VCCCAR

think tank report

Climate Change Adaptations: Fisheries, Estuaries and Knowledge Exchange

Prof Gerry Quinn, Deakin University, Assoc Prof Kevin O'Toole, Deakin University, Dr Helen Arundel, Glenelg Hopkins Catchment Management Authority

vcccar
victorian centre for climate change adaptation research

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Executive summary

Purpose

The aim of this think tank was to examine the responses of Victorian marine environments to realistic climate change scenarios, focusing on a whole-of-ecosystem approach while recognising the inherent connectivity of the marine ecosystems to each other and nearby freshwater and terrestrial environments. Approximately 25 representatives from research organisations, management agencies and industry met for a day and a half in September 2013 at Deakin University's Warrnambool City Centre to address these issues.

Three main themes were considered:

- changes to offshore ecosystems (including upwellings) and likely effects on productivity and fisheries
- changes to estuaries and likely effects on key taxa using estuaries during their life cycle
- the place of knowledge (scientific and other) in determining policy responses to marine climate change.

Desired outcomes

- ecosystem-level assessments of possible effects of climate change on Victoria's marine environments
- improved understanding of ways to enable the incorporation of scientific knowledge into policy decisions about marine environments
- identification of key knowledge gaps for understanding responses of Victorian marine ecosystems to likely climate change scenarios.

Key findings and recommendations

- warming seawater temperatures and changing currents are affecting marine animal distributions and commercial fishery stocks, representing opportunities and losses to specific parts of the sector
- long-term data on population sizes and distributions are critical to future management and adaptation to climate change
- industry engagement is vital for fisheries research and long-term data collection and management
- evidence based information to inform coastal adaptation under climate change should come from a single authoritative coordinating body that brings stakeholders and scientists together to examine issues and develop effective adaptation solutions
- boundary spanning is an important mediation process for linking issues and stakeholders and thereby defining a role for scientists to produce useable knowledge on climate change adaptation.

Attendees

Organising committee

Prof Gerry Quinn, Deakin University

Assoc Prof Kevin O'Toole, Deakin University

Dr Helen Arundel, Glenelg Hopkins Catchment Management Authority

Facilitator

Mr Mark Butz, Futures by Design

VCCCAR

Prof Rod Keenan, University of Melbourne

Mr Doug Scobie, University of Melbourne

Speakers

Dr Jan Barton, Deakin University

Dr Brian Coffey, Deakin University

Prof Graeme Hays, Deakin University

Mr Oliver Moles, Moyne Shire Council

Mr Harry Peeters, Western Abalone Divers Association

Dr Adam Pope, Deakin University

Participants

Dr Peter Gell, University of Ballarat

Ms Marty Gent, Glenelg Hopkins Catchment Management Authority

Mr Geoff Gooley, CSIRO

Ms Rose Herben, Corangamite Catchment Management Authority

Dr Alistair Hirst, Deakin University

Mr Tom Hurst, Melbourne Water

Prof Greg Jenkins, University of Melbourne

Mr Gary Kerr, professional fisher

Assoc Prof Laurie Laurenson, Deakin University

Dr Rebecca Lester, Deakin University

Mr Ross Martin, Department of Environment and Primary Industries

Dr Julie Mondon, Deakin University

Ms Margie Morrice, Deakin University and Blue Whale Study Inc.

Ms Natasha Vasey-Ellis, Gippsland Coastal Board

Introduction

Prof Gerry Quinn (Deakin University)
Overview of predicted changes to SW Victorian marine environment under climate change

Assoc Prof Kevin O'Toole (Deakin University)
Translating knowledge to policy for marine environments

Recent work on predicted changes to the Victorian coastal environment by CSIRO and Victorian state government agencies was collated and presented by Klemke and Arundel (2013) for the Glenelg Hopkins Catchment Management Authority and the Department of Environment and Primary Industries.

Key impacts include:

- rise in mean sea level from 0.18m (2030) to 0.82m (2100)
- rise in sea surface temperature of up to 1°C (2030) to 3°C (2100)
- increase in salinity in embayments and eastern coastal areas
- reduction in ocean pH of up to 0.3 units by 2100
- reduction in freshwater run-off into coastal areas by up to 30% by 2100
- potential increase in the strength of the Bonney upwelling in SW Victoria

Parks Victoria (2010) summarised some of the likely ecological consequences of these changes:

- Rising sea levels will reduce available habitat for intertidal communities, with particularly strong effects on saltmarshes and potentially mangrove communities.
- Rising sea surface temperatures will result in changed species distributions, with potential extinctions at southern ends of ranges, it will also make Victorian marine environments more suitable for some exotic species.
- Reduced catchment outflows may affect coastal productivity but will have the most marked changes in estuaries, especially salt wedge systems, where species distributions are likely to change.

Climate change adaptation options in marine coastal and offshore environments are probably more limited than in terrestrial environments, especially given the open nature and connectivity of marine ecosystems. Essentially, we can manage and protect habitat or we can directly manage key species. The two themes addressed in this workshop, offshore ecosystems and fisheries, and estuaries, illustrate both options.

Understanding climate change impacts and adaptation options relies on knowledge generation and exchange. This understanding also requires deciphering the operating environment of the issues associated with climate change. This is an active area of research in social sciences and the third theme in this workshop focuses on the way all stakeholders generate, utilise and communicate the knowledge required to develop mitigation strategies.

Theme 1: Offshore ecosystems and fisheries

Speakers

Prof Gerry Quinn (Deakin University)
Impact of climate change on fisheries and aquaculture – brief overview

Graeme Hays (Deakin University)
Impact of climate change on marine species distributions

Mr Harry Peeters (Western Abalone Divers Association)
Responses of the SW Victorian fisheries sector to changing climates

Gerry Quinn summarised the important research by CSIRO and University of Tasmania, among others, which have predicted responses of key commercial and recreational finfish, crustacean and mollusc species to changing environmental conditions resulting from changing climate.

One of the key messages from this work is that the southeastern Australian fisheries are very likely to be affected by changes in sea temperatures (Hobday et al. 2008), although changes in pH, freshwater inflows and strengths of upwelling in western Victoria are also potentially important (Pecl et al. 2011).

In particular, key invertebrate fisheries in western Victoria (abalone, calamari, rock lobster) will be vulnerable to increases in water temperature, and both temperature and acidification will impact on various life stages of King George whiting, snapper, sand flathead and Australian salmon.

Two key fishery species in southwest Victoria are abalone and southern rock lobster. Pecl et al. (2009) highlight that abalone are poor dispersers and are likely to be vulnerable to climate related changes. While data are scarce and more research is a priority, abalone may be susceptible to increasing temperature and acidification. Southern rock lobsters are better dispersers and may be more resilient to climate change but little is known as to how temperature and acidification impact on different stage of their life cycle, especially settlement and recruitment.

Broader oceanographic changes can also impact on commercially and recreationally exploited populations. The southward extension of the East Australian Current is linked to the extension of the southern limit of the sea urchin Centrostephanus rogersii, which can reduce kelp cover (habitat for abalone) and compete with abalone for food.

Climate change may also affect the Bonney upwelling, which is likely to be a significant influence on productivity in western Bass Strait. The responses of upwellings to climate change are uncertain, but upwelling strength and frequency will be sensitive to any changes in wind patterns, especially southeasterly winds in summer.

Graeme Hays emphasised the importance of relevant data at appropriate spatial and temporal scales if we are to understand how geographic ranges of key oceanic species will be affected by changing environmental conditions such as sea surface temperatures.

He provided two examples of such data:

- The Continuous Plankton Recorder (CPR) is a monitoring program that has been collecting plankton samples using ships of opportunity (sampling gear towed behind merchant and other vessels), especially in the North Atlantic, since 1931.

  Reliable data are available from 1950-2013 that have clearly shown changes in species distributions and resulting changes in species composition related to variations in water temperature.

  Plankton are the basis for many key ocean food webs so these changes are significant for higher order taxa, including commercial fisheries.

  These data also stress the importance of long-term data sets for interpreting responses to climate change and a key message was that it is never too late to start collecting long-term data, especially in the southern hemisphere where such data for marine ecosystems are lacking.

- Recent advances in how biologists can tag individual marine animals, especially vertebrates like turtles, have provided great insights into the movements of these species and how these animals respond to environmental conditions.

  Using satellite tags and data loggers, it has been shown that leatherback turtles are likely to increase their range both northwards and southwards as waters warm with potentially significant implications for food webs and the conservation status of these species.

The take-home message from Graeme Hays' talk was that ocean warming is causing range expansions and contractions, but there is little evidence of thermal adaptation for the species studied.

Finally in this theme, Harry Peeters discussed impacts and options for the two key commercial fisheries in southwest Victoria – abalone and southern rock lobster.

The Abalone Viral Ganglioneuritis outbreak in 2006-7 has focused the abalone industry on the need to respond quickly to such events, including climate-related changes.

The key for this industry is the availability of fine-scale (reef by reef) data on catch and size structures and such data are now available for the western zone abalone fishery, although less so for other stocks.

The two major threats to abalone stocks (besides potential disease outbreaks) are warming temperatures, prompting abalone to move into deeper, less accessible waters, and incursions by pest species.

Adaptation options include translocation of abalone to re-establish self-sustaining populations, restoration of habitat (especially kelp beds) and aquaculture methods.

Adaptation workshop - how can the fisheries sector respond to the anticipated changes in the marine environment?

Key points from the workshop discussion:

1. The importance of relevant data from long-term monitoring over appropriate spatial scales was a repeated message from the discussions. While marine exemplars exist in the northern hemisphere (e.g. Continuous Plankton recorder), long-term data sets, especially for offshore marine ecosystems, are rare.

   A number of issues and suggestions were identified:

   - The more researchers and industry stakeholders use datasets, the more likely is investment in their collection and interpretation
   - Datasets do exist in the southern hemisphere (through IMOS, fisheries stock assessments etc.) researchers should focus more on analysing existing data rather than always collecting new data
   - Data custodianship is critical. Changes in staff and data storage methods will often result in data being lost. Organisations need to ensure appropriate data management and custodianship
   - Researchers should make better use of any opportunities to collect relevant data, even if the sampling design is not ideal
   - It is never too late to start collecting long-term datasets. Coordinated efforts among marine scientists to commence strategic long-term monitoring should be a priority.

2. Closer links between researchers and industry, especially the fishing industry but also oil and gas, might be more productive than relying on government funding for assessing climate change effects and mitigation options.

   The fishing industry can provide existing data, vessels for collecting new data (including as ships of opportunity), qualified labour in the form of divers and other fishers as well as historical and anecdotal knowledge.

   University-based researchers need to be encouraged and rewarded for working with industry, especially as the usual returns (e.g. high impact publications) may be more difficult to produce in the short-term.

3. Remote sensing methods, such as multibeam sonar, Lidar and underwater video, can provide large datasets that are less reliant on field work in difficult and expensive conditions. Models linking biophysical characteristics of the seafloor, derived using sonar, to fish catch data will enhance our ability to predict changes to fish stocks under changing environmental conditions.

4. Adaptation methods are available for some fish stocks. Options for abalone include translocation to re-establish populations on individual reefs and restoration of key habitat features such as kelp beds.

5. Aquaculture will continue to be an alternative to wild-caught stocks for some species (e.g. abalone) and also an important source of animals for restocking and translocation.

Key barriers and knowledge gaps:

1. Willingness and infrastructure to share data without battles over intellectual property etc.

2. Lack of trust between industry, government, science and the community. New models of research partnerships need to be explored.

3. The absence of long-term data sets from which to assess change in offshore ecosystems and fish stocks. This is a major constraint and applies to any component of marine ecosystems that would be affected by a changing climate.

Theme 2: Estuaries

Speakers

Dr Adam Pope (Deakin University)
Physical effects on estuaries

Drs Jan Barton, Adam Pope and Rebecca Lester (Deakin University)
Biological changes in estuarine environments under climate change

Dr Helen Arundel (Glenelg Hopkins Catchment Management Authority)
Estuary management under climate change

Mr Oliver Moles (Moyne Shore Council)
Planning tools for estuary and coastal management

Adam Pope summarised our knowledge of the physical condition of Victoria's estuaries and how they might respond to changing climate.

Estuaries are naturally variable environments, especially the intermittent open-coast estuaries which show variations in water levels and salinity structure across a range of temporal scales (tidal, seasonal, annual scales).

The key physical changes predicted under a changing climate include:

- reduced freshwater flows, with likely percentage reductions in runoff between 30% and 40% by 2050, based on a two degree increase in median temperatures
- rising sea levels, this will change inundation patterns of estuaries, although in a complex manner. The effects of sea level rise will depend on whether sediment supply increases or decreases. Modelling of various scenarios for key estuary types along the coast is an urgent priority and new data (especially Lidar) are available
- increase in extreme events, including storm surges and floods, will fundamentally change the structure and extent of estuaries during these events. Modelling is now available for some estuaries, which will allow managers to design possible mitigation strategies
- rising water temperatures and reduced pH will affect the life cycles of many estuary-dependent species of plants and animals, although data on thermal and pH tolerances of most taxa (except some commercial species) are lacking, so predictions are difficult.

Jan Barton and colleagues provided an overview of the biological components (vegetation, invertebrates, fish and birds) and ecological; functioning of Victoria's estuaries.

Some likely impacts as a result of predicted changes in physicochemical parameters include:

- increased phytoplankton abundance as a result of increased air temperatures and CO2 levels could also increase the growth rates and hence food requirements for fish
- increased mortality of fringing vegetation will have negative effects on wading birds that utilise these habitats
- calcifying organisms are likely to be negatively affected by reduced pH
- distribution of fish species in the water column may be restricted as surface water temperatures increase and oxygen levels decline in deeper waters, restricting some fish species to a narrowing middle zone in the water column
- changes in the salinity structure and degree of connectivity with the ocean may result from decreased freshwater flows and increases in extreme events, leading to complex sets of responses of key species, including habitat forming vegetation. Evidence already exists of changing vegetation distributions and increased algal blooms in Victoria's estuaries.

Predicting biotic and ecosystem responses is difficult because cumulative effects from interacting processes are likely to have the greatest impact, and increasing human use of estuarine environments is already changing these ecosystems independently of climate.

Helen Arundel explained some of the management tools and processes in place for dealing with estuaries and the role of catchment management authorities in working with communities to manage the likely changes.

The following issues were discussed:

- estuary entrance management - how and when to open estuaries that have not opened naturally. Decision support systems such as EEMSS, might need modification under climate change scenarios
- lack of state-wide strategic infrastructure guidelines to inform decisions about placements of infrastructure such as jetties, boat ramps and fishing platforms in estuaries
- estuary monitoring - decisions and future planning limited by few even medium-term water quality monitoring programs, and no monitoring of biota
- range of incentives required - need to protect what is valuable now and what might be valuable into the future. A strategic approach to identifying land for purchase.
- more research to inform selection of appropriate incentive e.g. grants, stewardship, or land acquisition for land owners to protect estuaries and coastal environments
- community engagement - the diversity of stakeholder views on estuary management is a major challenge for management agencies. Community engagement strategies, and community education, need much greater emphasis and a consistent message from all agencies.

Oliver Moles outlined the complex and changing planning context for coastal and estuary management. Using Port Fairy within the Moyne Shire as an example, the results of a coastal hazard report showed that erosion, wave run-up and inundation were the greatest threats and no single planning tool could cover all three. The only options available to managers are defend, accommodate or retreat. Moyne is focusing on three specific actions – repairing a rock wall to protect land and residences, rehabilitating the primary dune with vegetation, and dredging the Moyne River and pumping the sand onto the at-risk beach.

Adaptation workshop - how can estuary management and 'industry' (e.g. planning, tourism, recreation) respond to changes in estuary environments?

Key points from the discussion:

1. Issues with data collection, longevity and custodianship that were raised for offshore ecosystems and fisheries are just as important and limiting for predicting estuarine responses to climate change
2. Jurisdiction over coastal and estuary management is currently complex and inefficient, with Dept Environment and Primary Industries, Parks Victoria, local government and Catchment Management Authorities all having control over some components and processes. There was a strong view that a single body should oversee coastal management, at least in terms of local operational issues. The roles of coastal boards need clarification
3. Linked with point 2, if a single management body cannot be formed, then a single 'one stop shop' shared between the key management agencies is required to handle local enquiries about coastal and estuarine issues. This could take the form of a 'citizens advice bureau' on coastal management
4. Communication with stakeholders and engagement with the broader community pose a time-consuming challenge for management agencies and an over-riding constraint to developing effective management partnerships. People with a specific skill-set are needed to package and deliver the message about climate change and coastal impacts and adaptation, yet currently this is seen as simply another role for existing staff who may not necessarily have the communication skills or resources to effectively educate the public
5. An appropriate risk assessment process involving the community and stakeholders is critical. This includes strategies for responding to extreme events (floods, storm surges) and clear guidelines on how to share risk (e.g. public versus private responsibilities, flood levies).

Key barriers and knowledge gaps:

1. developing effective communication strategies between management agencies and the public
2. simplify jurisdictional issues in coastal and estuarine management so there is a single coordinating body
3. lack of predictive capacity as to how individual species will respond to changing temperature and salinity regimes in estuaries.

Theme 3: Knowledge-policy interface: translating priority responses into policy

Speakers

Assoc Prof Kevin O'Toole and Dr Brian Coffey
(Deakin University)

A central part of understanding the adequacy of knowledge generation and exchange processes in climate adaptation planning is to decipher the operating environment of the issues or problems at hand, as this informs what kind of knowledge is included or excluded. The operating environment includes all the actors, institutions, stakes, issues, relationships, and objects that impinge upon how specific issues or problems are structured.

By way of example we used the proposed Warrnambool Harbour Redevelopment (WHR) and sought to understand:

1. what major issues were arising from the redevelopment
2. who were the stakeholders
3. who or what could act as 'boundary spanners' (see below)
4. what type of problem(s) were involved
5. what type of interventions could be used to help to resolve any conflicts.

Our aim was not to come to any agreement about desired outcomes but to generate discussion which provided insights into helping scientists and managers better understand the dynamics involved, and potentially structure how research can contribute explicitly to the articulation of improved outcomes.

Within this context, research can help mediate the relationship between an issue and what is at stake in a variety of ways, while always being mindful that research is part of the dynamics of the issue. For instance, actors in the WHR may create groups with very different ideas of what is at stake. Some (including scientists) might see the issue as being about fishing and economic development while others view the issue as a threat to biodiversity and conservation.

The work done to mediate between issues and stakes is termed 'boundary spanning', which embodies a diverse range of possible practices. Boundary spanning is a process of mediating between different groups, values and beliefs. It is the process of facilitating the interaction between actors by crossing the boundaries that are set up by different groups, institutions, organisations to protect their own values, beliefs or interests. Thus what is at stake for the variety of groups involved in the WHR depends upon their own values, beliefs and/or interests.

The role of research can be important in the process of boundary spanning. Done well, boundary spanning links issues and stakes and thereby defines a useful role for scientists to produce useable knowledge. When done poorly, especially where stakes are high and diverse and stakeholders numerous and/or powerful, boundary spanning can result in the politicisation of science and undermine the perceived credibility and legitimacy of science organisations or scientists. Accordingly, research about issues such as the WHR needs to be able to confront as many stakeholder concerns as possible before being capable of contributing to useful boundary spanning interventions.

Research undertaken as part of the CSIRO Coastal Collaboration Cluster has investigated such issues and argues that a number of steps can be taken before getting to the intervention stage:

1. **Issue:** It is important to clarify the issue as it pertains to the WHR.

   It is important to avoid bias at this juncture. This can be achieved through iteratively focussing on defining the issue and what is at stake, for whom. Looping between issue and stake requires open dialogue preferably by including the diverse stakeholders or people able to articulate their interests, stakes, values and goals. It is important to note boundaries that are set by each of the stakeholders and this will help to define the issue.

2. **Stake:** Identify the stakeholders and their values and stakes in the WHR.

   In this stage come considerations of equity, inclusion, influence and power. This stage is most appropriately done in a participatory fashion as that allows stakeholders to express their own values and stakes. In some instance it may be useful to apply approaches such as Stakeholder Analysis and mapping, as this can be very useful to formally capture values and stakes with divergent stakeholder groups. It is important to describe how the different stakeholders construct the boundaries around their perception of the issue.

3. **Boundary spanning:** Typify existing boundary spanning functions.

   This stage maps the relationships, organisations, objects/products, networks, people and institutions that mediate dialogue or debate relevant to the issue of WHR. Mapping current boundary spanning activity can provide a good template for analysis of risks, constraints, strengths, weakness and opportunities which can finally assist with diagnosis of points where intervention is likely to be most effective, efficient and equitable.

4. **Problem structure:** Once the issue, stakes and existing boundary functions are adequately described, it is possible to characterise how the problem is structured:

   Is the problem well, moderately or poorly structured, or unstructured? Where on this continuum can the problem be legitimately situated?

   - **Well-structured problems:** Where there are converging values and/or low stakes, a problem can be considered as well-structured and is amenable to direct application of technical information. For example, the problem of whether to take an umbrella on a business trip on a personal level, or what to do in preparation for a cyclone at a jurisdictional level. In addressing these problems the issue, desired outcomes and stakes are generally either uncontested or inconsequential.

   - **Moderately structured problems:** Where there is a possibility of a majority reaching agreed goals, and relatively high certainty about science, a problem can be considered as moderately structured.

   - **Poorly structured problems:** These are problems in which dilemmas are apparent, such that an outcome that is considered positive will create another that is considered negative, often depending on the divergent values. In trying to resolve poorly structured problems, decision-makers will use compromise to trade-off and 'balance' opposing outcomes or values.

   - **Unstructured problems:** In these problems there are divergent perspectives of what the issue is, and therefore no agreement about goals associated with the issue. In such problem contexts there is often distrust and the social license of science itself is threatened. Divergent claims, interests and values structure adversarial debates in which various players appear to be talking about completely different issues.

Drawing on the issues, stakes and boundary spanning processes in place for the WHR, workshop participants considered what kind of problem the WHR could be considered to be, and how different stakeholders might view it. Is it un/ poorly/ moderately or well – structured? And, is it possible to intervene in ways that legitimately shift the issue to being better structured?

5. **Design elements:** There is a need here to overcome the tendency towards the product focus of many research programs and projects, unless the problem is well structured.

   The less well-structured a problem is, the more different design elements will likely need to be included and integrated for scientific information to have a bearing on the way an issue is addressed.

The five key design elements and their focus can be considered as:

a. **Science communication (product focus):** Management agency has well defined needs for information and knows how to apply it, useful for well-structured problems (low stakes, value convergence, and well defined issues)

b. **Informal linkages (relationship focus):** Where problems are poorly structured or unstructured building informal linkages among key stakeholder groups can begin to create mutual understanding of stakes and values across groups, thereby allowing clearer definition of issues.

c. **Brokering/intermediary (actor focus):** build capacity within organisations that manage problems in which science and community values are both important,

d. **Temporary organisation (structure/network focus – e.g. reference groups):** complex, short-term, managed within specific organisation

e. **Boundary organisation (organisation focus):** long-lived, persistent 'wicked' problem, managing complex conditions, often within multiple organisations (local, state commonwealth, private) – potential for overreach.

None of these design elements are mutually exclusive, rather they are mutually reinforcing when planned and focused. In the case of WHR it is hoped that such a process, while not pleasing everyone, will at least be transparent and built upon good science.

Evaluation

Response to the evaluation questionnaire was relatively low with eight of the 25 participants (32%) replying. Seven of eight respondents rated the scope and issues presented at the think tank as good or excellent, there were very positive responses to the level of involvement or discussion and all agreed that the event achieved its stated purpose. Suggested improvements included a presentation on the draft Victorian Coastal Strategy and a stronger focus on knowledge gaps.

Appendix 1: Presentation by Rod Keenan

Climate: embrace the change?

Rod Keenan, Director

Partner Universities

Project Sponsor

www.vcccar.org.au

Centre Objectives

- Provide multi-disciplinary, research, analysis and advice to Government, industry and the community
- Increase decision-making capacity on climate adaptation
- Include adaptation needs into strategic planning
- Build partnerships between Victorian universities
- Expand funding for adaptation research

Adaptation in practice

Challenges

- Managing and presenting research outputs
- Building the innovation culture in government
- Integration and coordination of the national research agenda

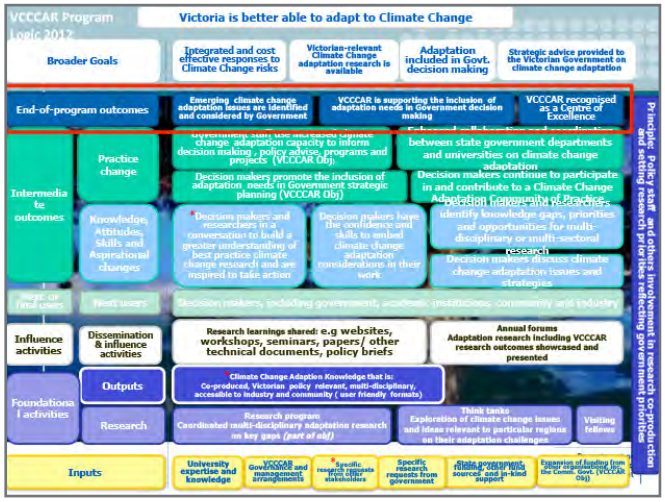
Adaptation policy challenge

The Department of Treasury and Finance has estimated that the Victorian Government has spent over $4 billion over the past 10 years on response and recovery to climate-related events such as bushfire, flood and drought.

Victorian research[2] has estimated that by 2050 increases in bushfires under projected future climate change will cost the agriculture sector an additional $1.4 billion ($46.6 million per year by 2050) and the timber industry $2.8 billion ($93.4 million per year by 2050).[3]

Informed decision-making requires research tailored to Victorian settings and needs

The Victorian Centre for Climate Change Adaptation Research provides a strong foundation for delivery of this priority



End of program outcomes

- ✓ Emerging climate change adaptation issues are identified and considered by Government
- ✓ VCCCAR is supporting the inclusion of adaptation needs in Government decision making
- ✓ VCCCAR recognised as a Centre of Excellence

Think tanks and 'conversations'

Adapting aspirations and expectations on the coastal suburban and regional fringe	Nov 2011
Adaptive learning - a think-tank on preparedness for climate change adaptation in local and state planning in Victoria	Jul 2010
Assessing, Managing and Building Resilience to Climate Emergencies	May 2012
Climate change adaptation and mitigation in Victorian drylands	Apr 2010
Climate change and floodplain management in Victoria	Aug 2011
Climate change and health in the regions	Jul 2010
Climate Services for Adaptation in Victoria	Jul 2012
Incorporating climate change impacts and adaptation into capital investment decision making	Apr 2011
Regional business development in a variable and changing climate: strategies for central Victoria	Jan 2013
Towards a Gippsland regional climate adaptation study	Aug 2011

Research Program

Governance, framing and implementation
- Framing adaptation for policy and practice
- Implementing adaptation
- Legal, financial and institutional arrangements for adaptation

Urban resilience
- Contribution to resilience of distributed systems for water and energy generation
- Design led approaches to spatial planning
- Planning urban green infrastructure to reduce urban heat impacts

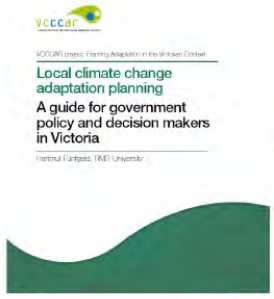
Decisions under uncertainty
- Scenarios in climate adaptation policy and practice
- Real options in water resource planning
- Decision taking – the sociology of decision making

Natural Resource Management in a variable and changing climate
- Integrated land management in a changing climate
- Incorporating traditional knowledge in floodplain management

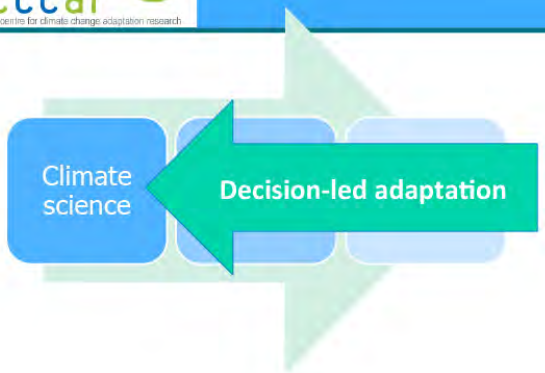
Where to next?

victorian centre for climate change adaptation research

Outputs for local government



1. Adaptation concepts and approaches
2. Working collaboratively on adaptation
3. Establishing the local context
4. Assessing current and future impacts
5. Developing responses



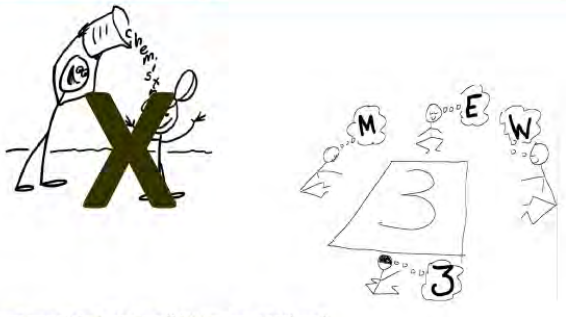


Image source: John Rowley http://ch301.cm.utexas.edu/learn/

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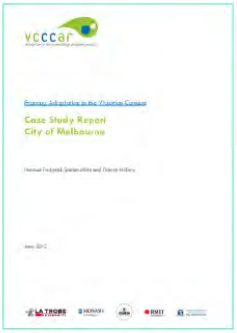
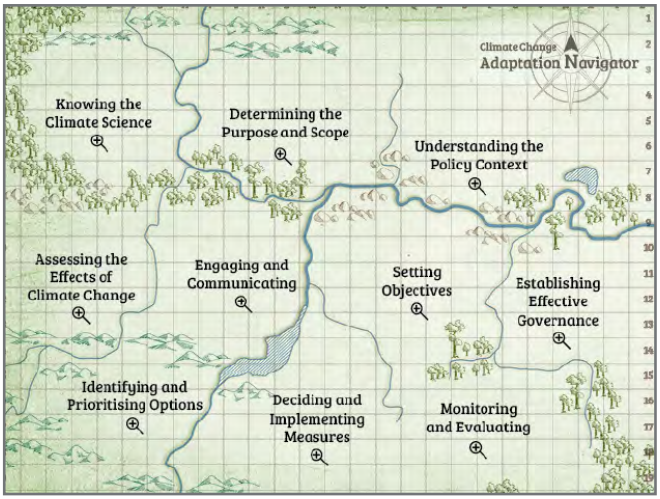
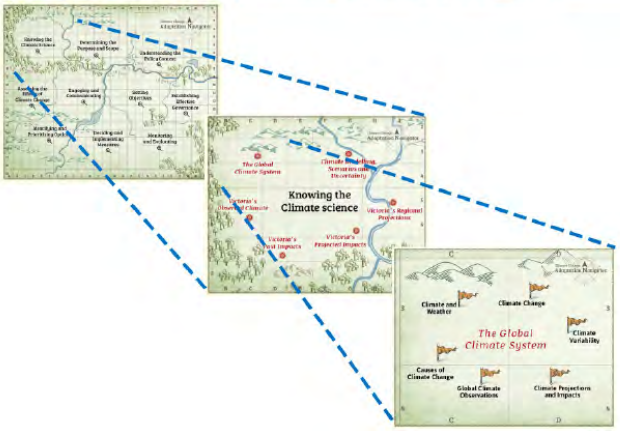
Outputs for local government



1. Meanings of climate adaptation
2. Adaptation framing
3. Climate risk management
4. Multi-level policy making for adaptation
5. Adaptation data and information needs



Adaptation Navigator



Navigating adaptation

Case Study: City of Greater Bendigo

The City of Greater Bendigo is the local government of a major regional centre servicing the towns and rural areas of the Loddon region, about 150 kms north west of Melbourne. While still significant, traditional reliance on manufacturing has diminished in recent years, with the development of a strong health, education and retail sector in the city. Commerce, finance and government administration are also important activities.

The map on the left shows the adaptation pathway for the City of Greater Bendigo (June 2012).

Click on the link below to access the full climate change adaptation pathway profile for Bendigo.

- City of Greater Bendigo Climate Change Adaptation Pathway

As part of the VCCCAR Framing Adaptation project focus groups, workshops and key informant interviews were held with three local government in Victoria: the City of Greater Bendigo, the City of Melbourne and the City of Greater Geelong. The

Framing project: Conclusions

Adaptation needs:

- ✓ Strategic thinking and planning, integrated within existing organisational structures to consider the longer-term implications of today's decisions
- ✓ A focus on the local - adaptation processes will be influenced by the local socio-economic, political and institutional context
- ✓ Managing across areas such as urban and regional planning, community development, infrastructure, and risk management
- ✓ A whole-of-organisation coordinated approach with strong leadership and active collaboration

McEvoy and Fuenfgeld 2013 – synthesis report

Wallis 2013 Presentation to NCCARF. VCCCAR Implementing Adaptation project

6. Key messages

Literature themes → Interview themes → Possibilities for NRM adaptation

- Managing uncertainty
- Fit-for-purpose governance
- Taking learning approaches

- Uncertainty
- Learning from history
- Framing adaptation
- Utilising sources of information

- Fostering innovation in regional governance
- Supporting regional facilitators
- Adopting an adaptation lens

Legal and regulatory research

Godden et al 2013 *Governance models for climate adaptation and natural disaster risk management: an initial legal and regulatory analysis* . Draft report to VCCCAR

Legal options for adaptation

Purpose-built legislation or legislative instruments	• Provisions relating to the Adaptation Plan in Parts 2 and 3 of the *Climate Change Act 2010* (Vic)
Express provision in legislation and legislative instruments	• Actions taken and decisions made under Acts listed in Schedule 1: *Climate Change Act 2010* (Vic), s 14. (*See Appendix 2*) • Victorian Planning Provision (VPP) 13.01-1 Coastal Planning Strategy
Implied provision in legislation and legislative instruments	• VPP 13.02-1 Floodplain management • VPP 13.05-1 Bushfire risk
Private law mechanisms	• Allocation of risk and legal liability in contract drafting – eg through the use of force majeure clauses • Liability in the tort of negligence • Liability in the tort of nuisance

Godden et al 2013 *Governance models for climate adaptation and natural disaster risk management: an initial legal and regulatory analysis* . Draft report to VCCCAR

Legal issues: flood case study

Reservoir operators

Irrigation networks managers

Local councils

Rural and town residents

Bureau of Meteorology

Private businesses

Water and sewer authorities

Property owners

State Emergency Services and CFA

State government

Environment Protection Authority

Catchment management authorities

Insurance companies

Adapting to flood risk

Article

Adapting to flood risk under climate change

Robert L. Wilby
Loughborough University, UK

Rod Keenan
University of Melbourne, Australia

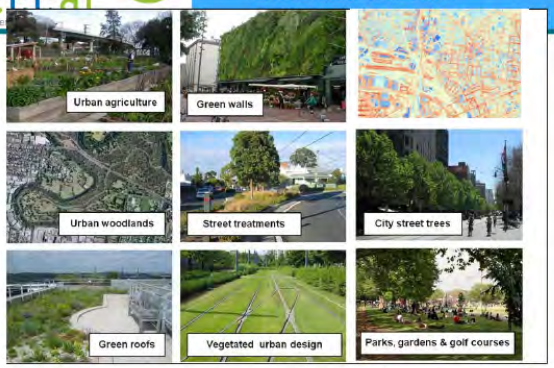
Abstract

Flooding is the most common natural hazard and third most damaging globally after storms and earthquakes. Anthropogenic climate change is expected to increase flood risk through more frequent heavy precipitation, increased catchment wetness and sea level rise. This paper reviews steps being taken by actors at international, national, regional and community levels to adapt to flood risk from tidal, fluvial, surface and groundwater sources. We refer to existing inventories, national and sectoral adaptation plans, flood insurance, building and planning codes, city plans, research literature and international policy reviews. We distinguish between the enabling environment for adaptation and specific implementing measures to manage flood risk. Enabling includes routine monitoring, flood forecasting, data exchange, institutional reform, bridging organizations, contingency planning for disasters, insurance and legal incentives to reduce vulnerability. All such activities are 'low regret' in that they yield benefits regardless of the climate scenario but are not cost-free. Implementing includes climate safety factors for new build, upgrading resistance and resilience of existing infrastructure, modifying operating rules, development control, flood forecasting, temporary and permanent retreat from hazardous areas, periodic review and adaptive management. We identify evidence of both types of adaptation following the catastrophic 2010/11 flooding in Victoria, Australia. However, significant challenges remain for managing transboundary flood risk (at all scales), protecting existing property at risk from flooding, and ensuring equitable outcomes in terms of risk reduction for all. Adaptive management also raises questions about the wider preparedness of society to systematically monitor and respond to evolving flood risks and vulnerabilities.

Adapting to flood risk: Conclusions

1. Floods are not all bad
2. 'Adaptation' is really just 'good practice'
3. Enabling factors (information, institutions and preparedness) are low regret and relatively low costs
4. Defending against, living with or withdrawing from flood risk require greater boldness on the part of decision makers
5. Economic appraisals of costs and benefits can help optimize the timing of such investments
6. Adaptive management isthe best hope of reducing flood risk in an uncertain social and physical climate

Urban Heat



A 10% increase in green infrastructure could result in a reduction of up to 2.5°C

Urban heat assessment

- Thermal mapping is an excellent tool for communicating the influence of urban design on urban climate
- Assessed the influence of green infrastructure on land surface temperatures
- Advice on the practical application of high resolution airborne thermal remote sensing for policy development targeting excess heat mitigation

Figure 2 | Scales of Melbourne's thermal footprint (adapted from Loughnan et al., 2013, City of Melbourne, 2012)

Urban heat and green infrastructure: perceptions and multi-agency policy

Analysis of perceptions revealed that stakeholder literacy in the thermal footprint must be improved.

Health

- **Educate children through preventative health programs,**
- **GI master plans for vulnerable urban 'hotspots'**
- **Promotion of co-benefits (air quality and active transport options)**

Transport

- **Reduce regulatory barriers around street trees and setback requirements**

Planning

- **incentivise maintenance or installation of GI at a site level**

Local government

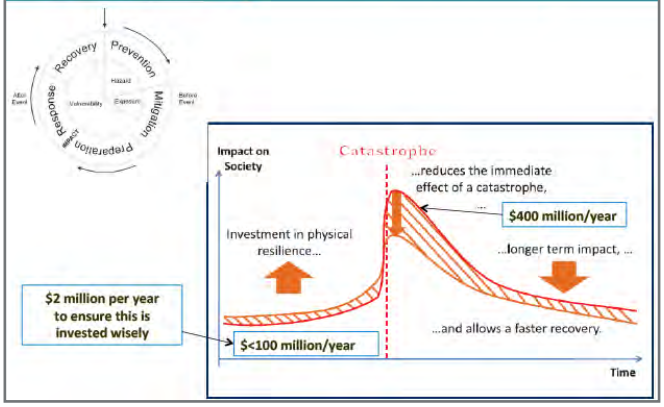
- **Identify priority neighbourhoods and streets within these**
- **Improve the health and resilience of existing green infrastructure by integrating water sensitive urban design**
- **Select appropriate green infrastructure elements**

Building learning organisations

1. **Allow time for reflection – be conscious of the 'bias for action', filling time with 'urgent' tasks**
2. **Avoid 'undiscussables'**
3. **Consider, and question, current power relations**
4. **Cope with 'not knowing'**
5. **Design projects that allow 'second order learning'**

Kate Lonsdale VCCCAR Visiting Fellow 2012

Investing in knowledge



Conclusions

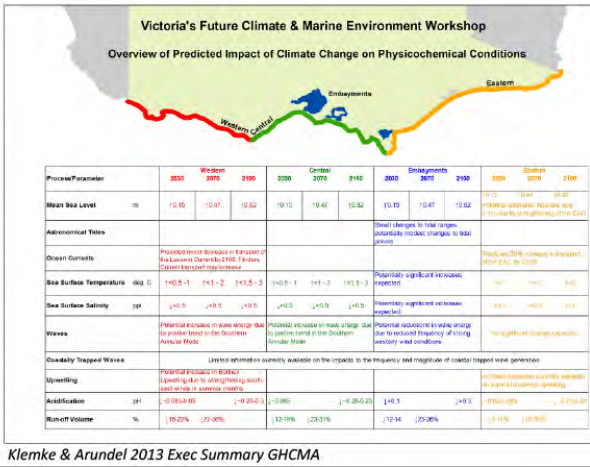
1. Researchers can work in teams across institutions
2. Researchers can work in partnership with local government to support better decision making
3. Challenge is to present new knowledge in ways, and in a time frame, that is useful for policy decisions
4. Need for adaptation, and the potential options, is becoming increasingly well understood among a growing community of practice
5. Not so well understood by those at senior policy levels, in leadership roles or in the wider community
6. We need your support for:
   - maintaining and expanding the community of practice
   - growing the knowledge base through co-production
   - building capacity
   - communicating adaptation options to the wider community

Appendix 2: Presentation by Gerry Quinn

Climate change and SW Victorian marine ecosystems

Gerry Quinn
Deakin University

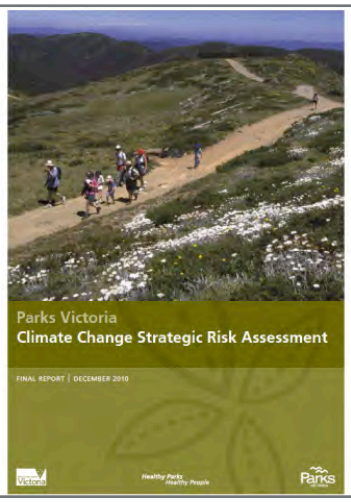
DEAKIN UNIVERSITY AUSTRALIA Worldly



Klemke & Arundel 2013 Exec Summary GHCMA

Summary	Regional Detail	Certainty/Gaps
Sea Surface Temperature		
SST's have increased in Southern Australia over the past 60 years (Hobday *et al.*, 2011), with a greater increase observed along the eastern Victorian coastline associated with the strengthening of the EAC.	SST's are projected to increase further, with greatest increase expected to occur on the eastern Victorian coastline due to the influence of the strengthening EAC. Lower rates of SST increases on the western Victorian coastline are projected due to a decline in the strength of the LC. Significant increases in SST are also projected for WP and PPB. While SST in CI has not yet been modelled, it can reasonably be expected to increase at least as much as the projected WP increase as it is of a similar semi-enclosed and shallow nature.	There is considered a high certainty in the projections of SST change. It is suggested that the existing models of the Embayments are utilised to undertake more comprehensive climate change impact assessments of these systems.
Sea Surface Salinity		
There has been an observed increase in SSS along the eastern Victorian coastline associated with the strengthening EAC and within the major embayments due to drought conditions over the last decade.	SSS along the eastern Victorian coastline is projected to increase along with increasing EAC strength and penetration. SSS along the western and central Victorian coastline are not projected to increase significantly, possibly due to projected weakening of the LC. Salinity changes are projected to be far more pronounced in embayments than along the oceanic coastline, due to greater susceptibility to changes in run-off volumes.	There is good confidence in projections of oceanic salinity and observations of the recent drought effects in the bays provides insight into what could be expected in the bays in a drier climate. Further finer scale regional climate change scenario modelling of the major embayments is suggested.
Upwelling		
Upwelling brings cool, nutrient rich water to the surface leading to high levels of primary production and subsequent fishery production.	The Bonney upwelling on the western Victorian coastline is the largest coastal upwelling system in south eastern Australia. Cold water upwelling can also occur along the far Eastern Victorian coastline.	Little is known about the potential impacts of climate change on the strength or frequency of upwelling events along the Victorian coastline.
Carbon Dioxide and Acidification		
Ocean pH has decreased (become more acidic) by 0.1 pH units since approximately the 1850's, due to dissolution of CO_2. Freshwater (i.e. run-off) pH already has naturally high variability.	Around the south-east Australian coastline, pH is projected to decrease by ~0.1 and ~0.3 pH units by 2030 and 2100 respectively. The projected change in oceanic pH decreases from west to east along the Victorian coastline. Changes in pH in the bays could be reasonably expected to be more pronounced than in the ocean due to the already high variability.	There is reasonable confidence in projections of oceanic pH (Hobday, pers. comm., 2012). pH changes in the Embayments are more difficult to project (Hobday, pers. comm., 2012).

Mills et al 2013 Chapter 1 GHCMA



#	STRESSOR	IMPACTS	CONSEQUENCES	Ratings		
				Priority (Current)	Priority (2030)	Priority (2070)
Generic risks						
10.2	Sea surface temperature (SST) and ocean warming	Effect changes in physical environment, alter ocean currents and vertical and horizontal circulation patterns, altered productivity	Change species' distribution, food chain dynamics, possible extinctions of spp at the southerly end of their range, emergence of new pests (exotic and/or endemic)	7 High	8 Very High	9 Very High
11.5	Ocean warming	Differential responses of algal species	Change in community composition and potential decline of kelp forests (NB poorly understood at present)	7 High	8 Very High	9 Very High
Seagrass communities						
12.1	Storm surges	Increase sediment mobilisation, increase turbidity and decrease light penetration. Smother and break seagrass shoots.	Reduce the viability of seagrass ecosystems	5 Medium	8 Very High	9 Very High
12.4	Increased air temperature and extremely hot days	Increased desiccation for plants and animals	Change species assemblies, reduce populations of vulnerable flora and fauna	6 High	7 High	8 Very High

Parks Victoria 2010

#	STRESSOR	IMPACTS	CONSEQUENCES	Ratings		
				Priority (Current)	Priority (2030)	Priority (2070)
Sheltered intertidal flats including mangroves and saltmarshes						
13.2	Sea level rise	Loss of suitable habitat for intertidal species	Permanently inundate present intertidal areas causing compression of available habitat for intertidal species and increased competition for available space between species (vertical compression) Mangroves decline where topography not suitable or blocked (e.g. by urban development)	4 Medium	7 High	8 Very High
13.4	Sea level rise	Inundate saltmarsh	Loss of saltmarsh communities	5 Medium	8 Very High	9 Very High
Pelagic environments						
15.2	Alteration of large-scale currents	Southward extension of East Australian Current, change in upwelling/ down welling e.g. in Bass Canyon Intensity of Leeuwin and Flinders current may change, change in upwelling/down-welling e.g. in Bonney region	Southward species shifts including potential pests Risk to species viability for species at southern end of range Alter recruitment patterns, aggregations, feeding grounds especially for upwelling dependant species (e.g. krill and Blue Whales, Penguins, seals, sea birds) – e.g. Bonney Upwelling, near-shore coastal systems	6 High	7 High	8 Very High
Estuaries						
16.1	Decrease in catchment inflows (all catchments)	Increased estuarine salinity, reduced flushing volumes, increased incidence of closing of estuarine mouths.	Change species assemblies	6 High	8 Very High	9 Very High
16.4	Sea level rise	Inundation of low lying areas	Increased habitat for some species such as mangroves where range expansion is not limited by ecological squeeze effects	5 Medium	8 Very High	9 Very High

Parks Victoria 2010

- Fisheries will be impacted differently according to the physical changes in the regional environment, for example:
  - South-east fisheries are most likely to be affected by changes in water temperature
  - Northern fisheries are most likely to be affected by changes in precipitation
  - Western fisheries are most likely to be affected by changes in the Leeuwin Current
- Socio-economic impacts
  - Aquaculture industries have considerable adaptation potential via selective breeding, regulating the environment, and new species opportunities.
  - Wild fisheries will see increased opportunity where tropical species move southward, while for southern fisheries, reconciling non-climate threats with increasing temperature will require proactive management.
  - Management structures and policies that account for climate change will allow most flexibility in adapting to future patterns.

Hobday et al 2008 CSIRO

Climate change adaptation priorities

Fisheries & Aquaculture
Undertake research on how fisheries and aquaculture management and policy can facilitate flexibility by operators seeking to adapt to climate change – are current management approaches suited to a changing climate?
Collect and analyse data on the impacts of climate variability and trends on marine biology to give insight into the impacts of climate change on fisheries and aquaculture and develop methods for assessing the vulnerability of fished and aquaculture species to environmental variables under climate change, including means, extremes, and cumulative impacts.
Develop robust genetic strains for aquaculture species that perform well in future environments, and examine industry locations and opportunities under future climate scenarios.
Develop predictive models for the occurrence of extreme events, and the thresholds for the biology (particularly for aquaculture). Deliver these warnings at a time in the production cycle that is useful to operators and build the capacity of these operators to integrate this information into their management plans.
Investigate regional case studies for the impacts of climate change on the biological, social and economic relationships in fisheries and aquaculture.

Stokes & Howden 2008 CSIRO

12: MARINE FISHERIES AND AQUACULTURE

Hobday, A. J.[1], Poloczanska, E. S.[1]

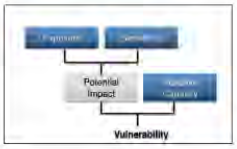
1. Wealth from Oceans National Research Flagship, CSIRO Marine and Atmospheric Research, GPO Box 258, Hobart, Tasmania, 7000

Key Messages:

- General ocean warming around Australia and in particular on the east coast, strengthening of the East Australia Current, is predicted to change the distribution of species targeted in wild fisheries, and modify the location of suitable environments for aquaculture species.
- Consideration of changes in distribution may allow fisheries management to facilitate adaptation to climate change.
- Selective breeding of aquaculture species may allow adaptation to warmer conditions, although changes in location may be inevitable for some operations.
- Focused regional studies on the relationship between the climate variables and the species of interest are one way to improve understanding of the potential impacts of climate change.

Adaptation Option Categories

- Exposure
  - This includes adaptation measures that reduce the exposure of the individuals/ populations/species to the physical effects of climate change
- Sensitivity
  - This includes adaptation measures that reduce the sensitivity of the organisms to the physical effects of climate change
- Adaptive capacity
  - This includes adaptation measures that increase the adaptive capacity of the individual/species to the physical effects of climate change



Adaptation options - general

Main directed adaptation classes are
- Habitat protection and management (H)
- Direct species management (D)

- Within E-S-AC model we can
  - Reduce exposure
    - Translocation (D)
    - Habitat modification (H)
  - Reduce sensitivity
    - Selective breeding (D)
    - Nest modification (H)
  - Enhance adaptive capacity
    - Population enhancement (D)
    - Reduce stressors (e.g. predator control) (D)
    - Habitat enhancement (H)

Climate change and marine fisheries

Gerry Quinn
Deakin University

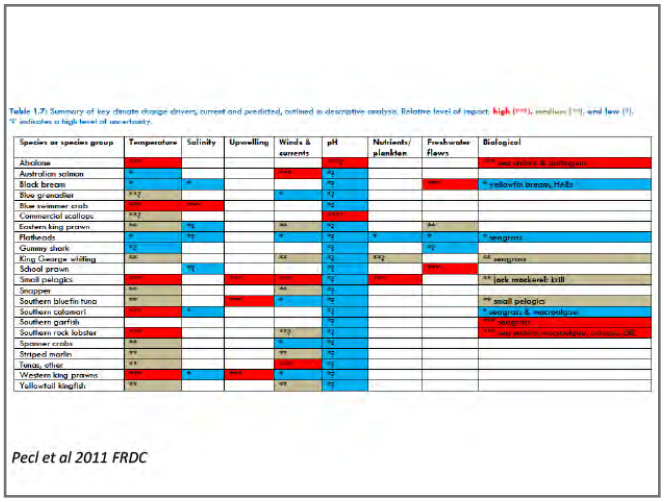


Table 1.7: Summary of key climate change drivers, current and predicted, outlined in descriptive analysis. Relative level of impact: high (***), medium (**), and low (*). ^ indicates a high level of uncertainty.

Species or species group	Temperature	Salinity	Upwelling	Winds & currents	pH	Nutrients/ plankton	Freshwater flows	Biological
Abalone	***				***			*** sea urchin & pathogens
Australian salmon	*			***	**			
Black bream	*	*			**		***	* yellowfin bream, mullet
Blue grenadier	***			*	*			
Blue swimmer crab	***	***			**			
Commercial scallops	***				***			
Eastern king prawn	**	**		**	**		**	
Flatheads	*	**		*	**	*	*	* seagrass
Gummy shark	**				**		**	
King George whiting	**			**	**	***		** seagrass
School prawn		**			**		***	
Small pelagics	***		***	***	**	***		** jack mackerel; krill
Snapper	**			**	**			
Southern bluefin tuna	**		***	*	**			** small pelagics
Southern calamari	***	*			**			* seagrass & macroalgae
Southern garfish					**			* seagrass
Southern rock lobster	***			***	**			*** sea urchins, macroalgae, octopus, ERL
Spanner crabs	**			*	**			
Striped marlin	**			**	**			
Tunas, other	**			***	**			
Western king prawns	***	*	***	*	**			
Yellowtail kingfish	**			**	**			

Pecl et al 2011 FRDC

Group	Life-history stage	Sea level & Tides	Ocean Currents	Temperature	Salinity	Wind/Waves	Upwelling	CO_2 & Acidification	Rainfall & Runoff
King George whiting	Eggs		•	••	•	•	••	•••	••
	Larvae	•	••	••	•	•	••	•••	••
	Juveniles	•	••	••	•	•	•	••	••
	Adults		•	••	•	•	•	••	••
Snapper	Eggs		•	••	•	•		•••	••
	Larvae		•	••	•	•		••	••
	Juveniles		•	••	•	•		••	••
	Adults		•	••	•	•		••	••
Sand flathead	Eggs		•	••	•	•		•••	••
	Larvae		•	••	•	•		••	••
	Juveniles		•	••	•	•		••	••
	Adults		•	••	•	•		••	••
Aust. salmon	Eggs		••	••	•	•	•	•••	••
	Larvae		••	••	•	••	••	•••	••
	Juveniles		••	••	•	••	••	••	••
	Adults		•	••	•	•	•	••	••

Relative vulnerabilities are indicated by colours: high=dark blue, medium=light blue, low=green.
Where uncertainty in predictions exists: ••• = high, •• = moderate, • = low level of uncertainty; no dot indicates relative confidence in prediction

Hirst & Hamer 2013 GHCMA

Abalone

Key points:
- Abalone reach critical thermal maxima in the high 20s (Celsius). There is some evidence that elevated temperatures retard growth and size of individuals.
- Abalone are very poor dispersers, and subpopulations are largely self-recruiting.
- Temperature is an important phenological cue.

Key point:
- Abalone, particularly BA, have a relatively wide distributional range, which also represents a large thermal range.

Key point:
- The southward range expansion of the barren-forming *C. rodgersii* will impact BA habitat and potentially outcompete BA for food resources.

Key points:
- Exploitation will likely compound the impacts of climate change, particularly if densities fall below a critical level to maintain the population.
- The AVG outbreak is an additional stressor in Victoria. Disease, pollution, and invasive species also impact abalone populations in NSW.

Key points:
- Nothing is known about the potential impacts of ocean acidification on abalone, which has been demonstrated to have negative impacts on other marine calcifiers.
- There is limited knowledge on the potential impacts of elevated temperature on abalone biology.

Pecl et al 2009 Dept Climate Change

Rock lobster

Key points:
- Growth rates are increasing in southern Tasmania but appear to be decreasing in South Australia.
- Evidence suggests that puerulus recruitment is declining in eastern Tasmania due to an increase in the southward penetration of the EAC.

Key point:
- Controlled aquaria experiments showed that phyllosoma growth is faster at 18.2°C than 14.3°C; however, most stage II larvae died at 21.5°C. Growth rates are slower in the cooler southern regions in Tasmania.

Key points:
- SRL have a high dispersal capacity, potentially increasing the species' resilience to changing environmental conditions.
- SRL is a generalist species, living in a wide range of reef habitat and consuming a wide range of prey.

Key points:
- There is some evidence to suggest that octopus are increasing in abundance in Tasmania and that there are range extensions of another octopus species, octopus is a key predator of SRL
- The southward range expansion of the barren-forming *Centrostephanus* and ERL may impact SRL

Key points:
- Limited information on the source of recruits and drivers of puerulus settlement.
- Impacts of ocean acidification and increasing UV are unknown.

Pecl et al 2009 Dept Climate Change

Adaptation options for lobster fishery

- Incorporate changes in lobster recruitment into catch modelling
- Establish long-term lobster monitoring program
- Develop regional management tools
  - Spatial tools to deal with, for example, *Centrostephanus*
- Redefine standard risk management in industry
  - Include climate change
- Develop longer-term priorities
  - Review arrangements for allied fisheries simultaneously
- Make no-regrets adaptation a priority
  - Measures beneficial under any future scenarios

Pecl et al 2009 Dept Climate Change

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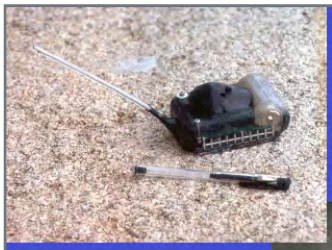
Appendix 3: Presentation by Graeme Hays

Impact of climate change on marine species distributions

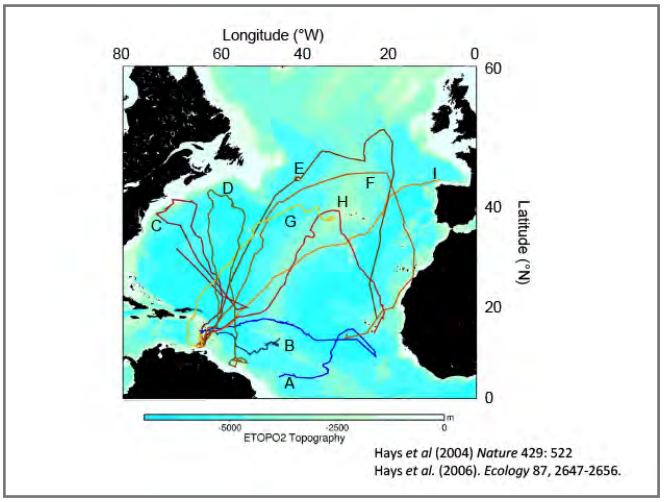
Graeme Hays

Assessing distribution: vertebrates versus plankton
Inferring range changes/thermal niche modeling
Measuring range changes
Adaptation

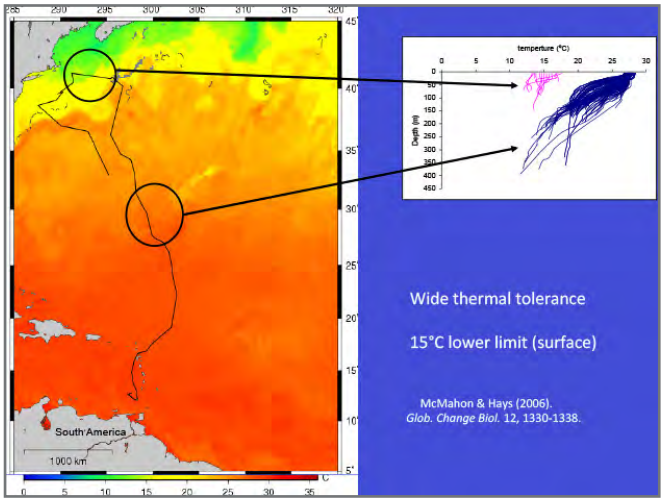


Argos satellite tracking
+ dive profiles

SRDLs attached to nesting females



Hays *et al* (2004) *Nature* 429: 522
Hays *et al.* (2006). *Ecology* 87, 2647-2656.

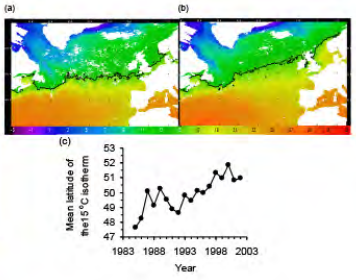


Wide thermal tolerance

15°C lower limit (surface)

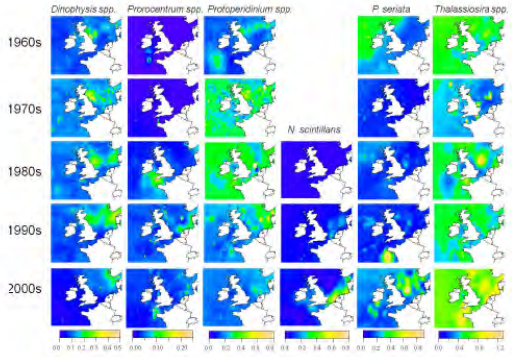
McMahon & Hays (2006).
Glob. Change Biol. 12, 1330-1338.

Implications of climate change ?



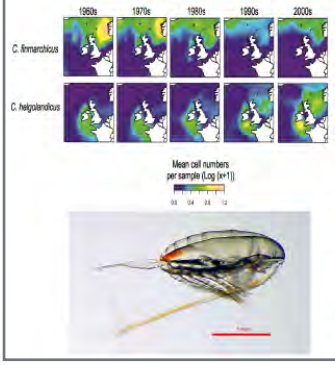
McMahon & Hays (2006). *Glob. Change Biol.* 12, 1330-1338.

Plankton ….implications of climate change … plankton/CPR

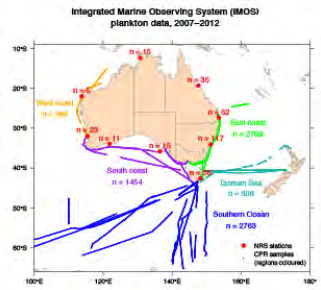


Current plankton directions …

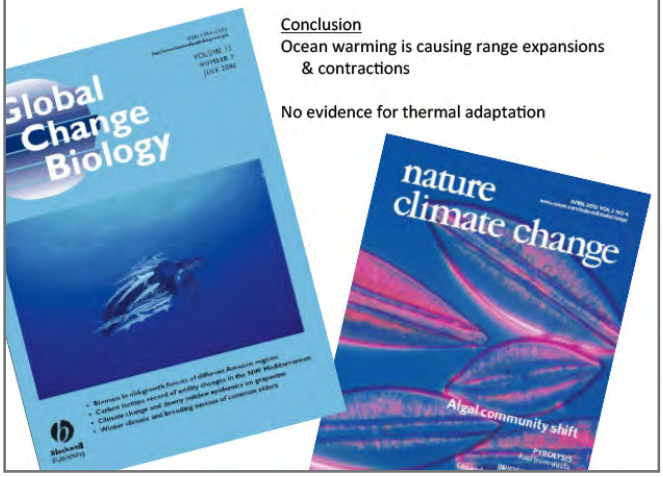
Thermal adaptation ?



Collaboration with Anthony Richardson (UQ & CSIRO)



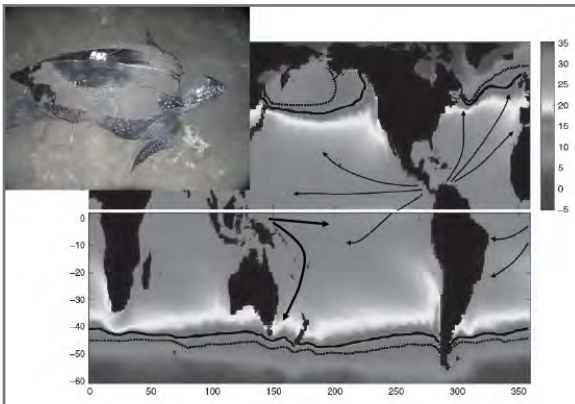
+ Gerry Quinn (Warrnambool), Mike Gravenor (Swansea), Tony Walne (Plymouth)



Conclusion

Ocean warming is causing range expansions & contractions

No evidence for thermal adaptation



Global rises in sea surface temperature … implied range changes for leatherback turtles

Plankton … implications of climate change

1950-2013

300,000 samples

200+ taxa

>10 million km of net towing

Appendix 3: Presentation by Harry Peeters

RESPONSES OF THE SOUTH-WEST VICTORIAN FISHERIES SECTOR TO CHANGING CLIMATE

The two major inshore commercial fisheries in South-west Victoria are the Rock Lobster and Abalone fisheries.

Both of these fisheries are in a depleted state and are currently undergoing a rebuilding phase.

In particular, the abalone industry has been hit hard by the effects of the Abalone Viral Ganglioneuritis disease that devastated the region in 2006-07. Quota is down from pre-disease levels of up to 278 tonnes to 49 tonnes for the current year.

The AVG outbreak has particularly focused the abalone industry on the need to be able to rapidly react to catastrophic incidents, whether they be caused by disease, climate change or other environmental factors.

Fortunately we had started adopting a system of fine-scale management of the resource prior to the disease outbreak. This involved monitoring catches and size limits on a reef-by-reef basis. The data we collected during this process proved invaluable in setting our recovery strategies. It is unlikely that we would have been able to recover at the rate we have without our data history.

In the future, fine-scale management will be crucial to most inshore fisheries, if we are to be able to respond effectively to the effects of climate change. Many of Australia's fisheries are data poor. The exception to this is the Western Zone abalone fishery, which is now one of the most data-rich fisheries in the world. Without such data, you cannot effectively monitor change and will have little chance of planning to manage it.

We have identified two main threats to the abalone fishery posed by changing climate. The first of these is water temperature rises, causing either large-scale mortalities or spawning failures or the gradual migration of abalone to deeper, cooler waters that are not accessible by divers.

The second threat is the incursion of pest species and the subsequent destruction of habitat.

The incursion of pest species has already been observed in South-west Victoria. In August 2011 and March 2012, our research divers located a number of Long-spined Sea Urchins (*Centrostephanus rodgersii*) at the Devils Kitchen and Cape Nelson areas of Portland. These locations are five kilometres apart.

The areas where the urchins were found have been dived exhaustively since 1967 and this species of urchin has never been detected previously.

Long-spined Sea Urchins have previously devastated areas of southern New South Wales and over the past 10 years have started to colonize abalone reefs in the Mallacoota area. The massive number of urchins invading the abalone reefs at Mallacoota is seeing large areas of productive reef reduced to absolutely barren, concrete-like reef in a very short time.

Tasmania also has a major problem of urchin barrens developing along their coast as water temperatures modify.

In response to the urchin finds at Portland and the invasions at Mallacoota, the Victorian Abalone Industry held an FRDC-funded workshop in Melbourne on 21 August this year.

This workshop brought together managers and scientists from all jurisdictions to share knowledge of the problem and prioritise activities for the future.

Following on from the workshop, WADA will be conducting a detailed survey of the Portland area later this year. This survey will provide us with fine-scale data as to the extent of the incursion and enable us to plan eradication strategies. WADA will be utilising the brilliant mapping work carried out by Dr Dan Ierodiaconou and his team from Deakin University in the South-west of Victoria.

The detailed information provided by Dan’s mapping work is the standard of information that will be required for fisheries management into the future.

The more serious of the threats is the gradual increase of seawater temperatures or a 'maritime heat wave", similar to that experienced in Western Australia during the summer of 2010-11.

That particular heat wave saw a spike in water temperatures of up to 5 degrees Celsius over a few days, which resulted in massive fish kills at the Abrolhos Islands and from Green Head to Moore River. In the case of Roe's Abalone, stocks suffered significant, if not total, mortality in areas north of the Murchison River.

I have here for distribution the executive summary of a WA Department of Fisheries report, '*The Marine Heat Wave off Western Australia during the summer of 2010/11*'.

This report highlights the devastating effects that water temperature rises can have and highlights the need for well-planned coastal monitoring.

As well as the abalone fishery, the 500 tonne crab fishery and major scallop fishery at Shark Bay have remained closed and show little sign of recovery. A heat wave such as this would have dire consequences for the abalone fishery in the South-west.

In order to be able to cope with an event such as what occurred in Western Australia, we are currently seeking funding to carry out a major project in the Western and Eastern Abalone Zones. The project is titled, '*Rebuilding abalone populations to limit impacts of the spread of Urchins, AVG and theft*'.

The purpose of this project is to undertake major translocations of abalone to re-establish self-sustaining populations of abalone on previously productive reef. The project will investigate methods for preparing reefs prior to translocations, methods of translocations, methods of re-establishing kelps and seaweeds, and provide long-term monitoring of the success of translocation.

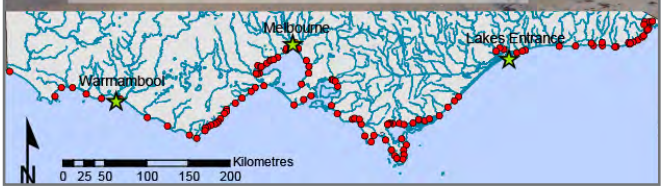
As water temperatures rise, it may be necessary for us to speed up nature and introduce heat-tolerant abalone on a large scale. Hopefully our project will give us the knowledge to be able to achieve this.

The key message that I have is the need to collect data now. There needs to be a co ordinated effort to establish a comprehensive data library for the South West. If we wait for government to do it , it may never happen. This needs to be driven by industry, researchers and industries allied to the coast in the south west. The obvious repository for this data is Deakin University.

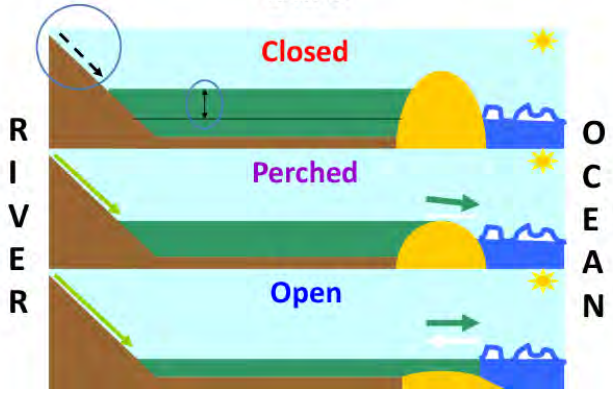
Appendix 5: Presentation by Adam Pope

Physical Effects on Estuaries

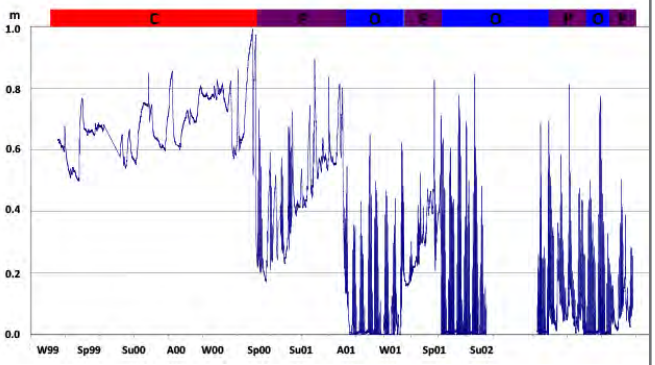
- Focus on Vic. open coast estuaries
- Largely intermittent (sand bar)
- Variable:
  - Water Levels
  - Salinity Structure



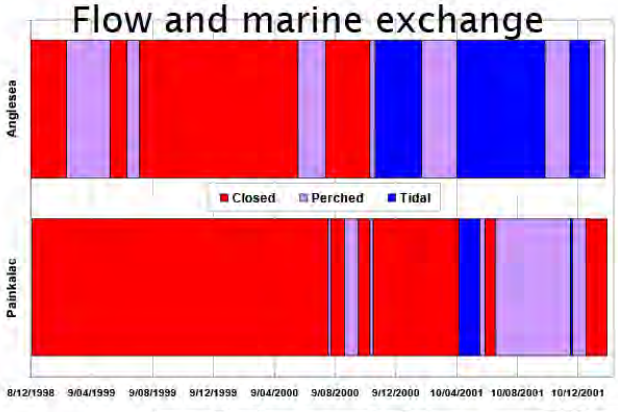
Intermittent Estuaries: Sand Bars



Sand Bars and Water Levels



Flow and marine exchange



	Closed	Perched	Tidal
+ Flow	44.4	28.8	26.8
- Flow	76.0	19.9	4.1

Salinity Structure

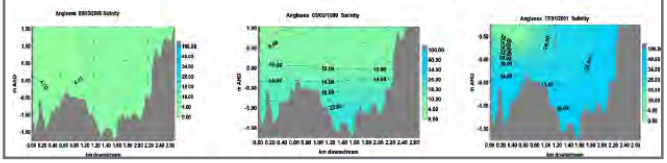
Depends on Fresh and Tidal Inflow

- ++ Flow → Fresh water flushing
- + Flow → Stratification

(Fresh layer on Salt Layer)

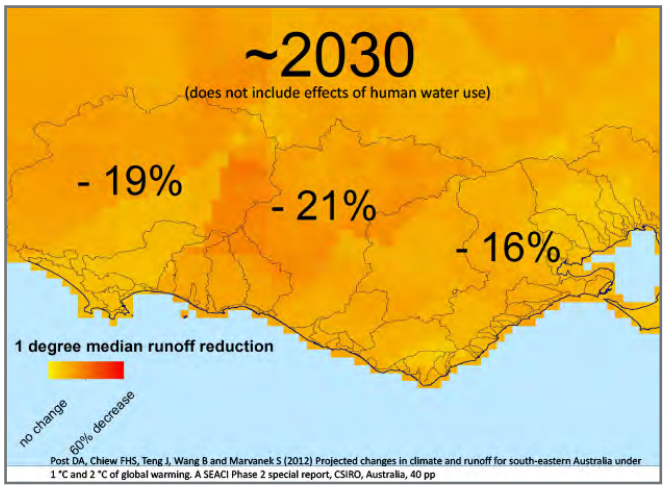
- - Flow → Vertical mixing

(Homogenous salinity through depth)

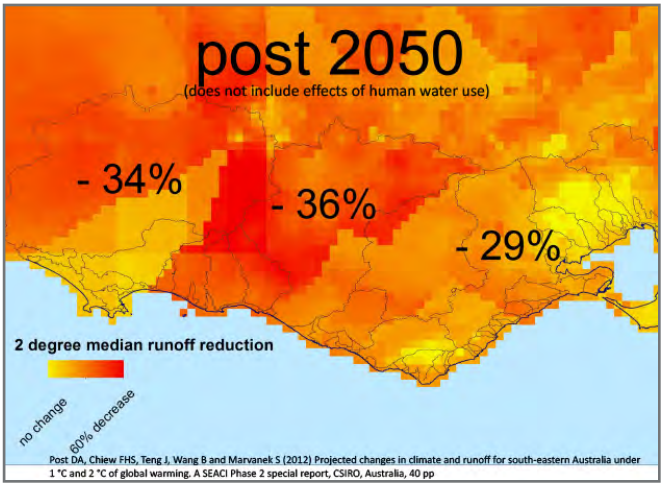


Physical changes to estuaries under climate change

- Freshwater flow
- Sea level rise
- Extreme events
  - Storm surge
  - Floods
- Temperature
  - Sea (0.7°C per decade last century)
  - Air
- pH – ocean acidification (8.1 to ~7.9 in 2100)

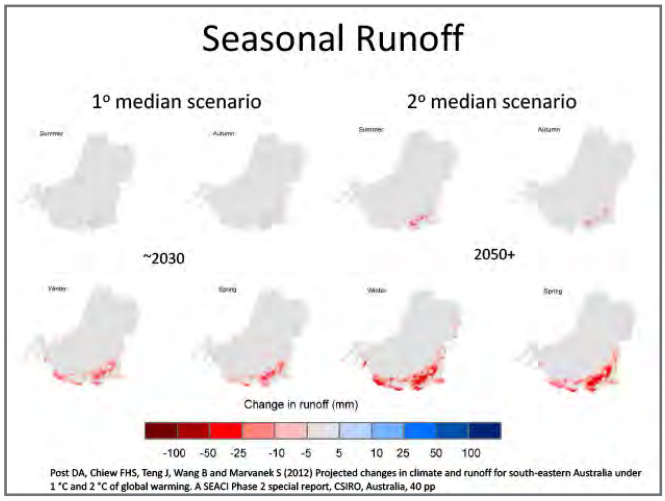


Post DA, Chiew FHS, Teng J, Wang B and Marvanek S (2012) Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming. A SEACI Phase 2 special report, CSIRO, Australia, 40 pp



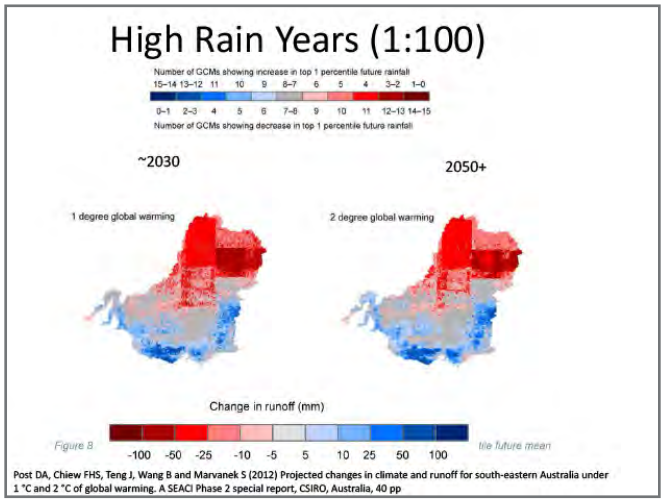
Post DA, Chiew FHS, Teng J, Wang B and Marvanek S (2012) Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming. A SEACI Phase 2 special report, CSIRO, Australia, 40 pp

Seasonal Runoff



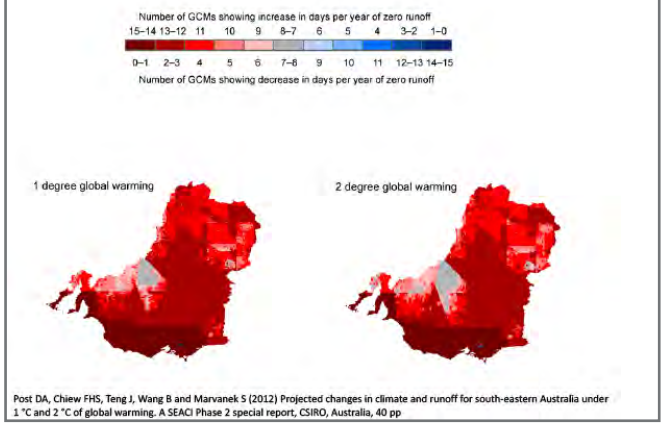
Post DA, Chiew FHS, Teng J, Wang B and Marvanek S (2012) Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming. A SEACI Phase 2 special report, CSIRO, Australia, 40 pp

High Rain Years (1:100)



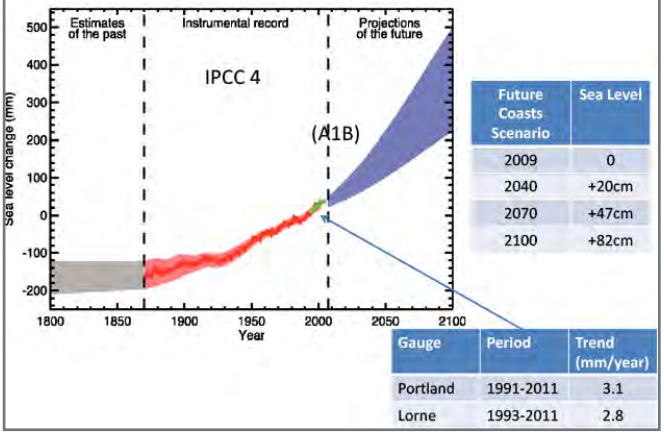
Post DA, Chiew FHS, Teng J, Wang B and Marvanek S (2012) Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming. A SEACI Phase 2 special report, CSIRO, Australia, 40 pp

Zero Runoff Days



Post DA, Chiew FHS, Teng J, Wang B and Marvanek S (2012) Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming. A SEACI Phase 2 special report, CSIRO, Australia, 40 pp

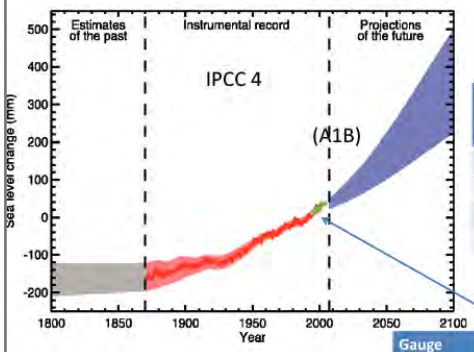
Sea Level



Future Coasts Scenario	Sea Level
2009	0
2040	+20cm
2070	+47cm
2100	+82cm

Gauge	Period	Trend (mm/year)
Portland	1991-2011	3.1
Lorne	1993-2011	2.8

Sea Level



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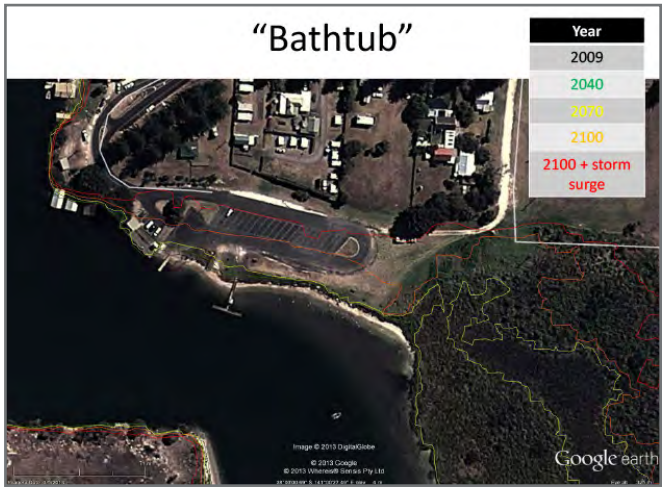
Gauge	Period	Trend (mm/year)
Portland	1991-2011	3.1
Lorne	1993-2011	2.8

"Bathtub" - floodplain

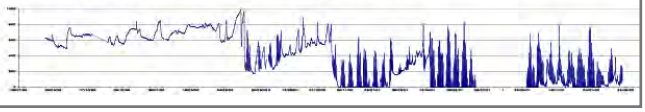
"Bathtub"



Sand Bars

- Sea level rise + sediment supply = Raised bar
- Sea level rise – sediment supply = More open

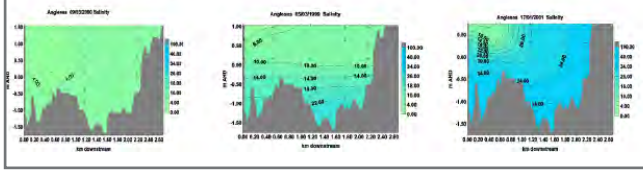
- Decreased flow = More closed
- Large floods = Deep opening



Salinity Structure

Depends on Fresh and Tidal Inflow

- ++ Flow → Fresh water flushing *(less of this?)*
- + Flow → Stratification *(less of this)*
- - Flow → Vertical mixing *(more of this)*



Physical changes to estuaries under climate change

- Freshwater flow
- Sea level rise
- Extreme events
  - Storm surge
  - Floods
- Temperature
  - Sea (0.7°C per decade increasing), Air (1-3°C)

↑ in water temperature; ↑ in nutrient cycling; ↑ evapotranspiration; ↑ frequency of hypoxia

- pH – ocean acidification (8.1 to ~7.9 in 2100)

↓ in pH & carbonate ion concentration, vary with salinity

Appendix 6: Presentation by Jan Barton, Adam Pope & Rebecca Lester

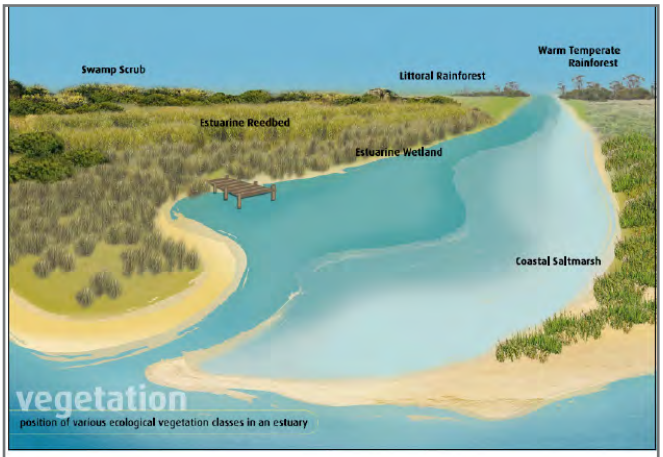
Biological Changes In Estuarine Environments Under Climate change

VCCCAR think tank

Jan Barton, Adam Pope & Rebecca Lester

Vegetation

- Submerged: seagrass, phytoplankton & benthic microalgae
- Emergent: saltmarsh, sedge, reed, herb, grass, shrub, (& mangroves)

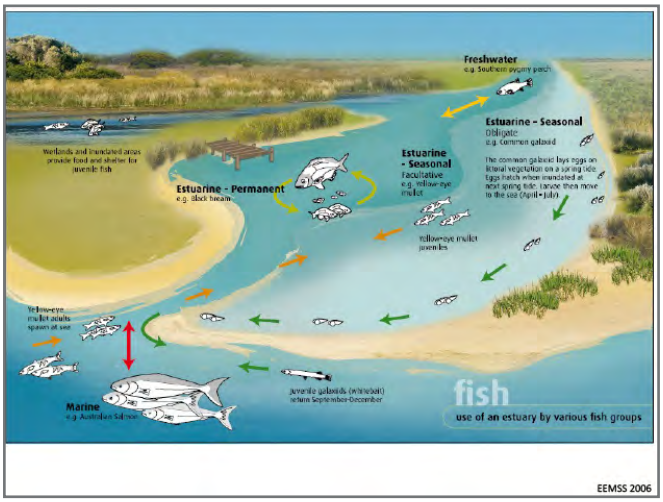


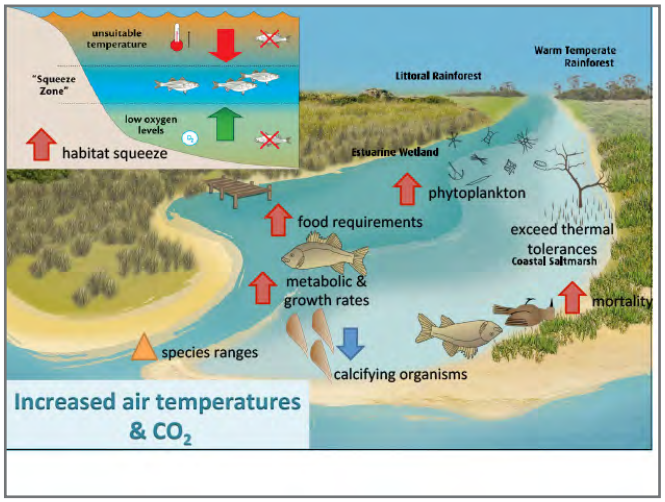
Invertebrates

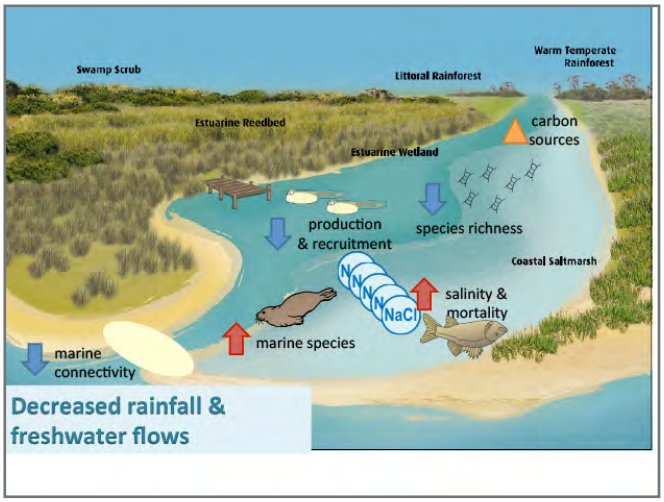
- Water column: zooplankton
- Benthic: polychaetes, bivalves, gastropods, crustaceans etc
- Recruitment, growth

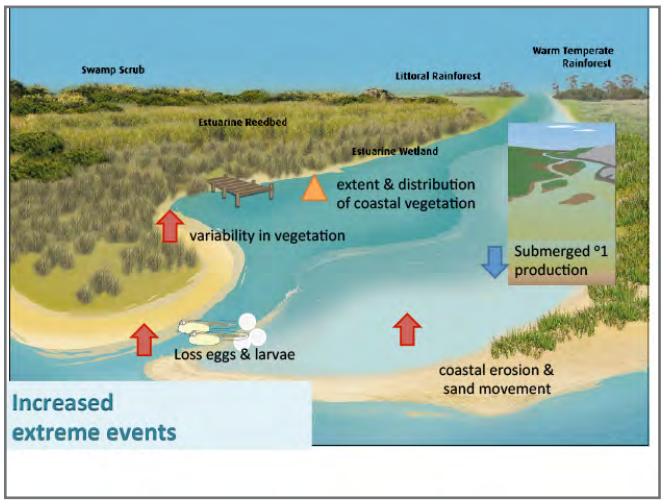
Fish

- Permanent, seasonal, freshwater & marine transients
- Spawning, growth, migration



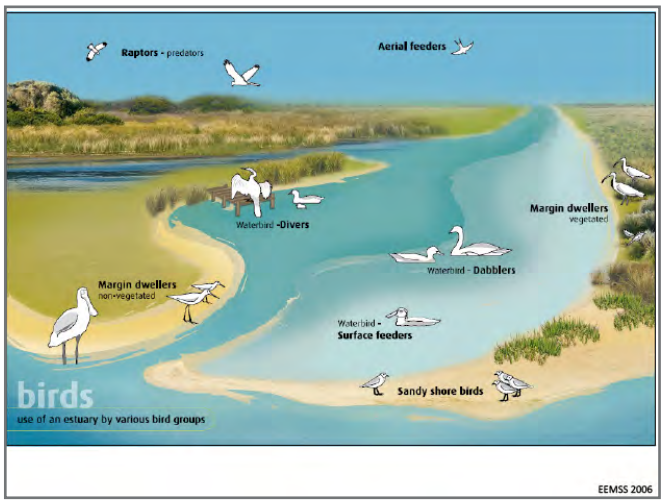


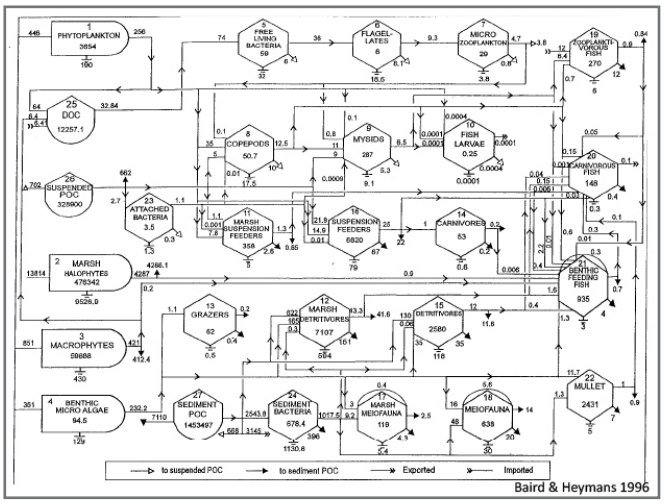




Birds

- Water birds, margin dwellers, aerial feeders, birds of prey & sandy shore dwellers
- Feeding, breeding, migration





Changed species distribution

Melaleuca die back

Sydenham Inlet 2012 (IEC)

Algal blooms

Merricks Creek 2010 (IEC)

Spring Creek 2009 (Deakin)

Not simple

- Cumulative effects from interacting processes will have the greatest impacts but will be hardest to predict
- The ability to recover or recolonise from larvae may decrease with changes in marine currents, upwellings & acidification
- Interact with other stressors
- Limited understanding of the combined effect of concurrent climate related & non climate related stressors

References

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IAN Symbol Library http://ian.umces.edu/

Appendix 7: Presentation by Helen Arundel

Estuary Management under Climate Change

VCCCAR workshop
16 &17 September 2013


Role of the CMA

- Integrated regional planning
- Protection of catchment & waterway health
- Monitoring and reporting on catchment and waterway healt
- Waterway protection approvals/referrals/permits
- Community engagement

Catchment and Land Protection Act (1994); Water Act (1989)

Key Activities

- Estuary entrance management
- Estuary physicochemical monitoring
- Incentive payments to protect natural values
- Community engagement


Other Activities

- Works on waterway permits
  - Drainage (enquiry underway)
  - Levy banks
  - Structures e.g. jetties, fishing platforms
- Develop Flood Plans
- Develop Seasonal Watering Plans to guide environmental flows
- Advice to landholders –farming practices
- NRM plan for climate change


Estuary Entrance Management

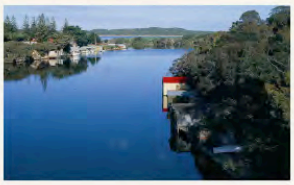
- Risk- based approach to estuary entrance management (EEMSS)
- Estuaries opened to protect environmental values or significant socioeconomic assets
- Land use and infrastructure should accommodate varying water levels


Estuary Entrance Management

Issues

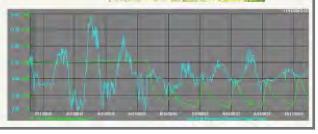
- Assumptions of EEMSS need to be tested under climate change
- Modifying risk assessments create uncertainty
- Lack of state-wide strategic infrastructure guidelines


Community Engagement



Estuary monitoring

- Estuary water monitoring
  - Telemetry stations
  - Hydroshare
- Estuary Watch



Estuary monitoring

Issues

- Telemetry stations on 4 of 7 major estuaries
  - only surface water values are measured continuously
- Collection of profile data stopped
- No monitoring of biota
- Estuary Watch- focus on estuaries with volunteer base.

Incentives to land managers

- Grants (fencing & revegetation)
- Stewardship
- MBI - Tenders
- Land acquisition

Appendix 8: Presentation by Oliver Moles

Planning Tools for Estuary and Coastal Management

FROM COUNTRY TO COAST

Oliver J Moles
Director Sustainable Development
MOYNE SHIRE COUNCIL

Planning System General

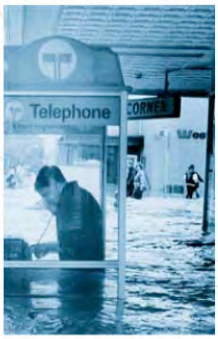
- Planning and Environment Act
  - Ministerial Directions
  - Planning Practice Notes
  - Planning Schemes
    - State Planning Policy Framework
    - Local Planning Policy Framework
    - Zones
    - Overlays
- Local Government is Responsible Authority and Planning Authority (or Minister for Planning in special cases)
- Catchment Management Authority is currently a "referral authority"

Planning System General

- Zones – not specifically for estuaries or coast. They are farming, residential, industrial etc. Public land, however, can have a Public Park and Recreation Zone or a Public Conservation and Resource Zone which is often along a river edge or a coast.
- Overlays – these are applied for specific purposes eg heritage, important landscapes, environmental significance. Frequently applied in riverine situations are the Land Subject to Inundation Overlay or the Floodway Overlay. As their names imply, they are to do with flood risk issues rather than broader catchment issues. Environmental Significance Overlays can also be applied around estuaries, coastlines and like situations.

Planning System Estuary Management

- State Planning Policy Framework
  - Clause 14.02-1 Catchment planning and management
  - Objective: "To assist the protection and, where possible, restoration of catchments, waterways, water bodies, groundwater, and the marine environment."
- Local Planning Policy Framework
  - Clause 21.06 Environment
  - Refers to the Glenelg-Hopkins Regional Catchment Strategy and sets objectives regarding catchment and environment issues



Planning System Coastal Management

- State Planning Policy Framework
  - Clause 13.01 Coastal Inundation and Erosion
  - Objective: "To plan for and manage the potential coastal impacts of climate change."
- Local Planning Policy Framework
  - Clause 22.02-1 Coastal Areas
  - Sets four objectives
- Practice Note 53
  - Managing coastal hazards and the coastal impacts of climate change
- Ministerial Direction No 13
  - Managing coastal hazards and the coastal impacts of climate change

Coastal Hazard Now

Coastal Hazard Now

What Moyne Is Doing

- Coastal Hazard Report:
  - Erosion, wave run-up, inundation
  - No single planning tool available covering all three
  - VCS – defend, accommodate, retreat

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Coastal Management

Port Fairy - Geography

What Are The Risks?

- Houses built on the primary dune
- East Beach is disappearing
- If the dune breaches the town may flood
- The old tip and night soil site are in the dune
- South Beach houses are inundated by the sea

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Part Of The Problem

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What Moyne Is Doing

- Works:
  - Repairing the rock wall with the help of a grant
  - Dune rehabilitation
  - Increasing the pumping of sand from the river onto East Beach
  - Monitoring erosion levels along East Beach
  - Fenced off old tip site
  - Monitoring ground water at tip site

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Rock Wall Repairs

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Dune Rehabilitation

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Increased Sand Pumping

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VCCCAR Publication ISBN: 978 0 7340 4933 9

Document available from VCCCAR website at:
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Layout and design by Inprint Design
inprint.com.au