz-Karp and Stocker, in press). Deliberative tech-
niques aim to “bring together a wide range of perspectives and
demographics in an egalitarian environment that encourages
mutual understanding and trust, carefully considering options and
producing decisions and actions that are broadly supported and
perceived to be legitimate” (Hartz-Karp and Stocker, in press).
Participatory mapping (5.2.2.2 below) is one example of a tool that
can be used to support deliberations.

5.1.4. Adaptive learning

Typically, iterations of coastal policies, programs and projects
have been ineffective in transferring learning from one phase to the
next. Evaluation cycles have not been reflexive (Smith and Smith, 2006). This can be partly attributed to the mismatch of the needs of political versus environmental decision-making time cycles. Adaptive learning is a contemporary concept offering a vision for improved transference of knowledge towards improved management practice. For adaptive learning to be applied in a coastal management context there is a requirement for coastal practitioners and their organizations to be intimately connected with the dynamic social and ecological dimensions of coastal systems (Smith et al., 2009). Adaptive learning follows a process that is cyclical and incremental, with each stage providing the foundation for the next (e.g., dynamic system goals; adaptive organizational goals, strategies and activities; reflection on goals and strategies; and networking and ideas generation). Detecting and responding to socio-ecological change must also facilitate broader system goals. This requires knowledge, creativity and vision. It also requires that organizations facilitate learning networks across various scales of learning and action (e.g., from individual to societal or local to global). By taking an approach that facilitates adaptive learning and adaptive practice, the knowledge interface between science, society and governance systems is enhanced (Smith et al., 2009). The South East Queensland ‘Healthy Waterways’ partnership (2001 – current) bases itself on an adaptive learning philosophy. It is a network of over 113 member organizations (including government, industry, research and the community) responsible for managing the water cycle from catchment to coast (SEQ Healthy Waterways, 2009). The Partnership implements five programs including monitoring, science and innovation, capacity building, education, and strategy coordination. It has won numerous awards and is recognized as a national leader for adaptive management along the catchment to coastal continuum.

5.2. Tools and techniques

The sections above highlight the roles that can be taken by individuals or organizations and the processes they might employ in trying to enhance the knowledge-policy dialogue. In each of the situations described above, there is an opportunity to use specific communication, negotiation and decision-support tools. Practical examples are set out below.

5.2.1. Communication support

‘Communication support’ provides opportunities to share information and raise awareness. The information may or may not have immediate application.

5.2.1.1. Coastal research web portal. The CSIRO’s coastal research web portal is an open access Internet resource for local councils (decision-makers), other stakeholders (agents) and researchers (knowledge-makers). The portal enhances the ability of decision-makers and stakeholders to access scientific knowledge in a form that is readily understandable. It uses a spatial visualization technique to locate Australian coastal research projects. Topic based icons on Google maps are viewable at a range of scales and include topics such as mangroves, wetlands, pollution, water quality, and iconic species. Summary information for each research project is available and links are provided to various data repositories; researchers may also provide links to data directly related to the project.

5.2.1.2. Coastal conversations. According to Preston et al. (2011) sharing knowledge about the risks posed by climate change to coastal communities is considered essential for the development of robust management solutions. Identifying and implementing solutions to complex problems where uncertainty is high has been shown to require conscious and active learning among multiple stakeholders (Walters and Holling, 1990). In recognition of an increasing trend in participatory approaches to strategic planning (Brownell, 2009) the Northern Agricultural Catchments Council (NACC) in Western Australia commenced a series of communication support initiatives titled: ‘the Coastal Conversation’ in 2009 and 2011. The series represented an opportunity for local communities, land managers, and other key stakeholders in a regional area of Western Australia, to discuss the future management of their coastlines with experts in the field of coastal management, shoreline monitoring and coastal protection.

5.2.1.3. Art and community cultural development. Art and community cultural development have the potential engage the public and possibly even decision-makers in the interpretation and representation of complex ideas about coastal adaptation. While scientific texts, figures and statistics are regarded as the most legitimate form of knowledge for policy and management of the coasts and seas, shifts in mind-sets are not always achievable by cognitive, scientific or didactic methods. Emotional and affective responses to the environmental threats can be more powerful than government reports or scientific data (Miles, 2010). Exposure to both the power of cognitive scientific evidence and imaginative representations together in a variety of projects and conditions may have a cumulative effect that leads to awareness and personal action (Miles, 2010; Stocker and Kennedy, 2011).

5.2.2. Negotiation support

‘Negotiation support’ provides opportunities through a purpose-designed deliberative process for participants to collectively shape and apply information to their individual and shared purposes. It includes the negotiated co-production of knowledge for immediate or future application.

5.2.2.1. Participatory modelling. Participatory modelling is a technique for improving social and policy learning about social ecological systems. It draws together a variety of stakeholder perspectives into a single visual object to enable collaborative description, negotiation and analysis. Participatory modelling can be agent-based (Perez et al., 2009), numerical (Jones et al., 2011), qualitative (Dambacher et al., 2007) or mixed (Fulton et al., 2011). The Coastal Collaboration Cluster used qualitative modelling (Dambacher et al., 2007) to investigate the extent to which current coastal planning arrangements can respond to climate change impacts such as coastal erosion and recession in the southwest of Western Australia. The workshop drew ideas from 70 participants from diverse backgrounds. The modeller used a whiteboard in real time, encouraging discussion and translation across the science–governance interface, and entering both scientific and governance variables and processes into the model (Stocker et al., 2011).

5.2.2.2. Participatory Google earth mapping. Participatory GIS enables participants to analyse land and resource use issues, raised awareness and knowledge of sustainability and fosters good governance incorporating the principles of participation, equity and transparency (McCall, 2003). Participatory Google Earth Mapping has been used by the Coastal Collaboration Cluster in workshops for the City of Fremantle, City of Mandurah, and Rottnest Island Authority (Hartz-Karp and Stocker, in press). The mapping collaboratively identifies sustainability and climate change pathways for coastal areas. Knowledge experts present critical information on coastal and climate issues orally and in map format. In small groups, participants deliberate on and document: coastal places of importance,
management hotspots, concerns about these hotspots, and proposed adaptive pathways. The method enhances dialogue through its spatially explicit platform, its ability to engage knowledge- and decision-makers simultaneously, its ability to map qualitative and quantitative information and community values, and its ability to consider social, cultural, ecological and economic values without giving primacy to any set.

5.2.2.3. Scenario planning. Scenario analysis is a process of ‘future-casting’ designed to assist decision-making for problems where there is considerable uncertainty and where decisions have the capacity to affect a great many people. Stakeholders are required to think through an array of different futures that may come to pass. The act of creating scenarios forces participants to challenge assumptions about the future. Decisions are shaped on the most likely scenarios.

Scenarios have become a ubiquitous feature of climate change science and dialogue and are central to the science communication strategy of the IPCC (2007). In the last few years they have been used for climate adaptation planning (Desai et al., 2005) as a way to engage stakeholders (Tomkins et al., 2008). A recent workshop carried out by the Coastal Collaboration Cluster for Western Australian Department of Sports and Recreation aimed to develop shared understandings within that agency about the implications of sea level rise, more extreme events, water shortages, temperature increase, and fossil fuel shortages to the future and present management of their core business – coastal sport and recreation in Western Australia. The workshop presented purpose-written creative stories and narrative scenarios about coastal sports and recreation under three clearly-defined climate futures. These were based explicitly on IPCC (2007) storylines, including embedded governance arrangements and social-economic structures, and used CSIRO climate projections for the region (Suppiah et al., 2007). Small groups of participants deliberated on these to develop strategic responses and practical projects (Hartz-Karp and Stocker, in press).

5.2.2.4. Visualizations. Visualizations are factually accurate, graphical representations of numerical data that may include changes over time (animation). The most useful kinds of visualization enable an understanding of large, multivariate and interdisciplinary datasets (Ellis and Doi, 2007; Mathies et al., 2007). These visualizations in turn help provide mutual understanding between the researcher and the stakeholders affected by the research results. Visualizations can help enable novel insights for both researchers and decision-makers by providing alternative representations and consequent interpretations of the data, for example through presenting different scenarios. In relation to coastal adaptation, 3D visualizations have proved useful in demonstrating the consequences of environmental change and fostering action (Sheppard, 2005; Paar et al., 2008). The Coastal Collaboration Cluster has worked closely with CSIRO Mathematics and Informational Sciences to produce an animation based on fluid dynamic modelling that shows the interactions among sea level rise, storm surge and catchment flooding on a hypothetical Australian estuary and adjacent coast, for use by coastal decision-makers. A proof of concept has been trialed in two workshops.

5.2.2.5. PhotoVoice. PhotoVoice involves participants taking photos according to a theme and discussing their photos in a group to reach a consensus about the message they wish to convey to decision-makers, using a selection of their photos and storyline or captions. As a result, it is a thoroughly engaging approach that fosters deliberation and learning, capacity building and empowerment. PhotoVoice has been used by a range of disciplines to understand community values and perspectives and to give the community a voice – health, community development (Wang and Burris, 1997; Baker and Wang, 2006), resource management (Baldwin, 2008), and climate change (Baldwin and Chandler, 2010). It has also been used with diverse communities: youth, children, minority groups (Carlson et al., 2006; Castleden and Garvin, 2008; Strack et al., 2004), and seniors (Baldwin et al., 2011). Such ‘participant elicited data’ in a visual form elicits a deeper insight into complex issues and puts participants in control of the responses. The Coastal Collaboration Cluster is using PhotoVoice to engage commercial rock lobster fishers at the Abrolhos Islands in considering the likely impacts of climate change on their industry and lifestyle.

5.2.3. Decision support

‘Decision support’ provides necessary and sufficient information and feedback to enhance the reliability and accuracy of decisions made by managers. Management Strategy Evaluation (MSE) is a decision support mechanism that was originally used in individual sectors e.g., fisheries and forestry (Walters, 1986) and more recently in coastal zone management. MSE involves feedback mechanisms and is referred to as ‘adaptive management’. In South-East Queensland, CSIRO worked with Healthy Waterways Partnership to develop integrated computer simulation MSE to compare the impacts of different management strategies on environmental, social and economic performance indicators related to water quality. Management actions to improve water quality resulted in proportional changes on indicators such as total nitrogen and turbidity (de la Mare et al., 2012). The costs of management actions (indicative capital and annual operating costs) are viewed alongside willingness to pay based household benefits due to and resulting from these actions, as are the environmental report cards scores and quantification of social values. The participatory workshop in which the MSE found that the process assisted decision-makers and stakeholders in not only direct knowledge but also implicit understanding of the environmental, economic and social outcomes of particular suites of management actions to improve water quality.

Earlier in this paper the wide array of voices contributing to coastal management decisions were identified. Accordingly, a final important decision-support tool for consideration is multimedia—video—stakeholder analysis. This offers a criteria-based and systematic method by which to select a sample of people, or organizations likely to be affected by a decision. It allows for the sorting of stakeholders both for their likely impact on an action and for the impact an action might have on them. This purpose of the process is to developing cooperation between the various parties engaged towards an agreed goal.

6. Conclusion: towards more integrated coastal knowledge—governance relations

This paper has explored issues associated with knowledge—governance relations for the coastal zone and suggested enabling pathways and associated tools and technology for enhancing knowledge uptake. Conventional modes of decision-making at the coast have had limited success in terms of sustainable coastal management, experiencing numerous inhibitors such as short-term decision cycles, the uncertainty of climate change, and poor knowledge—governance interaction. Effective coastal governance is clearly a substantial challenge, requiring action across several arenas, via a wide variety of institutions, processes, tools and techniques. It is also the case that integrated coastal knowledge—governance interactions will not happen suddenly; they may develop over time as a consequence of
both conscious action and as emergent practice. Therefore, while deliberate actions can be undertaken to enhance the interactivity of coastal knowledge and governance, more collaborative coastal governance may also be supported through a more open, outward looking and collaborative culture.

Conceptually, the complexity of coastal environments and the diversity of interests, worldviews and stakeholder knowledge means that there will never be one right way in which coastal governance should occur. Furthermore, coastal governance is an ongoing process, rather than one where issues may be solved once and for all. What emerges from such a perspective is that real progress can only be made through the adoption of more interactive and collaborative forms of knowledge-governance relations: solutions will emerge from engagement and interaction rather than through imposition. Importantly, this means that the processes will never be easy or formulaic; however, over the longer term it is possible to develop a more robust and resilient system.

A key element in progressing such an approach is the development of appropriate institutions and processes that enable different forms of knowledge to have a bearing on decision making. Awareness of the boundaries, which are cultural, social, epistemological boundaries, is integral to enabling such processes, and is a necessary precondition to working more effectively. The research being undertaken within the Coastal Collaboration Cluster represents a modest yet significant contribution to improving understanding of the challenges and pathways associated with exploring how and why appropriate institutional and governance arrangements can be developed, implemented and sustained.

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References


Paper 6


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Spanning the boundary between climate science and coastal communities: Opportunities and challenges

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ABSTRACT

Climate science is complex and sometimes controversial. One of the challenges for coastal adaptation is spanning the boundary between the technical scientists and other stakeholders including local communities and decision-makers. The technical science is very much the domain of professional climatologists, meteorologists, modellers, oceanographers, biologists and geomorphologists. However, the application of this science to the strategic and tactical management of a local coast and ocean requires applied knowledge about the particular coast and the marine environment, including its vulnerability, community values, local politics and relationships, and formal and informal decision-making pathways. We suggest here that there are many organisations and individuals who play important roles in spanning these boundaries. Their roles include some or all of the following: bringing stakeholders together to negotiate pathways forward; translating the complex technical science into terms useful for management and conveying the needs of management or community to scientists; facilitating new applied knowledge and awareness through deliberations; and mediating conflict resulting from different priorities among the stakeholders.

In this paper we focus on organisations and agents who are endeavouring to cross these long-standing boundaries and successfully move climate science information between the knowledge-makers and decision-makers in Australian coastal communities. We use two case studies to examine the opportunities and challenges for the uptake of climate science in these communities. The first case study (OceanWatch: a potential boundary organisation for enabling climate science uptake in the commercial fishing industry) is on enabling climate science uptake in the fishing industry through the potential role of a not-for-profit organisation. The second (Northern Agricultural Catchments Council: managing boundaries for coastal adaptation in the City of Geraldton and its region) explores planning for the coastal town of Geraldton, Western Australia and its surrounding region. For each case study we analyse the functions of convening, collaborating, translating and mediating played by boundary organisations and boundary spanners. We then assess their capacity to enhance the salience, credibility and legitimacy of the process.

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1. Introduction

In recent years, Australia has followed the trend of other western nations with a decline in the number of people who believe that the drivers of climate change are anthropogenic (Levinson et al., 2011). Furthermore, science around climate impacts on coastal and marine environments, such as sea level rise, increased sea temperatures and changing current patterns, has not been adequately embedded in decision-making in Australia.

We aim to analyse opportunities for creating more meaningful engagement and dialogue between climate scientists and coastal and marine decision-makers. Reasons for poor engagement and dialogue are well documented (see McNie et al., 2008; Moser and Ekstrom, 2010) and can include: lack of interest and focus, accessibility, salience and relevance as well as credibility and trust. McNie (2007) argues that ‘scientists may not be producing information considered relevant and useful by decision makers and may simply be producing too much of the wrong kind of information.’

Furthermore, decision-makers and scientists construct their own boundaries to distinguish and demarcate their respective
types of work (Guston, 2001; Janasoff, 1987, 2004), albeit these boundaries are blurry, dynamic, variable across scale and constantly under negotiation. These boundaries play important roles such as protecting science from political pressure, or enabling decision-makers to consider a range of factors beyond evidence. However, these boundaries can also inadvertently inhibit dialogue and use of science by decision-makers (Cash et al., 2002). Re-engagement is then required for scientists and decision-makers to generate appropriate action.

‘Boundary work’ is a term used to describe the processes both of demarcation and re-engagement. It involves attempts by actors on both sides of the boundary to define and demarcate their contrasting practices, as well as their attempts to find productive engagement across these boundaries (Halfman, 2003). Boundary work usually entails stakeholder negotiation and mediation and enables multiple knowledges and values to be shared and co-produced while maintaining the integrity and legitimacy of all stakeholders involved (McNie et al., 2008).

Boundary organisations and boundary work can cross a range of significant boundaries (Cash et al., 2002). In the boundary organisation literature, the boundary between scientists and policy-makers is commonly discussed, as is the boundary between scientists and decision-makers, although the last is an imprecise term. Government policy-makers’ role is to analyse and assess information, develop government policies, and advise and brief Ministers and senior management. Typically their analysis and assessment involves evaluating, researching and consulting with stakeholders, in the context of coastal adaptation, government policy makers and marine and coastal managers are important.

In a formal sense, a decision-maker is typically someone who controls resources and expenditures and/or outcomes. In government, ‘decision-makers’ typically include senior managers and politicians; in the context of a business, ‘decision-makers’ are those who control or administer that business. In relation to coastal adaptation in Australia, we suggest, ‘decision-makers’ include federal, state and local politicians, senior managers and also owners/operators of businesses such as professional fishers. Considering the role of private sector decision-makers is relatively new in the boundary literature.

Finally, relevant scientists include researchers and consultants with specialities in coastal adaptation and fisheries. In this paper we use the above explanations to explore the role of boundary work and boundary organisations — in enhancing the dialogue between knowledge- and decision-making about coastal adaptation to climate change.

The functions of boundary organisations identified by Cash et al. (2006a) are: convening, collaborating, translating and mediating. ‘Convening’ or bringing people together forms the background to strong relationships based on trust and mutual respect. Collaborating is about the co-production of knowledge. The function of translating is about interpreting information across ‘cultural’ boundaries. Mediating means ensuring procedural fairness is maintained in the face of conflict (Cash et al., 2006a).

Cash et al. (2006a) also argue that the knowledge used by boundary organisations should be ‘salient, credible and legitimate to multiple audiences’. In this context, salience responds to the question ‘does the science answer the right questions?’ Credibility responds to the question ‘do we believe this?’ Legitimacy responds to the question ‘is the process fair’?

Our paper analyses two case studies according to the theoretical framework presented by Cash et al. (2006a). For each case study we first analyse how and to what extent the boundary organisations under study perform the functions of convening, collaborating, translating and mediating. For each case study we then critically appraise the extent to which the boundary work creates greater salience, credibility and legitimacy in the process. We identify issues in each case study that would need to be addressed for the boundary work to be more effective for coastal adaptation. Finally, we hypothesise that organisations endeavouring to work across this particular boundary may have greater success and increased organisational vigour if they consciously plan and evaluate their activities using Cash et al.’s (2006a) framework.

2. Case study 1

2.1. OceanWatch: a potential boundary organisation for enabling climate science uptake in the commercial fishing industry

OceanWatch Australia Ltd., is a small national not-for-profit environmental organisation. The primary role of OceanWatch is to advance sustainability in the Australian seafood industry. The members of the organisation live and work in regional coastal communities around Australia and undertake projects to enhance fish habitats, improve water quality and minimise environmental impacts. OceanWatch also introduces the community and fishing industry to sustainable technologies and behaviours (www.Oceanwatch.org.au). The relevant boundary here lies between climate science and the commercial fishing community who need to make both strategic and tactical decisions based on information about the weather in the short term and the climate in the long term. Although not set up to function as a boundary organisation OceanWatch has some characteristics of this type of organisation in that it moves between policy, research and the community.

The study was chosen because anecdotally commercial fishers have been reluctant to make the connection between climate science and changes they had seen in the marine environment and OceanWatch may be in a position to enable this process.

2.2. Aims and processes

In October 2011, a workshop was held in Queensland with the aim of: gauging whether OceanWatch can function as a boundary organisation specifically in relation to climate science. This aim was further broken down with associated objectives including:

- gauging whether the OceanWatch agents interpret their role and function as that of a boundary organisation;
- better understanding the agents views on climate change and their perceptions of the fishing industry in relation to climate change;
- facilitating the sharing of information on climate change between a marine scientist and OceanWatch agents; and
- better understanding some of the opportunities and challenges in the delivery of climate change science to fishing communities;

All of the OceanWatch agents/officials from each State of Australia attended the workshop. As OceanWatch officials work closely within the community, their input on a range of issues was sought including the critical issues facing the fishing industry in the next 5–10 years. Each OceanWatch officer then completed a survey on their personal perceptions of climate change. A number of these questions were based on a large scale Australian survey undertaken by Leviston and Walker (2010). They were also questioned on their personal knowledge and understanding of climate change science as it related to the marine environment and their personal interest in climate change science. For each of these questions, officers were also asked to rate how well they thought participants in the fishing industry would score.
During the Workshop, the OceanWatch officers were also surveyed on the perceived role of their organisation. In an effort to reduce bias, there was no explanation or discussion of the term 'boundary organisation'. Rather, the group was asked to rate their views of the organisation against the criteria used in the Cash et al. (2006a) framework; convening, translation, collaboration and mediation. An explanation was provided for each criterion and participants were asked to provide examples of how they had fulfilled these criteria.

To increase understanding of marine climate change issues both globally and in Australia, a respected marine scientist presented information to the group. Topics covered included global warming hotspots, local sea surface temperature increases, examples of sensitivity and repercussions of small changes in the marine environment, species range shifts, a case study of a rock lobster fishery vulnerability assessment (Pcol et al., 2009), industry perceptions of climate change and priorities for adaptation. Robust discussion followed and included extensive observations of changes in the marine environment.

Small group deliberations identified what enabled good uptake of science in the fishing industry. Positive and negative examples were cited. Given the perceived barriers to climate science uptake in the fishing industry, this discussion preceded that which identified opportunities and challenges for the uptake of climate change science in the fishing industry. The group as a whole then prioritised the outcomes.

A number of OceanWatch officers then participated in a climate change project in 3 communities around Australia. In the first instance their role was to engage local members of the fishing industry and other community members and introduce them to the climate change project. As this project is part of a larger ongoing project, the responses of the local fishers and community to OceanWatch will be sought and evaluated at the end of the project to obtain a more detailed view of the functioning and success of this organisation as a boundary organisation and the Officers or Agents as boundary spanners.

2.3. Findings

2.3.1. Industry issues

Critical issues affecting the fishing industry were identified. They included: the reduced industry license to operate (e.g. acceptance, community support, access, resource sharing), fuel prices, knowledge transfer particularly in an ageing industry, market access, ownership of commercial licences, natural disasters, biological fluctuations, habitat loss and water quality. Climate change wasn’t identified specifically; however ‘natural fluctuations’ and the ‘fisher’s ability to adapt to a changing climate’ came up towards the end of the discussion. The issues raised appear to reflect the state of many fishing communities around Australia and in some cases the failure to take into account the cross-scale dynamics in human-environment systems (Cash et al., 2006b). These cross-scale and cross-level interactions present opportunities and challenges for many policy and management organisations. However, as OceanWatch is engaged in a climate change extension project, this question was also useful in understanding how important and relevant the officers believed climate change was, in the context of the fishing communities they work within.

2.3.2. Perception and knowledge

When asked their point of view of climate change, over half (58%) the participants believed that climate change was happening, and caused by humans. Approximately a third (33%) thought it was happening, but a natural fluctuation in earth’s temperatures. The participant’s perception of fisher’s views were different, with most (45%) assuming fishers had no idea whether climate change was happening or not. They perceived that if fishers believed in climate change it was considered to be natural fluctuations in the earth’s temperatures (36%). This is in comparison to a large CSIRO baseline survey of Australians (Leviston and Walker, 2010) which indicated 50.4% of Australians believed that climate change is happening and humans are largely causing it and 40.2% thought climate change was a natural fluctuation in the earth’s temperatures.

The smaller survey of the OceanWatch population indicated they may have been slightly better informed on climate change than those surveyed in the general population. However the OceanWatch officer’s view of the fishing industry was quite different to that reflected by the general Australian population. Interestingly, most (45%) of the OceanWatch officers thought that people in the fishing industry had no idea about whether climate change was happening or not, compared with 3.8% of the general population (Leviston and Walker, 2010). This considerable deviation from the general population may not reflect the actual situation in the fishing industry however it does reflect the complex cross-sectoral and cross scale issues when dealing with climate change uptake.

When asked to rate their personal knowledge and understanding of climate change, all participants rated themselves in an average or above average category. The majority of the participants (83%) perceived that people in the fishing industry were less well informed than themselves about climate change.

2.3.3. Knowledge uptake

The officers discussed barriers and opportunities to science uptake in the fishing community including the value of face to face meetings and the building of trust and relationships. They felt it was important to use appropriate language and translate complex science, personalising it if possible. The delivery of information was also significant; preferably in the fishers own environment by people who are independent and trusted in the fishing community.

Uptake and delivery of climate change science was understood to be a greater challenge and a number of the officers indicated that ‘climate change in itself was likely to turn interest off’. Also noted was the perception that some fishers may not want to be identified as recognising climate change was an issue for them or the industry. Other barriers were the time scales used for the climate models and projections. For many fishers, these projections are well outside their working life.

2.3.4. Convening

In the survey of the OceanWatch officer population, participants rated their organisation very highly for the function of convening. When asked if the organisation brought together stakeholders from different areas or organisations, 92% of participants rated the organisation as 4 or 5 in a scale of 1–5 (where 4 represented ‘mostly carried out this function and 5 ‘always’ carried out this function). The participants went on to cite multiple examples of how the organisation had instigated community engagement events, engaging a wide range of stakeholders. During the workshop participants identified ‘face to face’ contact as the most important method of communicating with fishers. Examples of successful community events which brought together commercial and recreational fishers and the general community at festival days; multi-stakeholder workshops; and projects involving OceanWatch, fishers and scientists were cited as good examples of convening.

2.3.5. Collaborating

Participants were asked to rate their organisation’s ability to create opportunities to share and produce new information with stakeholders to work out better options for future work and new
projects. The results indicated a strong belief that the organisation fulfilled this function (92% rated as mostly or always). Examples included moving information from researchers and management into the fishing community, delivery of new management systems that required collaboration by OceanWatch, scientists and industry, and the introduction of new gear technology to improve environmental outcomes.

2.3.6. Translating
Translating rated as the most significant function with 100% of participants rating the organisation highly (as 4 or 5 on a scale of 1–5). Many of the participants saw the translation and extension of information as the main role of their organisation. Numerous projects that required the interpretation of information from scientists to the fishing industry and the moving of information back to research and management were given. Extending information from research projects into coastal communities and translating the information needs of fishers back to the research community were also considered part of their role.

2.3.7. Mediating
Mediation was not rated as highly as other functions (67% as mostly or always fulfilling this function), although there were examples provided as to when this had occurred. Some of these examples would fit better into the convening rather than the mediation function; however, a few of the participants indicated they fulfilled an important role of mediation between the Government and fishers during issues of conflict.

2.4. Analysis

2.4.1. Credibility
OceanWatch employees live and work in coastal communities and quite often have a background in the fishing industry or related sectors. These attributes build trust and increase their credibility in the coastal communities and the fishing industry, factors which the OceanWatch officers rate as important in the delivery and uptake of science. This credibility can be generated individually and may differ between national employees and therefore coastal communities. Although credibility can be gained through the organisation it also is passed on to the organisation via the officer who has gained trust and respect from the community. In this case OceanWatch works hard to build credibility and trust at all levels and to employ officers who have experience in the industry and communities. In areas where the organisation has been active, this appears to have been successful. In communities where there has been little activity by OceanWatch or the officer is new to the community, the relationship has not developed and the officer may be reluctant to broach difficult issues such as climate change out of concern that their credibility may be compromised. OceanWatch employees commented that their hard-won credibility could be reduced if they began discussions with sceptical fishers on the topic of climate change. This suggests that their confidence around this topic is low. It also suggests that employees believe their high credibility may be damaged if they are seen to be pursuing what is seen as a non-salient topic in the industry.

2.4.2. Salience
OceanWatch employees indicated that climate science is not seen as very important to fishers because of the other more immediate imperatives they are facing which place them under considerable stress. Another issue is the relevance, accessibility and scale of climate science (e.g., sea surface temperatures and sea level increases) to the fishers and to the community. Much of the information is too spatially general for use by fishers. Furthermore, predicative models for 2030 and 2070 are beyond the life expectancy of many fishers. Down-scaling of climate change data to more relevant geographic (local and regional) and temporal scales could increase the salience of the information. As officers rate their knowledge of climate change at a relatively high level, and higher than that of the fishing community, this could be achieved, particularly with their linkages into the science community. Salience cannot be undervalued in science and technology systems (Cash et al., 2002). When the boundary to be spanned involves complex technical climate science, more innovative processes are required to translate climate science into a relevant downscaled form, in order to increase the salience of information to engage both the agents and their stakeholders.

2.4.3. Legitimacy
The fairness or legitimacy of a process is also an important attribute. OceanWatch recognises this by placing a high value on recruiting officers with a strong background in the fishing industry or in coastal communities. It also values input from experts and the production of appropriate and relevant information. However, in relation to climate change, the legitimacy of OceanWatch’s potential role as a boundary organisation would probably be compromised by any perceived fragility of officer credibility. This may be a result of a reduced level of legitimacy, if the officer or agent is new to the area and hasn’t built up a high level of trust in the fishing community. It may also result from a particularly close association and identification with the industry decision makers and a reluctance to discuss issues that are not considered salient for the industry or themselves as they share a similar world view.

As legitimacy brings together credibility and salience, each of these factors are important for the success of the organisation and officers in endeavouring to cross complex boundaries such as climate science uptake while working as a boundary organisation or as boundary spanning agents.

3. Case study 2

3.1. Northern Agricultural Catchments Council: managing boundaries for coastal adaptation in the City of Geraldton and its region

Over recent years, coastal communities in the Northern Agricultural Region (NAR) of Western Australia have shown a growing commitment to adapting to climate change as exhibited by an increased interest towards adaptation projects and multi-agency collaborations. This can be attributed to increasing availability of climate change scientific information, new policy requirements and a growing awareness amongst coastal communities of the importance of fostering dialogue between scientists and managers on this complex matter (Brownhill, 2009).

The Northern Agricultural Catchments Council (NACC), a not-for-profit organisation established by the Australian Government to deliver natural resource management outcomes has played a key role in supporting regional stakeholders in this endeavour (see www.nacc.com.au for more information). Since its establishment NACC has influenced the governance system in which they operate and has both initiated and supported regional adaptation initiatives for improved coastal adaptation outcomes. We suggest here that NACC has functioned well as a boundary organisation (Cash et al., 2006a; Agrawala et al., 2001) by:

- making scientific information accessible to policy-makers and decision makers;
- translating and communicating policy-relevant issues;
• establishing communication links with concerned parties;
• identifying knowledge gaps and prioritise future research; and
• bring together professionals who serve a mediating role (such as expert facilitators and technical experts) between policy makers and community.

NACC plays an important role in the implementation phase of adaptation initiatives by providing its communities with necessary resources to undertake research, on-ground works and improve knowledge in the field of coastal planning and management (Gaston, 2001).

In saying that, coastal governance in Western Australia is characterised by complex cross-scale and cross level interactions which can act as a blockage for adaptation planning processes and initiatives. The role of organisations such as NACC can facilitate these initiatives by spanning boundaries among policy, management, planning and on-ground activities, bringing together diverse actors. However this role is still poorly understood and recognised in Western Australia.

Hence, in this case study we examine an initiative that showcases NACC’s effort in spanning boundaries by fostering dialogue between coastal stakeholders (convening), facilitating information sharing between interested parties (collaborating), presenting and interpreting complex climate science and coastal adaptation issues in the NAR (translating) and ensuring procedural fairness including means to resolve conflicts (mediating). Information presented here is based on feedback and evaluation forms as well as participant observation.

The initiative was a workshop commissioned by the Batavia Regional Organisation of Councils (BROC)2 and undertaken by NACC following the development of the BROC Climate Change Adaptation and Action Plan (AECOM, 2010). The Plan belongs to the ‘first generation’ of institutional climate risk assessment and adaptation planning (Preston et al., 2010) funded through the Local Adaptation Pathways Program (LAPP). A review of the challenges to adaptation planning shows that the ability of local governments to absorb climate change into their strategic planning and operations and then to implement the actions within these plans depends upon hierarchical planning mechanisms, overlapping legislation, and political will (Jones and Preston, 2010; Preston et al., 2011). Hence, the workshop was developed in recognition of the need for a better understanding of how governance systems facilitate or hinder the ability of local governments to implement coastal adaptation actions identified through a multi-agency, collaborative, risk assessment and adaptation processes.

3.2. Aims and processes

The aim of the workshop was to engage participants with various backgrounds and roles in discussions that focused on achieving the workshop’s objectives. The workshop’s main objectives were to:

• explore alternative governance arrangements that are necessary for the implementation of high priority actions within the Climate Change and Adaptation Action Plan;
• explore governance opportunities to allow for climate change considerations to be embedded in decision-making processes;
• explore challenges and opportunities for multi-agency partnerships for the enabling of an overarching institutional commitment towards the consideration of climate change; and
• increase the understanding of the requirements for, and application of, coastal hazards assessments.

A total of 33 participants from eight local government authorities (all the eight coastal local government authorities in the NAR participated), other government agencies, not-for-profit organisations and educational institutions attended the workshop, which was facilitated by a representative from the Western Australian Local Government Association (WALGA) using specific deliberative techniques to focus and enhance the quality of discussion.

Participants attending the workshop were policy makers (from local and state government agencies), decision makers (councilors), coastal managers (from local and state government agencies), representatives from funding bodies (Midwest Development Commission, Northern Agricultural Catchments Council) and experts in the field of coastal adaptation (private consultants, researchers).

Five tables of participants each had one BROC member and one facilitator and worked through the workshop sessions. In session 1, an expert in the field of coastal adaptation was engaged to describe to the participants the alternative approaches for undertaking coastal hazards assessments at the local scale and to identify governance implications for both undertaking the assessments as well as implementing the findings into adaptation planning processes. In session 2, a technical panel with expertise in the field of coastal vulnerability and climate change adaptation was present to add value to the discussions by providing feedback and input throughout the workshop. In this session, participants were encouraged to brainstorm with the panelist’s governance opportunities that may enable local governments to undertake local scale coastal hazards assessments. Components of governance were used as prompts to guide this discussion, such as Institutional Arrangements, Relationships/Partnerships, Scale, Governance and Management Tools, and Research. The open room discussions with the technical panel were captured through a Fault Tree discussion template, which helped to identify key governance opportunities and challenges for undertaking coastal hazards assessments.

3.3. Findings

3.3.1. Convening

The large number of participants convened from a range of organisations and institutions played an important role in the success of this workshop by framing the discussion around the challenges that climate change pose to policy development. Policy makers were able to share their knowledge in the field of coastal policy and elucidate how the hierarchy of planning policies affects decision-making at the regional and local scale. At the same time they had the opportunity to learn about climate change assessment tools, challenges faced by local communities; governance implications and current policy limitations.

During the discussions it was identified the complexity, breadth, and constant debate surrounding climate change increases uncertainty within local government and across jurisdictions, making shared understanding and agreement between decision makers difficult. Participants agreed that climate change presents a major challenge for local government and the community and that addressing these issues would require long-term thinking and subsequently progressive longer-term policy approaches.

Participants highlighted that coastal hazards assessments could be utilised as a catalyst for bringing stakeholders together, enabling a transition towards required long-term adaptation and commitment within and across jurisdictions.

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2 Batavia Regional Organisation of Councils is a formal partnership of 3 local governments in the northern portion of the Northern Agricultural Region.
3.3.2. Collaborating

The workshop enabled each of the representatives to work together to achieve the desired outputs of the workshop including:

- A tool for the analysis of coastal governance arrangements and processes influencing regional and local decision-making;
- A set of prioritised recommendations as a basis for improving regional and local decision making; and
- A process that could be applied by a group of councils to address other areas within the Climate Change Adaptation Action Plan.

In an effort to seek collaboration between participants at an early stage of the workshop, participants were requested to clarify their expectations. The expectations were clustered in 4 themes (climate change science, actions, collaboration and coastal erosion) and checked against throughout the workshop. Participants expressed their desire to: learn from academic and experts; identify effective (cost effective) measures to address coastal erosion at the local scale; and gain better understanding on how a group like BROC can work together to help the community to adapt to climate change and many more.

The workshop enabled coastal stakeholders based in the capital city to meet in one single event in a regional centre. We believe that this event helped overcome the barriers of distance and isolation of professionals which often act as a deterrent to a more integrated and collaborative decision-making (Cash et al., 2003).

Through the provision of technical and expert advice the workshop helped strengthen multi-agency partnerships, clarify roles and responsibilities, and ensured an overarching (regional) institutional commitment towards the consideration of climate change.

The output (the Coastal Governance Report) was the result of a joint production and effort of a range of stakeholders through a participatory mechanism. The report is a summary of the governance challenges and opportunities discussed at this workshop, with key recommendations for progressing climate change adaptation in the coastal zone of the BROC. The key recommendations are:

- Foster leadership in climate change adaptation by providing climate change training and guidance targeted to a range of staff to build the adaptation capacity through climate change leadership programs, conferences, workshops, and dialogue with research institutes and technical specialists;
- Ensure that local policies and land use planning frameworks adequately consider climate change risks in a defensible, consistent and scientific manner;
- Improve existing, or introduce new Governance and Risk Management Tools to embed adaptation to climate change into decision making;
- Seek expert advice on legal implications associated with current and projected climate change impacts; and
- Continue to support existing partnership arrangements as a means to increase resource availability towards coastal hazards assessment, and build on existing regional climate change adaptation efforts.

3.3.3. Translating

Technical assessments for coastal vulnerability and risks have become increasingly popular in Australia. A variety of approaches and methodologies from national assessments to more local scale coastal vulnerability assessments currently exist. However, many of these methodologies have proven to be insufficient to answer all questions underpinning decision-making at the local scale and their effectiveness in influencing decision-making is still uncertain (Yuen et al., 2012). To date, confusion as to what methodology would be effective in supporting decision making at the local scale still exist.

One of the intentions of this workshop was to translate complex global information and bring it to bear on the local context. Critical to this workshop was that the latest information on coastal vulnerability and risk assessment was accessible to the participants. The information was provided by a leading expert in the field of coastal adaptation. In addition a technical panel with expertise in the field of coastal vulnerability and climate change adaptation was present to translate technical information for participants so that it could be usefully incorporated. Participants also had the opportunity to make comments and raise questions regarding liability, policy and planning matters relevant to local government.

Participants discussed alternative approaches to the so-called ‘bouncing ball’ approach used to date to assess coastal vulnerability and climate change risks. The group acknowledged that this approach requires:

- An understanding of the relevant climate change drivers and scenarios for a certain area;
- A detailed impact and risk assessment; and
- The development of adaptation policy options to mitigate risk.

It was stressed that even though this was a common approach, it often became a costly exercise for local governments due to the increasing number of available climate models and scenarios, and a lack of site-specific information about how these drivers may impact specific locations. It was also highlighted that questions have been raised by both academics and practitioners in relation to the cost-effectiveness of vulnerability assessments undertaken along coastlines of low population and urban density. The groups deliberated on a possible alternative approach that would be more achievable for local government with limited financial resources and would be help justifying government investment. This approach would require an understanding of the specific place based objectives before undertaking the vulnerability assessment.

The key recommendations developed to assist BROC in progressing with climate change adaptation as well as the key questions raised by the participants during the deliberative process were captured in the report prepared by NACC. The Report also details a range of opportunities identified for undertaking and implementing a coastal hazards assessment, in order of priority and with details regarding agency responsibilities and funding opportunities.

Since the workshop some of recommendations made have been implemented as demonstrated by the employment of a regional climate change coordinator and the development of the City of Geraldton-Greenough climate change policy. Two of the eight local government authorities present at the workshop have recently established a coastal partnership for undertaking a coastal vulnerability assessment.

3.3.4. Mediating

The workshop enabled stakeholders to engage in a positive and constructive discussion regarding institutional commitment towards the consideration of climate change in the region. The workshop supported coastal stakeholders in exploring challenges for undertaking coastal vulnerability assessments at the local scale, discussing alternative governance arrangements necessary for implementing actions, and identifying institutional opportunities for integrating scientific findings into practical outcomes. Hence, NACC provided a platform for actors from different arenas to understand the different perspectives and to find common ground.
Knowledge differentials were managed effectively through the provision of technical advisors and a trained facilitator at each table who's role was to facilitate constructive discussions, minimise individuals dominating the discussion and lessen potential conflicts.

As the workshop did not require consensus to be reached, conflict was less likely than in a consensus-seeking process.

A feedback survey confirmed that participants were satisfied with the workshop's format and that their expectations were met (75% agreed, 25% strongly agreed); participants indicated that in their opinion the objectives of the workshop were met (50% agreed, 25% strongly agreed), that the level of interactivity was appropriate (62% agreed) and that the skills learned would help informing future work (44% agreed and 44% strongly agreed).

3.4. Analysis

The role of boundary organisations in maintaining salience, credibility, and legitimacy for audiences on different sides of boundaries is a challenging task especially for non-statutory bodies such as NRM agencies. The inconsistently funded nature of the NRM model places the future of the organisation at risk, hence offering precarious support to communities and land managers. In addition, decision-making processes and outcomes are still subject to local politics and underlying priorities despite the best intention of boundary organisations and partnerships. A boundary organisation such as NACC also faces the challenges of the scale-dependence phenomenon described by Cash et al.: ‘What is salient, credible or legitimate to state level actors might be different from and antithetical to what is salient, credible or legitimate to local actors’ (Cash et al., 2002 p. 8).

3.4.1. Credibility

The BROCC Coastal Governance Workshop aimed to increase participants' knowledge and skills in the field of climate change adaptation by bringing multiple types of expertise to the table. Information and knowledge, provided by the technical panel and guest speakers, helped to frame the discussions and develop key recommendations for the report. The participation of relevant experts and the review by the respective scientific community is necessary to ensure the use of authoritative information and the scientific credibility of the assessment.

3.4.2. Salience

The way people understand and perceive climate change risk varies across organisations in the NAR. Despite the efforts of stakeholders to develop a shared vision for the coast and identify adaptation policy options to mitigate these risks, there are still major concerns over the lack of site-specific information about drivers of change and how these drivers may impact specific locations. Furthermore, skepticism towards climate change still persists and leadership for adaptation is strongly influenced by the political divide.

Participants of the BROCC workshop advocated for stronger leadership for climate change adaptation and a more targeted, cost-effective approach to vulnerability assessments so that expenditures become more justifiable (resources towards ‘hot spots’ or high priority areas rather than broad scale assessments) and projects achievable. This approach would require a better understanding of specific place-based objectives before undertaking vulnerability assessments. However, despite the number of international and national methodologies available for assessing vulnerability and risks to climate change impacts on the coast there are still uncertainties as to what is the best approach for assessing vulnerability at the local scale and what governance arrangements would best support this endeavour.

3.4.3. Legitimacy

NACC attempted to include a broad variety of stakeholders’ perspectives and incorporate placed-based knowledge in the initiative. Participants had a say in the content or type of information required for the BROCC workshop. Stakeholders from multiple arenas that were engaged in the initiative found the process fair and legitimate (NACC, 2009).

However there are risks that a boundary organisation faces when engaging in participatory initiatives: the risk of raising community expectations where decisions are still influenced by other priorities and local politics; manipulation by vested interests being veiled as participation; the precarious support to communities and land managers due to the inconsistently funded nature of not-for-profit organisations (e.g. NRM model); and/or reaching only those already engaged, rather than mainstreaming knowledge.

4. Conclusions

This section discusses the opportunities and challenges with those approaches described above, to move climate change science into coastal communities and governance.

Innovative methods, organisations and processes may be necessary to re-engage coastal communities in climate change information and its uptake. The above case studies describe: one deliberative workshop designed to investigate the potential of an existing not-for-profit organisation (OceanWatch Australia) to function as a boundary organisation relevant to climate change science and one deliberative workshop specifically designed to enhance dialogue across science-governance boundary in the field of coastal vulnerability assessment, using the existing organisation of Northern Agricultural Catchments Council (NACC).

Boundary organisations can provide a functional framework to move technical climate change information between science makers and coastal communities. Our findings show that while not specifically using the term boundary organisation to describe itself, NACC, a natural resource management group, functions well in this capacity. Various processes were successfully used by NACC including enabling eight coastal local Government authorities to share information on climate change vulnerability and risk assessment and to explore alternative governance arrangements for assessing coastal vulnerability. NACC fulfilled the four functions of a boundary organisation (convening, collaborating, translating and mediating) and successfully enhanced credibility, salience and legitimacy at the science-governance boundary.

The officers in the organisation OceanWatch strongly believe their organisation effectively functions as a boundary organisation, although again, they were not previously familiar with this name. Their attributes of credibility and legitimacy appear high; however their capacity to deliver technical information on climate change may be limited because they perceive that fishers do not see climate change science as salient or important to their industry. This view likely reflects OceanWatch’s strong ties to the industry, and an unwillingness to engage fishers in a complex issue which they believe may diminish their credibility in the industry. So while they appear to function well as a boundary organisation, they are likely to do so in relation to climate change science only with significant support.

While it is important for boundary organisations and boundary spanners to have linkages with the knowledge or decision makers, it appears that if these linkages are too strong, (and their views mirror the others), the boundary spanners in the organisation may have trouble accepting and building a new agenda. If on the other
hand, the linkages are not well established, the boundary spanners may not have the perceived legitimacy to deal with complex and difficult issues such as climate change.

OceanWatch may be able to effectively deliver technical climate change science information into coastal fishing communities because of its high level of credibility and trust in these communities. The salience of the material would be enhanced if the organisation and boundary spanning agents could develop the ability to translate climate science into a down-scaled regionally relevant format. It is likely that their confidence in their credibility with fishers and their legitimacy as a boundary organisation for climate science could potentially be enhanced.

Boundary work can occur in a variety of settings and in a range of different organisations. Boundary spanners are considered essential actors in facilitating linkages between knowledge and action for sustainable development (McNie et al, 2008). In OceanWatch it is the individual employees who act as boundary spanners and form the primary relationship with the community. These officers have the capacity to effectively span boundaries because they have strong linkages into the community.

In the two studies described, boundary organisations and boundary spanners have been successful to varying degrees in sharing knowledge and increasing the understanding of climate change science in coastal communities, but challenges still remain.

Organisations such as OceanWatch may have greater success and increased organisational rigour if they consciously plan and evaluate their activities using Cash et al’s (2006a) framework.

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References

Paper 7

Climate Change Adaptation
Building Community and Industry Knowledge

Jenny Shaw
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Appendix 4 Photovoice: an innovative method for the uptake of climate change science

This section describes an innovative method to engage a community and assist in increasing knowledge and understanding of climate change. Photovoice can be used to illustrate industry values and linkages among climate, environmental, economic and social changes.

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4.6 Conclusions ............................................................................................................ Error! Bookmark not defined.

Attachment 1 Visitor Survey ...................................................................................... 8
Attachment 2 Awards ................................................................................................ Error! Bookmark not defined.
EXCERPT From Appendix 4:

4.4 Methods
Fishers were invited to participate in a number of workshops to share knowledge and observations of environmental changes in the mid-west region of WA and specifically the Abrolhos Islands. The workshops were held on each of the four main groups of the Abrolhos Islands in March 2012.

At each of the workshops, the Principal Investigator (Jenny Shaw) introduced the project and methodology with a presentation titled Photovoice: the Abrolhos project. Dr Nick Caputi presented on management implications of climate change effects on fisheries in WA (FRDC-DCCEE Project: 2010/535). Dr Lynda Bellchambers presented on coral reefs in a changing environment. Chris Lewis (ABC) gave a presentation on tips and tricks when taking photographs.

To maximise participation and the contribution of views and ideas, particular care was taken to ensure that workshops were not perceived as Department of Fisheries meetings, and each gathering was kept as informal as possible. Project information was distributed and research consent obtained from each participant. Surveys were undertaken prior to and following the workshop to gauge fisher observations and perceptions of climate change.

During the workshop fishers were asked to describe any changes they had observed in the marine environment, ocean currents, weather or climate. They were also invited to discuss with the scientists any aspects of the information that had been presented.

The project was described, and the Photovoice methodology demonstrated with examples of photographic images (permission from C. Baldwin, N. Dunlop) that illustrated environmental values and environmental change. Funding had been secured to hold an exhibition at the WA Museum in Geraldton and although initially the format was not defined, the exhibition offered an opportunity for the Abrolhos fishing community to show the wider regional community the issues they were currently dealing with. It would also showcase their fishing industry and island life.

The fishers were asked to provide photos of images they valued in their industry, community and islands. They were also asked to take photographs of environmental change. Throughout the following 3 months, over 1,000 photographs were collected from members of the Abrolhos Island fishing community. The images were taken with a range of photographic equipment (including iPhones) and levels of resolution.

The images were roughly sorted, enlarged and laminated and the fishing community invited back to select the photos that most appealed to them. The photographs were selected for the power of their story, not just their photographic merit.

After the initial surveys were analysed, follow-up surveys and individual interviews were carried out to gain a better sense of fisher values and unpack some of their observations in relation to change.

The project was an Action Research project which enabled flexibility in the original methodological design. It also allowed for leads to be followed and changes made from lessons learned following workshops, interviews and surveys. For example, after the initial workshop and surveys, it appeared that many in the Abrolhos community believed the changes they were experiencing were the result of management changes only and did not necessarily relate these changes back to other drivers.

A further workshop was held in Geraldton to increase understanding of the drivers of change. At the start of the workshop, participants were asked what the most important factors were leading to the
change from the Abrolhos Islands community 6 years prior, to the Abrolhos Island community of today.

Each participant was then given a large (A3) colour version of a flow diagram graphic of cascading impacts leading to community loss (Figure 1). This graphic had been created largely from fisher photographs and was designed to facilitate discussion and illustrate the connectedness of changes that fishers had described from a strong vibrant community to a community reduced in numbers and social value. The layers included:

- climate drivers
- Abrolhos Islands marine ecology
- management and economic drivers
- fisher observations
- fisher response and adaptation

Each layer was discussed with respect to impacts and influences the community had experienced at the Abrolhos and in their fishery. Fishers were asked about the linkages and impacts they had already experienced. Their responses and future adaptation strategies for their fishing businesses were also canvassed.

The ‘Seeing Change’ exhibition was designed and curated to reflect the stories, views and values of the Abrolhos Islands fishing community while illustrating the linkages among climatic, environmental, management, economic and social changes. A range of tools were utilised to convey the story and increase knowledge and understanding of this complex information.

To personalise the exhibition story, the fisher interviews were transcribed and a collection of quotes and anecdotes separated out and printed onto story boards. These quotes were displayed anonymously throughout the exhibition. Interviews of fishers and scientists were incorporated into software that produced Word Clouds to illustrate the different views of these two groups. A large map of the Houtman Abrolhos identified Islands with fishing camps and important historic sites. Colourful posters displayed the Island names.

The Australian Broadcasting Corporation (ABC) produced a series of video vignettes (Stories from the Abrolhos Islands Chris Lewis, ABC Open Midwest Producer) specifically for the ‘Seeing Change’ exhibition and ABC Open productions. A number of these short videos describing the project were broadcast nationally on ABC TV and are still available for continuous download from the ABC Open website. They included interviews with rock lobster and wetline fishers; members of the fishing community and the project team.

Additional videos showed scenes of the Abrolhos Islands and underwater footage of the coral reefs. The ABC Landline video of the Abrolhos (Out to Sea by reporter Sean Murphy) was edited to focus on the historical background to the Abrolhos Islands as well as describe the special marine and ecological features of the group. These videos were spooled continuously throughout the exhibition in the ‘Deckies Lounge.’

The ‘Deckies Lounge’ was a room, separated from the main exhibition hall and designed to resemble a fisherman’s camp. The room had Abrolhos art, lobster designed wallpaper, family and community snaps, retro linoleum and comfy couches. Visitors could sit back on the couches and watch the videos. A kitchen table and chairs enabled video viewing and also a chance to view a monitor scrolling through all the other photographs that were submitted and not used in the exhibition.
Visitors were invited to comment on the exhibition by writing on ‘Seeing Change’ postcards and then hanging their card on a ‘Seeing Change’ peg-board. Views were also canvassed with a confidential survey (Attachment 1 Visitor Survey) inquiring about the visitor demographic, exhibition impact and climate change attitudes and awareness.

The exhibition was launched in Geraldton, Western Australia (Figure 2; Appendix 5 Appendix 5; Attachment 7 Exhibitions) on the 29th November 2012. It was open until the 24th of February 2013. The exhibition was also shown in Albany on the 26th of June to the 21st of July 2013, and in Fremantle at the WA Maritime Museum from the 7th of September to the 24th of November 2013.

Staff from the WA Museum Geraldton and the WA Maritime Museum in Fremantle were interviewed to gauge their views on the exhibition and to better understand the visitor response. Fishers were also interviewed and this work is ongoing.

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Figure 1 Cascading impacts leading to community loss
Western Australian Museum Presents

SEEING CHANGE
A photographic story from Abrolhos fishers

7 September - 24 November 2013
A FREE EXHIBITION

Western Australian Maritime Museum | Victoria Quay, Fremantle | Open 9:30am – 5pm daily
To find out more visit museum.wa.gov.au or call 9431 8334

Figure 2 Seeing Change Exhibition
Attachment 1 Visitor Survey

Seeing Change: A photographic story from Abrolhos fishers

*We would like to know a bit about the people who attend this exhibition.*

1a) Where do you live? ............................................................ 1b) If in Australia, what is your postcode? .........................

2) What is your occupation? ............................................................

3) What is your gender? Please circle  Male  Female

4) What is your age bracket? Please circle

   < 10 years  11-20 years  21-30 years  31-40 years  41-50 years  51-60 years  > 60 years

5) How often do you view museum exhibitions? Please circle

   This is the 1st time  Once per year  Several times per year

6) Have you ever visited the Abrolhos Islands? Please circle

   Never  Occasionally  Regularly

7) Do you fish? Please circle

   No  I don’t fish  I work in a commercial fishery or seafood industry  I am a recreational fisher

*We would also like to know how the exhibition impacted on you.*

*Please answer the questions after you view the exhibition.*

8) What was the overriding impression you have of the exhibition? Please comment

   ...........................................................................................................................................................................

9) What did you understand fishers value most highly at the Abrolhos Islands? Please comment

   ........................................................................................................................................................................................................................................

10) What do you believe has been the main cause of the changes experienced by fishers on the Abrolhos Islands? Please circle

   No idea  Economic issues  Fisheries management  Environmental change  Changing climate  Overfishing  Changing currents  Higher sea temperatures  Australian Dollar  Some other thing (Please comment) ........................................................................................................................................................................................................................................

11) Did the exhibition increase your understanding of local environmental changes? Please circle

   1 (not at all)  2  3  4  5 (influenced me a lot)

12) Do you think the climate is changing? Please circle

   Yes  No  Maybe
13) If yes, is this change caused by human activity? Please circle
   Yes   No   Maybe

14) Should anything be done to restore the Abrolhos Island community?
   If yes, what? Please comment

15) What was your favourite part of the exhibition? Please circle
   Photos: Camplounge: Art works and decorations: Fisher quotes: Video interviews: Oceanic
   current animations: Information about the Abrolhos: Information about the rock lobster fishery:
   Exhibition design: Climate change Brochures: Other (please comment):

16) Did you take any of the climate change information provided on the stands? Please circle
   Yes   No
   Did the exhibition:
   17) Stimulate your curiosity or interest to find out more about the Abrolhos Islands
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)
   18) Stimulate your curiosity or interest to find out more about the fishing industry
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)
   19) Stimulate your curiosity or interest to find out more about climate change
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)
   20) Raise your awareness about climate change issues
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)
   22) Encourage you to think about adapting to climate change
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)
   22) Encourage you to take action about climate change
       1 (not at all) —— 2 —— 3 —— 4 —— 5 (influenced me a lot)

Any other comments?

Thank you for participating

If you would like more information on the project please contact: jenny.shaw@postgrad.curtin.edu.au
Appendices 1-7: Co-author & copyright permissions
Appendix 1

Paper 1: Co-author & copyright permissions, refereed status

14 June 2016

Dear Jenny,

I am writing to confirm that, after resubmitting your paper in response to the double-blind peer review by established scholars in relevant fields, your research paper 'Seeing Change: An influential exhibition about climate change impacts on a WA fishing community' has been accepted for publication. It is hoped that the 'Rites of Spring' will be published towards the end of this year with Black Swan Press, Curtin University.

I have attached the latest copyedited version of this chapter for your records. Please note that the chapter may be subject to further style edits, and that the chapter numbering and page numbering will change.

If you need any more information, please do not hesitate to contact me.

Best regards,

[Redacted]

Julie Lunn
Editor, Rites of Spring
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Name: Julie Lunn
Position: Editor, Rites of Spring
Date: 14 June 2016

Please return the signed form to Jenny Shaw, CUSP, Curtin University
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Signature: [redacted] Date: 28th November 2015

I, as Co-Author, endorse that the level of contribution by Jenny Shaw indicated above is appropriate.

Signature - Laura Stocker: [redacted] Date: 10-12-2015
Appendix 2

Paper 2: Co-author & copyright permissions, refereed status


[http://dx.doi.org/10.1080/18366503.2015.1014016](http://dx.doi.org/10.1080/18366503.2015.1014016)
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Date: 28th September 2015

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Leonie Noble  Signature:  
Date:  20-11-2015
Appendix 3

Paper 3: Co-author & copyright permissions, refereed status


This paper has been double-blind peer reviewed by established scholars in relevant fields.

Publication and copies of this paper will be available in the coming month.
Hi Jenny,

I am writing to confirm that, after resubmitting your redrafted chapter in response to the double-blind peer review by established scholars in relevant fields, your chapter co-written with Laura Stocker has been accepted for publication in the Indian Ocean Futures: Communities, Sustainability and Security book to be published towards the end of this year by Cambridge Scholars Publishing. This volume is being co-edited by me and Professor John Stephens.

I have attached the latest copyedited version of this chapter for your records. Please note that the chapter may be subject to further style edits, and that the chapter numbering and page numbering will change. We expect your chapter will be published as Chapter 6, not 5, in this volume because John and I have decided to bring one chapter forward from the final section of the book into the first section. Your chapter will be the first chapter in the 2nd section of the book.

If you need any more information, please do not hesitate to contact me.

All the best,

Thor

Dr Thor Kerr
Department of Communication and Cultural Studies

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Appendix 4

Paper 4: Co-author & copyright permissions, refereed status

Western Australia Northern Agriculture Catchments Council.
Western Australia Northern Agriculture Catchments Council, p. 56.

The text in this book was reviewed by a number of experts and specialists in the field including:

- Ms Catherine Belcher, Director, Western Australian Museum Geraldton
- Ms Trish McDonald, Project Director, Western Australian Museum
- Dr Nick Caputi, Supervising Scientist Invertebrates, WA Fisheries and Marine Research Laboratories, Department of Fisheries Government of Western Australia
- Dr Rick Fletcher. Director Research, WA Fisheries and Marine Research Laboratories, Department of Fisheries Government of Western Australia
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Paper 6: Co-author & copyright permissions, refereed status


http://dx.doi.org/10.1016/j.ocecoaman.2012.11.008
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Name: Peter Horvat

Position: Communications, Trade and Marketing Manager

Date: 19-09-2016
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