Climate Change Adaptation in the Australian Edible Oyster Industry: an analysis of policy and practice

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This report identifies key collective actions and opportunities for adaptation for edible oyster aquaculture in Australia.

by Peat Leith and Marcus Haward

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Climate Change Adaptation in the Australian Edible Oyster Industry: an analysis of policy and practice

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Executive Summary

1.1 Introduction

The oyster industry occupies a unique geographical position in bays and estuaries, on the cusp of land and sea. This position makes the sector potentially vulnerable to changes in both terrestrial and oceanic environments. Projected climate changes are likely to mean that oyster growers will need to adapt in diverse ways across the many places in which they work. To encourage adaptation industry bodies and governments may also need to develop their approaches, programs, policies and practices. This report identifies key collective actions and opportunities for adaptation for edible oyster aquaculture in Australia.

The report is a review and synthesis of knowledge about climate impacts, the potential to build adaptive capacity and resilience, and to define adaptation options within the Australian edible oyster industry. We focus on the three main oyster growing states – New South Wales (NSW), South Australia (SA) and Tasmania (TAS), and detail the development and application of a rigorous social research methodology to integrate knowledge from diverse stakeholders in order to find pathways for adaptation in policy and practice. This approach, referred to as Rapid Collaborative Vulnerability Assessment (RCVA), draws together information and knowledge from various scientific disciplines and researchers, government agencies and their staff, and the local understandings and experience of oyster growers and industry representatives. The outcome is a broad-ranging and inclusive view of options and priorities for managing climate variability and change in the sector. We highlight possibilities for improving policies and practice, as well as the institutions and networks which underpin communication, knowledge production and decision-making.

Participants in this activity were generally enthusiastic about developing partnerships which will improve understanding of the drivers of change in oyster aquaculture, and in bays and estuaries, and thereby improve responsiveness to unexpected events and allow diverse adaptation options to be developed. The process for ongoing improvement of institutions, networks, programs and policy was widely considered to be fundamental to improving adaptive capacity of the sector.

Key recommendations from synthesising across workshops and the relevant scientific literature include specific cross-jurisdictional and regional priorities for building adaptive capacity and resilience, such as:

- **Investigation and development of improvements in coastal and estuarine monitoring programs, which integrate automated and other monitoring and utilise a central repository for data;**
- **Ongoing improvement and, where possible, streamlining of processes for regulatory compliance and assessment of development and planning applications for oyster aquaculture;**
- **Continued efforts between growers, industry, banks and state government to ensure that growers are able to borrow against lease entitlements;**
- **Continued development of knowledge-action networks that include growers, industry bodies, scientists, regional Natural Resource Management (NRM) organisations, and representatives of state and local government; and**
- **Ongoing development of industry-government relations through effective communication of clear and concise information that allows reciprocal understanding of the process of oyster farming and needs of growers, on the one hand, and of government regulatory and approvals processes on the other.**

1.2
Oyster aquaculture across three states

Across the three states, two species of oysters are grown in diverse situations. In NSW the native Sydney Rock Oyster (SRO), *Saccostrea glomerata*, is the main product grown in estuaries, tidal lakes and lagoons. Increasingly, the NSW industry is diversifying into exotic Pacific Oysters (POs), *Crassostrea gigas*, which dominate the product in SA and TAS. The native flat oyster, *Ostrea angasi*, is grown in small quantities in all three states, but is not considered in this report. As filter feeders, oysters are susceptible to changes in water chemistry, temperature, and the availability of algae and other food. The largely estuarine-based industry in NSW and TAS is affected by upstream human action that alters environmental flows and water quality. Bacterial matter, turbidity, salinity, water temperature and a variety of other factors can make oysters vulnerable to disease or lead to loss of condition. Key features of the industry are indicated in Table 1.1. In SA, oyster aquaculture mainly occurs in oceanic bays, in which terrestrial impacts are usually negligible. The TAS and SA industries are wholly dependent on hatchery reared juvenile oysters (spat), mostly from Tasmanian hatcheries. There has been a concerted and relatively successful effort to breed SROs for resistance to their two main diseases, QX and Winter Mortality. Breeding programs gained substantial support following QX outbreaks which destroyed the industry in two of the most important estuaries in 1994 (Georges River) and 2004 (Hawkesbury River). In NSW it is not uncommon for large-scale SROs kills following heatwave conditions, especially in the north. Biotoxins from harmful algal blooms (HABs) can contaminate oysters in all areas making them harmful to humans, and in some cases lethal. Some areas are much more susceptible to HABs than others.

Table 1.1: Key issues that affect management and their overlaps across the three main oyster growing states

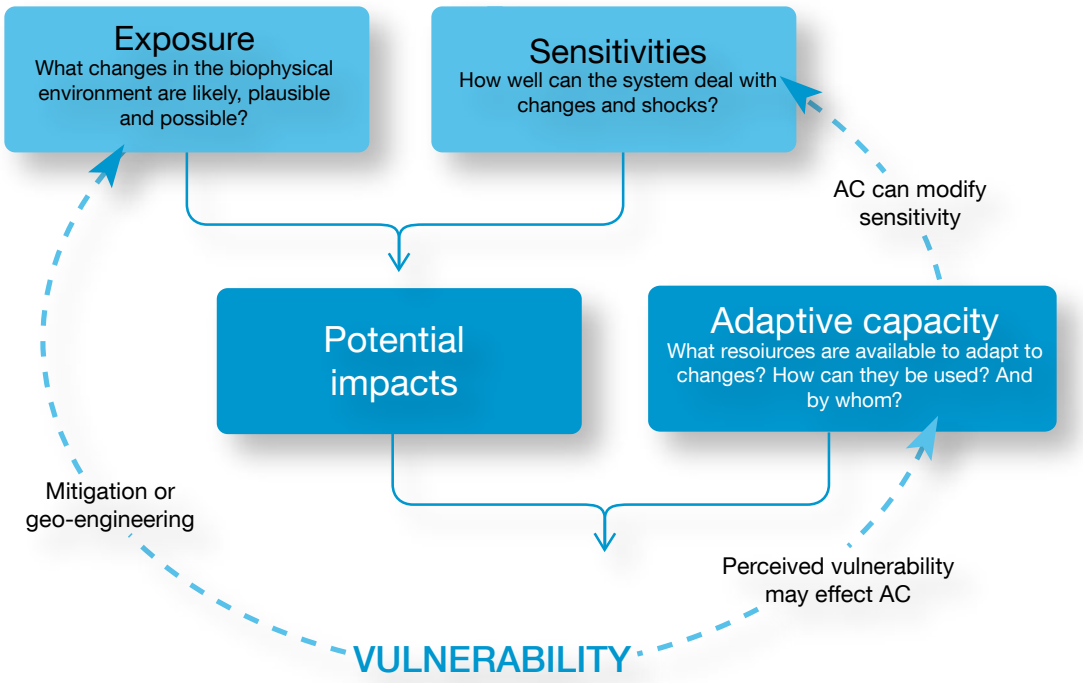
	South Australia	New South Wales	Tasmania
Main oysters Grown	Pacific Oyster	Sydney Rock Oyster, Pacific Oyster increasing	Pacific Oyster
Oyster growing environments	Oceanic Bays	Estuaries, bays and tidal lakes	Estuaries, bays, and tidal lakes
Source of spat (juvenile oysters) for industry)	Hatchery	Wild caught, with hatchery-reared increasing	Hatchery
Key diseases and causes of oyster mortality	Summer Mortality, unexplained mortality	QX more in the north, Winter Mortality in the south, overheating of beds	Unexplained mortality

Across the three states there are similarities and differences in governance - in terms of legislation, policies, institutions, and relationships among various stakeholder groups. The degrees to which industry groups are organised, coherent and well co-ordinated also varies between and within states. Relationships within industry and between industry and government are crucial to adaptive capacity because they enable collective action and generate or delimit trust. These relations are complex, multifaceted and variable across space and time. The bases of arrangements and relationships are detailed in Section 4.2, and discussed in terms of how they constrain and enable adaptive capacity in Section 5 and 6.

1.3
Approach to Rapid Collaborative Vulnerability Assessment (RCVA)

The RCVA approach applied in this report brings together scientific, local and policy knowledge across scales and jurisdictions. Including diverse forms of knowledge is necessary because thinking through adaptation requires consideration of the diverse perspectives, experience and needs of as many stakeholders as possible. Because there are substantial uncertainties about how climate changes will impact particular sectors in specific localities, adaptation will often proceed as responsive to change rather than pre-empting particular shifts. A key to enabling continuous adaptation is identification of things that constrain and enable the capacity of communities or sectors to adapt. Considering vulnerability in terms of potential impacts, adaptive capacity and the feedbacks among these and their sub-components (Figure 1.1) allows for a relatively holistic view of oyster aquaculture as a network or system with inter-connected social and ecological components.

Figure 1.1: Defining vulnerability as process, rather than outcome highlights the potential feedbacks in social-ecological systems (adapted from Allen Consulting (2005)



The process of integrating knowledge about the social-ecological system of oyster aquaculture was done in four stages (see Figure 1.2).

1. First, it moved quickly from a preliminary desktop investigation of the policy, science and practice of oyster aquaculture across NSW, SA and TAS, to engaging staff of relevant government agencies across the three states in a series of workshop to discuss state-wide policy drivers of adaptation and adaptive capacity. These workshops ensured the process could address relevant and legitimate questions for these government agencies.

2. The initial workshops helped to orient the subsequent stage of the process: a synthesis of scientific literature about potential impacts of climate change and sensitivities of oysters and of oyster aquaculture at the scales of organism, farm and industry.

3. The third stage of the process was a series of regional workshops with oyster growers, industry representatives, and various stakeholders from local and state government, regional NRM bodies, scientists and other interested parties. Five workshops across the three states with 56 participants highlighted key issues and priorities for the development of adaptive capacity for the industry and an understanding of regional vulnerabilities through discussion of the scientific, practical, economic and governance issues that affect the sustainability of the sector.

4. All the above work was pulled together and analysed and reviewed by the project team and an extended peer community of growers, and industry and government participants.

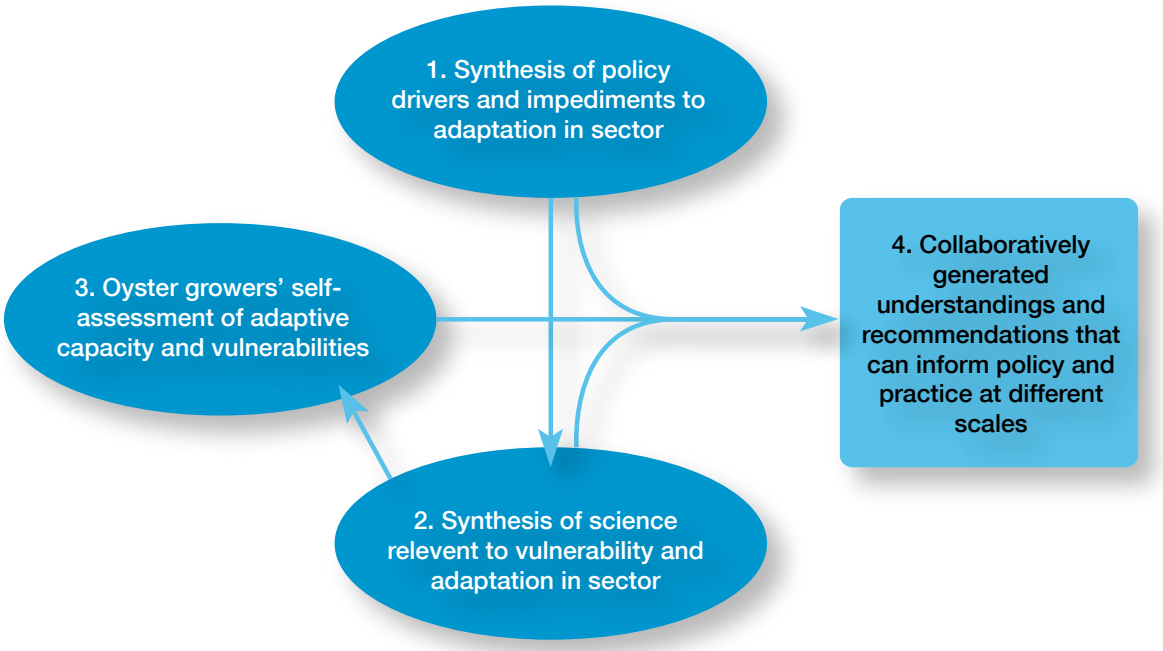


Figure 1.2: Schematic of approach to stages of RCVA applied in this project.

Five regional workshops were conducted in NSW (Batemans Bay and Forster), SA (Streaky Bay and Port Lincoln) and TAS (Campbell Town). The workshops were facilitated to identify and discuss issues of concern and prioritise collective actions to build adaptive capacity. Adaptive capacity was self-assessed by workshop participants through a discussion which identified key indicators that underpin regional capacity to adapt using a livelihoods framework (see Box 1).

Capital	Summary of capital
Human	the skills, health (including mental) and education of individuals that contribute to the productivity of labour and capacity to manage land.
Social	the social bonds that facilitate cooperative action and the social bridging, and linking via which ideas and resources are accessed.
Natural	the productivity of land, and actions to sustain productivity, as well as the water and biological resources from which rural livelihoods are derived.
Physical	built capital items produced by economic activity from other types of capital that can include infrastructure, equipment and genetic resources.
Financial	the level, variability and diversity of income sources, and access to other financial resources (credit and savings) that together contribute to wealth.

Box 1: What is adaptive capacity?

Adaptive capacity can be thought of as the resources available to adapt to change as it occurs, and the capability to deploy these resources in order to achieve adaptation goals. A livelihoods framework was used in the workshops to categorise indicators of adaptive capacity into five types of capital – human, social, physical, natural and financial.

Up to five indicators were derived for each of the capitals and subsequently rated according to how constraining or enabling each indicator was perceived to be, and the degree to which the indicator could be changed. Collective actions needed to develop adaptive capacity were discussed in relation to the indicators derived for each capital (see Section 3).

1.4
What potential impacts will climate change have on the edible oyster industry?

Changes in ocean currents and climate variables already affect oyster aquaculture substantially from year to year and season to season. In many cases these effects are likely to become more pronounced under future climate change scenarios. Specific impacts in each state associated with particular changes include:

Strengthening East Australian Current: May lead to warmer temperatures and lower nutrient status in estuaries and lakes of NSW and TAS, and is likely to change the timing of oyster growth and spawning. Changing water temperatures and windows for algal blooms are likely to alter the frequency and types of algal blooms that occur in a particular area, and may result in the emergence of unprecedented HABs. Changing water temperatures may also affect the distribution and intensity of disease outbreaks in SROs.

Rainfall changes: In NSW and TAS, projected changes in rainfall patterns may affect the period of time that estuaries are closed for harvesting. An important projection for oyster aquaculture is that rainfall is likely to become more sporadic, with heavy rainfall events followed by longer periods of dry weather and increasing evapotranspiration. Along with increasing human demands on water supplies and changes in land use, these issues could exacerbate bacterial contamination and turbidity in wet periods and reduce nutrient availability in dry periods. Changes in salinity in lakes and estuaries are also plausible, which may affect susceptibility of SROs to diseases. Low salinity can also stall growth and sometimes result in mortality of POs.

Increasing frequency of heatwaves: The projected increase in air temperature could lead to more summer kills of Sydney rock oysters, especially in northern NSW, and may also result in higher incidence of Summer Mortality in SA. These effects could be exacerbated by higher sea-surface temperatures.

Sea-level rise: Projected sea-level increase of up to, and possibly exceeding, 0.8 metres over the 21st Century will affect land-bases of oyster farming operations in NSW and TAS. Storm surge activity may exacerbate these impacts, and might make changes in exposure to wind and wave conditions greater in some areas. Modifications and upgrades of lease infrastructure are likely to be a necessary part of ongoing adaptation.

Acidification: Gradual increases in acidity of oceans will affect oyster reproduction and ability to lay down shell. Juvenile oysters (especially larvae and spat) will be most substantially affected. Some breeding lines and species appear more susceptible to acidification than others and this is a field of current research.

Climate change will affect oyster aquaculture in differing ways in different places. Although some changes, such as acidification, are likely to be gradual and incremental, most of the impacts will be felt as increased frequency or intensity of extreme events, such as floods, droughts, heatwaves and storm surges. Therefore increasing capacity to manage for climate variability and extremes is fundamental to adapting to climate change. In NSW and TAS, climate change impacts on oyster aquaculture will often relate closely with upstream management of resources and development, and thus need to be considered in a broader societal context of NRM and landscape scale planning decisions. Adaptation is likely to require management of non-climate stressors to estuary health in order to make estuarine systems more resilient to changing conditions. Efforts to these ends are also likely to provide increased resilience of riparian and aquatic systems and of fish species that use estuaries as spawning or breeding grounds.

Box 2: A social license to operate in oyster aquaculture?

Across the workshops, oyster growers expressed the need to improve the perception of the oyster industry through better marketing and community engagement. In a nutshell, the argument here is that, in order to prosper and adapt to new situations, oyster aquaculture needs to be recognised widely as an appropriate use of public waterways, having both community and government support. This support relies on development and maintenance good relationships with the broader community.

The oyster industry generates profit, in part, from the maintenance of good water quality in estuaries and bays. Yet the degree to which the general public understand the work done by the oyster industry to ensure this water quality (and other public goods) is maintained is probably limited.

The public standing of the oyster industry is only one aspect of a social licence to operate; another form of a social license to operate comes via prioritisation of the oyster aquaculture as a social and economic outcome. In NSW the Oyster Industry Sustainable Aquaculture Strategy (OISAS) (NSW Department of Primary Industries, 2006) provides a policy basis for a legitimate social license to operate by highlighting whole-of government responsibility to ensure oyster farming is treated as a 'priority outcome' in specific areas. OISAS sets out the roles and responsibilities of different agencies to ensure this 'outcome'; including how oyster aquaculture is considered in the planning process for upstream development, as well as practice guidelines and obligations for the industry and individual growers.

1.5 What constrains and enables adaptive capacity in the oyster industry?

Across the workshops, similar priorities and concerns were apparent among participating oyster growers. Indicators of adaptive capacity were also similar across the five capitals (Table 1.2). The most pervasive issues were also often rated as most substantially constraining adaptive capacity. Issues related to human and social capital included limitations in: proactive engagement within some parts of the industry culture (human capital), issues related to attracting, maintaining and developing skilled and unskilled staff (human-social), relationships between industry/growers and government agencies (social), efficiency and co-ordination in public sector management (social), issues constraining whole of catchment management (social – natural).

Physical capital issues were generally less concerning. Natural capital indicators generally related to water quality and ability to access suitable water and land resources. Key financial issues related to profitability and ability to borrow against lease entitlements. These issues are detailed in a series of tables in Section 5 of this report.

Table 1.2: Aggregated indicators of adaptive capacity across the workshops. The '+' in a given column indicates that this indicator was selected as an issue for this workshop. The colour indicates whether the indicator, on average, was considered to be constraining (dark blue), neutral (blue) or enabling (green) adaptive capacity. Relatively low attendance of oyster growers in SA workshops meant that the indicators were not rated on this scale. For more detail see the workshop reports in Section 5.4.

	Synthesised indicators	Batemans Bay (n=21)	Forster (n=10)	Port Lincoln / Streaky Bay* (n= 11)	Campbell Town (n= 11)
Human capital	Culture of apathy or conservatism among growers	+	+	+	
	Availability of unskilled labour			+	
	Availability of skilled labour	+		+	+
	Capacity for training staff		+		+
	Support for leadership	+			
	Ability to develop business (succession and expansion)			+	+
	Local knowledge and experience		+		+
	Time constraints on growers	+	+		
Social capital	Industry organisation, representation and communication	+		+	+
	Relationship with other industry bodies			+	
	Communication among growers		+		
	Industry-community interactions and relations	+	+	+	
	Information collection and collation				+
	Government - Industry relationships	+	+	+	+
	Co-ordination of management		+		+
	grower engagement with governance	+			
	Efficiency of state and local government processes				+
Natural capital	Access to productive water	+		+	+
	Inundation of landbases	+			
	Productivity of water	+	+	+	+
	Estuarine health	+	+		+
	Water safety (biotoxins and contaminants)		+		
	Heatwave frequency		+		
Physical capital	Stock genetics and breeding	+		+	
	Availability of stock	+			+
	Ability to relocate stock		+		
	Suitability of lease infrastructure		+	+	+
	Suitability of handling systems			+	
	Access to suitable landbases and foreshore	+		+	+
	Ability to change product or diversify		+		
Financial capital	Profitability of enterprises and industry	+	+	+	
	Ability to borrow against lease entitlements	+	+	+	+
	Fairness in rewards across supply chain	+			
	High overheads and infrastructure costs		+		+
	Location costs (foreshore land and living expenses)			+	+
	Cost of cost recovery programs			+	+
	Compliance costs, fees and charges			+	
	Costs associated with harvest closure				+

1.6
Recommendations: decreasing sensitivity, building adaptive capacity

The approach applied in this report generated and informed discussion about how to manage for potential climate impacts. It also focussed on steps that are necessary to make the sector more adaptive and responsive to change. In the face of uncertainty about long term climate impacts and the likelihood that many of the most substantial impacts will be related to extreme events and their aftermath, strategies that build adaptive capacity and resilience are likely to be of most general benefit. Recent localised collapse of oyster aquaculture following QX disease outbreaks indicates that the sector, especially in NSW, is not immune to dramatic changes in system function. Discussions around collective actions indicate pervasive interest and enthusiasm among participants to enter into partnerships at different scales to increase their knowledge about the biophysical systems on which they depend through monitoring and analysis of data.

Many measures for adaptation will require collaboration across traditional boundaries between industry and government. We argue that the oyster industry is uniquely positioned to take advantage of many of the imperatives of adapting to climate change, and it has substantial opportunities to partner with diverse local and regional groups to ensure that estuarine health is maintained in the face of potential changes to the ecological function of these systems. A great deal of adaptive capacity can be generated through such linkages in ways that are often difficult to predict, yet these partnerships will require commitment and rigorous institutional design to ensure they are effective and durable in the medium and longer term.

In summary, the key cross-jurisdictional recommendations are:

- **Investigation and development of a program of coastal and estuarine monitoring in which oyster growers, regional universities and regional NRM authorities are partners;**
- **Ongoing improvement and, where possible, streamlining of processes for regulatory compliance and assessment of development;**
- **Continued efforts between growers, industry, banks and state government to ensure that growers are more able to borrow against lease entitlements;**
- **Continued development of knowledge-action networks that include growers, industry bodies, scientists, regional NRM agencies, and representatives of state and local government. These networks are vital to the sustainability, adaptive capacity and growth of the industry both within and between states. They rely on clear lines of communication and ongoing relationships between individuals and organisations in which mutual respect engenders trust; and**
- **Development of industry-government relations through provision of clear and concise information that allows reciprocal understanding of the process of oyster farming and needs of growers, on the one hand, and of government regulatory and approvals processes on the other. Training and induction programs for government and industry managers could be a fruitful means of ensuring clear lines of communication and for managing expectation across boundaries.**

Recommendations that apply to specific regions, state, and across jurisdictions are detailed at the end of this report in Section 7.

Box 3: Managing oyster kills and disease in a changing climate: Genetics, Management and Environment

Large scale oyster kills have had substantial impacts on individual growers and the oyster industry as a whole. Increasingly, oyster diseases are seen as resulting from complex relationships between susceptibility of oysters, the disease pathogen(s) and the environmental conditions. Thus managing for disease outbreaks is a key aspect of climate adaptation.

Ways of avoiding disease outbreaks are generally limited by our knowledge of all three aspects of disease. But there is now widespread recognition that a single fix or a silver bullet will not address such complexity. Super oysters are not in the pipeline, and water quality will always vary.

Oyster growers, industry bodies, governments (commonwealth, state, local and regional NRM groups) and scientists all have a part to play in addressing the various elements of disease. Genetics of oysters can be advanced through scientific breading programs. Management practices can be improved through knowledge-sharing within the industry and with researchers and through innovation. Environmental conditions can be improved through such endeavours as whole of catchment management, underpinned by ongoing improvement in monitoring and analyses.

1.7
Do you want to find out more?

The full report can be downloaded from the website of the adaptation Network for Marine Biodiversity and Resources:
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1.8
Abbreviated table of contents





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