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Climate Change Adaptation
Building Community and Industry Knowledge

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WINSC partnered in the project and were available for input in workshops and surveys throughout the life of the project.

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Acronyms

ABC – Australian Broadcasting Corporation
ABS – Australian Bureau of Statistics
AFL - Abrolhos Football League
AFL – Australian Football League
AIMS - Australian Institute of Marine Science
AODN - Australian Ocean Data Network
ARC - Australian Research Council
BoM - Bureau of Meteorology
CC - Climate Commission
CRC - Cooperative Research Centre
CSIRO - Commonwealth Scientific and Industrial Research Organisation
CUSP - Curtin University Sustainable Policy Institute
DCCEE – Department of Climate Change and Energy Efficiency
DoF - Department of Fisheries, Government of WA
EAC – Eastern Australian Current
ENSO - El Niño Southern Oscillation
FRDC - Fisheries Research and Development Corporation
GBRMPA - Great Barrier Reef Marine Parks Authority
IMAS - Institute for Marine and Antarctic Studies
IMOS - Integrated Marine Observing System
IOCI - Indian Ocean Climate Initiative
IOD - Indian Ocean Dipole
MU – Murdoch University
NACC – Northern Agricultural Catchments Council
NCCARF - National Climate Change Adaptation Research Facility
NRM – Natural Resource Management
NGO - Non Government Organisation
OWA – OceanWatch Australia
REDMAP - Range Extension Database and Mapping Project
SST - Sea Surface Temperature
TAC – Total Allowable Catch
TEP – Threatened and endangered species
TSIC - Tasmanian Seafood Industry Council
UTAS - University of Tasmania
UWA - University of Western Australia
WAM – Western Australian Museum
WAMSI - Western Australian Marine Science Institution
WINSC – Women's Industry Network Seafood Community

Executive Summary

Climate change science can be complex, difficult to understand, confusing and contentious. To maximise opportunities for adaptation, increased knowledge and understanding of climate change is essential. The project '*Climate Change Adaptation: Building Community and Industry Knowledge*,' known as the 'Knowledge Project' was developed to address this need.

Additionally, the Knowledge Project was closely linked to the FRDC project '*A climate change adaptation blueprint for coastal regional communities*' known as the 'Blueprint Project'.

Objectives
The overall Knowledge Project ('project') objectives were to:

- Increase knowledge and understanding of likely climate change and adaptation measures that are open to local communities.
- Support a Case Study (Blueprint Project) for Australia in adaptive management that cross-correlates regional needs with Australia-wide policy and management.
- Tailor extension and knowledge sharing for regional needs.
- Synthesise, analyse and assist in adaptation of key climate change information, in the context of external drivers to marine biodiversity and fisheries business.

Methods
The key project components were:

- Perception Analyses: assessment of two organisations with close links to the fishing industry.
- Case Study (Blueprint Project) Support: facilitating community participation.
- Assessment of Knowledge Needs: community and industry surveys, boundary organisation effectiveness.
- Increasing Knowledge Uptake using Innovative Approaches: participatory co-production of knowledge.
- Climate Change Communication Products: development, production and uptake of climate science knowledge.

To achieve the project aim, collaborations with other agencies and groups were initiated, including the development of partnerships with two organisations having strong fishing industry links; OceanWatch Australia (OWA) and the Women's Industry Network Seafood Community (WINSC).

Coastal towns in three regions were used for the project; St Helens in the southeast, Bowen in the tropics and Geraldton in the southwest of Australia.

Results and Discussion
The results of perception surveys of OWA and WINSC indicate that this group had a greater acceptance that climate change was occurring compared to the general Australian population. However, according to OWA and WINSC, the fishing industry was likely to have a lower acceptance, less knowledge and limited interest in climate change when compared to the two peak groups. Furthermore, the perception that the fishing industry has a limited interest in climate change knowledge was supported by other areas of this project including direct feedback from fishers and project staff.

A range of barriers for climate change knowledge uptake were identified including, economics, fisheries management, time pressure, social licence to operate, and habitat and related stock loss. These barriers create a significant challenge for climate change knowledge extension and uptake,

where climate change issues take a low priority because the threat is not perceived as an immediate one.

The project facilitated 83 interviews as part of the Blueprint project in St Helens, Bowen and Geraldton with the information providing direct support for Blueprint project objectives. OWA was used to engage community members in the Blueprint project research and this engagement process was particularly successful where OWA Officers were locally resident or embedded in the local community.

The project explored the function and effectiveness of organisations in moving complex technical information such as climate change science from scientists to the community and decision makers. These organisations may be referred to as boundary organisations. An organisation may be well placed to function as a boundary organisation because of their high levels of trust and credibility in local communities. However, they may require additional support to function effectively with a subject such as climate change science which is a complex and contestable area. Effective knowledge transfer may be further complicated because of strong ties to industry, and an unwillingness to engage industry members in complex and controversial issues that they believe may negatively impact their relationship with the industry.

This project was successful in engaging a large number of fishers and members of coastal communities around Australia in the uptake of climate change science. For example, almost 30,000 visitors experienced the 'Seeing Change' exhibition which was exhibited in three coastal fishing communities in WA. Survey results during the exhibition indicate the method was an effective way of increasing knowledge uptake of climate change science for project participants, the fishing community and exhibition visitors.

An extensive range of climate change knowledge uptake products was developed and distributed to the three regional coastal communities and more broadly throughout Australia. The products used a variety of formats and media, and were tailored for their distribution area and audience. The products used input from all the results produced from other parts of the FRDC Program to address specific community and industry needs, reflecting the adaptive nature of the project, the extensive project coverage and project team expertise.

The project received extensive media coverage and was successful in National and State awards.

Over the course of the project, a number of general principals appeared to be relevant for maximising the uptake of climate change science:

- understand stakeholder learning needs
- build relationships and create trust (note that this may involve engagement over an extended period of time)
- ensure that the delivery of information is salient and credible
- maximise participatory engagement and empower stakeholders
- facilitate different learning needs by using a diversity of approaches.

Conclusions

The two partner organisations for this project (OWA and WINSC) had close links to the fishing industry and provided valuable insights on their perceptions of climate change and the functions of their organisations. OWA and WINSC were also able to provide a useful understanding of fishing industry perceptions related to climate change.

The use of organisations, individuals or tools that can effectively cross the boundaries between science and the community proved valuable at a national and regional level. Organisations and individuals which effectively function as boundary organisations or boundary spanners may require additional capacity to increase knowledge uptake in contentious and politically contested areas such as climate change where salience, credibility and legitimacy are important characteristics of successful knowledge uptake.

Climate change knowledge within coastal communities and the fishing industry can be built using a range of traditional and innovative communication methods. Innovative participatory techniques were shown to be successful in increasing community knowledge.

In fishing communities where participants were reluctant to articulate their views, an approach utilising shared experiences and shared knowledge was effective. Importantly, the use of information that was considered salient, credible and was respectfully delivered by trusted sources appeared to increase engagement and knowledge uptake.

A strong perception was recorded that the fishing industry does not see climate change knowledge and adaptation as important issues. To overcome the challenge of knowledge uptake for a reluctant audience, it appears that these programs require specialised understanding and approaches.

Recommendations

The following recommendations have resulted from the delivery of the project and are based on building community and industry knowledge of climate change:

1. Develop a direct and more detailed understanding of fisher perceptions of climate change knowledge and understanding to allow targeted knowledge uptake approaches and activities.
2. Deliver participatory community projects such as 'Photovoice' in priority coastal fishing communities around Australia to increase understanding of climate change science and adaptation opportunities.
3. Develop guidelines to support and increased capacity for appropriate organisations to function more effectively as boundary organisations, specifically to build climate change knowledge in coastal fishing communities.
4. Further develop practical guidance based on the general principals identified from this study regarding effective climate change knowledge uptake for the fisheries sector:
    - understand stakeholder learning needs
    - build relationships and create trust
    - ensure that the delivery of information is salient and credible
    - maximise participatory engagement and empower stakeholders
    - facilitate different learning needs by using a diversity of approaches.
5. Include extension and knowledge uptake for end users as separate project outcomes in future fisheries and climate change science research projects. While this function may not be achievable for individual scientists, specialised organisations and individuals that can span the boundary between scientists and decision-makers are likely to be more effective in communicating information and building knowledge.

Keywords

Climate change, coastal communities, knowledge, boundary organisations, Photovoice, communication

Introduction

The project 'Building Community and Industry Knowledge' was developed to ensure there was a component of extension, communication and knowledge development activities in the large suite of projects under the Climate Change Adaptation – Marine Biodiversity and Fisheries Program.

The project, known as the 'Knowledge' project is closely linked to project 2010/542 'A climate change adaptation blueprint for coastal regional communities' known as the 'Blueprint' project. The 'Blueprint' project has investigated case studies in the three fisheries management areas of the tropics, south east Australia and the south west of Australia. Rather than developing smaller, separate regional agreements in each of the three management areas, the knowledge project activities were coordinated from one centre: the Western Australian Marine Science Institution (WAMSI). This ensured that as well as separate regional foci, the project had national relevance. It also guaranteed that the lessons learnt from each individual case study could be built on and carried across to the next case study.

A variety of needs were outlined at the project inception including: maximising the benefits and outcomes to fishing communities: reducing the confusion around climate change impacts and adaptation strategies: synthesising the science and presenting in simple language: dealing with the confusion with respect to climate variability and climate change: placing climate change factors in the context of the other externalities affecting fishing communities. This included the existing climate change information where appropriate: regional delivery with an Australia-wide context, and the need for more adaptable and flexible fisheries management.

The original project needs described high level outcomes and as a result, the project methodology adopted a mixed-method 'action research' approach to modify and refine the methods and outputs throughout the life of the project (Figure 1 Project components), while keeping to the phases described. This approach enabled all project members to participate, reflect on each phase and input into the project, contributing to the outputs and project success.

To meet the project needs, the large project was broken down into case study areas from each of the three Australian fishery management areas. Coastal fishing communities within these case study areas were selected. St Helens in Tasmania, Bowen in Queensland and Geraldton in Western represented a range of community sizes, fishery types as well as varied community demographics and local industries.

This case study focus enabled an extensive cross–section of views to be canvassed regarding the knowledge needs of the fishing industry and coastal communities with respect to climate change information. It also enabled development of the most effective extension strategies for product development and knowledge uptake.

Objectives

The overall project objectives were to:

- Increase knowledge and understanding of likely climate change and adaptation measures that are open to local communities.
- Support a Case Study (Blueprint Project) for Australia in adaptive management that cross-correlates regional needs with Australia-wide policy and management policies.
- Tailor extension and knowledge sharing for regional needs.
- Synthesise, analyse and assist in adaptation of key climate change information, in the context of external drivers to marine biodiversity and fisheries business.

The project objectives were interlinked and spread over the life of the project; they have been schematically represented to illustrate the project complexity, general timeline of actions and project participants around Australia (Figure 3 Project objectives, actions and outputs).

The project was set a range of performance indicators to determine success against the objectives. A summary of how the performance indicators have been met for the project is addressed separately in Appendix 11 Objectives and performance indicators.

Methods

The project methods were developed based on input from the following:

- FRDC recommended project phases
- Project Steering Committee meetings including the Principal Investigators of the Knowledge and Blueprint Projects, and executive representatives from FRDC, OWA and WAMSI
- Methods workshop (Tasmania) including all project team members from the Knowledge and Blueprint Projects
- Review of relevant literature and other research projects
- Outcomes of monthly Knowledge and Blueprint project team meetings.

Coastal towns in three regions were used as case studies for the project; St Helens in the southeast, Bowen in the tropics and Geraldton in the southwest. The project also included a national-level outreach scope.

The project was undertaken using a mixed method 'action research' approach and as such, methods were reviewed and adapted while meeting project objectives, to accommodate the changing nature and results of the developing project.

There are many models of education, learning, communication, extension, adoption and knowledge uptake and a variety of theoretical frames. This project incorporated components from a range of theoretical approaches to meet the study objectives. In summary, the theoretical frameworks that influenced the project methodology included:

- Boundary organisational theory which discusses agents or organisations able to cross boundaries between technical science and decision makers (Aldrich and Herker 1977; Cash et al 2002, 2003, 2006; Jasanoff 2004; McNie 2007; McNie et al 2008; Moser and Ekstrom 2010).
- Photovoice which is a limited body of theory, however gives voice to participants through a camera lens (Wang and Burris 1997; Baker and Wang 2006; Baldwin and Chandler 2010; MacLean and Woodward, 2013).
- Cultural geography which uses art and stories to give meaning to complex situations (DeSilvey 2012; Hawkins 2012; Nettley et al 2013).
- Science communication which describes a more traditional deficit model that tends to maintain a hierarchical approach (Hilgartner 1990) often referring to experts (scientists) communicating with recipients (community).
- Environment education and sustainability (IUCN/UNEP/WWF 1991, UNESCO 2009, 2010) is based on the principles and values that underlie sustainable development and community empowerment.

Key Partnerships

In order to have national reach, deliver to peak-industry, non-government organisations and the wider community, WAMSI partnered with two national organisations: OceanWatch Australia Ltd (OWA) and the Women's Industry Network Seafood Community (WINSC).

OWA employs SeaNet Officers to work in coastal fishing communities all over Australia. Because of their extension capacity and strong links into the fishing industry, OWA SeaNet Officers provide a useful conduit into coastal communities, particularly fishing communities. As SeaNet Officers regularly communicate within the OWA network, they are also in a position to share information with other SeaNet Officers on the outputs from climate change and adaptation research projects around Australia. As they live and work in coastal communities, they can understand the issues and

tailor the delivery of this information into the fishing communities, while taking into account the other industry stressors operating at a national and regional level.

WINSC is a national organisation providing support and networking opportunities for women in the seafood community. WINSC is run by volunteers and is governed by a national Board of Directors from each State and Territory. The Board meets on a monthly basis, organises an annual Conference and supplies information to members via email and their website. The Directors and members are from a variety of industry sectors including wild catch, aquaculture and processing, and hold positions in a range of areas including sales, policy, research, management and representation on peak industry bodies. The network has extensive links throughout Australia and to all sectors of the fishing industry. Directors and members represent a range of views from each of these sectors.

A range of other collaborative partnerships was developed throughout the project to allow for the extensive research requirements and product development and delivery associated with the project. Other partners included Curtin University Sustainable Policy Institute, WA Museum and WA Department of Fisheries.

Project Components

The key project components were:

- Perception Analyses: assessment of two organisations with close links to the fishing industry.
- Case Study (Blueprint Project) Support: facilitating community participation.
- Assessment of Knowledge Needs: community and industry surveys, boundary organisation effectiveness.
- Increasing Knowledge Uptake using Innovative Approaches: participatory co-production of knowledge.
- Climate Change Communication Products: development, production and uptake of climate science knowledge.

The methods used for each of these components are outlined below. A detailed description of the methods is provided in the Appendixes 1 through 5 and illustrated in Figure 1 Project components.

Perception Analyses

A total of six workshops were held where perceptions of OWA SeaNet Officers and WINSC Directors were surveyed. Their climate change perceptions, understanding, and trusted sources of climate information were surveyed and compared with a large Australian survey undertaken by CSIRO. Each of these populations was also surveyed on their understanding of the views held by the fishing industry (Appendix 1).

As Oceanwatch extend marine and fisheries information directly to the fishing industry and coastal communities around Australia, their understanding of the barriers and opportunities to science and climate science uptake in the fishing industry were also sought. WINSC Directors perceptions were followed throughout the life of the project and their climate science knowledge surveyed on five occasions over three years (Appendix 1).

Case Study (Blueprint Project) Support

The Knowledge project worked closely with the Blueprint project and facilitated interviews within the three case study communities: St Helens, Bowen and Geraldton. As the OWA SeaNet Officers lived and worked in the communities, or were familiar with the local fishing industries, easy access

by the Blueprint researchers was enabled by familiar and trusted members of these coastal communities (Appendix 3 and Final Report FRDC 2010/542).

OWA SeaNet Officers returned to each of the case study communities towards the end of the project to deliver preliminary results from the Blueprint project and climate change information developed after assessing the knowledge needs of each case study community.

Assessment of Knowledge Needs

Individual climate knowledge needs of fishers were investigated at the same time as the Blueprint interviews in each of the case study communities. Additional surveys and interviews were also conducted with fishers at the Abrolhos Islands, a fishing community off the coast of Geraldton.

OWA SeaNet Officers have extensive national outreach through community events and specific industry engagement. Their collective assessment of the climate information requirements of fishers and coastal communities throughout the project also contributed to the knowledge needs assessment.

The information gathered informed the development of salient, credible, regionally relevant communication products that were then delivered back into each community (Appendixes 3, 4 and 5).

The function and effectiveness of OWA as a boundary organisation was also investigated throughout the project (Appendix 2). Criteria developed by Cash et al. (2006) were used to better understand the role and function of OWA in terms of their organisational ability in convening, translating, mediating and collaborating. The effectiveness of individual Officers was then assessed in terms of their salience, credibility and legitimacy.

Increasing Knowledge Uptake using Innovative Approaches

A number of innovative approaches were trialled in this project to gauge their effectiveness in moving complex and highly politicised climate change science into coastal fishing communities. One of the methods used was Photovoice, a social science technique that gives people a voice 'through the lens of a camera'. Two goals of Photovoice are the promotion of critical dialogue and knowledge; and the reaching of policy makers (Wang and Burris, 1997). In this study it also enabled a group (fishers) to have a conversation and convey their perspectives on significant issues affecting their lives and communities (Baldwin and Chandler, 2010).

Multiple workshops (4) with scientists and fishers were held on the Abrolhos Islands to share knowledge of environmental changes and regionally relevant climate change research.

Over 1000 photos were collected from Abrolhos fishers. Fishers were engaged throughout the project including during the photo selection phase. A multi-layered community exhibition was developed which included the fisher photographs and a range of other innovative materials specifically developed for this project (Appendix 4). The exhibition content was developed for both fishers and the general community. Three coastal fishing communities in Western Australia were chosen as locations for display of the exhibition.

Climate Change Communication Products

Using the information gathered from interviews, surveys, and workshops, and based on the input from project staff, an extensive range of products were designed and developed throughout the life of the project. In many cases the development and production of the products involved collaboration with multiple agencies and organisations.

The uptake of knowledge using these products was facilitated by direct community engagement by OWA. The OWA SeaNet Officers who returned to the case study communities to provide feedback on the Blueprint project and deliver a range of regionally relevant climate change materials. OWA also distributed more general climate change products nationally and directly to all coastal NRM groups (Appendix 3). Throughout the life of the project, aligned organisations including NCCARF, DoF, NACC, CUSP and WAM also contributed to the development of products (Appendix 5) and assisted in the distribution of materials. A large number of the project products and related climate science materials were available for visitors at the three large coastal exhibitions in WA (Appendixes 4 and 5).

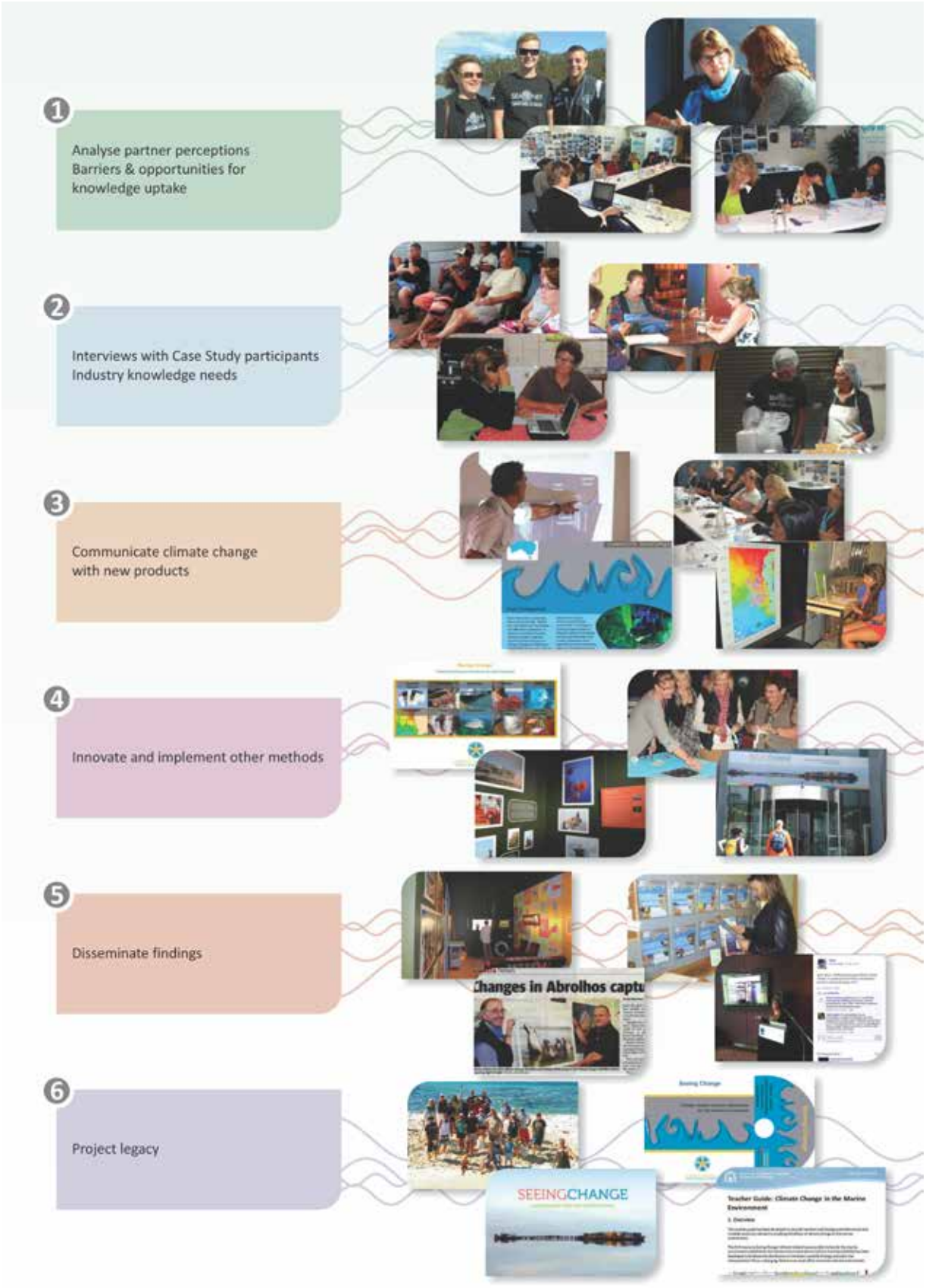

Figure 1 Project components

Project Methods Development and Planning

Project planning, activities and outputs were developed based on project objectives and project phases provided by FRDC. A stylised timeline of activities and outputs is illustrated in Figure 2 Project development and planning.

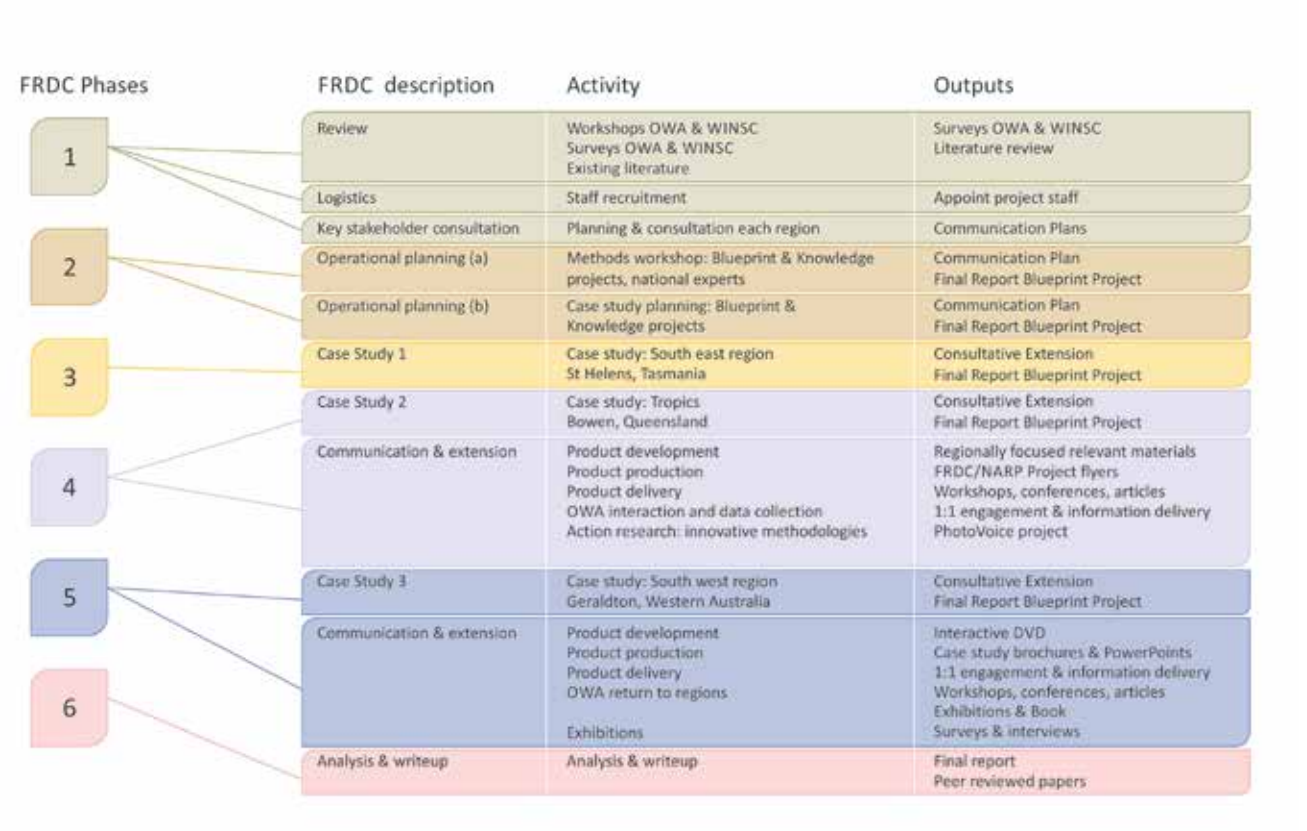

Figure 2 Project development and planning

Results and Discussion

This section provides an overview of the results and discussion for the various project components. For more detailed descriptions of the results and discussions see Appendixes 1, 2, 3, 4 and 5.

The multi-dimensional nature of the project provided a broad range of study outputs including a large number of communication products. The linkage of the objectives to actions, participants and the project outputs is described in Figure 3.

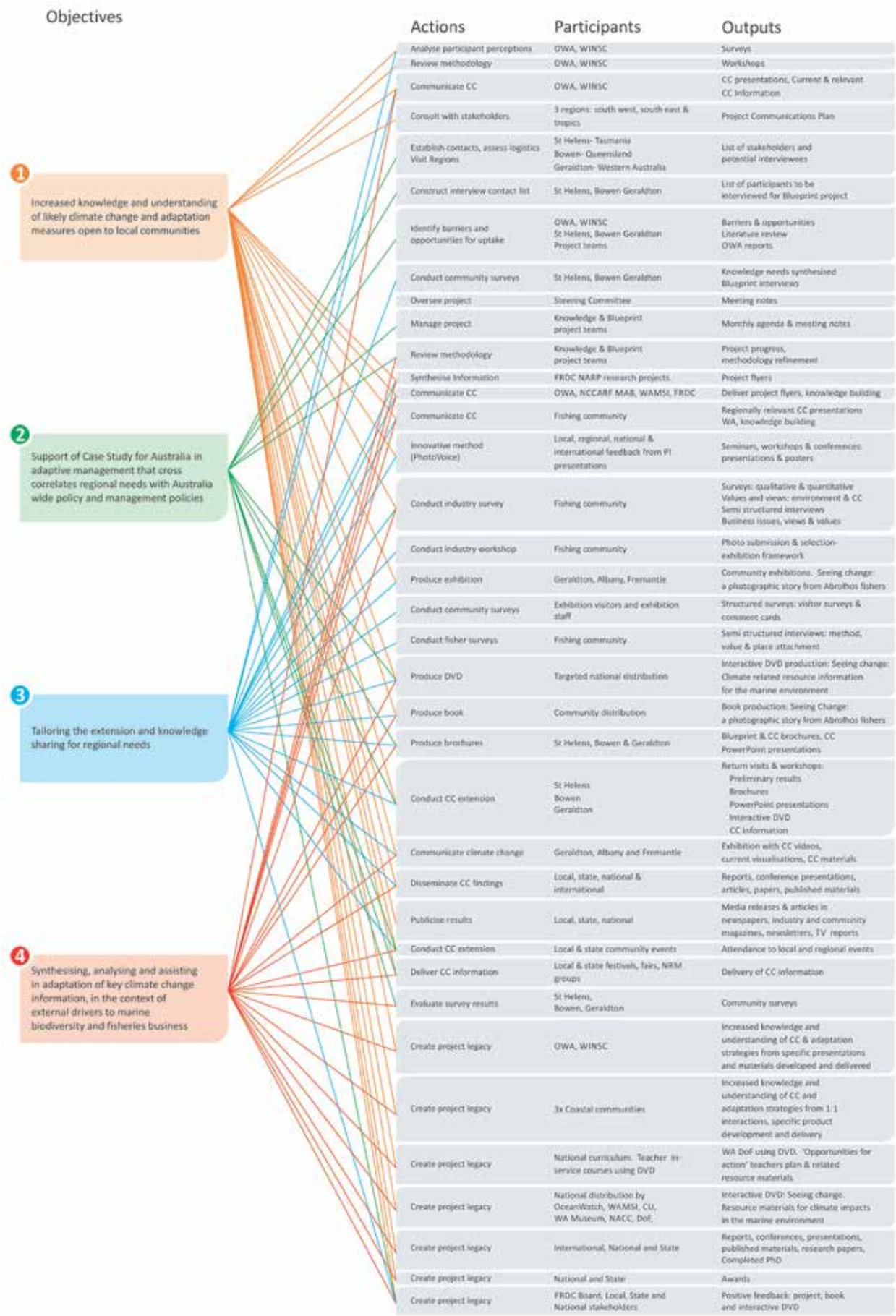

Figure 3 Project objectives, actions and outputs

Perception Analyses

The results of perception surveys of OWA and WINSC indicate that this group had a greater acceptance that climate change was occurring compared to the general Australian population (Appendix 1). However, according to OWA and WINSC, the fishing industry was likely to have a lower acceptance, less knowledge and limited interest in climate change when compared to OWA and WINSC. Furthermore, other areas of this project including direct feedback from fishers and project staff supported the perception that the fishing industry has a limited interest in climate change knowledge.

A range of barriers and opportunities for climate change knowledge uptake were identified including, economics, fisheries management, time pressure, social licence to operate, and habitat and related stock loss. The barriers create a significant challenge for climate change knowledge extension and uptake, where climate change issues take a low priority because the threat is not perceived as an immediate one and other issues take a higher priority.

The perceptions analyses were not the result of a large-scale survey of the fishing industry, however many of the survey participants are part of the fishing industry and the remainder have close links to the industry. For these reasons, their views on industry perceptions were revealing and important in understanding the attitude of fishers to climate change. They were also useful in formulating appropriate ways to increase climate change knowledge in the fishing industry and coastal communities.

The results from the OWA and WINSC surveys were supported by survey results and fisher interviews from other parts of the project as well as project staff observations. As a result, OWA and WINSC could be considered useful surrogate organisations to gain a better understanding of fishing industry perceptions and attitudes. However, further direct testing of fishing industry perceptions may provide a valuable basis for any future knowledge extension activities for this sector.

Interestingly, throughout the project there was some reluctance by OWA to approach climate change discussions in industry circles. This is further explored in Appendixes 2 and 3, however as OWA perceived that industry did not really believe in climate change and were not interested in climate change knowledge, it is not surprising they were reluctant to raise the topic.

Case Study (Blueprint Project) Support

The project facilitated 83 community interviews as part of the Blueprint project in St Helens, Bowen and Geraldton with the information providing direct support for Blueprint project objectives (Appendix 3). Over half the interviews were with fishers, aquaculture farmers or the seafood post-harvest sector. The remaining half comprised a range of community representatives. OWA was used to engage community members in the Blueprint project research. This engagement process was particularly successful where OWA Officers were locally resident or embedded in the local community.

OWA SeaNet Officers returned to each of the three case study areas with preliminary findings from the Blueprint project and additional climate change information. This information was available in three separate brochures as well as individual PowerPoint presentations for SeaNet Officers to deliver in a community workshop or in small groups from their laptop computers (Appendix 5).

OWA return surveys on climate change were completed by 17 fishers, aquaculture farmers or seafood post-harvest personnel (Appendix 3). Although respondents had an expectation that

government should provide information, help and advice on climate change, most (88%) believed OWA was the reason they were aware of climate change information and the Blueprint project. Given the difficulties anticipated by the OWA SeaNet team to engage fishers on the topic of climate change, these results were seen as encouraging.

Assessment of Knowledge Needs

The knowledge needs of fishers and the community were evaluated in a number of ways including from fisher interviews (Blueprint project, 83 participants - Appendix 3), surveys, interviews and workshops (Seeing Change project, 71 participants – Appendix 4), OWA SeaNet engagement of industry members (Activity logs, 250 participants – Appendix 3), OWA and WINSC surveys (Perception analysis, 41 participants - Appendix 1). These results were combined with the participant observations recorded by the Knowledge and Blueprint project staff.

Understanding fisher and community knowledge needs as well as barriers and opportunities for uptake (Appendix 1 and 3) in combination with a reflexive action research approach, allowed the research phases to be modified, the most suitable activities to be implemented, and appropriate products specifically tailored for fisher and community needs to be developed.

As well as the evaluation of knowledge needs, the effectiveness of an organisation such as OWA to function as a boundary organisation in moving complex, technical, climate change science from scientists into the community was investigated (Appendix 2). Although OWA appear well placed to function as a boundary organisation because of their high levels of trust and credibility in local communities where they operate, they may require additional support to function specifically in relation to climate change science. OWA's credibility and legitimacy appear high within the community, 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 may reflect the Officer's strong ties to the industry, and an unwillingness to engage fishers in a complex issue that they believe may diminish their credibility in the industry. It may also reflect personal views that climate change science is not a credible, salient or legitimate topic.

Increasing Knowledge Uptake using Innovative Approaches

Using fisher photographs to tell the story, a powerful narrative of climate and environmental drivers leading to social decline was respectfully woven into an experience that allowed fishers and visitors alike, to access and uptake knowledge and information. The 'Seeing Change' community exhibition was displayed in three coastal fishing communities around WA for 7 months to an estimated 27,000 viewers (Appendix 4).

Although the climate change message was subtle, the extensive communication tools utilised to illustrate what is generally considered a complex and controversial subject area, were presented in a variety of layers and levels of difficulty. These allowed each viewer to access knowledge individually and, in their own time, reach their own conclusions.

The feedback was positive from visitor surveys (202), comment cards (330), fisher interviews (11 ongoing), and museum staff (10 ongoing). Early data analyses indicate increased uptake on climate change by fishers and visitors. Museum staff in Geraldton indicated the exhibition had 'kick started the climate conversation in the community'.

The participatory method 'Photovoice' was found to be an effective method for allowing knowledge uptake, providing a means of expression for a community and engaging fishers and the community in a topic they had previously been reluctant to discuss.

Climate Change Communication Products

A large range of climate change knowledge uptake products was developed and effectively distributed to the three regional coastal communities and more broadly throughout Australia (Appendix 5). The products used a range of formats and media, and were tailored for their distribution area and audience. The products used input from all the results produced from other parts of the project to address specific community and industry needs, reflecting the adaptive nature of the project.

Products developed included: climate change research brochures (project flyers, case study findings), workshops and conference presentations, newsletters, magazine articles, media coverage (print, radio, electronic and TV), video vignettes, an interactive DVD (including videos, documentaries, current visualisations, animations, presentations, articles and a comprehensive Teacher Plan), three large community exhibitions, promotional materials, a book and peer reviewed research papers.

The project received excellent media coverage and was successful in National and State awards.

General principles for climate change knowledge uptake

Over the course of the project, a number of general principals appeared to be relevant for maximising the uptake of climate change science:

- understand stakeholder learning needs
- build relationships and create trust (note that this may involve engagement over an extended period of time)
- ensure that the delivery of information is salient and credible
- maximize participatory engagement and empower stakeholders
- facilitate different learning needs by using a diversity of approaches.

Conclusions

The two partner organisations for this project (OWA and WINSC) had close links to the fishing industry and provided valuable insights on their perceptions of climate change and the functions of their organisations. OWA and WINSC were also able to provide a useful understanding of fishing industry perceptions related to climate change.

The use of organisations, individuals or tools that can effectively cross the boundaries between science and the community proved valuable at a national and regional level. Organisations and individuals which effectively function as boundary organisations or boundary agents may require additional capacity to increase knowledge uptake in contentious and politically contested areas such as climate change where salience, credibility and legitimacy are important characteristics of successful knowledge uptake.

Climate change knowledge within coastal communities and the fishing industry can be built using a range of traditional and innovative communication methods. Innovative participatory techniques were shown to be successful in increasing community knowledge.

In fishing communities where participants were reluctant to articulate their views, approaches using shared experiences and shared knowledge were effective. Importantly, the use of information that was considered salient, credible and was respectfully delivered by trusted sources appeared to increase engagement and knowledge uptake.

A strong perception was recorded that the fishing industry does not see climate change knowledge and adaptation as important issues. To overcome the challenge of knowledge uptake for a reluctant audience, structuring programs to increase knowledge uptake appears to require specialised understanding and approaches.

Recommendations

The following recommendations have resulted from the delivery of the project and are based on building community and industry knowledge of climate change:

1. Develop a direct and more detailed understanding of fisher perceptions of climate change knowledge and understanding to allow targeted knowledge uptake approaches and activities
2. Deliver participatory community projects such as 'Photovoice' in priority coastal fishing communities around Australia to increase understanding of climate change and adaptation opportunities
3. Develop guidelines to support an increased capacity for appropriate organisations to function more effectively as boundary organisations, specifically to build climate change knowledge in coastal fishing communities
4. Further develop practical guidance based on the general principles identified from this study regarding effective climate change knowledge uptake for the fisheries sector:
   - understand stakeholder learning needs
   - build relationships and create trust
   - ensure that the delivery of information is salient and credible
   - maximise participatory engagement and empower stakeholders
   - facilitate different learning needs by using a diversity of approaches
5. Include extension and knowledge uptake for end users as separate project outcomes in future fisheries and climate change science research projects. While this function may not be achievable for individual scientists, specialised organisations and individuals that can span the boundary between scientists and decision-makers are likely to be more effective in communicating information and building knowledge.

It is recommended that this final report should be read in the knowledge that deeper and more academic analyses of the data will be forthcoming. Detailed analyses will be published in peer reviewed journals.

Further distribution of project products

The book '*Seeing Change: a photographic story from Abrolhos fishers'* including a copy of the interactive DVD, will continue to be sold for a small donation throughout the Museums of WA, the Northern Agricultural Catchments Council (NACC) and the Western Australian Marine Science Institution. The proceeds of the book will be distributed to the Abrolhos Islands Silver Chain Nursing Association and NACC to assist in offsetting the cost of the publication. The first donation to the Abrolhos Islands Silver Chain Nursing Association has already been made.

The DVD '*Seeing Change; climate related resource information for the marine environment'* has been sent to all coastal NRM groups (Appendix 3). This will be followed up with information on the Blueprint adaptation website when the site is launched.

The interactive DVD has been posted on the WAMSI Website for ongoing access and is likely to be posted on the WA Department of Fisheries and FRDC Websites in the near future.

The Department of Fisheries WA will be using the interactive DVD and Teacher Guide to provide teacher in-service on 'Climate Change in the Marine Environment.'

A number of research papers are in preparation and it is understood that deeper and more academic analysis of the data will be published in peer reviewed journals.

Published

- Shaw, J., Danese, C. and Stocker, L. (2013) Spanning the Boundary between Climate Science and Coastal Communities; Opportunities and Challenges. Ocean & Coastal Management **86**. 80 – 87.
- Shaw, J. (2013) Seeing Change: A photographic story from Abrolhos fishers. Northern Agricultural Catchments Council, Geraldton WA. 56pp.
- Shaw, J. (2013). Seeing Change: a DVD of climate related resource information for the marine environment. Available at http://www.wamsi.org.au/news/seeing-change-marine-environment
- Clarke, B., Stocker, L., Coffey, B., Leith, P., Harvey, Baldwin, C., N., Baxter, T., Bruekers, G., Danese, C., Good, M., Hofmeester, C., De Freitas, D.M., Mumford, T., Nursey-Bray, M., Kriwoken, L., Shaw, J., Shaw, J., Smith, T., Thomsen, D., Wood, D. (2013) Enhancing the Knowledge-Governance Interface: Coasts, Climate and Collaboration. Ocean & Coastal Management **86.** 88 – 99.

In preparation

- Shaw, J and Stocker L. (in press) Seeing Change: an influential exhibition about climate change impacts on a WA fishing community.
- Shaw, J. Caputi, N., and Stocker, L. Climate adaptation in the Abrolhos Islands fishing community: a cascade of climate, environment, management, economic and social changes.
- Shaw, J., Stocker, L. and Noble, L. Environmental changes and social impacts: women's perspectives from a fishing community in Western Australia.
- Shaw, J., Baldwin. C., and Stocker, L. Engaging fishers on climate change.

Extension and Adoption

The extension and adoption approaches for this project were incorporated into the ongoing project activities. This section outlines the extensive legacy created by this project.

Project legacy – ongoing activities:

- continuation of aspects of the Blueprint and Knowledge projects
- brochures, project flyers, FRDC/NARP project information. OceanWatch will continue to distribute and discuss
- increased capacity on marine climate change in two organisations; OceanWatch Australia and WINSC. These organisations have direct links into the national seafood communities
- the book: *Seeing Change A photographic story by Abrolhos fishers* is available at the Northern Agricultural Catchments Council in Geraldton, the WA Museum in Geraldton and the Western Australian Marine Science Institution in Perth. In the back cover of the book an interactive DVD is included with up-to date information on marine climate change research
- the interactive DVD: *Seeing Change: information and resources for a changing marine environment*, is a one-stop shop for marine climate change information. The DVD is available on a number of websites including WAMSI at http://www.wamsi.org.au/news/seeing-change-marine-environment
- In the DVD; 'opportunities for action' section there are a number of materials including a teacher's guide and school resources. The WA Department of Fisheries Marine Naturalist Discovery Centre is running teacher in-service sessions on Climate change and using the DVD as its primary resource
- a PowerPoint production (produced by NCCARF and in conjunction with the Knowledge and Blueprint projects) will be available for use by all OceanWatch SeaNet Officers for communication on climate change to fishers and the community. This has been designed for the three Case Study areas but can be simply modified for general use. The presentation is also recorded and available on the DVD – Seeing Change
- presentations, posters and papers ongoing
- PhD thesis; some of the information gathered will be explored further and written up in a PhD
- peer reviewed papers are in preparation for publication in national and international journals
- the Blueprint project will be launching a web application for adaptation in Coastal Communities.

Project coverage

The project had extensive coverage in the media (print, TV, radio, electronic) as well as in newsletters, bulletins, magazines, agency websites, articles, journals, billboards, conferences and workshops. A small selection of the extensive coverage is illustrated in Appendix 9 Project coverage media examples.

A large number and variety of products were produced (Appendix 4) and their coverage extended by the large number of project collaborators.

Project materials developed

An extensive range of project materials were developed, see Appendix 4 and Figure 3 Project objectives, actions and outputs.

Appendix 1 Climate change perceptions, understanding and knowledge needs

This section explores ideas related to maximising opportunities for building community and industry knowledge by examining two organisations strongly associated with the seafood industry: OceanWatch Australia (OWA) and the Women's Industry Network Seafood Community (WINSC).

The section documents and discusses the respective climate change perceptions, understanding and knowledge needs of OWA and WINSC.

1.1 Highlights

OWA and WINSC have strong linkages with the seafood community and could be considered useful surrogate organisations to gain a better understanding of industry perceptions and attitudes

OWA and WINSC reflected a much greater acceptance that climate change was actually happening when compared with the general Australian population

The majority of OWA and WINSC participants believed that humans were largely causing climate change

Trusted sources of climate change information came from the scientific community

Both organisations felt the fishing industry had less of a belief that climate change was happening, less knowledge about the subject and little interest when compared with themselves.

The fishing industry was perceived to be under pressure and currently dealing with a large number of critical issues

Participants believed the fishing industry would be unlikely to see climate change knowledge as a priority

When building fishing industry knowledge, important factors for climate change information uptake include: the nature of the relationship between scientists, the fishing industry and organisations functioning to facilitate knowledge movement between these groups; and developing an approach that takes into account the characteristics of the stakeholder, their specific needs and preferred methods of communication

It appears that climate change knowledge and attitudes can change over time and decline if not continually updated with information that is understood as salient, credible and legitimate

As people in the fishing industry do not see climate change and adaptation as important issues, structuring programs to increase knowledge uptake require specialised understanding and approaches

1.2 Background

Prior to commencement of the project 'Climate Change Adaptation: Building Community and Industry Knowledge', OWA and WINSC were approached to become project partners. While each organisation is very different in their structure and function, both organisations are characterised by strong linkages with the seafood industry.

OceanWatch Australia (OWA) is a small, national, not-for-profit organisation working with the seafood industry and coastal communities around Australia. The members of the organisation live and work in regional coastal communities around Australia and undertake projects to enhance fish habitats, improve water quality, minimise environmental impacts and increase the sustainability of the fishing industry.

The Women's Industry Network Seafood Community (WINSC) is a national organisation made up of volunteers who represent women in the seafood industry. WINSC has a voluntary Board made up of Directors and Directors-at-Large from each Australian State and Territory. To enable Board continuity, Directors are elected in alternate years. WINSC has a number of objectives and among other things, seeks to:

- Provide access to quality information, advice, national projects and conferences
- Facilitate women's skills development through workshops, participation in leadership programs, mentoring, youth initiatives, training and study tours
- Allow a coordinated approach to increasing awareness of social issues
- Promote the seafood industry through seafood festivals, website, newsletter, media releases
- Develop alliances, partnerships and strong links with peak industry bodies and agencies

Employees and volunteers from OWA and WINSC were selected as project partners because they work in, or alongside, people in the seafood industry. Both organisations either represent or are linked to all aspects of the commercial fishing industry including; wild catch, aquaculture, processing, marketing, sales, research and management as well as the recreational fishing sector. OWA and WINSC are national bodies and have strong representation in regional Australia, particularly coastal communities. Their collective high level of understanding of the seafood industry provided an opportunity for better understanding of their beliefs and attitudes to climate change as well as their perceptions of industry beliefs and attitudes on this complex and contentious topic.

1.3 Aims and Methods

Separate workshops were held with OWA and WINSC at project commencement with the following objectives:

- Gain a better understanding of the perceptions of the organisations and their members
- Compare these perceptions with a study of the wider Australian community
- Develop an understanding of industry perceptions and knowledge of climate change
- Identify which are the trusted sources of climate science information
- Identify any barriers and opportunities for climate change knowledge uptake
- Simultaneously provide climate change information and increase knowledge and understanding

OWA Methodology

All OWA staff from around Australia, including SeaNet Officers and OWA project staff attended and participated in the initial workshop. Project information was provided prior to the workshop and written research consents obtained from all participants. All staff (12) undertook pre- and post- rather than a sample as all members of the organisation were included.

For comparative purposes a number of survey questions were sourced and/or modified from recent research projects including the CSIRO National Research Flagships Climate Adaptation baseline surveys [Leviston, Z. & Walker, I.A. (2010), Leviston et al. (2011) for questions 1 and 2. Pecl G., et al. (2009) question 5. Cash et al. (2006) question 12]. The survey (Appendix 1, Attachment 1 OWA and WINSC Surveys) comprised structured and semi-structured questions as well as open-ended questions.

To meet the objective of building the organisation's capacity with regard to climate change knowledge, a presentation on the east coast Tasmanian rock lobster fishery was provided by Dr Greta Pecl. This gave an insightful account of the issues leading up to the Dr Pecl's project on vulnerability to climate impacts and adaptation responses in this Tasmanian fishery. Dr Pecl

described the environmental and fishery changes, as well as the responses by the fishers over the life of the project (Pecl et al., 2009).

Throughout the project, SeaNet Officers, especially those involved in the three Australian Case Studies (St Helens, Tasmania; Bowen, Queensland; Geraldton, Western Australia), were sent a range of materials and climate resources to assist in building their capacity and to facilitate a better understanding of the issues they were extending into the community.

WINSC Methodology

The initial WINSC workshop, 'Climate Conversations', was conducted with WINSC Directors from around Australia and covered a format consistent with the OWA workshop. Similar project information was provided and written research consents obtained from all participants. A presentation by the project Principal Investigator covered climate information relevant to the marine environment and fisheries and also addressed some of the arguments put forward by climate sceptics. All Directors (13) undertook a similar perception survey to that conducted with OWA (Appendix 1, Attachment 1 OWA and WINSC Surveys).

Where possible, WINSC Directors were followed throughout the three year project to see if their knowledge and attitude to climate change had altered over time. WINSC Directors and Members participated in a number of climate change related workshops and five surveys over the life of the project (a total of 29 participants provided survey responses).

1.4 Results

1.4.1 OWA: Changes to the marine environment

All OWA staff had either observed or heard of changes to the weather or changes to ecological aspects of the marine environment. Each participant provided examples of these changes which ranged from specific local observations of species changes (both fish and invertebrates), to regional changes including increased frequency and strength of tropical cyclones and more global understanding including ocean warming and acidification. Of this participant population, 50% definitively attributed these changes to climate change. The other half were undecided or believed it was related to other causes.

Similar questions had been asked of Tasmanian rock lobster fishers (Pecl et al. 2009). Pecl et al. reported that although many fishers had observed changes in the fishery, '…they were uncertain whether or not these changes were simply natural climatic variation…' as their view was that '…environmental change was cyclical…' (Pecl et al. 2009, p16).

1.4.2 Climate change attitudes

When OWA were asked to describe their thoughts about climate change (Figure 4), most (92%) believed that climate change was happening. Of those, more than half (58%) thought humans were largely responsible and approximately one-third (33%) thought climate change was happening, but it was due to natural fluctuations in the earth's temperatures. Fewer participants (8%) had 'no idea if climate change was happening or not'. No participants selected the response: 'I don't think that climate change is happening.'

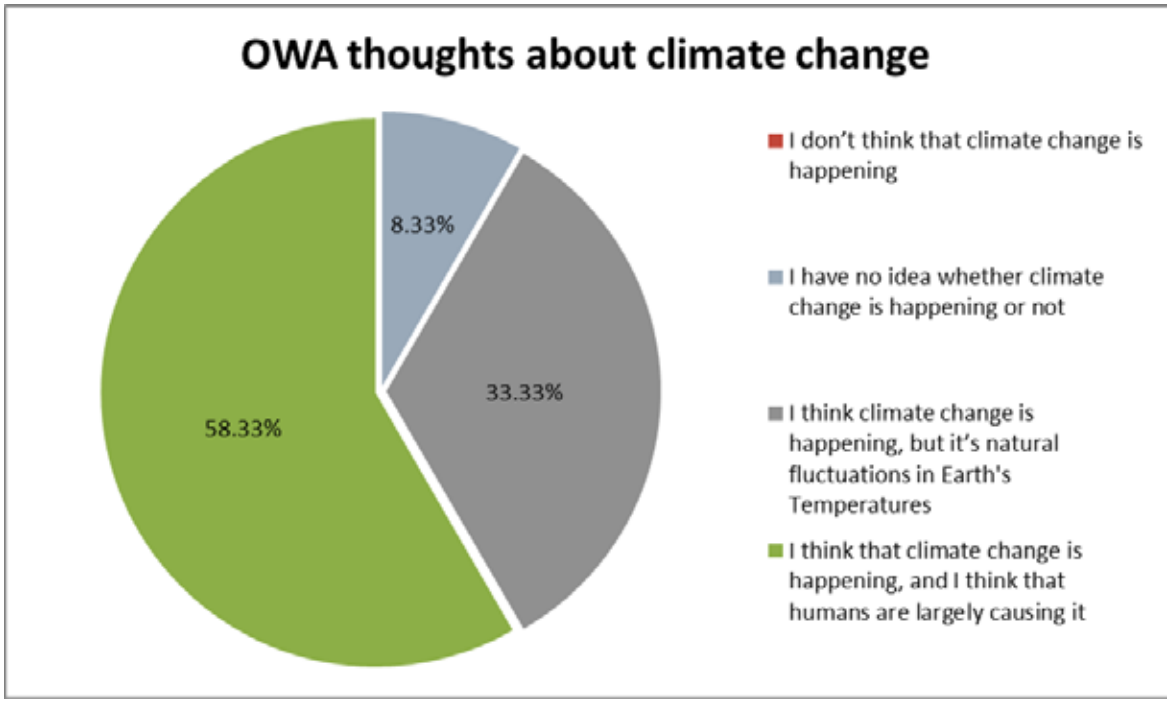

Figure 4 OWA thoughts about climate change

The OWA thoughts about climate change (Figure 4) can be compared with a large Australian longitudinal CSIRO survey (n= 2522) in Figure 5. In this survey, 88% of respondents thought that climate change was happening. Of these, 43% thought that humans were largely causing it and a slightly greater number (45%) thought climate change was happening, but it was just natural fluctuations in the earth's temperatures. Of this large survey, 4% had no idea if it was happening or not and 7% didn't think that climate change was happening at all.

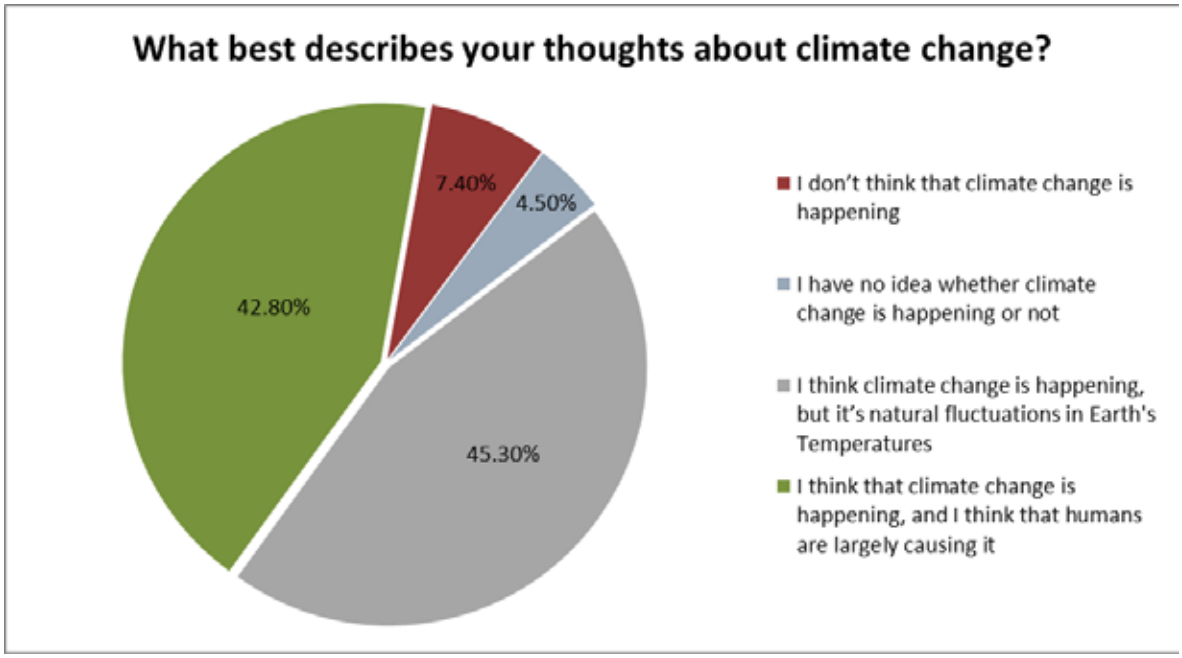

Figure 5 Australian Demographic thoughts about climate change

[Figure sourced from Leviston, Z. and Walker, I. 2011, Second Annual Survey of Australian Attitudes to Climate Change: Interim Report. Page 8, Figure 2. Where n= 2522.]

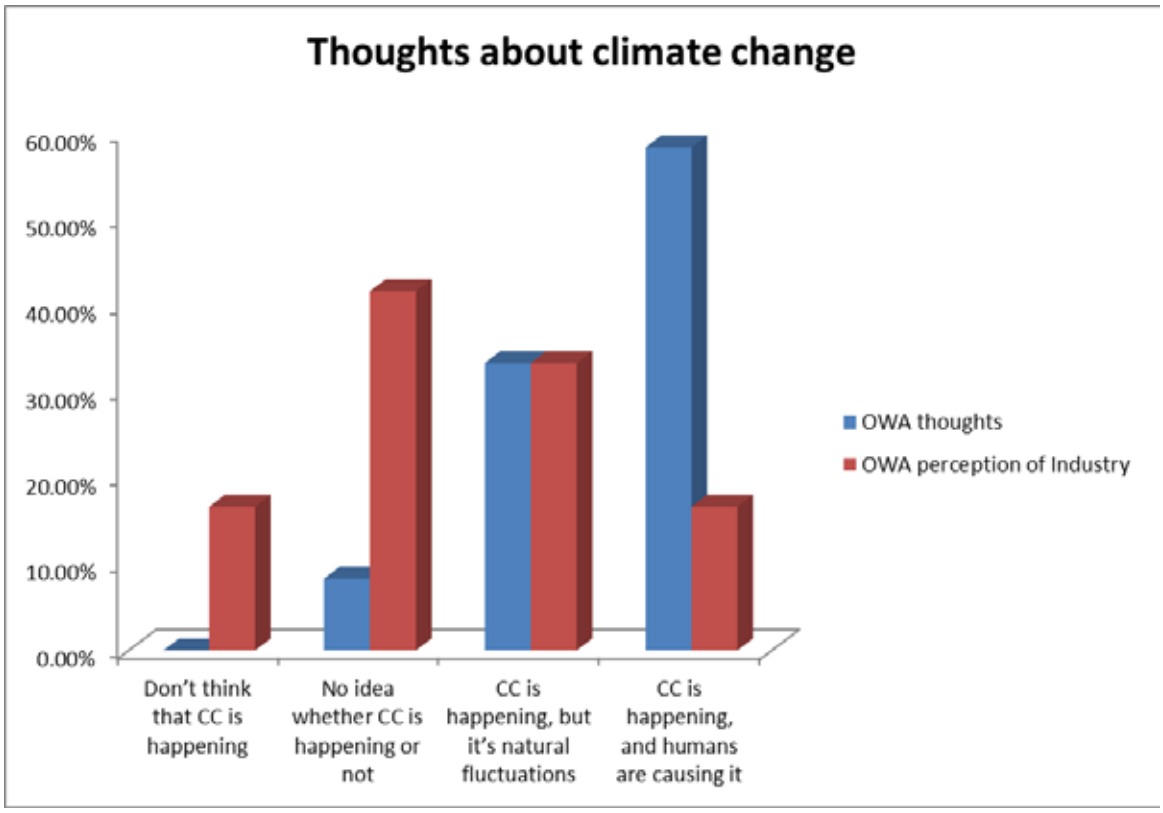

Figure 6 OWA and their perception of industry attitudes to climate change

When asked what the fishing industry would likely think about climate change (Figure 6), OWA respondents believed that in general there was more uncertainty about climate change (42%) and greater disbelief (17%). Their perception of industry was that only half (50%) of fishers believed that climate change was happening, and most of those, about one third (33%), believed it was natural fluctuations in the earth's temperatures rather than being caused by humans (17%).

1.4.3 Knowledge, understanding and interest in climate change

OWA respondents were asked to rate their own understanding of climate change science as it related to the marine environment (Figure 7). Most respondents (83%) rated themselves as moderately to very well informed. Their perception of industry's knowledge and understanding of climate change rated lower, with 75% describing industry as having little or no knowledge, or only some knowledge.

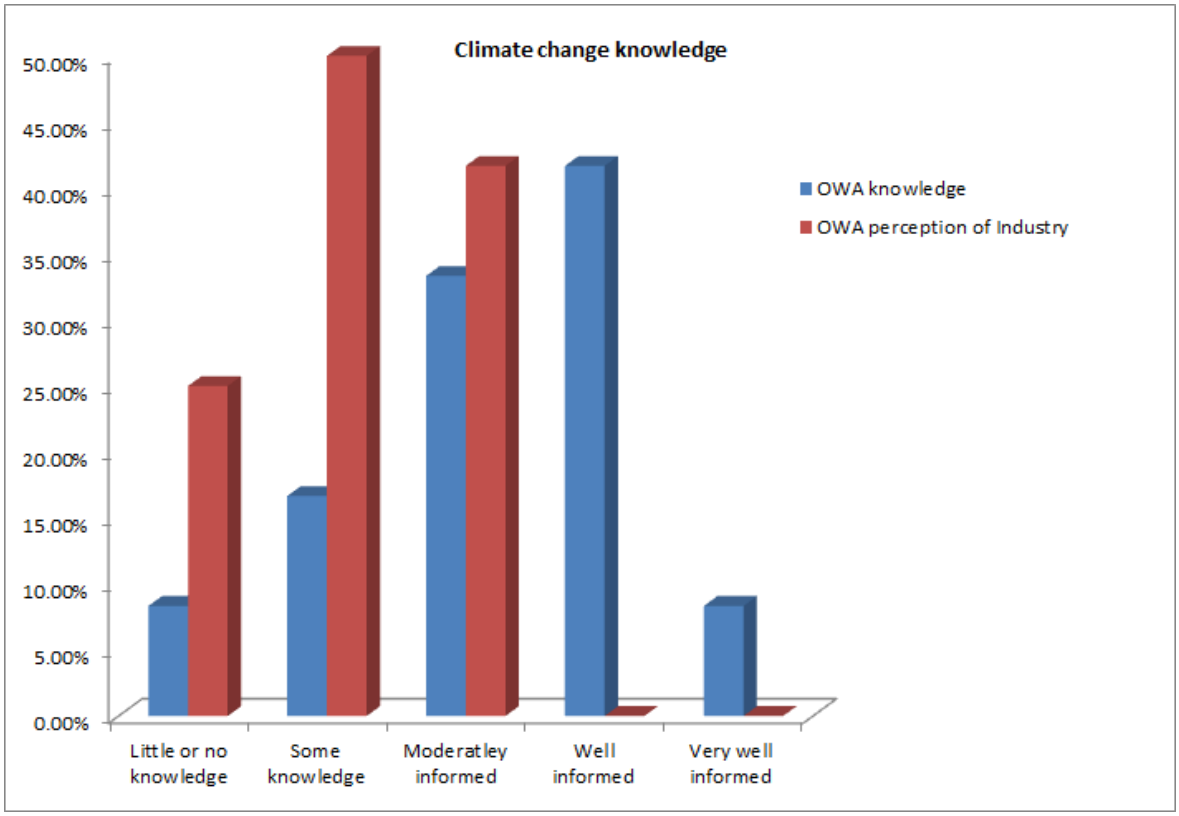

Figure 7 OWA and their perception of industry knowledge and understanding of climate change

OWA also rated themselves more interested in climate change knowledge than industry (Figure 8). A reason provided for this was that OWA needed to be better informed because of their responsibility to pass information onto an industry that will be impacted by climate change. For those respondents not interested, one of the reasons given was they were being swamped by other priority issues. This was repeated by a number of respondents as to why fishers may be less interested in climate change knowledge; '…they have too many other important issues to deal with'. On the other hand, explanations as to why industry would be interested in climate change knowledge included a desire to be better informed about the changes they are seeing in the marine environment and the future of their businesses.

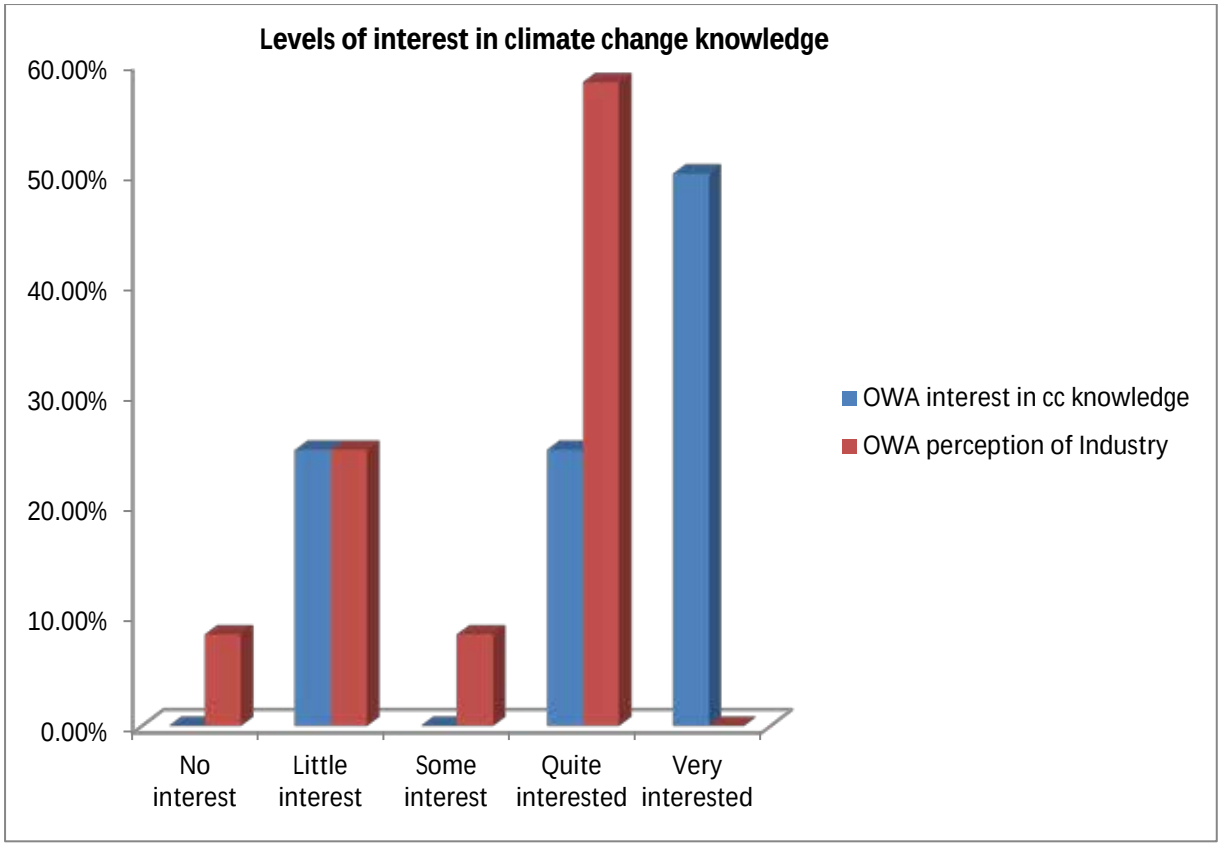

Figure 8 OWA interest and their perception of industry interest in climate change knowledge

1.4.4 Information and trusted sources

OWA were asked to list the sources they most trusted to provide credible information about climate change. Scientists (University Scientists, FRDC, Government Scientists, Scientific Journals and Fisheries Departments) rated the highest with TV, other forms of media, and books scoring less frequently (Figure 9). Leviston and Walker (2011) asked 5,030 respondents to rate their levels of trust in different sources to provide truthful information about climate change. The most popular response was 'University scientists' with 'family and friends' rating the second highest. In the OWA survey, 'Family and friends' was listed as an example in the survey, but not selected by any participants.

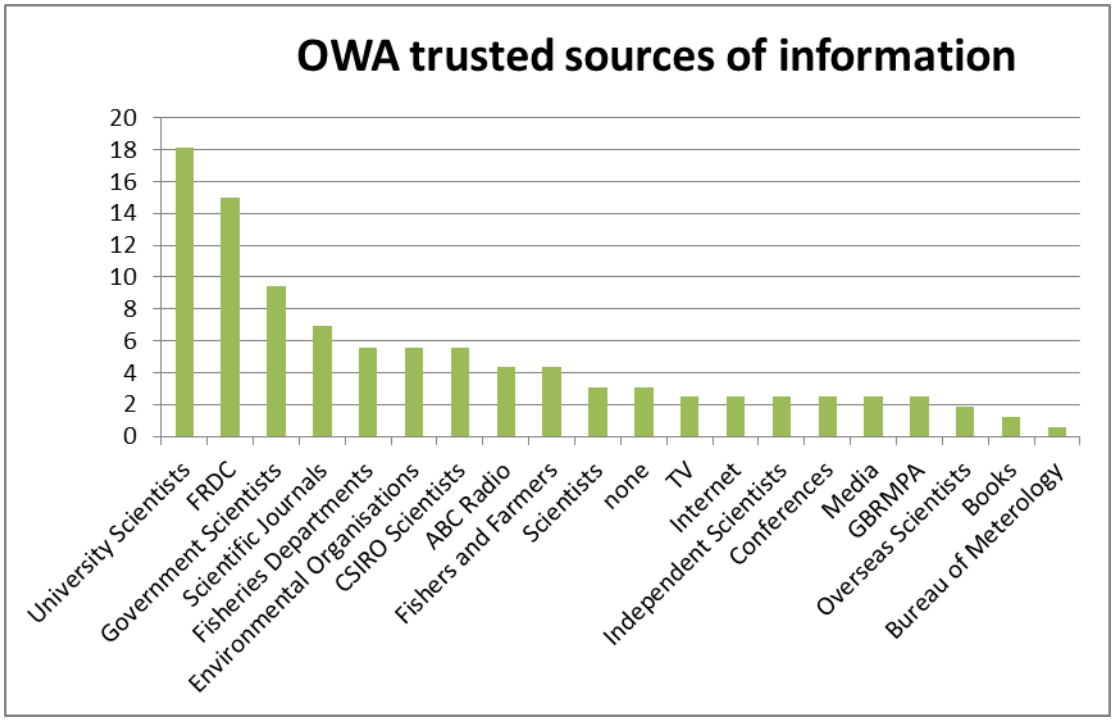

Figure 9 OWA most trusted sources of climate change information

1.4.5 Critical issues facing the fishing industry

To better understand some of the barriers to climate change knowledge uptake, particularly given the other demands currently facing the fishing industry, OWA participants discussed what they believe were critical issues facing the industry over the next 5-10 years (Table 1). These issues varied depending on the industry, region of operation and markets.

Critical issues facing the fishing industry
Fuel prices
Australian dollar
Social licence to operate, including · Community acceptance · Community support · Access e.g. marine parks · Pressure from recreational fishing lobby · Pressure from environment groups
Reduced fishers · Aging fishers · Lack of recruitment · Leaving industry because of reduced access/ viability · Leaving industry because of over-regulation
Knowledge transfer · Understanding fishing practices i.e. how to catch
Market access

· Imported product · Coles and Woolworths- primary producer pressure
Industry ownership · Licences going overseas
Biological fluctuations
Natural disasters –ecological
Anthropogenic issues e.g. oil
Mining
Habitat loss
Water quality
Ability to adapt to a changing environment
Natural fluctuations
Too much regulation · Fishers unable to diversify · Licence and boundary restrictions

Table 1 Critical issues facing the fishing industry over the next 5-10 years

1.4.6 Climate science uptake by fishing communities: opportunities and barriers

OWA SeaNet and Project staff have a primary 'extension' objective in all aspects of their work. They have input into a range of national projects and have extensive experience in extending information into specific industries and fishing communities around Australia. In small groups, and then with facilitated discussion, a list of barriers and opportunities for science and specifically climate science uptake were recorded based on the direct experiences of OWA (Table 2).

What works – opportunities for uptake
Science
Face-to-face, one-on-one conversation
'Straight talk'
Language is important, distil and make relevant to · Their business · Personal situation · Possible opportunities · Language – layman's; easy to digest
Format of presentation important · Not paper · No scientific reports · Summarise & translate science
Trust and relationships
Ask before tell. Often fishers know issues (often know more)
Depends on the message
Articles for fishers e.g. OWA newsletter, electronic & printed version
Use of Facebook and other social media
Kinaesthetic learning: look and touch, not reading
Deliver in own environment
Delivery by people who are trusted
Delivery by people who are independent

Climate change science
Fisher's stories. Use their past knowledge e.g. observations of sea level rise from disappearing mangroves and Islands
Fishers teaching fishers and fishers talking to fishers
Tangible examples of fishers doing things that could be transferable
Nurture and support industry champions that can often influence other fishers
Provide those in leadership roles with information that can be digested and translated
OWA has a range of projects and can be opportunistic about delivery
Initially approach a person you think may listen
Talk, talk and talk
Share information, make all communication a 2-way exchange
Input CC information at any & all meetings. OWA has a range of projects & can be opportunistic about delivery.
Provide research/work updates. If material is interesting it may be read
Ask fishers for input and provide information for checking
Enable fishers to reach conclusions by themselves e.g. by using Redmap
Build relationships so fishers are comfortable
Tailor information to the region, fishery and individual. St Helens probably more open to CC discussion as have seen such dramatic changes
Involvement in this project is putting fishers ahead of the game. This project is a first.
Keep all the information together (e.g. Pecl et al, 2009)
Be creative with climate change delivery.
Reward for participation & information, including refreshments, give-aways
SeaNet Officers should meet and personalise their experiences to scientists
Include family, especially wives (WINSC) as they are generally the business managers
Understand there are 3 levels with different ideas required for each level · Is climate change happening? · Does it affect me? · Can or will I adapt?
Use media e.g. 'Deadliest Catch' to talk about climate change
Listen to language e.g. some fishers more receptive to 'weather extremes' rather than 'climate change'
Fishers don't want 'dumbed down' information
iClimate an NCCARF database which documents impacts linked to the marine space
Keep group updated at least every 12 months
Have examples of tangible, successful adaptation options e.g. emissions calculator (QLD)
Be aware of different world views
Maximise opportunities for collaboration with other projects
Profile communities that are already changing

What doesn't work - barriers to uptake
Science
Formal meetings
Structured meetings
Moving lots of people into one place. Difficult as will often go fishing instead (e.g. if weather good)
Full scientific reports
Bringing very bad news
Delivering information outside OWA scope, changing their role
Approaching fishers when returning to Port as have other priority tasks

Climate change science
Fishers don't want to be identified as recognising CC as an issue
Time scales - for older fishers, projections are outside their working life
'Climate change' may turn off interest
Need to repackage to increase interest although this depends on project information required
No surveys or questionnaires

Table 2 What works and what doesn't: opportunities and barriers to the uptake of science and climate change science information

1.4.7 Knowledge and attitude changes

Prior to the workshop, OWA participants were asked to rate their knowledge and understanding of climate change science, particularly as it related to the marine environment (Figure 10). The highest proportion of participants indicated they were well informed (42%) or moderately informed (34%).

As one of the objectives of the workshop was to build capacity of climate change knowledge in the group, a presentation was provided on environmental and fishery changes of the east coast Tasmanian rock lobster fishery. The presentation was relevant in terms of environmental and fishery changes, and was also familiar in terms of the fishery and fisher responses. The questions that followed the presentation, resulting discussions and survey responses indicated that this type of presentation was useful in building an understanding of the issues. Having a relevant fishing example that could be used when discussing climate change with other fishers was also considered valuable.

At the end of the workshop, participants completed a post-workshop survey which asked them to rate their knowledge of climate change. The participant's responses indicated an increase in how they rated their knowledge and understanding of climate change (Figure 10).

Participants were also asked if their views on climate change had altered as a result of the presentations and discussions. This was not as clear. About half of the participants (54%) indicated their views had altered, primarily because they had more 'factual data' with 'more robust' science. The information on a specific fisheries project was also considered 'really helpful.' Of the participants who didn't think their views had been altered (45%), some of the comments acknowledged the use of practical examples for future discussions. Others indicated that they already 'understood the issues and still believed that climate change isn't directly related to humans- it's just a natural cycle.'

All participants were positive about the value of the workshop, particularly the 'brainstorming' or facilitated discussion of marine environmental changes and climate change extension opportunities as well as the specific fishery presentation.

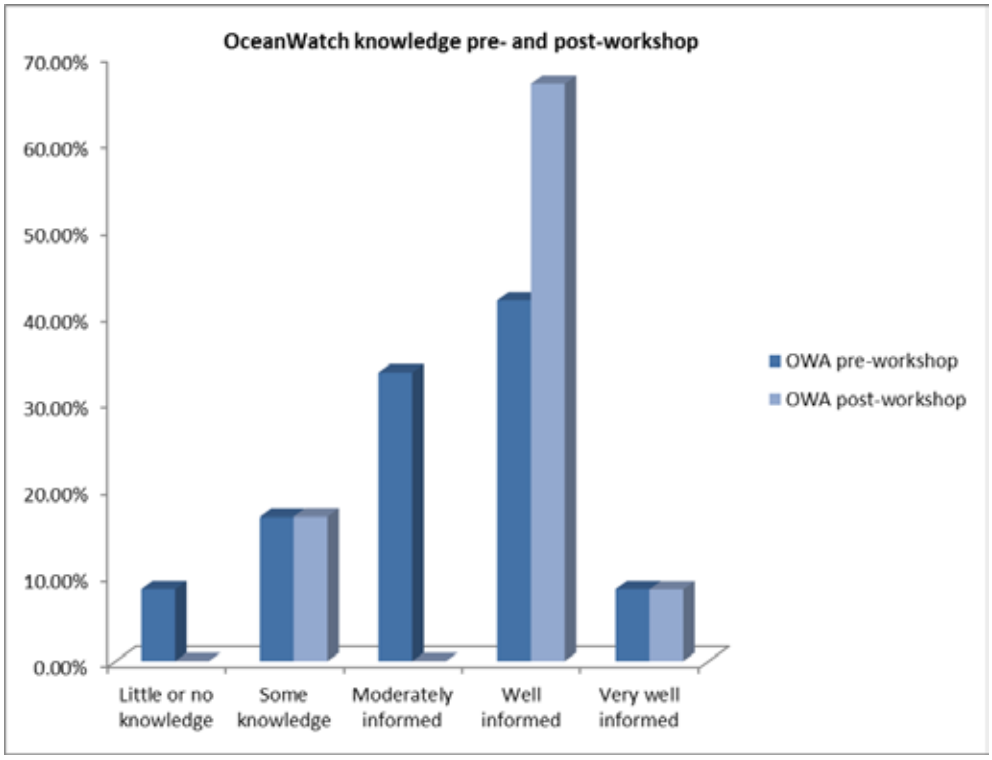

Figure 10 OWA knowledge and understanding of climate change pre- and post- workshop

Throughout the project, the SeaNet Officers, especially those involved in the Case Studies, were sent a range of relevant materials and climate resources to assist in building their capacity and facilitate a better understanding of the issues they were extending into the community. These materials included a range of technical levels and formats, relevant peer reviewed and grey literature, newsletters, brochures, web links, video presentations and DVDs. Although the materials were received, most participants spent little if any time familiarising themselves with the information or synthesising it for industry. In subsequent discussions, participants stated that there were always other priorities and little interest in the materials.

1.4.8 WINSC: Changes to the marine environment

The WINSC 'Climate Conversations' workshop included discussion of the changes people had observed or heard about in the marine environment. All participants responded with their observations and noted changes including weather patterns, water temperatures, species abundance, changing species distributions, currents (e.g. EAC and Leeuwin) and coastal erosion.

1.4.9 Climate change attitudes

When WINSC Directors were asked to describe their thoughts about climate change (Figure 11), most (82%) believed that climate change was happening. Of those, most (73%) thought humans were largely causing it. A small proportion (9%) thought climate change was happening, but it was natural fluctuations in the earth's temperatures. No participants selected the response: 'I don't think that climate change is happening,' however 18% of participants were unsure if climate change was happening or not'.

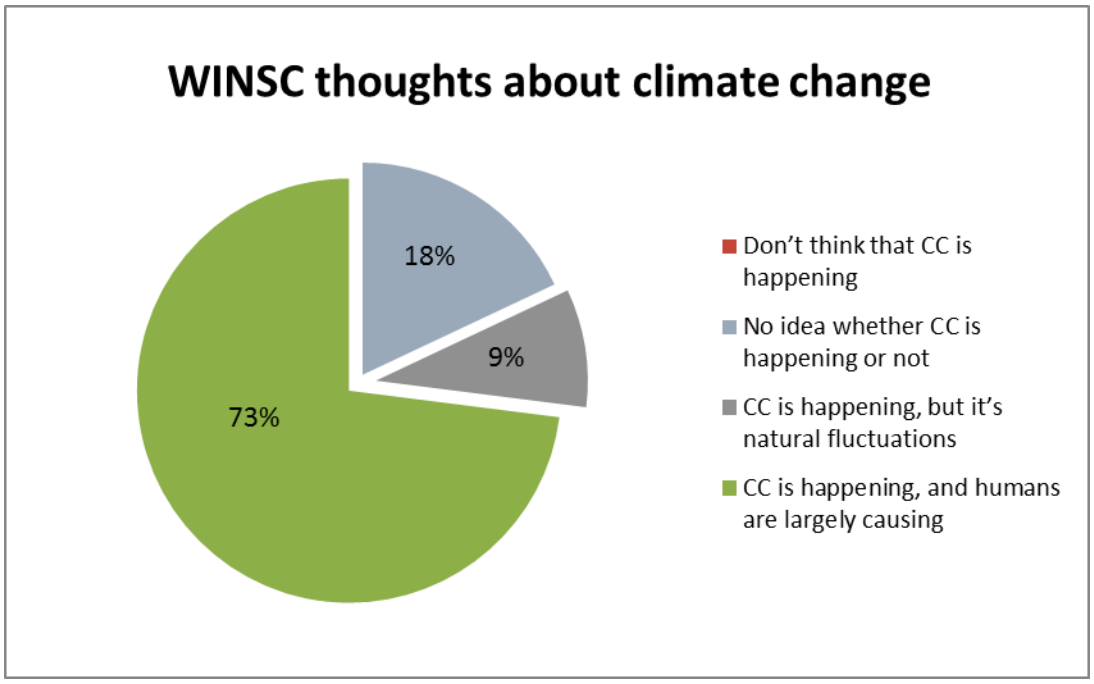

Figure 11 WINSC thoughts about climate change

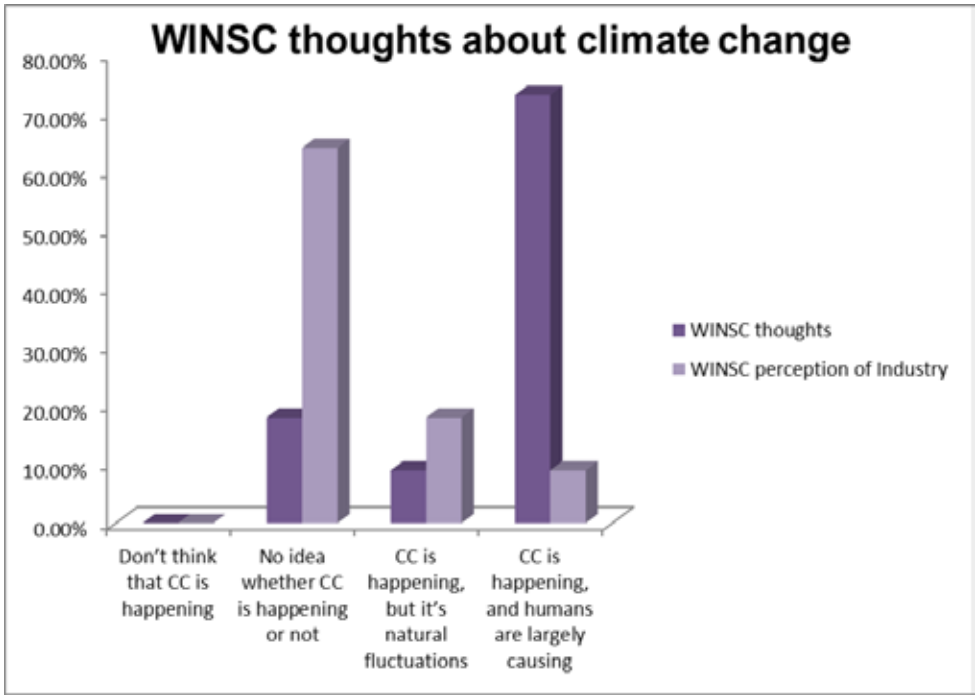

Figure 12 WINSC and their perception of industry attitudes to climate change

The majority of WINSC participants (73%) believed climate change is happening and humans were largely the cause (Figure 12). However, when asked what the fishing industry would likely think about climate change, WINSC respondents believed that fishers would have no idea whether climate change was happening or not (64%). Their perception of industry was that less than a third (27%) of fishers believed that climate change was happening, and most of those (18%), believed it was natural fluctuations in the earth's temperatures rather than caused by humans (9%).

The WINSC results can be compared to OWA data and to participants in the large CSIRO Australian survey. In all three groups, responses were consistent with most believing that climate change was happening (OWA 92%, WINSC 82%, Australians 88%). Both OWA and WINSC were ranked higher (58% and 73% respectively) than the large Australian survey (43%) in attributing the cause of climate change to humans. In considering industry perceptions of climate change, both OWA and WINSC believed that industry was less likely to believe that climate change was happening (49% and 27% respectively) and of those in industry that did believe climate change was happening, over half thought it was most likely to be natural fluctuations in earth's temperatures. Both OWA and WINSC shared the view that a significant proportion of industry (42% and 64%) probably had 'no idea whether climate change was happening or not'. This perception was much higher than the OWA and WINSC populations had scored themselves and also higher than the large Australian survey levels (4%). There was also a perception (by OWA) that a proportion of industry (17%) didn't think that climate change was happening. This proportion was double that of the Australian sample (7%).

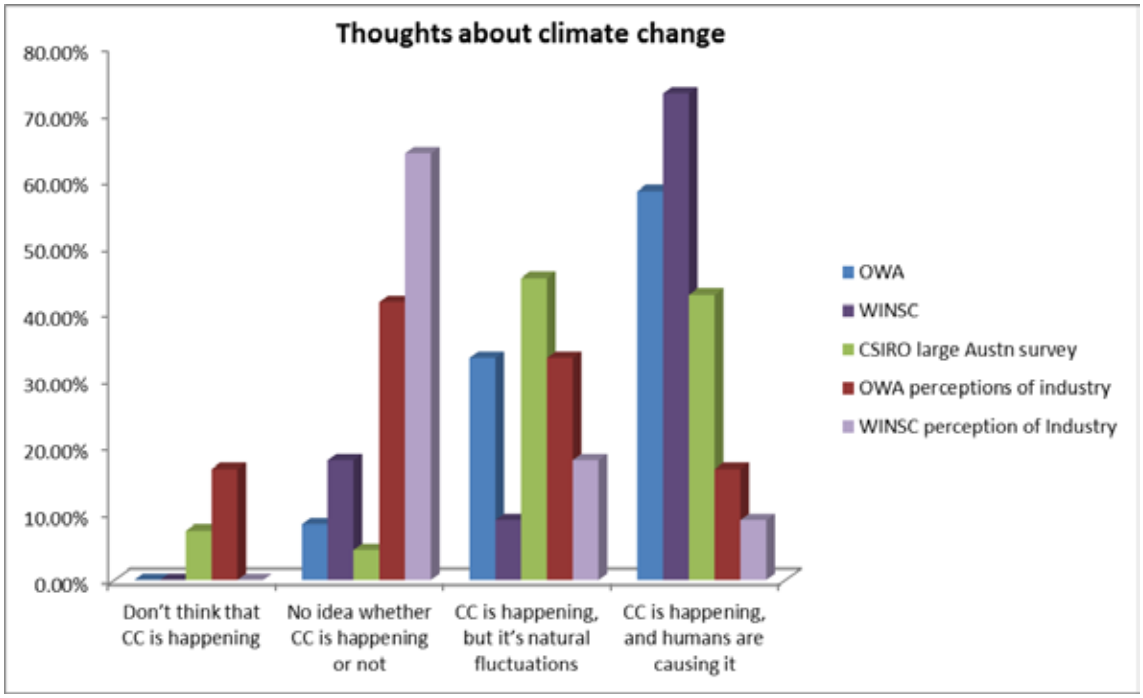

Figure 13 Thoughts about climate change for OWA, WINSC and CSIRO Australian survey

1.4.10 Knowledge, understanding and interest in climate change

WINSC respondents were asked to rate their understanding of climate change science as it related to the marine environment (Figure 12). Most respondents rated themselves lower than OWA in terms of their climate change knowledge (Figure 13) with far more (18%) believing they had 'little or no knowledge' of climate change. WINSC perception of industry was that they would likely have greater climate change knowledge than themselves, although the rankings were still low on a Likert scale with the perception that most (45%) would have 'some knowledge'. In the surveys and interviews there was a sense that fishers were possibly out on the water more than OWA/WINSC respondents were, and were likely to observe change more readily. As a result, fishers were perceived to have a greater understanding and knowledge of environmental change.

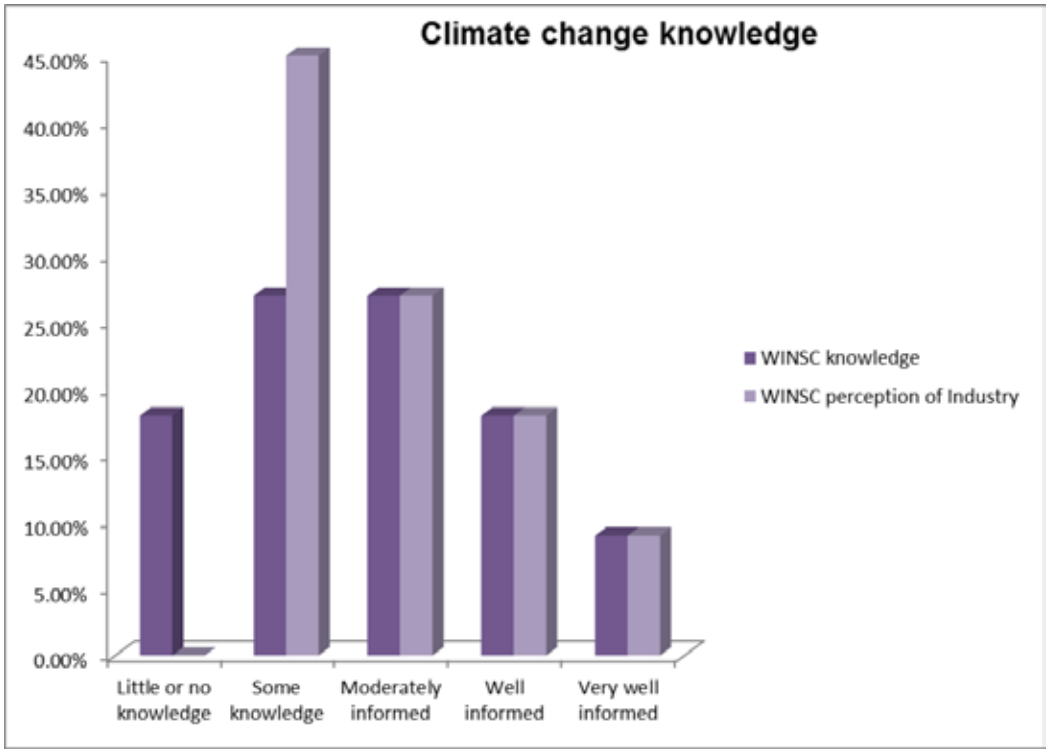

Figure 14 WINSC and their perception of industry knowledge and understanding of climate change

WINSC rated themselves more interested in climate change knowledge than industry (Figure 14). Although at times struggling with the concept of global climate change, they recognised more intense weather events and changes to the marine environment and wanted to know more about the issues. Those that were not as interested, cited a lack of professional interest or lack of time.

WINSC believed that industry had little interest in climate science knowledge (Figure 15) compared with themselves (WINSC 18%, industry 45%). They put forward a range of reasons including that: it was a low priority given the other imperatives they are currently facing; industry did not see climate change as a problem; and fishers see changes in the daily weather and adapt their fishing practises accordingly. A number of participants also indicated that the politicisation of climate change '…put people off…', and they did not want to hear about it.

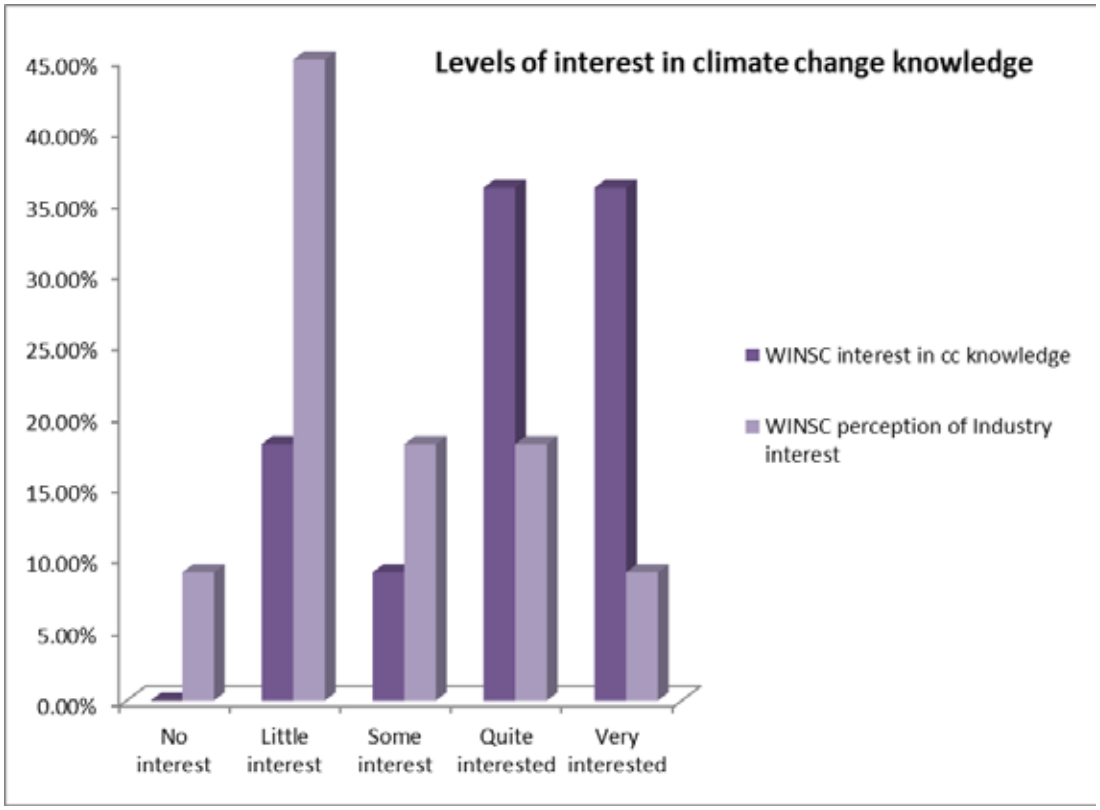

Figure 15 WINSC and their perception of industry interest in climate change knowledge.

1.4.11 Information and trusted sources

WINSC Directors were asked to list the sources that they trusted most to provide them with credible climate change information. Their responses were similar to OWA in most respects, although WINSC did rank Fishing Associations highly and OWA did not rate them at all. The responses of both organisations have been combined in Figure 16 to show the spread of trusted sources and illustrate the emphasis on scientists and scientific organisations.

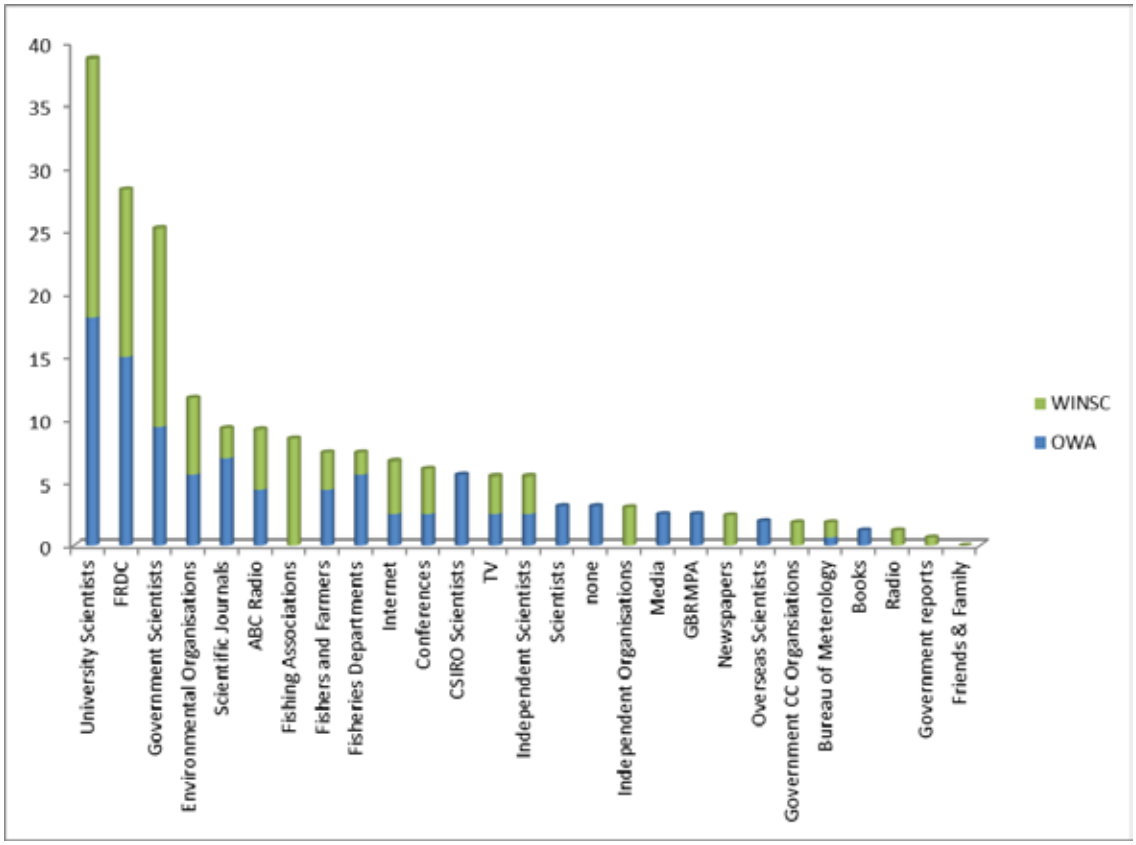

Figure 16 Trusted sources of information for WINSC and OWA

1.4.12 Knowledge and attitude changes

When asked if their views had altered as a result of the workshop, WINSC participants indicated that their knowledge had either improved (38%), or stayed the same (62%). Interestingly, even if participants had rated their knowledge as the same, comments indicated that they '…now felt more confident with their own knowledge.' Some participants believed their knowledge had improved significantly as a result of the workshop and as a population those participants who were 'well informed' about climate change increased from a quarter to half of the participants (Figure 17). One of the comments was '…I now (unfortunately) believe in climate change!'

The targeted presentation, which also focussed on dispelling climate change myths, was seen as particularly informative and beneficial. The group discussions were also important as they brought forward a variety of industry views, again stressing the difficulty of moving a subject such as climate change into a 'very stressed industry.'

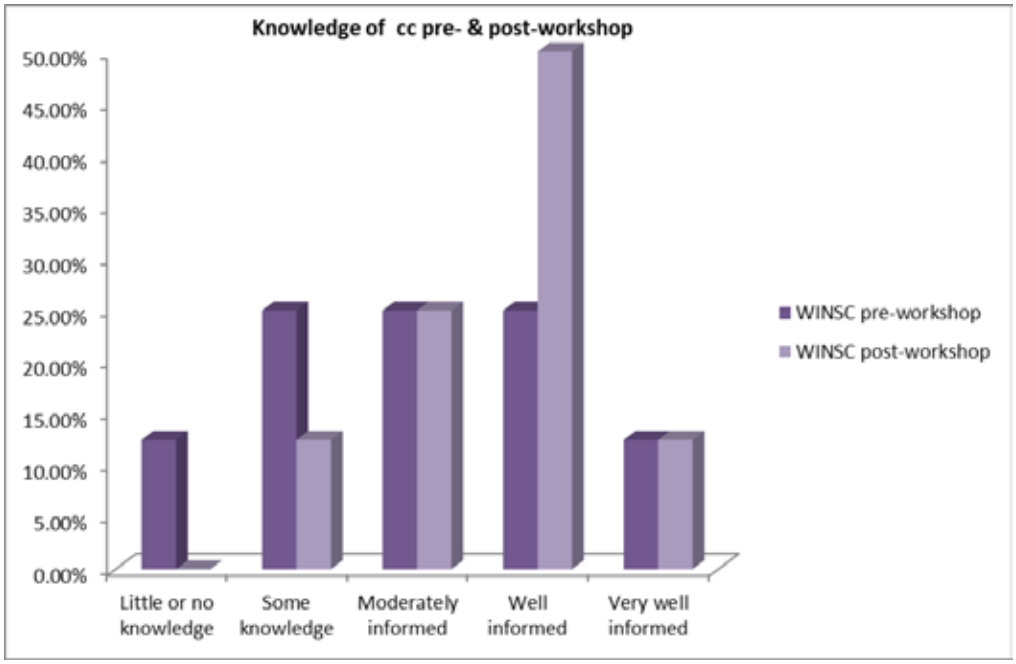

Figure 17 WINSC knowledge of climate change pre- and post- workshop

The WINSC group was followed over the life of the project. Of the 29 survey participants, only the Directors (10) were canvassed on their climate change knowledge throughout the three year period. Most of those surveyed (60%) indicated their knowledge and understanding of climate change had improved, a third (30%) indicated it had remained the same and 10% indicated it had declined. These data were gathered by asking the same question embedded in a written survey. Although the population is small, it is unlikely participants recollected their previous answers.

Not surprisingly, participant's perception of their knowledge varied over time and seems to have been influenced by their involvement in climate change activities. At the end of October 2012, after the group had been updated on this project and listened to a presentation about a fishing community affected by environmental and climate changes, they rated their knowledge and understanding much higher. That is, 80% thought their knowledge had improved, 20% had stayed the same and none had declined. A year later in October 2013, there had been limited interaction from this project and no other climate change workshops or information sessions. As a result, it appears that the perception of their knowledge and understanding of climate change had reduced.

1.5 Discussion

This section discusses the key findings of two organisations strongly associated with the seafood community: OceanWatch Australia (OWA) and the Women's Industry Network Seafood Community (WINSC). It focuses on their climate change perceptions, understanding and knowledge needs. It also explores their overall perceptions of industry understanding of climate change as well as their knowledge and interest in this subject. These results then formed the basis of the methodology for the community visits, product development and innovative methods for building community and industry knowledge of climate change.

1.5.1 Changes to the marine environment

Both OWA and WINSC have strong connections to the fishing industry and the marine environment. Not surprisingly they had all observed or heard about changes to the weather or marine

environment. The diversity of observations reflected their residential regions around Australia and individual interests. This high level of observation of change does not necessarily reflect a high level of attribution to climate change as Pecl et al. (2009) found in the Tasmanian lobster fishery.

Knowledge uptake is not a linear process; it can occur in many phases and layers and depends on a range of individual and often interacting factors. Observation and supporting scientific information is not always enough to change beliefs.

1.5.2 Climate change attitudes

To better understand and compare where these two populations fitted within the broader Australian demographic, both OWA and WINSC were asked the same questions as used in the large CSIRO survey (Leviston and Walker, 2011). One of the notable differences was that no respondents in the OWA or WINSC study group indicated that climate change was not happening. Although they may have been unsure about climate change, all participants had observed or heard about changes in the marine environment and could list specific events and make broad observations. Their strong marine awareness and in many cases specific scientific training reflected their understanding that change was definitely happening, although in OWA there was little consensus on the drivers of change, i.e. anthropogenic or natural fluctuations in the earth's temperature. Despite this lack of consensus, when compared to the large Australian CSIRO sample, both groups and particularly WINSC, had a greater awareness that climate change was happening and that humans were largely causing it.

As these organisations are closely linked to the fishing industry their views on what the industry perceived were revealing and important in formulating the best way to increase climate change knowledge in the seafood industry and coastal communities. Both groups believed that there was confusion in industry about whether climate change was happening or not, with some industry members not believing climate change was happening at all. These opinions are formed by participants who closely interact with industry. They either work directly with industry or in the case of WINSC, are partners in fishing businesses or work in the fishing sector in areas including processing, marketing, research and management.

When considering industry thoughts about climate change, there was also the view that fishers in general can be reactive in their responses and may disagree and be reluctant to embrace change. Although only anecdotal, this makes any extension and knowledge-building of a complex, contentious and a highly politicised subject such as climate change more difficult.

Throughout the project there was some reluctance by OWA to approach climate change discussions in industry circles. This is further explored in Appendixes 2 and 3, however as OWA perceived that industry did not really believe in climate change and were not interested in climate change knowledge, it is not surprising they were reluctant to broach the topic.

1.5.3 Knowledge, understanding and interest in climate change

When considering industry knowledge and interest in climate change, OWA believed that industry was generally not as well informed and had less interest in climate change knowledge then they did. This clear perception may be because most OWA staff are University trained and have covered aspects of climate change science at tertiary level. It may also partly explain why OWA rated themselves much higher compared with WINSC in climate knowledge. Gender biases may be another factor given that OWA is male-dominated and WINSC female-dominated. Within the OWA organisation there has also been a level of professional debate regarding climate change for many

years (L. Pryce, pers. comm.). Although this debate has not lead to consensus on climate issues, it may have increased people's perception of their knowledge and understanding of climate change.

Many WINSC Directors are fishing business partners and indicated that fishermen were very aware of changes in the marine environment as they deal with these changes on a daily basis. This was evident in their responses, with an understanding that industry had some knowledge of climate change. However like the WINSC participants, there were few in industry considered 'very well informed' on the topic.

Both organisations believed that fishers were less interested than themselves in climate change knowledge. WINSC are very aware of the other priorities and pressures facing the industry and indicated 'little interest' by fishers in this topic. It is not considered a priority issue for the fishing industry. This data also correlates with previous data from OWA (L.Pryce, pers. comm.) indicating that fishers want to know about environmental changes, however interest in changes on a macro scale do not resonate as well as changes on a finer, more local scale. OWA believed that understanding these smaller-scale changes was far more relevant for fishers and may give them a market advantage. As much of the climate change information is still based on large-scale predictions, it is only when the down-scaled information becomes available that fishers may become more interested.

1.5.4 Information and trusted sources

The trusted information sources listed by both organisations strongly reflected the participant's fisheries and marine connections compared with the large Australian CSIRO survey. As OWA and most WINSC Directors and members have access to scientists and comprehensive information networks, it is more likely they would go to the source of information rather than family and friends as many in the large Australian survey indicated.

Being clear about the best source of climate information coming from Universities, FRDC and other Government scientists certainly helps reduce confusion and maximises the opportunities for correct information being extended into the industry and communities via these organisations.

1.5.5 Critical issues facing the fishing industry

OWA and WINSC were acutely aware of the large number of critical issues currently facing the industry. This also explains why issues such as climate change are perceived as a low priority. The topic has complex large-scale predicted impacts, can be confusing and is often outside fisher's time frames. Many of these critical issues; fuel prices, Australian dollar, market share, fisheries management, habitat loss, water quality, regulation and access to water, appear out of the control of individual fishers. Climate change is but one more issue that fits into this category.

These barriers create a significant challenge for climate change knowledge extension and uptake, where climate change issues take a low priority because the threat is not perceived as an immediate one.

Despite this, encouraging industry to better understand issues that may impact their businesses, including climate change, provides an opportunity for them to better adapt by developing strategies which may help to future-proof their businesses.

1.5.6 Climate science uptake by fishing communities; opportunities and barriers

The opportunities and barriers for the extension and uptake of climate change science put forward by OWA (Table 2), were used extensively to refine the project methodology. Examples of measures that were used included: using OWA SeaNet Officers to extend climate change information (refer Appendixes 2, 3 and 5), talking to fishers face to face, incorporating return visits (Appendix 3), summarising outcomes to date (Appendixes 5; 5.3 and 5.4 and Attachment 1 Project Flyers, Attachment 2 Case Study Brochures), devising innovative methodologies (Appendix 4), developing an interactive DVD (Appendixes 5; 5.6 Attachment 4 Interactive DVD), providing rewards (Appendix 8 Promotional materials), using industry members for project interface (Appendixes 3 and 4), and synthesising research (Appendix 5; Attachment 1 Project Flyers, Attachment 2 Case Study Brochures, Attachment 3 PowerPoint Presentation Example).

1.5.7 Knowledge and attitude changes

Increasing the knowledge and capacity of both organisations was an objective of the project and a number of tools were used to achieve this, each with varying success.

Facilitated workshops in small groups enabled people to voice their opinions in a supportive environment and discuss the issues being raised. These workshops were considered valuable and useful by participants. Presentations by respected individuals which dealt with topics that were significant, pertinent and familiar and could be readily translated into individual situations were also considered helpful in building knowledge.

Published, more generic information, in different formats (including brochures, DVDs and web links), with a variety of specialisation and range of topics were not as successful, even if they had initially been requested by the participants. This outcome is especially relevant when considering ways of engaging industry and community in complex, contentious topics such as climate change.

As both organisations have very strong links into the fishing industry and coastal communities, the success of these methods of knowledge uptake were all carefully considered during the project delivery.

These outcomes lead to a greater focus on more innovative techniques for knowledge uptake including the Photovoice project and community exhibitions; incorporating a range of animation, visualisations, stories and quotes.

1.6 Conclusions

Both OWA and WINSC were useful partners in project 2011/503 Climate Change Adaptation: Building community and industry knowledge. Their strong links with the seafood industry provided an excellent insight into the attitudes and perception of an industry that is generally large, mobile, diverse, scattered and difficult to access.

OWA was employed to extend climate change information into the fishing industry and coastal communities as well as access communities for the Blueprint Project (FRDC 2010/542). It was also valuable to engage the organisational population with surveys, interviews and workshops and gauge their attitudes, interest and knowledge in this complex, highly politicised topic.

OWA and WINSC reflected a much greater acceptance that climate change was happening when compared with the general Australian population. Despite this, there was no consensus in either organisation on the drivers of this change; natural or anthropogenic.

Both organisations perceived that industry had less of a belief that climate change was happening, less knowledge about the subject and little interest in learning more compared with them. A range of barriers for climate change knowledge uptake were identified including, economics, fisheries management, time pressure, social licence to operate, and habitat and related stock loss. Given the stressors faced by the industry, climate change is seen as a low priority.

These barriers create a significant challenge for climate change knowledge extension and uptake, where climate change issues take a low priority because the threat is not perceived as an immediate one.

As people in the fishing industry, and in fact many of the Australian public, do not see climate change and adaptation as important issues, structuring programs to increase knowledge uptake require specialised understanding and approaches. Opportunities for successful information uptake include; dealing with individuals one-on-one, building trust and relationships, sharing information, respecting community knowledge, synthesising research materials to make information more understandable and relevant, tailoring information to the individual's needs, and delivering it in their environment.

Knowledge may change over time and this was demonstrated by the WINSC group who perceived they had greater knowledge after they had shared observations and listened to relevant, accessible climate change information which was personalised and transformed into material that was relevant to their own situations. Their knowledge increased with further workshops given by a trusted member of their organisation. Over time however, without discussion and further inputs, their perception of their climate change knowledge declined. This is important as there is much accessible information about climate change, however it can be confusing and contradictory and not necessarily from a trusted source. The role of an agent who is credible, legitimate and provides salient information appears to be important when building knowledge of complex problems such as climate change.

Both OWA and WINSC demonstrated that knowledge uptake is not always a linear process; it can occur in many layers and phases, and depends on a range of individual and often interacting factors. The provision of observation and supporting scientific information is not always enough to change beliefs.

Although OWA and WINSC fulfilled very different roles in the project, their strong linkages with the fishing industry and coastal communities enabled an excellent insight into the industry and helped

shape the project delivery and uptake of climate change knowledge and possible adaptation strategies. The reflective and adaptive process instigated over the life of the project maximised opportunities for knowledge uptake in both the fishing industry and coastal communities.

Attachment 1 OWA and WINSC Surveys

Survey on climate science perceptions and organisational understanding.
OceanWatch October 2011

Participant name: _____

Role in OceanWatch: _____

Q1.* What best describes your thoughts about climate change? Circle one answer.

a) I don't think that climate change is happening
b) I have no idea whether climate change is happening or not
c) I think that climate change is happening, but it's just a natural fluctuation in Earth's temperatures
d) I think that climate change is happening, and I think that humans are largely causing it

Any comments?_____

_____

Q2.* What do you think most people in the fishing industry believe about climate change?

a) They don't believe that climate change is happening
b) They don't know what to believe.
c) They believe that climate change is happening, and that it's just a natural fluctuation in Earth's temperatures
d) They believe that climate change is happening, and that humans are largely causing it

Any comments? _____

_____

Q3. How would you rate your knowledge and understanding of climate change science, particularly as it relates to the marine environment?

On a scale of 1-5 where 1 = very little or no knowledge 5 = very well informed
Please circle your answer

1___2___3___4___5

Q4. How would you rate most fishing industry participants' knowledge and understanding of climate change science, particularly as it relates to the marine environment?

On a scale of 1-5 where 1 = very little or no knowledge 5 = very well informed

1___2___3___4___5

Page 1 of 5

Survey on climate science perceptions and organisational understanding.
OceanWatch October 2011

Q5.* Over the past 5 to 10 years, have you noticed or heard about any changes in the weather and/or other marine-related ecological areas e.g. species distributions? Could you briefly describe any changes?

_____
_____
_____
_____
_____

Q6.* Would you attribute these changes (if any) to climate change or to other causes?

_____
_____

Q7. How interested are you in knowing more about climate change science?
Using a scale of 1 – 5 where 1 = no interest 5 = very interested

1___2___3___4___5

Q8. Can you say why you are or are not interested?
Responses may include, for example: I don't believe there is a problem, I'm too busy, I see change occurring, I'm interested in weather and climate.

_____
_____
_____
_____

Q9. How interested do you think people in the fishing industry are, in knowing more about climate change science?
Using a scale of 1 – 5 where 1 = no interest 5 = very interested

1___2___3___4___5

Q10. Can you say why you believe they are or are not interested?
Responses could include: don't believe there is a problem, low priority, seeing change occurring, interested in weather and climate, want to climate–proof their business.

_____
_____
_____
_____

Survey on climate science perceptions and organisational understanding.
OceanWatch October 2011

Q11. What sources do you trust most to provide you with good information about climate change?
Examples could include but are not limited to; FRDC, Government scientists, University scientists, Fishing Associations, Fisheries Departments, Environmental organisations, Friends and Family, Newspapers, TV, ABC radio, Internet (specify best websites), other sources?
Please rank you answers from 1 (most trustworthy) to 5.

☐ _____
☐ _____
☐ _____
☐ _____
☐ _____

Q12.* Most organisations have different roles and functions. On a scale of 1-5 how do you think OceanWatch undertakes the following roles and functions of convening, translating, collaboration and mediation?

Where 1 = never 2 = hardly ever 3 = sometimes 4 = mostly 5 = always

Remember there is no correct answer for these questions. The questions are designed to establish the 'type' of organisation and role fulfilled by OceanWatch

Convening: in your view, does OceanWatch bring together stakeholders from different areas or organisations for meetings and workshops?

1___2___3___4___5

Can you provide an example? _____

Translating: In your view, does OceanWatch interpret and move information from one group of stakeholders to another, for example from fishers to scientists and vice versa?

1___2___3___4___5

Can you provide an example? _____

Survey on climate science perceptions and organisational understanding.
OceanWatch October 2011

Collaboration: To your knowledge, does OceanWatch create opportunities to share and create new information with stakeholders to work out better options for future work and new projects?

1___2___3___4___5

Can you provide an example? _____

Mediation: In your view, does OceanWatch consciously acknowledge and address differences in the groups you work with and/or actively promote conflict resolution?

1___2___3___4___5

Can you provide an example? _____

Q16. Do you have any other comments or questions?

_____
_____
_____

For comparative purposes, this survey has sourced and/or modified a number of questions (marked with an *) from different publications including the CSIRO National Research Flagships Climate Adaptation baseline surveys: Leviston, Z. & Walker, I.A. (2010), Leviston et al (2011) for ques 1 and 2. Pecl G., et al (2009) ques 5. Cash et al (2006) ques 12.

-

Thank you very much for participating in this survey

Survey on climate science perceptions and organisational understanding.
OceanWatch October 2011

POST WORKSHOP self-assessment

Participant name: _____

Role in OceanWatch: _____

1. How would you now rate your knowledge and understanding of climate change science, particularly as it relates to the marine environment? Circle one answer.
On a scale of 1-5 where 1 = very little or no knowledge. 5 = very well informed. Please circle the most correct answer.

1___2___3___4___5

2. Have your views on climate change altered as a result of today's presentation and discussions?

In what way? Please describe?

3. What do you see as the biggest challenge to the success of these projects?

4. What features of the workshop did you find most useful?

5. What could we do differently next time??

Thank you very much for participating in this workshop and survey.

Page 5 of 5

Appendix 2 Spanning the boundary between scientists and coastal communities

A boundary organisation is an organisation that functions to span the knowledge boundary between those who create knowledge and those who may use the knowledge in decision making or as part of their industry or community roles. In the course of this project OceanWatch Australia (OWA) was identified as an organisation that may function as a boundary organisation. This section describes an evaluation of OWA against criteria that have been developed to characterise the functions of boundary organisations.

This section focuses on the opportunities and challenges that were identified from a workshop and the results of case studies supported by OWA (Shaw et al., 2013).

2.1 Highlights

Innovative methods, organisations and processes may be necessary to re-engage coastal communities in climate change information and its uptake

Boundary organisations can provide a functional framework to move technical climate change information between science makers and coastal communities

Boundary tools, boundary spanners and boundary organisations can be successful in sharing knowledge and increasing the understanding of climate change science in coastal communities, but challenges still remain in managing boundaries

The exact nature of a boundary spanner's relationship to both the decision makers and the scientists is of critical importance. It is possible to be too close or too removed from either.

Down-scaling of climate change data to more relevant geographic and temporal scales could increase the salience of the information

2.2 Background

Climate science is complex and often controversial. One of the challenges for coastal adaptation in response to climate change is spanning the boundary between technical scientists and other stakeholders including local communities. The technical science is very much the domain of professional climatologists, meteorologists, modellers, oceanographers, biologists and geomorphologists. However, the uptake and the application of this science 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.

The FRDC Knowledge project (2011/503) included three case studies (St Helens in Tasmania, Bowen in Queensland, and Geraldton in Western Australia) over a two year study period. In this section, the focus is on the challenges and opportunities of the OWA organisation and its agents who are endeavouring to cross these long-standing boundaries and move climate science information into Australian coastal communities and particularly fishing communities. The study analysed the functions of the organisation in terms of its ability to convene, collaborate, translate and mediate. These functions are considered important when defining a boundary organisation (Cash et al, 2002). We also assess the capacity of the organisation to enhance the salience, credibility and legitimacy of the process.

2.3 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 (Leviston and Walker, 2011). Barriers to knowledge uptake are well documented (see McNie et al., 2008; Moser

and Dilling, 2007; Moser and Ekstrom, 2010; Moser, 2011) 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, science forms its own boundaries to distinguish and demarcate scientific work (Guston, 2001; Jasanoff, 2004) from the activities of decision-makers and the broader community. This boundary can create additional barriers to dialogue and uptake of science. However it can also behave like a permeable cell wall (McNie et al., 2008) allowing information flow in both directions for the benefit of science and society. 'Boundary work' is a term used to describe activities that enhance this two-way communication. Boundary work usually entails stakeholder negotiation and mediation and enables multiple knowledge and values to be shared and co-produced while maintaining the integrity and legitimacy of all stakeholders involved (McNie et al., 2008).

The functions of boundary organisations as identified by Cash et al. (2006) 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., 2006).

Cash et al. (2006) 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 question'? Credibility responds to the question 'do we believe this'? Legitimacy responds to the question 'is the process fair'?

2.4 Aims and Methods

OceanWatch Australia Ltd. (OWA) 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. OWA also introduces the community and fishing industry to sustainable technologies and behaviours (www.Oceanwatch.org.au). Although not set up to function as a boundary organisation, OceanWatch has some characteristics of this type of organisation in that it moves between research, policy and the community. The organisation was invited to participate in the FRDC project because anecdotally, commercial fishers have been reluctant to make the connection between climate science and changes they had seen in the marine environment. It was considered that OWA may be in a position to better enable this process.

In October 2011, a workshop was held in Queensland with OceanWatch Officers (known as SeaNet Officers) from around Australia. The aims of the workshop were to; gauge whether the OceanWatch agents interpreted their role and function as that of a boundary organisation; to share personal observations and scientific information on climate change science; and to gain a better understanding of whether OceanWatch can in the future, function as a boundary organisation specifically in relation to climate science. The results of this workshop and subsequent discussions are presented below.

To better understand how the employees of OceanWatch perceived the role and function of their organisation, a survey was undertaken by the Officers that self-rated organisational function in terms of convening, collaborating, translating and mediating.

The workshop participants also discussed opportunities and challenges for communicating science and specifically climate science to the fishing community. Further climate science information

(electronic and hard copy videos, articles, papers and web-links) were distributed to the OWA SeaNet Officers over the following months.

For the Case Studies at St Helens (Tasmania), Bowen (Queensland) and Geraldton (Western Australia), the local OWA SeaNet Officer 'prepared the community' for the project by providing project information, community contacts, introductions and interview opportunities for the Post-Doctoral fellows from the related FRDC Community Blueprint Project (2010/542) Climate Change Adaptation: A blueprint for coastal regional communities.

In the following sections the perceptions of OceanWatch Officers from around Australia under the Cash framework (Cash et al., 2006) for boundary organisations is discussed. Examples of how these functions occurred in various States of Australia are also included. The criteria of salience, credibility and legitimacy are then explored in relation to the Case Studies as criteria for success (Cash et al., 2003).

2.5 Results

2.5.1 Convening

OceanWatch Participants rated their organisation very highly in 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.

2.5.2 Collaborating

Participants were asked to rate their organisation's ability to create opportunities to share and generate new information with stakeholders and 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 taking information from researchers into the fishing community and the introduction of new gear technology to improve environmental outcomes.

2.5.3 Translating

Translating rated the most significant with 100% of participants rating the organisation as 4 or 5 on a Likert scale of 1-5. Many of the participants saw the main role of their organisation as interpreting information for the fishing industry.

2.5.4 Mediating

Mediation was not rated as significant 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. This is especially relevant when they are translating Government information back to the fishing industry.

2.6 Discussion

2.6.1 Credibility

OWA 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. 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 the trust and respect from the community. In this case OWA 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. However, OWA employees commented that they are concerned their hard-won credibility would be reduced if they began discussions with skeptical 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 thought of as a non-salient topic in the industry.

When an officer is new to the community or not familiar with the local industry, credibility has to be built. This can take time and may be difficult to achieve if the Officer is not confident with their ability to translate and deliver the information, or perceives the fisher is not likely to be interested in the topic.

2.6.2 Salience

OceanWatch employees commented 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 rise) 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 business timeframe and 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.

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 and engage both the agents and their stakeholders.

2.6.3 Legitimacy

The fairness or legitimacy of a process is also an important attribute. OWA 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 OWA's potential role as a boundary organisation would probably be compromised by the perceived fragility of their credibility and their close identification with the fishing community. If OWA was able to develop the ability to translate regionally relevant climate science into a down-scaled format, their confidence in their credibility with fishers and their legitimacy as a boundary organisation for climate science could potentially be enhanced.

2.7 Conclusions

Innovative methods, organisations and processes may be necessary to re-engage coastal communities in climate change information and its uptake. The above section briefly describes 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. It also focuses on their engagement with the community against specific criteria which could determine their success or otherwise of moving this information into coastal communities.

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, the Officers in OWA strongly believe their organisation effectively functions as a boundary organisation, although they were not previously familiar with this name.

OWA's 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 may reflect the Officer's strong ties to the industry, and an unwillingness to engage fishers in a complex issue that they believe may diminish their credibility in the industry. It may also reflect their personal views that climate change science is not a credible, salient or legitimate topic.

So while OWA appear to function well as a boundary organisation more generally, they are likely to do so in relation to climate change science only with significant support. Despite this, it is likely that OWA could reposition itself to effectively deliver technical climate change science information into coastal fishing communities because of its high level of credibility and trust in these communities.

Boundary spanning 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 OWA 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.

An organisation such as OWA may have greater success and increased organisational rigour if they consciously plan and evaluate their activities using Cash et al.'s (2006) framework. For the purposes of this report however, OWA SeaNet Officers who live and work in the area appear to have considerable legitimacy and credibility in the communities in which they work and were suitable for their roles in the FRDC Blueprint Communities project. The selection of this organisation to 'prepare' the community for interviews and to better understand what information is required for fishers and the wider community, has been positive. However, more support may be required for individual Officers. This can be assessed by better understanding the individual's perceptions of the topic as well as their view of the credibility, salience and legitimacy of climate change as a topic.

Appendix 3 Consultative extension analysis

This section provides a summary of findings from the climate change and adaptation extension work undertaken by OceanWatch Australia.

3.1 Highlights

Extending complex, contentious or difficult information such as climate change adaptation requires additional training, support and tools for the confident delivery of the information by extension providers

Communications with the seafood industry need to emphasise long-term environmental change in the first instance, rather than climate change, in order to eliminate any negative connotations

Climate change information should acknowledge any limitations of the science, while highlighting key changing climatic patterns and processes in the stakeholders' specific region

Whilst one-on-one delivery is the preferred method, materials for the seafood industry on climate change and adaptation can also be effective if produced in a variety of formats and levels of detail to enable knowledge uptake in a range of ways

Those extending information on climate change should be mindful of political aspects related to the topic, and alter their approach and language accordingly

Proactive implementation of climate change adaptation measures can be presented to industry as a means to maintain their social licence to operate

Extension personnel can influence the discussion as a result of their own bias, whether negative or positive. In the case of climate change science and adaptation, a negative bias reflected the norm within the industry target group, and was a healthy stimulus to overcoming barriers

3.2 Background

OWA is a national not-for-profit organisation that works to advance environmental, economic and social sustainability in the Australian seafood industry. It was established in 1989 by Peter Doyle AO, as it was recognised that the seafood industry's future was dependent upon the existence of a healthy marine environment especially in estuaries and coastal regions. Since then, OWA has grown and now works on projects around Australia with the seafood industry and coastal communities to find or introduce practical solutions to problems that affect the industry or coastal estuaries and environments.

OWA's key activities involve:

- Enhancing fish habitats and improving water quality in estuaries and coastal environments
- Working with industry and local communities to minimise adverse environmental impacts
- Introducing industry and communities to sustainable technologies and behaviours

In undertaking these activities, OWA works in partnership with the Australian seafood industry; federal, state, territory and local governments; natural resource managers; private enterprise; and local communities. OWA derives its funding from a range of sources, including government, seafood industry and the community.

Funded as a program by the commonwealth government and managed by OWA, SeaNet is an independent team of experts familiar with the seafood industry (and often from industry) able to assist seafood harvesters implement world's best practice in environmental performance and to find or introduce practical solutions to problems that affect the Seafood industry and coastal communities.

3.3 Introduction

Ocean Watch Australia was engaged by WAMSI to communicate and extend information for the two linked projects: FRDC 2011/535 known as the 'Knowledge' project and FRDC 2010/542 the 'Blueprint' project.

The communicating, extending and facilitating of this project proved challenging to OWA, not only as a new environmentally challenging subject, but also a highly political topic. The debate in the seafood community on the merits and challenges of climate change was mirrored within the OWA team, particularly as noting environmental change within the marine domain is not unusual within the seafood industry, but rarely attributed to climate change – even by government agencies.

3.4 Methods

For this project, three members of the SeaNet team were selected to work directly on the project. They were the Tasmanian, Western Australian and Northern Queensland members of the SeaNet team. These members were chosen as they worked in the three locations selected by the Blueprint Project to undertake the coastal case studies; St. Helens (Tasmania), Geraldton (Western Australia) and Bowen (Northern Queensland).

They were tasked with;

- Researching and understanding the nature of the seafood operations in the three regions. This involved discussions with fisheries managers on the active fisheries working within the regions selected, contact with the industry peak bodies and sector bodies on who the active fishermen were and what aquaculture operations were present. Discussion with industry representatives on key industry personnel, and documentation of this information for internal SeaNet reporting purposes
- Undertaking preliminary engagement visits
- Making connections within seafood community as well as the broader community, councils and natural resource management sector
- Facilitating the Blueprint project's community consultation research visits to the three regions
- Providing a link between the researchers and the seafood community representatives and those who were involved as interviewees
- Evaluating industry knowledge needs
- Facilitating the return visits
- Communicating the early results and providing feedback to stakeholders on project progress
- Surveying the seafood stakeholders on their climate change knowledge and attitudes

In addition, the wider OceanWatch team was also involved with communicating the messages of the allied FRDC/ DCCEE Fisheries and Aquaculture projects to a broader audience Australia-wide, and were also involved in a climate change adaptation workshop, which was broadly information driven.

3.4.1 Development of the extension methodology

For a number of years OWA projects and programs working with communities throughout Australia to foster sustainable behaviour have used the community-based social marketing approach to 'behaviour change' - in which all OWA staff are trained. This methodology draws heavily on research in social psychology, and indicates that initiatives to promote behaviour change are often most effective when they are carried out at the community level.

This is also an acknowledgement of the understanding that programs which rely heavily or exclusively on media advertising (such as government drink driving or stop smoking campaigns) can be effective in creating public awareness and understanding of issues, but are limited in their ability to foster behaviour change – which is OWA's goal.

Community-based social marketing is composed of four main steps:

1. uncovering benefits and barriers to behaviour change and then, based upon this information
2. selecting which behaviour to promote
3. designing a program to overcome the barriers to the selected behaviour
4. piloting the program; and then evaluating it once it is broadly implemented.

In order to develop suitable materials and assist with the extension plan (Attachment 2 Communication and Extension Plan), a priority action of the SeaNet team was to obtain understanding of the issues surrounding the topic of climate change adaptation which may affect the seafood stakeholder. Issues which were considered and their implications were investigated by the team in a workshop scenario (Appendix 1). Solutions were incorporated into the extension plan.

Following from issues understanding, the OWA team developed an understanding of what could be considered opportunities or barriers to the uptake of the information (Attachment 1 Benefits, Barriers and Implications for Information Uptake), the purpose of which was for the extension team to understand the conditions in which information does or does not get favourable treatment by the stakeholder. Using these points and their implications, the team developed the most appropriate approach to communicating with the seafood stakeholders and in assisting the project Principal Investigators and Post-Doctoral Fellows. For the purposes of this project the full 'behaviour change' program was not utilised, but the outputs are of value for similar projects and programs, and would serve this project well in further extension.

Early stages of the project, through visits, provided an opportunity for the SeaNet team to build relationships and trust in the three communities to be studies. It also gave SeaNet an ability to test the local seafood industry's appetite for climate change information and understand their specific information needs. The research synthesising data phase was the opportune time for the communications materials to be developed and prepared for dissemination. Feedback from the SeaNet team's experience of what communication methods works with this stakeholder, was added to the Blueprint survey's findings of what information would be valued by the fishers. The Knowledge Principal Investigator and the OWA SeaNet team compiled which products and materials would be the most effective modes of delivery (refer Appendix 5; Products and Delivery).

The SeaNet team was able to assist the Blueprint project to incorporate the OWA extension philosophy, 'extension is not the end product of the research, but a holistic element to aid the research planning, execution and results of a project'. SeaNet team were able to inform the researchers that to visit the three case study towns to gain knowledge and not return to showcase results as was originally planned – would greatly disappoint many stakeholders. As a consequence, a return visit element was added to the project program which included the researchers preparing a

presentation on early project results for the three locations. These results presentations were delivered in a variety of events, including a community presentation, gatherings at a wharf, on a one-on-one basis, or via the interactive DVD.

This final stage was an opportunity to gauge community climate change awareness, and test the increase in climate change adaptation understanding in these three coastal regions. This was done through anecdotal discussions and a stakeholder questionnaire.

An Extension Strategy document (Attachment 2 Communication and Extension Plan) was developed to guide the SeaNet officer's activities, and to provide a combined strategic direction and approach to all three regions. The document included; project objectives, goals and target audience and the development of project key messages.

During the roll-out phase of the project, the objectives were to;

- Encourage the stakeholder to be aware of climate change science information
- Motivate the stakeholder to participate and provide feedback
- Reassure the stakeholder that having strategies for adaptation will give them advantages

The strategy also included an action plan, identification of communication methods and project progress reports. In addition, the Extension strategy also identified the need to identify changes in understanding climate change information amongst industry stakeholders participating in the case studies.

3.4.2 Industry and community engagement

OWA were involved in developing the communication products with the Principal Investigator, and communicating the messages of the allied FRDC/DCCEE Fisheries and Aquaculture projects to a broader audience.

OWA's work involved disseminating information, raising community awareness and providing learning experiences to stakeholders. Stakeholders were engaged by involvement in the projects or by participating in on-ground works, workshops and tours, attending community events or though engagement with our touring educational displays. It was at these events that OceanWatch staff disseminated the produced materials. These regional events included community events, industry meetings, workshops and conferences throughout Australia during the project roll-out timeframe, as well as through port visits and industry on-going engagement activities (Attachment 5 OWA Community and Industry Engagement)

In addition, the interactive DVD, which was developed as a legacy product, and contained all the produced materials and related research papers was also distributed to relevant coastal council and natural resource management bodies, as these are the organisations charged with planning for the impacts of climate change and for developing adaptation measures.

3.4.3 Return visits survey

The SeaNet team developed a short questionnaire to be given to the industry stakeholders during the Blueprint project's return to the three case study areas.

The purpose of the questions was to understand the respondent's level of:

- Climate change knowledge - which would indicate whether an increase had taken place as a direct result of the engagement activity
- Ability to interpret the knowledge - which would indicate if they saw relevance to their daily lives
- Ability to consider adaptation measures – which would indicate that they were seeing value to the blueprint project
- Interest in gaining further knowledge – which would be an indication that the project has been able to overcome the barrier of climate change as a politicised topic

Questions relating to communication preferences were also posed. These were included in recognition that not all climate change adaptation projects in the future would be able to engage with communities at a grass-roots level, and therefore less personal engagement would be necessary.

The following 14 questions were given to the attending industry stakeholders to complete:

1. Did you participate in the Blueprint project interviews?
2. Do you think climate change is impacting your home/work/business/industry today?
3. If YES/MAYBE, is this impact positive or negative?
4. Do you think climate change will impact on your home/work/business/industry in the future?
5. If YES/MAYBE, do you think this impact will be positive or negative for you?
6. Have you identified any home/business decisions you can make to adapt your home/business to climate change?
7. If YES/MAYBE, what might they be?
8. Who would you seek assistance/help/advice from if climate change was impacting on your business?
9. How did you hear about the Climate Change Knowledge and the Blueprint projects?
10. How much has this project contributed to your climate change knowledge?
11. Has the climate change information delivered to you been relevant (useful) to you?
12. If YES/MAYBE, has it been tailored to the region where you live/operate?
13. Would you be interested in attending future events dealing with climate change or how to adapt to climate change?
14. In what way would you like this information delivered?

These questionnaires were distributed to the seafood industry members who attended the return visits to St Helens, Bowen and Geraldton by the Blueprint research team, and were made up from the original group initially surveyed. As the process was anonymous, it is estimated that approximately half the initially interviewed seafood stakeholders completed and returned the questionnaires to project staff.

3.5 Results and Discussion

The results and discussion are split into four components:

1. Facilitating community interviews for the Blueprint Project (FRDC/ 2010/542)
2. Evaluation of industry knowledge and needs
3. Return visit surveys for the Blueprint Project
4. Industry and community engagement activities.

3.5.1 Facilitating community interviews for the Blueprint Project

A total of 83 community interviews occurred with each interview lasting between 1-1.5 hours. Approximately half of these interviews were with fishers, aquaculture farmers or the seafood post-harvest sector. The remaining half comprised a range of community representatives.

The Blueprint team were comfortable with the approach taken by OWA for the community interviews in the three locations. The numbers and desired interviews were achieved, despite the restriction in interviewing time-frames and the range of sectors they were planning to interview.

St Helens

A total of 35 community interviews were carried out in St Helens, of which approximately half were with seafood industry personnel (fishers, aquaculture farmers or post-harvest personnel). The remainder were from tourism, recreational fishing tackle shop, retail, real-estate, education sectors and Local Council.

St Helens was the smallest town targeted by the project, with a higher than average proportion of people in the aquaculture and fishing industries. The SeaNet Officer for this location was a long-standing local resident, and was therefore already in contact and known to all key stakeholders.

Knowledge obtained by the Blueprint project indicated that St Helens is unique in the fact that it is in a marine hotspot, meaning that climate driven changes in the marine environment are happening relatively fast. The expectation of climatic change was clearly present in the interviews with the stakeholders, with many indicating their awareness of projects such as Redmap (Range Extension Database and Mapping Project which records sightings of marine species that are 'uncommon' to local seas. Over time, Redmap will use this 'citizen science' data to map Australian marine species that may be extending distribution ranges in response to changes in the marine environment, such as ocean warming).

Bowen

A total of 23 interviews were carried out in Bowen, of which half were with seafood industry (fishers, aquaculture farmers or post-harvest personnel), and the remainder were a mix of tourism, recreational fishing/tackle, retail, real estate, and restaurant sectors. Council and Educational stakeholders did not participate.

Bowen is a medium-sized coastal town, and has a higher than average proportion of people in the aquaculture and fishing industries. Reef line fishing, especially for coral trout, is the main commercial fishery in Bowen and prawns and barramundi form the backbone of land based aquaculture industries.

The commercial fleet in Bowen has fallen from over 80 at its peak in the 1960's to less than 10 active vessels currently remaining. There were many identified causes for the decline – including falling catch rates, rationalisation of the fleet and reduced abundance of target species. Climate change (or warming waters and ocean current changes) were mentioned, but survey respondents often found it difficult to attribute the abundance changes to climate change only. Not all believed there was a link between abundance and warming waters although most recognised that 'things' were happening out there.

In terms of engagement, the decline in the size of the fleet had led to less engagement by SeaNet in this location over the past 5 years. Therefore the SeaNet Officer's contacts were not extensive. The focus was to visit and re-establish contacts as quickly as possible.

These dramatic fleet reductions have occurred throughout Australia, however the downsizing occurring in Queensland and New South Wales seems to have left a residue of fear, isolation and sense of hopelessness in the fishing communities. SeaNet Officers regularly report on difficulties engaging these small communities. Pre-project time and effort is required to building-up confidence and trust between fishermen and extension Officers to fully access the experience of the fishermen – often outside the scope of the project.

In Bowen, the Officer reported that significant decline in the commercial fishing fleet and the fraught marine park zoning process has led to a fractured, suspicious community. Engagement was slow and had to be done on a one-on-one basis, to build trust between SeaNet Officers and the stakeholders. The officer made a number of trips to engage with the fishermen, but progress was slow, with the Officer reporting considerable difficulty in engaging fishermen on the topic. The outcome - whilst achieved satisfactorily did reflect the industry's disconnection within the community.

Geraldton

A total of 25 interviews were conducted in Geraldton, of which half were with seafood industry, and the remainder were a mix of recreational fishing/tackle, tourism, retail, accommodation, restaurants, education, and City Council.

Geraldton is a relatively large regional town at a just over 30,000 people and has traditionally been characterised as a fishing town. There is a noticeable impact from a decline in active local fishing boats over the last 4 years and associated marine industries such as slipway operators, vessel maintenance and marine chandlery as well as fish outlets, restaurants, and processing facilities.

In terms of engagement, the relatively new SeaNet Officer for WA had to rely on industry peak-body contacts in Geraldton. Visits were scheduled to meet the down-time of the fleet. However, scheduling meetings with fishers is always difficult, as they work as the weather permits. The Officer also reported that the community was displaying signs of consultation fatigue.

3.5.2 Evaluation of industry knowledge and needs

Information collated from the SeaNet Officer's monthly activity logs, indicate that a total of over 250 industry members were engaged through this project between 2012 and 2013. In addition, over 52,000 community members received information on climate change through attendance at community events/workshops/presentations/stall events and printed material displays throughout coastal Australia (Attachment 5 OWA Community and Industry Engagement).

The understanding of the drivers – benefits and barriers, allowed the team to modify the research approach, decide upon the most appropriate engagement activities and creation of appropriate material through analysis of industry knowledge needs.

Deciding upon the right mix of information materials was based upon; the relevant climate change information available to the three locations, the experience of the SeaNet team in understanding what works and what does not, as well as asking the fishermen participating in the initial engagement activities and during the Blueprint surveys what information they wanted and how they would like this information delivered.

Given that half the respondents surveyed would come back again for more knowledge, the choice of workshops and one-on-one engagement was deemed as the best way to deliver this information. However, given the prohibitive cost of workshops, the development of the DVD (Appendix 5, Attachment 4 Interactive DVD) was deemed most cost effective, accompanied by localised information leaflets and a specific PowerPoint presentation (Appendix 5, Attachment 2 Case Study Brochures, Attachment 3 PowerPoint Presentation Example). This knowledge was fed into the product development process.

3.5.3 Blueprint project: return visit surveys

A total of 17 fishermen, aquaculture farmers or seafood post-harvest personnel completed the return visit survey (St Helens, 6; Bowen, 3; Geraldton, 8). This is estimated to be approximately one-quarter of the original number surveyed as part of the Blueprint project.

It is recognised that the numbers of respondents are statistically low, and therefore the results are only a guide to attitudes and perceptions of the target group. However, given the difficulties anticipated by the SeaNet team to engage fishermen on the topic of Climate Change, the results are encouraging.

47% of respondents thought that climate change was impacting their home/work/business/industry today, with a further 23% believing the impact was negative and 61% not knowing if impact was positive or negative. Around half of respondents recognise that climate change is impacting their lives– with many seeing its impact as negative with over half unsure.

41% of respondents thought climate change would be impacting on their home/work/business/industry in the future, with 27% believing the impact to be negative. This trend of impacting and impacting negatively is expected to continue.

31% respondents had identified home/business decisions they can make to adapt their home/business to climate change. Example of respondents ideas of what these actions could be include:

- Accessing species previously unexploited
- Creating new business
- Species movement – buy different licence
- Trialling different species
- Different gear/different species
- Conserve energy, use solar

A third of respondents felt they have some strategies to cope – with many examples involving strategic changes as well as opportunistic changes, which reflects an industry which is used to seeing change and reacting to it.

The most popular choice for assistance/help/advice on business impacts from climate change was Government agencies (38%), followed by OWA (19%), and then Family/Friend (14%) and Other Fishermen (10%).

Respondents had an expectation that government should provide information, help and advice. OWA (88%) was the reason respondents were aware of the Climate Change information and the Blueprint projects.

OWA's role in the Blueprint project and Knowledge project in extending information has been of value and informed the stakeholders. 50% of respondents believed this project contributed some knowledge to their understanding of climate change, with a further 44% believed they had gained a lot of knowledge.

The Blueprint project has been informative and of value. 69% of respondents believed that the climate change information delivered had been relevant (useful) to them, with 81% believing the information had it been tailored to the region where they live/operate.

The Blueprint project has been informative and appropriate. 50% of respondents were interested in attending future events dealing with climate change or how to adapt to climate change, and a further 37% would maybe consider attending.

Half the respondents would come back again for more knowledge. 28% of respondents chose workshops as the preferred way to deliver this information, followed by one-on-one (23%), e-mail (19%), presentations (15%), telephone, (10%) and newsletter (5%).

Community workshop and one-on-one discussions are the engagement methods of choice for these stakeholders, however, other options such as DVDs and leaflets are also of value when practical and cost effective methods are required.

3.5.4 OceanWatch: industry and community engagement activities

Materials and Information Dissemination

As an environmental charity, OWA has a number of community engagement activities in the annual calendar. Attendance at these events was seen as a suitable vehicle for dissemination of the materials.

During the project roll-out, the SeaNet team, and the OWA staff attended the following activities where the climate change leaflets, resources and information from staff were available or presented.

Event	Number	Number of people engaged (approx.)
Field days	4	2,060
Tour	1	500
Presentations	19	2,600
Stand/Stalls	15	46,600
Workshops	1	70
Launch	1	40
Community events	7	80
Public displays	1	10
Working boat/camp visits	193	480

Port visits	101	Unknown
Total	**343**	**52,400**

Table 3 OWA staff activities

Due to the nature of the events it was not possible to assess the suitability of the materials apart from noting that materials were well received, and were distributed widely. The above events occurred throughout Australia, in metropolitan locations, as well as rural and remote locations.

The ***Seeing Change DVD – Climate related resources information for the marine environment,*** was developed by the Knowledge Project Principal Investigator and distributed by OWA staff (Appendix 5, Attachment 4 Interactive DVD, Attachment 3 Knowledge Project DVD Distribution List). As a legacy product, this contained all the produced materials and related research papers connected to the project.

OWA distributed the materials to relevant coastal council and natural resource management bodies located within the same state/regions as the case study locations (Attachment 4 OWA Letter to Coastal NRM Groups). All the coastal regional Natural Resource Management (NRM) Groups in Queensland, Western Australia, and Tasmania have received the DVD, along with the planning departments for coastal local councils. The reason these organisations have been targeted is because they are the organisations which are required to develop regional climate change adaptation plans. A number of the targeted Councils and some of the NRM groups have since expressed keen interest to receive further information on the Blueprint Project and other project outcomes when completed. Once the Blueprint project is completed, it is expected a 7 Step Approach to developing a Blueprint will be made public and available to encourage analysis to occur in other towns and locations around Australia.

3.6 Conclusions

The project proved challenging for OWA, not only as a complex environmental subject, but also a highly political topic, particularly with regard to the causes of climate change and the role of humans. However, for the sample of fishers involved in the knowledge project, their change in attitude was notable during the return visits. They were particularly keen for more localised knowledge, which indicates that this sector may be interested in further information on adaptation measures which they can implement.

People engaged in sea-based commercial activities, such as commercial fishing, have observed environmental changes over time as part of their operations. However, those changes have not necessarily been understood as climate change signals. Therefore, this project provided background information for seafood people to better understand the environmental changes they witness in a climate change context.

In some of the study areas, such as Bowen and Geraldton, livelihood adaptation has already occurred within the fishing industry due to capacity reduction. This demonstrates that some local communities have already undergone economic changes. Such conditions may make those communities more resilient and able to undergo similar processes to adapt to climate change. These conditions have already created outcomes for further climate change adaptation. For example, St Helens has recently seen the flourishing of a whole new industry as a result of range expansion of a sea urchin species.

Through this project there has been a considerable improvement in the understanding of climate change by the fishers participating in the project with a majority of participants responding to the return visit questionnaire believing that the climate change information delivered had been relevant and useful. Climate change perceptions by local commercial fishing operators may also have shifted with a third of the return visit respondents able to identify actions or decisions they could make to adapt to climate change.

The knowledge developed could also better equip managers and policy makers to design communication plans aimed at delivering climate change adaptation information. The information arising from this project indicates that climate change adaptation will only be possible through a mix of bottom-up and top-down approaches. For instance, fishermen may become aware of environmental changes before fisheries management. As a consequence, fisheries management will need flexible frameworks to allow modifications of fishing operations in response to climate change.

Attachment 1 Benefits, Barriers and Implications for Information Uptake

Benefits to information uptake		Barriers to information uptake	
Fishers will proactively undertake changes to their business to ensure they can secure resource access within the boundaries of the regulatory framework within which they operate. Under a climate change scenario this could mean current quota adjustments, changes to target species or shifts of fishing grounds.	*Implications:* Communications need to show how adapting to climate change will affect fishermen securing resource access and how they could be assisted if this was an issue.	Fishers are reluctant to adopt any changes to their fishing businesses or practices if those will attract costs that out-weigh the benefit.	*Implications:* Communications need to show how they can incorporate best practice in their current activities, with minimal effort and cost.
Due to the competitive nature of fishing businesses, fishers often keep a 'watching brief' on others within the industry, in particular to those who adopt changes, which can include targeting different fish species with a higher market value. Fishers will also seek advice from respected peers -often 'industry leaders' or fish processors- for making decisions relating to their businesses, that is 'wharf talk' rules (informal engagement).	*Implications:* Need to ensure that 'opinion formers' are part of the Communication Plan, as well as harness the positive effects of 'peer pressure' through social facilitation.	The industry is highly fragmented, making it difficult to communicate relevant messages with all industry participants using one method or tool.	*Implications:* Communications need to take into account the different types of fishers from different sectors and tailor their messages accordingly.
Fishers are the 'canaries' of the estuaries and ocean and are often the first to detect changes to habitats or marine species present.	*Implications:* Fishers are often the first to detect changes in the marine environment and their views could be regularly	It is almost impossible to get every fisher into a single room for a workshop or meeting as they have obligations and time constraints when running a business at sea.	*Implications:* Consideration of the fishery, fishing season and methodology is crucial when communicating.

	sought and shared with the scientific community.
Fishers have a good understanding of what the physical environment within which they operate contains in terms of species and are aware that the marine environment is highly dynamic.	*Implications:* Information should be provided on how climate change will affect their local fishing grounds, including species composition turnover and whether fisheries management will have a flexible framework to adjust harvest strategies to novel conditions.

	Time of the year, day of the week and time of the day are all important when organising meetings.
Many in the community, including fishers, are reluctant to speak out and discuss issues in a large group or at a workshop.	*Implications:* One-on-one communication or communication with a small group is often the most effective engagement method.
Each project case study site incorporates a variety of different fisheries making it difficult to get fishers all together at once.	*Implications:* Individual visits and one-on-one communication or communication with a small group is often the most effective approach.
Contentious and politically polarised topics such as climate change can be difficult to discuss in large groups.	*Implications:* One-on-one communication or communication with a small group is often the most effective approach.
All fishers have different approaches and generally don't like to be lumped together.	*Implications:* Individual personalised visits where information can be shared is often the best way to communicate.

		Many fishers within industry are time poor which constrains the possibility of attending meetings or reading lengthy and complicated information.	*Implications*: Communications to the fishing industry should be personalised and include materials that are very graphic with little text.
		Some community members, including fishers, are constrained in literacy and numeracy.	*Implications*: Communications should be personalised and include materials that are graphic with limited text.
		Some fisheries have fishers whose first language is not English, which limits their capacity to receive information.	*Implications*: Materials developed to engage industry should be multi-lingual depending on the fishery.
		Fishermen are sometimes reluctant to participate in research projects as they have been engaged in the past with no extension or clear follow-up benefits.	*Implications*: Research projects engaging the fishing industry should have clear mechanisms of extension to demonstrate benefits to research participants and the industry.
		Disclosure of information by fishers has sometimes resulted in restrictions to resource access, creating mistrust in the relationship between industry, researchers and government.	*Implications*: Any engagement with the fishing industry for research purposes should have clear and transparent objectives. In this regard, using fisheries extension to create an individual rapport

				and trust with fishers can lead to improved engagement, uptake, and confidence of the information delivered.
			Many fishers are apathetic to information provided as fisheries management and government agencies are known to send out overwhelming volumes of information to industry.	*Implications*: Communications need to use materials that are relevant, avoid replication, and be delivered in a timely manner to industry.
			Competing pressing issues that may jeopardise resource access more immediately generally deviate the attention from extension processes. For example changes to fisheries regulations and the establishment of Marine Protected Areas attracts industry attention for consultation preventing them from engaging in receiving information on other topics such as climate change.	*Implications* Any extension of information about climate change to the fishing industry should consider the current pressures and political climate, in order to tailor the schedule.
			Adaptation to climate change can be an abstract concept, which may have precluded effective dissemination and uptake of information. It can be difficult to understand how climate change will impact remote coastal communities.	*Implications:* Information delivered to coastal communities should be specific about how climate change may affect them, and adaptation should be presented as a set of pragmatic strategies or actions.

Attachment 2 Communication and Extension Plan

FRDC Project 2011/503

Climate Change Adaptation - Building Community and Industry Knowledge

Communication & Extension Plan

Phase 5 & 6 SeaNet Action Plan

Version 2 November 2012

Version 1 November 2011

Project Progress

The Blueprint Projects has visited the 3 Australian regions; south west (Geraldton, WA), south east (St Helens, Tasmania) and the tropics (Bowen, QLD) and the researchers are synthesising data to better understand community and industry needs and provide information and opportunities for climate change knowledge and adaptation strategies, in order to report back and develop a blueprint template as a legacy product.

In extension terms, the final two phases of the project are the most significant in leading to the desired outcomes to - ***Increased knowledge and understanding of climate change and adaptation measures for coastal fishing communities***.

Early Phases (Research visits) of the project have provided an opportunity for the Extension team to build relationships and trust in the three communities studied.

The research synthesising data phase is the opportunity for the communications materials to be developed and prepared for dissemination

The final phase is when the relationships developed by SeaNet/research team can be used to encourage community climate change awareness, and increase climate change adaptation understanding in these three coastal regions. In short to focus on educating (encourage to be aware of climate change science information), to motivate (to participate and provide feedback) and to reassure (that having strategies for adaptation will give them advantages).

In preparation for return visits to extend the research outcomes to the communities studied, and to further disseminate relevant NCCARF supported Climate Change project information to these communities, and updated SeaNet Action Plan for Phase 5 & 6 has been developed to guide the output extension requirements and for the final phases of the project .

Project Objectives

- Increased knowledge and understanding of likely climate change and adaptation measures available to regional communities
- Support of case study that cross correlates regional needs with Australia-wide policy and management policies
- Tailoring extension and knowledge for regional needs
- Synthesizing, analysing & assisting in the context of external drivers to marine biodiversity and fisheries business

Project Goal

- Increased knowledge and understanding of climate change and adaptation measures for coastal fishing communities

Target Audiences

The groups of people to communicate with include;

- Key organisational stakeholders
- Industry
- Community

Key Organisational Stakeholders (WA examples)	Possible contact or representative (WA examples)	Task responsibility & timeframe
Department of Fisheries (as appropriate in each State)	e.g. WA: DoF CEO - Stuart Smith, Heather Brayford, Rae Burrows. DoF Regional Manager – Ron Shepard DoF Research – Rick Fletcher, Nick Caputi, Dan Gaughan	Shaw
Fisheries Research and Development Organisation CEO & Board	CEO – Patrick Hone Board - various	Creighton
WAMSI (internal)	CEO - Steve Blake Board Chair – Peter Rogers	Shaw

Representative fishing organisations (as appropriate in each State)	e.g. WA: WAFIC CEO – Guy Leyland, WAFIC Chair – Brad Adams ProWest Editor – Jo Ledger WRLC – ACWA -	Shaw & Shoesmith
Recreational fishing organisations (as appropriate in each State)	WA: Recfishwest – Frank Prokrop	Shaw & Shoesmith
OceanWatch (internal)	CEO - Lowri Pryce Chair – Brad Warren	Shaw
Seafood CRC	Alexandra McManus & Janet Howieson	Shaw

Industry (WA examples)	Possible contact or representative (WA examples)	Task responsibility & timeframe
Local fishing organisations (as appropriate - in each State)	WA: Geraldton PFA - WA: Dongara PFA – Bruce Cockman	Shaw & Shoesmith
Industry leaders - rock lobster		Shoesmith
Industry leaders - other finfish		Shoesmith
Industry leaders – aquaculture		Shoesmith
WINSC	President: Mary Howard WA Director: Leonie Noble	Shaw
Fishers – professional		Shoesmith
Fishers – recreational		Shoesmith
Fishers – indigenous		
Small businesses – fishing tackle shops	Geraldton	Shoesmith
Small businesses – bait & boat bits		Shoesmith
Small businesses – boat manufacturing		Shoesmith
Small businesses - local processors	WA: Geraldton Fisherman's Co-op	Shoesmith

Community (WA examples)	Possible contact or representative	Task responsibility & timeframe
WA Northern Agricultural Catchment Council	CEO - Shelley Spriggs Coastal Coordinator – Ashley Robb	Shaw
Friends of the Abrolhos	Leonie Noble	Shaw
City of Geraldton Greenough	Mayor & CEO	Shaw
2029 and Beyond (G/G Climate of Opportunity)	Director Creative Communities – Andrea Selvey	Shaw
Geraldton Community Champions	Project Coordinator – Jackie Stanger	Shaw
Geraldton Guardian	Editor in Chief	Shaw
Geraldton Deliberative Democracy Project	CU Project Leader - Janet Hartz-Karp	Shaw

Key Messages

- This project will build an understanding of climate change science and adaptation opportunities for fishers and coastal communities
- This national project will focus on Geraldton WA, Bowen QLD and St Helen's TAS
- Climate Change is already occurring
    - WA experienced record sea surface temperatures in February this year, resulting in significant fish and invertebrate deaths in the south-west of Australia
    - Sea levels along the west coast of WA have been rising at more than double the global average
- Understanding climate science will give fishers a better opportunity to adapt their business
- Understanding climate science will provide the basis for better fisheries policy and management decisions
- Accurate climate forecasting will improve fisher profitability
- Mitigation can be an opportunity for everyone

The Key Messages (above) require further development. In the roll-out of the project we are hoping to;

1. educate (encourage to be aware of climate change science information)
2. motivate (to participate and provide feedback)
3. reassure (that having strategies for adaptation will give them advantages)

Project Methods

(P = phase) The adjusted timeline will be confirmed Hobart 2012

- P1 Review (literature) [Feb 12]
- P1 Logistics (appoint & brief Extension Officers) [2011]
- P1 Stakeholder consultation (in each region) [2011]
- P2 Operational planning (Hobart workshop) [Feb 12]
- P2 Operational planning (regional focus) [Feb 12]
- P3 Case Study 1 (St Helens) [Jan12 -Mar12]
- P4 Case Study 2 (Geraldton, after review St Helens) [May/Jun 12]
- P4 Communication & extension (prelim findings +other projects) [Jun 12]
- P5 Case Study 3 (Bowen) [Sept 12]
- P5 Communication & extension (findings) [July 13]
- P6 Analysis & write up [August 13]

Action Plan and Communication Methods

It is important when communicating with fishers to build trust and relationships. It is valuable to listen to issues raised, focus on the language used and synthesise information so that it is easily digested and understood. The subject material should be relevant to their businesses and the information personalised. Any opportunities that participation may provide should be stressed.

The format is also important as is the way scientific information is synthesised and translated. Below are some of the communication methods that are being utilised in this project.

Communication methods

- Face to face conversations
- Talking at fisher meetings
- Articles for Fishers
- Magazine articles (Prowest, FISH, WA Fish eNews, Western Fisheries, SSA, OceanWatch)
- Media releases
- Local and Community Newspapers
- Launch legacy document
- Websites (Climate Commission, NCCARF, OceanWatch),
- Weblinks (Coastal Series in Geraldton)
- Pamphlets and Brochures (FRDC, CC; The Critical Decade, NCCARF newsletters and pamphlets)
- CD ROM
- Exhibitions
- Conferences
- Promotional materials and icebreakers (clever T-shirts, practical e.g. cooler bags, stubby holders). Good icebreakers and rewards or incentives for participation.
- Presentation (Conferences, Meetings)
- Briefing notes
- Facebook

SeaNet Extension Plan

Extension Outputs:

To date, much of the extension outputs of SeaNet has focussed on servicing the needs of the project FRDC 2010/542: Climate Change Adaptation: blueprint for coastal communities.

St Helens Action Plan

Communication method	Objective	Target audience	Responsibility
Face-to- face briefings and presentations, and DVD giveaways	Report back on research Provide requested data	St Helens fishermen St Helens Community	Tasmanian SeaNet Officer
Presentations, articles and briefings to Board of Directors/Steering Committees/Reference Groups		Tasmanian Sector/Industry Peak Bodies	
Briefings and project flyers		Tasmanian Government (DPI, Environment, Education)	
Presentation, briefings and project information + Launch of Internet tool		St Helens Council	
Presentation, briefings and project information		Research Providers	
Seafood Industry Partnerships in Schools Project	Information on climate change	Education Sector/Schools Seafood Industry Partnerships in Schools Project	
Presentations and briefings	Report on research	Catchment Groups	

Bowen Action Plan

Communication method	Objective	Target audience	Responsibility
Face-to- face briefings and presentations, and DVD giveaways	Report back on research Provide requested data	Bowen fishermen Bowen Community	Queensland SeaNet Officer
Presentations, articles and briefings to Board of Directors/Steering Committees/Reference Groups		Queensland Sector/Industry Peak Bodies	
Briefings and project flyers		Queensland Government (Q DAFF, Environment, Education)	
Presentation, briefings and project information + Launch of Internet tool		Bowen Council	
Presentation, briefings and project information		Research Providers	
Material distribution	Information on climate change	Education Sector/ Schools Project e.g. Reef Guardian Schools	
Presentations and briefings	Report on research	Catchment Groups	

Geraldton Action Plan

Communication method	Objective	Target audience	Responsibility
Face-to- face briefings and presentations, and DVD giveaways	Report back on research Provide requested data	Geraldton fishermen Geraldton Community	PI & Western Australian SeaNet Officer
Presentations, articles and briefings to Board of Directors/Steering Committees/Reference Groups		WA Sector/Industry Peak Bodies	
Briefings and project flyers		WA Government	
Presentation, briefings and project information + Launch of legacy document		Geraldton Council	
Presentation, briefings and project information		Research Providers	
Materials distribution	Information on climate change	Education Sector/ Making Waves Project	
Presentations and briefings	Report on research	Catchment Groups	

Monitoring and Evaluation

Monitoring on climate change awareness, will be carried out by the distribution of one page questionnaires at briefings, presentations and engagements in phases 5 & 6. These questionnaires will evaluated the increased knowledge and understanding of climate change and adaptation measures of the returning industry participants in the three coastal fishing communities.

Attachment 3 Knowledge Project DVD Distribution List

Western Australia	Regional NRM Bodies (Coastal)	Local Councils (Coastal)
	- Northern Agricultural NRM region - Rangelands NRM region - South Coast NRM region - South West NRM region - Swan NRM region	- Shire of Exmouth - Shire of Carnarvon - Shire of Shark Bay - Shire of Northampton - Shire of Chapman Valley - City of Geraldton-Greenough - Shire of Irwin
Queensland	Regional NRM Bodies (Coastal)	Local Councils (Coastal)
	- Burdekin NRM region - Burnett Mary NRM region - Cape York Peninsula NRM region - Fitzroy NRM region - Northern Gulf NRM region - Mackay Whitsunday NRM region - South East Queensland NRM region - Southern Gulf NRM region - Wet Tropics NRM region	- Cairns Regional Council - Cassowary Coast Regional Council - Hinchinbrook Shire Council - Townsville City Council - Burdekin Shire Council - Whitsunday Regional Council - Rockhampton Regional Council - Gladstone Regional Council
Tasmania	Regional NRM Bodies (Coastal)	Local Councils Coastal)
	- NRM South Region - NRM North Region - NRM West Region	- Break O'Day Council - Dorset Council - Glamorgan-Spring Bay Council - George Town Council - Launceston Council - West Tamar Council - La Trobe Council - Devonport Council - Central Coast Council - Burnie Council

Attachment 4 OWA Letter to Coastal NRM Groups

OCEANWATCH AUSTRALIA

HEALTHY CATCHMENTS HEALTHY OCEANS

23 July 2013

Scott Hardy
Executive Manager – Community and Environment
Whitsunday Regional Council
PO Box 104
Proserpine QLD 4800
AUSTRALIA

Dear Mr Hardy,

RE: Change in coastal fishing communities: Bowen Queensland

Over the past 18 months, industry extension staff from OceanWatch Australia have been involved in a research project in Bowen (also Geraldton - WA and St. Helens - TAS) in connection with Climate Change Adaptation strategies for coastal communities.

This project is now coming to fruition and I believe you may be interested in hearing about it.

The project has already produced resources (which I enclose) to enable councils and/or NRM groups to develop Adaptation Strategies using the University of Tasmania/James Cook University and Western Australian Marine Science Institution methodologies. It is the intention of the project, in its final few months, to develop a legacy document, as a blueprint, to assist Council in the next stage of Adaptation.

If you or any of your staff would like further information, I can be contacted on 02 96602262 or by email Lowri@oceanwatch.org.au

Yours sincerely,

Lowri Pryce
Executive Officer
OceanWatch Australia

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AUSTRALIA

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ABN 86 073 195 901
ACN 073 195 901

SEANET
SMARTER FISHING FOR INDUSTRY
TIDE TO TABLE
RESTORING AQUATIC HABITAT

www.oceanwatch.org.au

Attachment 5 OWA Community and Industry Engagement

OceanWatch National Community and Industry Engagement Activities 2012-13
Climate Change Adaptation Project

Loaves and Fishes BBQ	New South Wales	2012	Field day	800
Oyster Field Day	New South Wales	2012	Field day	160
Sydney Fish Market Tours	New South Wales	2012	Tour	500
Pallarenda beach and Mangrove marine debris	Queensland	2012	Presentation	90
Burnett Mary Regional Group show case	Queensland	2012	Presentation	150
Blokes against breast cancer	South Australia	2012	Presentation	600
School presentations	Tasmania	2012	Presentation	20
Victorian Royal Agricultural Society	Victoria	2012	Stand	15000
Oysters in the House	New South Wales	2012	Stand	400
Hervey Bay Seafood Festival	Queensland	2012	Stand	1200
Tin Can Bay Seafood Festival	Queensland	2012	Stand	9000
Darwin Careers Expo	Northern Territory	2012	Stand	2500
Sustainable Local Seafood Promotion	Northern Territory	2012	Presentation	450
Barra Beef and Bulldust Expo	Queensland	2012	Presentation	500
Creekwatch Community Day	Queensland	2012	Stand	90
Schools Eco Challenge	Queensland	2012	Presentation	50
Fishshute	South Australia	2012	Presentation	35
Tribuanna Seafest	Tasmania	2012	Stand	700
Seafood Industry Partnerships in Schools	Tasmania	2012	Workshop	66
Cranbrook school fishing day	Queensland	2012	Presentation	100
Tide to Table/SeaNet work promotion	Queensland	2012	Presentation	79
Maritime museum holiday program	Tasmania	2012	Presentation	65
Probus club	Tasmania	2012	Presentation	113
Narweena School Festival	Tasmania	2012	Presentation	90
Royal Melbourne Show	Victoria	2012	Stand	1000
Darwin Harbour Advisory Committee presentation	Northern Territory	2012	Presentation	16
SeaNet presentation at Indigenous Marine Ranger training	Western Australia	2012	Presentation	12
Reef Guardian Annual Networking Meeting	Queensland	2012	Stand	60
Victorian National Parks Association (VNPA) Marine Parks Symposium	Victoria	2012	Presentation	35
Seafarers Festival	Tasmania	2012	Stand	200
Seafarers Multicultural festival	Victoria	2013	Stand	150
Loaves and Fishes BBQ	New South Wales	2013	Field day	800
Schools eco challenge	Queensland	2013	Presentation	70
Hervey Bay Seafood Festival	Queensland	2013	Stand	10000
Tin Can Bay Seafood Festival	Queensland	2013	Stand	6000
Seafest Festival	Tasmania	2013	Stand	200
Wallis Lakes Open Day	New South Wales	2013	Presentation	60
Trawl vessel EMS ministerial launch	New South Wales	2013	Launch	40
San Remo Fishing festival	Victoria	2013	Stand	60
Loaves and Fishes BBQ	Queensland	2013	Field day	300
Indo Pacific Marine "Sustainable Seas" display	Northern Territory	2013	Presentation	63
Prawn By-catch Reduction Device workshop with industry and community	New South Wales	2012	Community event	15
Moreton Bay Connectivity Tour	Queensland	2012	Community event	16
Primary Industry Centre for Science Education (University of the Sunshine Coast)	Queensland	2012	Community event	30
State of our Sea Symposium	Queensland	2012	Community event	15
What a SeaNet officer does	Queensland	2012	Community event	2
Quick Response code Project – videos on the Moreton Bay tunnel netters, species in	Queensland	2012	Video/Brochures	50
Connectivity tour – including Tide to Table and what does a SeaNet officer do?	Queensland	2012	Community event	50
Loaves and Fishes BBQ	New South Wales	2013	Community event	8
Darwin Harbour Clean-up	Northern Territory	2013	Media	15
Indo Pacific Marine Aquarium Display	Northern Territory	2013	Public display	6
Industry videos highlighting sustainability and wildlife protection	Northern Territory	2013	Video	12
Port Philip Bay clean-up	Victoria	2013	Media	1
				52044

Also

	Working boat trips/Camp visits	Number of seafood producers engage
Year 3 (2012)	146	313
Year 4 (2013)	47	165
Total	**193**	**478**

Port Visits

2012	?
2013	97

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.

4.1 Highlights

Environmental change consistent with climate predictions have been observed by fishers and measured by scientists at the Abrolhos Islands

Management responses to protect the stocks significantly reduced catch, effort and fishers. The social cost has been high, with community collapse on some Islands

Linkages among climatic, environmental, management, economic and social changes were described and communicated back to the fishing community using the fisher's own photographs to tell their story

Participation is important for knowledge building and attitudinal change

Photovoice is an effective methodology to give voice to a community

The exhibition 'Seeing Change: a photographic story from Abrolhos fishers' personalised this climate story on many levels, engaging fishers, local community and visitors from around Australia and overseas

In the exhibition, the climate change message was subtle, however the techniques employed were complex and effective in enabling visitors to reach conclusions in their own time

This multi-dimensional community exhibition appeared to be successful in building knowledge of climate change and adaptation in the industry and community

4.2 Background

The south west 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 degree over the past 50 years (Pearce and Feng, 2007). A recent 'marine heat wave' (Fisheries Department, 2011; Feng et al., 2013; Pearce et al., 2011) resulting in extensive fish and invertebrate kills has increased the focus of the fishing industry, research scientists, fishery managers and the community on the impacts of climate change. The effect of these changes is of concern, particularly in areas such as the Abrolhos Islands, a group of low lying islands approximately 70km off the coast of Geraldton where commercial fishing is at the centre of the social and economic life of the community. As fishers are considered 'traditionally resistant' to change; new and innovative methods are needed to facilitate the uptake of climate change science and adaptation strategies.

The project study area, the Houtman Abrolhos Islands, is 'the heart' of Australia's largest and most valuable single species fishery, the Western Rock Lobster Fishery (de Lestang et al., 2012). The islands have a long fishing history and in some cases fishing licences have been handed down over three and four generations (L. Noble, pers comm).

In Western Australia from 2006 to 2012 there has been a very low rate of settlement of post-larval rock lobsters (de Lestang et al., 2012; Brown 2009; Caputi, 2008), which appears to be climate driven

(Caputi et al., 2010). Long term climate changes that may have contributed to the larval decline include increased sea temperatures leading to early spawning, and a decline in winter storms that facilitate larval return and settlement into coastal habitats (de Lestang et al., 2012; de Lestang et al., 2013).

As a result of the low puerulus settlement, there was strong management intervention to protect the stocks with significant catch and effort reductions imposed across the entire fishery. The catch and number of active fishing licences has effectively been halved between 2006 and 2012 (Department of Fisheries 2008; Fisheries WA, 2010; de Lestang et al., 2012, 2013). A different style of management was also introduced (catch quota management) and the fishing season was extended from 3.5 to 12 months (de Lestang et al., 2013).

These combined factors have changed the way people fished. Many fishers have exited the industry, making the decision to sell or lease their licences (unit entitlement). The fishers who remained in the fishery at the Abrolhos Islands have adapted by buying units from other fishers to remain viable; and/or altering their pattern of fishing so that they fish to price, coming to the Islands only when the price is high; and/or supplementing their income with alternative livelihoods. As a result, there are now few people on the islands at any one time; all schools, clubs and sporting events have shut down.

Impacts from climate change are already being measured in the marine environment (Climate Commission, 2011) and changes observed (Feng et al., 2013; Abdo et al., 2012; Caputi et al., 2010; Pecl et al., 2009). However, little has been done to effectively communicate relevant, regionally specific information or better understand the observations of fishers and possible adaptation strategies in the context of their industry. This section describes an innovative method to increase understanding and uptake of these complex issues, while focusing on the values of the fishing community and the changes fishers are experiencing.

Photovoice is a visual research method which has been used previously for communities to explore the threats and impacts of climate change and rising sea levels on coastal communities (Baldwin and Chandler, 2010; Chandler and Baldwin, 2010). This methodology is a particularly powerful tool for illustrating change (Baldwin and Chandler, 2010), giving voice to significant community issues (Wang and Burris, 1997; Baldwin et al., 2012), building consensus (Baldwin and Ross, 2012) and capturing values and demonstrating these values to the broader community (Baldwin and Chandler, 2010).

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

The innovative method was chosen as a powerful alternative way for fishers to express their collective views about changes they are currently experiencing in their fishing communities. It was also used to increase understanding and uptake of climate change knowledge and look at some of the ways fishers are adapting to these changes. This sub-project was designed and undertaken in one of Australia's iconic fishing communities; the Houtman Abrolhos Islands. The predominantly rock

lobster fishing community was chosen within one of the three national project Case Study areas - Geraldton in Western Australia.

This methodology formed the basis of the project which resulted in community exhibitions in a number of important coastal fishing centres in Western Australia; Geraldton, Albany and Fremantle.

4.3 Aims and Objectives

The aim of the project was to build industry and community knowledge of climate change and adaptation. The FRDC objectives for the project included;

- increasing knowledge and understanding of likely climate change and adaptation measures open to local communities
- tailoring the extension and knowledge sharing for regional needs
- synthesising, analysing and assisting in adaptation of key climate change information, in the context of external drivers to marine biodiversity and fisheries business

The project had a number of more specific objectives including:

- developing heightened fisher and community understanding of climate change science and possible adaptation strategies
- creating an understanding of the drivers of changes currently being experienced in the Abrolhos Islands fishing community
- encouraging a shared understanding of the values and issues affecting the islands, the fishery and the community
- facilitating a greater dialogue and linkages among fishers, scientists, the community and in the longer term – managers and policy makers
- identifying adaptation strategies being taken up by an industry that may already be experiencing climate change impacts
- giving voice to fishers' strong community values and sense of place at the iconic Houtman Abrolhos Islands
- evaluating if the Photovoice methodology is a useful method to increase understanding and knowledge uptake of climate change.

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 18). 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 19; 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.

4.5 Results and Discussion

4.5.1 Fishers observing change

An estimated 98% of fishers on the Islands attended the workshops on 'Climate change effects on WA fisheries' and 'Coral reefs in a changing environment'. From the surveys, most of these fishers (71%) had observed environmental change, although fewer (58%) thought 'the climate was changing'.

This outcome was consistent with the views expressed by OceanWatch Australia (OWA) in that most had observed or were aware of changes to the marine environment, but fewer believed that the 'climate was changing'. By contrast, while WINSC Directors had also observed environmental change, a much larger proportion (82%) believed that climate change was happening and most (73%) attributed it to humans. Interestingly, the perception WINSC Directors attributed to industry was similar to that reflected by the Abrolhos fishers.

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. Some of those 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 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
- increased numbers of birds on some islands (likely from removal of cats)
- 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 events

4.5.2 Scientists recording change

The Department of Fisheries WA (DoF) provided logistical and data support for the project which assisted in shaping the story for the exhibition, book and CD. The data will be used in future journal publications. The following information is included for completion and more detailed information can be found in 'Background' at the start of this Appendix (4.2) and in other studies (de Lestang et al., 2012 and 2013; Brown, 2009; Caputi, 2008).

DoF has monitored changes in rock lobster ecology and other environmental parameters over a long period of time and developed extensive time series data sets. Using these data sets, DoF and CSIRO have historically been able to accurately predict the catch of rock lobsters by the number of larvae (puerulus) settling along the coast. The annual variation was previously linked to the strength of the Leeuwin Current. Simplistically, a strong Leeuwin Current resulted in higher numbers of puerulus and greater numbers of rock lobsters in three to four years' time. In 2006 there was a significant decline in the puerulus settlement. Although originally thought to be caused by over-fishing, it appears to be due to long term environmental change consistent with climate change predictions.

4.5.3 Management responses

As a result of the low puerulus settlement, there was swift management intervention to protect the breeding stocks and allow carry-over for future spawning. A reduction in effort of approximately 50-70% across the entire fishery also reduced the number of fishers by a similar amount. In the Abrolhos Islands in 2006 there were 128 Managed Fishing Licences (MFLs); by 2012 this had reduced to 74. The corresponding catch of 2,076t reduced to 894t (TAC). Another significant management change was the move to quota management in 2010 (Fisheries WA, 2010). This has resulted in an extension of the fishing season at the Abrolhos Islands from 3.5 months in 2006 to 12 months in 2013. This change has significantly changed the way people fish (G.Finlay, pers comm).

4.5.4 Economic outcomes

Other factors, in combination with the fisheries management changes, have also influenced fishing patterns. For example, fishers have experienced increases in costs of production, such as fuel and labour prices, and changes in export conditions due to a high Australian dollar and international economic instability.

The management changes to the industry have resulted in economic 'winners' and 'losers'. Many fishers have exited the industry, making the decision to sell or lease their licences (unit entitlement). Those who remained in the fishery at the Abrolhos Islands have adapted by buying units from other fishers to remain viable; and/or altering their pattern of fishing so that they fish to the market price, coming to the Islands only when the price is high; and/or supplementing their income with alternative livelihoods.

Prior to the management changes in 2006 and the introduction of quota management, the number of rock lobsters caught in each pot (CPUE or catch per pot lift) was consistent. However after the management changes the numbers have steadily increased (1.6kg to approx 4.5kg) and the fishery is operating at close to maximum economic yield (Reid, 2009). The average price per kilo has also increased ($28.50 to $36.33) (M.Rossbach, pers comm). In 2013 the price for rock lobster reached $90/ kg (L.Noble, pers comm).

4.5.5 Social change

The changes in the fishery have caused major changes to fishing behaviour and as a result, the social structure and dynamics of the Abrolhos Islands fishing community has also been significantly altered.

In contrast to a generally regular and constant residence in the islands during a limited fishing season, the fishers presence is sporadic over the now longer, year-round season; fishing to the market price and in some cases, alternating their fishing with other employment. As a result, there are now few people on the islands at any one time. In 2006 there were 128 camps or active accommodation units. Each camp could include up to three dwellings for crews and families. 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 74 active camps and an estimated 150 people (G. Finlay, pers comm).

Despite all the environmental, management and economic changes observed and discussed in workshops, surveys and interviews, the most important change emphasised by stakeholders was related to people and social changes experienced from a reduced community on the Islands.

4.5.6 Community values

The community expressed their values in the workshops, surveys and interviews and also in the photos they submitted for the exhibition. The community's numerous and varied values were broadly grouped into social, cultural, economic and environmental categories.

Social values

The social fabric of the community had been built up over three and four generations, and was characterised by a very strong attachment to place and a community identity based on the fishing industry. Many fishers spoke of their fathers and grandfathers who preceded them in the industry and what it was like to 'grow up on the Abrolhos.' Families lived on the Islands during the fishing season and children attended the five schools operating on the larger Islands.

The community structure was described as supportive and active with five community halls operating throughout the season. Festivals were celebrated and there was a range of sporting events. Inter-island sporting rivalry was high and the AFL (Abrolhos Football League) was in place long before the national AFL (Australian Football League) was named. The commemoration for ANZAC Day and customary '2-up' games were important social events.

Cultural values

The community at the Abrolhos Islands appears culturally diverse with a proud and generally harmonious mix of southern European and Anglo-Saxon backgrounds. As well as the ethnic diversity and inter-generational families, the community identified with a strong 'sense of belonging' and an appreciation of the island lifestyle. There was a sense of pride in the fisher camps with quirky paintwork, art and sculptural pieces - often made out of marine debris. This cultural expression and unique aesthetic was evident on all the Islands.

The Abrolhos Islands was the site of Australia's first recorded European settlement in 1629 and the wreck of the Batavia and remnants of fortification provide a stark and historic reference to that episode in Australian history.

Economic values

The rock lobster industry has been one of the main economic drivers for the Geraldton and mid-west region. Over recent years this industry has diminished in regional importance, with mining taking over from primary production. Despite this, fishers still refer to the economic support the industry provides for the many fishing families and crews and the allied marine industries such as boat builders, processors, chandleries, bait and fuel suppliers in the region.

Environmental values

There was strong appreciation for all aspects of the environment. The marine and terrestrial life, sea birds and even the 'windy weather' were all highly valued. This was particularly evident in the large number of photos submitted with images of the marine and terrestrial wildlife. Environmental stewardship was high and this had increased substantially over the previous 20 years. A not-for-profit organisation (*Friends of the Abrolhos*) had operated for many years and was instrumental in securing funding for a large number of environmental projects with excellent outcomes for the community as well as the marine and terrestrial environment.

4.5.7 Community and social changes

Many of the values that were put forward by the community have changed substantially over the past six years. As discussed, the catch has been reduced and the number of fishers declined. The fishing season has extended and there are now few fishers on the Islands at any one time.

In 2012, all the schools (5) on the islands were closed. Most of the community halls were not viable and three of the five halls have closed. Many inter- and intra- island sporting events that were an important part of the Abrolhos calendar no longer occur. The brightly painted spectator chairs around the football fields made from craypots, have fallen into disrepair. Carrier boats that brought supplies to the islands and returned to Geraldton with live lobsters have reduced in number from four vessels to two. Many fishers transport their own lobsters back to the processors on the mainland. This has had implications for the size of the boats operating in the fishery.

Many of the fishers talked about the increasing numbers of recreational boats and tourists. There was also the perception that many of these visitors did not respect or look after the islands and infrastructure in the same manner as the fishers. Leaving waste, trampling over vegetation and using jetties without permission was seen as a significant problem.

In 2006 there were three fixed wing air services and an emergency helicopter service. In 2012, one operator remained. The Silver Chain nursing post has reduced its presence from 18 weeks to 10 weeks.

Some of the camps have fallen into disrepair from the harsh weather conditions and lack of maintenance with fishers no longer living at the Islands.

4.5.8 Drivers of change leading to social decline

Using many of the photos submitted by fishers, a diagram (Figure 18) was developed to illustrate the connectedness of changes described by fishers over the past years from a strong and vibrant community to one reduced in numbers and social complexity. It was also used to better understand how the community saw the connectedness of change and the linkages to climate and the environment.

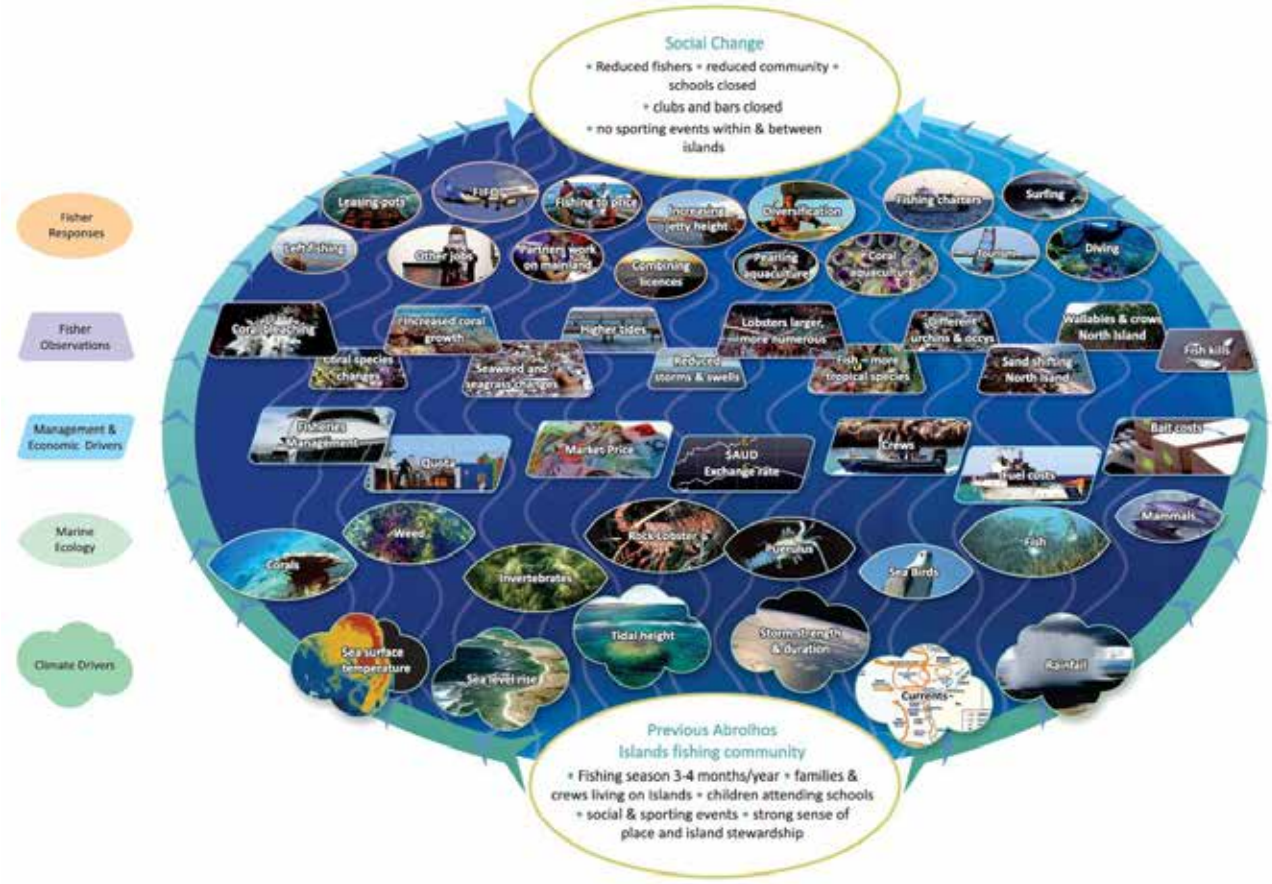


Figure 18 Cascading impacts leading to community loss

Climate and oceanographic drivers

Of the oceanographic and climate drivers discussed, increased sea surface temperature was thought to have the most influence on the Abrolhos Islands marine ecology. Rainfall, salinity, ocean acidity and increasing sea levels were also noted. As most fishers have temperature monitoring on their vessel instrumentation, this observation of temperature increase is not surprising; particularly as the mid-west of WA experienced a marine heat wave in early 2011, followed by anomalously high sea surface temperatures for the following 2 years.

Marine ecology

When asked which if any, ecological features may have been impacted by these climate drivers, one of the participants summed up by indicating '…everything in small degrees.' Others were more specific with impacts on; puerulus, rock lobster, fish, corals and coral colour, weed growth, sea birds and the overall marine habitat.

Most of the impacts listed were actually observed by the fishers in their daily activities. Those impacts not observed, for example puerulus numbers, had been emphasised by DoF and it was better understood by the time of the workshop that the decline in puerulus was related to some long–term environmental change rather than overfishing.

Management and economic drivers

The diagram (Figure 18) used in the workshop had icons of the following management and economic drivers; fisheries management and quota, market price, Australian dollar, crews, fuel and bait costs.

When asked about other influences on their businesses; financial stress and banks, global financial crisis and the loss of US markets, availability and lease price of pots, increases in all capital costs as well as cartage costs (to and from the Islands), all featured. The management and economic drivers that affected businesses the most, varied between fishers however fisheries management, quota and pot lease prices ranked the highest.

These issues are all interlinked and reflect the significant and recent changes to the fishery from an 'input-' to an 'output-' controlled fishery. The strong fisheries management intervention following the drop in puerulus numbers resulted in catch reductions of between 50 – 70% and the introduction of quota management. As the 'unit entitlement' is calculated by pot, it is not surprising that there was upward pressure on pot availability and pot lease prices.

Fisher observations

When asked what the most important environmental changes were over the past 5- 10 years fishers provided a range of responses; coral growth, coral bleaching, fish kills, species changes including more tropical species, increased shark numbers as well as hungry birds were important biotic observations. Increases in water temperature, higher tides, erosion, more calm weather but increases in storm strength related more to weather and abiotic changes. The changes to corals in terms of the species changes, increased growth of some species, colour changes and bleaching had been observed in most of the Island groups. As there is significant coral growth throughout the Abrolhos in both shallow and deep water, it is possibly one of the easiest features to distinguish changes in.

Adaptation and response to change

When considering adaptation and responses to the environmental changes, participants were asked to identify what they had already done in their business and other things they may consider doing in the future.

It should be noted that when the rock lobster catch was reduced, the number of fishers also reduced. This meant that many fishers made the decision to leave the Industry. In the Abrolhos this was approximately half of the fishers and on some islands the reduction was even greater.

Those who remained in the industry did one or more of the following:

- additional work on the mainland
- aquaculture development
- wetline fishing
- purchased another business
- partners now working on the mainland
- partners working as crew
- sold pots
- leased pots
- brought smaller boat to reduce costs
- reduced crew
- fish to price

To stay viable, other fishers leased or bought additional pots (unit entitlement). Fishers also downsized their vessels and crews to reduce overheads. Many fishers diversified into other fishing and aquaculture activities or combined fishing with work on the mainland. In WA at the time, there

was high employment in the oil and gas industry, particularly for skippers. As one of the largest marine service providers was in Geraldton, many skippers found work as fly-in, fly-out (FIFO) work to supplement their incomes. Partners who had previously stayed at the Islands for the season, found work on the mainland or became part of the fishing crew.

Drivers of change

Using the large diagram provided (Figure 18), workshop participants were asked what they thought were the main reasons the Abrolhos Islands community changed from what it was six years ago to the community it is today? Every participant marked management and economic drivers. Within this category, 'fisheries management' was singled out as the main reason.

This outcome matched well with the other surveys and interviews, however as the workshop had teased apart different layers of impact starting from the climate drivers through to the adaptive responses, it was noteworthy that no climate drivers including an increased sea temperature had been selected by any of the participants as one of the main reason for the changes being experienced in the Abrolhos Islands fishing community.

There is no doubt that the fisheries management intervention to reduce catch and move from an input- to an output- managed fishery changed the number of fishers and the way people fished. These changes had a significant impact on the social fabric of the Abrolhos Islands community. At the time of this workshop, the community my not have understood that the drivers of these changes were environmental and likely to be climate driven.

4.5.9 Photovoice exhibition

The community exhibition '*Seeing Change: A photographic story from Abrolhos fishers'* (Figure 19) was curated from a selection of over 1000 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 with three TV monitors, art work, island artefacts, couches, surveys and a large amount of climate change material that could be taken away for further information.

Figure 19 Seeing Change Exhibition

The exhibition wove a story of the Houtman Abrolhos Islands, the rock lobster fishery and island community. It described the environmental changes observed by fishers and the changes recorded by scientists. It 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 slogan and complex in the techniques utilised to enable visitors to deepen their understanding of climate change.

4.5.10 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, the exhibition 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 almost 30,000 people viewed the exhibition in total.

The exhibition was highly acclaimed, winning both State and National awards (Appendix 4, Attachment 2 Awards).

The project and exhibition was extensively publicised in local and national media (print, TV and radio), websites (WA Museum, WAMSI, NACC, ABC Open), newsletters, magazine articles, large billboards and by invitation (Appendix 4, Figure 19 Seeing Change Exhibition; Appendix 5, Attachment 7 Exhibitions).

4.5.11 Book

A book of the exhibition was published: Shaw, J. 2013. *Seeing Change: A photographic story from Abrolhos fishers*. Northern Agricultural Catchments Council. The book included the interactive DVD '*Seeing Change: climate related resource information for the marine environment'*. Western Australian Marine Science Institution, 2013.

When any exhibition is dismantled, this snapshot in time is lost forever. The publication of the book which included most of the exhibition photos, text and fisher quotes was to provide a record or memento of this important exhibition and its deeper meaning. The book was released at the opening of the Albany Exhibition and launched in Geraldton in August 2013. It was available during the Albany and Fremantle exhibitions and at the WA Museum Geraldton and the Northern Agricultural Catchments Council (NACC). Proceeds from sales of the book will go to the Abrolhos Islands Silver Chain Nursing Association and NACC.

4.5.12 Surveys and Interviews

Analysis of the fisher interviews and viewer surveys are ongoing and will be published separately. Early results from the visitor surveys have indicated strong linkages had been made among environmental changes, climate change, the resulting management responses and the community decline.

Fishers

Interviews with fishers are continuing and results will be published separately. Data from a preliminary follow-up survey and interviews indicate that the reaction from the fishing community

was very positive. From initial feedback the 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 quotes. A number of fishers appreciated that the climate change message 'wasn't in their face', but when they saw their photos enlarged and in a formal setting showing images of a jetty underwater, bleached coral, different species; it changed their understanding and perception.

Further communication work is necessary, however rather than avoiding anything to do with 'climate change science', the fishing community appear to be more accepting and open to receiving information on this complex and contentious subject. Importantly, appreciating the changes they are observing and moving to accepting and seeking knowledge will likely increase their opportunities for adaptation.

Of the fishers (10) interviewed so far in follow-up surveys, the majority (90%) 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…'

Museum staff

Museum staff were interviewed following the Geraldton exhibition as they are on the floor, mix with exhibition visitors and are privy to a range of visitor reactions and interviews. Their reactions to the exhibition and visitor feedback were all very positive. One of the most consistent comments was the number of local people who visited the exhibition who had not previously ever visited the Museum in Geraldton. They also noted that people visited the exhibition on numerous occasions and were there for hours, sometimes becoming emotional with the changes to the community revealed in the photos.

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…'
- '…we had more people rsvp than had been invited…yeah…we did have a lot of interest…'
- '…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…'

Exhibition visitors

In a preliminary review of results from 103 visitor surveys (Geraldton and Albany), most were positive with their reactions to the exhibition. The majority of respondents indicated that the exhibition had;

- 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
- encouraged them to take action about climate change.

Although only a subsample of total visitors, a number of respondents who had provided a low rating for these questions, also commented that they had rated the questions in this way because they were already aware of climate change issues and were personally taking action.

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

4.5.13 Climate Change Information

Each exhibition displayed a large amount of information on marine climate change including FRDC/DCCEE research projects (Appendix 5), climate change information (NCCARF), booklets (Climate Commission; The Critical Decade, Marine Report Card), and opportunities for action (Redmap). This material was available for people to take away (Appendix 5, Figure 20 Project Flyers displayed and available at the Seeing Change exhibitions).

The climate change science materials were regularly replenished and indicated an interest in the current research work and available knowledge in this area. This interest in climate change information was contrary to the reaction of a number of Government Departments and some media outlets who felt unable to support or promote material that could be related to climate change. This also reflects the importance of Boundary Organisations as they are in a better position to promote information that some institutions feel unable to deliver.

The level of interest for the exhibition appeared high in each coastal community with Museum staff commenting that people came to see the exhibition that had previously never been to the Museum. In Albany, a community 'curatorial' was held the week following the Exhibition launch. The Principal Investigator spoke for an hour on 'Seeing Change: A cascade of environment, management, economic and social changes' to a large group including marine science students, Fisheries Department staff, commercial fishers and general community. In all cases the interest level was excellent and the response to the presentation positive.

This interest in the exhibition, acquisition of published climate change materials, high attendance at community talks and workshops indicates that there is an interest in climate change knowledge even if this interest does not appear reflected by mainstream media or major political parties.

4.6 Conclusions

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 and subsequent book '*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 identified the linkages between climate and environmental changes, management responses, economic outputs and social changes.

Using fisher photographs to tell the story, a powerful narrative of climate and environmental drivers leading to social decline was respectfully woven into an experience that allowed fishers and visitors alike, to access and uptake knowledge and information.

Although the climate change slogan was subtle, the various communication tools utilised to illustrate what is generally considered a complex and controversial subject area, were presented in a variety of layers and levels of difficulty. These allowed each viewer to access knowledge individually and in their own time reach their own conclusions.

Over 27,000 people visited the exhibition with Museum staff reporting that many people came multiple times and had lengthy stays. The feedback was positive and early data indicate increased uptake on climate change by fishers and visitors. Museum staff in Geraldton indicated the exhibition had 'kick started the climate conversation in the community'.

The exhibition received excellent publicity and appears to have increased dialogue between fishers, scientists and the community. A number of Ministers, politicians and agency CEOs were interested enough to have 'private viewings' of the exhibition.

Fishers were invited to participate in workshops, surveys and interviews, provide photographs and select images for the exhibition. This 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.

Presenting the fisher photographs in a formal exhibition setting appeared to have increased the wider community understanding of the fishers, their values and strong environmental linkages. It also enabled fishers to reflect on images they had seen regularly over an extended period (e.g. jettys underwater) and combined with the other changes in the marine environment, pointed to environmental and climate changes consistent with climate predictions. As one fisher stated 'it was a bit like a light going on.'

The Photovoice methodology was an excellent method to build understanding and knowledge of climate science as well as a shared understanding of the values of the fishing community. It enabled participation on many levels and ownership across the community. As a research project it also 'gave back' to the fishers on the Abrolhos. The research data will continue to be published however the exhibition provided proud memories of a strong community built up over generations. The book of the exhibition was given to all participants and is a treasured possession. The enlarged photos from the exhibition were returned to the individual photographers. The appreciation of the 'return to community' has been particularly evident in follow-up interviews.

Instead of a reluctance to believe or talk about 'climate change' within the fishing community, this project has allowed fishers to better understand and deal with the climate and environment issues they are currently dealing with, as they do with all critical issues facing their industry. The increased knowledge is likely to have a positive impact on further adaptation strategies and the future of their fishing businesses.

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

1

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 so, what? Please comment.....

.....

15) What was your favourite part of the exhibition? Please circle

Photos: Camp lounge: 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

Attachment 2 Awards

Jenny Shaw for the 'Seeing Change' Project

Appendix 5 Products and delivery

A range of products were developed to build industry and community knowledge of climate change and adaptation.

5.1 Highlights

To build industry and community knowledge a number of products were developed including; project flyers, case study brochures, magazine articles, media coverage (print, radio, electronic and TV), presentations at workshops and conferences, video vignettes, an interactive DVD, community exhibitions, a book and research publications

Specific products were developed for the project, by the project, and in collaboration with other climate-related projects

A number of the products developed have an on-going legacy including the interactive DVD, teacher plans and research publications

5.2 Background

To meet the objectives outlined in the project agreement a series of products were developed over the life of the project. These products were created within project 2011/503 or in collaboration with other related projects. Many of the products were designed to have a national reach, while others focused on the three case study areas.

Early in the project, the focus on product outputs and delivery methods for knowledge uptake (see Appendixes 1, 3 and 5) lead to collaborative partnerships with OceanWatch Australia (OWA) and the Women's Industry Network Seafood Community (WINSC). Facilitated workshops and feedback from these organisations combined with industry and community surveys and reviews of the current literature provided a useful framework for product development and effective delivery for the uptake of knowledge. These outputs were refined as the project progressed so all deliverables (outputs and outcomes) could be met.

Product delivery occurred at a number of levels and included a large number of individuals and organisations. OWA was tasked specifically with product delivery; however other organisations and individuals assisted with delivery and dispersal of information, for example via websites and e-newsletters.

A number of the products and the delivery method are described in this section.

5.3 Project Flyers

Project flyers were developed to summarise the FRDC/ DCCEE research projects being undertaken nationally. They were also designed to synthesise the research information to be delivered in the 3 case study areas and in coastal communities around Australia. Every flyer was a collaborative effort between the FRDC/ DCCEE project, the Knowledge PI, OWA and NCCARF. The titles and project outline are given below and the full brochures available in Attachment 1 Project Flyers.

The flyers were designed to be eye catching, informative, contain a lot of images as well as project contacts, web links or references where further information could be found. A map of Australia displayed the geographic extent of the research and the FRDC project number was identified. A stylised wave design linked the flyers and was subsequently incorporated into other project products.

Each of the research projects have been completed or are in the final stages of completion. The final reports can be found at http://frdc.com.au/research/final-reports/Pages/default.aspx

The project flyers were distributed by OWA in the three case study regions and other coastal communities around Australia. They were available at OWA community activities and presented to industry either individually and during port visits (Appendix 3). The flyers were also available at each of the Seeing Change Exhibitions in Geraldton, Albany and Fremantle (Appendix 5, Figure 20 Project Flyers displayed and available at the Seeing Change exhibitions). The visitation rate for the exhibitions was estimated at 27,000 people.

Figure 20 Project Flyers displayed and available at the Seeing Change exhibitions

As well as the Project Flyers, the exhibition had other climate change publications freely available including NCCARF information sheets, Redmap, Climate Commission's The Critical Decade and The Marine Report Card. These materials were prominently displayed, available to the public and regularly replenished.

The flyers were and are currently available on the WAMSI website (http://www.wamsi.org.au/category/region/publications-scientific-publications), as well as the NCCARF and FRDC websites. They were widely publicised by NCCARF in several Marine Adaptation Bulletins.

The flyers have been incorporated into the interactive DVD '*Seeing Change; climate related resource information for the marine environment*'. The DVD was extensively distributed nationally and is available to download from the WAMSI Website.

Each research project received copies of their particular flyer and many of the projects had additional copies printed for their own extension purposes.

The project flyers were double sided and included the; project background, outline, outcomes, benefit to the community, more information, contacts and acknowledgements. Below are the Project Outlines for each flyer. See Appendix 5, Attachment 1 Project Flyers, for individual Flyers.

5.3.1 Climate Change Adaptation: Building Community and Industry Knowledge

This project focused on three study areas; St Helens in Tasmania, Bowen in Queensland and Geraldton in Western Australia. It is investigated what people in coastal fishing communities would like to know about climate change, and aimed at increasing the knowledge and understanding of

these issues and looking at possible adaptation measures open to local communities, particularly fishing communities.

5.3.2 An adaptation blueprint for coastal communities

St. Helens in Tasmania, Geraldton in Western Australia and Bowen in Queensland have been selected to collect information on:

- the role of marine dependent industries in communities
- the connection of marine dependent industries to other economic activities
- the role of marine dependent industries in the social fabric of communities
- the potential impacts on the community from changes in the utilisation of marine resources due to a changing climate.

5.3.3 Management implications of climate change effects on fisheries in Western Australia

The first phase of the project was to understand how environmental factors such as water temperature and salinity affect the fish stocks in WA based on available historical data. The second phase looked at historical trends and possible future scenarios of WA marine environments using climate model projections. For example, If water temperatures off the south-west coast of WA will likely rise by another 2°C in 2070 compared to present, and the occurrences of marine heatwaves become more frequently, how will this impact on the highly sensitive and valuable abalone fisheries in WA? Lastly, the changes that are occurring now and the expected changes from climate change requires management consideration. This means reviewing existing management arrangements to examine their robustness to climate change effects and developing management policies in consultation with stakeholders to deal with climate change effects on fish stocks.

5.3.4 Changing currents in marine biodiversity, governance and management: responding to climate change

The project involved:

- identifying governance and management requirements for conserving marine biodiversity in the context of climate change
- assessing how well current arrangements meet these requirements
- identifying alternative arrangements that would better conserve marine biodiversity
- providing advice to authorities on implementing reforms. To do this, we are using scenario planning, system modelling and workshops with stakeholders and authorities.

5.3.5 Estuaries and Coasts: adaptation options for a changing climate

The project was aimed at producing a framework to facilitate Climate Change Adaptation Strategy decision-making that is relevant across Australia's estuaries and coastal ecosystems. The project investigated tools for making decisions and tested the benefits of the framework on a number of case studies.

5.3.6 Growth opportunities & critical elements in the value chain for wild fisheries & aquaculture in a changing climate

Analysis of all activities within a sector known as value chain analysis will reveal climate related adaptations for a selected set of fisheries representing commercial (e.g. southern rock lobster, prawn), indigenous (Torres Strait lobster) and aquaculture sectors (oyster, prawn). Information on the existing conditions and prospective opportunities and barriers forms the basis to develop adaptation strategies through life cycle analysis, demand analysis and social perception studies.

5.3.7 Developing adaptation options for seabirds and marine mammals impacted by climate change

This national project evaluated impacts and adaptation options for seabirds and marine mammals, including the development of climate indicators over large regions via regional multi-species indices. It developed monitoring protocols to increase the detection of climate-related effects. Overall, this project will support adaptation efforts by those managing these iconic animals.

5.3.8 An Information Portal for the Oyster Industry

This project collated and translated environmental, industry, catchment and climate related data into a user-friendly, online, map-based portal. The oyster industry, its stakeholders and Natural Resource Management agencies were consulted throughout, with an initial focus on four oyster producing areas in NSW, for this proof of concept project.

5.3.9 Effects of climate change on reproduction, larval development, and population growth of coral trout

The aims of this project were;

- to assess sensitivities of coral trout to climate-related changes in temperature and seawater chemistry, during fertilisation and early larval development
- to test the effects of increasing temperature and ocean acidification on growth, condition, behaviour and survivorship of early post settlement coral trout
- to test for spatial variation in sensitivities to increasing temperatures for coral trout in three distinct sectors along the Great Barrier Reef
- to measure coral-dependence at different ontogenetic stages, to test whether coral trout will be adversely affected by climate induced bleaching and coral loss.

5.3.10 The vulnerability of an iconic Australian finfish to an altered climate: Barramundi

Researchers at James Cook University investigated the genetic and physiological tolerances to thermal and parasitic stresses of five genetically distinct Australian barramundi strains. They investigated different methods to identify how strains respond when placed under varying stresses. Modelling against future climate change scenarios were incorporated to predict what strains may be at threat, or advantaged, under future conditions.

5.4 Case Study Brochures

One of the project objectives was to support FRDC project 2010/542: A climate change adaptation blueprint for coastal regional communities. Following the initial contacts, interviews and analyses for the 'Blueprint' project, OWA returned to the case study communities of St Helen's, Bowen and Geraldton to feedback preliminary results and also share results between case study communities (see Appendix 3 for more detail). The case study brochures were produced for each community with the following information headings:

- what's unique about St Helens (or Bowen or Geraldton) and small coastal communities?
- the marine sector in a small coastal community
- the flow-on effects of the marine sector
- what you said: changes in the marine sector
- what you said: changes in the marine environment
- what the scientists say
- contacts and collaborators

The case study brochures were an entry point for discussion with project participants in the fishing industry and other sectors in each of the case study communities. These double-sided brochures were designed to be informative and easily understood. See Attachment 2 Case Study Brochures .

Following is the introductory paragraph for each brochure:

5.4.1 Change in Coastal fishing communities: Geraldton, Western Australia

Although a relatively large regional town at a just over 30,000 people, in some aspects Geraldton is typical of Australian coastal towns that are beyond commuting distances. For instance, the health services and retail sectors assume a larger role in these communities as they provide services to the surrounding areas. However, large coastal communities in Western Australia, like Geraldton are different to other States in that the construction sector associated with the mining industry is particularly important. Even though Geraldton has traditionally been characterised as a fishing town, commercial fishing also has a much greater role in smaller coastal communities in Western Australia when compared with other Australian communities.

5.4.2 Change in Coastal fishing communities: Bowen, Queensland

Bowen is a medium sized coastal town of just over 10,000 people. In some aspects Bowen is typical of Australian coastal towns that are beyond commuting distances. For instance, secondary industries such as accommodation and food services are increasingly dominating the economy over commercial fishing. But despite a decline in the primary industries nationally, coastal communities like Bowen still have a higher proportion of people in the aquaculture and fishing industries. Reef line fishing, especially for coral trout, is the main commercial fishery in Bowen and prawns and barramundi form the backbone of land based aquaculture industries. Recreational fishing and dive operators make up the marine tourism sector.

5.4.3 Change in Coastal fishing communities: St Helens, Tasmania

Although a relatively small town at less than 4,000 people, St Helens is typical of the many small coastal towns in Tasmania that are beyond commuting distances, that makes up nearly 30% of the population. Secondary industries such as accommodation and food services are increasingly dominating St Helens economy over commercial fishing. But despite a decline in the primary

industries nationally, small coastal communities like St Helens still have a higher proportion of people in the aquaculture and fishing industries. Like other small coastal communities, St Helens has a greater proportion of older people, average household incomes are lower, and work opportunities are limited. St Helens is unique in the fact that it is in a marine hotspot, meaning that climate driven changes in the marine environment are happening relatively fast.

5.5 PowerPoint Presentations

At the project outset, it was considered important that the case study communities be kept informed of project outcomes. Participants had also been canvassed for their climate-related knowledge needs and this information required delivery back into the community.

Although the results were preliminary, OWA SeaNet Officers were not totally comfortable delivering information where they may not be confident with under detailed questioning. As workshops were to be held in each case study area, three PowerPoint presentations were developed to outline the initial 'Blueprint Project' results and provide information on regional climate related changes (Appendix 5, Attachment 3 PowerPoint Presentation Example).

Each PowerPoint presentation comprised around 38 slides, including specific ABS generated data for each community, preliminary data from the 'Blueprint Project' and comparisons with the 3 case study regions. There was numerous animated data showing ocean currents, interviews with scientists and other climate –related information. Extensive speaker's notes were included to support the SeaNet Officers delivery of this product.

5.5.1 Coastal Communities: St Helen's

Change in coastal fishing communities: what does the future hold?
Example Attachment 3 PowerPoint Presentation Example

5.5.2 Coastal Communities: Bowen

Change in coastal fishing communities: what does the future hold?
Example Attachment 3 PowerPoint Presentation Example

5.5.3 Coastal Communities: Geraldton

Change in coastal fishing communities: what does the future hold?
Example Attachment 3 PowerPoint Presentation Example

Each PowerPoint presentation was incorporated into the interactive DVD '*Seeing Change; climate related resource information for the marine environment'*. This DVD was extensively distributed nationally and is available to download on the WAMSI website.

5.6 Interactive DVD

Climate change information is complex, contentious and can be difficult to understand. Initial surveys and industry feedback of knowledge needs showed a range of understanding and interest which also varied between regions and fishery type.

Rather than a mass of brochures and web links, an interactive DVD was produced which contained myriad of climate related resource information for the marine environment. The DVD '*Seeing Change; climate related resource information for the marine environment'* was designed to be of small size, easy to carry and distribute, easy to play in any portable computer or laptop and packed full of interesting climate change-related information. Explaining complex information with different tools including animation and visualisation had been beneficial and in many cases, novel and stimulating.

The DVD content was divided into the three marine geographic areas of the southwest, southeast and tropics to support OWA SeaNet Officers return to each of the Case Study regions. It enabled the SeaNet Officers to go into the community, engage the respondent in a one-on–one or small group discussion and introduce them to interesting animations for example; currents on the east coast, rock lobster larval distribution models on the west coast, rainfall projections or sea surface temperature changes. If the industry member had participated in the 'Blueprint Project,' preliminary results were also incorporated into the DVD. At the end of the discussion, copies of the DVD were distributed free of charge.

The DVD included a large amount of published material, documentaries, videos and specific presentations on marine climate change. As the DVD dealt with key issues of climate change, possible impacts and opportunities for action and adaptation, there was considerable interest from a range of stakeholders including teachers. For this reason a Teacher Plan was included in the 'Opportunities for Action' (5.6.9). The Teacher Plan (contributed by the Department of Fisheries Western Australia) follows the National Curriculum and points to a range of useful resources within the DVD. The Department of Fisheries is using the interactive DVD as a resource to in-service teachers specifically on climate change and impacts on the marine environment.

The distribution of the DVD was extensive and is ongoing. It is a lasting legacy of the project.

Following are the headings of each section of content:

5.6.1 Australia General

Climate Commission (CC)

- The Critical Decade: Climate science, risks and responses
- The Critical Decade: Key messages
- The Critical Decade: Extreme weather - key facts
- Extreme Weather and Climate Change in Australia: today and into the future

National Climate Change Adaptation Research Facility (NCCARF)

- Species Response to Climate Change in the Ocean
- Ecosystem responses to climate change in the ocean
- Climate Change and the Marine Environment: South Australia
- Developing a toolkit for economic instruments to facilitate marine climate change adaptation
- Adaptive Management of Temperate Reefs for Climate Change: new approaches for ecological monitoring and predictive modelling

Fisheries Research and Development Corporation (FRDC)

- Preparation, the best business practice
- Climate change, marine biodiversity and the fishing and aquaculture industries
- Climate change adaptation: building community and industry knowledge
- Changing currents in marine biodiversity governance and management: responding to climate change
- An adaptation blueprint for coastal communities

- Estuaries and Coasts: adaptation options for a changing climate
- Growth opportunities & critical elements in the value chain for wild fisheries & aquaculture in a changing climate
- Developing adaptation options for seabirds and marine mammals impacted by climate change

Marine Report Card 2012

- Marine report Card 2012: Marine Climate Change in Australia - Impacts and Adaptation Responses

5.6.2 South West

Climate Commission (CC)

- The Critical Decade: Western Australia climate change impacts

National Climate Change Adaptation Research Facility (NCCARF)

- Climate change effects on the marine environment and fisheries: WA

Indian Ocean Climate Initiative (IOCI)

- How WA's Climate Has Changed
- The Future of WA's Climate
- The Role of IOCI in Understanding WA's Changing Climate
- WA Rainfall – What the past can tell us, and what the future may hold
- Summary for Policymakers

Fisheries Research and Development Corporation (FRDC)

- Management implications of climate change effects on fisheries in Western Australia
- Change in coastal fishing communities: Geraldton, Western Australia

Research Papers

- La Nina forces unprecedented Leeuwin Current warming in 2011. (2013). Feng, M., McPhaden, J. M., Xie S. and Hafner, J.
- The 'marine heat wave' off Western Australia during the summer of 2010/11. (2011). Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D.
- Fisheries-dependent indicators of climate change in Western Australia. (2010). Caputi, N., Pearce, A. and Lenanton, R.
- Observations of warming on the Western Australian continental shelf. (2007). Pearce, A.F. and Feng, M.

5.6.3 South East

Tasmania

Climate Commission (CC)

- The Critical Decade: Tasmanian impacts and opportunities

Antarctic Climate & Ecosystems CRC (ACE CRC)

- Climate futures for Tasmania: Extreme events
- Climate futures for Tasmania: General climate impacts
- Climate futures for Tasmania: Break O'Day Municipality

Fisheries Research and Development Corporation (FRDC)

- Change in coastal fishing communities: St Helens, Tasmania

National Climate Change Adaptation Research Facility (NCCARF)

- Climate change impacts on Tasmania's marine life
- Pre-adapting Tasmanian Coastal Reefs to Climate Change

Tasmanian Climate Change Office

- Projected Climate Change Impacts for Tasmania

Tasmanian Seafood Industry Council (TSIC)

- Seaing Change: Catch up on changes in our marine environment

Research Papers

- The East coast Tasmanian rock lobster fishery – vulnerability to climate change impacts and adaptation response options. (2009). Pecl, G., Frusher, S., Gardner, C., Haward, M., Hobday, A., Jennings, S., Nursey-Bray, M., Punt, A., Revill, H., van Putten, I.

Victoria

National Climate Change Adaptation Research Facility (NCCARF)

- Climate Change, the Marine Environment and Fisheries Adaptation: Victoria
- Changes in community composition and distribution under climate change: New South Wales

Fisheries Research and Development Corporation (FRDC)

- An Information Portal for the Oyster Industry

Department of Primary Industries Victoria (DPI VIC)

- Abalone fisheries
- Blue grenadier fishery
- Blue mussel aquaculture
- Pacific oyster aquaculture
- Atlantic salmon aquaculture
- Snapper fisheries
- Southern rock lobster fisheries

5.6.4 Tropics

Climate Commission (CC)

- The Critical Decade: Queensland climate change impacts and opportunities

CRC Reef Research Centre

- Coral bleaching and global climate change

Fisheries Research and Development Corporation (FRDC)

- Effects of climate change on reproduction, larval development, and population growth of coral trout
- The vulnerability of an iconic Australian finfish to an altered climate: Barramundi
- Change in coastal fishing communities: Bowen, Queensland

Great Barrier Reef Marine Parks Authority (GBRMPA)

- Impacts of tropical cyclone Yasi on the Great Barrier Reef. © Commonwealth of Australia. Great Barrier Reef Marine Park Authority 2011, a report on the findings of a rapid ecological impact assessment, July 2011, GBRMPA, Townsville
- Climate change adaptation principles. © Commonwealth of Australia. Great Barrier Reef Marine Park Authority and the National Climate Change Adaptation Research Facility (2011), Climate change adaptation principles, GBRMPA, Townsville

5.6.5 Videos

- Climate Variability
- ABC Catalyst: Taking Our Temperature
- Pelagic Fish
- Measuring Marine Climate Change
- Marine Report Card Provides a Benchmark for Climate Impacts
- Arctic Report Card
- Climate Change Fuelling Wilder Weather
- Piecing Together the Temperature Puzzle
- Sea Level Rise
- The *Centrostephanus* Project: Urchin Activity at Night, Time Lapse
- Stories from the Abrolhos
    - Photovoice; the Abrolhos project
    - The Abrolhos Islands with Dave McCann
    - Never put them on lumps on the moon
    - Snorkel dive with Jenny
    - Island life
    - Abrolhos Islands timelapse
    - A chat with the Basile's
    - A chat with Sam
    - A chat with Karen

5.6.6 Animations

- Australian Currents
- West Australia's Leeuwin Current
- Ocean Current Flows with Sea Surface Temperatures (SST)
- Western Australia's Marine Heatwave
- Western Australian Rock Lobster Larvae Movement Offshore
- What is Coral Bleaching?
- Impacts of Climate Change
- Ocean Acidification
- Five-Year Global Temperature Anomalies from 1880 to 2012

5.6.7 Gallery

- 32 Images

5.6.8 Presentations

- 2011 Costal Conservations Series, Geraldton WA Session 3; Dr Alistair Hobday
- Lessons learned from conducting adaptation research; Dr Gretta Pecl
- Management implication of climate change effects on fisheries in WA; Dr Nick Caputi
- From climate change to economic and social adaptation in coastal communities; Dr Sarah Metcalf
- Coral reefs in a changing climate; Dr Lynda Bellchambers
- Taking the adaptation message to the commercial fishing industry; Mr Eric Perez
- Skin in the Game; Mr Ryan Donnelly
- Coastal Communities: Geraldton; Dr Ingrid van Putten
- Coastal Communities: St Helens; Dr Ingrid van Putten

- Coastal Communities: Bowen; Dr Ingrid van Putten

5.6.9 Opportunities for Action

- Teacher's Resources
    - Teacher Guide: Climate Change and the Marine Environment
    - A Climate for Change
    - What can we do to protect our coral reefs from climate change?
    - Monitoring Coral Bleaching on Christmas Island
    - Management for a Sustainable Future
    - Little drifters are beacons of climate change
    - Who goes with the flow?: The Leeuwin Current
- Redmap: What's on the move around Australia?
- Redmap: What's on the move around Western Australia?
- Fuel Efficiency Guide

5.6.10 Related Resources

General Information

- Glossary of Terms
- Climate Change Links
- Organisation Abbreviations
- Unlocking lobster secrets
- Houtman Abrolhos System
- Living with the Leeuwin Current

5.7 Workshops, conferences and presentations

To heighten awareness of the project, increase the uptake of climate science and enable feedback on project methods and results, the PI spoke at numerous workshops, conferences and symposia throughout the life of the project. Specific researchers were brought in for specialised presentations and these are referred to in the relevant sections. The presentations included:

Shaw, J., Caputi, N., and Stocker, L. (2013) Fishers Seeing Change: a cascade of environment, management, economic and social changes. *Adapt, Interact and See Food*. Seafood Directions Conference, Port Lincoln South Australia, 27-30 October 2013.

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, 25-27 October 2013.

Shaw, J., and Stocker, L. (2013) A Changing Island Community: Driven by Climate, Governance or Both? *Balancing Communities and Coasts.* WA State Coastal Conference. Esperance Western Australia. 24-26 July 2013.

Stocker, L. and Shaw, J-presenter. (2013) Principles for Coastal Adaption to Sea Level Rise. *Balancing Communities and Coasts.* WA State Coastal Conference. Esperance Western Australia. 24-26 July 2013.

Shaw, J., Caputi, N., and Stocker, L. (2013) Seeing Change: A cascade of environment, management, economic and social changes. *Tuesday Curatorial Community Presentation*, Albany Museum. Albany Western Australia. 2 July 2013.

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. *Climate Adaptation in Action 2013: Knowledge and Partnership.* NCCARF Conference, Hilton Hotel. Sydney NSW. 25 - 27 June 2012.

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. *NCCARF Post-graduate workshop*. Hilton Hotel. Sydney NSW. 24 June 2013. *Overall Winner Postgraduate Presentation Award.*

Shaw J., Noble L., and Stocker L. (2013) Environmental changes and cultural impacts: Women's perspectives from a fishing community in Western Australia**.** *Gender in Aquaculture and Fisheries*. 4th Global Symposium on Gender in Aquaculture and Fisheries (GA4) Symposium. Yeosu Republic of Korea. 1 - 4 May 2013.

Shaw J., Stocker L., and Noble L. (2013) Social change and adaptation: Driven by governance, climate or both? *Blue Waters and Green Fisheries*. 10th Asian Fisheries and Aquaculture Forum (10AFAF) Conference. Yeosu Republic of Korea. 30 April - 4 May 2013.

Shaw J. (2013) Photovoice: people making sense of climate change by taking and looking at photos. *Climate Change Adaptation*. Shire of the Cocos (Keeling) Islands, Home Island Shire Office. Cocos Islands Indian Ocean Territories. 10 April 2013.

Shaw J. (2012) Project presentations, May, June and July 2012. Abrolhos Islands and WA Museum Geraldton.

Shaw, J. (2012) Fishers making sense of climate change through the lens of a camera*. Multidiscplinary Perspectives on the History and Future of Marine Animal Populations*. Oceans Past IV International Conference: University of Notre Dame. Fremantle Western Australia. 7-9 November 2012.

Shaw, J. (2012) Social Change: Driven by governance, climate or both? *Sustainable Seafood: Opportunities and Challenges.* Women's Industry Network Seafood Community Conference: Canberra ACT. 6 - 7 October 2012.

Shaw, J. (2012) *Geraldton: local to global regional city*. FRDC / WAMSI/ UTAS Workshop, Murdoch University. Perth Western Australia. 21 September 2012.

Shaw, J. (2012) *Social change in the rock lobster fishery*. FRDC / WAMSI/ UTAS Workshop, Murdoch University. Perth Western Australia. 21 September 2012.

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. (2012) The uptake of climate science in fishing communities. *When Knowledge isn't Power. Science Technology and the Environment.* Noami Oreskes Master Class. Institute of Advanced Studies. University of Western Australia. Perth Western Australia. 6 August 2012.

Shaw J. (2012) Photovoice: the Abrolhos Project (4). Fisher Workshops. WA Museum Geraldton. Geraldton Western Australia. 5 July April 2012.

Shaw, J., and Stocker, L. (2012) 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. *Winner Postgraduate Presentation Award.*

Shaw J. (2012) Photovoice: the methods and the photos (2). North Island, Big Pigeon, Roma Island and Basile Island, Houtman Abrolhos Islands, Geraldton Western Australia. 30 April - 2 May 2012.

Shaw J. (2012) Photovoice: the Abrolhos Project. Fisher Workshops. Rat Island, North Island, Big Pigeon and Basile Island, Houtman Abrolhos Islands, Geraldton Western Australia. 3-4 April 2012.

Shaw, J. (2012) Climate Change Adaptation; Building community and industry knowledge. *Climate Change Adaptation Research in Western Australia.* NCCARF Conference, Perth Western Australia. 14 March 2012.

Shaw, J., Stocker, L., Bruekers, A. & Danese, C. & (2012) Spanning the Boundary between Climate Science and Coastal Communities: Opportunities and Challenges. *Coastal Councils Conference and Research Forum.* Hobart Tasmania. 4 March 2012.

Clarke, B., Stocker, L., Coffey, B., Leith, P., Harvey, Baldwin, C., N., Baxter, T., Bruekers, G., Danese, C., Good, M., Hofmeester, C., De Freitas, D.M., Mumford, T., Nursey-Bray, M., Kriwoken, L., Shaw, J., Shaw, J., Smith, T., Thomsen, D., Wood, D. (2012) Enhancing the Knowledge-Governance Interface: Coasts, Climate and Collaboration. *Coastal Councils Conference and Research Forum,* Hobart Tasmania. 4 March 2012.

Shaw, J. (2011) Climate Conversations. Women's Industry Network Seafood Community Conference, Gold Coast QLD. 21-23 October 2011.

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

5.8 Other publications

5.8.1 Book

A 58 page book was published.

Shaw. J. (2013) *Seeing Change: a photographic story from Abrolhos fishers.* Northern Agriculture Catchments Council. Geraldton Western Australia.

5.8.2 Research Papers

A number of research papers are in preparation and it is understood that deeper and more academic analysis of the data will be published in peer reviewed journals.

Shaw, J., Danese, C., Stocker, L. (2013) Spanning the Boundary between Climate Science and Coastal Communities; Opportunities and Challenges. Ocean & Coastal Management **86**. 80 – 87.

Clarke, B., Stocker, L., Coffey, B., Leith, P., Harvey, Baldwin, C., N., Baxter, T., Bruekers, G., Danese, C., Good, M., Hofmeester, C., De Freitas, D.M., Mumford, T., Nursey-Bray, M., Kriwoken, L., Shaw, J., Shaw, J., Smith, T., Thomsen, D., Wood, D. (2013) Enhancing the Knowledge-Governance Interface: Coasts, Climate and Collaboration. Ocean & Coastal Management **86.** 88 – 99.

5.8.3 Posters

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. *Climate Adaptation in Action 2013: Knowledge and Partnership.* NCCARF Conference. Hilton Hotel, Sydney NSW. 25-27 June 2013.

Shaw, J., and Stocker, L. (2013) Social Change and Adaptation: driven by governance, climate or both? *Integrating Climate into Action*. European Climate Change Adaptation Conference. Hamburg University, Hamburg Germany. 18-20 March 2013.

Shaw, J., and Stocker, L. (2012) Photovoice: a Photographic Exploration of Attitudes to Climate Change and Adaptation*. Climate Adaptation in Action 2012: Sharing Knowledge to Adapt.* NCCARF Conference. Sebel Hotel Albert Park, Melbourne Victoria. 26-28 June 2012.

5.9 Exhibitions

Seeing Change: A photographic story from Abrolhos fishers. Western Australia Museum Geraldton. 29 November 2012 – 24 February 2013.

Seeing Change: A photographic story from Abrolhos fishers. Western Australia Museum Albany. 26 June – 21 July 2013.

Seeing Change: A photographic story from Abrolhos fishers. Western Australia Maritime Museum Fremantle. 7 September – 24 November 2013.

5.10 Awards

A number of awards and commendations were received as a result of the Photovoice project (Appendix 4, Attachment 2 Awards) and Seeing Change exhibition:

MAGNA 2013 Museums and Galleries National Awards
Winner - Best Temporary Exhibition under $20,000
http://museum.wa.gov.au/about/latest-news/climate-change-abrolhos-wins-magna-award

Western Australian Coastal Awards for Excellence 2013
Winner - Coastal Heritage Preservation Award
http://www.planning.wa.gov.au/683.asp

Goodness Awards for Sustainability and Innovation 2013
Winner - Science Award
http://everythinggeraldton.com.au/geraldton-news/2013/8/21/the-goodness-awards

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

Western Australian LANDCARE AWARDS 2013
Finalist – Coastcare Award

Winner Postgraduate Presentation Award. Shaw, J., and Stocker, L. (2012) 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.

5.11 Promotional materials

Promotional materials (Appendix 8 Promotional materials) were used in all case study areas for those interviewed for the Blueprint project (See Appendix 3). WAMSI shirts, caps, can coolers and bags were also given out to the partnering organisations; OceanWatch Australia and the Women's Industry Network Seafood Community for their use at Conferences and workshops.

Fishers interviewed were given an OWA T-shirt with the Charles Darwin quote:

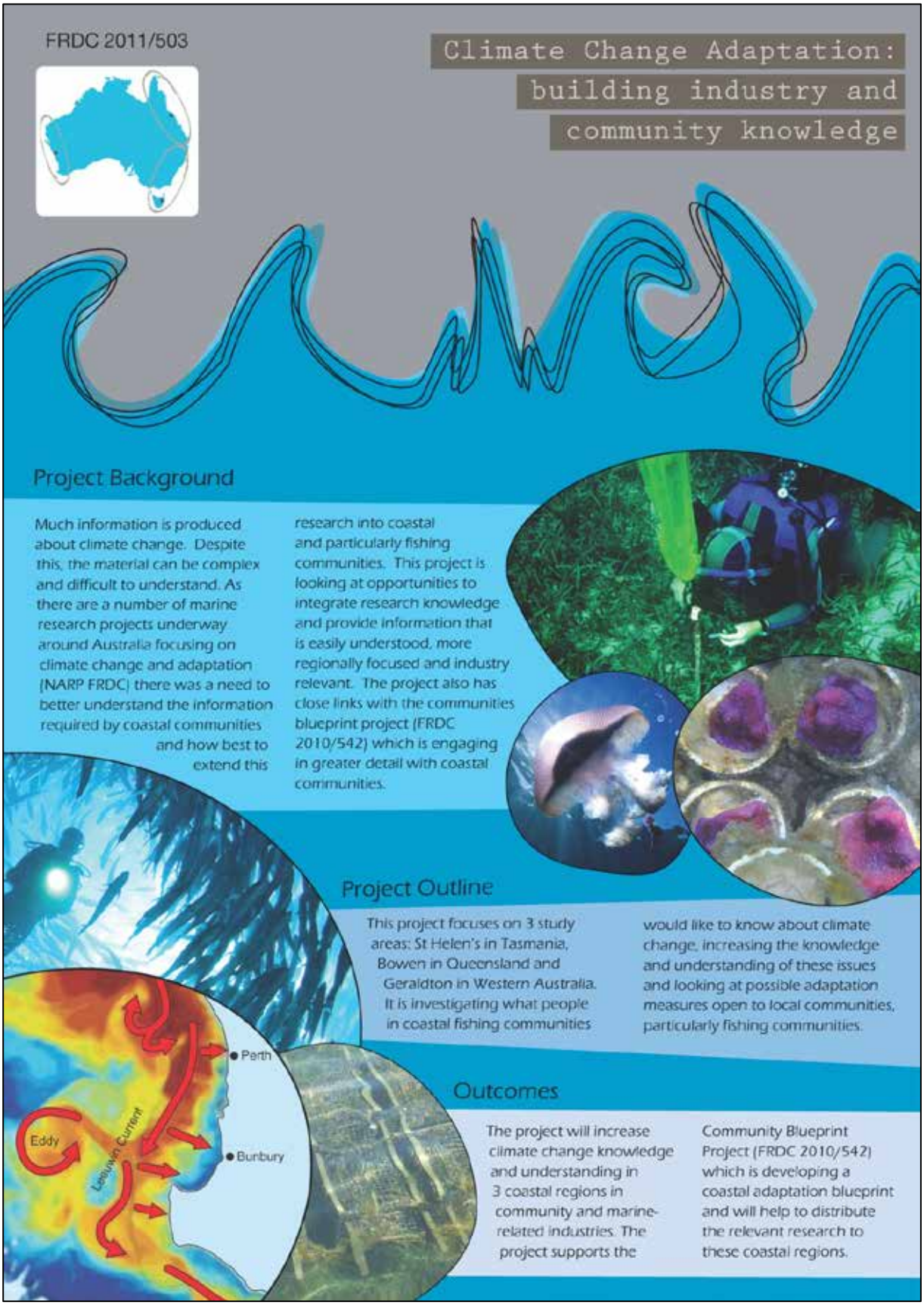
'It is not the strongest species that survive,
not the most intelligent
but the most responsive to change'

This quote seemed most appropriate given the project topic.

All fishers who provided photographs for the 'Seeing Change' exhibition were given a copy of the book of the same name (Attachment 5 Book). Those fishers with photos selected and enlarged for the exhibition were given the large photos at the end of the exhibition.

All project contributors and collaborators, including Departmental Heads, CEOs and the FRDC Board were sent a copy of the Seeing Change book and DVD (Attachment 5 Book, Attachment 4 Interactive DVD) with a letter explaining the project and acknowledged their contribution and support.

Attachment 1 Project Flyers



Benefit to the Community

The project will assist in understanding some of the barriers to climate science uptake and look beyond the traditional methods of community engagement to move beyond these barriers. It will provide information that is more relevant to the local coastal fishing communities by better understanding the type and content of information required and to deliver this information to maximise opportunities for climate change and adaptation strategies.

More Info

www.frdc.com.au/knowledge/Factsheets/Factsheet - Fisheries Climate Change.pdf

http://climatecommission.gov.au/basics/climate-change

www.oceanclimatechange.org.au/content/index.php/2012/home

www.cmar.csiro.au/climateimpacts

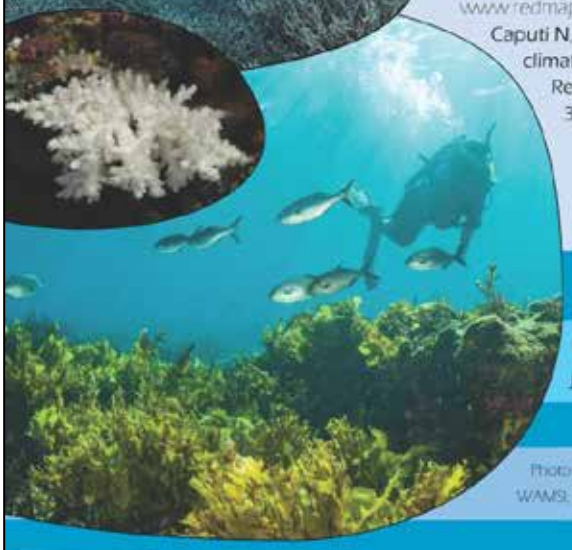
www.nccarf.edu.au/marine

www.climatechange.gov.au/publications/coastline/east-coast-rock-lobster.aspx

www.redmap.org.au

Caputi N, Pearce A and Lenanton R (2010) Fisheries-dependent indicators of climate change in Western Australia WAMSI Sub-project 4.2.3. Fisheries Research Report No. 213. Department of Fisheries, Western Australia. 36pp.

Pearce A, Lenanton R, Jackson G, et al. (2011) The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40pp.



Contact

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Photo credits: J. Shaw, S. Conway, T. Bosile, WAMSI, Department of Fisheries

The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.

Australian Government – Department of Climate Change and Energy Efficiency

Australian Government – Fisheries Research and Development Corporation

NCCARF – National Climate Change Adaptation Research Facility

NCCARF – National Climate Change Adaptation Research Facility – Adaptation Research Network – Marine Biodiversity and Resources

western australian marine science institution

OCEANWATCH AUSTRALIA

FRDC 2010/542

An adaptation blueprint for coastal communities

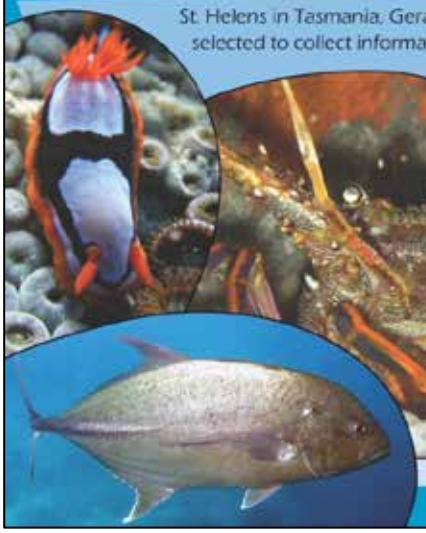
Project Background

Commercial and recreational fishing, tourism, aquaculture, fish processing, as well as transport and other associated industries all depend on the marine environment. These marine dependent sectors contribute to the economic and social wellbeing of communities and impact the way the community operates. The economic health of marine dependent sectors has significant flow-on effects to other parts of the economy which affects the social fabric of the community. Changes in the marine environment, such as those expected from climate change, are likely to significantly impact small- to medium-sized rural coastal communities with marine-dependent sectors. Consequently, the need for effective adaptation in these coastal communities has been recognised. Developing tools to reduce risks and increase capacity to cope with, and benefit from, change is urgently needed. These tools can't be developed unless we understand the needs, priorities, perceptions, and attitudes of people in the communities. Without such information, the ability to make timely and effective adaptation decisions will be limited.

Project Outline

St. Helens in Tasmania, Geraldton in Western Australia and Bowen in Queensland have been selected to collect information on:

- the role of marine dependent industries in communities;
- the connection of marine dependent industries to other economic activities;
- the role of marine dependent industries in the social fabric of communities; and
- the potential impacts on the community from changes in the utilisation of marine resources due to a changing climate.



Outcomes

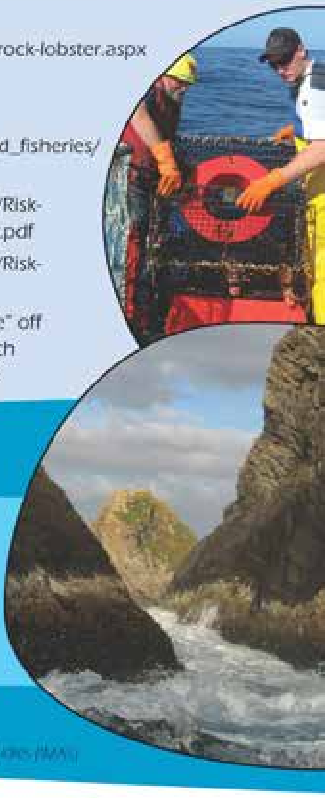
From the information collected, the project will develop a 'blueprint' for adaptation plan development in coastal communities at two levels:

1. A detailed assessment – where scientific input is available.
2. A general assessment – where scientific input is not readily available.

Benefit to the Community

The outcomes of the project will assist industries, governing bodies, communities and individuals to make informed decisions to maximise opportunities for the future. The location and case studies (i.e. size of town and types of industries) were chosen to enable our results to also address the needs and priorities of coastal rural communities throughout Australia. We are spending time in each community to learn about their marine industries. To register your interest or for more information please contact your local OceanWatch representative or the researchers listed below.

More Info



http://www.oceanclimatechange.org.au

http://www.climatechange.gov.au/publications/coastline/east-coast-rock-lobster.aspx

http://www.redmap.org.au/

http://nccarf.edu.au/marine

http://www.daff.gov.au/fisheries/environment/climate_change_and_fisheries/cc-action-plan-fish-aquaculture

http://www.imas.utas.edu.au/__data/assets/pdf_file/0019/221923/Risk-assessment-report_Part1-Fisheries-and-Aquaculture-Risk-Assessment.pdf

http://www.imas.utas.edu.au/__data/assets/pdf_file/0017/222092/Risk-assessment-report_Part2-Species-profiles-02.pdf

Pearce A, Lenanton R, Jackson G, et al (2011) The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40pp.

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Dr Nadine Marshall, CSIRO Townsville.
Email: Nadine.Marshall@csiro.au; Ph (07) 4753 8537

Dr Malcolm Tull, Murdoch University.
Email: M.Tull@murdoch.edu.au; Ph (08) 9360 2397

Photo credits: G. Carlos, T. Cooper, G.Pecl, Institute for Marine and Antarctic Studies (IMAS)

The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.

Australian Government Department of Climate Change and Energy Efficiency
Australian Government Fisheries Research and Development Corporation
NCCARF National Climate Change Adaptation Research Facility
NCCARF National Climate Change Adaptation Research Facility — Adaptation Research Network Marine Biodiversity and Resources
OceanWatch Australia
western australian marine science institution
UTAS
IMAS
CSIRO
Murdoch University

FRDC 2010/532

Changing currents in marine biodiversity governance and management: responding to climate change

Project Background

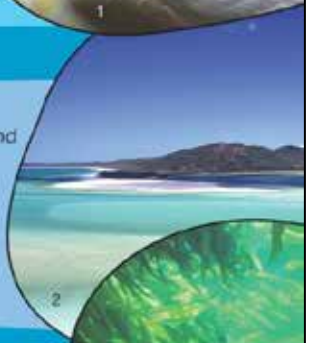
Climate change and a range of coastal and marine development pressures mean that we need an adaptive approach to conserving marine biodiversity. Current arrangements have limited adaptive capacity to deal with expected shifts in the structure and composition of marine ecosystems and habitats. This project is identifying adaptive governance and management arrangements for conserving marine biodiversity in the context of climate change. We focus on three study areas: Whitsundays (Queensland), Tweed-Morton (NSW/Queensland), and East Coast Tasmania. This work will assist in securing the future of marine biota and associated dependent values, including tourism and fisheries.

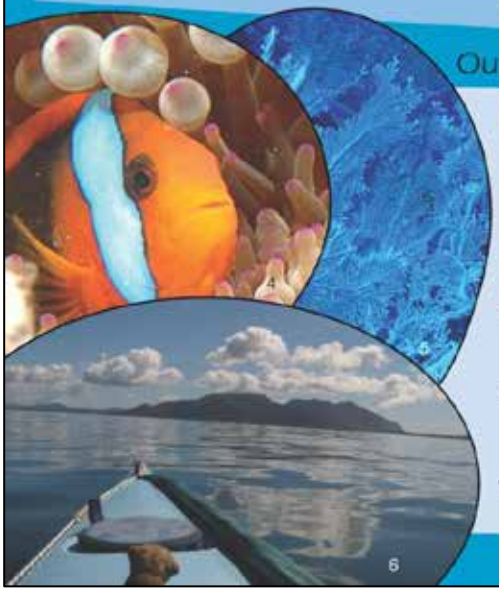
Project Outline

The project is:

- identifying governance and management requirements for conserving marine biodiversity in the context of climate change;
- assessing how well current arrangements meet these requirements;
- identifying alternative arrangements that would better conserve marine biodiversity; and
- providing advice to authorities on implementing reforms.

To do this, we are using scenario planning, system modelling and workshops with stakeholders and authorities.



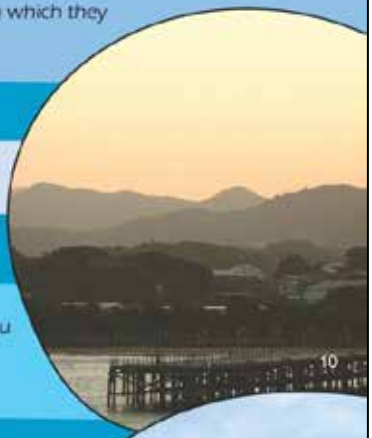


Outcomes

1. A set of governance and management requirements for conserving marine biodiversity in the face of major environmental change. These requirements are applicable to all marine situations, and provide a 'benchmark' against which current and potential future arrangements can be assessed.
2. Assessment of how well current arrangements in three study areas meet the requirements, highlighting strengths and aspects that could be improved.
3. Identification of alternative arrangements that better meet the requirements, and therefore deliver more effective responses to climate change and development pressures.
4. Recommendations for reforms to current arrangements that will, through improved adaptive capacity, better conserve marine biodiversity.

Benefit to the Community

Many people across Australia, and internationally, care about the future of marine biodiversity. This research hopes to benefit these people by helping bring about governance and management arrangements that improve our capacity to conserve marine biodiversity. Through improving conservation of the resource on which they depend, we aim to benefit the sustainability of marine nature-based tourism industry. Sustaining marine tourism would also yield economic benefits to those regional communities dependent on this industry. In the medium to long-term, recreational and commercial fishers also stand to benefit from improved capacity to conserve marine biodiversity and the associated fish stocks on which they depend.



More Info

For further information and updates:
www.geog.utas.edu.au/geography/changingcurrents/

Contact

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Dr Julie Davidson
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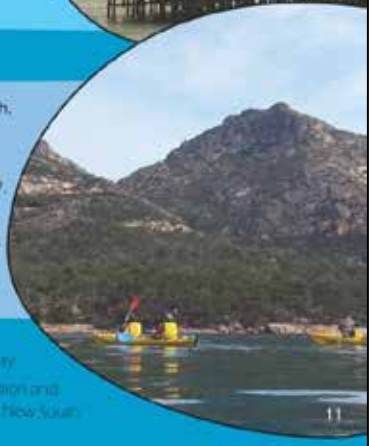
Images



1. Loggerhead sea turtle (*Caretta caretta*). Image: Brian Gratwicke; 2. Whitehaven Beach, Whitsunday Island. Image: Damien Dempsey; 3. Kelp forest, Tasmania. Image: Lorne Kriwoken; 4. Clownfish, Great Barrier Reef, Cairns, Australia. Image: Leonard Low; 5. Fan coral, Pacific. Image: Lorne Kriwoken; 6. Kayak, Tasmania. Image: Chris Allchin; 7. Fish and scuba diver, Tasmania. Image: Lorne Kriwoken; 8. Phytoplankton bloom, Great Barrier Reef. Image: Jesse Allen; 9. Shy albatross. Image: JJ Harrison; 10. Coffs Harbour. Image: frumbert, CC; 11. Sea kayaking, Coles Bay, Tasmania. Image: Trin

Disclaimer: The use of these photos in no way suggests the author endorses this work

The research team involves collaboration from the University of Tasmania and Queensland University. Agency partners are: Australian Government's Department of Sustainability, Environment, Water, Population and Communities; Marine Division; Great Barrier Reef Marine Park Authority; Queensland Parks & Wildlife Service; New South Wales Government of Primary Industries (Division of Fisheries); Tasmanian Parks and Wildlife Service.

The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.

Australian Government
Department of Climate Change and Energy Efficiency

Australian Government
Fisheries Research and Development Corporation

NCCARF
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MARINE BIODIVERSITY AND RESOURCES

OCEANWATCH
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UTAS

FRDC 2010/534

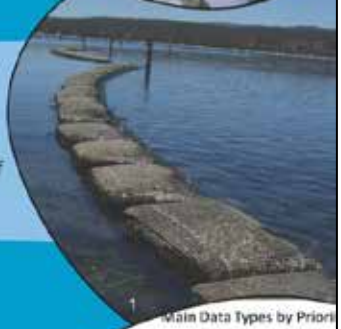
An Information Portal for the Oyster Industry

Project Background

The Australian oyster industry collects a great deal of environmental data through their monitoring programs However this data is dispersed, inaccessible and/or difficult to interpret. Therefore, the industry identified a need to collate this information in one place – via an information portal. By accessing and relating information such as environmental and management approaches with oyster performance, the oyster industry should become stronger and more resilient. It will provide the industry with the capacity to be pro-active in their adaptation to climate change.

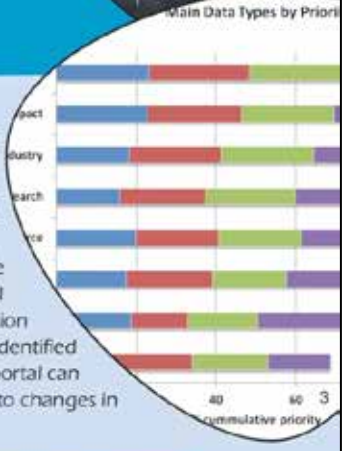
Project Outline

This project will collate and translate environmental, industry, catchment and climate related data into a user-friendly, online, map-based portal. The oyster industry, its stakeholders and Natural Resource Management agencies will be consulted throughout, with an initial focus on 4 oyster producing areas in NSW, for this proof of concept project.



Outcomes

Oyster industry members and stakeholders will provide feedback throughout the project for a portal that includes spatial, temporal, and quantitative information that is of value to the industry. Such conditions may include water quality parameters, harmful algal blooms and lease or river oyster production performance. Scenarios and applications identified in the project will demonstrate how the portal can inform practical and adaptive responses to changes in environmental conditions.



Benefit to the Community

Environmentally healthy coasts and estuaries are crucial to the production of seafood. Oyster farmers and estuary fishermen rely on healthy waterways for seafood production and the continuation of their industry. Increasing understanding of what the important drivers are for the success and long life of their industries is vital. Such information exists and the delivery of it in an easily accessible format will benefit the industry and will add value to existing monitoring programs.

More Info

http://www.uow.edu.au/science/research/smfc/oysterinformationportal/index.html
http://emmbr.org/content/images/uploads/OYSTER_REPORT_FINAL_web.pdf

Contact

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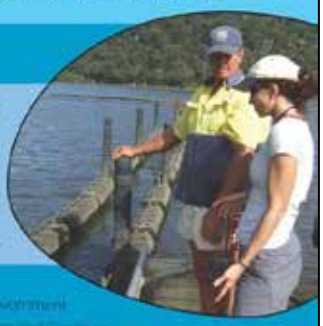
Mobile: 0427 285 999; Email: arubio@uow.edu.au

Dr Pia Winberg
Shoalhaven Marine and Freshwater Centre, University of Wollongong,
Shoalhaven Campus, Nowra, 2541
Phone: 02 4429 1522 ; Mobile: 0429 338 846; Email: pia@uow.edu.au

Images

1. Floating oyster cultivation units in Merimbula Lake, NSW. 2. Oyster industry priorities for inclusion the Oyster Information Portal; 3. Oyster grader; 4. Demonstration of the Oyster Information Portal; 5. Grower driving through oyster leases, Shoalhaven River (NSW); 6. Comparing Sydney rock oysters (*Saccostrea glomerata*) meat quality.



With in-kind support from the NSW Food Authority, Coastal Councils and Government Departments in the areas of Port Macquarie-Hastings, Hawkesbury, Shoalhaven and Eurobodalla

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National Climate Change Adaptation Research Facility
Adaptation Research Network MARINE BIODIVERSITY AND RESOURCES

OCEANWATCH AUSTRALIA

western australian marine science institution

NSW Catchment Management Authority Southern Rivers

NSW

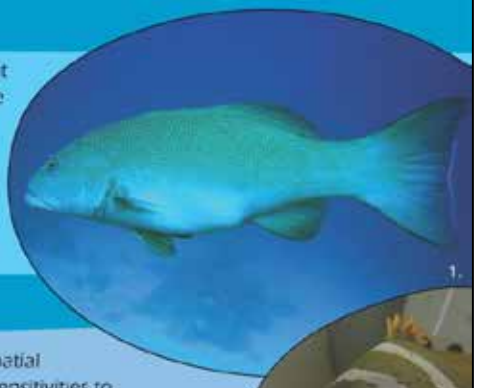
Northern Rivers CMA

FRDC 2010/554

Effects of climate change on reproduction, larval development, and population growth of coral trout

Project Background

Climate change is emerging as the single greatest threat to coral-reefs and reef fish. However, current research is limited to small species, such as anemone fishes, which have little relevance to seafood and fisheries. Our goal is to test the effects of increasing temperature and the acidity of ocean water on coral trout (*Plectropomus leopardus*), which is the most important fisheries species on the Great Barrier Reef. As such, this research will clearly establish the economic consequences of climate change on coral reefs in Australia and overseas.



Project Outline

1. To assess sensitivities of coral trout to climate-related changes in temperature and seawater chemistry, during fertilisation and early larval development;
2. To test the effects of increasing temperature and ocean acidification on growth, condition, behaviour and survivorship of early post-settlement coral trout;
3. To test for spatial variation in sensitivities to increasing temperatures for coral trout in three distinct sectors along the Great Barrier Reef; and
4. To measure coral-dependence at different ontogenetic stages, to test whether coral trout will be adversely affected by climate-induced bleaching and coral loss.

Outcomes

One of the likely outcomes of this research is that certain populations (e.g., northern or southern populations) will be much more vulnerable to projected climate impacts (due to their differences in sensitivity and/ or exposure to environmental changes), which may necessitate a complete overhaul of planning and policy processes (e.g. new spatial management plans) to ensure sustainability of future catches.

If climate change is likely to undermine the long-term sustainability of wild harvests of coral trout then aquaculture may prove critical in meeting increasing national and international demands for coral trout. In this instance, data on key sensitivities of coral trout to changing environmental conditions (especially during early life-history stages) will be fundamental in assessing logistical and infrastructure needs (e.g. sea cages versus closed-system land-based aquaculture) for successful aquaculture production of this important and valuable food fish.

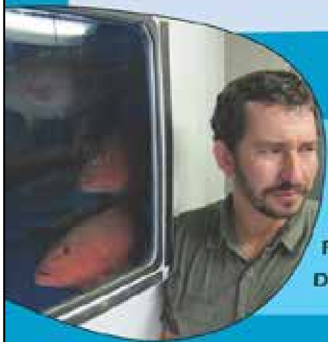
Benefit to the Community

This is the first comprehensive study on effects of climate change on the biology and ecology of a commercially important tropical reef fish. Moreover, this study is focused on the single most important coral reef fisheries target species, coral trout (specifically *Plectropomus leopardus*, in the first instance). Identifying the extent to which this species may be sensitive to climate related changes in environmental conditions (especially temperature and acidity of waters) within the Great Barrier Reef Marine Park and associated nearshore waters is critical in assessing the vulnerability of reef fisheries to climate change. Ultimately, this research will help to fill key knowledge gaps about climate change impacts on larger fish which are fundamental to improving management, and in turn improve the capacity of industries and communities along the Great Barrier Reef to adapt to this changing environment.

More Info

Pratchett M, Reynolds A (2012) Effects of Climate Change on Coral Trout (*Plectropomus leopardus*), the Most Important Marine Fisheries Species in Tropical Australia. Marine Adaptation Bulletin (MAB), Vol 4, Iss 1, Autumn 2012; p2. ISSN: 2200-5684

http://arnmbr.org/content/images/uploads/MAB_v4_i1_Autumn_2012_ISSN_2200-5692.pdf



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Mr Adam Reynolds – adam.reynolds@deedi.qld.gov.au

Prof. Philip Munday – philip.munday@jcu.edu.au

Dr. Richard Knuckey – richard.nuckey@deedi.qld.gov.au

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western australian marine science institution
OCEANWATCH AUSTRALIA
Queensland Government
JAMES COOK UNIVERSITY AUSTRALIA
ARC Centre of Excellence Coral Reef Studies

FRDC 2011/040

Estuaries and Coasts: adaptation options for a changing climate

Project Background

Australia's estuaries and coasts are important habitats. However, both Climate Change impacts (e.g. sea-level rise, changing rainfall and increased storm frequency/intensity) and various human impacts have detrimental influences on such areas, putting them at risk. Much Climate Change research has concentrated on mitigation strategies, which involve trying to offset or reverse their effects, but recently the focus has begun to shift towards adaptation strategies, with the purpose of minimising the negative impacts of Climate Change. Consequently, this project focuses on developing and assessing adaptation strategies for estuaries and other coastal ecosystems to optimise ecosystem functions, fisheries outcomes and biodiversity values in a changing world.

1

Project Outline

The project is aimed at producing a framework to facilitate Climate Change Adaptation Strategy decision-making that is relevant across Australia's estuaries and coastal ecosystems. We will investigate tools for making decisions and test the benefits of the framework on a number of case studies.

3

4

2

Outcomes

The framework will be generally applicable across Australia, but also adaptable to regional differences. The project will provide a range of strategies and tools to facilitate management that is sensitive to:

(a) regional differences;

(b) the complex nature of estuaries and their various habitats;

(c) the implications that adaptation strategies could have on the services and values of estuaries;

(d) the competing needs, scales of influence, impacts, outcomes, consequences and costs across the sectors affected by Climate Change and adaptation responses (policy, management, environment, social/urban, financial/industry).

Benefit to the Community

The project will develop a framework to assist coastal managers make informed, appropriate adaptation strategies that are sensitive to the diverse end users needs, including; recreational and commercial fishers, aquaculture farmers, and recreational users of Australian coasts. Minimising the negative influences of Climate Change on estuarine and coastal habitats is vital for the continued health and wellbeing of the environment which communities such as those rely upon.

More Info

National Climate Change Adaptation Research Facility
http://nccarf.jcu.edu.au/terrestrialbiodiversity/

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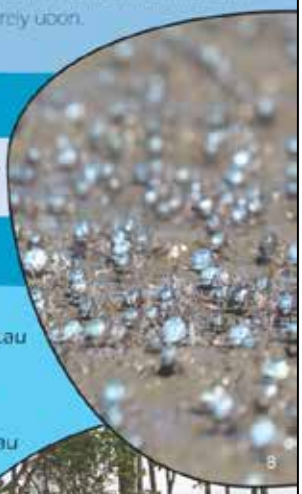
Mike Ronan: Mike.Ronan@derm.qld.gov.au
Ilva Sporne: i.sporne@griffith.edu.au



Images

1. Destruction of mangrove habitat after tropical cyclone YASI in 2011; 2. Coastline, Dawson Inlet, WA. 3. White-Bellied Sea-Eagle with a fish at Blacksoil Creek-Qld; 4. Stranded loggerhead turtle at Lucinda Beach-Qld; 5. Estuarine habitat at Parry Inlet WA; 6. crocodile resting on the mangrove banks in the Daintree-Qld; 7. The mouth of the Moore Estuary, WA; 8. Soldier crabs on the intertidal banks of the Ross River-Qld; 9. Flooded mangrove forest.

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MARINE BIODIVERSITY AND RESOURCES

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CSIRO

Griffith UNIVERSITY

JAMES COOK UNIVERSITY AUSTRALIA

TropWATER

FRDC 2011/233

Growth opportunities & critical elements in the value chain for wild fisheries & aquaculture in a changing climate

Project Background

Much of climate change research on fisheries to date been on the species biology and the perceptions of fishers. Climate change impacts can spread from the wild catch end of the chain, or impact directly on higher elements of the value chain. Therefore opportunities for improvement, efficiencies and adaptation may occur at different points along the value chain or through different industry activities. The adaptation options and efficiency suggestions are directly linked to policy and management agencies with the inclusion of senior departmental staff from Western Australia, New South Wales, Victoria, Queensland, Tasmania, South Australia, and AFMA.

Project Outline

Analysis of all activities within a sector known as value chain analysis will reveal climate-related adaptations for a selected set of fisheries representing commercial (e.g. southern rock lobster, prawn), indigenous (Torres Strait lobster) and aquaculture sectors (oyster, prawn). Information on the existing conditions and prospective opportunities and barriers will form the basis to develop adaptation strategies through life cycle analysis, demand analysis and social perception studies.

Outcomes

This project's outcomes will include:

- Value chains (present and future) for the case study fisheries and aquaculture businesses and life cycle analysis (LCA) for selected value chains will identify inefficiencies and potential points for increasing profitability.
- Market integration and demand analysis for each case study will identify strengths and weaknesses in the value chain, and together with the life cycle analysis, contribute to the development of adaptation options.
- Development of realistic adaptation management and policy options will enhance cost-effectiveness along the supply chain. We expect to generate targeted recommendations in relation to efficiencies and reduction of the carbon footprint. Consultation and interaction with stakeholders (industry and policy) via social research methods (interviews and workshops) will evaluate the feasibility of adaptations across the fisheries value chain.

Benefit to the Community

Potential impact of the research:

- Stakeholders engaged in planning their future;
- Future strategies that take advantage of opportunities identified in the LCA, demand and market integration analysis;
- Pathways for policy and management support of fisheries adaptation are constructed. Planning documents can now include a climate adaptation strategy for major fisheries; and
- Development of approaches to aid fisheries adapt to climate change across the value chain.

More Info

http://www.cmar.csiro.au/climateimpacts/index.htm

http://www.imas.utas.edu.au/

http://www.dpi.vic.gov.au/fisheries

Brown CJ, Fulton EA, Hobday AJ, et al (2009) Effects of climate-driven primary production change on marine food webs: implications for fisheries and conservation. Global Change Biology, 16, 1194-1212.

Hobday AJ, Poloczanska ES and Matear R (2008) Implications of Climate Change for Australian Fisheries and Aquaculture: A preliminary assessment: Report to the Department of Climate Change, Canberra, Australia, August 2008. Available from http://www.cmar.csiro.au/climateimpacts/reports.htm.

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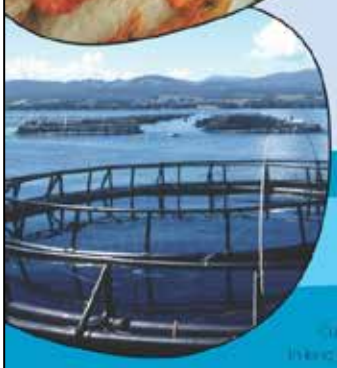

Contact

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Dr Rodrigo Bustamante: Rodrigo.Bustamante@csiro.au

Collaborators: CSIRO, IMAS, Fisheries Victoria

Linkage support: AFMA, QDAFF, NSW DPI, Victoria, WA Department of Fisheries, SARDI, DEEDI, QED

The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.

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OCEANWATCH AUSTRALIA

western australian marine science institution

FRDC 2010/521

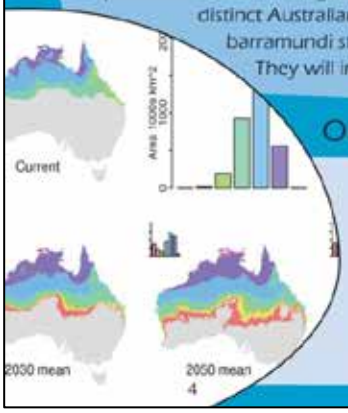
The vulnerability of an iconic Australian finfish to an altered climate: Barramundi (*Lates calcarifer*)

Project Background

Barramundi-associated industries are important to tropical communities. This species supports a strong commercial and aquaculture fishery and is an important recreationally targeted fish in tropical waters. Because of this, there is a need to understand future climate patterns and how it will impact on Barramundi. In particular, the climate impact on their distribution, changes to the carrying capacities of the environment and local abundances within the commercial and recreational fisheries, as well as the threats and opportunities for aquaculture. This project will determine how resilient Australian populations are to change and provide adaptation strategies on how barramundi will respond to a changing climate. The project will also determine what genetic strains will perform best for aquaculture production.

Project Outline

Researchers at James Cook University are investigating the genetic and physiological tolerances to thermal and parasitic stresses of five genetically distinct Australian barramundi strains. They will investigate different methods to identify how strains respond when placed under varying stresses. Modelling against future climate change scenarios will then be incorporated to predict what strains may be at threat, or advantaged, under future conditions.



Outcomes

The project will illustrate:

a) possible changes in wild fishery numbers;
b) aquaculture threats and opportunities;
c) adaptation strategies based on commercial and recreational fishing exploitation of natural population variability; and
d) increased understanding of biophysical factors.


Benefit to the Community
Beneficiaries of knowledge from this project will include fisheries and conservation managers, aquaculturists, policy planners, and commercial and recreational fishers. The project will for the first time measure the effects an altered climate will have on the barramundi fishery and allow the identification of any fisheries sectors under threat, or that may become available for exploitation. This information will aid long term resource planning, future fishery management and aquaculture zoning plans. Identification of barramundi that can survive in warmer waters and be resilient to disease will also permit the aquaculture industry to farm more tolerant and efficient strains.
More Info
http://www.jcu.edu.au/mtp/research/projects/JCU_083894.html
Contact
Associate Professor Dean Jerry
Centre for Sustainable Tropical Fisheries and Aquaculture
and School of Marine and Tropical Biology
Phone: 07 4781 5586; Email: dean.jerry@jcu.edu.au
Images
1. Seacage barramundi facility; 2 Large barramundi caught; 3. Tropical estuary habitat of barramundi; 4. Current and predicted future suitability (estimated as gains per day) for barramundi aquaculture under changing climate conditions; 5. Inspecting sedated barramundi for parasites; 6. Copepod (Lernanthropus latis) infection on gills; 7. Experimental hatching of parasites under different temperature and salinities; 8. Barramundi juveniles. Photo credits: Kate Hudson & Dean Jerry.
The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.
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AUSTRALIA
JAMES COOK UNIVERSITY
AUSTRALIA
Centre for Sustainable Tropical Fisheries & Aquaculture

FRDC 2011/533

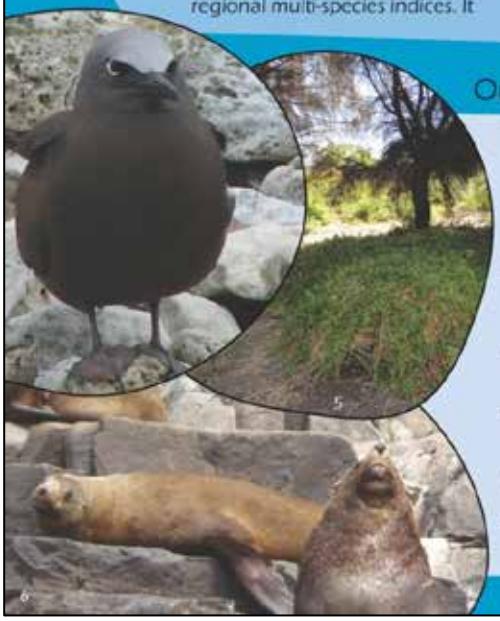
Developing adaptation options for seabirds and marine mammals impacted by climate change

Project Background

Climate change is already impacting Australia's oceans. Responses by marine life to both climate variability and change have been documented for lower trophic (food chain) levels, however, Australia's iconic higher trophic level marine animals, including conservation-dependent seabirds and marine mammals, are poorly understood. These species are protected throughout Australia and in some cases populations are recovering from previous human exploitation. Improved understanding of climate change impacts versus other non-climate threats is needed to implement appropriate and timely adaptive management responses. In addition, monitoring approaches for some species may need to be reassessed and modified to better detect the impacts of climate change, and assess effectiveness of management actions.

Project Outline

This national project evaluates impacts and adaptation options for seabirds and marine mammals, including the development of climate indicators over large regions via regional multi-species indices. It will develop monitoring protocols to increase the detection of climate-related effects. Overall, this project will support adaptation efforts by those managing these iconic animals.



Outcomes

1. Connect researchers, managers and policy makers to focus on climate monitoring and adaptation options for seabirds and marine mammals.
2. Link ongoing seabirds and marine mammal monitoring programs with relevant wildlife and conservation management agencies.
3. Determine climate influence on selected seabird bird and mammal populations around Australia.
4. Develop protocols for monitoring impacts of environmental variation on indicator species.
5. Develop multi-species productivity indicators for Australian regions.
6. Provide practical adaptation guidelines for science and management, including on-ground monitoring protocols.

Benefit to the Community

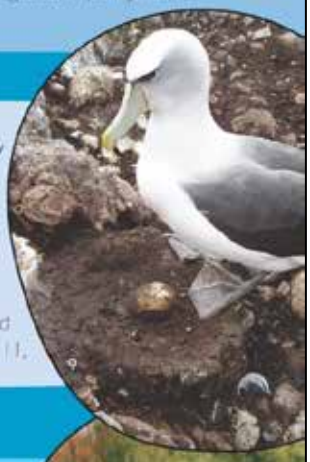
improved management and conservation of an important component of the marine ecosystem. These species are often seen as iconic and of cultural value. They can also have significant economic value, particularly for tourism (e.g. Little Penguins of Phillip Island, Australian Sea Lions of Seal Bay, Kangaroos Island, and bird-watching associated tourism), and are important in the ecosystem for nutrient transfer, seed dispersal and as movers of organic matter through soil layers. Development of appropriate adaptation options and monitoring protocols for seabirds and marine mammals based on improved knowledge and consultation with researchers, managers and policy makers.

More Info

Marine Report Card (including seabird chapter) **http://www.oceanclimatechange.org.au/content/index.php/site/welcome/**

Climate Change and the Great Barrier Reef: A Vulnerability Assessment **http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/climate_change_vulnerability_assessment/climate_change_vulnerability_assessment**

Chambers LE, Devney CA, Congdon BC, et al (2011) Observed and predicted effects of climate on Australian seabirds. Emu, 111, 235-251.



Contact

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Dr Lynda E. Chambers: L.Chambers@bom.gov.au
Assoc. Prof. John P.Y. Arnould: jarnould@deakin.edu.au

Images

1. Australian fur seal female exposing flippers to facilitate cooling in high ambient temperatures. 2. Protection of seabird habitat through human exclusion. 3. Juvenile Bridled Tern at Penguin Island, WA. 4. Noddy on a beach, Lord Howe Island. 5. Nesting box planted over with vegetation provides added insulation for nesting penguins. 6. Sea level rise and storms may make low elevation nesting areas unsuitable in future. 7. Supplemental feeding of chicks may improve survival. 8. Boardwalk over Short-tailed Shearwater colony reduces human impact. 9. Improving the availability of nest material in wet years may improve breeding success of some seabirds. 10. Feral cat hunting in seabird colony. Photo credit: Lynda E. Chambers & Alistair Hobday.

The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.

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FRDC 2010/535

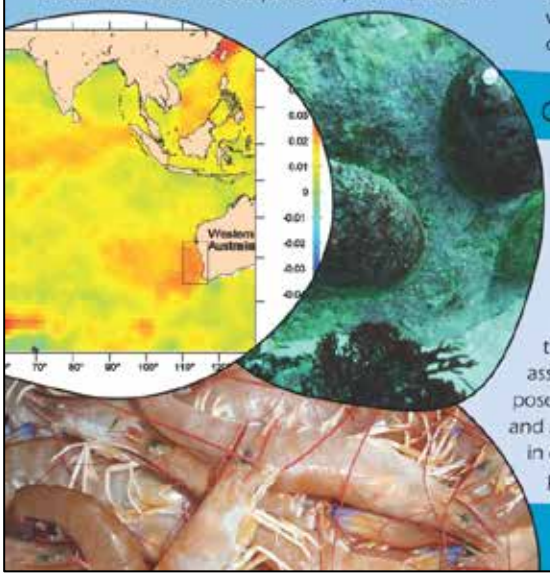
Management implications of climate change effects on fisheries in Western Australia

Project Background

Fisheries scientists and managers worldwide face the challenge of understanding, predicting and incorporating the effects of climate change when assessing the sustainability of our marine resource. This project aims to understand the stock assessment and management implications that climate change may be having on fish stocks in Western Australia. Both short and long-term changes in climate patterns will impact on the marine environment, which in turn will affect the life cycle of fish stocks, their food source, and important biological aspects such as growth and distribution. If the biology and habitat of fish stocks slowly change then it is also important to develop appropriate management policies for dealing with possible future changes.

Project Outline

The first phase of the project is to understand how environmental factors such as water temperature and salinity affect the fish stocks in WA based on available historical data. The second phase looks at historical trends and possible future scenarios of WA marine environments using climate model projections. For example, if water temperatures off the south-west coast of WA will likely rise by another 2°C in 2070 compared to present, and the occurrences of marine heatwaves become more frequently, how will this impact on the highly sensitive and valuable abalone fisheries in WA. Lastly, the changes that are occurring now and the expected changes from climate change requires management consideration. This means reviewing existing management arrangements to examine their robustness to climate change effects and developing management policies in consultation with stakeholders to deal with climate change effects on fish stocks.



Outcomes

The outcomes of this project will deliver greater understanding into the complex relationships between the environment and the biology of key WA commercial fisheries species. This knowledge will help our risk assessment of species vulnerability to the effects of climate change. Through assessing the level of risk climate change poses for key fisheries, research strategies and management policies will be developed in consultation with stakeholders to deal with potential climate change effects on fish stocks.

Photo credits: Department of Fisheries


Benefit to the Community
We envisage both positive and negative impacts from climate change and these are likely to be different on different fish stocks. Therefore both commercial and recreational sectors would greatly benefit in understanding what the predicted changes are and how this will impact their future fishing operations and their economic viability. For example, range extension of tropical species further south along the WA coastline may result in greater bycatch of these species by different commercial sectors and also greater fishing pressure from the recreational sector, especially if it is a popular catch.
Outcomes of this project will also inform fisheries managers in developing both short and long-term management policies to ensure on-going sustainability of fish stocks.
More Info
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Pearce A, Lenanton R, Jackson G, et al. (2011) The "marine heat wave" off Western Australia during the summer of 2010/11. Fisheries Research Report No. 222. Department of Fisheries, Western Australia. 40pp.
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Front: Map - Rate of increased sea surface temperature in the Indian Ocean during 1951-2004 (from Pearce and Feng, 2007). The box indicates the hot spot along the south west of WA.
The National Climate Change Adaptation Research Plan (NARP) for Marine Biodiversity & Resources identifies research priorities in five sectoral areas: marine aquaculture, commercial & recreational fishing, conservation management, tourism & recreational uses, and cross-cutting issues.
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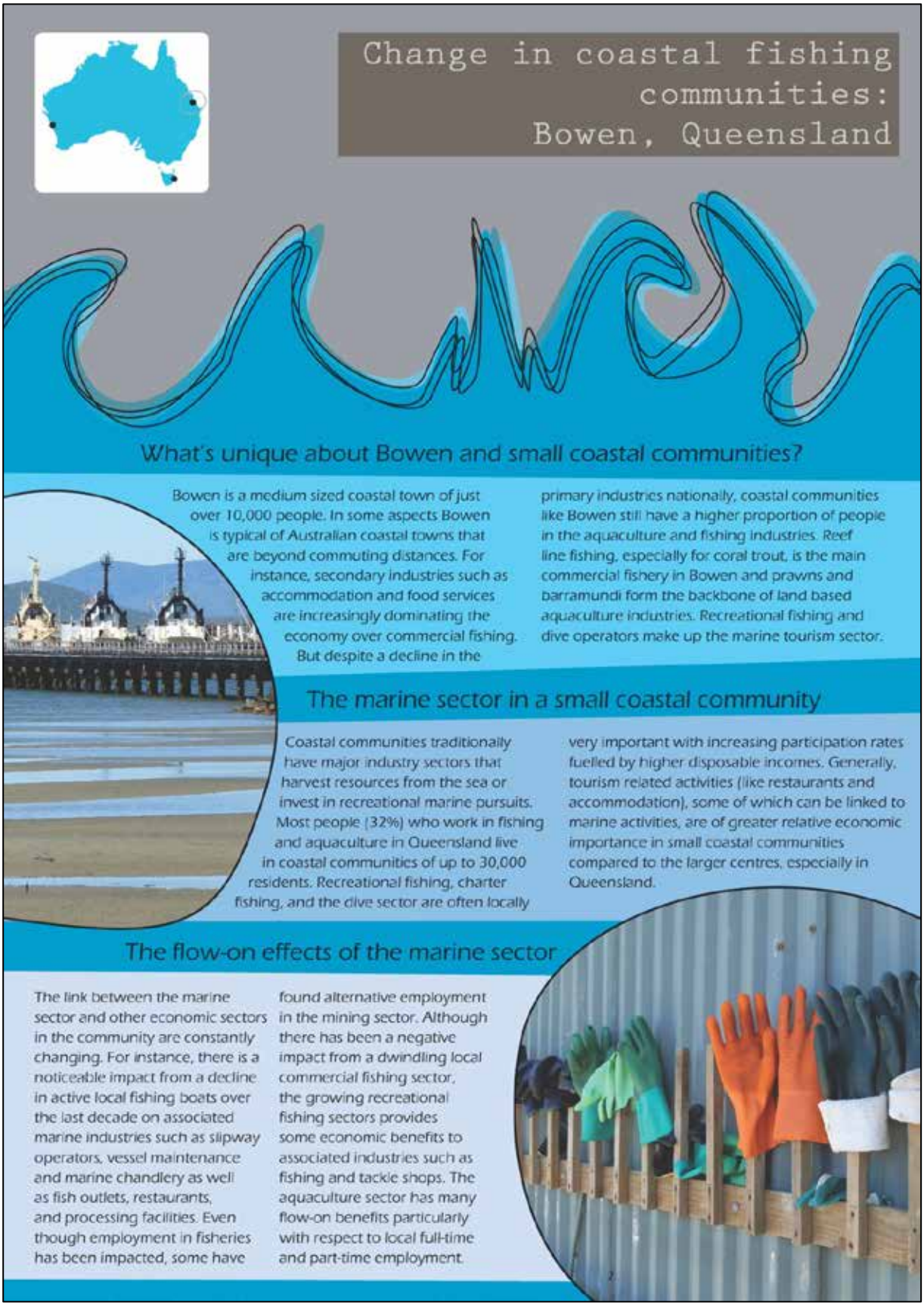
Government of Western Australia
Department of Fisheries

Attachment 2 Case Study Brochures

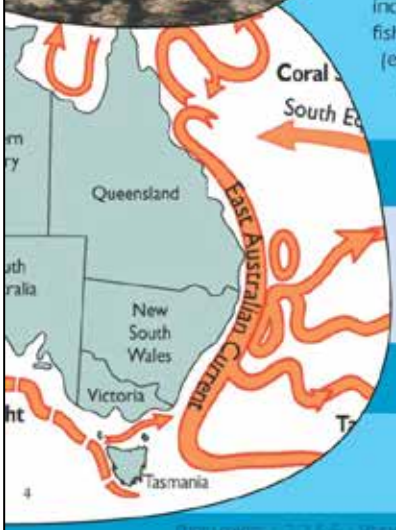


What you said: Changes in the marine sector

The size of the local commercial fishing fleet has declined significantly to around 10 active boats. Marine park zoning and changes in management partly explained this decline. The social implication of a declining fleet and change in fishing behaviour has been noticeable in the local community. The dive sector has remained relatively stable and has been consistently present in the area for a number of years. Even though there had been a charter fishing operator in the area it was difficult to operate without cross-subsidisation from other business (much like the dive sector).

What you said: Changes in the marine environment

Decline in abundance of several commercial species was due to a number factors including: commercial and recreational fishing pressure and climate related factors (especially the effect of cyclones and storms but also coral bleaching). Misinformation about the physical infrastructure and marine environment destruction after cyclonic events was responsible for prolonged economic hardships in the local community with tourists staying away. However, at present the local marine environment seemed to be 'repairing' benefitting the dive charters.



What the Scientists Say

There have been a number of cyclonic weather events that have had destructive effects on the marine environment in the past years. Marine species respond differently to these destructive effects with the recovery rate of some species being higher than others and the ability of some species to move to more suitable places.

Contact

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Disclaimer: The information presented is from a range of sources including Census data, published reports, and interviews held for the Blueprint project. The aim of the flyer is to present some preliminary and highly simplified information. Further details will be provided after the full project finishes at the end of 2013.

Census and other existing research information were combined with information collected from 3 coastal towns in Australia, St Helens TAS, Bowen QLD and Geraldton WA. The information presented here is preliminary and should not be considered final for the 'blueprint for coastal community adaptation planning' project. The 'blueprint for coastal community adaptation planning' project will be finalised by the end of 2013.

Change in coastal fishing communities: Geraldton, Western Australia

What's unique about Geraldton and small coastal communities

Although a relatively large regional town at a just over 30,000 people, in some aspects Geraldton is typical of Australian coastal towns that are beyond commuting distances. For instance, the health services and retail sectors assume a larger role in these communities as they provide services to the surrounding areas.

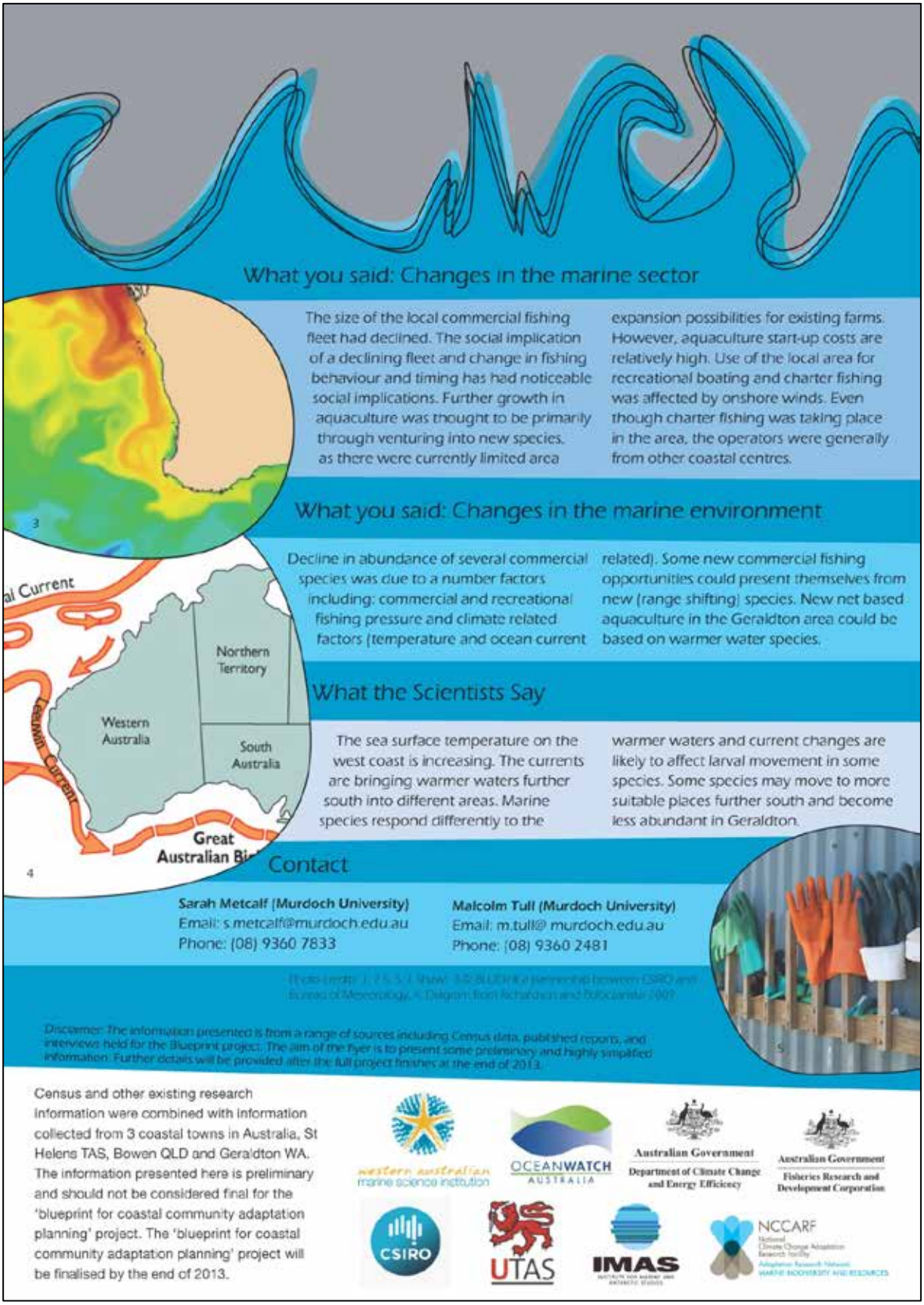
However, large coastal communities in Western Australia, like Geraldton are different to other States in that the construction sector associated with the mining industry is particularly important. Even though Geraldton has traditionally been characterised as a fishing town, commercial fishing also has a much greater role in smaller coastal communities in Western Australia when compared with other Australian communities.

The marine sector in a small coastal community

Australian coastal communities traditionally have major industry sectors that harvest resources from the sea. Recreational fishing and charter fishing are often locally very important with increasing participation rates fuelled by higher disposable incomes. Generally, tourism related activities (like restaurants and accommodation), some of which can be linked to marine activities, are of greater relative economic importance in small coastal communities compared to the larger centres.

The flow-on effects of the marine sector

The link between the marine sector and other economic sectors in the community are constantly changing. For instance, there is a noticeable impact of a decline in active local fishing boats over the last 4 years on associated marine industries such as slipway operators, vessel maintenance and marine chandlery as well as fish outlets, restaurants, and processing facilities. Even though employment in fisheries has been impacted, many have found alternative employment in the mining and oil and gas sector. Although there have been negative flow on effects from the smaller commercial fishing sector, the recreational fishing sector provides some economic benefits to associated industries such as fishing and tackle shops. The aquaculture sector has many flow-on benefits including local employment and direct pearl sales to tourists help promote Geraldton as a tourism destination.


What you said: Changes in the marine sector
The size of the local commercial fishing fleet had declined. The social implication of a declining fleet and change in fishing behaviour and timing has had noticeable social implications. Further growth in aquaculture was thought to be primarily through venturing into new species, as there were currently limited area expansion possibilities for existing farms. However, aquaculture start-up costs are relatively high. Use of the local area for recreational boating and charter fishing was affected by onshore winds. Even though charter fishing was taking place in the area, the operators were generally from other coastal centres.
What you said: Changes in the marine environment
Decline in abundance of several commercial species was due to a number factors including: commercial and recreational fishing pressure and climate related factors (temperature and ocean current related). Some new commercial fishing opportunities could present themselves from new (range shifting) species. New net based aquaculture in the Geraldton area could be based on warmer water species.
What the Scientists Say
The sea surface temperature on the west coast is increasing. The currents are bringing warmer waters further south into different areas. Marine species respond differently to the warmer waters and current changes are likely to affect larval movement in some species. Some species may move to more suitable places further south and become less abundant in Geraldton.
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Malcolm Tull (Murdoch University)
Email: m.tull@ murdoch.edu.au
Phone: (08) 9360 2481
Northern Territory
Western Australia
South Australia
Leeuwin Current
Great
Disclaimer: The information presented is from a range of sources including Census data, published reports, and interviews held for the Blueprint project. The aim of the flyer is to present some preliminary and highly simplified information. Further details will be provided after the full project finishes at the end of 2013.
Census and other existing research information were combined with information collected from 3 coastal towns in Australia, St Helens TAS, Bowen QLD and Geraldton WA. The information presented here is preliminary and should not be considered final for the 'blueprint for coastal community adaptation planning' project. The 'blueprint for coastal community adaptation planning' project will be finalised by the end of 2013.
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Change in coastal fishing communities: St Helens Tasmania

What's unique about St Helens and small coastal communities?

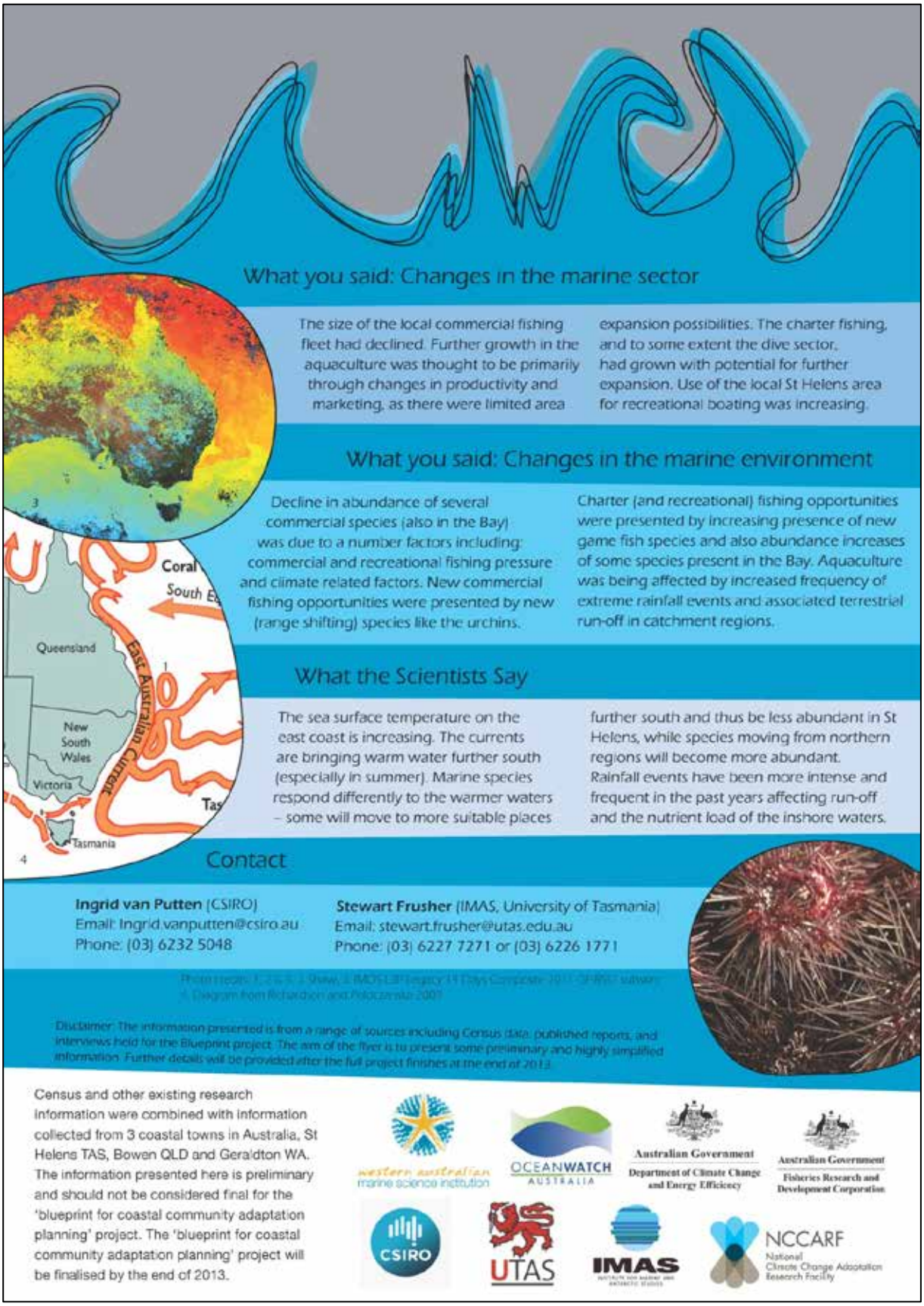
Although a relatively small town at less than 4,000 people, St Helens is typical of the many small coastal towns in Tasmania that are beyond commuting distances, that makes up nearly 30% of the population. Secondary industries such as accommodation and food services are increasingly dominating St Helens economy over commercial fishing. But despite a decline in the primary industries nationally, small coastal communities like St Helens still have a higher proportion of people in the aquaculture and fishing industries. Like other small coastal communities, St Helens has a greater proportion of older people, average household incomes are lower, and work opportunities are limited. St Helens is unique in the fact that it is in a marine hotspot, meaning that climate driven changes in the marine environment are happening relatively fast.

The marine sector in a small coastal community

Coastal communities traditionally have major industry sectors that harvest resources from the sea. Recreational fishing and charter fishing have become locally very important and the charter fishing sector has built increasing presence and reputation. Moreover, Tasmania has a high participation rate in recreational fishing which is also evident in St Helens. The charter and recreational fishing sectors are predicted to remain an important tourist activity in St Helens and potentially increase as more "game fish" move adjacent to the coast with warming waters. Generally, tourism related activities (like restaurants and accommodation), some of which can be linked to marine activities, are of greater economic importance in small coastal communities compared to the larger centres.

The flow-on effects of the marine sector

The link between the marine sector and other economic sectors in the community are constantly changing. For instance, the impact of a nearly 70% decline in active local fishing boats over the last 20 years on associated marine industries such as slipway operators, vessel maintenance and marine chandlery as well as fish outlets, restaurants, and processing facilities, has been great. Although there has been a negative impact from a smaller local commercial fishing sector, there is increased seasonal activity associated with the charter fishing and recreational fishing sectors providing economic benefits to associated industries such as fishing and tackle shops and accommodation and restaurant business. The aquaculture sector has many flow-on benefits including local employment, equipment maintenance and transport operations. Direct sales to tourists and restaurants help promote St Helen's as a marine tourism destination.


What you said: Changes in the marine sector
The size of the local commercial fishing fleet had declined. Further growth in the aquaculture was thought to be primarily through changes in productivity and marketing, as there were limited area expansion possibilities. The charter fishing, and to some extent the dive sector, had grown with potential for further expansion. Use of the local St Helens area for recreational boating was increasing.
What you said: Changes in the marine environment
Decline in abundance of several commercial species (also in the Bay) was due to a number factors including: commercial and recreational fishing pressure and climate related factors. New commercial fishing opportunities were presented by new (range shifting) species like the urchins.
Charter (and recreational) fishing opportunities were presented by increasing presence of new game fish species and also abundance increases of some species present in the Bay. Aquaculture was being affected by increased frequency of extreme rainfall events and associated terrestrial run-off in catchment regions.
What the Scientists Say
The sea surface temperature on the east coast is increasing. The currents are bringing warm water further south (especially in summer). Marine species respond differently to the warmer waters – some will move to more suitable places further south and thus be less abundant in St Helens, while species moving from northern regions will become more abundant. Rainfall events have been more intense and frequent in the past years affecting run-off and the nutrient load of the inshore waters.
Coral
South E
Queensland
East Australian Current
New South Wales
Victoria
Tas
Tasmania
1
3
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Contact
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Phone: (03) 6232 5048
Stewart Frusher (IMAS, University of Tasmania)
Email: stewart.frusher@utas.edu.au
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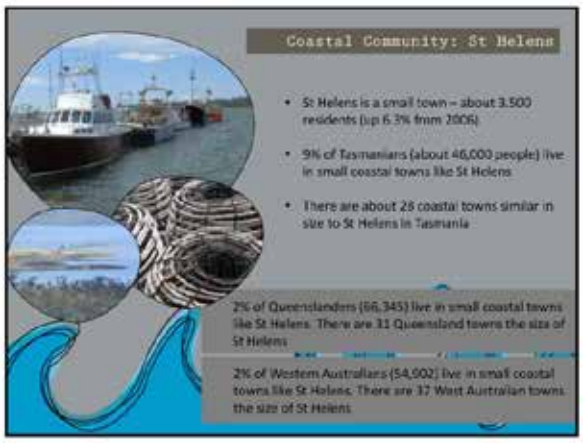
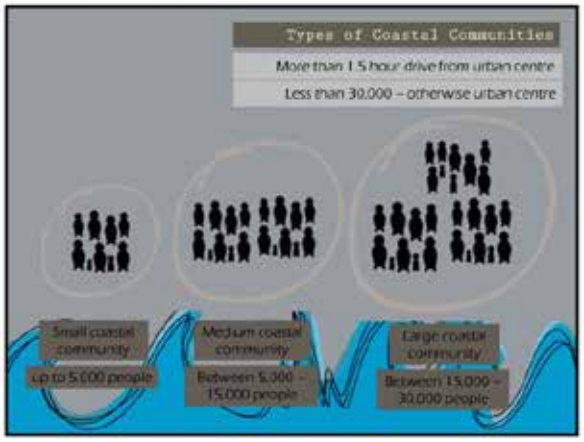
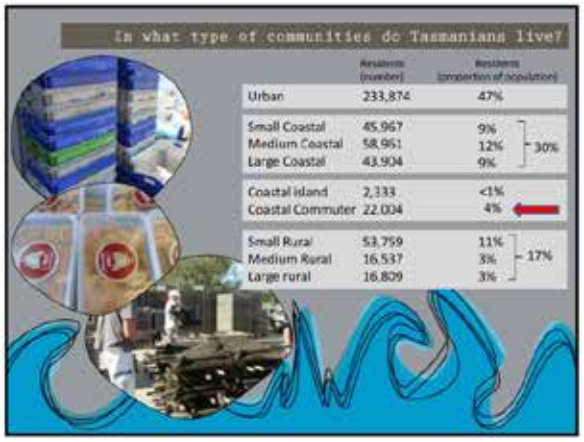
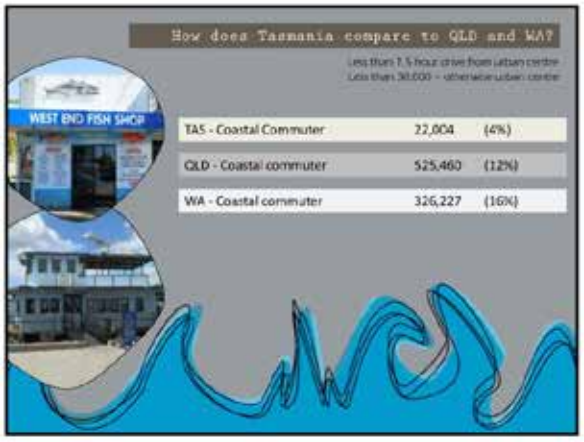
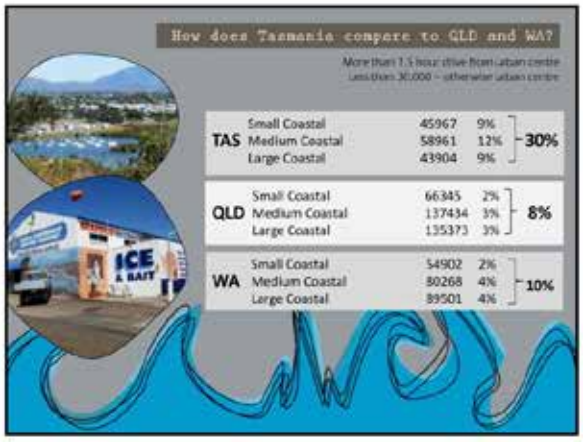
Attachment 3 PowerPoint Presentation Example

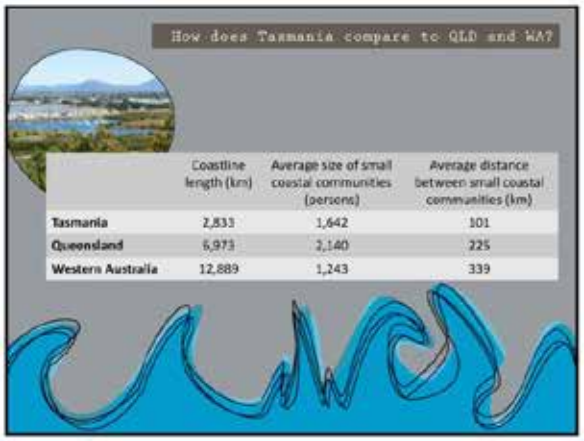




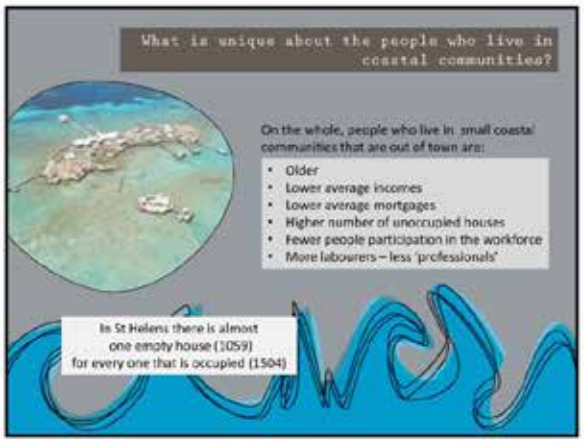


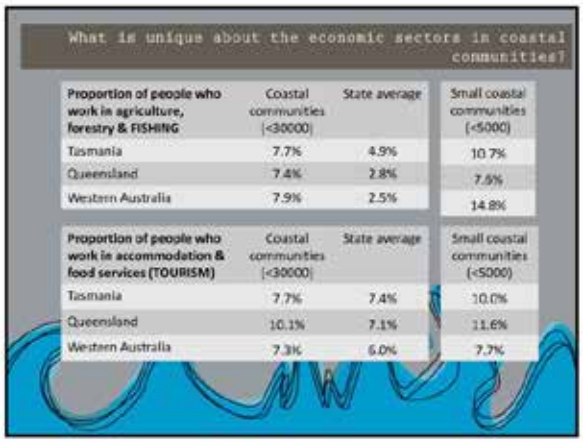


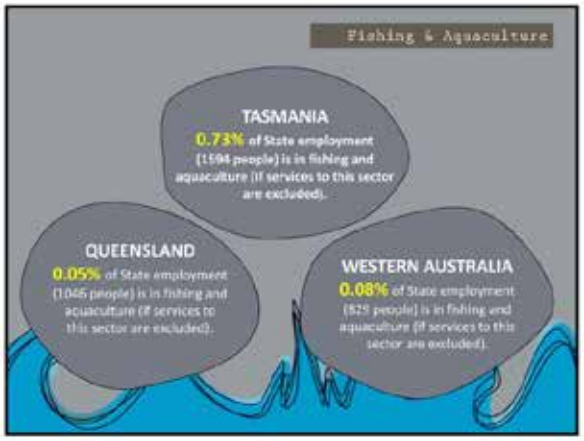


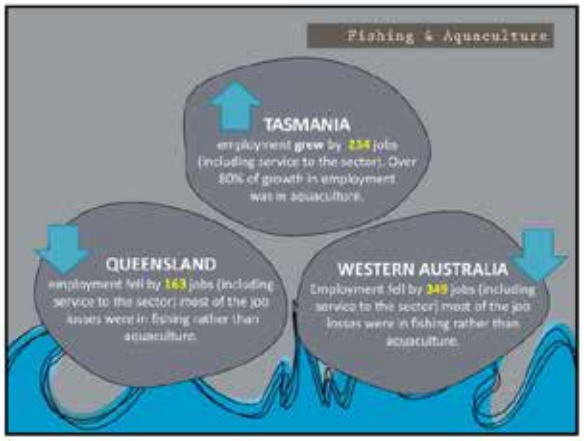

How does Tasmania compare to QLD and WA?
Coastline length (km)
Average size of small coastal communities (persons)
Average distance between small coastal communities (km)
Tasmania 2,833 1,642 101
Queensland 6,973 2,140 225
Western Australia 12,889 1,243 339

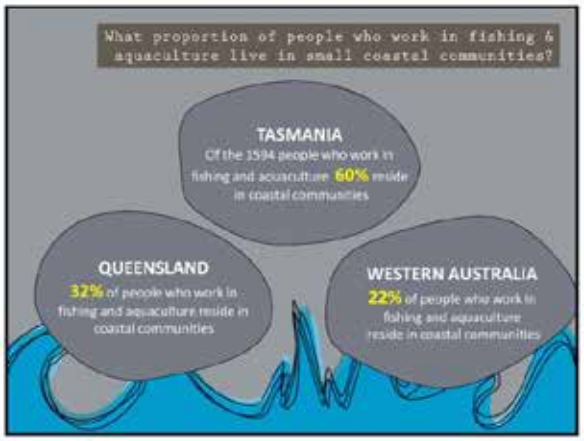

Some summary facts about Tasmanian coastal communities
High proportion of Tasmanian people live in coastal communities of up to 30,000
Small coastal communities are relatively close together in Tasmania (think of Scamander, St Helens, Bicheno)
Smaller proportion of Tasmanians live in coastal commuting communities

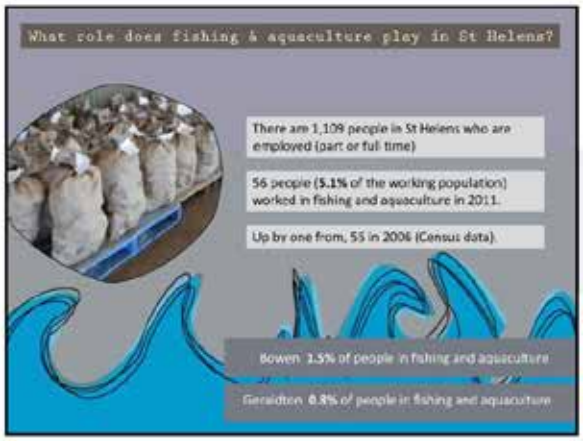

What is unique about the people who live in coastal communities?
On the whole, people who live in small coastal communities that are out of town are:
Older
Lower average incomes
Lower average mortgages
Higher number of unoccupied houses
Fewer people participation in the workforce
More labourers – less 'professionals'
In St Helens there is almost one empty house (1059) for every one that is occupied (1504)

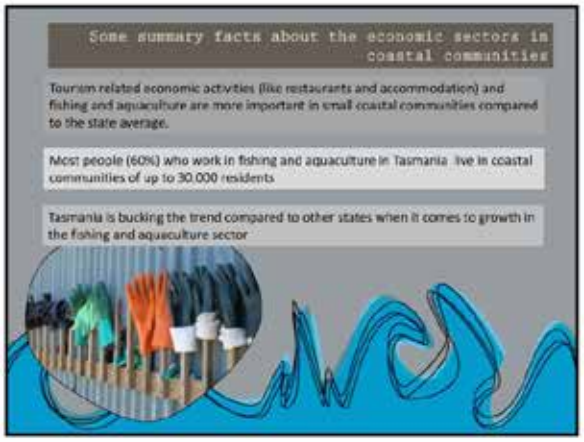

What is unique about the economic sectors in coastal communities?
Proportion of people who work in agriculture, forestry & FISHING
Coastal communities (<30000)
State average
Small coastal communities (<5000)
Tasmania 7.7% 4.9% 10.7%
Queensland 7.4% 2.8% 7.6%
Western Australia 7.9% 2.5% 14.8%
Proportion of people who work in accommodation & food services (TOURISM)
Coastal communities (<30000)
State average
Small coastal communities (<5000)
Tasmania 7.7% 7.4% 10.0%
Queensland 10.1% 7.1% 11.6%
Western Australia 7.3% 6.0% 7.7%


Fishing & Aquaculture
TASMANIA
0.73% of State employment (1594 people) is in fishing and aquaculture (if services to this sector are excluded).
QUEENSLAND
0.05% of State employment (1046 people) is in fishing and aquaculture (if services to this sector are excluded).
WESTERN AUSTRALIA
0.08% of State employment (829 people) is in fishing and aquaculture (if services to this sector are excluded).


Fishing & Aquaculture
TASMANIA
employment grew by 234 jobs (including service to the sector). Over 80% of growth in employment was in aquaculture.
QUEENSLAND
employment fell by 163 jobs (including service to the sector) most of the job losses were in fishing rather than aquaculture.
WESTERN AUSTRALIA
Employment fell by 348 jobs (including service to the sector) most of the job losses were in fishing rather than aquaculture.

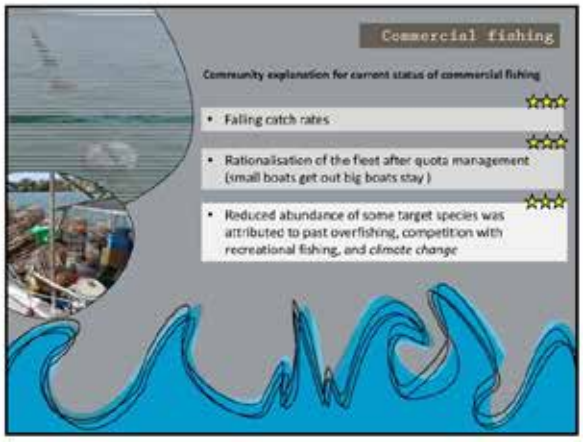

What proportion of people who work in fishing & aquaculture live in small coastal communities?
TASMANIA
Of the 1594 people who work in fishing and acuaculture 60% reside in coastal communities
QUEENSLAND
32% of people who work in fishing and aquaculture reside in coastal communities
WESTERN AUSTRALIA
22% of people who work in fishing and aquaculture reside in coastal communities

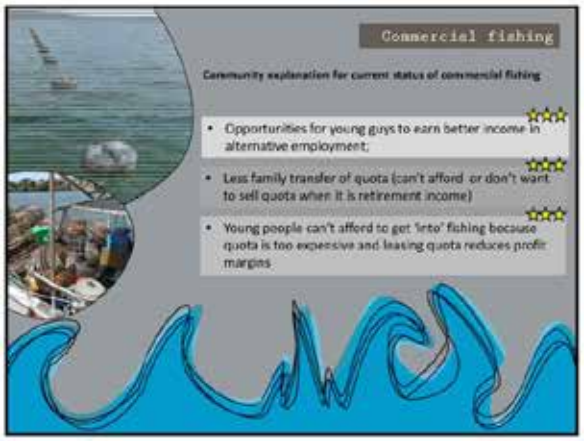

What role does fishing & aquaculture play in St Helens?
There are 1,109 people in St Helens who are employed (part or full time)
56 people (5.1% of the working population) worked in fishing and aquaculture in 2011.
Up by one from, 55 in 2006 (Census data).
Bowen 1.5% of people in fishing and aquaculture
Geraldton 0.8% of people in fishing and aquaculture

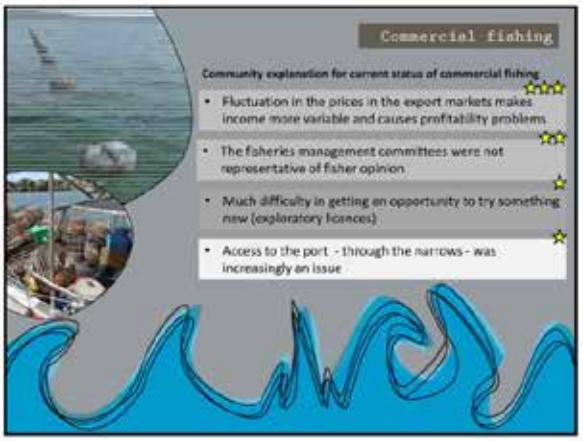

Some summary facts about the economic sectors in coastal communities
Tourism related economic activities (like restaurants and accommodation) and fishing and aquaculture are more important in small coastal communities compared to the state average.
Most people (60%) who work in fishing and aquaculture in Tasmania live in coastal communities of up to 30,000 residents
Tasmania is bucking the trend compared to other states when it comes to growth in the fishing and aquaculture sector

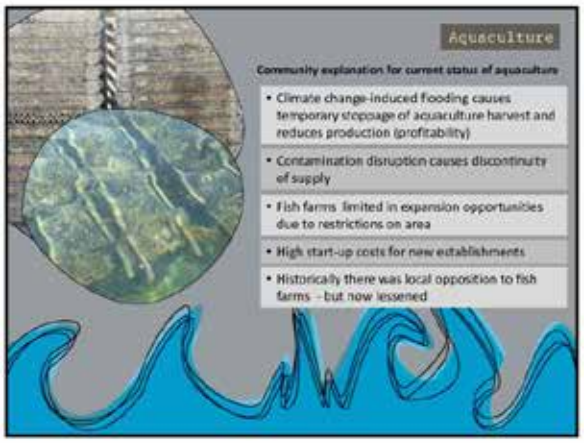

Coastal community residents interviews
Bowen
Geraldton
September 2012
Restaurants
Aquaculture
Education
Council
Processors

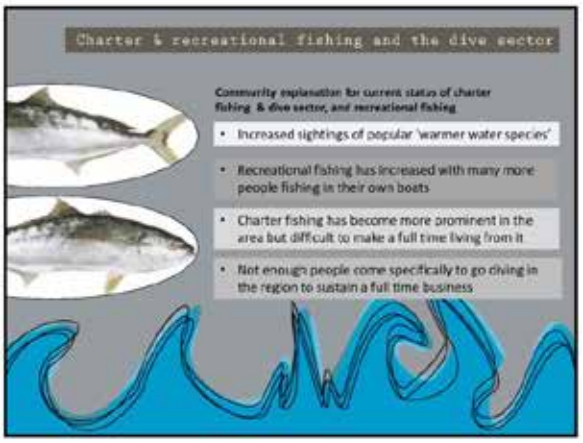

The community noticed significant changes
BLACK WITCH
• Commercial fishing declined in all three places - TAS, WA & QLD
• Far fewer vessels moor in the local harbours (very noticeable to residents)
• St Helens commercial fishing fleet was estimated to have fallen from around 35 vessels 20 years ago to around 10 vessels in 2012.
The commercial fleet in Bowen has fallen from over 80 in the peak season in the 1960's to just over 30 about a decade ago, with less than active 10 vessels currently remaining.
The Geraldton rock lobster fleet has dropped from over 300 vessels to less than 200 in the past four years.


Commercial fishing
Community explanation for current status of commercial fishing
• Falling catch rates
• Rationalisation of the fleet after quota management (small boats get out big boats stay)
• Reduced abundance of some target species was attributed to past overfishing, competition with recreational fishing, and climate change

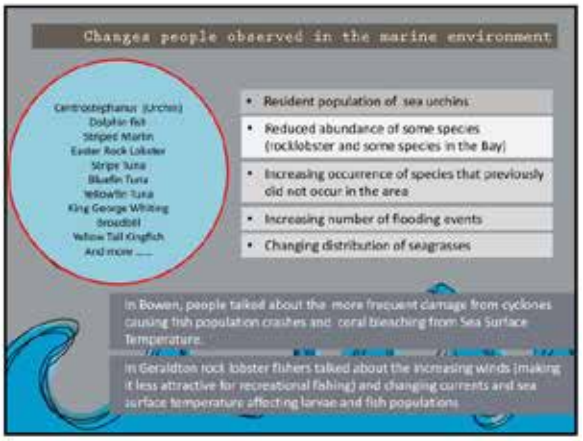

Commercial fishing
Community explanation for current status of commercial fishing
• Opportunities for young guys to earn better income in alternative employment;
• Less family transfer of quota (can't afford or don't want to sell quota when it is retirement income)
• Young people can't afford to get 'into' fishing because quota is too expensive and leasing quota reduces profit margins

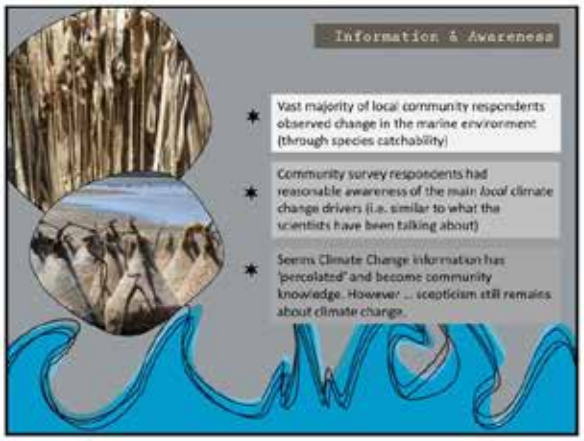

Commercial fishing
Community explanation for current status of commercial fishing
• Fluctuation in the prices in the export markets makes income more variable and causes profitability problems
• The fisheries management committees were not representative of fisher opinion
• Much difficulty in getting an opportunity to try something new (exploratory licences)
• Access to the port - through the narrows - was increasingly an issue

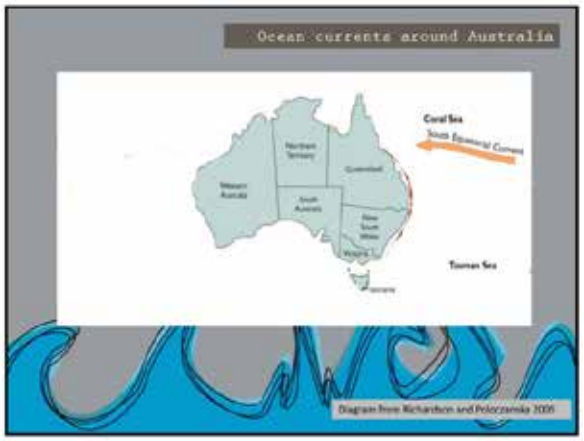

Aquaculture
Community explanation for current status of aquaculture
• Climate change-induced flooding causes temporary stoppage of aquaculture harvest and reduces production (profitability)
• Contamination disruption causes discontinuity of supply
• Fish farms limited in expansion opportunities due to restrictions on area
• High start-up costs for new establishments
• Historically there was local opposition to fish farms - but now lessened


Charter & recreational fishing and the dive sector
Community explanation for current status of charter fishing & dive sector, and recreational fishing
• Increased sightings of popular 'warmer water species'
• Recreational fishing has increased with many more people fishing in their own boats
• Charter fishing has become more prominent in the area but difficult to make a full time living from it
• Not enough people come specifically to go diving in the region to sustain a full time business

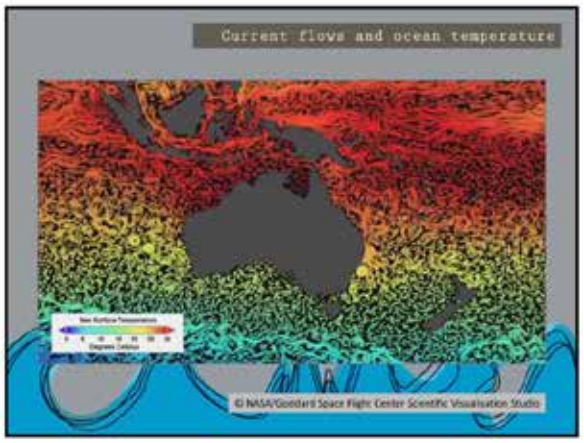

Business in that are linked to the marine sector
Lolly shop
Petrol
Mechanics
Café's
Restaurants
Liquor shops
Supermarket
Accommodation places (hotels / B&B resorts caravan parks)
Wood yards
Gallery
MARINE SECTOR
Private accommodation & rentals
Medical centre & pharmacy
Hair & beauty centre
Fish and tackle shops
Fish sales
Bookshop
Sport shop
Real estate agents
Fish processing
Slipway(s)

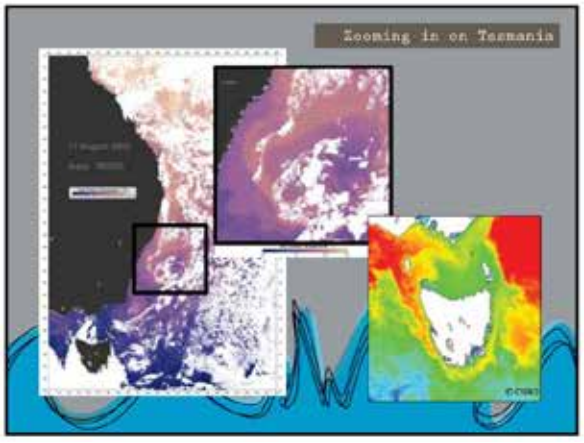

Changes people observed in the marine environment
Centrostephanus (Urchin)
Dolphin fish
Striped Marlin
Easter Rock Lobster
Stripe Tuna
Bluefin Tuna
Yellowfin Tuna
King George Whiting
Snapper
Yellow Tail Kingfish
And more .....
• Resident population of sea urchins
• Reduced abundance of some species (rocklobster and some species in the Bay)
• Increasing occurrence of species that previously did not occur in the area
• Increasing number of flooding events
• Changing distribution of seagrasses
In Bowen, people talked about the more frequent damage from cyclones causing fish population crashes and coral bleaching from Sea Surface Temperature.
In Geraldton rock lobster fishers talked about the increasing winds (making it less attractive for recreational fishing) and changing currents and sea surface temperature affecting larvae and fish populations


Information & Awareness
Vast majority of local community respondents observed change in the marine environment (through species catchability)
Community survey respondents had reasonable awareness of the main *local* climate change drivers (i.e. similar to what the scientists have been talking about)
Seems Climate Change information has 'percolated' and become community knowledge. However ... scepticism still remains about climate change.

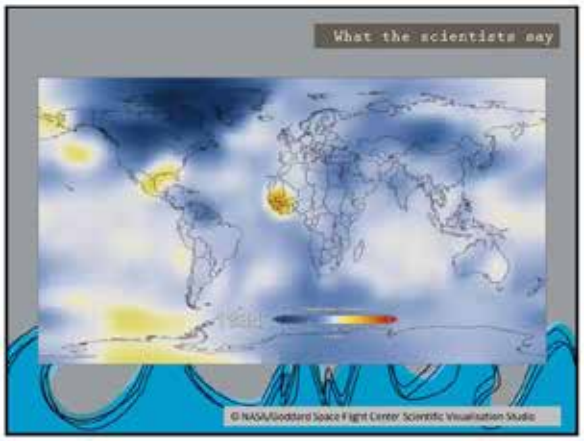

Ocean currents around Australia
Coral Sea
South Equatorial Current
Tasman Sea
Diagram from Richardson and Poloczanska 2008

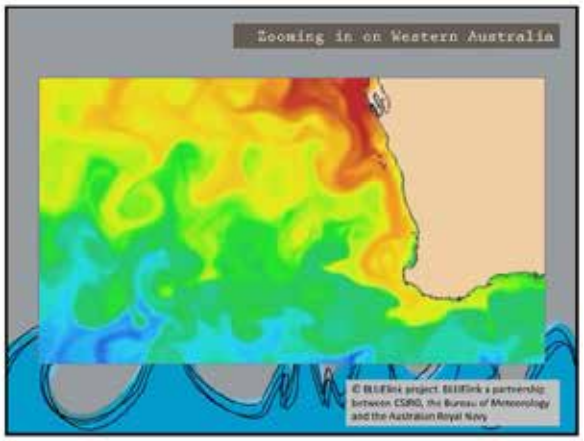

The upper ocean currents and bottom water around Australia
Upper Ocean
Bottom Water
Dianne Wilkin, CSIRO Marine and Atmospheric Research

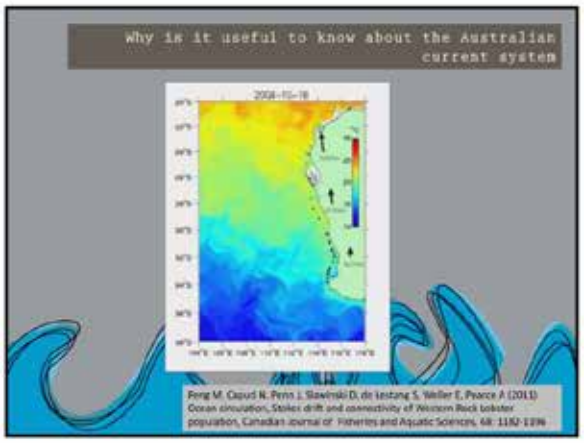

Current flows and ocean temperature
© NASA/Goddard Space Flight Center Scientific Visualization Studio

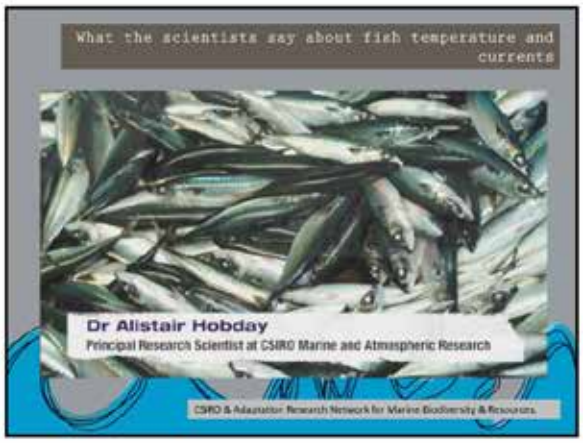

Zooming in on Tasmania

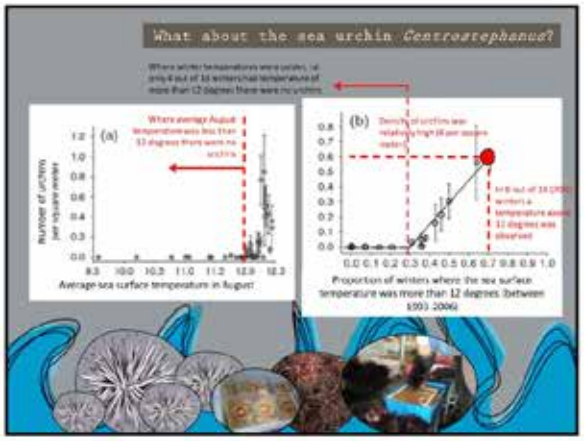

Where are the oceans being measured around Australia?

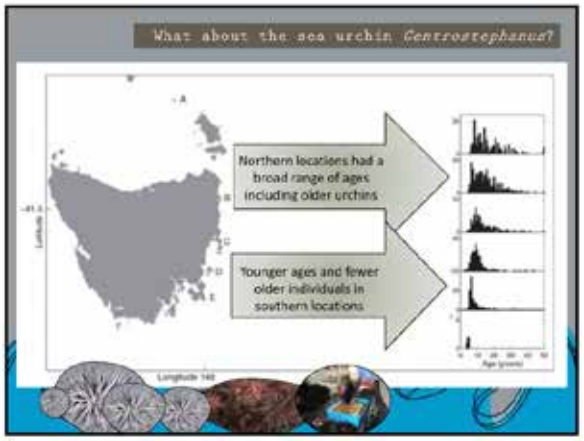

What the scientists say
© NASA/Goddard Space Flight Center Scientific Visualization Studio

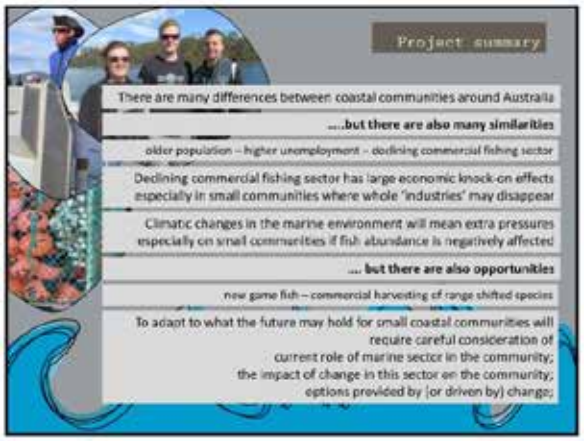

Zooming in on Western Australia

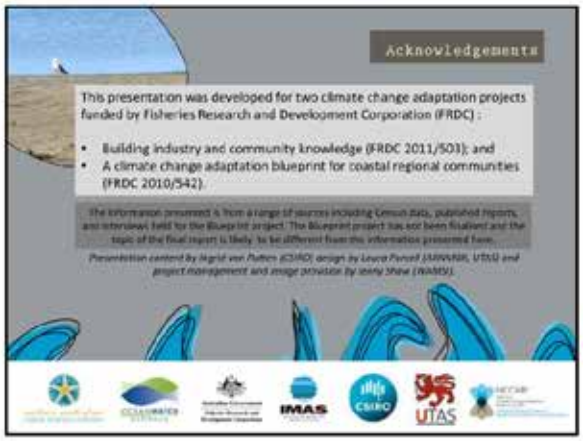

Why is it useful to know about the Australian current system
Feng M. Caputi N. Penn J. Slawinski D. de Lestang S. Weller E. Pearce A (2011)


What the scientists say about fish temperature and currents
Dr Alistair Hobday
Principal Research Scientist at CSIRO Marine and Atmospheric Research

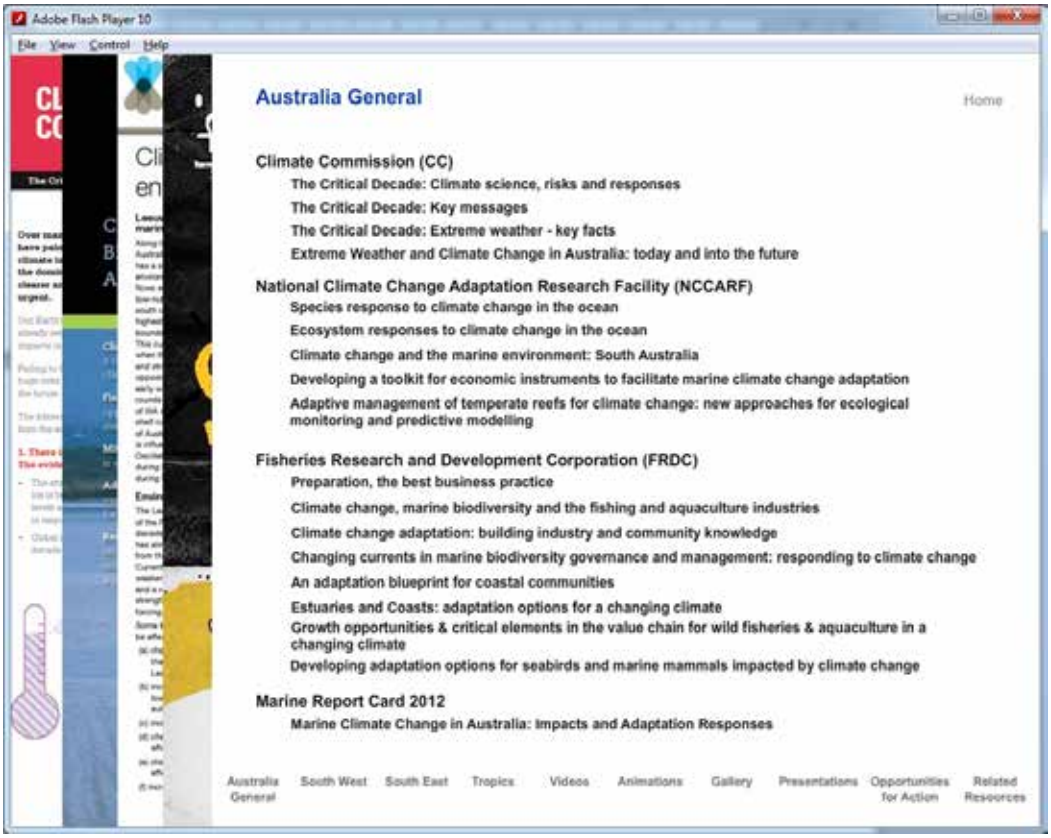

What about the sea urchin Centrostephanus?
(a)
(b)
Average sea surface temperature in August
Proportion of winters where the sea surface temperature was more than 12 degrees (between 1993-2006)

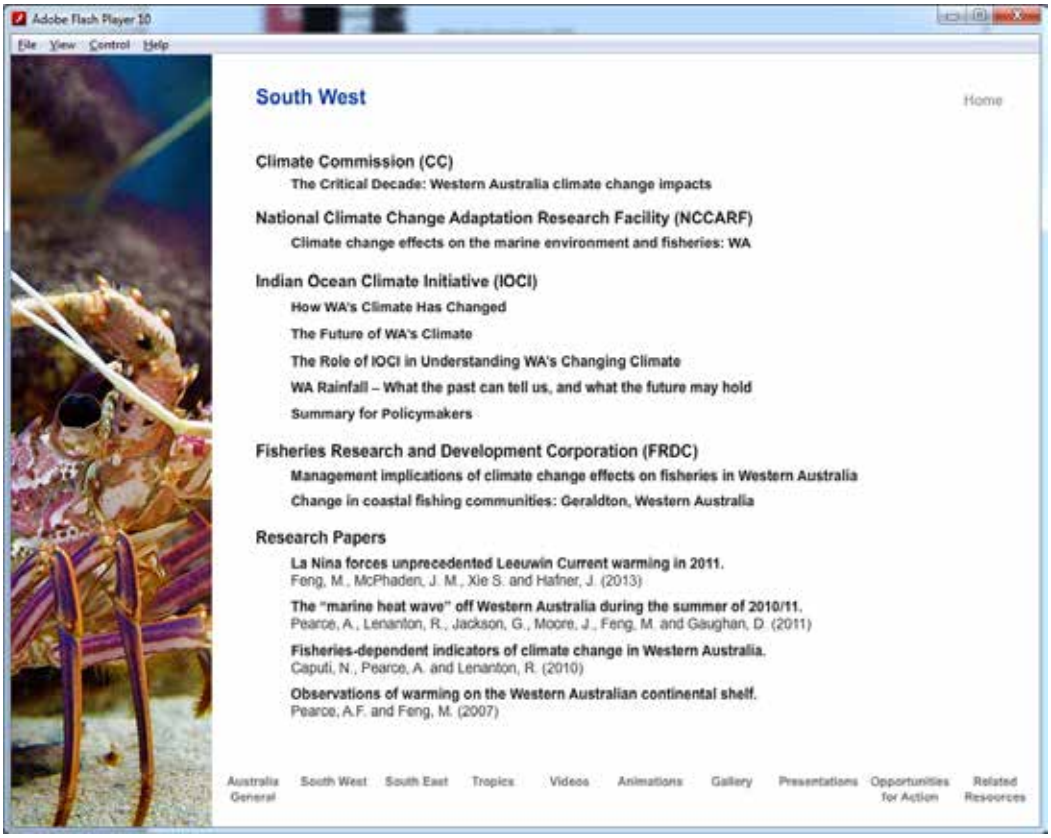

What about the sea urchin Centrostephanus?
Northern locations had a broad range of ages including older urchins
Younger ages and fewer older individuals in southern locations


Project summary
There are many differences between coastal communities around Australia
....but there are also many similarities
older population – higher unemployment – declining commercial fishing sector
Declining commercial fishing sector has large economic knock-on effects especially in small communities where whole 'industries' may disappear
Climatic changes in the marine environment will mean extra pressures especially on small communities if fish abundance is negatively affected
.... but there are also opportunities
new game fish – commercial harvesting of range shifted species
To adapt to what the future may hold for small coastal communities will require careful consideration of
current role of marine sector in the community;
the impact of change in this sector on the community;
options provided by (or driven by) change;


Acknowledgements
This presentation was developed for two climate change adaptation projects funded by Fisheries Research and Development Corporation (FRDC) :
Building industry and community knowledge (FRDC 2011/503); and
A climate change adaptation blueprint for coastal regional communities (FRDC 2010/542).
IMAS
CSIRO
UTAS

Attachment 4 Interactive DVD

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South West
Home
Climate Commission (CC)
The Critical Decade: Western Australia climate change impacts
National Climate Change Adaptation Research Facility (NCCARF)
Climate change effects on the marine environment and fisheries: WA
Indian Ocean Climate Initiative (IOCI)
How WA's Climate Has Changed
The Future of WA's Climate
The Role of IOCI in Understanding WA's Changing Climate
WA Rainfall – What the past can tell us, and what the future may hold
Summary for Policymakers
Fisheries Research and Development Corporation (FRDC)
Management implications of climate change effects on fisheries in Western Australia
Change in coastal fishing communities: Geraldton, Western Australia
Research Papers
La Nina forces unprecedented Leeuwin Current warming in 2011.
Feng, M., McPhaden, J. M., Xie S. and Hafner, J. (2013)
The "marine heat wave" off Western Australia during the summer of 2010/11.
Pearce, A., Lenanton, R., Jackson, G., Moore, J., Feng, M. and Gaughan, D. (2011)
Fisheries-dependent indicators of climate change in Western Australia.
Caputi, N., Pearce, A. and Lenanton, R. (2010)
Observations of warming on the Western Australian continental shelf.
Pearce, A.F. and Feng, M. (2007)
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South East
Tropics
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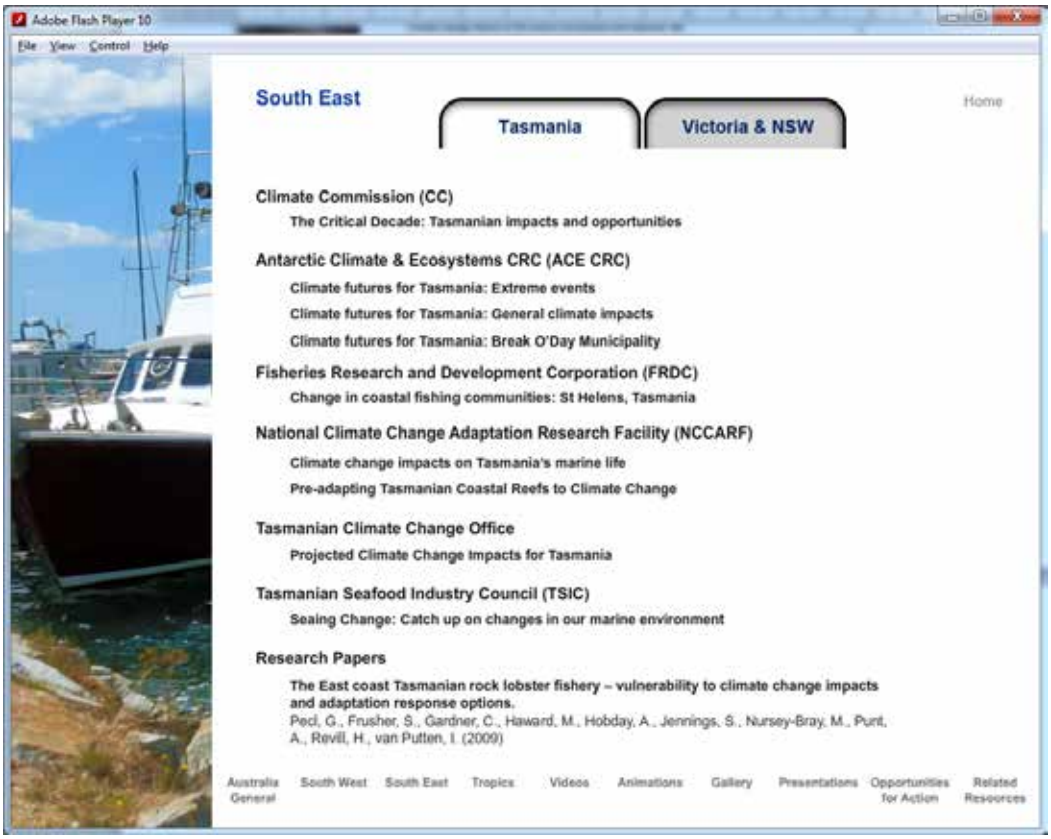
Related Resources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Tasmania
Victoria & NSW
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Climate Commission (CC)
The Critical Decade: Tasmanian impacts and opportunities
Antarctic Climate & Ecosystems CRC (ACE CRC)
Climate futures for Tasmania: Extreme events
Climate futures for Tasmania: General climate impacts
Climate futures for Tasmania: Break O'Day Municipality
Fisheries Research and Development Corporation (FRDC)
Change in coastal fishing communities: St Helens, Tasmania
National Climate Change Adaptation Research Facility (NCCARF)
Climate change impacts on Tasmania's marine life
Pre-adapting Tasmanian Coastal Reefs to Climate Change
Tasmanian Climate Change Office
Projected Climate Change Impacts for Tasmania
Tasmanian Seafood Industry Council (TSIC)
Seaing Change: Catch up on changes in our marine environment
Research Papers
The East coast Tasmanian rock lobster fishery – vulnerability to climate change impacts and adaptation response options.
Pecl, G., Frusher, S., Gardner, C., Haward, M., Hobday, A., Jennings, S., Nursey-Bray, M., Punt, A., Revill, H., van Putten, I. (2009)
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South East
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Videos
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Opportunities for Action
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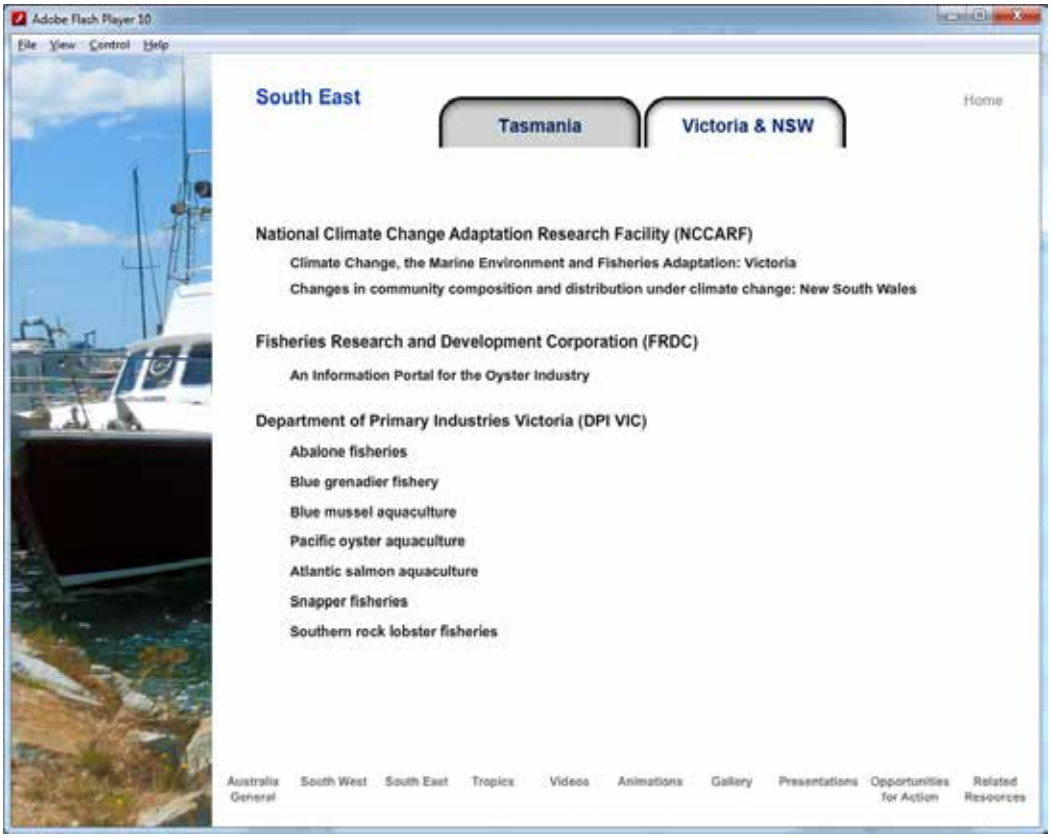
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Victoria & NSW
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National Climate Change Adaptation Research Facility (NCCARF)
Climate Change, the Marine Environment and Fisheries Adaptation: Victoria
Changes in community composition and distribution under climate change: New South Wales
Fisheries Research and Development Corporation (FRDC)
An Information Portal for the Oyster Industry
Department of Primary Industries Victoria (DPI VIC)
Abalone fisheries
Blue grenadier fishery
Blue mussel aquaculture
Pacific oyster aquaculture
Atlantic salmon aquaculture
Snapper fisheries
Southern rock lobster fisheries
Australia General
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South East
Tropics
Videos
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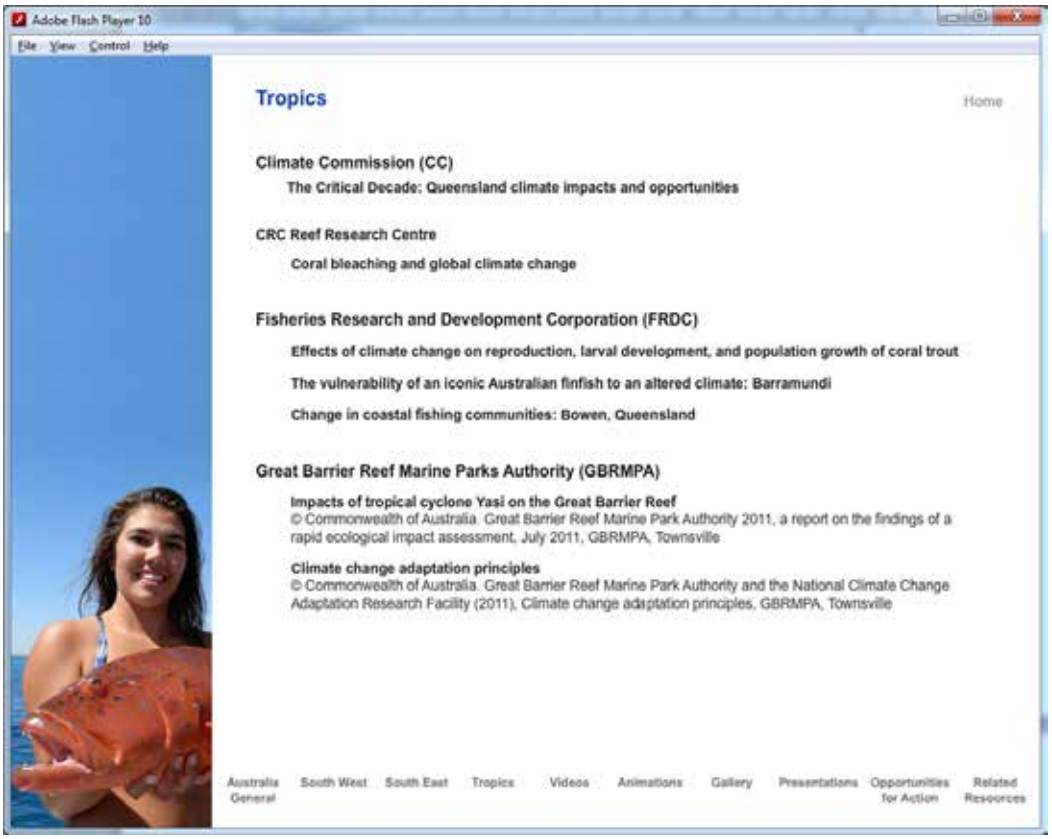
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Climate Commission (CC)
The Critical Decade: Queensland climate impacts and opportunities
CRC Reef Research Centre
Coral bleaching and global climate change
Fisheries Research and Development Corporation (FRDC)
Effects of climate change on reproduction, larval development, and population growth of coral trout
The vulnerability of an iconic Australian finfish to an altered climate: Barramundi
Change in coastal fishing communities: Bowen, Queensland
Great Barrier Reef Marine Parks Authority (GBRMPA)
Impacts of tropical cyclone Yasi on the Great Barrier Reef
© Commonwealth of Australia. Great Barrier Reef Marine Park Authority 2011, a report on the findings of a rapid ecological impact assessment, July 2011, GBRMPA, Townsville
Climate change adaptation principles
© Commonwealth of Australia. Great Barrier Reef Marine Park Authority and the National Climate Change Adaptation Research Facility (2011), Climate change adaptation principles, GBRMPA, Townsville
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South East
Tropics
Videos
Animations
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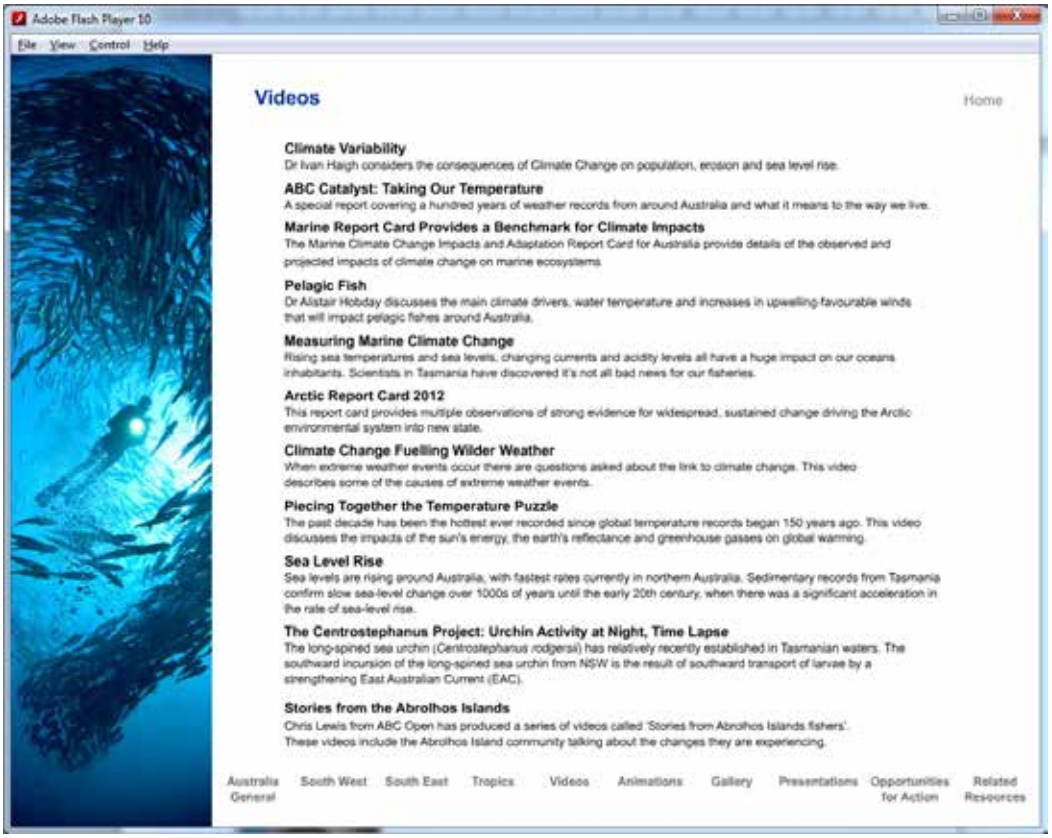
Presentations
Opportunities for Action
Related Resources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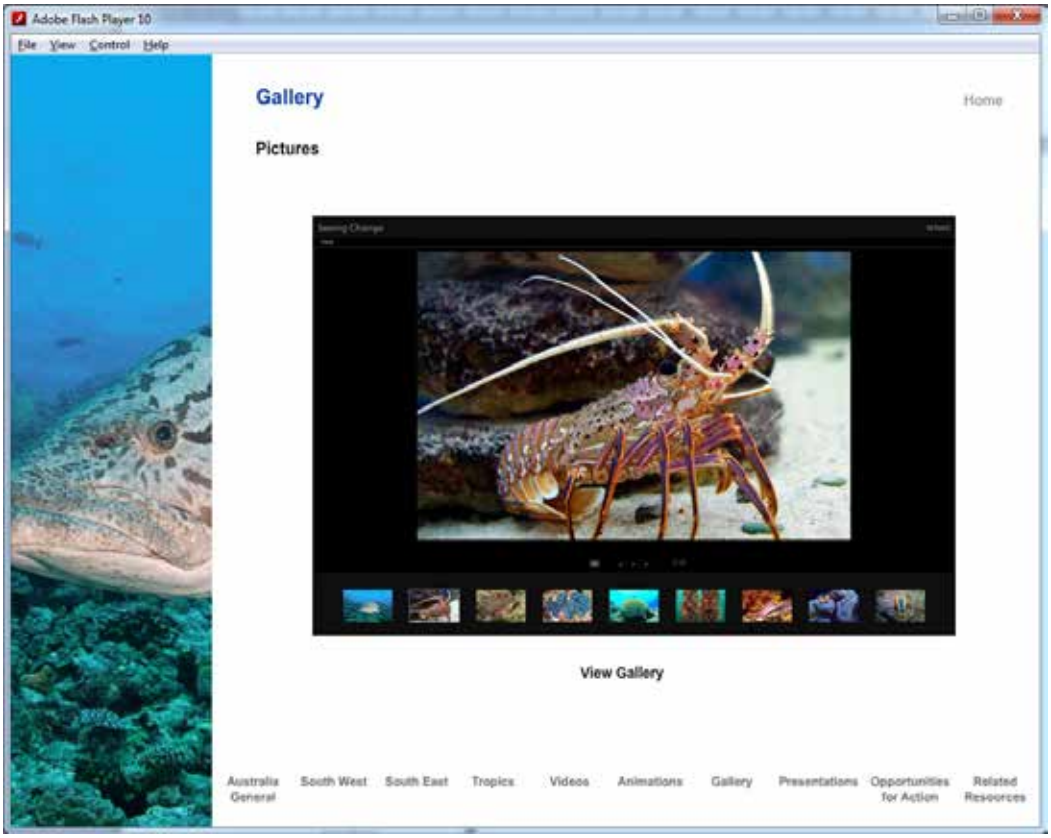
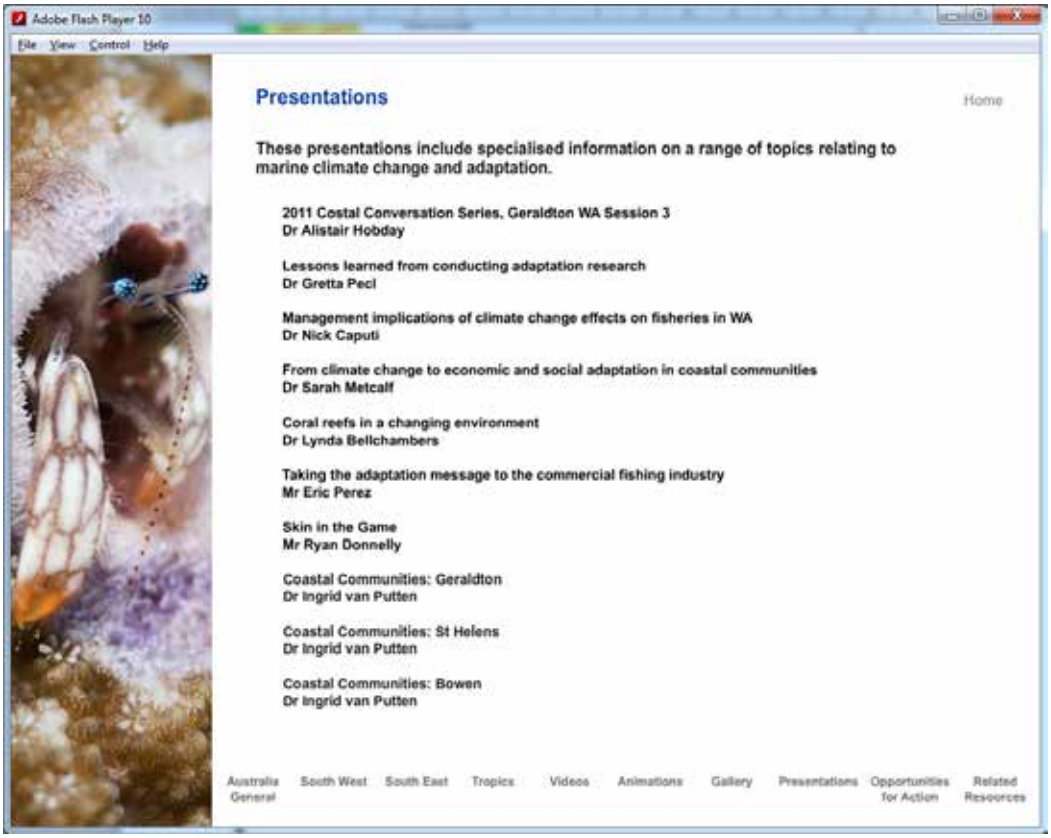
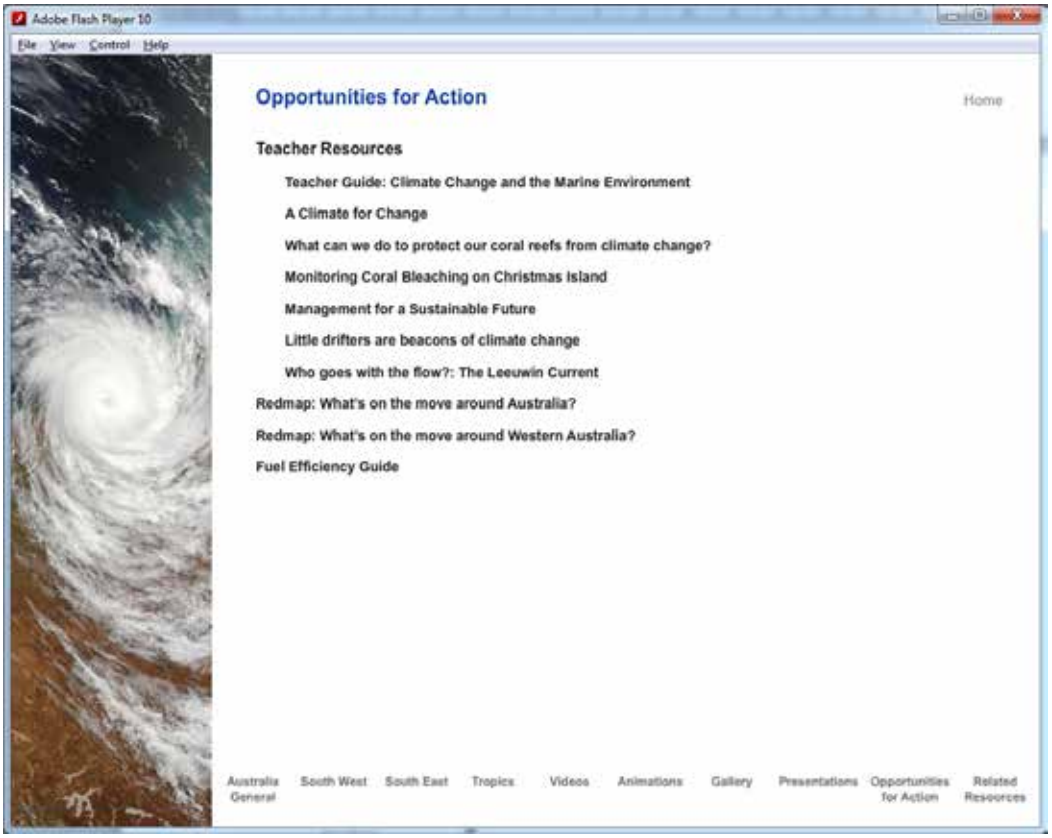
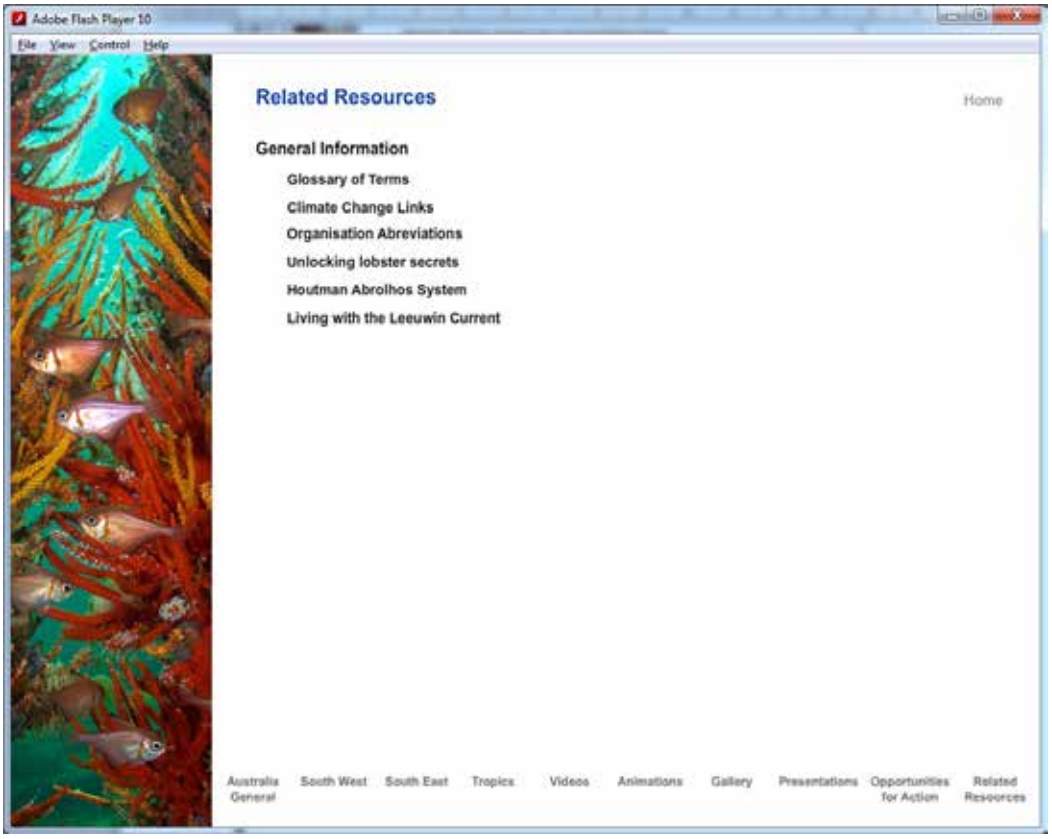
Climate Variability
Dr Ivan Haigh considers the consequences of Climate Change on population, erosion and sea level rise.
ABC Catalyst: Taking Our Temperature
A special report covering a hundred years of weather records from around Australia and what it means to the way we live.
Marine Report Card Provides a Benchmark for Climate Impacts
The Marine Climate Change Impacts and Adaptation Report Card for Australia provide details of the observed and projected impacts of climate change on marine ecosystems.
Pelagic Fish
Dr Alistair Hobday discusses the main climate drivers, water temperature and increases in upwelling-favourable winds that will impact pelagic fishes around Australia.
Measuring Marine Climate Change
Rising sea temperatures and sea levels, changing currents and acidity levels all have a huge impact on our oceans inhabitants. Scientists in Tasmania have discovered it's not all bad news for our fisheries.
Arctic Report Card 2012
This report card provides multiple observations of strong evidence for widespread, sustained change driving the Arctic environmental system into new state.
Climate Change Fuelling Wilder Weather
When extreme weather events occur there are questions asked about the link to climate change. This video describes some of the causes of extreme weather events.
Piecing Together the Temperature Puzzle
The past decade has been the hottest ever recorded since global temperature records began 150 years ago. This video discusses the impacts of the sun's energy, the earth's reflectance and greenhouse gasses on global warming.
Sea Level Rise
Sea levels are rising around Australia, with fastest rates currently in northern Australia. Sedimentary records from Tasmania confirm slow sea-level change over 1000s of years until the early 20th century, when there was a significant acceleration in the rate of sea-level rise.
The Centrostephanus Project: Urchin Activity at Night, Time Lapse
The long-spined sea urchin (Centrostephanus rodgersii) has relatively recently established in Tasmanian waters. The southward incursion of the long-spined sea urchin from NSW is the result of southward transport of larvae by a strengthening East Australian Current (EAC).
Stories from the Abrolhos Islands
Chris Lewis from ABC Open has produced a series of videos called 'Stories from Abrolhos Islands fishers'. These videos include the Abrolhos Island community talking about the changes they are experiencing.
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources


Adobe Flash Player 10
File View Control Help
Animations
Home
Ocean Currents and Climate Change around Australia
Australian Currents
Follow the ocean currents around Australia. This animation shows the ocean circulation in the Australian region.
Western Australia's Leeuwin current
This southward flowing current forms in the Indo-Pacific region and moves along the coast of Western Australia. The Leeuwin Current is a warm, low nutrient current that is stronger during winter months and weaker in summer months.
Ocean Current Flows with Sea Surface Temperatures (SST)
This visualization shows the ocean current flows on a flat map of Australia. The flows are coloured by sea surface temperatures with blues being cooler waters and yellows/reds warmer waters. The time period for this visualization is 10 January 2005 through to 2006. Each second that passes in the visualization is about 2.5 days.
Western Australia's Marine Heatwave
The movement of an unusually warm body of water that was 2 degrees above average (yellow) in November 2010, peaking to 3+ degrees Celsius above average (orange) in February 2011 before dissipating in March.
Western Australian Rock Lobster Larvae Movement Offshore
This oceanographic model represents the release of rock lobster larvae (November), their movement offshore (up to 1,500kms) and their successful return and settlement along the coast (September) the following year. The different colours represent the different larval stages.
What is Coral Bleaching?
As the climate changes, coral bleaching is predicted to become more frequent and severe. Sea temperature increases and coral stress from other impacts may increase corals' vulnerability to bleaching.
Impacts of Climate Change
Climate change is now considered to be the greatest threat to the Great Barrier Reef. This animation is designed to help people understand the impacts climate change could have on the Reef and how their individual choices can influence the degree of impact.
Ocean Acidification
A simplified animation to a complex topic which does not explain the process in detail, rather it uses a characters experience to illicit an understanding of the effect of acidification on coral reefs.
Five-Year Global Temperature Anomalies from 1880 to 2012
This color-coded map displays a progression of changing global surface temperatures anomalies from 1880 through 2012. Higher than normal temperatures are shown in red and lower than normal temperatures are shown in blue.
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources

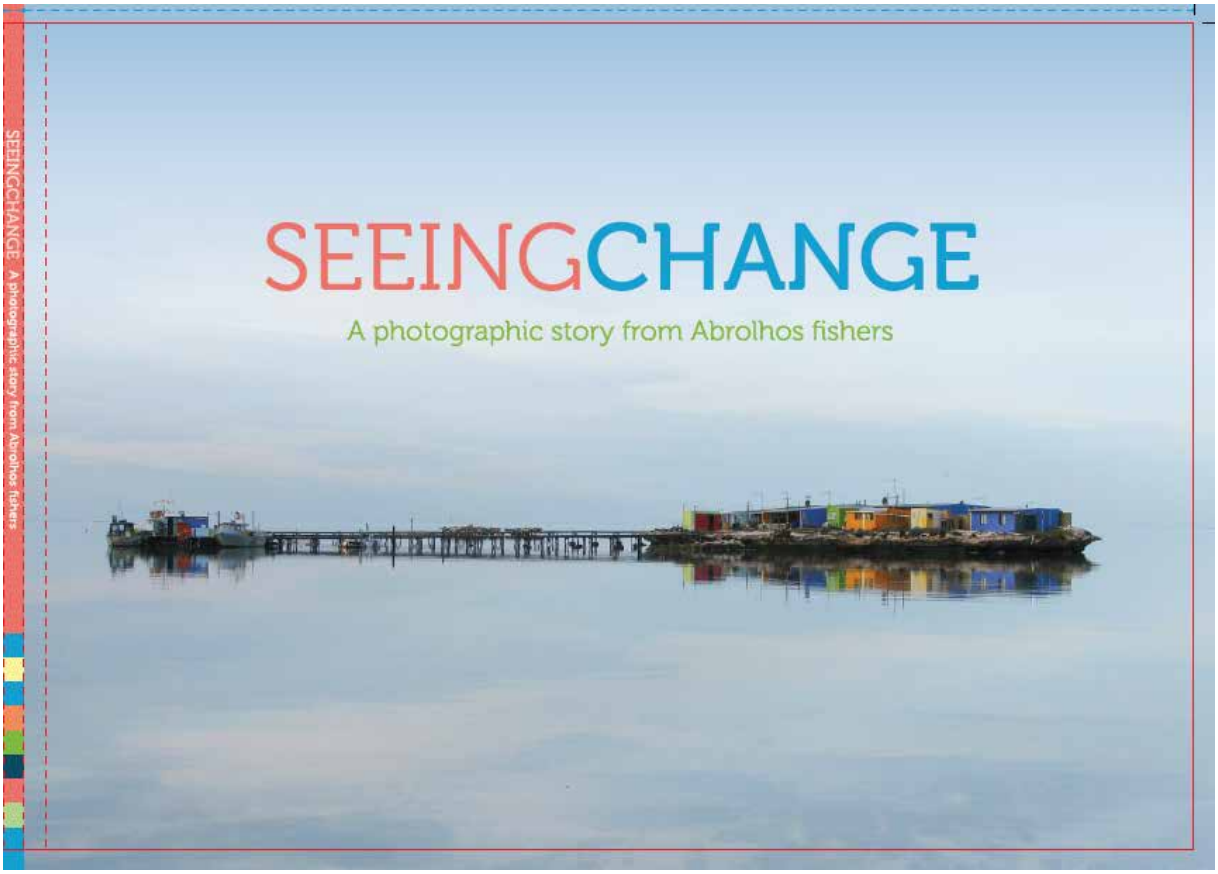

Adobe Flash Player 10
File View Control Help
Gallery
Home
Pictures
View Gallery
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources


Adobe Flash Player 10
File View Control Help
Presentations
Home
These presentations include specialised information on a range of topics relating to marine climate change and adaptation.
2011 Costal Conversation Series, Geraldton WA Session 3
Dr Alistair Hobday
Lessons learned from conducting adaptation research
Dr Gretta Pecl
Management implications of climate change effects on fisheries in WA
Dr Nick Caputi
From climate change to economic and social adaptation in coastal communities
Dr Sarah Metcalf
Coral reefs in a changing environment
Dr Lynda Bellchambers
Taking the adaptation message to the commercial fishing industry
Mr Eric Perez
Skin in the Game
Mr Ryan Donnelly
Coastal Communities: Geraldton
Dr Ingrid van Putten
Coastal Communities: St Helens
Dr Ingrid van Putten
Coastal Communities: Bowen
Dr Ingrid van Putten
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources


Adobe Flash Player 10
File View Control Help
Opportunities for Action
Home
Teacher Resources
Teacher Guide: Climate Change and the Marine Environment
A Climate for Change
What can we do to protect our coral reefs from climate change?
Monitoring Coral Bleaching on Christmas Island
Management for a Sustainable Future
Little drifters are beacons of climate change
Who goes with the flow?: The Leeuwin Current
Redmap: What's on the move around Australia?
Redmap: What's on the move around Western Australia?
Fuel Efficiency Guide
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources


Adobe Flash Player 10
File View Control Help
Related Resources
Home
General Information
Glossary of Terms
Climate Change Links
Organisation Abreviations
Unlocking lobster secrets
Houtman Abrolhos System
Living with the Leeuwin Current
Australia General
South West
South East
Tropics
Videos
Animations
Gallery
Presentations
Opportunities for Action
Related Resources

Attachment 5 Book



Shaw. J. (2013). Seeing Change: a photographic story from Abrolhos fishers. Northern Agriculture Catchments Council. Geraldton Western Australia. 56pp.

Attachment 6 Poster Examples

Attachment 7 Exhibitions

Appendix 6 List of researchers and project staff

Principal Investigator: Jenny Shaw, part time contract with WAMSI

OceanWatch Australia project staff:

Lowri Pryce	Executive Officer
Anita Paulsen	SeaNet Officer Tasmania
David Schultz	SeaNet Officer Queensland
Jay Shoesmith	SeaNet Officer Western Australia
Cassandra Price	SeaNet Officer Tasmania
Eduardo Gallo	Project Officer

The 'Knowledge Project' 2011/503 had linkages to the 'Blueprint Project' 2010/542.

Principal Investigators: Stewart Frusher, UTAS; Nadine Marshall, CSIRO; Malcolm Tull, MU

Post-Doctoral Fellows: Ingrid VanPutten, CSIRO; Sarah Metcalf, MU.

Appendix 7 Intellectual property

Written project information was given out prior to all surveys being undertaken and written research consents obtained from survey participants. All findings from the study are publicly available. The raw data remains the property of the researcher and will be held securely for at least 7 years in order to satisfy the ethical requirements for survey based research. These data will be further analysed and used in peer reviewed publications.

Appendix 8 Promotional materials

Appendix 9 Project coverage media examples

museum

Climate change in the Abrolhos wins MAGNA Award

SCOOP PUBLISHING

WA EVENTS

Seeing Change: A photographic story from Abrolhos fishers

4 Extra News

Changes in Abrolhos captured on film

BUSH TELEGRAPH 25 October 2013

Jenny Shaw & Leonie Noble interviewed by Judy Kennedy

Recorded (24.10.13) ABC Perth for National distribution. Approx 20 min broadcast

OPEN What's Your Story?

MID WEST

PhotoVoice; the Abrolhos Project

Bush Telegraph

Climate change a suspect in decline of island life

CUSP News!

Last Days of "Seeing Change" Exhibition

GWN7

You're worth holding onto. Belt up.

GWN7 NEWS

Climate change through the lense

Jessica Millward

A photographic exhibition focusing on the effects of climate change seen through the eyes of Abrolhos fishers has won a prestigious award for the WA Museum and its partners.

On display over the Christmas and New Year period at the WA Museum Geraldton, Seeing Change: A photographic story from Abrolhos fishers won the award for Best Temporary Exhibition under $50,000 at the Museums and Galleries National Awards (MAGNAs).

WA Museum chief executive officer Alec Coles congratulated teams involved in putting the exhibition together.

"Seeing Change is a community-led exhibition and the result of a hugely successful collaboration between the Western Australian Marine Science Institution, Curtin University, WA Department of Fisheries, Coastwest, ABC Open, the Northern Agricultural Catchment Council, the WA Museum and, of course, the Abrolhos fish-

Island reflection: Abrolhos Islands. Picture: Leonie Noble

ing community" he said.

"This exhibition evolved through the development of a shared understanding between fishers, scientists and the community of the values and issues affecting the Abrolhos Islands, the rock lobster fishing industry and the Island's communities over the last five to ten years."

Mr Coles said the exhibition was a very worthy winner.

"The WA Museum is as much about embracing today's history as it is the past," he said.

"It's about exploring what it means to be Western Australian.

"This chapter of fundamental change within the Abrolhos Islands' western rock lobster fishing community is an important Western Australian story with many universal themes."

Curtin University researcher Jenny Shaw initiated the project to encourage a greater interest in regional climate change science using Photovoice, a technique that gives participants a voice through the lens of a camera.

Appendix 10 Implications

The impacts and benefits of a project of this nature, which was aimed at knowledge uptake, may be difficult to measure. However, preliminary results suggest that the project objectives were successfully met and project outcomes were excellent. Very positive feedback on the project was gathered through follow-up surveys in the case study areas (Appendix 3), follow-up fisher interviews in Geraldton (Appendix 4), comment cards and surveys of visitors to the 'Seeing Change' exhibition (Appendix 4) and interviews with Museum staff in Geraldton and Fremantle (Appendix 4).

Outcomes and outputs, as well as the benefits to fishers and coastal communities, were maximised through collaborating with related projects. The project also provided leverage for further funding which increased the scope of the outputs.

Delivery of information was targeted at the main project benefactors. Project products successfully synthesised new climate science information from the FRDC NARP suite of climate change projects. Existing climate science information and expert presenters were utilised where appropriate (Appendixes 1, 3, 4 and 5). High levels of interest were generated from the target audience as a result of this focus and also as a result of the project emphasis on using information that was regionally relevant, current and salient. Consolidating and interpreting information that was contentious and difficult to understand helped reduce the confusion about climate change in the industry and community.

Both the Knowledge and Blueprint projects had a regional focus, however they were delivered nationally in an Australia-wide context using a number of specific products. For the Knowledge project, an interactive DVD was produced which focused on specific climate information relevant to the three marine management areas (south east, south west and tropics) and also included information (publications, videos, related links) relevant to the whole of Australia (Appendix 5, Attachment 4 Interactive DVD). A 'Teacher Guide: Climate Change and the Marine Environment' was developed utilising resources from the DVD. The Teacher Guide follows the National Curriculum and will be used in future teacher development courses. The Blueprint project targeted the three case study regions and developed an interactive website that can be applied nationally (coastalclimateblueprint.org.au).

Placing climate change factors within the context of other externalities affecting the fishing industry was important in project development and was addressed throughout the life of the project with the project partners and industry. It was recognised that fishers and fishing communities throughout Australia are under considerable pressure from a range of external pressures (Appendixes 1, 3 and 4) and as a result, do not see climate change as a priority issue. Rather than denying climate change, a participatory method such as Photovoice, enabled the fishers and community to understand these complex and often contentious issues in a familiar context, in their own time. This participatory style of knowledge-building appeared to stimulate conversation on the issue and allowed topics related to climate change to be put into context. The implication was that climate change is now seen as another externality affecting the industry and will be dealt with as the need arises. The advantage of knowledge building is that adaptation strategies can be considered in advance, and as one fisher commented, '...they are in a better position to future proof...' their fishing business.

An outcome of the project was extensive media coverage, broad community focus and cross-agency collaboration. This maximised benefits to the whole community. The project had a large number of collaborators including industry bodies, Government Agencies and not-for-profit organisations. Throughout the project, dialogue with each of these organisations was ongoing. This dialogue was

also at a high level with relevant Government Ministers and agency CEO's taking the opportunity to visit the 'Seeing Change' Exhibition. The need for flexible management arrangements and for taking into account the impact of management settings on important social values was highlighted in the 'Seeing Change' exhibition and book.

The project identified barriers and opportunities for science uptake in the fishing industry and also developed recommendations for uptake of climate change information. This work will be relevant and transferable across the industry and coastal communities.

The impact of this project has been far-reaching, exceeding expectations of the flow-on benefits to the fishing community (commercial and recreational) and the wider community.

Appendix 11 Objectives and performance indicators

Objective 1

Increased knowledge and understanding of likely climate change and adaptation measures open to local communities.

Performance Indicators

- Heightened community awareness;
- Positive feedback to FRDC Board from key stakeholders;
- Continued interest and number at workshops over the two year period;
- Series of products developed to help communicate the likely impacts of climate change

Community awareness was increased in myriad ways, including running multiple workshops, giving presentations, speaking at conferences, extensive OWA community engagement, high impact exhibitions as well as the targeted and national delivery of specialised products. In a number of surveys at the end of the project (OWA case study regions, WINSC Directors, Geraldton fishers and Exhibition visitors), participants indicated an increased awareness and interest in climate change science.

Project feedback from key stakeholders (including the FRDC Board) has been excellent. The fisher uptake from the project has been very good. There have been multiple requests from the Geraldton fishing community asking if the project can be repeated in two years.

There has been continued interest in the project over the life of the project. A highly acclaimed community exhibition in 3 Western Australian coastal communities increased knowledge and understanding of climate change and adaptation. Multiple tools were used to increase knowledge uptake for the fishing industry and community. Visitation rates to the exhibitions were excellent (almost 30,000) and people including fishers, visited the exhibition multiple times.

WINSC Directors were followed throughout the life of the project. Their self-assessed level of knowledge on climate change fluctuated, however the knowledge of all Directors surveyed, remained the same or increased over the 3 year study period.

OWA SeaNet Officers incorporated return visits to each of the case study areas to deliver preliminary results of the Blueprint project and specific products developed to increase community knowledge and understanding of climate change. There was continued interest in both the results and products delivered.

Multiple products were developed specifically for the 3 case study coastal communities and the broader Australian coastal communities to effectively communicate climate change information. OWA were engaged directly to extend this knowledge into coastal communities.

Objective 2

Support of Case Study for Australia in adaptive management that cross correlates regional needs with Australia wide policy and management policies.

Performance Indicators

- Final report from project 2010/542 (Blueprint project) on Case Studies in SW, SE and tropical region of Australia.
- Final report 2011/503 (Knowledge project).
- Principal Investigator's PhD awarded.

This project; Building Community and Industry Knowledge (the Knowledge project) was closely associated and supported FRDC project (2010/542); a Climate Change Adaptation Blueprint. The Blueprint project focused on the 3 case study regions and was engaged to develop a 'Blueprint' for adaptation options in coastal communities. This project has been completed and is reported separately (Frusher et al, 2013).

OWA SeaNet Officers were engaged to support the Case Study project and were active in all 3 Case Study towns (St Helens –Tasmania, Bowen -Queensland and Geraldton –Western Australia). Project staff agree that having local people familiar with the fisheries, towns, regions was useful in 'paving the way' for the Case Study interviews in each community.

The final report for project 2011/503, the 'Knowledge' project has been completed.

The Principal Investigator's PhD is underway and due for completion early 2015.

Objective 3

Tailoring the extension and knowledge sharing for regional needs

Performance Indicators

- Providing information on regional FRDC CC research projects which leads to informed discussions with fisheries management agencies.
- Key stakeholders willing to share information;
- Positive feedback to FRDC Board from key stakeholders

FRDC Research projects were summarised and project flyers produced for each project. The flyers were distributed nationally and in each of the case study towns.

OWA, a project partner in the Knowledge project employed local SeaNet Officers around Australia and provided a mechanism to; support the three Case Studies; provide relevant, regional information on the case study communities, better understand the needs of the selected communities and; provide a conduit for climate change science into these communities.

The PI collaborated with many organisations (including UTAS, CSIRO, MU, CU, NCCARF, DoF, ABC) to share information across a range of climate change topics. The production of the interactive DVD relied on goodwill and collaboration from multiple organisations and individuals to include the high level regional ad relevant information.

The project feedback from key stakeholders (including the FRDC Board) has been excellent.

Objective 4

Synthesising analysing and assisting in adaptation of key climate change information, in the context of external drivers to marine biodiversity and fisheries business.

Performance Indicators

- New and novel techniques in information dissemination to the local fishers/fishing communities.
- Contribution to the 2013 report card so that the report card addresses the community knowledge needs.
- Annual performance review by the NCC on behalf of the funders.

An interactive DVD was produced which included an extensive range of climate change science, adaptation options and opportunities for action. This has been distributed nationally and is available to download on a number of websites.

Innovative methods including Photovoice were used to give voice to a significant fishing community in Western Australia. Three highly acclaimed community exhibitions and book were produced which identified the linkages between climate and environmental changes, management responses, economic adjustments and social decline. This exhibition and project received multiple National and State awards.

As part of the Blueprint for adaptation in local communities, in-depth interviews were undertaken to characterise the communities, identify linkages including climate and non-climate impacts on marine sectors and assess potential adaptation strategies for communities. This information was developed into specific brochures for each case study town. Informative PowerPoint presentations with a range of visualisations and animations were developed and produced so the OWA SeaNet Officers could extend the research information to individuals or small groups, specifically targeting their knowledge needs.

Project results have been fed into the annual performance report.

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